

## WALLACE'S ISLAND LIFE.\*

IN his recently published *Island Life* Mr. Wallace has given us a valuable supplement to his *Geographical Distribution of Animals*. Four years' additional thought and research upon the lines laid down in that suggestive work have brought to a completion the general scheme of inquiry which he from the first proposed to himself, and he now propounds, as a clear and definite theory, the results of investigations which might at first sight appear fragmentary and disconnected. Mr. Wallace has entitled himself to be called the father of the new science of zoological geography, showing that we have in the present distribution of living things over the earth's surface a key to the problem of the most ancient relations of land and water. The aggregation of existing faunas and floras in definite assemblages within certain areas is proved to be the direct result of a complex set of causes which may be grouped or classified as partly physical, partly biological. Starting from the general law of evolution, and regarding all the main types of animals and plants as having diverged from certain common centres, the author proceeds to trace the changes and modifications which they exhibit to the operation of the same causes through long ranges of time, and he points to these changes as in themselves an index to the primary laws which make up the constitution of nature. There may be laid down upon the globe, he remarks, certain well-defined zoological regions or provinces which indicate far more truly than the old geographical divisions the range and the history of animal existence upon the earth. The main divisions of land and water which constitute the great continental masses have undergone no essential change. The continents and oceans as they now exist have had throughout all geological time much the same general outline. There have been local changes here and there; elevations and depressions have taken place, altering coast lines, isolating portions of land, and drying up areas of water; but the general contour of the continents has remained the same. Great changes of climate have occurred in various regions, not due to any shifting of the earth's axis, or to extra-telluric influences of any kind, but, as Sir O. Lyell and all sober geologists have maintained, to local derangements of the surface, especially to changes in the distribution of land and water about the Polar regions. These altered conditions have largely influenced the dispersal of living organisms, and to them are to be traced the divisions or varieties of distribution exhibited by the animals and plants of our day. The first part of Mr. Wallace's book is occupied with this world-wide dispersal of organisms, its phenomena, laws, and causes. Of these agencies the most important have doubtless been such changes of climate as marked the extension of the ice-cap far beyond the present boundaries of the Arctic regions, and the contrary phenomenon of a milder range of temperatures prevailing towards the Pole. Our author discusses anew, with the aid of the latest evidence, the causes of glacial epochs, illustrating his arguments by the analogy of the planet Mars as most akin to our globe in relation to the sun. He is able to correct Mr. Oroll's calculations of the effects of high excentricity, showing how far more influential have been geographical changes of the earth's surface. The last glacial epoch was the climax of a great process of continental development which had been going on throughout long geological ages. It was the direct consequence of the North Temperate and Polar land having attained a great extension and a considerable altitude just at a time when a phase of very high excentricity was coming on. Taking this period to coincide with the change from the Miocene to the Pliocene period, Mr. Wallace assigns to it a date of about 200,000 years before our era, the next preceding cycle of high excentricity and consequent ice-age, still falling within the Miocene, going back to 850,000 years. The present condition of the earth, beginning with the Pliocene, he looks upon as one of exceptional stability, and within it have been brought about those changes in the earth's flora and fauna which it is the object of the present work to bring under review. Enormous ranges of time, as well as vast and stupendous cataclysms or terrestrial convulsions, may be banished from the consideration of science.

With the physical proofs of the general permanence of continents and oceans Mr. Wallace combines the interesting evidence supplied by the distribution of living forms. He is able to map out six primary zoological provinces or divisions of the earth, which correspond in the main with the received continental boundaries, though exhibiting modifications in detail owing to

