

III.

The Origin and Classification of Islands.

EVERY island has its history, and in the case of all but newly-formed volcanic islands or coral islets, every island has a double history, that of the island itself and that of its colonisation by the plants and animals which live upon it. The rocks of which an island consists will give us an insight into, though not always a complete knowledge of, its geological history; and a study of its living inhabitants will generally enable us to decide whether it has been colonised as an island or by direct former connection with a continent. Some biologists maintain that the fauna of an island will show whether it has ever been united to a continent or not, and this is the question which I propose to discuss in the present paper, because the answer to it involves some important inferences and conclusions.

There are many ways in which an island can be formed; it may be but a portion of a continent severed from the mainland by the erosive action of the sea; it may be the mountainous part of a country which has sunk beneath the ocean; it may have been thrown up from the floor of the ocean by volcanic action, or it may have been built up by the growth of reef-making corals. There are, however, only two ways in which an island can have been populated without the intervention of man; either it must once have been united to a continent and its inhabitants must be the descendants of those that then lived on that continent, or else its tenants must have been transported across the sea by the help of drift-wood, or by birds, or by winds and storms.

It is evident, therefore, that *in most cases* there is likely to be a certain relation between the geological structure of an island and the nature of its fauna and flora. Islands formed in the ocean, whether by direct upheaval, or by volcanic eruptions, or by coral growths, are not likely to possess a large assemblage of plants or of animals; they may be covered with vegetation, but the animals found on them must be the descendants of occasional waifs and strays. On the other hand, an island which has once been part of a continent will, if it remain large enough, continue to support a large number of animals, and these will generally include a certain number of Mammalia and Amphibia.

Islands have consequently been divided into two great classes—

oceanic and continental—which are defined by Dr. A. R. Wallace in the following terms:—

Oceanic islands are “of volcanic or coralline origin, usually far from continents, and always separated from them by very deep sea, entirely without indigenous land mammalia or amphibia, but with a fair number of birds and insects, and usually with some reptiles.”

“Continental islands are always more varied in their geological formation, containing both ancient and recent stratified rocks. They are rarely very remote from a continent, and they always contain some land mammals and amphibia, as well as representatives of the other classes and orders in considerable variety.”¹

As general definitions framed for the purpose of describing the conditions which have governed and limited the geographical distribution of animals, these sentences are doubtless sufficiently accurate, especially as Dr. Wallace admits there are some islands which do not come very clearly under either of these categories; but he proceeds to lay down a *canon* the truth of which is by no means so apparent. He says:—“The total absence of warm-blooded terrestrial animals in an island otherwise well suited to maintain them, is held to prove that such island is no mere fragment of any existing or submerged continent, but one that has been actually produced in mid-ocean. It is true that if a continental island were to be completely submerged for a single day, and then again elevated, its higher terrestrial animals would be all destroyed, and if it were situated at a considerable distance from land, it would be reduced to the same zoological condition as an oceanic island; but such a complete submergence and re-elevation appears never to have taken place, for there is no single island on the globe which has the physical and geological features of a continental, combined with the zoological features of an oceanic island.”

Seeing how little we yet know of the geology of distant islands, this is a statement which further knowledge may at any time disprove, and there is, even now, good reason to believe that it is contrary to facts. If this assertion can be proved to be incorrect, I shall claim to reverse Dr. Wallace's argument, and to maintain that inasmuch as an island does exist which combines the geological features of a continental island with the zoological features of an oceanic one, then we may assume that the submergence and re-elevation of a continental island can take place, and, consequently, the absence of mammals in an island *cannot* be held to prove that it has never been united to a continent.

Considering the many subsidences and upheavals which are known to have occurred along the borders of continental areas since the beginning of Tertiary time, it would indeed be strange if some tracts, isolated by subsidence, had not been completely submerged for a time, and afterwards raised afresh from the sea. The West Indian

¹ “Island Life,” by A. R. Wallace, second edition, 1892, p. 243.

region is one where such an occurrence is very likely to have happened, for deep-water deposits of late Tertiary age occur in many of the islands; while the raised coral-reefs which are found in the same islands, and reach up to a height of 1,800 ft. above the sea, prove that there has been recent upheaval to at least that extent.

