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ART. I. — GEOGRAPHICAL DISTRIBUTION OF ANIMALS.

THE greatest obstacles in the way of investigating the laws of the distribution of organized beings over the surface of our globe, are to be traced to the views generally entertained about their origin. There is a prevailing opinion, which ascribes to all living beings upon earth one common centre of origin, from which it is supposed they, in the course of time, spread over wider and wider areas, till they finally came into their present state of distribution. And what gives this view a higher recommendation in the opinion of most men is the circumstance, that such a method of distribution is considered as revealed in our sacred writings. We hope, however, to be able to show that there is no such statement in the book of Genesis; that this doctrine of a unique centre of origin and successive distribution of all animals is of very modern invention, and that it can be traced back for scarcely more than a century in the records of our science.

There is another view, to which, more recently, naturalists have seemed to incline; namely, the assuming several centres of origin, from which organized beings were afterwards diffused over wider areas, in the same manner as according to the first theory, the difference being only in the assumption of several centres of dispersion instead of a single one.

We have recently been led to take a very different view

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of the subject, and shall presently illustrate the facts upon which the view rests. But before we undertake to introduce more directly this subject, there is another point which requires preliminary investigation, which seems to have been entirely lost sight of by all those, without exception, who have studied the geographical distribution of animals, and which seems to us to be the keystone of the whole edifice, whenever we undertake to reconstruct the primitive plan of the geographical distribution of animals and plants. The distribution of organized beings over the surface of our globe in its present condition cannot be considered in itself, and without an investigation, at the same time, of the geographical distribution of those organized beings which have existed in former geological periods, and had become extinct before those of the present creation were called into being. For it is well ascertained now that there is a natural succession in the plan of creation, an intimate connection between all the types of the different periods of the creation from its beginning up to this day; so much so, that the present distribution of animals and plants is the continuation of an order of things which prevailed for a time at an earlier period, but which came to an end before the existing arrangement of things was introduced.

The animal kingdom, as we know it in our days, is therefore engrafted upon its condition in earlier periods, and it is to the distribution of animals in these earlier periods that we must look, if we would trace the plan of the Creator from its commencement to its more advanced development in our own time.

If there is any truth in the view that animals and plants originated from a common centre, it must be at the same time shown that such an intimate connection between the animals existed at all periods, or, at least, we should, before assuming such a view for the animals living in our days, discover a sufficient reason for ascribing to them another mode of dispersion than to the animals and plants of former periods. But there is such a wonderful harmony in all the great processes of nature, that, at the outset, we should be carefully on our guard against assuming different modes of distribution for the organized beings of former periods, and for those which at present cover the globe. Should it be plain that the ani-

imals and plants did not originate from a common centre at the beginning of the creation, and during the different successive geological periods, we have at once a strong indication that neither has such been the case with the animals of the present day. And, on the other hand, if there were satisfactory evidence that the animals and plants now living originated from a common centre, we should consider the matter carefully, before trusting to the views derived from geological facts. Let us, therefore, examine first the value of the evidence on both sides.

We have already expressed, and we repeat here, our earnest belief that the view of a unique centre of origin and distribution rests chiefly upon the supposed authority of the Mosaic record, and is in no way sustained by evidence derived from investigations in natural history. On the contrary, wherever we trace the animals in their present distributions, we find them scattered over the surface of our globe in such a manner, according to such laws, and under such special adaptations, that it would baffle the most fanciful imagination to conceive such an arrangement as the mere result of migrations, or of the influence of physical causes over the dispersion of both animals and plants. For we find that all animals and plants of the arctic zones agree in certain respects and are uniform over the three continents which verge towards the northern pole, whilst those of the temperate zone agree also in certain respects, but differ somewhat from each other within definite limits, in the respective continents. And the differences grow more and more prominent as we approach the tropical zone, which has its peculiar Fauna and Flora in each continent; so much so, that it is impossible for us to conceive such a normal arrangement, unless it be the result of a premeditated plan carried out voluntarily according to predetermined laws.

The opinion which is considered as the Biblical view of the case, and according to which all animals have originated in a common centre, would leave us at a loss for any cause by which to account for the special dispersion of animals and plants beyond the mere necessity of removing from the crowded ground to assume wider limits, as their increased number made it constantly more and more necessary and imperative. According to this view,

the animals of the arctic zone, as well as those of the tropics, — those of America, as well as those of New Holland, — have been first created upon the high lands of Iran, and have taken their course in all directions to settle where they are now found to be strictly limited. It does not appear how such migrations of polar animals could have taken place over the warmer tracts of land which they had to cross, and in which they cannot even be kept alive, in our days, with the utmost precautions; nor how the terrestrial animals of New Holland, which have no analogues in the main continents, could have reached that large island, nor why they should have all moved thither. And, indeed, it is impossible, with such a theory, to account, either for the special adaptation of types to particular districts of the earth's surface, or for the limited distribution of so many species which are found only over narrow districts in their present arrangement. It is inconsistent with the structure, habits, and natural instincts of most animals, even to suppose that they could have migrated over any great distances. It is in complete contradiction with the laws of nature, and all we know of the changes our globe has undergone, to imagine that the animals have actually adapted themselves to their various circumstances during their migration, as this would be ascribing to physical influences as much power as to the Creator himself.

