NOTES ON THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

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THE study of the geographical distribution of living and extinct organisms has recently become one of the most important branches of philosophical natural history, from the light which it throws both on the former condition of the earth, and on the greatest scientific question of the day, namely, that of the origin of species. The geographical distribution of animals has lately received much attention, the most important contribution to the subject being a large work by Mr. A. R. Wallace; but in the present paper we propose to bring together such observations as may prove interesting, either from their importance or from their having been less fully discussed elsewhere.

Most naturalists are now agreed in recognising six main regions of geographical distribution, as originally proposed by Dr. Sclater, viz. the Palæarctic, Ethiopian (or African), Indian (or Oriental), Australian, Neotropical (or tropical American), and Nearctic (or North American) regions. The Palæarctic region includes Europe, North Africa, the northern half of Arabia, and the whole of Western and Northern Asia, as far as the Indus and Himalayas, and a line drawn eastwards, running south of Thibet and Mongolia, and somewhat north of Formosa. The Indian region includes, besides South Asia, the large islands of Borneo, Java, Sumatra, and the Philippines; but the islands further to the east belong to the Australian region. The Neotropical region includes the West Indies, Central and South America, and the south of Mexico; the remaining regions require no further explanation.

Although these regions are generally recognised as natural, we must not consider the divisions between them as hard and fast lines, except that between the Indian and Australian regions, where the island of Celebes is almost the only de-

batable ground. Indeed, the fauna of much of the west coast of America, especially that of California and Chili, exhibits such marked affinities with that of the Palæarctic region, that these countries have been regarded by some writers rather as outlying districts of the latter than as biological portions of the continents to which they actually belong. It is also to be observed that this division of the world into six main regions is more applicable to some groups of animals and plants than to others. Various attempts have been made to subdivide the regions, but though some subdivisions, such as the Mediterranean subregion, are eminently natural, our knowledge of the natural productions of most of the regions is not yet sufficiently exact to allow of their being divided in such a manner as to gain the general assent of naturalists.

Owing to the much greater competition of rival forms in large continents, the larger and more highly developed forms always appear to have originated and been brought to relative perfection on the greatest continuous districts of land. But notwithstanding the frequent alterations of level during geological ages, which have constantly united or separated various portions of the earth's surface, yet it appears that the largest masses of land, though differing in outline and continuity, have always occupied nearly the same places; that is, it is more probable that the contour of former continents has been changed by gradual increase or diminution, than that a whole continent should be submerged or elevated *de novo*. It also appears that the northern hemisphere, and more especially the Palæarctic region, has been the birthplace of most of the principal groups of animals, including those now confined to tropical Africa, or even to South America.* Nor need this surprise us, poor as is the present Palæarctic region, when we consider the great vicissitudes to which this region has been more especially exposed, and the many conditions unfavourable to animal life which it now presents. There is little doubt that the amazingly rich fauna possessed by Europe previous to the glacial epoch was then almost entirely swept out of it, a very large proportion of its original fauna and flora being either wholly exterminated or driven into distant regions, whence, on the abatement of the cold, their descendants would return very slowly, if at all. Besides, it is urged by Mr. Belt that during the glacial period such vast masses of water were locked up in snow and ice that the average level of the sea

* This is confirmed even by groups of which very few fossil remains exist. Mr. S. H. Scudder, in his recent work on fossil butterflies, only admits nine species, all European; but of these four are preponderatingly American in their affinities, three Oriental, one Mediterranean, and one African.

would be at least 1,000 feet lower than at present, and probably far more. This would lay bare great tracts of land possessing a much warmer climate than any other portion of the globe at that time, where many tropical forms may have survived the glacial period, though some would doubtless have been subsequently exterminated by the great floods which Mr. Belt argues would have occurred towards its close, from the melting of the ice. This view receives considerable support from the numerous traditions of submerged countries in the Atlantic, and off the coasts of China, India, Ceylon, and East Africa.

