3-2010

On the Physical Geography of the Malay Archipelago (1863)

Alfred Russel Wallace

On the Physical Geography of the Malay Archipelago (1863)

By Alfred Russel Wallace

Transcribed and Edited by Charles H. Smith, Ph.D.

This paper, read at the Royal Geographical Society meeting of 8 June 1863 (and published in volume 33 of their Journal series later the same year), was a notable success, and did much to solidify Wallace's reputation as the leading expert on the natural history of the Indonesia region. Discussion following the paper's presentation was recorded, separately, in volume seven (for 1862-63), issue five, of the Society's Proceedings series. Both are reproduced below, with the original paginations indicated within double brackets. See more information on Wallace at The Alfred Russel Wallace Page, at: http://people.wku.edu/charles.smith/index1.htm

[[p. 217]] The Malay or Indian Archipelago is that extensive group of islands which occupies the space between south-eastern Asia and Australia, and divides the Indian from the Pacific Ocean. From whatever point of view we survey this portion of the earth's surface—whether as regards its superficial extent, or the immense number of islands with which it is overspread, or the individual size of those islands; whether we examine their peculiarities of climate, or their geological structure, their rich and varied vegetation, their wonderful animal productions, or the

strongly-contrasted races of mankind that inhabit them; or if, lastly, we look at them from a commercial and political point of view, noting the varied products which they furnish to supply the necessities and luxuries of mankind, trace the struggles of the chief nations of Europe for a share in their fertile soil, and watch the interesting moral and political problems now being worked out there; we shall be convinced that no part of the world can offer a greater number of interesting facts for our contemplation, or furnish us with more extensive and varied materials for speculation in almost every great department of human knowledge.

On the present occasion I propose to give a sketch of what is most interesting in the physical geography of this region, including [[p. 218]] in that term the general relations of the organic world to the present and past conditions of the earth's surface.

1. *Definition of the Archipelago, Position, Extent, and Magnitude of the chief Islands.*—It first becomes necessary to define accurately the limits of the Archipelago, pointing out exactly what islands we include within it; for, though "all the islands between south-eastern Asia and Australia" seems pretty definite, yet to the eastward this region blends insensibly into the vast extent of the Pacific islands. According to my views, the Malay—or, as I should prefer to name it, the Indo-Australian—Archipelago extends from the *Nicobar Islands* on the north-west to *St. Christoval*, one of the Solomon Islands, on the south-east, and from *Luzon* on the north to *Rotti*, near Timor, on the south. The eastern boundary is drawn at this particular point for reasons which will be explained further on. Though not geographically correct to include any part of a continent in an archipelago, it is necessary for our purpose to consider the Malay peninsula as not only almost but quite an island, since it cannot be physically separated from the region of which we are now treating.

Thus limited, the Archipelago is of a somewhat triangular form, with an extreme length of about 5000, and a breadth of rather more than 2000 English miles. The mere statement of these dimensions, however, will give but an imperfect idea of the extent and geographical importance of this region, which, owing to its peculiar position, is worse represented on maps than any other on the globe. In many atlases of great pretension there is no map of the whole Archipelago. A small portion of it generally comes in with Asia, and another piece with the Pacific Islands; but in order to ascertain its form and extent as a whole we are almost always obliged to turn to the map of the Eastern Hemisphere. It thus happens that seldom seeing this region, except on a diminutive scale, its real form, dimensions, and the size, situations, and names of its component islands, are, perhaps, less familiar to educated persons than those of any other countries of equal importance. They can hardly bring themselves to imagine that this sea of islands is really in many respects comparable with the great continents of the earth. The traveller, however, soon acquires different ideas. He finds himself sailing for days or even for weeks along the shores of one of these great islands, often so great that the inhabitants believe it to be a boundless continent. He finds that voyages among these islands are commonly reckoned by weeks and months, and that the inhabitants of the eastern and western portions of the Archipelago are as mutually unknown to each other as are the native races of North and South America. On visiting the coasts of one of the larger islands, he hears of the [[p. 219]] distinct kingdoms which lie along its shores, of the remote north or east or south of which he can obtain little definite information, and of the wild and inaccessible interior, inhabited by cannibals and demons, the

haunt of the charmed deer which bears a precious jewel in its forehead, and of the primæval men who have not yet lost their tails. The traveller, therefore, soon looks upon this region as one altogether apart. He finds it possesses its own races of men and its own aspects of Nature. It is an island-world, with insular ideas and feelings, customs, and modes of speech; altogether cut off from the great continents into which we are accustomed to divide the globe, and quite incapable of being classed with any of them. Its dimensions, too, are continental. You may travel as many thousand miles across it, in various directions, occupying as many weeks and months as would be necessary to explore any of the so-called quarters of the globe. It contains as much variety in its climate, in its physical phenomena, its animate and inanimate life, and its races of mankind as some of those regions exhibit. If, therefore, the claim of Australia to be a *fifth* division of the globe be admitted, I would ask for this great archipelago (at least on the present occasion) to be considered a *sixth*.

I will now endeavour to give you a clearer idea of its extent and magnitude by comparing it with some regions nearer home. If, first, we bring the Malay Archipelago to Europe, keeping the meridians parallel, and place the western extremity of the island of *Sumatra* upon the *Land's End*, *New Guinea* will then spread over *Turkey* and a good deal of *Persia*, and the *Solomon Islands* will reach to the borders of the *Punjaub*; while the northern extremity of *Luzon* will be near the *White Sea*, and the islands of *Timor* and *Rotti* in *Syria*. The area of the whole Archipelago is, however, much less than its dimensions would seem to imply, being, on a fair calculation, about equal to that portion of Europe which lies south of St. Petersburg and the Shetland Islands.

