

*SOME DIFFICULTIES IN ZOOLOGICAL
DISTRIBUTION.*

IN offering to the readers of the *Nineteenth Century* some remarks upon the geographical distribution of animals, I will ask them to excuse me if, in the first place, I shall go rather more into the elementary part of the subject than is perhaps usual in this Review. But 'distribution' is a comparatively recent branch of biological science; its value and importance are scarcely understood except amongst the most advanced and philosophic naturalists; and unless I am permitted to explain rather fully what 'distribution' is, I fear I shall not be able to make my readers comprehend the 'difficulties' which I wish to notice. I shall, therefore, endeavour first to point out shortly the observed facts of zoological distribution, next to state the hypothesis that will best account for these facts, and lastly to give examples of some of the difficulties that have to be overcome or explained before we can affirm that this hypothesis is perfectly established, and ought to be universally accepted by reasonable persons.

Every animal, such, for example, as a bird, has a certain structure, form, size, and colour, which enable naturalists to assign it to its place in the system amongst its fellows, and to decide that it belongs to a particular family, genus, and species. These attributes of structure, size, shape, and colour are what are called its 'specific characters,' and are common to all the individuals of the 'species' that the bird in question belongs to. But, besides these more obvious attributes, the species has two other important qualities which are not so generally recognised; that is to say, it exists in a state of nature only within a certain definite area of space, and only through a certain definite lapse of time. Of the latter kind of distribution—that is, of 'distribution in time'—I will say nothing on the present occasion, as I wish to confine my remarks to distribution in space, and to recent animals—that is, to such as are now existing on the world's surface.

Well, then, every species, such as that of which this bird is an example, is found in its natural state of existence only within a certain definite area of the world's surface. This area is termed its 'specific

area,' and may be small or large. The little blue magpie of Spain, to which I shall again call attention presently, being found only in certain provinces of Spain and Portugal, is a good instance of limited distribution. Other instances of limited distribution are furnished by certain humming-birds, such as *Oreotrochilus chimborazo* and *O. pichincha*, which are found only on the two mountains after which they are respectively named. But in many instances species have a much wider distribution, and in some few cases the area which they occupy is very large, and nearly coextensive with the world's surface. The Barn-owl (*Strix flammea*), the Osprey (*Pandion haliaëtus*), and the Turnstone (*Streptilas interpres*), are good examples of cosmopolitan species of birds, their specific area being nearly coextensive with the land-surface of the world.

When we proceed to genera—*i.e.* to groups of species that possess certain characters in common—a similar phenomenon as regards distribution is found to prevail. As in the case of species, genera are mostly confined within a certain definite area, large or small, cases of cosmopolitan or universally distributed genera being quite the exception. For instance, the generic area occupied by the robins (*Erithacus*) extends over Europe, Africa north of the Atlas, and Northern Asia. Within this generic area three species of robin are met with—namely, our familiar *E. rubecula*, *E. hyrcanus* of Persia, and *E. akahige* of North-east Asia. On the other hand, another of our most familiar birds, the swallow, belongs to a very widely distributed or nearly cosmopolitan genus, species of swallows being met with in every part of the world's surface. In the like manner families, *i.e.* groups of genera resembling one another in certain particulars, orders, *i.e.* similar groups of families, and in some cases even higher groups, are more or less limited in the geographical area which they occupy, although, when we come to these larger divisions, it may be naturally supposed that instances of very limited range are the exception. It thus follows that every different part of the world has species, genera, families, and in some cases even orders, peculiar to it, so that a mere glance at a collection of animals from any particular locality will enable the experienced naturalist to tell, often within a very few miles, where the collection has been made.

A second phenomenon attached to specific and generic areas, besides their being limited in extent, is that they are 'continuous.' We do not find that a species, genus, or other higher natural group, occurs in two separate localities, without being found also in the intervening space. Still less do we find the intervening space occupied by another species of the same group. Take for example the birds of two such countries as England and Japan, which are well known to have a considerable number of species (perhaps one hundred) in common. We expect to find, and do find, that these species are also met with (that is, in such spots as are suitable to their particular

mode of life) all through Northern Europe and Northern Asia. If, therefore, we meet with a species or genus in two distant localities, we may be pretty sure that it likewise exists in the intermediate space.

