
II.—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.: 1880.)

THE author desires this volume to be regarded not only as a popular supplement to his *Geographical Distribution of Animals*, but as a work complete in itself. He considers that the treatment of the subject has been placed on a sounder basis owing to the establishment of a number of preliminary doctrines, of which the most important are those "which establish and define (1) the former wide extension of all groups now discontinuous, as being the necessary result of Evolution; (2) the permanence of the great features

of the distribution of land and water on the earth's surface; and (3) the nature and frequency of climatal changes throughout geological time."

Thus it will be perceived that this work, though dealing in the main with biological questions, enters to a considerable extent into physical ones, and has therefore a double claim to the notice of geologists, who will be anxious to know whether the author succeeds in establishing the three preliminary doctrines detailed above, and how far they assist him in clearing up the many anomalies of Island Life.

The first part of the book is occupied with the phenomena, laws, and causes of the *dispersal of organisms*, wherein the author discusses the general features presented by animal distribution, as well as the changes which have been the most important agents in bringing about the present condition of the organic world. In the second part he proceeds to apply the principles previously enunciated in the elucidation of the phenomena appertaining to *Insular Faunas and Floras.*

Part I.—The first five chapters deal mainly with the zoological aspects of distribution. Amongst the elementary facts some remarkable instances of discontinuity even on continents are detailed, and it is observed that such "numerous examples of discontinuous genera and families form an important section of the facts of animal dispersal which any true theory must account for." We may feel sure that the question of Evolution as the key to Distribution is ably stated by a naturalist who shares with Darwin the honour of having established the most important principles as to the origin and development of species and genera. The tendency to change, always more or less inherent, though stimulated and taken advantage of by circumstances, in combination with the powers of dispersal of organisms under different conditions, may serve to explain much of the existing distribution of plants and animals. In concluding this part of the subject, the author observes that the theory of Evolution necessitates the former existence of a whole series of extinct genera to fill up the gap between the isolated genera which in many cases now alone exist, while it is almost an axiom of natural selection, that such numerous forms of one type could only have been developed in a wide area and under varied conditions implying a great lapse of time.

Thus far, Mr. Wallace has been on his own ground, and there are few palæontologists at this time of day who are not more or less convinced of the truth of the first of his three great principles or doctrines. But when, in dealing with geographical and geological changes, he arrives at the consideration of the second principle, viz. the permanence of continents, there is by no means that unanimity amongst the authorities which the statement in the preface might lead the public to suppose. Geologists, especially in England, cling to the views of the great fathers of their science, and thus the opinions of Lyell and others as to a complete change of land and sea having taken place over and over again are, as he

admits in Chapter VI., very generally held. Nor are these views confined to such speculations as those of a late President of the Geological Society of Liverpool. They are still held, to a certain extent, by no less an authority than Professor Huxley, who writes (*Nature*, Nov. 4, 1880): "There is nothing, so far as I am aware, in the biological or geological evidence at present accessible, to render untenable the hypothesis that an area of the mid-Atlantic or Pacific sea-bed as big as Europe should have been upheaved as high as Mont Blanc, and have subsided again, any time since the Palæozoic epoch, if there were any grounds for entertaining it." Thus the believers in the possibility of an Atlantis, notwithstanding the severity of our author's remarks (p. 398), may take comfort in the fact that Prof. Huxley deems such a thing possible, though he does not say that the event ever took place. The business of geologists is not so much to speculate on possibilities as to weigh the available evidence, and nothing can be clearer than the fact that the Jurassic, Lower Cretaceous, and Tertiary deposits, in our own country at least, are more or less of a shallow water or marginal character; but when Prof. Huxley, some three-and-twenty years ago, spoke of Atlantic mud as "modern chalk," the converse of this proposition was immediately taken for granted, viz. that the chalk must have been an abyssal deposit. Thus this latter supposition strongly favoured the then prevailing doctrine of the secular interchangeability of the great land and water areas. To combat this notion the author devotes several pages, and he certainly has the authority of Sir Wyville Thompson in support of his introductory statement, "That few of the rocks known to geologists correspond exactly to the deposits now forming at the bottom of our great oceans."