Again, if we compare it with Equatorial America, we shall find its extent in longitude to exceed the width of that great continent, *Sumatra* stretching out into the Pacific to the west of *Panama*, while *New Guinea* would be washed by the Atlantic to the east of *Pernambuco*.

This great region of mingled land and water is, then, as a whole, comparable in its dimensions with the primary divisions of the earth, while its component parts are on an equally extended scale,—two of the islands, *Borneo* and *New Guinea*, being the largest on the globe. They are nearly equal in extent, and the only other island which approaches them is *Madagascar*. Borneo would contain within its vast area the whole of Great Britain and [[p. 220]] Ireland, with all their islets from Scilly to Shetland in their true relative positions, and still leave boundless forests stretching out like an ocean beyond them. Then comes *Sumatra*, about equal to Great Britain; after which follow *Java*, *Luzon*, and *Celebes*, either of which may compare in size with *Ireland* or one of the larger *New Zealand Islands*. After these succeed eighteen islands, which average as large as Jamaica; more than *one hundred* about the size of the isles of Wight and Man, with many thousands of isles and islets below these, and which are practically innumerable.

In their physical constitution and attendant phenomena the islands of the Archipelago offer us some remarkable and instructive contrasts. Active and extinct volcanoes are abundant in many of the islands, in others they are altogether absent. The former, as a general rule, are subject to frequent earthquakes, which in the others are quite unknown. In the greater part of the Archipelago one vast, ever-verdant forest covers hill and valley, plain and mountain, up to the

very loftiest summits; whereas in another and much smaller portion such dense and gloomy forests are altogether unknown, the country consisting of arid hills and plains, with a comparatively scanty covering of shrubs and trees. Again, over some extensive districts the monsoons, or periodical winds, with their attendant rains or drought, divide the year into a well-defined and regularly-recurring wet and dry season. Over other scarcely less extensive districts no such regularity exists; the inhabitants themselves can hardly tell you when their rainy or dry season usually begins, and the traveller soon finds the climate to be almost as variable and the skies as inconstant as in our own much-abused island. Even in districts where the season is regular, there are no less striking contrasts; one portion of an island having its wet weather while the remainder is parched up, and islands within sight of each other having very different seasons.

There is yet another contrasting aspect in which the Archipelago may be viewed, less obvious but leading to far more important results than any I have yet mentioned, namely, that one large portion of it is connected by a very shallow sea to the continent of Asia, another part is similarly joined to Australia, while the remaining islands are surrounded by a practically unfathomable ocean. We shall consider the chief islands of the Archipelago, therefore, under the heads of,—1st. *Volcanic* and *Non-Volcanic*; 2nd. *Forest Country* and *Open Country*; 3rd. *Well-marked Seasons* and *Undefined Seasons*; and 4th. *The Western or Indo-Malayan Region*, and the *Eastern or Austro-Malayan Region*.

Looking at a map on which the volcanic regions of the Archipelago are marked out—those which are subject to earthquakes, which are of volcanic origin, and which abound more or less in [[p. 221]] extinct as well as active volcanoes—we see at a glance that the great islands of Borneo and Celebes form the central mass around which the volcanic islands are distributed so as rudely to follow their outline and embrace them on every side but one in a vast fiery girdle. Along this great volcanic band (about 5000 miles in length) at least fifty mountains are continually active, visibly emitting smoke or vapour; a much larger number are known to have been in eruption during the last 300 years; while the number which are so decidedly of volcanic origin that they may at any moment burst forth again, must be reckoned by hundreds.

In the whole region occupied by this volcanic belt, and for a considerable breadth on each side of it, earthquakes are of continual recurrence, slight shocks being felt at intervals of every few weeks or months, while more severe ones, shaking down whole villages, and doing more or less injury to life and property, are sure to happen in one part or another of this district almost every year. In many of the islands the years of the great earthquakes form the chronological epochs of the native inhabitants, by the aid of which the ages of their children are remembered, and the dates of many important events are determined.

It is not now my object to describe the many fearful eruptions that have taken place in this region. In the amount of injury to life and property, and in the magnitude of their effects, they have not been surpassed by any upon record. Forty villages were destroyed by the eruption of Papaudayang in Java, where the whole mountain was blown up by repeated explosions, and a large lake left in its place. By the great eruption of Toruboro in Sumbawa 12,000 people were destroyed, and the ashes darkened the air, and fell thick upon the earth and sea for 300 miles round. Even quite recently, since I quitted the country, a mountain which had been quiescent for

more than 200 years suddenly burst into activity. The island of Makiau, one of the Moluccas, was rent open in 1646 by a violent eruption which left a huge chasm on one side, extending into the heart of the mountain. It was, when I last visited it, clothed with vegetation to the summit, and contained twelve populous Malay villages. On the 29th of December, 1862, after 215 years of perfect inaction, it again suddenly burst forth, blowing up and completely altering the appearance of the mountain, destroying the greater part of the inhabitants, and sending forth such volumes of ashes as to darken the air at Ternate, 40 miles off, and almost entirely to destroy the growing crops on that and the surrounding islands.

The island of Java contains more volcanoes, active and extinct, than any other known district of equal extent. They are about forty-five in number, and many of them exhibit most beautiful examples of the volcanic cone on a large scale, single or double, [[p. 222]] with entire or truncated summits, and averaging 10,000 feet high.

