
IV. ANIMAL GEOGRAPHY.*

NE of the most striking distinctions between the old and the new school of Natural History is the greatly increased amount of attention paid in the present day to the *locality* of every species. Our predecessors, if any specimen had not been derived from their own country, quietly dubbed it "exotic." Any creature from a tropical climate was labelled as a native of "the Indies,"—which might include either Venezuela, Hindustan, or New Guinea. To the modern naturalist, on the contrary, an accurate knowledge of the locality of every specimen he examines is a point of the first moment. Without this he regards it in much the same manner as a lawyer looks upon an unsigned document. "The structure, affinities, and habits of a species now form only a part of its natural history. We require also to know its exact range at the present day and in pre-historic times, and to have some knowledge of its geological age, the place of its first appearance upon the globe, and of the various extinct forms most nearly allied to it."

But though the correct locality of each species is now recorded in every systematic work on natural history, though local faunæ have been compiled, and attempts made at a general classification of the animal world from a geographical point of view, a work was still wanting which should com-

* The Geographical Distribution of Animals, with a Study of the Relations of Living and Extinct Faunas as elucidating the Past Changes of the Earth's Surface. By ALFRED RUSSEL WALLACE. London: Macmillan and Co. Opening Address of the Biological Section of the British Association, 1876. By the President, ALFRED RUSSEL WALLACE.

bine and harmonise the mass of unconnected facts ascertained, and which should not merely propose an arrangement, but should demonstrate it by a careful and exhaustive analysis. This deficiency has been supplied by Mr. Wallace in a manner which must greatly enhance the well-merited esteem in which he is held by naturalists. The result is a work which in its department has no equal in any language, and which must at once be received as the text-book of zoological geography.

It may, at the first glance, appear an easy matter to determine the geographical distribution of the animal kingdom. We have only, it is said, to take a census of species in every country, to compare the returns, and to arrange our divisions accordingly; but the moment we make the attempt difficulties spring up on all sides. We require a trustworthy classification of animals, so that we may know what forms can be legitimately included under each species, genus, or family. We must then decide whether our classification is to be positive or negative, founded on the presence or on the mere absence of certain groups. Our own view, like that of Mr. Wallace, is that mere negative characteristics can have but very limited value. The extirpation of certain striking forms of life in a given island, whether effected by human agency or by natural causes, cannot give such island a higher rank as a zoological province than it had before. To distinguish two regions, *a* and *b*, we must be able to show that each contains something which is wanting in the other. Why, for instance, are the claims of Australia to rank as a distinct primary region so universally allowed? Not from the mere absence of monodelphic mammals, whether Carnivora, Rodentia, Ungulata, and the like, but because, in the stead of all these, there are didelphic groups which to some extent replace, or at least simulate, the monodelphic orders and families. This brings us to another fundamental principle,—the higher the rank of the group present in one country and absent in another, the more fundamental is the distinction between them. Thus two adjacent islands might contain not a single Lepidopterous species in common; yet if all the species belonged to genera common to both islands we should rank both in the same region, sub-region, province, and district. But suppose that they had no genera or no families in common, we should consider it necessary to refer them at any rate to distinct sub-regions. If, again, the very orders are distinct, as is the case if we compare the mammals of Australia with those of the rest of the world,* we

* With the exception of the opossums of North and South America.

have before us a distinction of the highest order. But here is a fresh difficulty: it is only Australia which offers us so sharp a demarcation, and even this extends merely to the Mammalia: its birds and insects, though very distinct, not being separated from those of other parts of the world by so broad a boundary line. In separating region from region we cannot always avail ourselves of characteristics absolutely equal in value. This, as we shall afterwards see, has led some systematists to maintain that Australia and South America are marked off from each other and from the rest of the world by features more striking than those presented by any other region. We must therefore call in another principle, already shadowed forth in the admission that mere poverty of species cannot constitute a zoological region. We must take into consideration richness and variety of forms, as well as speciality. Nor must we insist upon being able to prove that all our primary divisions are of precisely equal rank. Nature will not adapt itself to our systematic classifications, whether geographical or morphological. Look, *e.g.*, at our use of the term "order." It is applied equally to two such groups as Carnivora and Marsupialia. It must be admitted that the latter comprises at least four groups which, if more developed, might claim to rank as distinct orders. Or let us look at that vast assemblage of animated beings known as the "order" Coleoptera, but containing carnivorous, omnivorous, frugivorous, and lignivorous groups, differing widely as well in structure as in habits. Were they bulkier creatures, would not the "stirps" Geodephaga be entitled to the position of an order equivalent and parallel to Carnivora? Thus we see that our morphological groups, as well as our geographical regions, are by no means equal in value.

