THE

GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

PART I.

THE PRINCIPLES AND GENERAL PHENOMENA OF DISTRIBUTION.

CHAPTER I.

INTRODUCTORY.

It is a fact within the experience of most persons, that the various species of animals are not uniformly dispersed over the surface of the country. If we have a tolerable acquaintance with any district, be it a parish, a county, or a larger extent of territory, we soon become aware that each well-marked portion of it has some peculiarities in its animal productions. If we want to find certain birds or certain insects, we have not only to choose the right season but to go to the right place. If we travel beyond our district in various directions we shall almost certainly meet with something new to us; some species which we were accustomed to see almost daily will disappear, others which we have never seen before will make their appearance. If we go very far, so as to be able to measure our journey by degrees of latitude and longitude and to perceive important changes of climate and vegetation, the differences in the forms of animal life will become greater; till at length we shall come to a country where almost everything will be new, all the familiar creatures of our own district being replaced by others more or less differing from them.

If we have been observant during our several journeys, and have combined and compared the facts we have collected, it will become apparent that the change we have witnessed has been of two distinct kinds. In our own and immediately surrounding districts, particular species appeared and disappeared because

the soil, the aspect, or the vegetation, was adapted to them or the reverse. The marshes, the heaths, the woods and forests, the chalky downs, the rocky mountains, had each their peculiar inhabitants, which reappeared again and again as we came to tracts of country suitable for them. But as we got further away we began to find that localities very similar to those we had left behind were inhabited by a somewhat different set of species; and this difference increased with distance, notwithstanding that almost identical external conditions might be often met with. The first class of changes is that of *stations;* the second that of *habitats.* The one is a *local,* the other a *geographical* phenomenon. The whole area over which a particular animal is found may consist of any number of *stations,* but rarely of more than one *habitat.* Stations, however, are often so extensive as to include the entire range of many species. Such are the great seas and oceans, the Siberian or the Amazonian forests, the North African deserts, the Andean or the Himalayan highlands.

There is yet another difference in the nature of the change we have been considering. The new animals which we meet with as we travel in any direction from our starting point, are some of them very much like those we have left behind us, and can be at once referred to familiar types; while others are altogether unlike anything we have seen at home. When we reach the Alps we find another kind of squirrel, in Southern Italy a distinct mole, in Southern Europe fresh warblers and unfamiliar buntings. We meet also with totally new forms; as the glutton and the snowy owl in Northern, the genet and the hoopoe in Southern, and the saiga antelope and collared pratincole in Eastern Europe. The first series are examples of what are termed *representative species,* the second of distinct groups or *types* of animals. The one represents a comparatively recent modification, and an origin in or near the locality where it occurs; the other is a result of very ancient changes both organic and inorganic, and is connected with some of the most curious and difficult of the problems we shall have to discuss.

Having thus defined our subject, let us glance at the opinions that have generally prevailed as to the nature and causes of the phenomena presented by the geographical distribution of animals.

It was long thought, and is still a popular notion, that the manner in which the various kinds of animals are dispersed over the globe is almost wholly due to diversities of climate and of vegetation. There is indeed much to favour this belief. The arctic regions are strongly characterised by their white bears and foxes, their reindeer, ermine, and walruses, their white ptarmigan, owls, and falcons; the temperate zone has its foxes and wolves, its rabbits, sheep, beavers, and marmots, its sparrows and its song birds; while tropical regions alone produce apes and elephants, parrots and peacocks, and a thousand strange quadrupeds and brilliant birds which are found nowhere in the cooler regions. So the camel, the gazelle and the ostrich live in the desert; the bison on the prairie; the tapir, the deer, and the jaguar in forests. Mountains and marshes, plains and rocky precipices, have each their animal inhabitants; and it might well be thought, in the absence of accurate inquiry, that these and other differences would sufficiently explain why most of the regions and countries into which the earth is popularly divided should have certain animals peculiar to them and should want others which are elsewhere abundant.