Still, the origin of chalk is a great puzzle, and some of Mr. Wallace's statements are likely to lead to much discussion. Sometimes, indeed, he seems to advance arguments against his own hypotheses, as, for instance, when he claims for his great central sea the depth of a few thousand feet, and immediately quotes S. P. Woodward to the effect that Ammonites, etc., were limited to depths not exceeding 180 feet. We are far from saying, however, that even these statements are essentially irreconcilable. There are large vertical regions of the chalk singularly free from Cephalopoda, and though, perhaps, not much of the sea in which chalk was deposited ever attained a depth of a few thousand feet, yet a depth of several hundreds—say even a thousand—might be sufficient to prevent the accumulation of any notable quantity of Ammonite remains.

The composition of chalk is also an enigma, for Foraminifera form only a small part of it. On the strength of the Faxoe beds in Denmark being highly coralline, he observes, "We have a clear indication of the source whence the white calcareous mud was derived which forms the basis of chalk." This is a bold assumption. In the first place, there are no regular reef-builders at Faxoe, the principal species being a *Caryophyllia*. Secondly, Lyell (Tr. Geol. Soc. vol. v. p. 248) expressly says, "There are patches of coral cemented together by white chalk, but with these exceptions no

portion of our Oolitic rocks can less resemble ordinary chalk than the stone of Faxoe." We may add that the undoubted coral muds which have gone to form many of our Jurassic limestones yield a very different kind of rock to any variety of chalk known to us. Yet it must be admitted that Sorby, in his first address to the Geological Society in 1879, says, "that very many of the minute granules (of chalk) are identical in appearance with those derived from aragonite shells and corals," and he further observes that, though the more or less entire shells of Foraminifera form an important constituent, "yet that other larger calcareous organisms have probably yielded the greater part of the rock." When we quit the basin of the North Sea for that of the S.W. of France, the evidence for coral life is stronger, and the abundance of *Hippurites*, a relative of the reef-dwelling *Chama*, also points in this direction.

Whatever has been the origin of the composition of the peculiar rock known as chalk, the fairest inference seems to be that the conditions which produced it, in this country at least, were pelagic, though by no means oceanic, and hence its existence gives no colour to the notion of a great interchange of continent and ocean. Sir Wyville Thompson is quite in accord with the author on this point when he says (*Nature*, Nov. 1880), "The Chalk of the Cretaceous period was not laid down in what we now consider deep water, and its fauna, consisting mainly of shallow water forms, merely touches the upper limit of the abyssal fauna." Prof. Geikie (quoted at p. 94) is practically of the same opinion, when he says that during the Cretaceous period "the Atlantic sent its waters across the whole of Europe and into Asia, but they were probably nowhere more than a few hundred feet deep." Unfortunately, in thus ignoring the existence at this period of the Scandinavian and other highlands of Old Europe, Prof. Geikie gives colour, perhaps unintentionally, to the notion that the leading features of continents are less permanent than the theory adopted by the author would lead us to suppose.

This doctrine, viz. the permanence of continents and oceans, he considers lies at the root of all our inquiries into the past changes of the earth and its inhabitants, and it receives strong confirmation from the evidence adduced by Darwin, who has observed that hardly one truly oceanic island has been known to afford a trace of any Palæozoic or Mesozoic formation, so that they have not preserved any fragment of the supposed ancient continents, nor of the deposits which must have resulted from their denudation.[1]

Thirdly, the author discusses the changes of climate which have influenced the dispersal of organisms, and this leads him to the subject of glacial epochs and their causes, to which he devotes three chapters. Those readers who are anxious to arrive at the gist of the work, viz. the phenomena of insular life, will perhaps regret that so much space has been devoted to this class of speculation, and some might even think that with a concise summary of conclusions in the text, the rest of the matter might have been relegated to an appendix, or reserved for a separate work. But these subjects are

[1] See ante, p. 75, "Oceanic Islands," by T. M. Reade, F.G.S.

undoubtedly popular—they appeal so powerfully to the imagination,—and may in a certain sense enhance the value of the volume. The last chapter of Part I. discusses the earth's age, and the rate of development of animals and plants.