And, again, the regular distribution, requiring precise laws, as we find it does, cannot be attributed either to the voluntary migration of animals, or to the influence of physical causes, when we see so plainly that this distribution is in accordance with the geographical distribution of animals and plants in former geological periods. But about this presently. We will only add, that we cannot discover in the Mosaic account any thing to sustain such a view, nor even hints leading to such a construction. What is said of animals and plants in the first chapter of Genesis, what is mentioned of the preservation of these animals and plants at the time of the deluge, relates chiefly to organized beings placed about Adam and Eve, and those which their progeny had domesticated, and which lived with them in closer connection. That Adam and Eve were neither the only nor the first human beings created is intimated in the statement of Moses himself,

where Cain is represented to us as wandering among foreign nations after he was cursed, and taking a wife from the people of Nod, where he built a city, certainly with more assistance than that of his two brothers. Thus we maintain that the view of mankind as originating from a single pair, Adam and Eve, — and of the animals and plants as having originated from one common centre, which was at the same time the cradle of humanity, — is neither a Biblical view nor a correct view, nor one agreeing with the results of science, and our profound veneration for the Sacred Scriptures prompts us to pronounce the prevailing view of the origin of man, animals, and plants as a mere human hypothesis, not entitled to more consideration than belongs to most theories framed in the infancy of science. It is not for us, — for we have not the knowledge necessary for undertaking such an investigation, — it is not for us to inquire further into the full meaning of the statements of Moses. But we are satisfied that he never meant to say that all men originated from a single pair, Adam and Eve, nor that the animals had a similar origin from one common centre or from single pairs.

Let us now look at the results of geological investigations respecting the origin of earlier races of animals and plants. It is satisfactorily ascertained at present, that there have been many distinct successive periods, during each of which large numbers of animals and plants have been introduced upon the surface of our globe, to live and multiply for a time, then to disappear and be replaced by other kinds. Of such distinct periods, such successive creations, we know now at least about a dozen, and there are ample indications that the inhabitants of our globe have been successively changed at more epochs than are yet fully ascertained. But whether the number of these distinct successive creations be twelve or twenty, the fact stands in full light and evidence, that animals and plants which lived during the first period disappeared, either gradually or successively, to make room for others, and this at often-repeated intervals; and that the existence of animals and plants which live now is of but recent origin, is equally well ascertained.

There is another series of phenomena, not less satisfactorily established, which go to show that the extent of

dry land rising above the surface of the ocean has neither been equally extensive at all times, nor has it had the same outline at all periods. On the contrary, we know that, early in the history of our globe, there has been a period, when but few low groups of islands existed above the surface of the ocean, which, through successive elevation and depression, have gradually enlarged and modified the extent and form of the mainland.

Again, in examining the remains of organized beings preserved in the different strata constituting the solid crust of our globe, we find that at each period animals and plants were distributed in the ocean and over the mainland in a particular manner, characteristic of every great epoch. A closer uniformity in their distribution is found in the earlier deposits, so much so that the oldest fossils discovered in the southern extremity of Africa, on the eastern and southern shores of New Holland and in Van Diemen's Land, in North America, or in various parts of Europe, are almost identical, or at least so nearly related, that they resemble each other much more than the animals and plants which at present live in the same countries; showing that uniformity in the aspect of the surface of the globe, as well as in the nature of animals and plants, was at first the prevailing rule, and that, whatever was the primitive region of these animals and plants, their types occupied much more extensive districts than any race of living beings during later periods. Are we to infer from this fact, that, at that period, these animals and plants originated from one common centre, and were distributed equally all over the globe? By no means. Though slight, we find nevertheless such differences among them in distant parts of the world as would rather sustain the view of an adaptation in the earliest creations to more uniform circumstances, than that of one centre of origin for all animals and plants of those days. During later periods, indeed, we find from geological evidence that large islands had been formed, more extensive tracts of land elevated above the surface of the ocean, and the remains both of the animals and plants derived from these different regions present already marked differences when we compare them with each other,—varieties similar to those which exist between the respective continents at present, though perhaps less

marked. Shall we here again assume that animals and plants originated from another centre, or from the same centre as those of former periods, to migrate over those different parts of the world, through the sea as well as over land? It is impossible to arrive at such a conclusion, when we consider the distribution of fossil remains in the more recent geological deposits, or in those strata which were formed during the latest geological periods, immediately before the present creation. For we find in these comparatively modern beds a distribution of fossil remains which agrees in a most remarkable manner with the present geographical arrangement of animals and plants. For instance, the fossils of modern geological periods in New Holland are of the same types as most of the animals now living there. Again, the recent fossils of Brazil belong to the same families as those prevailing at present in Brazil; though, in both cases, fossil species are distinct from living ones. If, therefore, the organized beings of the recent geological periods had arisen from one central point of distribution, to be dispersed and finally to become confined to those countries where their remains are found in a fossil condition, and if the animals now living had also spread from a common origin over the same districts, and had then been circumscribed within equally distinct limits, we should be led to the unnatural supposition, that animals of two distinct creations, differing specifically throughout, had taken the same lines of migration, had assumed finally the same distribution, and had become permanent in the same regions, without any other inducement for their removal and final settlement than the mere necessity of covering more extensive ground after they had become too numerous to remain any longer together in one and the same district. This were to ascribe to the animals themselves, or to the physical agents under which they lived, and by which they may be influenced, as much wisdom, as much providential forethought, as is evinced throughout nature, both in the distribution of animals and in their special adaptation to particular portions of the globe in which they are closely circumscribed at present, and to which they were limited under similar circumstances during those periods which preceded immediately the present arrangement of things. Now these facts in themselves leave not the shadow of a