But to return: the question next arising concerns the foundation of our regional division. Shall it be founded upon the consideration of some one sub-kingdom or class, and, if so, upon which? Mr. Wallace, like some of his predecessors, takes the Mammalia as his standard, and only calls to his aid the distribution of other groups to determine doubtful points, or by way of corroboration. We cannot help thinking that insects have a higher claim to be selected for our guidance. They form, so to speak, the round numbers of the world's animal species, all other tribes and classes being in comparison a mere fractional amount: they are rarely purposely introduced by man into foreign countries, and the few which follow him parasitically, such

as the cockroach and the house-bug, are well known. If imported in articles of commerce they prove, as a rule, incapable of maintaining themselves, and soon disappear. Like the Mammalia, their means of dispersal are mainly dependent upon "the distribution of land and water, on the presence or absence of lofty mountains, desert plains, and great forests." Strange as it may seem, we can also trace their existence and distribution in remote geological epochs, and can identify genera in the tertiary and families even in the palæozoic period. It is true that no part of the world would be so sharply demarcated by its entomological fauna as is Australia by its mammalian forms of life; but this might not be wholly a disadvantage. Yet whilst we wish that an attempt might be made to draw up a system of animal geography based upon the distribution of insects, we are strongly inclined to believe that the main results of such an undertaking would confirm the labours of Mr. Wallace. Even plants will doubtless be found to conform to the same arrangement. "The floræ of tropical America, of Australia, of South Africa, and of Indo-Malaya, stand out with as much individuality as the faunæ, while the plants of the Palæarctic and Nearctic regions exhibit resemblances and diversities of a character not unlike those found among the animals."

Before entering upon an examination of the system of Mr. Wallace we may find it useful to take a brief survey of the divisions proposed by earlier authorities. The first attempts in animal geography are due to Fabricius, the eminent entomologist. He divides the world into eight sections: the Indian, comprising the tropical regions of both hemispheres; the Egyptian, including the northern subtropical lands, apparently in the new as well as in the old continent; the Mediterranean Islands, with southern Europe, and a part of Asia Minor; the North European; the North Asiatic; the North American; China, with Japan; and, finally, all mountains throughout the globe which reach the level of perpetual snow. It does not appear that Fabricius ever made any attempt to demonstrate his theory, which must inevitably break down under even the most superficial analysis, and which merely serves to prove how little attention must have been paid in his day to the localities of animal species. Latreille divides the world into "climates," each extending 12° of latitude by 24° of longitude. He does not, however, express himself satisfied that each of these plots is characterised by a distinct fauna. Kirby maintains that the limits of animal species are fixed

not by isothermal lines,* but by the will of the Creator. He thus withdraws the subject entirely from the domain of Science, forgetting that Absolute Reason will work not arbitrarily, but according to fixed laws, even if the human intellect should not be equal to the task of their discovery.

Dr. Prichard adopts, as his zoological provinces, the Arctic, the Temperate, and Equatorial regions of the old and new continents; the Indian Archipelago; New Guinea, with New Britain, New Ireland, and the island groups of the Pacific; Australia proper; and, lastly, the southern extremities of America and Africa. This classification might be very briefly dismissed if it did not, at first sight, seem to anticipate certain views put forward by Mr. Wallace in his earlier writings, and developed in the present work. He finds that the respective faunæ of the western and eastern portions of the great Malay Archipelago differ essentially: hence he places the former group in his "Oriental" and the latter in his "Australian" region, drawing his line of demarcation between Borneo and Celebes. Whether Dr. Prichard's boundary falls in the same place, or, rather, more to the eastward between the Moluccas and New Guinea, it is evident that he considers the distinction between the Indian islands and New Guinea of no higher rank than that between the former and the south-eastern portion of the Asiatic continent, or than that between the latter and Australia. On the other hand, Mr. Wallace clearly demonstrates that widely as Australia differs from New Guinea in climate, soil, humidity, and state of surface, their respective faunæ show a well-marked affinity. New Guinea and Borneo, almost identical in their meteorological conditions, are decidedly distinct in their forms of animal life. Hence we must decide that Mr. Wallace has not been anticipated by Dr. Prichard, and that the latter was evidently not aware of the importance of the truth which he had approached.

Swainson's arrangement has at least the merit of not requiring any novel terminology. His five grand divisions are simply Europe, Asia, Africa, America, and Australia. How a man of his reading and research could succeed in persuading himself that the zoological distinction between Europe and Asia exceeded, or even equalled, those between Central Asia and India, or North and South America, respectively, might be an interesting puzzle for the laboriously idle. Like Kirby, Swainson supposes that the various

* It will be observed that the boundaries of Latreille's regions are not necessarily isothermals.

groups of organic beings were originally placed by the Creator in certain regions for which they are peculiarly and exceptionally adapted. How completely this hypothesis is at variance with facts requires no further demonstration.

Mr. Wallace, as the basis of his arrangement, adopts the six regions originally proposed in 1857 by Dr. Sclater. This view, at first established merely on a study of the distribution of birds, has since been applied by its author to the mammals, and by Dr. Günther to reptiles. The regions are—the Palæarctic, embracing the eastern continent from the Icy Ocean down to the Sahara, the Indus, and the Himalaya; 2nd, the Ethiopian, including all Africa south of the Great Desert, the tropical portion of Arabia, the islands of Madagascar, Mauritius, Bourbon, the Seychelles, and others in the Indian Ocean, but excluding the Azores, Madeiras, Canaries, and the Cape Verde group; 3rd, the Oriental region, comprising India, both hither and farther, along with the south-eastern portion of China, Ceylon, the Andamans and Nicobars, the Sunda Islands up to the Straits of Macassar, Hainan, and Formosa, and probably the Philippines; 4thly comes Australia, with New Guinea, the Moluccas and Celebes to the westward, and New Zealand and Polynesia to the south and east. Next follows the Neotropical region, or South America, with the West Indies, Central America up to the southern slope of the great Mexican table-land, and the Galapagos. Lastly we have the Nearctic region, including the whole of North America from the Mexican table-land to the furthest limit of animal life in the Polar regions.