A more detailed and accurate knowledge of the productions of different portions of the earth soon showed that this explanation was quite insufficient; for it was found that countries exceedingly similar in climate and all physical features may yet have very distinct animal populations. The equatorial parts of Africa and South America, for example, are very similar in climate and are both covered with luxuriant forests, yet their animal life is widely different; elephants, apes, leopards, guinea-fowls and touracos in the one, are replaced by tapirs, prehensile-tailed monkeys, jaguars, curassows and toucans in the other. Again, parts of South Africa and Australia are wonderfully similar in their soil and climate; yet one has lions, antelopes, zebras and giraffes; the other only kangaroos, wombats, phalan-

gers and mice. In like manner parts of North America and Europe are very similar in all essentials of soil climate and vegetation, yet the former has racoons, opossums, and humming-birds; while the latter possesses moles, hedgehogs and true fly-catchers. Equally striking are the facts presented by the distribution of many large and important groups of animals. Marsupials (opossums, phalangers &c.) are found from temperate Van Diemen's land to the tropical islands of New Guinea and Celebes, and in America from Chili to Virginia. No crows exist in South America, while they inhabit every other part of the world, not excepting Australia. Antelopes are found only in Africa and Asia; the sloths only in South America; the true lemurs are confined to Madagascar, and the birds-of-paradise to New Guinea.

If we examine more closely the distribution of animals in any extensive region, we find that different, though closely allied species, are often found on the opposite sides of any considerable barrier to their migration. Thus, on the two sides of the Andes and Rocky Mountains in America, almost all the mammalia, birds, and insects are of distinct species. To a less extent, the Alps and Pyrenees form a similar barrier, and even great rivers and river plains, as those of the Amazon and Ganges, separate more or less distinct groups of animals. Arms of the sea are still more effective, if they are permanent; a circumstance in some measure indicated by their depth. Thus islands far away from land almost always have very peculiar animals found nowhere else; as is strikingly the case in Madagascar and New Zealand, and to a less degree in the West India islands. But shallow straits, like the English Channel or the Straits of Malacca, are not found to have the same effect, the animals being nearly or quite identical on their opposite shores. A change of climate or a change of vegetation may form an equally effective barrier to migration. Many tropical and polar animals are pretty accurately limited by certain isothermal lines; and the limits of the great forests in most parts of the world strictly determine the ranges of many species.

Naturalists have now arrived at the conclusion, that by some

slow process of development or transmutation, all animals have been produced from those which preceded them; and the old notion that every species was specially created as they now exist, at a particular time and in a particular spot, is abandoned as opposed to many striking facts, and unsupported by any evidence. This modification of animal forms took place very slowly, so that the historical period of three or four thousand years has hardly produced any perceptible change in a single species. Even the time since the last glacial epoch, which on the very lowest estimate must be from 50,000 to 100,000 years, has only served to modify a few of the higher animals into very slightly different species. The changes of the forms of animals appear to have accompanied, and perhaps to have depended on, changes of physical geography, of climate, or of vegetation; since it is evident that an animal which is well adapted to one condition of things will require to be slightly changed in constitution or habits, and therefore generally in form, structure, or colour, in order to be equally well adapted to a changed condition of surrounding circumstances. Animals multiply so rapidly, that we may consider them as continually trying to extend their range; and thus any new land raised above the sea by geological causes becomes immediately peopled by a crowd of competing inhabitants, the strongest and best adapted of which alone succeed in maintaining their position.

If we keep in view these facts—that the minor features of the earth's surface are everywhere slowly changing; that the forms, and structure, and habits of all living things are also slowly changing; while the great features of the earth, the continents, and oceans, and loftiest mountain ranges, only change after very long intervals and with extreme slowness; we must see that the present distribution of animals upon the several parts of the earth's surface is the final product of all these wonderful revolutions in organic and inorganic nature. The greatest and most radical differences in the productions of any part of the globe must be dependent on isolation by the most effectual and most permanent barriers. That ocean which has remained broadest and deepest from the most remote geological epoch