doubt, in our mind, that animals were primitively created all over the world, within those districts which they were naturally to inhabit for a certain time. The next question is, Were these organized beings created in pairs, as is generally thought and believed? The opinion, that all animals must be referred to one single, primitive pair, is derived from evidence worthy of consideration, no doubt, but the value of which may fairly be questioned by naturalists; since this point, at least if we except Adam and Eve, is entirely of human construction, and only assumed because it is thought to show a wise economy of means in the established order of things which exists. It is supposed, that, if one pair were sufficient, there is no reason why the Creator should have introduced at one time a greater number of each kind, as economy of means is always considered an indication of high wisdom. But are not these human considerations? And if they are, and if we are entitled to question their value, let us see how they answer the object which was intended, namely, the peopling of the whole world with various races of organized beings.

Whenever we consider the economy of nature, we observe great varieties in the habits of different animals. There are, indeed, some which live constantly in pairs, and which by nature are designed to perpetuate their races in that way, and to spread generation after generation over their natural boundaries, thus mated. But there are others to which it is equally natural to live in herds or shoals, and which we never find isolated. The idea of a pair of herrings or of a pair of buffaloes is as contrary to the nature and habits of those animals, as it is contrary to the nature of pines and birches to grow singly and to form forests in their isolation.

But we can go further. There are animals in which the number of individuals of different sexes is naturally unequal, and among which there are either constantly more males or constantly more females born, as the result of their peculiar nature and habits in the creation. A beehive never consists of a pair of bees, and never could such a pair preserve the species, with their habits. For them it is natural to have one female and many males devoted to it, and thousands of neutral bees working for them. And this is the natural original mode of

existence among that species of animals, which it would be utterly contrary to the laws of nature to consider as derived from a single pair. There are a number of birds, on the contrary, in which only a few males are universally found with many females living together in companies, such as the pheasants, and our domesticated fowls. It were easy to multiply examples in order to show that a creation of all animals in pairs would have been contrary to their very nature, as we observe it in all. To assume that they have changed this nature would be to fall back upon the necessity of ascribing to physical influences a power which they do not possess,—that of producing changes in the very nature of organized beings, and of modifying the primitive plan of the Creator.

Again, there are animals which, by nature, are impelled to feed upon other animals. Was the primitive pair of lions to abstain from food until the gazelles and other antelopes had sufficiently multiplied to preserve their races from the persecution of these ferocious beasts? Were all animals, and the innumerable tribes of ferocious fishes which live upon smaller ones, to abstain from food till these had been multiplied to a sufficient extent to secure their preservation? Or were, perhaps, the carnivorous animals created only at a later period? But we find them everywhere together. They constitute natural, harmonious groups with the herbivorous tribes, both in the waters and on land, preserving among each other such proportions as will maintain for ages an undisturbed harmony in the creation.

Again, we find animals and plants occurring in distinct districts, unconnected with each other, in such ways that it would seem almost impossible for either to migrate from any point of their natural circle of distribution over its whole surface. Have, for instance, such animals as are found identical both in America and Europe been created either in Europe or in America, and wandered from one of the continents over to the other? Have those species which occur only in the far north, and upon the higher summits of the Alps, been created either in the Alps or in the north, and wandered from one place to the other? We are at a loss for substantial arguments for believing that either one or the other place has been the primitive location of such animals, or for denying their simultaneous creation in both.

Evidence could be accumulated to show, we will not say the improbability only, but even the impossibility, of supposing that animals and plants were created in single pairs, and assumed afterwards their present distribution. But the facts mentioned will be sufficient to introduce our argument, and from all we know of the laws of nature and of the distribution of animals, we conclude that they could neither originate from a single pair, nor upon a single spot. And as for plants, we would ask naturalists whether it were not superfluous to create more than a single stock of most plants, as vegetables, with a few exceptions, may multiply extensively from a single stem. But if it is granted that animals could not originate from a single pair, nor upon a single spot, what is the more natural view to take of the subject?