It is now well ascertained that almost all volcanoes have been slowly built up by the accumulation of the matter—mud, ashes, and lava—ejected by themselves. The openings or craters, however, frequently shift their position; so that a country may be covered with a more or less irregular series of hills in chains and masses only here and there rising into lofty cones, and yet the whole may be produced by true volcanic action. In this manner the greater part of Java has been formed. There has been some elevation, especially on the south coast, where are extensive cliffs of raised coral limestone; and there may be a substratum of older stratified rocks, but still essentially Java is volcanic; and that noble and fertile island—the very garden of the East, and perhaps upon the whole the richest, the best cultivated, and the best governed tropical island in the world—owes its very existence to the same intense volcanic activity which still occasionally devastates its surface.

The great island of Sumatra exhibits in proportion to its extent a much smaller number of volcanoes, and a considerable portion of it has had probably a non-volcanic origin.

To the eastward the long string of islands from Java passing by the north of Timor and away to Banda are probably all due to volcanic action. Timor itself consists of ancient stratified rocks, but is said to have one volcano near its centre.

Going northward, Amboyna, a part of Bouru, and the west end of Ceram, the north part of Gilolo and all the small islands around it, the northern extremity of Celebes, and the islands of Siau and Sauguir are wholly volcanic. The Philippine Archipelago contains many active and extinct volcanoes, and has probably been reduced to its present fragmentary condition by subsidences attending on volcanic action.

All along this great line of volcanoes are to be found more of less palpable signs of great upheaval and depression of land. The range of islands south of Sumatra, a part of the south coast of Java, and of the islands east of it, the west and east end of Timor, portions of all the Moluccas, the Ké and Aru Islands, Waigiou, and the whole south and east of Gilolo consist in a great measure of upraised coral-rock, exactly corresponding to that now forming in the adjacent seas. In many places I have observed the very surfaces of the upraised reefs, with the great masses of

coral standing up in their natural position and hundreds of shells, so fresh-looking that it was hard to believe they had been more than a few years out of the water; and, in fact, it is very probable that such changes have occurred within a few centuries.

In striking contrast with this region of subterranean fires, the [[p. 223]] island of Celebes in all its southern peninsulas, the great mass of Borneo, and the Malay peninsula, are not known to contain a single volcano, active or extinct. To the east of the volcanic band is another quiescent area of 1000 miles wide, the great island of New Guinea being free from volcanoes and earthquakes. Towards its eastern extremity, however, these reappear in some small islands off its coast, and in New Britain, New Ireland, and the Solomon Islands, which contain active volcanoes.

The difference between the aspect of the volcanic and the non-volcanic regions is by no means so striking as might be imagined. Where active volcanoes or true volcanic peaks exist, a peculiar character is at once given to the islands, which are also in almost every case characterised by excessive fertility. In many of the adjoining districts, however, though volcanic products may be everywhere visible, the general aspect of the country, the outline of the hills, and the character of the vegetation, does not differ materially from those of many parts of Borneo and New Guinea. The island of Amboyna, for instance, consists principally of raised coral-rock almost everywhere covered with deep-red volcanic clays and gravels, and in places capped with basalt and lavas; yet the soil is by no means fertile, and where the native forest vegetation is cleared off, the ground bears only a scanty covering of dwarf shrubs and rigid herbage. The chief characteristic of the non-volcanic regions appears to me to consist in the great flat valleys that line the coasts, and penetrate far inland between the mountain ranges—the result of the long and uninterrupted action of rivers and tropical rains (combined probably with a slow elevation of the land) in filling up the gulfs that once intervened between the mountain ranges. A subsidence of a few hundred feet would reduce Borneo into a shape very similar to that of Celebes, which island may be considered to be now in the state that Borneo has just passed out of, and to be still engaged in filling up and converting into swampy plains the deep gulfs that at present occupy the spaces between her radiating lines of mountains.

The very extraordinary forms of Celebes and Gilolo have been imputed by some authors to sudden and capricious elevation. Mr. Windsor Earl speaks of the volcanic action where it was strongest “throwing the islands into fantastic forms.” Celebes, however, is free from volcanoes except at its northern extremity, and its southern peninsula consists of mountains of basalt and limestone. From peculiarities in its natural productions, the shallowness of some of the gulfs between its peninsulas, and the number of coral islets that surround the southern portion of it, Celebes was once probably much more extensive, perhaps equal to Borneo, at a time when Borneo was just rising above the ocean, [[p. 224]] and having the form rudely represented in the diagram. As in every part of the world of which we have accurate geological knowledge, risings and sinkings of the land to the amount of several hundreds of feet have repeatedly occurred, these two islands may each have successively assumed the form of the other without any violent convulsion. From the vast, swampy, level plains which stretch into the very heart of Borneo, allowing vessels to ascend its southern rivers about 300 miles in a straight line, it has probably been for a long time stationary, and thus been enabled to fill up the gulfs that formerly penetrated

it. At a still earlier period it must have been much more deeply submerged, when the extensive coal-beds found in almost every part of it were being formed. This, however, was at no very remote period, geologically speaking, for the coal of Borneo is all tertiary. Instead of the ferns and lepidodendra, and other plants of extinct genera which abound in our coal-shales, those of Borneo contain only impressions of leaves of exogenous trees which can hardly be distinguished from those growing in the surrounding forests.

The contrasts of vegetation and of climate in the Archipelago may best be considered together, the one being to some extent dependent on the other.

Placed immediately upon the Equator, and surrounded by extensive oceans, it is not surprising that the various islands of the Archipelago should be almost always clothed with a forest vegetation from the level of the sea to the summits of the loftiest mountains. This is the general rule. Sumatra, New Guinea, Borneo, the Philippines and the Moluccas, and the uncultivated parts of Java and Celebes, are all forest countries, except a few small and unimportant tracts, due perhaps, in some cases, to ancient cultivation or accidental fires. To this, however, there is one important exception in the island of Timor and all the smaller islands opposite, in which there is absolutely no forest such as exists in the other islands, and this character extends in a lesser degree to Flores, Sumbawa, Lombock, and Bali.

