WALLACE'S GEOGRAPHICAL DISTRIBUTION OF ANIMALS.*

I.

IT is Buffon who is to be credited with having first promulgated precise generalizations respecting the geographical distribution of animals. Buffon, in this respect, not only advanced much beyond his predecessors, but leaped at once to a position which some of the more pretentious naturalists of our own times have failed to attain. In brief, he recognized (1) that the inhabitants of the tropical and southern portions of the old and new worlds were entirely different from each other; (2) that those of the northern portions of the two were, to a considerable extent, identical; and (3) that the confluence of the two was most apparent towards the proximate portions of America and Asia. The truth that animals in fact had, for the most part, originated in the regions of the earth where they are now found, became incontrovertible; and geological research demonstrated that they were preceded by forms which were the ancestors of those now living on the soil. Numerous zoölogists, from time to time, took up the problem of the distribution of animals as a special study. At length an English ornithologist, Mr. P. L. Sclater, in 1857, published a memoir, to which adventitious circumstances gave considerable celebrity, and in which the formerly recognized regions were redefined under new but by no means appropriate names. (1) The European region was christened Palæarctic; (2) the African or Ethiopian, the Western Palæotropical; (3) the Indian, the Middle Palæotropical; (4) the Australian, the Eastern Palæotropical; (5) the North American, the Nearctic, and (6) the tropical American, the Neotropical. These regions were contrasted, as implied in their nomenclature, under two prime categories—the Palæogean and Neogean, corresponding respectively with the old and new worlds of geographers. The limitations of the regions were, for the most part, judiciously adopted by the author from his predecessors, although without any acknowledgment and with a tacit assumption of originality. The major combinations, however, so far as animal geography was involved, were peculiar to Mr. Sclater, and, for most classes of animals, were extremely unfortunate. It is but just to add that subsequently, when his attention had been re-directed to the subject by Prof. Huxley's writings, this objectionable feature of the classification was appreciated by the author himself, yet he has meanwhile been not without followers.

Mr. Sclater's views call for mention here simply because they have been accepted and pushed into great prominence by Mr. Wallace in his recent work, and by several other naturalists, whose experience might have taught them better. Whatever is true in them had long before been apprehended, and what was new has been rejected by those best qualified to judge. The ignorance of the literature of zoölogical geography on the part of the gentlemen in question may perhaps account for the claims to originality which have been put forth and recognized in respect to the regions accepted. Mr. Wallace has long been known as an adventurous and scientific traveller in many regions, an excellent collector in several departments of natural history, but especially of birds, and, more than all, as one to whom Mr. Darwin himself accredits the discovery of the law of natural selection simultaneously with himself. He has published several notable volumes of travels and essays, and many articles in various periodicals, chiefly on birds and insects. He is also entitled to the honor of having first clearly defined the boundaries between the Australian and Indian realms, and recognized in the inconsiderable strait which intervenes between the islands of Lombok and Bali the true dividing line, very properly designated as Wallace's line or strait, separating the great regions indicated. His experience in the field thus qualified him for considering

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and giving weight to a certain class of facts. His writings and his own admissions, however, prove that he was but little acquainted with the structure and classification of animals, and little imbued with taxonomic tact. Prepared as he was, nevertheless, he undertook the formidable task of a work upon 'The Geographical Distribution of Animals.' The title-page would naturally lead us to suppose he meant to consider the problems of zoölogical geography in general, but in the preface he states that it "is an attempt to collect and summarize the existing information on the distribution of land animals" (p. v.) When, however, we examine the contents of the two volumes in question we find that the work, in fact, is mostly devoted to the consideration of what the Germans would call "binnenländische Thiere," which is perfectly expressible by the scarcely-used English term "inland animals," with some references to the distribution of marine animals, although extremely meagre. Further, we find that even of the inland animals a very small proportion are considered, and indeed only the vertebrates and a few invertebrates are discussed. On a review of these discussions it becomes also very soon apparent that the author had an autoptical acquaintance only with the birds and several families of insects, and that his knowledge of the other forms was almost entirely derived from a few authors of more or less repute. Inasmuch as authors have greatly differed in their estimation of the values of groups and their mode of weighing differences in the several classes of the animal kingdom, we should naturally expect that under such circumstances there would be considerable incongruity in the basis of the work. Such, indeed, is the case to a greater extent than even might at first be looked for in the work of our author.