It is not necessary on the present occasion to pursue this particular branch of the subject further, but we may sum up the results arrived at in the following propositions:—

Every species occupies a definite area on the world's surface; and in like manner every genus and family, or other higher assemblage of species, occupies a definite area on the earth's surface; or, more shortly, locality—that is, existence in a certain spot—is quite as much an attribute of any natural group of animals as structure or the possession of a certain form or shape.

Let us now consider a little more closely the mode in which species are distributed within their generic areas. From what has been already stated, it will be evident that a generic area is formed by the sum of the specific areas of the species which belong to the genus. In an ideal generic area the species would be arranged to occupy contiguous areas, and the whole of these contiguous areas would together constitute the 'generic area.' Such instances of neatly defined specific and generic areas do not often occur in nature, but still they are to be found in some instances. One of the best examples of them known to me in the class of birds is afforded by the American Bell-birds of the genus *Chasmorhynchus*. Four species only of this form are known to exist, which, in the male sex at least, are very well marked and easily distinguished. One of these inhabits the forests of Costa Rica and Veragua (*C. tricarunculatus*), a second (*C. variegatus*) those of Venezuela, a third (*C. niveus*) those of Cayenne, and a fourth (*C. nudicollis*) those of South-east Brazil.¹ The generic area of the genus *Chasmorhynchus* of course embraces the whole district within these limits. But in most instances, it must be allowed, generic areas are not allotted out in this tidy way. Species frequently overlap each other's areas, and occur three or four in the same district, are absent where they ought to be found, and turn up in localities where they are least to be expected. The arrangement I have here indicated can only be looked upon as an ideal, which, as a careful study of the distribution of animal life shows us, we must always expect to find only approximated to, and more or less concealed by casual irregularities.

I must now say a few words upon another phenomenon of distribution—that is, upon what are commonly termed 'representative' species, as the observed facts connected with them have a very important bearing on the subject. In groups of islands, such as the West India Islands, the Philippines, and the various groups of South

¹ Cf. 'The Bell-birds of America.' *Intellectual Observer*, vol. x. p. 40, 1867.

Pacific Islands, we constantly find the different islands inhabited by different species of the same genus, which, from the idea that they represent one another in the economy of nature, are termed 'representative species.' The specific differences between these representative species are sometimes minute and sometimes considerable, but, the further and more accurately we carry out our investigations into insular faunas, the more instances do we find of the occurrence of more or less nearly allied representative species in the different islands. Two or three years ago, for example, it would have been thought quite sufficient to give as the habitat of a bird the Philippine Islands generally. But we now know from the researches of Dr. Steere² and Mr. Everett³ that nearly all the larger islands of the Philippine Archipelago, and many even of the smaller ones, possess numerous representative species. Some of these are so different from one another that no one would hesitate to admit their distinctness; in other cases the differences are minute, and require the eye of a practised ornithologist to realise them.

A good instance of insular representative species is afforded by the Tanagers of the genus *Spindalis*. The genus is peculiar to the larger Antilles, extending from Jamaica to the Bahamas. Five species are known, each of which inhabits a different island, namely:—

1. *Sp. zena*, from the Bahamas.
2. „ *pretrii*, from Cuba.
3. „ *multicolor*, from Haiti.
4. „ *portoricensis*, from Porto Rico.
5. „ *nigricephal*, from Jamaica.

The peculiar little birds of the genus *Todus*, constituting together the family *Todidae*, which is restricted to the West India Islands, have a nearly similar distribution. Four nearly allied species are known, namely:—

1. *Todus multicolor*, from Cuba.
2. „ *dominicensis*, from Haiti.
3. „ *viridis*, from Jamaica.
4. „ *hypochondriacus*, from Porto Rico.

Islands also often possess modified forms, or representatives of the species of the adjoining continent. A most striking instance of this is afforded by the little island of Guadeloupe, situated in the Pacific off the coast of Lower California. From the researches lately made by Dr. Edward Palmer, it appears that 'every one of the resident species of land-birds in this island (eight in number) is distinct from

² Cf. Sharpe, *Trans. Linn. Soc.*, ser. 2, Zool. p. 307.

³ See Lord Tweeddale's papers on Philippine birds in the *Proceedings of the Zoological Society of London* for 1877 and 1878.

any found on the neighbouring mainland, although each has a continental representative more or less nearly allied.'⁴

Another significant fact connected with representative species is that, in the case of a series of them, those species of which the areas are nearest to each other are most nearly allied. If one species be intermediate between two others in locality, it will almost certainly be found to be also intermediate in its structural characters.