In Timor the most common trees are *Eucalypti* of several species, so characteristic of Australia, with sandalwood, acacia, and other sorts in less abundance. These are scattered over the country more or less thickly, but never so as to deserve the name of a forest. Coarse and scanty grasses grow beneath them on the more barren hills, and a luxuriant herbage in the moister localities. In the islands between Timor and Java there is often a more thickly wooded country, but thorny and prickly trees abound. They seldom reach any great height, and during the force of the dry season they almost completely lose their leaves, allowing the ground to be parched beneath them, and contrasting strongly with [[p. 225]] the damp, gloomy, ever-verdant forests of the other islands. This peculiar character, which extends in a less degree to the southern peninsula of Celebes and the east end of Java, is most probably owing to the proximity of Australia. The south-east monsoon, which lasts for about two-thirds of the year (from March to November), blowing over the northern parts of that country, produces a degree of heat and dryness which assimilates the vegetation and physical aspect of the adjacent islands to its own. A little further eastward in Timorlaut and the Ke Islands, a moister climate prevails, the south-east winds blowing from the Pacific through Torres Straits, and as a consequence every rocky islet is clothed with verdure to its very summit. Further west again, as the same winds blow over a wider and wider extent of ocean, they have time to absorb fresh moisture, and we accordingly find the island of Java possessing a less and less arid climate in the dry season, till in the extreme west near Batavia rain occurs more or less all the year round, and the mountains are everywhere clothed with forests of unexampled luxuriance.

The changes of the monsoons and of the wet and dry seasons in some parts of the Archipelago, are very puzzling; and an accurate series of observations in numerous localities is required to elucidate them.

"Speaking generally," said Mr. Wallace, "the whole south-western part of the Archipelago, including the whole range of islands from Sumatra to Timor, with the larger half of Borneo and the southern peninsula of Celebes, have a dry season from April to November, with the south-east monsoon. This same wind, however, bends round Borneo, becoming the south-west monsoon in the China sea, and bringing the rainy season to Northern Borneo and the Philippines."

In the Moluccas and New Guinea the seasons are most uncertain. In the south-east monsoon from April to November, it is often stormy at sea, while on the islands it is very fine weather. There is generally not more than two or three months of dry hot weather about August and September. This is the case in the northern extremity of Celebes and in Bouru, whereas in Amboyna July and August are the worst months in the year. In Ternate, where I resided at intervals for three years, I never could find out which was the wet and which the dry season. The same is the case at Banda, and a similar uncertainty prevails in Menado, showing probably that the proximity of active volcanoes has a great disturbing meteorological influence. In New Guinea a great amount of rain falls more or less all the year round. On the whole the only general statement we can make seems to be that the countries within about 3° on each side of the Equator have much rain and not very strongly contrasted seasons; while those with more south [[p. 226]] or north latitude, have daily rains during about four months in the year, while for five or six months there is almost always a cloudless sky and a continual drought.

We have next to consider the Malayan Archipelago in its geological and zoological relations to Asia and to Australia, it being now a well established fact that one portion of it is almost as much Asiatic in its organic productions as the British Isles are European, while the remainder bears the same relation to Australia that the West India Islands do to America.

It was first pointed out by Mr. George Windsor Earl, in a paper read before this Society eighteen years ago, that a shallow sea connected the great islands of Sumatra, Borneo, and Java, to the Asiatic continent, with which they generally agreed in their natural productions; while a similar shallow sea connected New Guinea and some of the adjacent islands to Australia. Owing, however, to that gentleman's imperfect knowledge of the natural history of the various islands, he did not fully appreciate the important results of this observation, and in fact in the same paper argued in favour of the former connection of Asia and Australia—a connection to which the whole bearing of the facts in physical geography and natural history is plainly opposed.

In order to make this subject intelligible, it is necessary to make a few observations on the relations of the geographical distribution of animals and plants with geology.

It is now generally admitted that the present distribution of living things on the surface of the earth, is mainly the result of the last series of changes that the surface has undergone. Geology teaches us that the surface of the land and the distribution of land and water is everywhere slowly changing. It further teaches us that the forms of life which inhabit that surface have, during every period of which we possess any record, been also slowly changing.

It is not now necessary to say anything about *how* either of those changes took place; as to that, opinions may differ; but as to the fact that the changes themselves *have* occurred from the earliest geological ages down to the present day, and are still going on, there is no difference of opinion. Every successive stratum of sedimentary rock, sand or gravel, is a proof that changes of level have taken place; and the different species of animals and plants, whose remains are found in these deposits, prove that corresponding changes did occur in the organic world.

Taking, therefore, these two series of changes for granted, some of their effects are visible in the present peculiarities and anomalies in the distribution of species. In our own islands, with a few very trifling exceptions, every quadruped, bird, reptile, insect, and plant, is found also on the adjacent continent. In the small island of Corsica, there are some quadrupeds, birds and insects quite peculiar [[p. 227]] to it; in Ceylon, more closely connected to India than Britain is to Europe, many animals and plants of all kinds are quite different from those found in India. In the Galapagos Islands every indigenous living thing is peculiar to them, though closely resembling other kinds found in the neighbouring parts of the American continent.

Now, in all cases where we have independent geological evidence, we find that those islands, the productions of which are identical with those of the adjacent countries, have been joined to them within a comparatively recent period, such recent unity being in most cases indicated by the very shallow sea still dividing them; while in cases where the natural productions of two adjacent countries is very different, they have been separated at a more remote epoch—a fact generally indicated by a deeper sea now dividing them. The reason of this is obvious. For example: let a subsidence take place, cutting off any portion of a continent, and forming an island. The organic productions of the two portions are at first identical, but they are not permanent. The changes that have always gone on still go on. Some species slowly die out, new ones take their place, and thus in time the animals and plants of the island come to differ from those of the country from which it was severed; and if the subsidence which first separated them goes on widening and deepening the sea between them, there will come in time to be such a marked difference in their productions as we see between Madagascar and Africa.