Mr. Wallace discusses his subject under four leading heads. In Part I. (vol. i. pp. 1–104) he treats of "the principles and general phenomena of distribution"; in Part II. (vol. i. pp. 105–170) of "the distribution of extinct animals"; in Part III. (vol. i. pp. 171–485, vol. ii. pp. 1–164) he enters upon the consideration of "zoölogical geography, a review of the chief forms of life in the several regions and sub-regions, with the indications they afford of geographical mutations"; and in Part IV. (vol. ii. pp. 165–553) he gives, under the caption of geographical zöology, "a systematic sketch of the chief families of land animals in their geographical relations." We need only consider a few of the questions involved.

Mr. Wallace very properly postulates (vol. i. p. 83) that "a little consideration will convince us that no enquiry into the causes and laws which determine the geographical distribution of animals or plants can lead to satisfactory results unless we have a tolerably accurate knowledge of the affinities of the several species, genera, and families to each other; in other words, we require a natural classification to work upon." In order, too, to compare things and conditions, it is necessary that they should be referred as nearly as possible to the same common standard. In all of these particulars we find a woful degree of imperfection and incongruity in the work of Mr. Wallace. In some respects he has carried differentiation into orders, families, and genera to an extreme degree, while in others he has accepted, as counterparts, groups whose representatives show the most fundamental differences among themselves. Thus, in the class of birds 10 orders and 181 families are admitted, and to such an extent is subdivision carried that not less than 50 families are named for the passerines and 8 for the parrots; although those groups are two of the most natural assemblages of the animal kingdom, and have been regarded by authors of the highest scientific ability (*e.g.*, Prof. Alphonse Milne-Edwards, Prof. Garrod, in 1874, and, apparently, Prof. Huxley), in one or both cases, as of simply family value. Again, the innocuous snakes are subdivided into 19 families, and the butterflies into 16.

In striking contrast with such families are many of those of fishes and mollusks. For the former the classification of Dr. Günther is adopted, and we find the heterogeneous groups designated under the names *Percidæ*, *Triglidæ*, *Trachinidæ*, *Scombridæ*, *Carangidæ*, *Gobiidæ*, *Pediculati*, *Blenniidæ*, *Gadidæ*, *Siluridæ*, and a number of others, to be compared as natural families with those of birds. More incongruous and heterogeneous still are some combinations designated as families adopted from the earlier parts of Woodward's 'Manual of Mollusca.' Ignoring that author's own latest improvements, Mr. Wallace has reverted to his cruder first conceptions, and we find families too numerous to mention of the most unnatural description, and which could be accepted by no scientific malacologist of the present generation any more than they were retained by Woodward himself in his later writings. We are quite safe in asserting that under several of the families thus alluded to, or hinted at, the differences of structure exemplified are greater than those exhibited by the extremes of living birds. When such is the case, it is evident that we can have no just or adequate idea of the comparative characteristics as to the zoölogical geography of the several classes considered in Mr. Wallace's work. In every class, not excepting the birds (*e. g.*, "orders" Picariæ and Gallinæ, "family" Pelicanidæ), there is apparent a want of familiarity with the principles of taxonomy, and a great deficiency in classificatory ability. Even when the author has attempted to give the more recent views of systematic authors, he has sometimes signally failed—as, *e. g.*, when he would give the latest views of Dr. Günther respecting the primary classification of fishes (vol. i. p. 102), or the ideas of Pfeiffer and Von Martens on the Pulmonates (vol. i. p. 104). Mr. Wallace has evidently been influenced rather by the numbers of species than by morphological considerations in the application and assessment of classifications, and, it may be also added, by physiological rather than structural differences. The consequences of these sins are entailed upon every branch of his subject, and it must be always remembered that each class, and sometimes each order, has been considered from a different point of view in a systematic sense.

As already indicated, Mr. Wallace has, for the most part, followed Mr. Sclater in the adoption of the number and names of the primary "regions" of the globe, but has subdivided those regions for himself, each into four sub-regions, thus (vol. i. pp. 81–82):

I. Palæarctic, with the sub-regions (1) North Europe, (2) Mediterranean or South Europe, (3) Siberia, and (4) Manchuria or Japan.