But it is not only upon islands that representative species occur. They are met with also in all large continental areas. Let us take the wide continent of North America for example. The birds of the eastern United States have been long well known to us. Subsequently those of California and the Pacific States have been studied, and a large number of cases discovered in which the eastern forms are replaced in the west by representative species which have received different names, and show more or less well-grounded points of difference on comparison. But the more recent researches of our energetic brother naturalists in the United States have proved that in very many instances these eastern and western species—at first sight so obviously distinct—are connected together by intermediate forms which occur in the interior of the continent. And such is the case in other parts of the world. When examples of two representative species from widely distant localities are compared, they are distinct and easily recognisable. When specimens come to be obtained from intermediate localities, it is usually found that these specimens possess intermediate characters.

Now is there any hypothesis which will explain the existence of these phenomena of distribution just alluded to?—namely:

1. The restriction of species and other natural groups to limited and continuous geographical areas.
2. The occurrence of insular and continental representative species.
3. The frequent existence of intermediate forms between representative species occupying adjacent continental areas.

I need hardly say that the derivative origin of species or their descent from a common ancestor is, so far as we yet know, the only hypothesis that offers a reasonable explanation of these facts, and of other phenomena of geographical distribution. In his imperishable work on the *Origin of Species*, Mr. Darwin has devoted two chapters to those arguments in favour of the derivative theory which may be obtained from a study of distribution, and such naturalists as have paid special attention to distribution will readily acknowledge that there is no other class of facts that tells more strongly in favour of Mr. Darwin's views. It must be allowed by every one that the derivative theory is the only hypothesis yet started that will in any way account for the known phenomena of distribution; and I may con-

⁴ 'Ornithology of Guadeloupe Island,' by Robert Ridgway, in *Rep. U. S. Geological and Geographical Survey of the Territories*, Washington, 1876.

fidently affirm that no philosophic naturalist of the present day who has studied the distribution of any group of animals has failed to adopt it, at least as a working hypothesis.

If we assume that the species of the same genus are descendants of common parents, the reason of their occupying adjacent areas is at once manifest, as is likewise the reason of these areas being continuous. If we allow with Mr. Darwin that species, so far from being fixed and unchangeable (as was formerly supposed), are ever slowly varying, the mystery of representative species is no longer a mystery. A species extending itself over a given area will vary most at the extremities of its range, because the individuals occupying these extremities will have less chance of intercrossing. If, in the progress of geological time, the area becomes broken up into islands, as we suppose has actually happened in the case of the West Indies, we find distinct representative species occupying these several islands. If the area remains unchanged, we find in many cases intermediate forms between the representative species still existing.

A good example of the latter case is afforded by the pheasants of the genus *Euplocamus*, which are distributed along the Himalayas from Cashmir to Assam, and thence through Burmah into China. Of this genus, six species are usually recognised, namely:—

1. *E. albi-cristatus*, of Nepal.
2. *E. melanotus*, of Sikim and Bhotan.
3. *E. Horsfieldi*, of Assam.
4. *E. lineatus*, of Pegu, Tenasserim, and Siam.
5. *E. Andersoni*, of Upper Burmah.
6. *E. nycthemerus*, of China.

Between species 1 and 2, and between species 3 and 4, intermediate forms, often called hybrids, are actually well known to exist in the intermediate localities, while species 5 is certainly nothing more than an intermediate form between species 4 and 6.

The hypothesis of the derivative origin will therefore explain generally the phenomena of distribution, and no other theory that has been yet started will do so.

But the question is, will it explain all the individual cases, and are there no exceptions? For it must be recollected that, to acquire universal acceptance, an hypothesis is bound to explain all the known cases of the subject to which it relates.

To this question I cannot doubt that every naturalist who has carefully studied the species of any group and their distribution will reply that there are many individual exceptions, and that, in order to explain these exceptions and to reconcile them with the general hypothesis, we are often obliged to indulge in other—occasionally not very convenient—subordinate hypotheses. As our knowledge of the exact structure of many animals is very incomplete, though increasing every day, and as our knowledge of their distribution is still

more incomplete, many of these apparent difficulties may be ultimately reconciled with the general law. For instance, it was until lately believed that the *Viverridæ* or Civets, one of the principal families of Carnivorous Mammals, are confined to the Old World, with the exception of a single form, the *Bassaris* of Mexico. The occurrence of *Bassaris* in Mexico, so widely separated from its congeners, was regarded as a great anomaly. But, upon a more accurate examination of *Bassaris*, Professor Flower has lately shown⁵ that this genus properly belongs to the American family *Procyonidæ*, and that this supposed anomalous exception does not really exist.