This general principle is of almost universal application, so that when we find an island whose animals and plants exactly agree with those of an adjacent land, we look for evidence of its recent separation from that land; while, on the other hand, any remarkable diversity of natural productions forces on us the conclusion that the watery barrier which now exists has existed for a very long geological period; and when the diversity is almost total, not only in species but in larger groups such as general families and orders, we conclude that these countries could never have been connected since our continents and oceans had assumed their present general outlines.

Returning now to the Malay Archipelago, we see that the whole of the seas connecting Java, Sumatra, and Borneo with Malacca and Siam are under 50 fathoms deep, so that an elevation of only 300 feet would add this immense district to the Asiatic continent. The 100 fathom line will also include the Philippine Islands and the island of Bali, east of Java. From this we should naturally conclude that the subsidence breaking up this portion of Asia had recently taken place, and we have a very sufficient cause for such subsidence in the vast range of volcanoes in Sumatra and Java, whose elevatory action must have been counterbalanced by some [[p. 228]]

adjacent depression. On examining the zoology of these countries this opinion is confirmed, for we find the most overwhelming evidence that these great islands must have once formed a part of the continent, and could only have been separated at a very recent geological epoch. The elephant and tapir of Sumatra and Borneo, the rhinoceros of Sumatra and the allied species of Java, the wild cattle of Borneo and the kind long supposed to be peculiar to Java, are now known all to inhabit some part or other of Southern Asia. None of these large animals could possibly have passed over the arms of the sea which now separate these countries, and therefore plainly indicate that a land communication must have existed since the origin of the species. Among the smaller mammals a considerable portion are common to each island and the continent; but the vast physical changes that must have occurred during the breaking up and subsidence of such extensive regions have led to the extinction of some in one or more of the islands, and in some cases there seems also to have been time for a change of species to have taken place. Birds and insects illustrate the same view, for every family and almost every genus of birds and insects found in any of the islands occur also in the Asiatic continent, and in a great number of cases the species are exactly identical. Birds offer us one of the best means of determining the laws of distribution; for though at first sight it would appear that the watery boundaries which keep out the land quadrupeds could be easily passed over by birds, yet practically it is not so, for if we leave out the aquatic tribes which are pre-eminently wanderers, it is found that the others (and especially the passeres or true perching-birds which form the vast majority) are generally as strictly limited by straits and arms of the sea as are quadrupeds themselves. As an instance among the islands of which I am now speaking, it is a remarkable fact that Java possesses numerous birds which never pass over to Sumatra, though they are separated by a strait only 15 miles wide, and with islands in mid-channel. Java, in fact, possesses more birds and insects peculiar to itself than either Sumatra or Borneo, and this would indicate that it was earliest separated from the continent; next in organic individuality is Borneo, while Sumatra is so nearly identical with the peninsula of Malacca in all its animal forms, that we may safely conclude it to have been the most recently dismembered island.

The general result, therefore, at which we arrive is, that the great islands of Java, Sumatra, and Borneo resemble in their natural productions the adjacent parts of the continent, almost as much as such widely-separated districts could be expected to do even if they still formed a part of Asia; and this close resemblance, joined with the fact of the wide extent of sea which separates them being so uniformly and remarkably shallow, and lastly, the existence of the [[p. 229]] extensive range of volcanoes in Sumatra and Java, which have poured out vast quantities of subterranean matter and have built up extensive plateaux and lofty mountain ranges, thus furnishing a "*vera causa*" for a parallel line of subsidence—all lead us irresistibly to the conclusion that at a very recent geological epoch the continent of Asia extended far beyond its present limits in a south-easterly direction, including the islands of Java, Sumatra, and Borneo, and probably reaching as far as the present 100 fathom line of soundings.

The Philippine Islands agree in many respects with Asia and the other islands, but present some anomalies, which seem to indicate that they were separated at an earlier period, and have since been subject to many revolutions in their physical geography.

Turning our attention now to the remaining portion of the Archipelago, we shall find that all

the islands from Celebes and Lombock eastward, exhibit almost as close a resemblance to Australia and New Guinea as the Western Islands do to Asia. It is well known that the natural productions of Australia differ from those of Asia more than those of any of the four ancient quarters of the world do from each other. Australia, in fact, stands alone: it possesses no apes or monkeys, no cats or tigers, wolves, bears, or hyenas; no deer, or sheep, or oxen; no elephant, horse, squirrel, or rabbit; none, in short, of those familiar types of quadruped which are met with in every other part of the world. Instead of these, it has marsupials only, kangaroos and opossums, wombats and the duck-billed *platypus*. In birds it is almost as peculiar. It has no woodpeckers and no pheasants, families which exist in every other part of the world; but instead of them it has the mound-making brush-turkeys, the honey-suckers, the cockatoos, and the brush-tongued lories, which are found nowhere else upon the globe.

CHIEF ISLANDS OF THE MALAY ARCHIPELAGO.