II. Ethiopian, with the sub-regions (1) East Africa, (2) West Africa, (3) South Africa, and (4) Madagascar.

III. Oriental, with the sub-regions (1) Hindostan or Central India, (2) Ceylon, (3) Indo-China or Himalayas, and (4) Indo-Malaya.

IV. Australian, with the sub-regions (1) Austro-Malaya, (2) Australia, (3) Polynesia, and (4) New Zealand.

V. Neotropical, with the sub-regions (1) Chili or S. Temp. Am., (2) Brazil, (3) Mexico or Trop. N. A., and (4) Antilles.

VI. Nearctic, with the sub-regions (1) California, (2) Rocky Mountains, (3) Alleghanies or East United States, and (4) Canada.

Mr. Wallace's idea is that the primary regions of the globe should be few; that they should be as nearly as possible co-equal "with the great natural regions of the globe marked out by nature"; and that the regions should "represent as nearly as possible the main features of the distribution of existing animals, and not those of any or all past geological epochs." He carries out his idea so far as to give us a most Procrustean series of sub-regions. Here it can only be premised that many of these divisions, at least, will require to be re-examined and otherwise limited and contrasted.

There are several illusions which many naturalists seem to labor under and which are too often assumed or taken for granted; such as that there are certain very definite regions in which, severally, animals are segregated from all others; that those regions and their mutual relations are equally indicated by all classes of animals; and that the distribution of marine animals is collateral with that of inland forms. But little knowledge of facts and little reflection is necessary to render obvious the fallacy of these views.

The regions, or realms as some would call them, defined by Mr. Wallace have been just specified. Their bounds are in several instances disputable, and would be more or less modified by students of different classes, as Mr. Wallace, in fact, admits. The marches between contiguous regions in which species of the two commingle on common ground may be many hundreds of miles in width. In few cases, indeed, except when bordered by the wide ocean, are the exact limits of the regions defined, or, it may be added, will ever be definable. We should be amiss even if we looked to the highest mountains as invariable dividing lines. The Rocky Mountains, for example, do not at all trenchantly separate the "eastern" and "western" regions, as is alleged by Mr. Wallace (v. i. p. 6), but the plains west of the Mississippi form neutral ground intervening between the two. The differences between the Atlantic and Gulf slopes on the one hand and the Pacific and Rocky Mountain on the other are rather, at least to a considerable extent, attributable to the "mediterranean" seas which in tertiary times covered so great a portion of the present hydrographical basin of the "Mississippi" rivers. The new-made land was apparently mostly colonized from the eastern and northern regions, and the subsequent commingling of types, extensive as it has been, has still not obliterated the primeval diversity between the two, although this is now most distinctly exemplified by the fishes.

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II.

THE indications as to the relations of the realms or regions furnished by the different classes of animals are very conflicting, and depend in a great measure, as might naturally be expected, on the ability of individuals to extend their limits, or the reverse. The two classes that perhaps are most antithetical in this respect are birds and inland fishes. The former are in an eminent degree fitted for the extension of their range, and consequently for accommodation to the "lay of the land"; while the latter are restricted by sharply-defined boundaries within very definite areas, and physiologically prevented from extending their range either over the land or across the expanse of ocean to any great extent. The two classes are also antithetical in another respect, inasmuch as the birds are a highly specialized group, very liable to modifications resulting from environing causes, and ever susceptible to the changes of condition that may supervene, while the fishes are a generalized type, and live in a medium where they are much less exposed to the vicissitudes of climate and other conditions, and where change, therefore, is less likely to supervene; consequently the representatives of the two classes might naturally be expected to indicate differences in the relations of the several faunas to each other, and such is markedly the case.

It has already been noticed that Mr. Sclater, from an ornithological point of view, segregated the several regions of the globe under two primary groups—Palæogæan and Neogæan. To a greater extent, perhaps, than would at first be supposed by special students of other classes, he was justified in such a differentiation, for the interchanges of the species of the north and the south with those of the tropics, and *vice versa*, are so numerous as to give a stamp of *comparative* homogeneity to the two great areas known as the old and new worlds. The birds, in fact, indicate in the most marked manner the effected accommodation to existing conditions. The fresh-water fishes, on the contrary, point to an entirely different relationship, and if we should take these animals for the determination of the primary regions of the globe, the present combinations of land and water must be entirely ignored, and their faunas correlated *de novo* on a very different basis. In such case, North America, Europe, and Asia would form one great division, in contradistinction to another, which would be constituted by Australia, South America, and Africa. These great divisions, however, are very unequal in one respect: the northern division, or Pliogæa, is comparatively homogeneous, and its several regions not very well defined, while the southern district, or Eogæa, is, on the contrary, subdivisible into three very distinct regions, the most generalized of which is Australia, and the least so Africa, while South America intervenes between the two, and, on the one hand, shares with Australia some forms, and, on the other hand, some with Africa, the common ones being in each case restricted to the two mentioned together. To some extent our author recognizes these relations (vol. i. p. 174).