Without entering fully into this question, we may as well state that we have been gradually led to the conclusion, that most animals and plants must have originated primitively over the whole extent of their natural distribution. We mean to say that, for instance, lions, which occur over almost the whole of Africa, over extensive parts of Southern Asia, and were formerly found even over Asia Minor and Greece, must have originated primitively over the whole range of these limits of their distribution. We are led to these conclusions by the very fact, that the lions of the East Indies differ somewhat from those of Northern Africa; these, again, differ from those of Senegal. It seems more natural to suppose that they were thus distributed over such wide districts, and endowed with particular characteristics in each, than to assume that they constituted as many species; or to believe that, created anywhere in this circle of distribution, they have gradually been modified to their present differences in consequence of their migration. We admit these differences to be primitive and contemporaneous, from the fact, that there are other animals of different genera extending over the same tracts of land which have different representatives in each, circumscribed within narrower bounds, and this particular combination in each special district of the wider circle covered by the lion seems, in our opinion, the strongest argument in favor of the view that the particular districts of distribution have been primitively as-

cribed, with definite limits, to each species. Why should the antelopes north of the Cape of Good Hope differ from those of Arabia, or those of the Senegal, or those of the Atlas, or those of the East Indies, if they were not primitively adapted with their special modifications to those districts, when we see the lion cover the whole range? And why should the varieties we notice among the lions within these boundaries not be primitive, though not constituting distinct species, when we see the herbivorous species of the same genus differ from one district to another? And why should the differences in that one species of lion be the result of changes in its primitive character, arising from its distribution into new districts, when we see that the antelopes are at once fixed as distinct species over the same ground?

This argument cannot be fully appreciated by those who are not extensively acquainted with natural history, but we may, perhaps, make it plainer by alluding to some other similar facts. Our fresh waters teem everywhere with animals and plants. Fishes and mollusca are among the most prominent of their animals. Let us compare for a moment the different species which occur in the Danube, in the Rhine, and in the Rhone, three hydrographic basins entirely unconnected with each other throughout their whole extent. They spring from the same mountain chain, as we may take the Inn as the source of the Danube. These three great rivers rise within a few miles of each other. Nevertheless, most of their fishes differ, but there are some which are common to the three. We find the pickerel, the European pickerel, in the three basins. The eel is also common to them all. One kind of trout occurs in the three. But how strange the distribution of some others!—for instance, the perches. In the Rhine we find *Perca fluviatilis*, and *Acerina cernua*; in the Rhone, *Perca fluviatilis* and *Aspro vulgaris*; in the Danube, *Perca vulgaris*, *Lucioperca Sandra*, *Acerina cernua*, *A. Schraitzner*, *Aspro vulgaris*, and *A. Zingel*. If these animals had not originated in these rivers separately, why should not such closely allied species, some of which occur in the three basins, have all spread equally into them? and if they originated in the separate basins, we have within close limits a multiple origin of the same species.

And that this multiple origin must be admitted as a fact is shown by the following further evidence. Among the carps we find, for instance, *Barbus*, *Gobio*, *Carpio*, common to the three. But the Danube has three *Gobios*, whilst the others have but one, one of the Danube being identical with the one of the other two rivers. The most striking fact, however, occurs in the genus *Leuciscus*. *Leuciscus Dobula* is common to the three; but in addition to it, the Danube has several species which occur neither in the Rhine nor in the Rhone. The basin of the Rhone, again, has several species which occur neither in the Danube nor in the Rhine; and in the Rhine there are species which belong neither to the Rhone nor to the Danube. Now we ask, Could all these species of *Leuciscus* have been created in one of the basins,—in the Danube, for instance,—and have migrated in such a way, that a certain number of the species should remain solely in the Danube, while some others left the Danube altogether to settle finally only in the Rhone, and others to settle only in the Rhine; that one accompanying those species peculiar to the Rhone remained in the Danube with those species peculiar to it, and settled also in the Rhone with those species peculiar to that river, and also in the Rhine with the species peculiar to the Rhine? And whether we assume the Rhone as the primitive centre, instead of the Danube or the Rhine, the argument holds equally good. We have one species common to the three rivers, and several species peculiar to each, which could never have migrated (if migration took place) in such a manner as to assume their present combinations. But if, on the contrary, we suppose that all the species originated in the rivers where they occur, then we have again a multiple origin of that species which is common to the three, for it were wonderful if that one alone had migrated, when they are all so closely allied. Here, again, we arrive at the conclusion, that the same species can have a multiple origin, in the same manner as, from the considerations alluded to before, we have decided that species do not originate from single pairs, but in their natural proportion with the other species with which they live simultaneously over the whole ground which they cover. And this is the view which we take of the natural distribution of animals, that they originated primitively over the whole extent of their

natural distribution; that they originated there, not in pairs, but in large numbers, in such proportions as suits their natural mode of living and the preservation of their species; and that the same species may have originated in different unconnected parts of the more extensive circle of their distribution. We are well aware that there are very many species which are known to have spread beyond what we would call their natural limits; species which did not occur in North America before the settlement of the whites, that are now abundant here over very extensive tracts of country; other species which have been introduced from America into Europe, and also into other parts of the world, in different ways. But these are exceptional facts; and, what is more important, these changes in the primitive distribution of organized beings, both animals and plants, have taken place under the influence of man,—under the influence of a being acting not merely from natural impulses, or under the pressure of physical causes, but moved by a higher will. So that these apparent exceptions to the rule would only go to confirm it; as, within the limits of these secondary changes, we see a will acting, just as we consider that the primitive distribution of all organized beings has been the result of the decrees of the Creator, and not the result of mere natural influences.