		Square Miles.		Square Miles..
A.	1. New Guinea	290,000	Comp. with German States	250,000
A.	2. Borneo	237,000	„ Spanish Peninsula	167,000
B.	3. Sumatra	120,000		
B.	4. Celebes	70,000	„ France	137,000
B.	5. Java	50,000	„ Great Britain ..	80,000
B.	6. Luzon	40,000	„ Cuba	54,000
B.	7. Mindanao	28,000	„ Ireland	32,000
C.	8. Timor	15,000	„ Portugal	29,000
C.	9. Flores	10,000		
C.	10. N. Britain	10,000	„ Sardinia Islands	9,000
C.	11. Ceram	8,500		
C.	12. Gilolo	7,000	„ Holland	8,300
C.	13. Sumbawa	6,000		
C.	14. Bouru	5,000		
C.	15. Banca	4,500		
C.	16. N. Ireland	4,500	„ Jamaica	4,200

Indian Region. *Characteristic Birds.*	
Palæornis	Ring-necked parroquets.
Picidæ	Woodpeckers.
Bucconidæ	Barbets.
Trogonidæ	Trogons.
Ixodinæ	Fruit-thrushes.
Musapeta	Paradise flycatchers.
Phyllornithidæ	Green birds.
Edolites	Paradise shrikes.
Pericrocotus	Minivets.
Irena	Blue drongo.
Phasianidæ	Pheasants and jungle fowl.

Australian Region. *Characteristic Birds.*	
Trichoglossidæ	Lories, Brush-tonged parroquets.
Plyctolophidæ	Cockatoos.
Platycercidæ	Broad-tailed parrots. Celebes only.
Meliphagidæ	Honeysuckers.
Paradiseidæ	Paradise birds.
Cracticus	Crow shrikes.
Megapodiidæ	Brush turkeys.
Casuaridæ	Cassowary and emu.

Indian Region. *Characteristic Mammals.*	
Simiadæ	Apes and monkeys.
Galeopithecus	Flying lemur.
Felidæ	Tigers, &c.
Canidæ	Wolves, &c.
Viverridæ	Civets, ichneumons, &c.
Mustelidæ	Polecats, otters, &c.
Ursidæ	Bears.
Cervidæ	Deer.
Bovidæ	Cattle and sheep.
Tapirus	Tapir.
Rhinoceros	Rhinoceros.
Elephas	Elephant.
Sciuridæ	Squirrels.
Hystricidæ	Porcupines.
Manis	Scaly ant-eater.

Australian Region. *Characteristic Mammals.*	
Simiadæ	In Celebes only, 1 sp.
Viverridæ	In Celebes and Moluccas only, 1 sp.
Cervidæ	In Celebes and Moluccas only, 1 sp.
Bovidæ	In Celebes only, 1 sp.
Sus	As far as N. Guinea.
Belideus	Marsupial flying-squirrels.
Cuscus	Eastern opossums.
Dendrolagus,&c.	Kangaroos.

Now all these peculiarities exist also in the Australian portion of the Malay Archipelago, as may be seen by the tables of characteristic mammals and birds of the two regions. The contrast is nowhere so abruptly exhibited as on passing from the island of Bali to that of Lombock, where the two regions are in closest proximity. In Bali we have barbets, fruit-thrushes, and woodpeckers; on passing over to Lombock these are seen no more, but we have abundance of cockatoos, honeysuckers, and brush-turkeys, which are equally unknown in Bali and every island further west. The strait here is 15 miles wide, so that we may pass in two hours from one great division of the earth to another, differing as essentially in their animal life as Europe does from America. If we travel from Java or Borneo, to Celebes or the Moluccas, the difference is still more striking. In the first, the forests abound in [[p. 231]] monkeys of many kinds, wild cats, deer, civets, and otters, and numerous varieties of squirrels are constantly met with. In the latter

none of these occur; but the prehensile-tailed opossum is almost the only terrestrial animal seen, except wild pigs, which are found in all the islands, and deer (which have probably been recently introduced) in Celebes and the Moluccas. The birds which are most abundant in the Western Islands are woodpeckers, barbets, trogons, fruit-thrushes, and leaf-thrushes: they are seen daily, and form the great ornithological features of the country. In the Eastern Islands these are absolutely unknown, honeysuckers and small lories being the most common birds; so that the naturalist feels himself in a new world, and can hardly realise that he has passed from the one region to the other in a few days, without ever being out of sight of land.

The inference that we must draw from these facts is undoubtedly that the whole of the islands eastwards from Java and Borneo do essentially form a part of a former Australian or Pacific Continent, from which they were separated, not only before the Western Islands were separated from Asia, but probably before the extreme south-eastern portion of Asia was raised above the waters of the ocean; for a great part of the land of Borneo and Java is known to be geologically of quite recent formation, while the very great difference of species and in many cases of genera also between the productions of the Eastern Malay Islands and Australia, as well as the great depth of the sea now separating them, point to a comparatively long isolation and an early epoch of separation. It is interesting to observe among the islands themselves how a shallow sea always intimates a recent land-connection. The Aru Islands, Mysol, and Waigiou, as well as Jobie, agree with New Guinea in their mammalia and birds much more closely than they do with the Moluccas, and we find that they are all united to New Guinea by a shallow sea. In fact, the 100 fathom line round New Guinea marks out accurately the range of the true Paradise birds.

The existence of a Pacific continent was long ago indicated by Mr. Darwin's researches on the structure and origin of coral-reefs, the numerous atolls and barrier-reefs in the whole of this district being shown to depend upon the subsidence of land for long periods. This so exactly agrees with the singular unity now existing among the organic productions of a vast number of islands, which at the same time are very different from those of any other part of the world, that we must accept it as a fair deduction from the only evidence we can ever hope to obtain of this class of changes.