will separate countries the productions of which most widely and radically differ; while the most recently-depressed seas, or the last-formed mountain ranges, will separate countries the productions of which are almost or quite identical. It will be evident, therefore, that the study of the distribution of animals and plants may add greatly to our knowledge of the past history of our globe. It may reveal to us, in a manner which no other evidence can, which are the oldest and most permanent features of the earth's surface, and which the newest. It may indicate the existence of islands or continents now sunk beneath the ocean, and which have left no record of their existence save the animal and vegetable productions which have migrated to adjacent lands. It thus becomes an important adjunct to geology, which can rarely do more than determine what lands have been raised above the waters, under what conditions and at what period; but can seldom ascertain anything of the position or extent of those which have sunk beneath it. Our present study may often enable us, not only to say where lands must have recently disappeared, but also to form some judgment as to their extent, and the time that has elapsed since their submersion.

Having thus briefly sketched the nature and objects of the subject we have to study, it will be necessary—before entering on a detailed examination of the zoological features of the different parts of the earth, and of the distribution of the orders, families, and genera of animals—to examine certain preliminary facts and principles essential for our guidance. We must first inquire what are the powers of multiplication and dispersal of the various groups of animals, and the nature of the barriers that most effectually limit their range. We have then to consider the effects of changes in physical geography and in climate; to examine the nature and extent of such changes as have been known to occur; to determine what others are possible or probable; and to ascertain the various modes in which such changes affect the structure, the distribution, or the very existence of animals.

Two subjects of a different nature must next engage our attention. We have to deal with two vast masses of facts, each involving countless details, and requiring subdivision and grouping to be capable of intelligible treatment. All the continents and their chief subdivisions, and all the more important islands of the globe, have to be compared as regards their various animal forms. To do this effectively we require a natural division of the earth especially adapted to our purpose; and we shall have to discuss at some length the reasons for the particular system adopted,—a discussion which must to some extent anticipate and summarize the conclusions of the whole work. We have also to deal with many hundreds of families and many thousands of genera of animals, and here too a true and natural classification is of great importance. We must therefore give a connected view of the classification adopted in the various classes of animals dealt with.

And lastly, as the existing distribution of animals is the result and outcome of all preceding changes of the earth and of its inhabitants, we require as much knowledge as we can get of the animals of each country during past geological epochs, in order to interpret the facts we shall accumulate. We shall, therefore, enter upon a somewhat detailed sketch of the various forms of extinct animals that have lived upon the earth during the Tertiary period; discuss their migrations at various epochs, the changes of physical geography that they imply, and the extent to which they enable us to determine the birthplace of certain families and genera.

The preliminary studies above enumerated will, it is believed, enable us to see the bearing of many facts in the distribution of animals that would otherwise be insoluble problems; and, what is hardly less valuable, will teach us to estimate the comparative importance of the various groups of animals, and to avoid the common error of cutting the gordian knot of each difficulty by vast hypothetical changes in existing continents and oceans —probably the most permanent features of our globe.

CHAPTER II.

THE MEANS OF DISPERSAL AND THE MIGRATIONS OF ANIMALS.

ALL animals are capable of multiplying so rapidly, that if a single pair were placed in a continent with abundance of food and no enemies, they might fully stock it in a very short time. Thus, a bird which produces ten pairs of young during its life-time (and this is far below the fertility of many birds) will, if we take its life at five years, increase to a hundred millions in about forty years, a number sufficient to stock a large country. Many fishes and insects are capable of multiplying several thousandfold each year, so that in a few years they would reach billions and trillions. Even large and slow breeding mammals, which have only one at a birth but continue to breed from eight to ten successive years, may increase from a single pair to ten millions in less than forty years.

But as animals rarely have an unoccupied country to breed in, and as the food in any one district is strictly limited, their natural tendency is to roam in every direction in search of fresh pastures, or new hunting grounds. In doing so, however, they meet with many obstacles. Rocks and mountains have to be climbed, rivers or marshes to be crossed, deserts or forests to be traversed; while narrow straits or wider arms of the sea separate islands from the main land or continents from each other. We have now to inquire what facilities the different classes of animals have for overcoming these obstacles, and what kind of barriers are most effectual in checking their progress.

Means of Dispersal of Mammalia.—Many of the largest mammalia are able to roam over whole continents and are hardly