Great changes have recently taken place in the inland seas of the Palæarctic region. It was formerly bounded to the south by a great inland sea, resembling the Mediterranean, occupying the place of the Sahara; and a chain of inland lakes appears to have extended from Spain to the Black Sea. Wallace believes the Mediterranean to have then consisted of two great lakes, while North Africa was connected with Spain and Italy by extensive tracts of land now submerged. At this time, too, much of Northern Asia may have been depressed below the sea, or, at any rate, the great lakes, such as the Caspian, Aral, and Baikal, appear to have communicated with the Arctic Ocean. But there is still much obscurity relating to the geological history of Northern Asia; and until increased facilities of communication and changes in politics render China and Asiatic Russia more accessible to scientific men, it cannot be entirely cleared up. It is so difficult to account for the total disappearance of such forms as the mammoth from a country like Siberia, that some have suggested that they were destroyed by floods, to which indeed a great part of Central and Northern Asia was very probably subject, considering the much greater number and extent of the inland seas in former times, even if a large portion of the country was not actually covered by the Arctic Ocean. Much valuable geological information relating to Northern Asia in recent times must be still locked up in Chinese annals; and I have not yet met with any history by a competent geologist of the series of great volcanic disturbances, inclusive of earthquakes and floods, which devastated China during the first half of the fourteenth century, and which were felt with great severity at least as far as Austria and Greenland, and indirectly over the whole of the then known world, and there is reason to believe even in America. A history of these extraordinary phenomena, which are unparalleled in modern times for their extent and severity, if collected from the numerous available materials, and worked up by a competent hand, would be of the greatest scientific value.*

* The most accessible account of this period is perhaps that in Hecker's History of the Black Death, in his "Epidemics of the Middle Ages."

And here I may remark that I am convinced that great light would probably be thrown on the former state of the world in historic times by the study of Oriental literature by scientific men. There has been much discussion among Orientalists about the identification of the islands of Wák-wák, mentioned by Arab geographers, as well as in the "Arabian Nights." These are the islands, seven years' journey from Baghdád, where the trees bear fruit in the shape of female heads, suspended by the hair, which cry out, "Wák-wák" at sunrise and sunset. Then, to connect these islands more distinctly with birds, they are inhabited by jinneeyehs, who fly about in feather-dresses, which are sometimes stolen by some enterprising hero. Wallace describes the great bird of Paradise (*Paradisea apoda*) as being very abundant in the Aru Islands, and settling on the trees in flocks at sunrise, uttering a loud and shrill note audible at a great distance, which sounds like "wawk-wawk-wawk-wŏk-wŏk-wŏk." Anyone who will consult Lane's "Arabian Nights," vol. iii. chap. 25, note 32, and Wallace's account of the Great Bird of Paradise, in his "Malay Archipelago," chap. 38, will, I think, be convinced, like myself, of the identity of the Aru Islands with the islands of Wák-wák of the Arabian writers.* But even when animals are spoken of under their proper names, it will often be no easy matter to identify them in a translation; for I have generally found that the English, French, and German equivalents for the vernacular names of common animals or plants are rarely to be ascertained with any accuracy from the best existing dictionaries; and this difficulty would be greatly increased in the case of Oriental or ancient writings, in which animals, perhaps now extinct, would frequently be described in very hyperbolical language.

To return from this digression to Europe, we need not wonder that its present fauna is so much poorer than in post-glacial times, or even than a few centuries ago. The advance of cultivation, the felling of forests, and the draining of marshes have exterminated many species, even in our own day, while others have been destroyed as noxious creatures, as the wolf in Britain, and the lion in Germany† and Greece. Others were exterminated for food, as the great auk in the northern regions; and the urus and aurochs, both now almost extinct, the former only existing as *Bos scoticus*, and the other in Lithuania and the Caucasus, the last being the only locality where it is still actually wild. As, however, these wild cattle

* I am not aware that the reputed occurrence of this bird in New Guinea has been confirmed; and the islands of Wák-wák are always spoken of in the plural.

† Which it is believed to have inhabited during the heroic age.

are fierce and dangerous animals, they may have been exterminated partly for this reason. A very interesting volume could be written on the animals which have disappeared from Europe within historic times. When the ancient world was overrun by huge and destructive animals, it must have been difficult for men to make any progress in civilization; but when the glacial epoch had swept all before it, it was much easier for men to improve their condition. So far as we know, the ancient centres of civilization, such as Central Asia and Egypt, were less overrun with wild beasts than others.