Our first thought concerning this arrangement is that its nomenclature is unhappy. Four, if not five, of the names do not at once tell their own tale. Instead of Neotropical and Nearctic, it would surely be simpler to say West-Southern and West-Northern, or even South-American and North-American. The term "Oriental" might be supposed applicable to Persia, Arabia, and Syria, and may therefore be usefully replaced by the name "Indian," as originally proposed by Dr. Sclater. In like manner we would substitute "East-Northern" for "Palæarctic," and "African" for "Ethiopian."

But these six regions, howsoever named, are not universally accepted by naturalists. Prof. Huxley points out that the Australian and Neotropical regions differ more widely from the other four above mentioned than do these latter respectively from each other. Hence if we take Australia, South America, and all the rest of the world, which he calls

"Arctogæa,"—Arctic land, a rather grotesque name for a stretch of country which would have to include the Cape of Good Hope,—we should have only three primary regions, nearly equivalent. The same author also suggests that the peculiarities of New Zealand may perhaps justify its claim to rank as a primary region. Mr. Murray, in his "Geographical Distribution of Mammals," assumes four primary regions,—the Palæarctic of Dr. Sclater, with the addition of the Sahara and Nubia; the Indo-African, embracing Dr. Sclater's Oriental and Ethiopian regions; the Australian; and the American, including South as well as North America.

Mr. W. T. Blanford proposes to call the Oriental region of Mr. Sclater the Malayan, as being most highly developed in the Malay countries. He doubts whether India proper belongs to this region at all, and considers that it has derived a great part of its fauna from Africa.

Mr. E. Blyth, basing his classification upon mammals and birds, seeks to establish seven primary divisions:—the Boreal, comprehending the Palæarctic and Nearctic regions of Dr. Sclater, in addition to the West Indies, Central America, and the Andes down to Chili and Patagonia. Next comes the Columbian region, embracing the residue of South America. His Ethiopian region, in addition to Africa, comprehends Arabia, the south of Syria, the plains and tablelands of India, and even the northern half of Ceylon. Next follows the Lemurian region, comprising Madagascar and the adjacent island groups. Mr. Blyth's "Austral-Asian" region agrees with Dr. Sclater's "Oriental" region if the greater part of India proper is cut off. Finally, Dr. Sclater's "Australian" region is divided into two portions of equal rank—Melanesia, including Australia proper, New Guinea, and Celebes; and Polynesia, comprising the South Sea Islands and New Zealand.

Mr. J. A. Allen, again, assumes a "law of circumpolar distribution of life in zones," and divides the world into eight "realms,"—the Arctic; the North Temperate; the American Tropical; the Indo-African Tropical; the South-American Tropical; the African Temperate; the Antarctic; and the Australian. The North Temperate is again subdivided into the American and the Europæo-Asiatic regions; the Indo-African into the African and Indian regions; and the Australian into the Tropical Australian and the South Australian, with New Zealand. His other realms are not subdivided.

It is evidently disheartening to see such an utter want of

accordance among authors who have certainly given this important subject their careful attention. No one indeed has proposed to unite Australia with any of the other primary zoological regions, or to dis sever from it the eastern portion of the Malay Archipelago—the Austro-Malayan region of Mr. Wallace.* But short of this it would almost seem as if zoo-geographers had been “ringing the changes” on the possible number of arrangements. Even with the boldly isolated Australian region strange liberties have been taken: thus while one classifier would confer upon New Zealand the rank of a coequal primary region, another regards it as fit for amalgamation with South Australia, in contradistinction to the northern or tropical half of that continent.

As to most of these modifications of Dr. Sclater’s original views, we think that Mr. Wallace is fully justified in their rejection. The fusion of South with North America, or that of the latter with the West Indies, Chili, Patagonia, Central America, Europe, and Asia, seems to us to involve the neglect of important distinctions and of plain affinities, and to offer great practical inconvenience. Mr. Wallace well remarks—“There can be little use in the knowledge that a group of animals is found in the Boreal region, if their habitat might still be either Patagonia, the West Indies, or Japan.” Concerning the proposal of Prof. Huxley—latterly adopted by Dr. Sclater—to consider New Zealand as a primary province, our author reminds us that “it is absolutely without indigenous Mammalia, and very poor in all forms of life, and therefore by no means prominent or important enough to form a primary region of the earth.”