Again, the musk-deer of Northern Asia (*Moschus*) was until recently supposed to belong to a family (*Moschidæ*) widely distributed over India and Africa. But it has now been shown by Alphonse Milne-Edwards that the supposed Indian and African members of the group constitute a very different family of the *Ungulata*—the Chevrotains or *Tragulidæ*. The musk-deer, therefore, now consists only of a single form (*Moschus*) peculiar to Central Asia. This is another instance of how much our knowledge of distribution is dependent on accurate classification.

It should also be recollected that if we adopt the hypothesis of the derivative origin of species, it is manifest that the distribution of animals in the present epoch is entirely dependent upon that of the past epoch. And I need hardly expatiate on the 'imperfection of the geological record' to which Mr. Darwin has so forcibly called our attention, nor upon the comparatively slight acquaintance we as yet have with the geology of most parts of the world's surface beyond the limits of Europe.

But, after making all these allowances, there are, as I have already said, many abnormal cases of distribution in every class of animals, and on the present occasion I will call attention to some half-dozen of them in the classes of mammals, birds, and reptiles, to the distribution of which animals my attention has been principally directed.

Before doing this I may perhaps be allowed to run over briefly the principal divisions of the earth's surface into what are called Zoological Regions, which are now generally in use, as I shall have to make frequent references to them. Taking the class of mammals, of which on the whole the distribution is best known to us, as our guide, we find the orders of mammals, according to the best authorities, arrangeable under three very distinct heads:—

- I. Monotremes, or Ornithodelphs.
- II. Marsupials, or Didelphs.
- III. Typical Mammals, or Monodelphs.

Now, when we come to examine the distribution of these three groups on the map, we shall find that the monotremes are wholly confined to Australia; that the marsupials predominate in Australia,

† *Proceedings of the Zoological Society of London*, 1869, p. 4.

and are only met with elsewhere in South America—one or two species of opossum (*Didelphys*) occur in North America, but are probably only recent intruders from the south; and that the typical mammals are distributed over the rest of the world.

Again, after examining the distribution of the ten orders of typical mammals, we remark the following significant facts:—

1. The absence of *Insectivora* in South America.

2. The prevalence of *Edentata* in the same country; the sloths, armadilloes, and ant-eaters, three out of the five known families of this order, being entirely confined to South and Central America.

Taking these main facts, we may divide our earth, as follows, into three great divisions:—

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| I. Land where monodelphs only occur; no marsupials nor monotremes | } | Europe, Asia, Africa, Asiatic Islands down to Wallace's line, and North America down to the Isthmus of Tehuantepec. |
| II. Land where monodelphs and marsupials occur; no monotremes | } | America, south of the Isthmus of Tehuantepec. |
| III. Land where marsupials prevail; no monodelphs but rodents and bats; all the known monotremes | } | Australia and islands up to Wallace's line. |

The fault of this division is that it leaves the great mass of land in the northern hemisphere undivided and rather unmanageable. But this great northern land is easily separable into four sections, although it must be understood that these sections are not really equivalent in value to the two remaining undivided primary divisions. Thus we obtain a division of the land-surface of the globe for mammals into six areas, which may be called **RÉGIONS**, and may be defined and named as follows:—

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| I. Europe, Africa north of Atlas, and Northern Asia | } | I. <i>Palaearctic Region</i> . |
| II. Africa, south of Atlas, and Madagascar | } | II. <i>Ethiopian Region</i> . |
| III. Southern Asia, Philippines and islands of Indian Archipelago down to Wallace's line | } | III. <i>Indian Region</i> . |
| IV. North America, down to Isthmus of Tehuantepec | } | IV. <i>Nearctic Region</i> . |
| V. Central America, south of the Isthmus of Tehuantepec, and South America | } | V. <i>Neotropical Region</i> . |
| VI. Australia, New Guinea, and islands up to Wallace's line | } | VI. <i>Australian Region</i> . |

These regions were originally proposed by me for the class of birds in 1858,⁶ and have since been adopted by Mr. Wallace in his great work on the distribution of animals. It has been shown by Mr. Wallace, in his work above named, that these regions are the most convenient that can be adopted for other branches of the animal kingdom, as well as for mammals and birds; and it will be understood that, as a general rule, the genera, families, and other groups of animals that are found in these six regions, or at any rate many of them, are distinct from one another, and are characteristic of the regions which they occupy respectively.