Many of the smaller islands are volcanic, and may have been thrown up at any time; but Barbados, the most westerly of all the islands, has just the features of which we are in search; in its faunal aspect it is decidedly oceanic, while its geological structure is a curious combination, being partly continental and partly oceanic. The facts of the case are so remarkable that a brief review of them may here be given.

Barbados stands on a submarine bank or ridge which slopes away in every direction till a depth of more than 1,000 fathoms is reached. The core and base of the island consists of stratified rocks, ordinary sandstones, clays, and limestones, such as are formed in shallow water near a coast-line where rivers of some size carry detritus into the sea, and these strata must have been deposited very near such a shore, for many of the sandstones are composed of large quartz grains, which would not be carried far from land. Above these shallow water strata lie deposits of a totally different character, consolidated oceanic oozes, like those which are now found only in the deeper parts of the ocean, and are known as Globigerina Ooze, Radiolarian Ooze, and Red Clay. All these kinds of ooze occur in Barbados, and there is not only a superficial resemblance between them and the modern oceanic oozes, but a complete identity of structure, and a close analogy in chemical composition; upheaval and exposure to rain and weather have, of course, effected some little alteration, but have not obscured their structure.

It is certain, therefore, that the shallow sea and the extensive shore-line which it bordered sank to a very great depth, certainly to more than 1,000 fathoms, and probably to as much as 2,000 fathoms (12,000 feet). The site of Barbados was then part of the ocean-floor, but after a time upheaval took place, and it was gradually raised till it came within the sphere of reef-building corals; a small coral islet was the result, but as the upheaval continued, the earliest reefs were raised above the sea, and the area of the island was gradually enlarged. This process went on till the island attained its present dimensions (about the size of the Isle of Wight), the soft oceanic deposits and the still older sandstones and clays being protected from the erosive action of the waves by a thick coating of coral rock, except over a small area in the north-west part of the island, where the rain has cut deep valleys through the stratified rocks, and by carrying sand and mud into the sea has prevented the growth of continuous coral reefs on that side.

Now, an island with such a history must necessarily have received its present fauna and flora in the same casual way as an

oceanic island that had never formed part of a continental area. Accordingly, though Barbados is exceedingly fertile, and though the island when first discovered was clothed with forest and underwood, its native terrestrial fauna is a very small one.

There are only two mammals in Barbados which have been supposed to be indigenous, a monkey and a racoon-like animal, but I am informed by Col. Fielden that the monkey proves to be the Green Monkey of Western Africa, *Cercopithecus callitrichus*, and the "racoon" is a South American animal (*Procyon cancrivorus*). The monkey was doubtless brought over in slave-ships, and as it is known that the Caribbean Indians frequented the island before it was colonised by Europeans, and as the early settlers had intercourse with the colonists of Guiana, it is quite possible that the *Procyon* was introduced by man.

There are no indigenous Amphibia, but there are two Snakes and four species of Lizards. One of the snakes is a species peculiar to Barbados, the other may have been introduced by human agency from some of the other islands. Of the lizards, three are South American species, and the fourth is found in all the Lesser Antilles, though it is not yet known from South America. The manner in which reptiles may be landed on an island like Barbados is illustrated by the case recorded by Col. H. W. Fielden in the "Zoologist" of 1888, p. 236; this was the landing of an alligator on the shore from a floating tree-trunk, actually witnessed in 1886; it had doubtless been transported from one of the great South American rivers, but it was promptly dispatched by those who witnessed its arrival.

In a paper on the birds of Barbados, Col. Fielden remarks that, so far as he can judge, "the mammals, reptiles, and land molluscs owe their introduction either to ocean-currents, accidental occurrences, or to the direct agency of man, and a review of its avifauna does not point to a different conclusion." He also speaks of Barbados as a "truly oceanic island in the sense of its never having formed part of a continent since the introduction of its present meagre fauna," nor "since it emerged as a coral-reef from the ocean." This is perfectly true, but yet it does not come under Wallace's definition of an oceanic island for the reason already stated.