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local geographical changes. The animal forms of Southern Africa, for instance, differ so widely from those of the Northern extremity of the continent, whilst those of the North approximate to those of Southern Europe, as to make it probable that a wide area of sea held at no distant geological period the place of the Sahara; Southern Africa thus forming a great separate island or geological province, with a flora and fauna of its own. Six such zoological divisions are to be traced out, Mr. Wallace considers, by comparative study of the living forms inhabiting them. 1. The Palæarctic, equivalent to Europe, with North Temperate Africa and Asia. 2. The Ethiopian, comprising Africa south of the Sahara, with Madagascar. 3. The Oriental—i.e. tropical Asia to the Philippines and Java. 4. The Australian, including the Pacific Islands, Moluccas, &c., New Zealand remaining doubtful. 5. The Nearctic, North America to Northern Mexico; and 6. The Neotropical, i.e. South America, with tropical North America and the West Indies. A map on Mercator's projection makes clear at a glance these zoological divisions, with their relation to the ordinary geographical regions. There are of course overlapping areas in which the flora and fauna have a partial community of character, and others which are discontinuous or isolated, wide gaps separating them from those of the neighbouring region. Of the higher animals, as the author shows, there are not many that have a world-wide distribution. Among the mammalia there is no such thing as a truly cosmopolitan genus. All the higher orders, for instance, except the mice, are absent from Australia, while the genus *Mus*, which occurs there, is represented by a distinct group, *Hesperomys*, in America. If the dingo of Australia be taken as a native animal, the genus *Canis* might be classed as cosmopolitan, but that the wild dogs of South America form, with some naturalists, a genus apart. Many genera, however, range over three or more continents, as *Felis* (the cat genus), absent only from Australia; *Ursus* (the bear genus), absent from Australia and tropical Africa; *Cervus* (the deer genus), with nearly the same range; and *Sciurus* (the squirrel genus), found in all the continents save Australia. The superior locomotive power of birds gives them scope for a wider range. Still there are among perching birds only *Turdus*, the thrush, and *Hirundo*, the swallow, which are truly cosmopolitan, though there are many genera of hawks, owls, wading and swimming birds, which have a world-wide range. Of isolated orders, the insectivora among the mammalia offer the most conspicuous example, several of their families inhabiting areas more or less apart from the rest, while the Marsupialia have six families in Australia, and one, the opossums, far off in America. Still more marked is the limitation of some entire orders to certain well-defined regions. Thus the Proboscidea, comprising the single family and genus of the elephants, and the Hyracoidea, that of the Hyrax or Syrian coney, are confined to parts of Africa and Asia; the marsupials to Australia and America; and the Monotremata, the lowest of all mammals, comprising the duck-billed Platypus and the spiny Echidna, to Australia. The Struthionæ, or ostrich tribe of birds, are well-nigh limited to the three Southern continents—South America, Africa, and Australia; and among Amphibia, the tailed Batrachia—the newts and salamanders—are in like manner restricted to the Northern hemisphere.

From a wide range of observations of this kind Mr. Wallace works out the great lessons of his book. It is especially from the study of the oceanic and continental islands, treated in the second portion of the work, that the great problem of the distribution of life is made in his hands to receive its solution. For this study islands possess, as he points out, special advantages, since they have a restricted area and definite boundaries, and their geographical and geological limits as a rule coincide. The number of genera and species they contain is always much smaller than those of continents, and their peculiar species and groups are in general well defined and strictly limited in range. Islands have had two distinct modes of origin. They have either been broken off by some cause or other from continents, or have risen from the ocean by volcanic upheaval or coralline formation. The latter class are wholly without indigenous mammalia or amphibia, though abounding in birds and insects, with occasional reptiles. It has been very generally maintained that the Azores once formed part of the submerged continent Atlantis. But, were this so, the plants and animals of those islands would assuredly follow the type of those existing on the mainland of which they formed a part. Such, however, is by no means the case. There is no mammalian or amphibian form, and no lizard, snake-lizard, frog, or fresh-water fish. Flying creatures, birds, and insects abound; and there is also one flying mammal, a small European bat. Rabbits, weasels, rats and mice are believed to have been imported. Birds and insects have been borne thither either by their own wings or those of the wind. Land shells may have been easily transported by birds or floating wood, or their tiny eggs wafted over the sea by storms. Of the 69 known species, 37 are common to Europe, 32 being peculiar. Though allied to European types, many of them date back to beyond the Glacial epoch. The evidence brought together by Mr. Wallace, coupled with Mr. Darwin's interesting experiments, amply verifies the presumption that the seeds of plants of continental type here found may have been ferried over by ocean currents and winds. Now these islands are wholly of volcanic origin, with the exception of a single small one, Santa Maria, which exhibits some marine deposits of Upper Miocene age—a fact indicating some change of level, or wider extension of the land in earlier times, but not any connexion with the mainland, or former union with the rest of the group. It proves, moreover, the antiquity of the islands, and is of