“It may be as well here to notice what appears to be a serious objection to making New Zealand, or any similar isolated district, one of the great zoological regions, comparable to South America, Australia, or Ethiopia, which is that its claims to such distinction rest on grounds that are liable to fail. It is because New Zealand, in addition to its negative merits, possesses three families of birds (Apterygidæ living, Dinornithidæ and Palapterygidæ extinct), and a peculiar lizard-like reptile, *Hatteria*, which has to be classed in a distinct order, Rhyncocephalina, that the rank of a region is claimed for it. But supposing, what is not at all improbable, that other Rhyncocephalina should be discovered

* As an additional proof of the close connection between New Guinea and Australia we may mention that M. Bruyn, of Ternate, has obtained a new species of *Echidna* from the mountains of Arfak, in the former island. The only two allied species hitherto known are confined to Australia proper.

in the interior of Australia or in New Guinea, and that Apterygidæ or Palapterygidæ should be found to have inhabited Australia in post-pliocene times (as Dinorthidæ have already been proved to have done), the claims of New Zealand would entirely fail, and it would be universally acknowledged to be a part of the great Australian region. No such reversal can take place in the other regions, because they rest not upon one or two, but upon a large number of peculiarities of such a nature that there is no room upon the globe for discoveries that can seriously modify them. Even if one or two peculiar types like Apterygidæ or *Hatteria* should permanently remain characteristic of New Zealand alone, we can account for these by the extreme isolation of the country and the absence of enemies, which have enabled these defenceless birds and reptiles to continue their existence, just as the isolation and protection of the caverns of Carniola have enabled the *Proteus* to survive in Europe. But supposing that the *Proteus* was the sole representative of an order of Batrachia, and that two or three other equally curious and isolated forms occurred along with it, no one would propose that these caverns or the district containing them should form one of the primary divisions of the earth. Neither can much stress be laid on the negative peculiarities of New Zealand, since they are found to an almost equal extent in every oceanic island."

As regards Prof. Huxley's tripartite arrangement—Australia, South America, and Arctogæa—Mr. Wallace urges that the comparative importance or equivalence of value of two or more zoological provinces is very difficult to determine. "It may be considered from the point of view of speciality or isolation, or from that of richness and variety of animal forms. In isolation and speciality, determined by what they want as well as by what they possess, the Australian and Neotropical regions are undoubtedly each comparable with the rest of the earth. But in richness and variety of forms they are both very much inferior, and are much more nearly comparable with the separate regions which compose it."

It might possibly, however, be contended that Mr. Blyth is right in claiming for Madagascar and its adjacent islands the rank of a primary region, instead of viewing it, with Dr. Sclater and Mr. Wallace, as a sub-region of "Ethiopia." True its extent is very trifling compared with any of the other regions, but there are some grounds for regarding it as the mere fragment of a former continent. It possesses twelve families of terrestrial Mammalia (or only two fewer

than the Australian region), three of which are peculiar, whilst the Lemuridæ—although extending to continental Africa, the Malay Islands, India, and China—have evidently their metropolis in Madagascar, where they take the place of the monkeys. Of its twenty-seven genera and sixty-five species, no fewer than twenty genera and all the species are peculiar. Out of its one hundred and eleven species of land birds only twelve are identical with species inhabiting the adjacent continents, and not one of the exclusively African families is represented in Madagascar. The gigantic extinct bird *Æpyornis*, three species of which have been discovered, forming the family *Æpyornithidæ*, as far as is known was peculiar to Madagascar and the adjoining islands. Among reptiles it contains none of the African *Colubers*, but it has three genera—*Herpetodryas*, *Philodryas*, and *Heterodon*—which are only found elsewhere in North and South America, whilst the *Lycodontidæ* and *Viperidæ*, both well developed in Africa, are here absent. Its insect affinities are largely Oriental, Australian, and South-American, the African element being represented rather by special forms belonging to West Africa or South Africa than by such as are common to the whole Ethiopian region. Amongst the *Lepidoptera* the beautiful diurnal moth *Urania* occurs here, the remaining species being found only in the Neotropical region. Of the twenty-three *Cetonian* genera known in Madagascar, two alone—according to the “British Museum Catalogue”—are represented elsewhere. None of the characteristic *Cicindelas* of Africa are here met with, and with the *Carabs* the case is almost similar. Having regard to these facts, most if not all of which are duly recorded by Mr. Wallace, it certainly seems that “Lemuria,” if not a primary region, differs more widely from the other Ethiopian sub-regions than they do from each other, or perhaps even than do the respective sub-regions of any other region.

The subdivision of the six primary regions is the next question. Mr. Wallace proposes in every case four sub-regions, a numerical agreement which, if fully borne out by facts, is exceedingly curious. Doubts, however, may be entertained both as regards the number and the boundaries of these subdivisions. In the *Nearctic* or *North-American* region the four districts are—the *Californian*, consisting of Upper California and the narrow strip of country to the northwards between the Rocky Mountains and the Pacific; the *Rocky Mountains*, embracing Lower California, the table-lands of Mexico, and the mountainous territories extending northwards towards the British frontier; the *Appa-*

lachian, including the valley of the Mississippi and all the eastern and southern States of the American Union; and, lastly, the Canadian, comprehending British North America (except perhaps Columbia), the former Russian territory, Greenland and the Polar lands, so far as they have any animal life at all.* These sub-regions, as Mr. Wallace admits, are not so well characterised as might be desired, and their boundaries, and even their number, are therefore open to doubt.