Having now some idea of the general principles of distribution of animals, we will proceed to consider some of the exceptional cases to which I have previously alluded.

I. *The Little Blue Magpie of Spain.*—The general character of the birds of Spain does not differ from that of Southern Europe generally. A few North African species intrude into its limits, such as *Caprimulgus ruficollis* and *Telephonus erythropterus*, and some slightly modified forms of European species, such as the form of the green woodpecker, called *Gecinus Sharpii*, and that of the imperial eagle recently denominated *Aquila Adalberti*; but the general *facies* of Spanish ornithology has nothing specially exceptional about it. One little bird only seems to have been introduced from afar, and disturbs the general uniformity. The Little Blue Magpie of Spain (*Cyanopica Cooki*) has not only no near relative in the rest of Europe, but we must go to the furthest part of Siberia and Northern China before we meet with any similar bird. Here, in the district beyond Lake Baikal, and extending into Northern China and Japan, is found the *Cyanopica cyanus* (*Pica cyanus* of Pallas), so closely allied to the Spanish bird as to be barely distinguishable.

Here is, therefore, an instance of what may be most undoubtedly called a discontinuous generic, if not specific, area, and, in order to bring it within the rule, it is necessary to suppose that the parent-form of these two Blue Magpies was formerly existent throughout Europe and Central Asia, but has for some reason become extinct. That it has only recently become extinct we must suppose from the very close resemblance of the two forms, but to what causes can we attribute its dying out throughout so large a tract of country? If there were other parallel cases of a similar character, this singular fact of distribution would be less wonderful; but I know of none, except it be the case of the insectivorous mammals of the genus *Myogale*, of which one is found in Russia (*M. moschata*), and the other in the Pyrenees (*M. pyrenaica*).

Here, therefore, unless a somewhat unwarrantable assumption be made—that is, that the parent-form of *Cyanopica* was once distributed throughout Europe and Central Asia, but has become extinct—is a

⁶ *Journ. Proc. Linn. Soc.* ii. p. 130.

decisive instance of the infringement of our canon as to the continuity of specific and generic areas.

II. *Oxyrhamphus and Neomorphus of the Neotropical Region.*—As other parallel cases of the discontinuity of generic, if not of specific, areas, I may call attention to the rather isolated passerine form *Oxyrhamphus*, and to the distribution of the cuculine genus *Neomorphus*. *Oxyrhamphus flammiceps* of South-east Brazil was long supposed to be the only known form of the former genus. But a form so closely allied (*O. frater*) as to be scarcely distinguishable has been recently ascertained to occur in Central America, whereas the genus is quite unrepresented in intermediate localities.

In the case of *Neomorphus*, our canons of distribution are also decidedly transgressed, the Central American *N. Salvini* being very nearly similar to the Brazilian *N. Geoffroyi*, whereas in the intermediate countries three other distinct species are known to occur.⁷

III. *The case of Pitta angolensis.*—Returning for an instant to the Old World, a very singular case of exceptional distribution is manifested in the case of the brilliantly plumaged birds of the well-marked genus *Pitta*, of which not less than from thirty to forty species are now known to naturalists. As a rule, the distribution of these birds is much in accordance with other recognised facts, the area occupied by them being well defined by the limits of the Indian region on the north, while on the south, as is the case with several other Indian groups, they overlap into the Australian region as far as New Britain and Eastern Australia. But the remarkable point is that one single species (*Pitta angolensis*), in every way typical in structure, and closely allied to a common Indian species, occurs in a limited district of Western Africa, the genus being unrepresented in every other part of the Ethiopian region, and throughout Western Asia until we get to India.

There are other well-known instances of the occurrence of Indian genera in Western Africa, such as that of the bushy-tailed porcupines (*Atherura*), of which two species are Malayan and one West African, and the remarkable Indian group of moose-deer or chevrotains (*Tragulidæ*), of which one single form is West African, the remainder being strictly denizens of the Indian region. There are also several parallel cases in the class of fishes, which Professor Mivart has commented upon in his *Genesis of Species*.⁸ But these parallelisms do not render the fact less significant when we consider that between Angola and India there is a wide stretch of country, whence *Pitta* seems, if it ever existed, to have wholly vanished.