Part II.—When the difficulties presented by the peculiarities of island life are mastered, Mr. Wallace is of opinion that we shall find it comparatively easy to deal with the less clearly defined problems of continental distribution. Hence the importance of the subject. Islands have had two distinct modes of origin, and the difference is fundamental. They are *oceanic* or *continental*. Darwin has shown that with very few exceptions all the remoter islands of the great ocean are of volcanic or of coralline formation, and that none of them contained indigenous mammalia or amphibia. Continental islands are more varied in their geological formation, and may be divided into two groups—ancient and recent. Islands of an anomalous character constitute a fourth section.

Amongst the *Oceanic Islands* are the Azores, Bermuda, the Galapagos, St. Helena, and the Sandwich Islands. Amongst the *recent continental islands* are the British Islands, Borneo and Java, and Japan and Formosa. Madagascar is an example of the type of *ancient continental islands*, whilst Celebes and New Zealand figure in the exhaustive division.

It would clearly be impossible within the limits of a review to give even a sketch of all these chapters, each of which is a little treatise of itself, full of the best information in that branch of natural history which is connected with the geographical distribution of animals and plants. A sample of the mode of treatment of each of the three principal sections must suffice.

1. *Oceanic Islands.*—The Azores, which bear the same relation to Europe that the Bermudas do to America, lie in the course of the south-westerly return trades, and also of the Gulf-stream. They are 900 miles from the coast of Portugal, with a maximum depth of 2,500 fathoms intervening, and are destitute of all terrestrial indigenous vertebrata. To the oceanic type they present a single exception, in that one of the islands contains a small deposit of Miocene age. Thus the group may be of considerable antiquity, but the fauna, "at all events as regards the birds, had its origin since the date of the last glacial epoch." The small amount of differentiation which time has effected in the birds—a bullfinch being the only speciality—is one of the principal reasons for this belief in the recent origin of the fauna, but the explanation to which Mr. Wallace points is scarcely satisfactory. The glacial theory is a dangerous weapon even in the hands of the most experienced geologists, and draws quite as largely upon the unscientific imagination as Atlantis or Lemuria—those especial bugbears of the author. When, therefore, he would have us infer that all land birds were destroyed by the severity of glaciation in a group of islands situated as these are, and at the sea-level, we should at least expect him to indicate some undoubted evidences of ice action in the islands themselves, before consenting to entertain such a proposition.

Why not try submersion? He believes that a submersion to the extent of nearly 2,000 feet destroyed much of the life of the British Isles during the latter part of the Glacial epoch. And if a steady-going continental island like Britain, with a pedigree of rocks equal to any in the world, should have thus suffered, why not a volcanic accumulation in mid-ocean, presumably unstable by reason of its composition? It is true that Pico is 7,000 feet above the sea, though this is very exceptional.

But the submersion of an oceanic island is inconvenient, as this might favour the notion of Atlantis. The zoological reasoning is, as usual, admirable throughout the chapter.

2. *Recent continental islands.*—"Great Britain is perhaps the most typical example of a large and recent continental island now to be found on the globe." All geologists are aware that the British Islands rest upon the 100-fathom platform, which extends in a sweep from the coast of Jutland round by Shetland and Ireland to the south-west of France, and that a rise of less than half this depth would join England to the continent. Mr. Wallace goes into the question of the direct evidence that exists of this recent union, especially quoting the cases of the well-known submerged forests in Cornwall, Devon and the Bristol Channel. Certainly the forest-bed of Cromer, in Norfolk, also mentioned by him in this connexion (p. 317), belongs to quite a different category, as this is a pre-glacial forest bed, almost Pliocene in its character, and can afford very little proof of our latest union with the continent, which "geologists are all agreed was subsequent to the greatest development of the ice, but probably before the cold epoch had wholly passed away." The buried river channels in Scotland, far below the present sea-level, and the discovery of fresh-water and littoral shells at considerable depths off our coasts, are additional proofs of former elevation. On the other hand, the well-known phenomena of Moel Tryfaen, and elsewhere, are indications of a submergence which is, the author states, in no small degree, the cause why our islands are so poor in species, since sufficient time had not elapsed for immigration to have been completed "before the influx of purely terrestrial animals was again cut off." This would seem to imply also that the communication might not have been very wide.