In the Neotropical region the four divisions are—the Andean, comprising Patagonia, the chain of the Andes, and the Pacific Coast up to the Equator; the Central American, with the hot low-lying coasts of Mexico; the Antillean, including all the West Indies except Tobago and Trinidad. The remaining sub-region comprises these two islands, Guayana, Venezuela, and the greater part of New Grenada and Ecuador, those portions of Peru and Bolivia which lie on the eastern slope of the Andes, the vast empire of Brazil, and a part of Paraguay and the States of La Plata. This arrangement has not escaped criticism. It has been pointed out that the last sub-region, superficially very large in proportion to the three others, and greater still in the amount of fruitful land which it contains and in its multitude of animal species, may probably be found less homogeneous than Mr. Wallace supposes. We do not think that the attention of naturalists has been sufficiently directed to a passage in which Sir R. Schomburgk, speaking of the brilliant flora of the mountains of British Guayana, notices the almost total absence of insects. The remark has been made that this statement, if confirmed, agrees ill with certain modern views on the part played by insects in the fructification of plants and on the use of brilliant colouration in flowers. Waterton, whose testimony would have been invaluable, unfortunately paid little attention to insects.†

It is instructive to compare the West Indian islands with the Malay Archipelago. Both these groups are closely

* We have always been of opinion that the extremely high latitudes would be found completely devoid of a fauna, and we observe with much interest that this view is decidedly confirmed by the results of the late Polar Expedition. The explorers appear to have reached, and even passed, the boundaries of animal life. The bearing of this fact upon the notion of a circumpolar zoological region is obvious.

† Mr. Norman Moore, in his edition of Waterton's "Essays," declares that Schomburgk "has copied whole pages from the 'Wanderings' with no other change than the transformation of an interesting into a heavy style, and, notwithstanding all his obligations to Waterton, he has never once mentioned him in his books with respect."

similar in soil, climate, and possible productions, but the poverty of the Antilles, whether in the higher or lower forms of animal life, is as remarkable as the wonderful riches of the Eastern islands.

Turning to the Australian region we find again four sub-regions :—Austro-Malaya, or New Guinea;* Celebes and the Moluccas; Australia proper, with Tasmania, New Zealand; and, lastly, the South Sea Islands. Mr. Wallace doubts, however, whether the Sandwich Islands are not entitled to rank as a fifth sub-region, distinct from the rest of Polynesia, and having affinities which apparently point to a former connection with the western coast of North America. Concerning the Philippines, he is also uncertain whether they should be ranked with the Austro-Malayan sub-region or assigned to the Malayan section of the Oriental region. This being the case it is the more to be regretted that the author omits to furnish an analysis of the insect forms of this interesting group.

The distribution of animals, recent and fossil, in the Australian region is the more important since from its study we may hope to obtain light on such questions as the former existence of a vast equatorial continent of which the Polynesian islands are the mountains, or of an antarctic continent of which New Zealand may have formed an outlying portion, or of a former eastward extension of Australia and its connection with or approximation to New Guinea.

The divisions of the Oriental or Indian region are—the Malayan, comprehending the Sunda Islands, with the peninsula of Malacca, and possibly the Philippines; the remainder of further India, with the southern coast of China, and probably the islands of Hai-nan and Formosa; southern Hindustan, with Ceylon; and northern Hindustan. The position of Hai-nan, and especially of Formosa, is somewhat doubtful. Its fauna has, on the one hand, affinities with that of China (Palæarctic region), and, on the other, with those of the Indo-Chinese, and even the Malayan sections of the Oriental region. Here, again, it is to be regretted

* Reports have been spread which if verified would have necessitated the total exclusion of New Guinea from the Australian region. Thus one traveller declared that he had met with the recent dung of a rhinoceros, and had seen the track of buffaloes in the mire. A more competent observer, however, Signor D'Alberti, has shown that the dung was merely that of the *Casuarinus*, and that the tracks had been made by wild swine. New Guinea is remarkable for the beauty of its insects and of its birds. According to Mr. Wallace fully 50 per cent of the latter are brilliantly coloured, whilst in such districts as Malacca and the Valley of the Amazon the proportion is not above 33 per cent.

that no information has been given concerning the insects of the two islands.*

The Andaman and Nicobar groups have been assigned, the former to the Indo-Chinese and the latter to the Malayan region, an arrangement which we think no judicious zoo-geographer will call in question.

But a much more serious question remains. Certain naturalists, who have made the fauna of India their especial study, hold that its affinities with Africa overbalance those with Malaya. Mr. Crawford maintains that this Ethiopian affinity was more pronounced in the tertiary period than it is at present. It is further urged that as there is easy communication for birds, and even for mammals, between India and Indo-China, or even Malaya, but long tracts of sea and desert between the former and the Ethiopian region, the affinities of India and Africa ought to be estimated at a higher value than if the means of access were equal in each case. Still, as far as the Mammalia are concerned, we question if the affinities of the Indian sub-region for Africa are more pronounced than those for Malaya, or even for the Palæarctic territories. Bears and deer occur in India, but have not been met with in Africa, either living or fossilised. Of the thirty-eight mammalian genera inhabiting India proper, eight are so widely distributed as to give no special clue to the question; "fourteen are exclusively Oriental; five have as much right to be considered Oriental or Ethiopian, extending as they do over the greater part of the Oriental region; two (the hyæna and gazelle) show Palæarctic rather than Ethiopian affinity; seven are Palæarctic and Oriental, but not Ethiopian; and only two (the hunting leopard and the *Mellivora*) are distinctly Ethiopian."