IV. *The Solenodon of the Antilles.*—I will now call attention

⁷ See also Mr. Salvin's remarks on some similar facts in the distribution of the species of the passerine genus *Geothlypis* in *Ibis*, 1872, p. 149 *et seqq.*

⁸ First edition, p. 146 *et seqq.*

to the distribution of the mammals of the order *Insectivora*, which presents some points of special interest in relation to this subject. The *Insectivora*, according to Professor Mivart's last arrangement,⁹ founded upon the most recent researches, although few in number, constitute not less than ten distinct families, mostly restricted to the Palæarctic Indian and Ethiopian regions. In the Australian region *Insectivora* are wholly absent, and only two families of them extend across into the northern portion of the New World—the moles (*Talpidae*) and the shrews (*Sorecidae*). But there is one very singular exceptional case. The curious insectivore *Solenodon* is peculiar to the West India Islands. Two species of the genus are known—one found in Cuba, and the other in Haiti.

Now we will first notice that one of the distinguishing points of the Neotropical Region (to which the Antilles most undoubtedly belong, although they possess some peculiar forms of their own) is the entire absence of *Insectivora*. Judging from the present state of their distribution, *Insectivora* would seem to have been but a recent introduction to the New World. Only the shrews and moles have entered it from Northern Asia (along with the sheep and antelopes and many other Old World forms which have spread over the Nearctic Region), and some of these American insectivores betray their origin in the most unmistakable way.¹⁰ The shrews alone descend the continent into Mexico, and, in the case of one species, intrude even into Guatemala. But one of the special peculiarities of the Neotropical Region, as a whole, is the want of *Insectivora*. The existence of any form of *Insectivora* in the West Indies is, therefore, an anomaly. But much greater is this anomaly when we come to consider the relationship of *Solenodon*, and find that instead of appertaining, as we should have expected, to one of the two recognised American families of *Insectivora*, *i.e.* the shrews or moles, it belongs, according to those excellent authorities, Dr. Peters and Professor Mivart, to the *Centetidae*, which are otherwise entirely confined to Madagascar.

If, therefore, we are to assume the descent of *Solenodon* and *Centetes* from a common ancestor, the following facts require consideration.

1. The total absence of *Centetidae* in the rest of the Neotropical Region. It should be observed that there are other forms peculiar to the West India Islands, such as the genera *Spindalis* and *Todus* in the class of birds, of which I have already spoken, and the hystricine genera *Capromys* and *Plagiodon* in the class of mammals. But these all have their nearest allies in South America.

⁹ See *Proceedings of the Zool. Soc. of London*, 1871, p. 58.

¹⁰ *E.g.* *Urotrichus Gibbsi* of the Cascade Mountains, which is very close to *U. talpoides* of Japan, and forms the second species of a well-marked generic form.

2. The entire absence of any member of the *Centetidae* in Africa.

3. The existence of the deep Atlantic Ocean between Africa and America.

And we should have to make the following assumptions:—

1. That the West India Islands must have been united to Madagascar through Africa since the time that they were joined to America, for otherwise members of the *Centetidae* would have been found in South America.

This would, I need hardly point out, be a very hazardous supposition, for the prevailing *facies* of the fauna of the West Indies is, I have just said, essentially Neotropical.

2. That the *Centetidae* formerly extended all through Africa, but have now become extinct.

It has been suggested that the supposed near affinity of *Solenodon* to the *Centetidae* may be an error, which will be corrected by more accurate examination. This may be so, but at the same time there are other reasons for suspecting an American element in the fauna of Madagascar.

Madagascar possesses iguanoid lizards (*Hoplurus* and *Chalarodon*) and certain species of snakes of the family *Boidae*, both of which are purely American groups. Moreover, one of its rodents (*Nesomys*), lately described by Dr. Peters, belongs to the American group of *Hesperomyes*. Again, the beautiful green moths of the genus *Urania*, most of which are peculiar to the Neotropical Region, and are quite unknown in Europe, Asia, Africa, and Australia, are likewise represented by a single species in Madagascar.¹¹

V. *The Distribution of Lemurs.*—We will next turn to Madagascar itself, and consider the inferences to be drawn from the distribution of one of its most characteristic groups—the lemurs, now generally recognised to constitute one of the principal divisions of the mammalian order allied to the monkeys.