great weight in considering the origin and peculiar features of their fauna and flora. The other North Atlantic islands—Madeira, the Canaries, and the Cape de Verdes—present analogous phenomena, modified by their more southern position, their richer vegetation, and perhaps their greater antiquity. The Bermudas, a coralline group, stand in much the same relation to the American Continent as the Azores do to Europe. Here are no indigenous mammals, frogs, or snakes. Migratory birds flock hither in vast numbers, upwards of 180 species having been recorded. The Galapagos Islands, volcanic like the Azores, and equally destitute of indigenous mammalia and amphibia, differ from that group in many important respects. They lie not more than 600 miles from the west coast of South America, and some 700 from Veragua, within the belt of equinoctial calms. They are traversed, however, by strong and constant ocean currents, setting north-westwards from the coast of Peru. Without any indigenous mammals, they have a very peculiar series of birds and insects, including two species of large land tortoises which are wonderful swimmers and quite competent to have made their way from the mainland of South America. Two species of snakes may equally have made the passage by swimming, or by the aid of drift-wood. The Sandwich Islands, separated from the great continents by more than two thousand miles, and by ocean depths of three thousand fathoms, are connected in a measure with the other Pacific Islands by countless coral reefs and atolls. Volcanic mountains rise to a height of 14,000 feet. Indigenous mammals are here altogether unknown. The birds, which are fairly numerous and highly peculiar, exhibit on the whole affinities with Australian and Pacific types. Their marked speciality is suggestive of extreme antiquity, or of connexion with some very ancient land now submerged.

Coming to the British Isles, Mr. Wallace dwells upon the features which characterize continental as distinct from oceanic islands. To the same class belong Japan, Formosa, and the larger Malay Islands, especially Borneo, Java, and Celebes. As they are one of the most recently formed island groups, we have still amongst us, he shows, the material for highly instructive study of geographical distribution. The biological identity of Great Britain with continental Europe is by no means so distinct as is commonly supposed. Among birds, our author points to at least three undoubted peculiarities. Peculiar fishes are five times as numerous. Of mosses and Hepaticæ there are peculiar British forms. Many insects common with us have never been found on the Continent. The Shetland Islands, on the other hand, the Isle of Man, and the little Lundy Island, possess forms unknown to our principal island. Islands, the author remarks, form in all parts of the world a refuge for species or groups which have become extinct elsewhere. On the whole, however, the fauna and flora of Great Britain follow closely the Continental type, the special points of divergence supplying a fair approximate test of the interval of time that has elapsed since their separation. In Borneo and Java, which may be, Mr. Wallace thinks, not much more ancient than Great Britain, there is a considerable amount of speciality. The channel which parts these two islands is not more than fifty fathoms deep; while to the east they are separated from Celebes by a strait varying from 1,690 to 2,500 fathoms in depth. In geological structure Borneo is thoroughly continental, a character entirely in accordance with its fauna and flora. Of the ninety-six species of mammals discovered in the island, nearly two-thirds are identical with those of the surrounding countries, and nearly one-half with those of the mainland. Java, with many peculiarities, presents unmistakable relations with the Asiatic continent. A comprehensive survey of the whole Malayan group leads our author to the conclusion that the Philippines were the first to separate, then at a considerably later period Java, somewhat later Sumatra and Borneo, and finally the islands south of Singapore to Banca and Biliton.

The Japanese islands hold a position on the eastern shore of the great Euro-Asiatic continent very like that of the British Isles on the western; but their separation dates probably much further back, probably to the early portion of the Pliocene period. The fauna and flora of Japan and Formosa correspond in their diversity with the comparative antiquity hereby indicated. The richness which won for the latter island from its Portuguese discoverers the name of "the beautiful" gives abundant scope for the study of naturalists, of whom Mr. Swinhoe has made himself the chief. Above most continental islands it is shown by Mr. Wallace to throw light upon the obscure subject of the decay and extinction of species, whilst yielding an overwhelming mass of evidence in favour of the theory of descent with modification. In Madagascar we see a continental island of much more ancient date, and showing animal and vegetable types far more dissimilar from those of the mainland. Of mammals the most important are the lemurs, forming an entire half of the mammalian population of the island. This group of lowly-organized and very ancient creatures ranges from Western Africa to India, Ceylon, and the Malay Archipelago. Mr. Wallace, however, is justified by his latest researches in his rejection of the popular hypothesis of a submerged Lemuria, in which are held to lie buried the bones that should have made good the missing link between ourselves and our supposed anthropoid ancestors. The Atlantis having received its deathblow from the chapter on oceanic islands in the *Origin of Species*, it may be thought that the lost continent of the Southern hemisphere may henceforth be relegated to the region of scientific fable.

In the great island of Australia the primitive forms of animal

life correspond strikingly with the immense antiquity of its separation from the continental masses of the southern half of the globe. Nor in the case of New Zealand is there a less strongly marked correspondence between the zoological character of its fauna and the physical features of that isolated group. Mr. Wallace's survey of the widely separated island systems of the globe sets upon a solid basis his views of the wonderful powers of dispersion and modification existing in the organic world. In his theory of local geographical changes modifying the general stability of continents, we have perhaps a key to the most difficult and complex problems involved in the phenomena of the variation and distribution of living forms.

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