Having thus led the way to what we would consider as a fairer ground for investigating the natural geographical distribution of animals and plants, let us now examine the natural lines which seem to regulate this distribution. Nothing can be more striking to the observer than the fact, that animals, though endowed with the power of locomotion, remain within fixed bounds in their geographical distribution, although an unbounded field for migration is open to them in all directions, over land, through the air, and through the waters. And no stronger argument can be introduced to show that living beings are endowed with their power of locomotion to keep within genial boundaries, rather than to spread extensively. There is another fact which shows that animals are made to remain within these natural limits. We would allude especially to the difficulty we experience whenever we attempt to transport animals from their native country into other countries, even if we secure for them as nearly as can be the same

conditions in which they used to live. Again, observe the changes which animals undergo when they are once acclimatized to countries different from their native land. There can be no more striking evidence of this than the endless variety of our domestic animals, and there is no subject which more requires a renewed and careful investigation than this. We do not, however, feel competent to introduce this point more fully to the notice of our readers. Some facts bearing upon the question may best be mentioned in a reference to the different animals which man has thus made subservient to his social condition. We shall here allude only to the laws of distribution of wild animals in their natural condition.

It has already been stated, that the present distribution of animals agrees with the distribution of extinct types belonging to earlier geological periods, so that the laws which regulate the geographical distribution of animals seem to have been the same at all times, though modified in accordance with the successive changes which the animal kingdom has undergone from the earliest period of its creation to the present day. The universal law is, that all animals are circumscribed within definite limits. There is not one species which is uniformly spread all over the globe, either among the aquatic races, or among the terrestrial ones. Of the special distribution of man, who alone is found everywhere, we shall speak hereafter. The special adaptation of animals to certain districts is not merely limited to the individual species. We observe a similar adaptation among genera, entire families, and even whole classes. For instance, all Polypi, Medusæ, and Echinoderms, that is to say all Radiata without exception, are aquatic.\* That large group of animals has not a single terrestrial representative upon any point of the surface of the globe; and during all periods of the history of our earth, we find that they have always been limited to the liquid element. And they are not only aquatic, they are chiefly marine, as but exceedingly few of them are found in fresh waters. Among Mollusca we find almost the same adaptation. Their element also

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\* The following statements have been strictly considered, and are made in reference to a revised classification of the animal kingdom, the details of which must, however, be omitted here, as they would extend this article beyond our allotted bounds.

is the sea. The number of fresh-water species is small compared with that of marine types; and we find terrestrial species in only one of their classes. In former periods, also, Mollusca were chiefly marine; fluviatile and terrestrial types occurring only in more recent periods.

With the Articulata we find another state of things. Two of their classes, the worms and Crustacea, are chiefly marine, or at least aquatic, as we have a number of fresh-water worms, and some fresh-water Crustacea. But insects are, for the most part, chiefly terrestrial, feeding upon terrestrial plants, at least in their full-grown condition; though a large number of these animals are fluviatile, and even some marine, during their earlier periods of life. In the Vertebrata, the adaptations are more diversified. Only one class of these animals is entirely aquatic, the fishes; and the number of the marine species is far greater than that of the fresh-water kinds. Among reptiles there are many which are aquatic, either throughout life, or through the earlier period of their existence. But, as if animal life rose to higher organization as it leaves the ocean to inhabit dry land or fresh waters, we find that the greater number of the aquatic reptiles are fluviatile, and but a few marine. This fact agrees wonderfully with the natural gradation of the classes already mentioned. The lower type of animals, the Radiata, is almost exclusively marine. Among Mollusca we have a greater number of marine types, a large number of fluviatile species, and fewer terrestrial, and these are the highest in their class. Again, among Articulata the lower classes, worms and Crustacea, are marine, or at least fluviatile, whilst the highest class, that of insects, is chiefly terrestrial, or fluviatile during the earlier periods of their growth. Among the Vertebrata we see the lowest form, that of fishes, entirely aquatic, and the same rule applies partially to the reptiles; but as the class rises, the number of the fluviatile species is greater than that of the marine types. Next, among birds, which by their structure are exclusively adapted to live in the atmospheric air, we find the larger number to be terrestrial, and only the lower ones to live upon water, or dive occasionally into it, always seeking the surface, however, to breathe and to perform their most important vital functions. It is, nevertheless, not a little strange, that this class should by nature be adapted to rise into the air, just as if



the first tendency towards liberating them from the aquatic element had been carried to an excess, and gave them a relation to the earth which no other class, as a whole, holds to that degree, except, perhaps, the insects, which are placed among the *Articulata* in the same relation to the lower classes and the natural element, which the class of birds maintains among *Vertebrata*. The highest class of *Vertebrata* affords us examples of these three modes of adaptation, the lowest of these being entirely aquatic, and even absolutely marine; next we have fluviatile types of the large terrestrial *Mammalia* in the family of *Manatees*, again a swimming family among *Carnivora*, another flying, most of them, however, walking upon their four extremities on solid ground, but at the head of all man, standing upright, to look freely upwards and to contemplate the whole universe.