The Ethiopian region, if we include Madagascar, is also divided into four sub-regions, which, however, Mr. Wallace regards as "in some extent provisional." The East-African sub-region includes all the open country south of the Great Desert, and extending eastwards to the Indian Ocean, and southwards to about 20° S. latitude. It has few peculiar forms, and its north-eastern regions are almost as much Palæarctic as Ethiopian; while the fauna of the forests of Mozambique, though on the eastern coast, approaches in character to the western or southern sub-region. The western district includes the mass of forest which lies in the

* A large amount of our knowledge on the distribution of animals is due to sportsmen, who often do excellent service as regards mammals and birds, but who generally overlook the reptiles, and almost invariably ignore the insects.

form of a crescent along the Gulf of Guinea, having its northern limits at the River Gambia; extending eastwards to the head-waters of the Nile and the mountains forming the western boundary of the great lakes of Central Africa, and reaching southwards "to that high but marshy forest country in which Livingstone was travelling at the time of his death." Its extreme southern limit may be about 11° S. latitude. The author tells us in a footnote that Dr. Schweinfurth found this region very sharply defined in $4\frac{1}{2}^{\circ}$ N. lat. and $28\frac{1}{2}^{\circ}$ E. long. A sudden change occurs here in the character of the vegetation, and the chimpanzee and the West-African grey parrot first make their appearance. The South-African sub-region, which Mr. Wallace pronounces "the most peculiar and interesting part of Africa," occupies the extreme south of the continent, as far as the Kalahari Desert and the Limpopo River. The more typical portion of the region scarcely extends beyond the boundaries of the Cape Colony and Port Natal.

There is evidently much to be done before the fauna of Africa can be mapped out with even approximate exactness. Possibly some of its variations may be considered cases of "station" rather than of "habitat." The western district is a luxuriant forest, whilst the eastern is to a great extent elevated table-land, with a vegetation of high grasses, thorny scrub, and here and there patches of forest. It is very intelligible that the animal population of two such districts should show a well-marked difference. We need not wonder, therefore, that the forests of Mozambique should possess a fauna more western in its character, and that the Ethiopian affinities of the Indo-Malayan sub-region should point more to Western than to Eastern Africa.

The Palæarctic region, lastly, is divided into the following four sub-regions:—the European, comprising all the land north of the Pyrenees, the Alps, the Balkan, the Black Sea, and the Caucasus, and west of the valley of the Irish and the Caspian, and including the British Islands, "whose animal productions are so uniformly identical with continental species as to require no special notice." The Mediterranean sub-region includes Spain, Italy, Turkey (European and Asiatic), Persia and Afghanistan up to the banks of the Indus, Northern Arabia, Egypt to the second cataract of the Nile, Northern Africa so as to include the extra-tropical portion of the Sahara and the Azores, Madeiras, Canaries, and even the Cape Verde Islands. It may at first sight seem strange that the northern and southern shores of a deep sea like the Mediterranean should belong to the same

sub-region, since deep seas generally mark out a primary division in the faunæ of the lands they separate—a truth which Mr. Wallace has enforced and utilised in his work on the Malay Archipelago. But the Mediterranean, though a very deep sea, did not always form a continuous barrier between Europe and Africa. It was bridged over at Gibraltar, and again at the part between Sicily, Malta, and the African coast, and thus an easy communication between its northern and southern shores was possible. The traveller who proceeds from Spain or Italy, either southwards or eastwards, finds no very marked transition until he has reached the Niger in the one direction or the Indus in the other. The faunæ of the Azores, Madeiras, and Canaries have been carefully examined, and show unmistakable Palæarctic affinities, having been derived at an early period either from South-Western Europe or North-Western Africa. This circumstance speaks against the supposition that these island groups are the last remains of a former continent (Atlantis), either independent or connected with tropical America. In either of these cases their faunæ would have exhibited a marked distinction from that of Mediterranean Europe.

The third Palæarctic sub-region, the Siberian, occupies the whole of Northern, North-Eastern, and Central Asia as far as the frontiers of the Oriental region. Middle and Northern China and the islands of Japan form the fourth and last sub-region.

Each of the six great regions “has had a history of its own, the main outlines of which we have been able to trace with tolerable certainty.”

The question now arises, what are the causes of the distribution of animals as at present existing—a distribution which mere differences of temperature, of moisture, and of the supply of food are far from fully explaining?