The islands of Corsica and Sardinia, though barely alluded to by Wallace, are interesting from the number of peculiar species which they already contain, and for the still larger number of local forms, which, if isolated for a sufficient time, will ultimately become perfectly distinct species. Their fauna appears to have been derived from the mainland of Italy at a period when that country was already fully stocked with its present fauna, as they possess a large proportion of the Italian species. They have apparently been separated from the mainland for a much longer period than Britain from France; for, although Guénée calls Britain "le pays des variétés," well-marked species have not yet had time to develop themselves. Here, however, other considerations step in. The much hotter and finer climate of Corsica and Sardinia may have stimulated the more rapid differentiation of species. And although we are still ignorant of many of the laws which govern the range of species, yet it appears from the large proportion of species common on the French coast, and not extending to Britain, that Britain was separated from France before France had fully acquired its present fauna and flora. The same reasoning will apply to Ireland, which is much poorer in species than Britain.

Some writers think that the Glacial Period has not wholly passed away, and that the earth has not yet recovered its normal temperature; and although it would require a long series of observations, extending over many years, if not centuries, to arrive at absolute certainty, yet there are some historical grounds for believing that the climate of all Europe was much more severe only 2,000 years ago than at present.* How far the clearing of forests, &c., may have influenced the climate we do not yet know, nor whether its gradual improvement is due to local or general causes. It is quite possible that the animals and plants now confined to Eastern, Southern, or Central Europe are still extending their range north and west, so far as they meet with no barriers to their further migrations.

* Compare Mallet's "Northern Antiquities," pp. 242, 243.

In the case of the British Islands, there are other conditions besides breaks of geographical continuity which hinder the spread of some species. The unfavourable climate of the northern and western portions is probably one cause of the restricted range of many species, and their total absence from Scotland, Ireland, and in many cases, even from the north or west of England. Nothing strikes a naturalist, accustomed to the comparative abundance of insect life, even in the south of England, than its usual scantiness in Ireland, although the latter country probably possesses about two-thirds of our English species.

The Mediterranean subregion presents us with several interesting problems, in addition to some previously mentioned. During the time that Spain and Italy have been separated from North Africa, great changes have occurred in the insects of the opposite coasts, as well as in the larger animals which now inhabit those countries. Oberthur, in his recently published work on the Lepidoptera of Algeria, doubts if any Algerian species of *Zygæna* is identical with any European species. This, however, might perhaps be expected, for the genus *Zygæna* consists of a great number of closely allied and highly variable species which have their head-quarters in the Mediterranean subregion; and while some groups of animals (as many Mollusca) may remain almost unchanged for entire geological periods, yet others, which, like the species of *Zygæna*, are specifically unstable, may become modified very rapidly. But, notwithstanding the large amount of specialty in the Algerian insect-fauna, it is essentially the same as the European, and the African element is exceedingly small. (There are some species of insects confined to South Spain and South Russia. These are probably very ancient forms, and may even be relics of the preglacial Palæarctic insect-fauna.) The large mammals of Algeria are apparently nearly all of African origin, having crossed from the south after the Glacial Epoch, and subsequently to the disappearance of the Saharan sea, and to the final separation of Europe and Africa, although some identical species of wide range penetrated into, or perhaps returned to Europe through Asia Minor, such, for instance, as the lion.

The Ethiopian Region, or Africa, is at the present day chiefly remarkable for the great number of large mammalia which inhabit it. Many of these, though formerly abundant in Europe and India, have long disappeared from both countries; and Africa has now a highly specialized character of its own. The Malagasy subregion, including Madagascar and the adjacent islands, is peculiarly remarkable, and "appears to indicate a very ancient connection with the southern portion of Africa, before the apes, ungulates, and felines had entered it"

(Wallace, "Geogr. Distr." i. p. 273). The insects of Madagascar, however, are closely allied to existing African species, and many of the most remarkable, formerly supposed to be peculiar to the island, have since been received from Natal or Zanzibar. There is also a considerable resemblance between the Mascarene fauna, and that of distant parts of the world, in which connection we may refer to the numerous traditions, previously mentioned, of recent subsidences in various parts of the Indian Ocean.