This wonderful adaptation of the whole range of animals, as it exists at present, shows the most intimate connection with the order of succession of animals in former geological periods. The four great types, *Radiata*, *Mollusca*, *Articulata*, and *Vertebrata*, were introduced at the beginning simultaneously. However, the earliest representatives of these great types were all aquatic. We find in the lowest beds which contain fossils, *Polypi*, together with star-fishes, bivalve shells, univalves, chambered shells, cases of worms, and *Crustacea*, being representatives of at least seven out of nine classes of invertebrate animals, if we are not allowed to suppose that *Medusæ* existed also, and if insects were still wanting for a time. But in addition to these, fishes among *Vertebrata* are introduced, but fishes only, all of which are exclusively marine. At a somewhat later period insects come in. We find next reptiles in addition to fishes, the lower classes, or invertebrates, continuing to be represented through all subsequent epochs, but by species changing gradually at each period, as all classes do after they have once been introduced. The first representatives among reptiles are marine, next huge terrestrial ones, some, perhaps, flying types, and with them, and perhaps even before them, birds, allied to the wading tribes. Still later *Mammalia*, beginning again with marine and huge terrestrial types, followed by the higher quadrupeds. And last only, Man, at the head of the

creation in time as well as in eminence, by structure, intelligence, and moral endowments.

Besides the general adaptation of animals to the surrounding media, there is a more special adaptation, which seems not less important, though it is perhaps less striking. Animals, as well as plants, do not live equally at all depths of the ocean, or at all heights above its surface. There must be a deep influence upon the geographical distribution of animals in a vertical direction derived from atmospheric pressure above the surface of the waters, and from the pressure of the water itself at greater and greater depths, — the level of the ocean, or a small elevation above its surface, or a shallow depth under its surface, being the field of the most extensive and intensive development of animal life. And it is not a little remarkable that in the same classes we should find lower types at greater depths in the ocean, and also lower types at greater heights above. We will quote a few examples, to show how much we may expect from investigations pursued in this direction, for at present we have but little information which can aid us in ascertaining the relationship between atmospheric and hydrostatic pressure and the energies of animal life.

Among Polypi, the higher forms, such as Actiniæ, are more abundant in shallow water than the lower coral-forming types. Among Medusæ, the young are either attached to the bottom, or grow from the depth, while the perfect free forms of these animals come to the surface. Among Echinoderms, the Crinoids are deep-water forms; free star-fishes and Echini, and above all Holothuriæ, living nearer the surface. Among Mollusca, the Acephala, which are lowest, have their lower types, — the Brachio-pods, entirely confined to deep waters; the Monomyarians appear next, and above them the Dimyrians; among these latter, the highest family, the Nayades, rises above the level of the ocean into the fresh waters, and extends even to considerable heights above the sea, in lakes and rivers. A number of examples of all classes should be mentioned to show that this is the universal case; as, for instance, among Crustacea the Macrura are in general species of deeper water than the true crabs, of which some come even upon dry land. Again, on the slopes of our mountains, the highest forms among Mammalia which

remain numerous are the Ruminants and Rodents. There are no Carnivora living in high regions. Among birds of prey, we have the vultures, rising above the highest summits of mountains, while eagles and falcons hover over the woods and plains, by the water-sides, and along the sea-shores. Among reptiles, salamanders, frogs, and toads occur higher than any turtles, lizards, &c. But the same adaptation may be traced with reference to the latitudes under which animals are found. Those of the higher latitudes, the arctic and antarctic species, resemble both the animals of high, prominent mountain chains, and those of the deep-sea waters, which there meet in the most unexpected combinations (and it is surprising to see how extensively this is the case); while, in lower latitudes, towards the tropics, we find everywhere the higher representatives of the same families. For instance, among Mammalia we observe monkeys only in warm latitudes, and they die out in the warmer parts of the temperate zone. The great development of Digitigrades — lions, tigers, &c. — takes place within the tropics, smaller species, like wolves and foxes, weasels, &c., occurring in the north, whilst the Plantigrades, which come nearer and nearer to the seal, follow an inverse progression, the largest and most powerful of them being the arctic ice-bear, which meets there his family relations, the Pinnipedia, that are so numerous in the polar regions. Again, the families of Ruminants and Pachyderms seem to form an exception, for though belonging to the lower types of Mammalia, they prevail in the tropical zone; but let us remember that they were among the earlier inhabitants of our globe, and the fact of their occurring more extensively in warm climates is rather a reminiscence of the plan of creation in older times, than an adaptation to the law regulating at present the distribution of organized beings. The gradation of animals among birds being less satisfactorily ascertained, we do not venture to say any thing respecting their geographical distribution in relation to climates. But among reptiles, we cannot overlook the fact, that the crocodiles, which are the highest in structure, are altogether tropical, and the Batrachians, which rank lowest, especially the salamandroid forms, are rather types of the colder temperate zone, than of the warm, &c. From these facts it is plain that

the geographical distribution of all groups has a direct reference to atmospheric and hydrostatic pressure on one side, and also to the intensity of light and heat over the surface of the globe.