Among the agencies which have influenced the migrations and re-migrations of species, a prominent rank belongs to the Glacial epoch—perhaps we might rather say the Glacial epochs. It is important to note that on this subject Mr. Wallace accepts the views of Mr. Belt. This acute geologist holds that glaciation was simultaneous over both hemispheres, and that the amount of water piled up in the form of ice upon the continents so far lowered the depth of the ocean as to lay dry extensive tracts of land, now submerged to the depth of 2000 feet, these low-lying regions becoming the refuge for tropical forms of animal and vegetable life. It is scarcely necessary to add that this hypothesis would never have secured suf-

frages so exalted if it did not harmonise well with the phenomena of the variation and distribution of species. But there are undoubtedly difficulties in the way. A simultaneous glaciation of the whole earth, preceded or followed by a period like the Miocene, with a luxuriant vegetation penetrating at once almost to either Pole, implies a wonderful oscillation in the total available amount of heat at the earth's surface.

Another important cause has been the fluctuation in the distribution of land and water on the earth's surface. It is true that on this subject exaggerated views have been entertained. Mr. Wallace does not consider it either justifiable or necessary to assume that—at any rate in recent geological periods—the great masses of land and of water have changed their respective positions; but he holds that along the margins of the continents great mutations may have taken place. Northern Asia and the Sahara are probably recent upheavals of shallow sea-bottoms. Borneo, Java, and Sumatra may probably have been united with further India, and again separated; Australia may have very probably extended to the great barrier reef, and the Antilles may have been part and parcel of the American continent. Nay, at a very early period Madagascar may have been connected with Africa, and subsequently with Ceylon and Southern India.

Such changes would follow naturally from the conditions assumed in Mr. Belt's hypothesis of the Glacial period; but Mr. Wallace decidedly opposes the theory of a former direct communication either between Africa and South America or the latter and Australia. The occurrence of certain peculiar forms of life in countries mutually very remote, and their absence in intermediate regions, may, he shows, be explained much more naturally than by the assumption of direct and special connection. Such species may have been once very widely diffused, but being worsted in the great struggle for existence they have been exterminated, save in remote islands and inaccessible districts. Such species it will be found are rarely powerfully armed. As a confirmation of this view, it may be noticed that the strongest and most formidable animals are found either in the large continents or in the islands recently dis severed from them, such as Sumatra or Java. The faunæ of true oceanic islands, on the contrary, are characterised not merely by scantiness, but by the general feebleness and inoffensive character of the species. A very curious fact, to which Mr. Wallace more than once refers, is the evident extinction of many large species

of animals since the post-pliocene times, and either just before or shortly after the appearance of man. This phenomenon was apparently simultaneous in Europe and America, and will doubtless be traced in other quarters of the globe when their palæontology has been more fully studied. Among the animals which have thus disappeared are some which seem to have been eminently qualified to "hold their own." Such is the extinct genus *Machairodon*, or sabretoothed tiger, several fossil species of which, apparently more formidable than any existing cat, have been found in both continents.

Another very important conclusion is, that the theory of the independent origin and development of animal life in a number of distinct points can no longer be upheld. The great northern continents appear to have been the seat and birthplace of all the higher forms of life, whilst certain strange creatures—such as the gigantic fossil *Edentata*—seem to have originated in the south and to have gradually spread northwards.

In one respect we must own ourselves disappointed with Mr. Wallace's book, although the author, in his Address delivered before the Biological Section of the British Association at Glasgow, has done very much to supply the deficiency. We had expected that the work would have contained a summary of facts, and possibly some interesting generalisations on the influence of locality on the colour, the size, and the form of animal species. Every naturalist—save such, if they deserve the name, who confine their researches to books—knows that the fauna of each country has a peculiar general physiognomy, more or less pronounced. These peculiarities are sometimes difficult to express in words, and may escape any but the most patient observer, but in other instances they are open and palpable. Thus, according to Mr. Goodman, there appear in the birds of the Azores modifications all tending towards a more sombre plumage, and a greater strength of feet, legs, and bill. Mr. Blanford finds that Persian specimens are, on the average, paler in colour than their nearest allies in Europe. Mr. Wallace, in his Glasgow Address, remarks that it is "in islands we find some of the most striking examples of the influence of locality on colour, generally in the direction of paler, but sometimes of darker and more brilliant hues, and often accompanied by an unusual increase of size." He then shows how the butterflies of certain genera, such as the *Euplaas*, are in the larger islands dark-coloured, whilst in Banda, Ké, and Matabello there are three

species, not nearly related to each other, "all broadly banded or suffused with white." "The small island of Amboyna produces larger-sized butterflies than any of the larger islands which surround it. This is the case with at least a dozen butterflies belonging to many distinct genera."

Corresponding cases of paleness are found in Fiji, in the Andamans, and in Jamaica.

In Celebes, as Mr. Wallace has shown in an earlier work,* instead of any modification of colour, there is "a peculiar form of wing and a much larger size running through a whole series of distinct butterflies."

The Philippine Islands seem to have the property of developing intense metallic lustre, both in butterflies and beetles. Thus the hind wings of *Ornithoptera Magellanus* "glow with an intense opaline lustre not found in any other species of the entire group, and *Adolias calliphorus* is larger and of more brilliant metallic colouring than any other species in the Archipelago. In these islands, also, we find the extensive and wonderful genus of weevils, *Pachyrhynchus*, which in their brilliant metallic colouring surpass anything found in the whole eastern hemisphere, if not in the whole world."