These combinations may be explicable by different hypotheses: (1) the

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forms found in the several regions may be the remnants of a once widely-spread fauna, or (2) derivatives of a special fauna diffused when the continents were closely connected, directly or indirectly. The former supposition is perhaps best applicable in some cases, as in the dispersion of the sirenoids; but the latter seems to be the more probable in the case of most of the other forms. It is significant that the similarity of the ichthyic faunas of South America and Australia is exemplified chiefly on the southern and western slopes of the former, while the forms common to it and Africa are characteristic especially of the eastern slope. The moral from all these facts seems to be that the birds, and animals of analogous powers of extension, are the most apt exponents of the present relations of land and water, while the fishes, and animals of like restriction of locomotion, furnish the best hints as to the ancient connections of the precursors of the existing continents.

Mr. Wallace asserts that the class of animals best adapted to determine zoölogical regions is the one which exhibits "by their existing distribution the past changes and present physical condition of the earth's surface" (vol. i. p. 56), and that class, he thinks, is the mammals. He maintains (vol. i. p. 57) that "we should therefore construct our typical or standard zoölogical regions, in the first place, from a consideration of mammalia, only bringing to our aid the distribution of other groups to determine doubtful points." Mr. Wallace's argument throughout is tantamount to the admission that the division into regions is an arbitrary matter, and that there can only be a conventional agreement as to those divisions. This is to a considerable extent true, although it is probable that Mr. Wallace would object to this view being the natural outcome of his argument. Here it may be premised that in their indications the mammals are somewhat intermediate between the birds and fishes. And, by the way, we must wonder that when Mr. Wallace considers the distribution of the mammals as all-important, and that "the negative character of the absence of certain families or genera is of equal importance" to the positive character of their presence (vol. i. p. 54), he has refused to recognize the distinction of the Polynesian and New Zealand subregions of his Australian region from the Australian and Austro-Malayan.* His reasons for so doing (vol. i. p. 62) might be extended equally to the negation of one at least of his admitted regions.

As to the geographical distribution of marine animals Mr. Wallace has been quite reticent, simply giving some facts respecting the range of families of sea mammals, fishes, and mollusks in the fourth part of his work, and some brief general remarks in the first (*e.g.*, vol. i. pp. 15, 30). At any rate, he nowhere insists upon the want of correlation between the inland and marine faunas, and no reader would be enlightened as to the positive incongruity, and even contrast, between the two in their relations with others. This antagonism has been appreciated by very few. In most works it is quietly assumed or insisted upon that the sea and inland animals of a given region are integral constituents of a homogeneous fauna, and by implication, at least, that such fauna has in its several parts one and the same relation to others. Such is very far from being the case. In the distribution of marine life temperature plays an all-important part. Thus, the relations between the successive faunas, in a latitudinal direction, of the shores of the several continents are traversed by relations existing in a longitudinal direction. The several tropical faunas are, for example, much more closely related to each other than they are to the faunas along the same reach of shore toward the arctic or antarctic regions. This relationship is evinced more or less in every class and branch of animals, *e.g.*, the mammals, the fishes, the mollusks, the crustaceans, the worms, the echinoderms, and the cœlenterates. Consequently the marine faunas cannot be at all correlated with the primary realms or regions of the globe. To such an extent does temperature determine the distribution of life in the seas that even bathymetrical conditions *may be* subordinated, and types of the shallow arctic and antarctic seas represented in the cold deep sea under the equator. Some forms almost identical reappear at the opposite poles. The inference is irresistible that such types have migrated from common ground, and may have originally developed either in the deep sea and thence dispersed in opposite directions, or at one of the extremes and wandered thence over the bottom to their final resting places. However this may be, a primary combination of the marine faunas is most natural under the categories of tropicalian, arctalian, and notalian, while the temperate ones are rather the complexes of the bounding regions.