I would particularly call attention to the fact that the division of the Archipelago here pointed out, into two regions characterised by a striking diversity in their natural productions, does *not* correspond to any of the physical or climatal divisions of the surface. [[p. 232]] The great volcanic chain runs through both parts: Borneo closely resembles New Guinea, not only in its vast size but in its climate and the general aspect of its vegetation; the Moluccas are the counterpart of the Philippines in their volcanic origin, their extreme fertility, their luxuriant forests, and their frequent earthquakes; and the east end of Java has a climate almost as dry as that of Timor. Yet between these corresponding groups of islands, constructed as it were after the same pattern, there is the greatest possible contrast in the animal productions. Nowhere does the ancient doctrine—that the peculiar animal and vegetable productions of the various countries of the globe are directly dependent on the physical conditions of those countries (such as climate, soil, elevation, &c.)—meet with a more direct and palpable contradiction. Borneo and New Guinea, as physically alike as two distinct countries can be, are zoologically wide as the poles asunder; while Australia, with its dry winds, its open plains, stony deserts, and temperate

climate, yet produces the quadrupeds and birds which are most nearly allied to those inhabiting the hot, damp forests which everywhere clothe the plains and mountains of New Guinea.

We can now give the reason for limiting the Malay Archipelago on the east by the Solomon Islands in the Pacific Ocean. Certain groups of birds, which have their metropolis in New Guinea and extend over the Moluccas to the westward, are found also as far as the Solomon Islands to the eastward, but do not extend to New Caledonia (which is much more Australian in its productions), or to the Fejee Islands, where the peculiar Pacific fauna commences. These groups are the *scarlet lories* and the *white cockatoos*, and the occurrence of a new species of cassowary in New Britain is a further indication of these islands being as closely allied to New Guinea on the one hand as are the Moluccas on the other.

The nature of the contrast between these two great divisions of the Malay Archipelago will be best understood by considering what would take place if any two of the primary divisions of the earth were brought into equally close contact. Africa and South America, for example, differ very greatly in all their animal forms. On the one side we have baboons, lions, elephants, buffaloes, and giraffes; on the other spider-monkeys, pumas, tapirs, ant-eaters, and sloths; while among birds, the hornbills, turacos, orioles, and honey-suckers of Africa contrast strongly with the toucans, macaws, chatterers, and humming-birds of America.

But let us endeavour to imagine (what it is very probable may occur in future ages) that a slow upheaval of the bed of the Atlantic should take place, while at the same time earthquake-shocks and volcanic action on the land should cause increased volumes of sediment to be poured down by the rivers, so that the two continents should gradually spread out by the addition of [[p. 233]] newly-formed lands, so as to reduce the Atlantic which now separates them to an arm of the sea a few hundred miles wide. At the same time we may suppose islands to be upheaved in mid-channel, and, as the subterranean forces varied in intensity and shifted their points of greatest action, these islands would sometimes become connected with the land on one side or other of the strait, and at other times again be separated from it. Several islands would at one time be joined together, at another would be broken up again, till at last, after many long ages of such intermittent action, we might have an irregular archipelago of islands filling up the ocean channel of the Atlantic, in whose appearance and arrangement we could discover nothing to tell us which had been connected with Africa and which with America. The animals and plants inhabiting these islands would, however, certainly reveal this portion of their former history. On those islands which had ever formed a part of the South American continent we should be sure to find such common birds as chatterers and toucans and humming-birds, and some of the peculiar American quadrupeds; while on those which had been separated from Africa, hornbills, orioles, and honey-suckers would as certainly be found. Some portion of the upraised land might at different times have had a temporary connection with both continents, and would then contain a certain amount of mixture in its living inhabitants. Such seems to have been the case with the islands of Celebes and the Philippines. Other islands, again, though in such close proximity as Bali and Lombock, might each exhibit an almost unmixed sample of the productions of the continents of which they had directly or indirectly once formed a part.

In the Malayan Archipelago we have, I believe, a case exactly parallel to that which I have

here supposed. We have indications of a vast continent, with a peculiar fauna and flora, having been gradually and irregularly broken up; the island of Celebes probably marking its furthest westward extension, beyond which was a wide ocean. At the same time Asia appears to have been extending its limits in a south-east direction, first in an unbroken mass, then separated into islands as we now see it, and almost coming into actual contact with the scattered fragments of the great southern land.

In dwelling upon this subject—which I trust I have succeeded in making intelligible—my object has been to show the important bearing of researches into the natural history of every part of the world upon the study of its past history. An accurate knowledge of any group of birds or of insects, and of their geographical distribution, may assist us to map out the islands and continents of a former epoch; the amount of difference that exists between the [[p. 234]] animals of adjacent districts being closely dependent upon preceding geological changes. By the collection of such minute facts alone can we hope to fill up a great gap in the past history of the earth as revealed by geology, and obtain some indications of the existence of those ancient lands which now lie buried beneath the ocean, and have left us nothing but these living records of their former existence.

It is for such inquiries the modern naturalist collects his materials; it is for this that he still wants to add to the apparently boundless treasures of our national museums, and will never rest satisfied as long as the native country, the geographical distribution, and the amount of variation of any living thing remains imperfectly known. He looks upon every species of animal and plant now living as the individual letters which go to make up one of the volumes of our earth's history; and, as a few lost letters may make a sentence unintelligible, so the extinction of the numerous forms of life which the progress of cultivation invariably entails will necessarily render obscure this invaluable record of the past. It is, therefore, an important object, which governments and scientific institutions should immediately take steps to secure, that in all tropical countries colonised by Europeans the most perfect collections possible in every branch of natural history should be made and deposited in national museums, where they may be available for study and interpretation.

If this is not done, future ages will certainly look back upon us as a people so immersed in the pursuit of wealth as to be blind to higher considerations. They will charge us with having culpably allowed the destruction of some of those records of Creation which we had it in our power to preserve; and while professing to regard every living thing as the direct handiwork and best evidence of a Creator, yet, with a strange inconsistency, seeing many of them perish irrecoverably from the face of the earth, uncared for and unknown.