The special adaptation of minor groups begins very early in the history of our globe, and extends at present all over its surface. In the same manner as animals are adapted to natural limits in their large primitive groups which we call classes, we find also the minor divisions more closely adapted to particular circumstances of the physical condition of all parts of the globe. Among Mammalia, the great type of Marsupialia is placed in New Holland, and extends little beyond that continent into the adjacent islands. A very few representatives of that family are found in America. Asia, Africa, the colder parts of North America, and its southern extremity, are entirely deprived of this type. The family of Edentata again has its centre of development in South America, where the sloth, dasypus, ant-eaters, &c., form characteristic types, of which a few analogues occur in Africa along its southern extremity and western coast. Now it is a fact upon which we cannot insist too strongly, that the same districts of New Holland and South America were, during an earlier geological period comparatively recent, the seat of an equally wide development of the same animals in the same extensive proportions as at present. We need only refer to the beautiful investigations of Dr. Lund, upon the fossil Mammalia of Brazil, and to those no less important of Professor Owen, upon the fossil remains of Mammalia of New Holland, to leave not a shadow of a doubt upon this adaptation, which indicates distinctly these two regions, at two distinct periods remote from each other, as the points of development of two distinct families, which have never spread over other parts of the globe at any period since the time of their existence, indicating there at least two distinct foci of creation, with the same characters, at two successive epochs; a fact, which, in our opinion, can never be reconciled to the idea of a unique centre of origin of the animals now living. But though other families have never been and are not now localized in so special a manner, we nevertheless find them circumscribed within certain limits, in particular districts, or, at least, in particular zones.

As already mentioned, the monkeys are entirely tropical. But here, again, we notice a very intimate adaptation of their types to the particular continents, as the monkeys of tropical America constitute a family altogether distinct from the monkeys of the Old World, there being not one species of any of the genera of *Quadrupana*, so numerous on this continent, found either in Africa or in Asia. The monkeys of the Old World, again, constitute a natural family by themselves, extending equally over Africa and Asia; but the species of Africa differ from those of Asia; and there is even a close representative analogy between those of different parts of these two continents, the orangs of Africa, the chimpanzee and gorilla, corresponding to the red orang of Sumatra and Borneo, and the smaller long-armed species of continental Asia. And what is not a little remarkable is the fact, that the black orang occurs upon that continent which is inhabited by the black human race, whilst the brown orang inhabits those parts of Asia over which the chocolate-colored Malays have been developed. There is again a peculiar family of *Quadrupana* confined to the island of Madagascar, the Makis, which are entirely peculiar to that island and the eastern coast of Africa opposite to it, and to one spot on the western shore of Africa. But in New Holland and the adjacent islands there are no monkeys at all, though the climatic conditions seem not to exclude their existence any more than those of the large Asiatic islands, upon which such high types of this order are found. And these facts more than any other would indicate that the special adaptation of animals to particular districts of the surface of our globe is neither accidental, nor dependent upon physical conditions, but is implied in the primitive plan of the creation itself. Whatever classes we may take into consideration, we shall find similar adaptations, and though, perhaps, the greater uniformity of some families renders the difference of the types in various parts of the world less striking, they are none the less real. The Carnivora of tropical Asia are not the same as those of tropical Africa or those of tropical America. Their birds and reptiles present similar differences. The want of an ostrich in Asia, when we have one, the largest of the family, in Africa, and two distinct species in Southern America, and two cassowaries, one in New Holland and an-

other in the Sunda Islands, shows this constant process of analogous or representative species repeated over different parts of the world to be the principle regulating the distribution of animals, and the fact that these analogous species are different, again, cannot be reconciled to the idea of a common origin, as each type is peculiar to the country where it is now found. These differences are more striking in tropical regions than anywhere else. The rhinoceros of the Sunda Islands differs from those of Africa, and there is none in America. The elephant of Asia differs from that of Africa, and there is none in America. One tapir is found on the Sunda Islands, there is none in Africa, but we find one in South America, &c. Everywhere special adaptation, particular forms in each continent, an omission of some allied type here, when in the next group it occurs all over the zone.

As we ascend into the temperate zone, we find, however, the similarity greatly increased. The difference between the species of the same family in temperate Asia, temperate Europe, and temperate America is much less than between the corresponding animals of the tropical zone, and no doubt it is to this great assemblage of more uniform animals, living originally within the main seat of human civilization, that we must ascribe the idea of their common origin, which has so long prevailed and been so serious an obstacle to a real insight into these natural phenomena. What, indeed, could be more natural for man, when for the first time reflecting upon nature around him, — when seeing, as far as he could extend his investigations, all things alike, — than to imagine that every thing arose from a common centre, and spread with him over the world, as it has been the fate of the white race, and of that only, to extend all over the globe, and that, influenced by the phenomena of the zone in which he lived, and wandered, and from which he extended farther, he took it for granted that all animals followed the same laws? But now that we know the whole surface of our globe so satisfactorily, there can no longer be a question about the difference between animals and plants in the lower latitudes in all continents. Besides, we see them equally striking in the southernmost extremities of the three great continents, so that there can no longer be any doubt about the primitive adaptation of

these various types to the continents where they live, as we do not find a single one naturally diffused everywhere over all continents. Notwithstanding, therefore, the slighter differences we notice between the animals of different continents in the temperate zone, we are thus led step by step to ascribe to them also a special origin upon those continents where they now occur.