Continental districts likewise have their peculiarities of colouration. Thus two unrelated groups of butterflies from tropical Africa "are characterised by a prevailing blue-green colour not found in any other continent." Similarly, in South America, "nine very distinct genera are implicated in parallel changes, groups of three or four of them appearing in the same livery in one district, while in an adjoining district most or all of them undergo a simultaneous change of colouration or marking."

These local peculiarities may perhaps be overlooked because they occur in insects, but Mr. Wallace very aptly asks—What should we think if similar phenomena were to be traced amongst large mammals?

In birds, however, local characteristics of a corresponding nature occur, as the author proves by reference to the avifaunæ of the West Indies, the Andamans, the Philippines, Celebes, Timor, Flores, and Lord Howe's Island. In New Guinea, Australia, Madagascar, and the Mascarenes we have black parrots and pigeons—a curious instance of the phenomenon known as melanism.

* Contributions to the Theory of Natural Selection, pp. 168—173.

It has been maintained that, in the Nearctic region at least, the Mammalia increase in size with the latitude and altitude of their birthplace. This view is disputed by Mr. Allen, who declares that it does not agree with the development of the American Carnivora. Indeed as regards altitude, and consequently rarefaction of the ambient medium, the very opposite law has been proposed. The largest animals are now found in the denser medium, water; many of the next largest species—such as the elephants, hippopotamus, &c.—inhabit river-marshes and deltas almost on a level with the sea. There is also good reason for supposing that the atmosphere in the epochs which produced the gigantic extinct animals must have been denser than it is at present. Mr. Allen considers that the largest individuals of every species, and the largest, best-developed, and most typical species of every group, will be found near its centre of distribution.

It has also been suggested, at least as regards insects, that in all regions dark-coloured species are characteristic of woods, whilst white or light-coloured forms occur in the open plains. This law holds good in some well-known genera of butterflies, such as the "whites" as compared with the forest-loving *Hipparchias*, *Erebias*, &c.; but the deeply-coloured *Vanessas* inhabit the open country. Among Coleoptera we find the dung-beetles, mainly black in colour, abundant in the open country, like the ruminants on whose excrement they prey. The common ground-beetles, also (*Harpalidæ*, &c.), are chiefly sombre in colour, and certainly show no exclusive preference for woods. On the other hand, the chafers (*Melolonthidæ*) and the Buprestids frequent the woods, and yet display some of the most striking instances of pale colouration to be found among the entire tribe of Coleoptera.

For further details on the influence of locality we must refer the reader to Mr. Wallace's most instructive Address, but we cannot help expressing our regret that he has not introduced the consideration of this subject into his *magnum opus*.

We may rest assured that the peculiarities to which we have so briefly referred point to causes of variation at work other than protective mimicry or than sexual selection. This is evidently the opinion of Mr. Wallace, who insists that "one of these causes is an influence depending strictly on locality, whose nature we cannot yet understand, but whose effects are everywhere to be seen when carefully

searched for. If it be asked why so little attention is given to this and to other interesting problems connected with the distribution of organic life, one important cause has been pointed out by Mr. Wallace—the total want of a museum geographically arranged. Our museums, more or less complete, are arranged morphologically. Birds, reptiles, insects, &c., which approximate in their structure are placed together, quite irrespective of the locality from which they have been obtained. Such collections are obviously indispensable, and all we recommend concerning them is that they should be made much more complete and more accessible than is now the case, and should invariably be placed in some central position, and not in a remote, even though fashionable, suburb. But along with such we want also a museum geographically arranged, where we may see, *e.g.*, in one hall the fauna of India, in another that of New Guinea, of Australia, of Madagascar, or of the Cape. Who can doubt that if such collections were accessible, relations, similarities, contrasts would strike us which escape unnoticed when the species of the whole world are placed side by side. It would likewise be instructive to exhibit the species of every country in juxtaposition with their nearest allies or representatives in other countries, and to show specimens of widely-distributed species from the centre and the extremes of its range. Surely if any nation can produce such an institution it ought to be England; yet hitherto we have little even pointing in this direction save the collections of "British" birds and insects, which have been multiplied both by public institutions and by private collectors, and which are the less instructive because Britain is not a definite zoological district, but merely an impoverished portion of the north-western Palæartic region. Is it too much to hope that the great Colonial Museum which looms in the future, and which by the special favour of all good powers is to be placed on the Thames Embankment, may include a department of the kind desired?

We must now, however, take our leave of Mr. Wallace and of his truly magnificent contribution to Natural History. If we cannot pronounce the work as in all respects perfect—if we here and there entertain a doubt or desire fuller information—the cause lies not in any shortcoming on the part of the author, but in the extent and the complexity of the subject and in the limited state of our present knowledge. The plan which he has traced with so masterly a

hand will doubtless be elaborated in its details, and may perhaps here and there be somewhat modified. But we shall all feel that Alfred Russel Wallace is the architect whose designs we are carrying out.