☆ ☆ ☆

[[p. 210]] The PRESIDENT remarked that as a geologist, he must say, in all the years he had had the honour of being connected with the Society, he had never heard a paper read of a more luminous character, and which so bound together in the most perfect forms all the branches of the science of natural history, more particularly as it developed the truths of geography upon what he considered to be its soundest basis, that of geological observation and analogy. He was perfectly certain there was no person

present, who could not say that they had never sent a traveller into a foreign country, who had more completely studied all the grand features of its natural history, or who had combined them together in a more profoundly philosophical spirit.

Mr. CRAWFURD said the subject of the Malay Archipelago had been the study of his life; but he felt himself much enlightened by the paper of Mr. Wallace. He did not know that he could add any information. He might not entirely agree with all his theories, and, perhaps, not even with his divisions of the Archipelago; but for all that, his paper was a most enlightened [[p. 211]] and a most able one. He wished Mr. Wallace had said something about the human inhabitants of these regions. Mr. Wallace knew more about them than any Englishman, for he had lived among them; and he should be glad to hear his opinion of them. He divided the Archipelago into two parts, the Indian portion and the Australian portion. Now he wished to ask Mr. Wallace, seeing that he conjoined Australia and New Guinea as part of the same region, how it happened that the human inhabitants were totally different? Again, if the Indo-Malay portion of the Islands were grouped with India, how came it that no two human beings could be more unlike than the Hindoo and the Malay? How did the Malays come there? How were the dwarfish inhabitants of the Andaman Islands to be accounted for? for there were no such people in India—that was certain. How were the pigmy negroes of the Malay Peninsula to be accounted for? There were differences here which he (Mr. Wallace) might perhaps be able to reconcile. Mr. Wallace had mentioned the eruption of the mountain Tomboro. He was himself old enough to have been an eye-witness of the commencement of that eruption, probably the most remarkable one on record. In the year 1814 he proceeded with an expedition to the island of Celebes; and as they approached the island of Sumbawa, which contained this famous mountain, they thought they saw a very heavy squall coming on. They were beating up against the south-east monsoon, and as they approached they saw that it was a volcano. As they beat up nearer the shore of the island, the ashes fell on the deck. That was one whole year before the great eruption took place. He was then at Soerabaya, at the eastern extremity of Java, about 300 miles distant from the mountain of Tomboro. For three days it was pitch dark. Mr. Wallace had greatly underrated the extent of ashes that were ejected, which were certainly not confined to an area of 300 miles, as they fell at Bencoolen, 1200 miles distant, transported thither by the south-east monsoon; and they were carried by a second current of air a thousand miles in an opposite direction, as far, in fact, as the island of Banda. For ten days he had to write by candlelight; and the country-people were compelled to travel into the country with flambeaux. For six weeks together they could not see the plain disc of the sun. There was one difference between the volcanic and non-volcanic portions of these islands. Generally speaking, the volcanic part was highly fertile. Mr. Wallace had given a just eulogy of the island of Java. He himself resided on that island six years, and he was tolerably well acquainted with it. Java was about half the size of Great Britain; it was a fertile island, beautifully watered, and at present contained a population of full 12,000,000; indeed, the last accounts make it about 13,200,000. On the other hand, he did not believe the population of Borneo exceeded four or five inhabitants to the square mile, and probably on the whole did not exceed one million and a quarter. If Borneo were as fertile as Java, as well watered, and as suitable to maintain a population, it ought, according to its immense size, to contain a population of 80,000,000. The people of Java were civilised, having fine monuments and a literature. The whole of the inhabitants of Borneo, who were not strangers, were savages. There was a still more remarkable example. Mr. Wallace had mentioned the islands of Bali and Lombok. Now, those two very small islands were highly fertile, and although they were not above one-eightieth part of the size of Borneo, they contained a population equal to that of Borneo, and a civilised population too, well-clothed and well-fed, and possessing a literature. These were striking differences between the volcanic and non-volcanic islands.

Mr. WALLACE said with regard to the question that Mr. Crawfurd had asked, why he did not refer to the races of men inhabiting these islands, it was simply because his paper was already too long, and it would require another paper equally long to do justice to the subject.

Mr. CRAWFURD.—Will you promise one?

Mr. WALLACE.—Certainly. He should just like to say a word with regard [[p. 212]] to the number of very difficult problems that Mr. Crawfurd had proposed to him—problems which, as Mr. Crawfurd, who had devoted his whole life to the subject, was unable to answer, it was not likely he should be able to answer upon such short notice, if indeed at all. However, he would say, generally, that the races of man do not correspond at all accurately to those two great divisions of the Archipelago, which differed so remarkably in their natural productions. The reason why they did not correspond appeared to him to be simply this; that man is a migratory animal and continually moving about. We had a great deal of historical evidence of the number of changes of the races of man in the Archipelago itself. Some races have been driven out; others have come in; others have made conquests; others have gone to more fertile regions. Therefore, the races of man would not correspond to those of animals and plants. Still there was a slight general correspondence. There was the Malay race, the whole of which, generally speaking, corresponded to the western half of the Archipelago; they did stretch into the eastern half, but not a great part of it. The Papuan race occupied the eastern half, and extended into New Guinea. It was probable they had extended still further west, but they had been driven back by the Malayan race.

The PRESIDENT, in adjourning the Meeting, congratulated them upon having had from Mr. Wallace a proof that Geography as a science embraced all the sciences relating to Natural History. He had proved himself not alone a first-rate naturalist, but also a good geologist.

The Meeting then adjourned, after a cordial vote of thanks had been unanimously passed to Mr. Wallace for his most interesting and instructive paper.