But as soon as we rise to the highest latitudes, the uniformity becomes so close, that there is no longer any marked difference noticed between the animals about the arctic regions, either in America, Europe, or Asia; and we are naturally led to restrict the idea of a common centre of origin, or at least of a narrow circle of primitive development, to those animals which spread equally over the icy fields extending around the northern pole upon the three continents which meet in the north. The phenomena of geographical distribution which we observe there among the terrestrial animals are repeated in the same manner among the aquatic ones. The fishes in the arctic seas do not materially differ on the shores of Europe, Asia, and America, and through the Northern Atlantic and through Behring's Straits they extend more or less towards the colder temperate zone, or migrate into it at particular seasons of the year, as do most birds of the arctic regions also. But in the temperate zone we begin to find more and more marked differences between the inhabitants of different continents, and even between those of the opposite shores of the same ocean; as, for instance, the fishes of Europe (some of the northern species excepted) are not identical with those of the temperate shores of North America, notwithstanding the very open field left for their uniform distribution across the Atlantic. Such is also the case between the fishes of Western Africa and those of Central America, and between those of the southern extremities of these continents. The fishes of the Indian Ocean and the fishes of the Pacific vary greatly, and, though some families have a wider range, there are many which are circumscribed within the narrowest limits. It is one of the most striking phenomena in the geographical distribution of aquatic animals, to find entire families of fishes completely circumscribed within particular groups of islands, such, for instance, as the Labyrinthici, which are peculiar to the

Sunda Islands, and the family of Goniodonts, which are found only in the rivers of South America.

A similar narrow limitation occurs also among the terrestrial animals, as the family of Colubris is entirely circumscribed within the boundaries of the warmer parts of the American continent. The appearance during the warmer season of the year of a few species of that family in the Northern States does not make this case less strong. Examples might be multiplied without end to show everywhere special adaptation, narrow circumscription, or representative adaptation of species in different parts of the world; but those mentioned will be sufficient to sustain the argument that animals are naturally autochthones wherever they are found, and have been so at all geological periods; that in northern regions they are most uniform; that their diversity goes on increasing through the temperate zone till it reaches its maximum in the tropics; that this diversity is again reduced in the aquatic animals towards the antarctic pole, though the physical difference between the southernmost extremities of America, Africa, and New Holland seems to have called for an increased difference between their terrestrial animals.

We are thus led to distinguish special provinces in the natural distribution of animals, and we may adopt the following division as the most natural. First, the *arctic province*, with prevailing uniformity. Second, the temperate zone, with at least three distinct zoölogical provinces: the *European temperate zone* west of the Ural Mountains, the *Asiatic temperate zone* east of the Ural Mountains, and the *American temperate zone*, which may be subdivided into two, the *eastern* and the *western*, for the animals east and west of the Rocky Mountains differ sufficiently to constitute two distinct zoölogical provinces. Next, the tropical zone, containing the *African zoölogical province*, which extends over the main part of the African continent, including all the country south of the Atlas and north of the Cape Colonies; the *tropical Asiatic province*, south of the great Himalayan chain, and including the Sunda Islands, whose Fauna has quite a continental character, and differs entirely from that of the islands of the Pacific, as well as from that of New Holland; the *American tropical province*, including Central America, the West Indies, and



tropical South America. *New Holland* constitutes in itself a special province, notwithstanding the great differences of its northern and southern climate, the animals of the whole continent preserving throughout their peculiar typical character. But it were a mistake to conceive that the Faunæ or natural groups of animals are to be limited according to the boundaries of the mainlands. On the contrary, we may trace their natural limits into the ocean, and refer to the temperate European Fauna the eastern shores of the Atlantic, as we refer its western shores to the American temperate Fauna. Again, the eastern shores of the Pacific belong to the western American Fauna, as the western Pacific shores belong to the Asiatic Fauna. In the Atlantic Ocean there is no purely oceanic Fauna to be distinguished, but in the *Pacific* we have such a Fauna, entirely marine in its main character, though interspread with innumerable islands extending east of the Sunda Islands and New Holland to the western shores of tropical America. The islands west of this continent seem, indeed, to have very slight relations in their zoological character with the western parts of the mainland. South of the tropical zone we have the *South American temperate Fauna*, and that of the *Cape of Good Hope*, as other distinct zoological provinces. Van Diemen's Land, however, does not constitute a zoological province in itself, but belongs to the province of New Holland, by its zoological character. Finally, the antarctic circle incloses a special zoological province, including the *antarctic Fauna*, which, in a great measure, corresponds to the arctic Fauna in its uniformity, though it differs from it in having chiefly a maritime character, while the arctic Fauna has an almost entirely continental aspect.

The fact that the principal races of man, in their natural distribution, cover the same extent of ground as the great zoological provinces, would go far to show that the differences which we notice between them are also primitive; but for the present we shall abstain from further details upon a subject involving so difficult problems as the question of the unity or plurality of origin of the human family, satisfied as we are to have shown that animals, at least, did not originate from a common centre, nor from single pairs, but according to the laws which at present still regulate their existence.

L. A.