As a rule, competition is far more severe on continents than on islands; hence the great number of peculiar forms which survive in islands, though long superseded on continents, and it appears that according to this principle, the insects of Madagascar have become less strongly modified than those of the African Continent, and therefore represent to some extent a more ancient fauna. A remarkable case is afforded by two pairs of butterflies, inhabiting different parts of the world. One is *Papilis Merope*, a large black and white butterfly, with tails on the hind wings, found all over Tropical Africa, and varying considerably in different localities. The females are altogether unlike the male, being without a tail, and of a totally different shape and colour, resembling butterflies of other groups, which are protected from birds, &c., by their nauseous odour. But *P. Merope* is represented in Madagascar by *P. Meriones*, the female of which only differs from the male in the presence of an additional black bar on the fore wings. The other example is that of *Argynnis Niphe*, a common Indian species, which is tawny, with black spots, and the female of which has the tips of the forewings broadly dusky, with a black bar across them, giving it a great resemblance to *Danaus Chrysippus*, a widely distributed insect, which is "mimicked" in the same way by the females of several other butterflies besides *A. Niphe*, even including one of the female varieties of *Papilio Merope*, already referred to. But the Australian representative of *A. Niphe* (*A. inconstans*), though differing so little from the male of *A. Niphe* that it was long considered to be no more than a slight local variety, has the sexes alike, the female having no white bar on the wings, although a small *Danaus* (*D. Petilia*), closely allied to *D. Chrysippus*, is also found in Australia.

Turning to the Oriental Region, we find that North India is much richer in species than the south. This is partly owing to the greater variety of elevation (just as the southern peninsulas of Europe are poorer in species than the districts in which the central ranges lie*), but not entirely, since many North Indian

* Andalusia scarcely produces more species of butterflies than Sweden; Austria, Switzerland, or South France have nearly twice as many.

species, not found in South India, reappear in the Malayan peninsula and islands. The spread of Indian forms into Europe has been much checked by the position of the mountain ranges. Where these are more open, as along the coast of China and Japan, we find Indian forms extending much further north, and mingling with those which really belong to the Palæarctic Region.

One of the most striking features in the Australian Region in recent times was the abundance of large wingless birds, now mostly extinct. Traditions, more or less authentic, relating to the great birds of the remote islands, are common in Oriental writers, who referred to them under the names of Rukh, Seemurgh, Anka, &c. The rukh was said by Middle Age writers to be found in Madagascar (doubtless referring to the *Æpyornis* or its egg); but the Arabian writers always give the rukh the habits of an eagle or a vulture. The Arabs, we know, extended their voyages at least as far as Madagascar and the Aru Islands, and there is no improbability in their having also visited New Zealand, where I believe that remains of a gigantic bird of prey have recently been met with. The Arabs, of course, were well acquainted with the ostrich, now the largest living bird; hence, nothing but the great extinct birds could have given rise to the stories of the rukh. The Persians, less acquainted with these distant countries than the Arabs, made a mythological bird of the Seemurgh, but there is little incredible in the Arabian accounts of the rukh, except its gigantic size. The Greek or German Griffin may have had a similar origin.*

The Neotropical Region presents a great contrast to Africa, the other southern continent, for instead of a preponderance of large mammalia, we have here an enormous abundance of some of the smaller forms of life; in some groups, as, for instance butterflies, more than half of all the known species come from Tropical America.

The Nearctic Region, though somewhat poor in special forms as compared with the Palæarctic, to which its affinities are so close that it could scarcely be separated as a distinct region, if we confined ourselves to isolated groups, yet possesses as many large mammalia as South America. The fauna of both North and South America was formerly much richer than at present; but the Glacial Period was as destructive in North America as in Europe. What caused the destruction of the large mammalia

* The Rukh, or Roc, as in our old translation of the "Arabian Nights," is only alluded to, so far as we remember, in connection with its egg; the egg was probably that of *Æpyornis*, and the bird manufactured to suit it.—Ed.

in South America is less certainly known; but Africa is now the only region which is sufficiently rich in the higher forms of life to lead us to suppose that it in any degree adequately represents the zoology of former times; and it appears to have been exposed in a less degree than other countries to the agencies which have destroyed animal life to so great an extent elsewhere.

In concluding this somewhat desultory article, we may remark that, contrary to the general idea, extreme heat seems to have a tendency to reduce the size of animals. The largest known animals are, or were, natives of cold countries; and most insects common to Europe or Japan, and India, are considerably smaller in the latter country. Even the tropical representatives of widely distributed genera are nearly always inferior in size and beauty to temperate forms.