With our recollections of *Solenodon* we might well have expected the lemurs would have had representatives in America; but such is not the case. On the contrary, they extend rather the other way, over India and some of the Greek Asiatic islands. But their principal and peculiar *sedes* is Madagascar, all the most marked genera and two-thirds of the known species being peculiar to that island. Three genera only are found in Africa, and three forms are met with in India and the islands.

I will not now stop to discuss the whole features of the fauna of Madagascar, which is certainly one of the most anomalous faunas existing on the world's surface. But I may say that there are several other

¹¹ A second Old World species of *Urania* (*U. Cræsus*) has recently been described from Zanzibar. But there is some doubt whether this insect was really obtained in Zanzibar, and whether it is really distinct from *U. rhipheus* of Madagascar.

points in which Indian affinities are manifest; and that, as regards its birds, Dr. Hartlaub, who has recently published an excellent synopsis of the Avi-fauna of Madagascar, has come to the conclusion that it has very little to do with Africa, and that, after taking out its individual peculiarities, the balance predominates largely in favour of a greater relationship to India.

This was indeed my own opinion when, writing in 1864 upon the mammals of Madagascar,¹² I proposed the name *Lemuria* for that ancient land which formerly must have occupied part of the bed of the Indian Ocean and constituted the home of the lemurine family, now so widely scattered. But I need hardly point out how difficult it is to reconcile this theory with the hypothesis of a former land-connection of Madagascar and the Antilles through Africa, which I have previously adverted to.

VI. *The Giant Land-Tortoises*.—Another still more extraordinary instance of erratic distribution is presented to us in the case of the giant tortoises, which have lately formed the subject of the elaborate studies of the Keeper of the Zoological Department of the British Museum.¹³

These giant tortoises, until recently referred to one or two species, have been shown by Dr. Günther to belong to no less than fifteen closely allied forms, divisible into three groups. Two of these groups only have representatives now living, which are found in two very out-of-the-way and distant parts of the world—namely, in the Galapagos Islands, and on the coral reef of Aldabra to the north of Madagascar. The third group, which formerly inhabited the Mascarene Islands, has become recently extinct. Now, in order to derive these three groups of allied species from the same stock, it is necessary, first, to suppose that giant land-tortoises were formerly distributed all over South America and Africa, where no traces whatever of animals of the sort are known to occur;¹⁴ secondly, to imagine that the Galapagos were formerly united to America; and, thirdly, to suppose that the Aldabra reef has formed part of land that was once joined to the African coast. But our difficulties are not even then over, for the most extraordinary fact connected with the distribution of these animals remains to be told—that is, that the Mascarene tortoises are more closely allied to the Galapagan forms than to those of Aldabra. In order, therefore, to bring this fact into harmony with the derivative origin of species, it would be necessary to add to the three hypotheses already suggested a fourth and still more unsatisfactory one—namely,

¹² *Quarterly Journal of Science*, vol. i. p. 215, April 1864.

¹³ See *The Gigantic Land-Tortoises, living and extinct, in the Collection of the British Museum*, by Albert C. L. Günther, M.A., M.D., Ph.D., F.R.S. (London, 1877), 1 vol. 4to.

¹⁴ It should be stated that fossil remains of a giant-tortoise apparently allied to the Galapagos form have been lately discovered in Malta.

that the Mascarene Islands had remained united to Africa after the Aldabra reef had been separated from it.

Looking to the geographical position of the Mascarene Islands, and to what we know of their indigenous fauna, I need hardly say that this is an almost untenable hypothesis.

I have now given half a dozen examples, taken from groups to which I have paid most attention, of the difficulties of accounting for all the known facts of distribution by the hypothesis of the derivative origin of species. It would be easy to add to them, and I am quite sure that any of my brother naturalists who have studied the distribution of fishes, land-shells, insects, and other groups, would have no difficulty in furnishing similar instances of anomalies that have come under their observation. I will now briefly allude to two other more general phenomena of distribution, which, as it seems to me, it is hard to reconcile with the derivative theory. These are the existence of 'tropicopolitan' forms, and the presence of allied species in the same area.