It is impossible within the limits of a review to discuss the numerous questions raised in Mr. Wallace's work, or to notice errors of detail. Numerous as are the subjects discussed, many of equal importance are scarcely, if at all, noticed. Such are the correlations between development in size, as a whole and in different parts, and longitude and latitude; the correlation of color with surface of country; and the connection of physiological modifications and habitat. We have to say, too, that the errors in detail are extremely numerous, and are sometimes the results of imperfect information *per se*, and sometimes of misunderstanding of the authorities consulted. Some of these errors are very grave. Thus, Mr. Wallace informs us that "the operculata of the globe are about one-seventh, the inoperculata about six-sevenths of the whole" of the terrestrial gastropods; "but when we come to the Antilles we find them to amount to nearly five-sixths, about half the operculata of the globe being found there!" (vol. ii. p. 527; the exclamation mark is Mr. Wallace's own). The truth is that in the Antilles the operculate species are, as elsewhere (although in a much less degree), very much less numerous than the inoperculate, there being, according to Mr. Bland in 1866 (whom Mr. Wallace quotes), only 603 operculate to 737 inoperculate species. How Mr. Wallace happened to make such an astounding blunder it is difficult to conceive. But we add with pleasure that even this error is to a considerable extent atoned for by the judicious remarks on principles of distribution which immediately follow. The want of familiar knowledge of the different classes treated of, and consequently of immediate and instinctive availability of the facts, has often prevented the author from following the facts to their logical results. Mr. Wallace's aim was a lofty and laudable one, viz.: "that his book should bear a similar relation to the eleventh and twelfth chapters of the 'Origin of Species' as Mr. Darwin's 'Animals and Plants under Domestication' does to the first chapter of that work." His want of knowledge and of research, however, has certainly prevented him from attaining "the standard of excellence" he so nobly aimed at. He is an ornithologist so far as knowledge of the skins and external features, as well as habits, of a number of birds may constitute one; in like manner he is an entomologist; his acquaintance with mammals is slight; he evidently knows almost or absolutely nothing, through autopsy, of the reptiles, amphibians, pisciform vertebrates, and mollusks. By travel in many lands he has gained vivid conceptions of distances and physiographical features, and the *tout ensemble* of animal and vegetable types. Such are his qualifications and want of qualifications for the work undertaken. He can undoubtedly plead his imperfection of knowledge in bar of criticism, and maintain that, for example, he relied for ichthyology on Günther, and for conchology on Woodward. This is a valid plea so far as it goes, even though his suspicions might have been aroused; "for," says he, "when we find a group of [family or generic] rank scattered, as it were, at random over the earth, we have a strong presumption that it is not natural" (vol i. p. 84). Indeed, it might even be a plea for total silence on the subject; for surely it is not unreasonable to demand that a writer should have some knowledge of what he would treat about. We have a right to demand that he should at least have knowledge sufficient to select in matters of dispute.

The imperfections thus indicated detract materially from the value of Mr. Wallace's work. Nevertheless it is a valuable work. A great number of facts, real or apparent, are brought together in new connection; the argumentation on those facts is mostly logical; the composition is generally very good, and much pleasant reading is afforded; the pleasure of perusal is enhanced by the large, clear type. (The American edition is printed apparently from electrotype plates of the English one; but in the binding and in compactness the former is superior to the latter.) There are also several chapters which indicate considerable familiarity with the subjects treated of, as well as a more than moderate acumen. Such are those on "the means of dispersal and the migrations of animals" (vol. i. pp. 10–34), and "distribution as affected by the conditions and changes of the earth's surface" (vol. i. pp. 35–49), as well as those parts of the one on "the oriental region" relative to the Indo-Malayan subregion (vol. i. pp. 334–362). Perhaps, then, on the whole, we should be justified in closing, even at the cost of adding to the onerous duties already imposed, with the trite old formula that "no gentleman's library will be complete without it." We at least recommend it to those interested as worthy of perusal, and as being, on the whole, really the best general work on the subject under discussion that has yet been published.

* There are no indigenous terrestrial mammals in New Zealand or Polynesia, while they are richly developed in the Australian and Papuan regions.