Amongst the higher animals no more than three species—all birds—can be said to be peculiar, and, whilst Germany has ninety species of land mammalia, Great Britain has forty, and Ireland twenty-two. Possibly the respective areas of the three countries may have something to do with this, but the same cannot be said of the more slowly moving reptiles and amphibia, since Belgium has twenty-two species and Ireland only four. We are much better off in freshwater fishes, there being no less than fifteen peculiar, of which ten are species of trout and charr restricted to certain lakes in the British Isles. These local modifications are due to restricted intercourse, and the result is the same as with the life of Oceanic islands. The remainder of this chapter (xvi.) deals with the insects, land and fresh water shells and flora, and is full of highly interesting matter.

3. *Ancient continental islands.*—The extraordinary complexity of the organic relations of Madagascar, says Mr. Wallace, is due, partly to its having received its animal forms from two distinct sources, but mainly to its having been separated from a continent now zoologically in a different condition. The facts and reasonings of this important chapter, though in the main zoological, have a distinct geological bearing. Madagascar has not the characteristic animals of either Africa or Asia. Half the existing species consist of Lemurs. In fact, the island is a sort of Zoological Garden of high antiquity, free from the ravages of the large Carnivora, where decaying groups of creatures, which have elsewhere perished or become scarce, maintain a comparatively secluded existence.

Why is this so? When Madagascar was united to Africa, from which it is at present separated by waters of considerable depth, the adjacent continent was then entirely severed from Arctogæa by the nummulitic sea, and constituted a sort of Australia, poor in the higher forms of life. The upheaval of this sea-bed in Miocene times admitted the higher types of mammalia, which were developed in the great Euro-Asiatic continent, to the mainland of Africa, but Madagascar had then become an island, and the great beasts were thus excluded from it. We know from the rich deposits of fossil mammals in the Miocene beds of Europe and N.W. India that the great African mammals inhabited those regions.

These reasonings tend to explain the absence of certain forms; we must next consider the origin of the existing groups. Doubtless Madagascar, through the mainland of Africa, had an earlier union with Arctogæa, though it is rather a strong assumption that, otherwise, it could never have obtained any mammalia (p. 391). However, the Lemurs, Insectivores, and Civets are known to have inhabited Europe during the Eocene and Miocene periods, and thus a certain geographical link is established between the ends of groups now wide asunder. The dispersal of these groups, superinduced by changes of surface and climate, throughout long ages of geological time, may thus serve to render possible an explanation of such an extreme case as that of the insectivorous *Centetidæ*, now confined to Madagascar and the West Indies.

The question whether the birds of Madagascar require the adoption of the hypothetical Lemuria is scarcely one to be discussed in the Geological Magazine. There are about one hundred and five land birds, all but four or five being peculiar. When we consider that the Azores, more than thrice as far from the mainland, contain but one bird peculiar to them, and bear in mind also that the author regards their whole avifauna as the result of recent immigration, voluntary or involuntary, we can only express surprise at the unenterprising character of the birds of East Africa, who do not care to cross the Mozambique channel, though the Comoro Islands offer a series of convenient halting-places.

The chapters on New Zealand, and on the Arctic element in South Temperate Floras, complete the details of Island Life—a work which is certain to be extensively read, and which is full of instructive

matter. We recognize throughout the vigorous original touches of the accomplished biologist, and if, in his treatment of some of the problems of speculative geology, the results seem not quite so satisfactory, the faults, if there be any, are perhaps less with the author than in the nature of the subject.

The volume is well got up, and usefully illustrated with maps throughout. W. H. H.