First as to 'tropicopolitan' forms, by which I mean tropical forms that are found in the tropics of both hemispheres. As a rule, the families prevalent in the eastern and western tropics are essentially different, and such families as are met with in both are also distributed more or less over other parts of the world. In these cases, therefore, there is less difficulty in the hypothesis of a descent from common ancestors. But when we come to such cases as that of the family of Barbets (*Capitonidæ*), which occur in the tropical forests of India, Africa, and America alike, it does appear to me that there is much difficulty in supposing the existence of a land where the ancestors of this now far-divided group may have existed. Recent researches have certainly tended to show, in the judgment of those most competent to form an opinion, that the great oceans have existed, if not from the beginning of geological time, at least from a very early period. Where then did this common tropical land exist? It must have been either in the Atlantic or in the Pacific. The latter hypothesis is, I think, quite out of the question. The Australian forms of life, which are utterly distinct from those of the Indian and American tropics, extend nearly up to the Equator, and the Pacific Islands show no signs of such remnants, as they must have done¹⁵ in case the 'missing link' had traversed the Pacific. The Atlantic hypothesis is more probable, and many facts (such as the repetition of Indian genera in Western Africa, and the occurrence of Old World forms in the West Indies) would seem to favour this view. But the subject is full of difficulties. Take the Barbets for instance. It is very difficult to conceive that this form of bird, specially modified as it is, can have ever existed outside of the tropics. It is almost equally difficult to

¹⁵ The presence of a single iguanoid lizard (*Brachylophus fasciatus*) in the Fiji Islands can hardly be regarded as an exception.

believe that tropical land can have united Africa and South America within the period of the tertiary epoch. But when we retrocede further into the secondaries it seems rather doubtful whether birds, as we now understand them, had even come into being at that period, much less into such modified forms as that of the barbets. Where then did the common ancestors of the Old and New World barbets disport themselves?

A second difficulty which I have never seen satisfactorily explained is the presence of several nearly allied species in the same area. Take, for instance, two such near allies as the willow-warbler and the chiff-chaff. These two little birds, both abundant in our fauna, are so nearly alike that even the best ornithologist may be puzzled to distinguish their dried skins. Yet in life they are quite distinct, as well as in mode of life and in habits. No intermediate forms exist between them. How then did they come to exist within the same area? If we choose to suppose that they were formerly representative species, occupying adjacent, but different, areas, and subsequently shifted their range into one, the difficulty is readily solved. But to assume that all allied species have been manufactured in this way seems to be rather hazardous. We have in Europe five or six species of titmouse found in the same district—in many cases in the same forests. It is hard to believe that these can all have originated in different areas, such as those I have pointed out in the case of the American bell-birds, and then have come together again into the same area.

On the other hand, it is difficult to understand how they can have come into being in the same area out of one original stock; for supposing, as we well may, that variation may proceed in several advantageous directions, the intercrossing of the different forms would, it seems to me, neutralise any permanent distinctions between them. It is easy to understand how one species, as originally suggested by Mr. Wallace, comes to be replaced by one other in the same area, and by two or any other number in different areas. But it is difficult to comprehend how more than one species can succeed another in the same area.

These and other difficulties, some of which I have endeavoured to set before my readers, have led me sometimes to question what seems now to be generally taken for granted by those who hold to the theory of the derivative origin of species—namely, that *identity of structure is, without exception, an indication of descent from a common parent*. Ultimately—that is, if we go back far enough—this is, no doubt, the case; but in some instances the common parent must, I think, have been many generations further off than is usually supposed. In fact, it appears to me that we cannot always safely predicate that two similar organisms, wherever they may now be found on the earth's surface, must have had immediate common parents. We

know that cases occur of nearly similar human individuals being born from parents in no way related to each other. Is it not possible that the corresponding phenomena may occur in animals and plants in some exceptional cases?

In bringing forward this subject for speculation, it will not, I hope, be supposed that I am an opponent of the theory of the derivative origin of species. Far from such being the case, I maintain that there is no other hypothesis as to the origin of species that a working naturalist can use, and that new facts are being discovered every day which tend to render it more and more likely to be correct. At the same time I will take this opportunity of acknowledging that I am not one of those who would go so far as to convert the derivative theory of the origin of species into a dogma, as some of our friends appear to wish to do, and would force it down the throats of old and young alike, as an absolute and incontrovertible fact.

There are still many difficulties to be explained before the derivative hypothesis can be accepted as fully proven. It is, perhaps, fortunate that such is the case. Were everything relating to the subject so plain and straightforward as some would have us suppose, one of the great incentives to work upon the origin of species, and upon the many and most interesting subordinate questions that lead up to it, would altogether fail us.

P. L. SCLATER.