The difficulty of drawing hard and fast lines between oceanic and continental islands is also illustrated by the structure and fauna of the Seychelles Archipelago, in the Indian Ocean. These islands are surrounded by water of more than 1,000 fathoms, and are 850 miles distant from the coast of Africa. They might, therefore, be expected to exhibit all the features of oceanic islands; the facts, however, are as follow: The larger islands consist entirely of granite, and granite is a deep-seated rock which can only be exposed by the prolonged and repeated processes of erosion which take place on large areas of land. Dr. Wallace admits them to be remnants of

"a very extensive island," though he doubts whether this island ever formed part of a continent.

Turning to their zoology, we find that they are entirely destitute of mammals, but that they possess Amphibia, having two species of frogs and three species of *Cæcilia*, snake-like creatures, which burrow underground in the manner of worms. Now, it seems impossible to explain the presence of these Amphibia unless, at some remote period, the islands formed part of a continent, for salt-water is fatal to them, and destroys even the eggs of frogs. On the other hand, if the former connection with a continent be admitted, what can be said of the absence of mammals, for one would have expected that some of the smaller genera, such as rats, mice, civets, lemurs, and insectivores would have survived. Dr. Wallace suggests that the islands have at some time been so nearly submerged that the portions remaining above water were too small to support the existence of the smallest mammals. If this be the explanation, and if we accept the evidence of the Amphibia as to ancient continental connection, then the absence of mammals in such islands cannot be taken as proof that they have never been part of continental land.

New Caledonia, again, in the Pacific, is regarded by Dr. Wallace as an oceanic island. There are no indigenous Mammalia or Amphibia, the solitary frog being known to have been introduced. There are several peculiar lizards and a snake (one of the Boas); and the island is separated from neighbouring groups by water of more than 1,000 fathoms deep. Notwithstanding this limited vertebrate fauna there is evidence that New Caledonia has once been part of an extensive land area. Stratified rocks, believed to be of Secondary and Tertiary age, enter into its geological structure, and there is a genus of land snails (*Placostylus*) which occurs in the neighbouring archipelagoes, as well as on Lord Howe's Island and in New Zealand. Hence it has been recently argued that the unity and limitation of the *Placostylus* area can only be explained by the supposition that these islands are portions of a broken-up and submerged continent which was distinct from Australia. To reconcile such a supposition with the absence of mammals, it is only necessary to assume that this continent dates back to a time when mammals were not in existence in the Pacific region, just as Australia dates from a time when only marsupial mammals were in existence.

The cases above mentioned show that there is no constant relation between the geological structure of oceanic islands and the manner in which they have received their present inhabitants, for there are islands which are not far from a continent, and have clearly formed part of the continental area within the limits of Tertiary time, and yet are without any indigenous Mammalia or Amphibia. There are other islands which are destitute of Mammalia and are geographically oceanic, but nevertheless, have a geological structure of continental type. In other words, there are islands which testify to the former

existence of continents in what are now oceanic areas; and when all the facts are considered it is seen that they are opposed to the extreme views regarding the permanence of oceans and continents which have been accepted and maintained by Dr. Wallace in his "Island Life."

It would appear, therefore, that if the division into continental and oceanic islands be retained, a fourth class must be admitted into the classification; not only must continental islands be divided into ancient and modern, but oceanic islands must be defined geographically and then divided into those which are the remnants of sunken continents and those which are of recent origin. It will, however, be very difficult to distinguish islands of recent formation from mountain peaks which have been submerged and again elevated above the ocean level, for lofty mountain peaks so often consist of volcanic rocks.

I am convinced that the attempt to exclude islands in which stratified rocks occur from the category of oceanic islands will only lead to confusion and misconception, and that it is a mistake to infer from "the absence of warm-blooded terrestrial animals in an island otherwise suited to maintain them," that the island is of recent formation. The characters of an island fauna may, perhaps, be relied on to show whether the island has been *colonised* by former connection with a continent or not, but beyond this it will be no guide to the geological history of the region. The biological evidence must simply be taken for what it is worth, and the geological history of the island must be read from its geological structure, without the bias given by any preconceived theoretical ideas about the permanence of oceans and continents. There is, in fact, no hard and fast line to be drawn between oceanic and continental islands.

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