ANTARCTICA: A VANISHED AUSTRAL LAND.

THE student of the general fauna and flora of the different countries of the world soon finds himself faced by this remarkable fact, that the same species of a genus or the same genera of a family often occur at spots on the earth's surface separated by enormous distances, in the interval between which there is to be found not a single specimen of any of them. Before the Darwinian era we were taught that those similar isolated forms originated where they are now found by the fiat and at the incomprehensible will of the Creator; an explanation, however unsatisfying, which there was no going behind. The purpose and design in this distribution may have appeared strangely erratic and arbitrary, yet our longing to "know why" had to be stifled before this ultimate fact that the Power that willed it so was inscrutable; nor dared one to question further without incurring the charge of sacrilegiously prying into the Unknowable. The light from laborious embryological investigation, however, revealed no fact more clearly than this, that the individuals of the same family, however far separated on the globe, had arisen from the same progenitors by ordinary generation, and that the cause of this random distribution of the same forms of life in distant regions might, without impiety, be investigated, and with some hope of success. Having once, therefore, all had a common ancestry, how did they reach their present habitats, which are half the circumference of the globe apart, and separated by wide and deep oceans, impassable to them unless they flew, swam, sailed over on floats, or marched across by bridges that have disappeared between their present and their former homes? For instance, the members of that curious family of animals with something of the horse and the elephant in their composition, the tapirs, are now found only in the southern parts of South America on the one side of the globe, and in the centre of the islands of Sumatra and Borneo of the Malay Archipelago on the other, and nowhere else. Their bizarre appearance and their close similarity in form and structure render it absolutely certain that they have had a common parentage, and that, though now living so widely sundered from each other, they radiated from one ancestral home. To trace out the migration of the varied forms of life—both animal and vegetable—to their present habitats forms one of the most absorbing of zoo-geographical investigations—a "study," as Mr. Wallace well remarks, "which will surely lead . . . to a fuller comprehension of the complex relations and mutual interdependence, which link every animal and vegetable form with the

ever-changing earth which supports them, into one grand organic whole," and which, besides, will enable the investigator to demark with increasing certainty, as his labours progress, the changes in fluctuation of land and water which the globe has from age to age restlessly experienced. As soon as our knowledge of the fauna and flora of the continents and islands of the globe had advanced sufficiently far to enable fairly accurate systematic catalogues of the animals and plants inhabiting them to be drawn up, many singular anomalies came to light, some of which have been apparently sufficiently explained, while of others the causes are still as inexplicable as ever.

In the year 1861 those distinguished palæontologists, Professors Herr and Unger, pointed out that the present vegetation of the Eastern States of America exhibited remarkable resemblances to that which flourished in Europe during the Miocene age, and they suggested the hypothesis that during the Miocene period Europe and America were united by a land bridge (long celebrated as the Atlantis continent), which stretched across the Atlantic Ocean. By the perusal of the essay of these botanists, *Recherches sur le Climat et la Végétation du Pays Tertiare,* Professor Oliver of Kew, having been induced to investigate "carefully the relations between the Tertiary and some existing floras," was led to the conclusion that the inter-community of "types in the Tertiary beds of Europe and the present flora of the Eastern States of the North American continent took place, not over an Atlantis, but over land probably in a comparatively high latitude to the north of the Pacific Ocean" [1] —that is to say, that the flora of Europe followed the climate as, in that epoch, it became more and more genial into the circumpolar regions, and thence it dispersed southwards again on the advent of the cold, into such parts of Asia and America as it could obtain foothold in. That a genial climate and a vegetation of very temperate character did exist to within nearly eight degrees of the North Pole, was proved in a most conclusive manner by the officers of the Arctic Expedition of 1876, who discovered, in those now ice-bound latitudes, fossil plants which now grow not further north than mid-Europe.

Perhaps nothing in natural history surprised naturalists more than the distributional facts—both of the fauna and the flora—first indicated by Mr. A. R. Wallace on the east and west sides of what is known as Wallace's Line, which separates the two Malayan islands of Bali and Lombock. The strait that separates these islands is so narrow that, standing on the vessel's deck, the voyager to the southward has an excellent view of the land on

(1) "The Atlantis Hypothesis in its Botanical Aspect," *The Natural History Review,* 1862, p. 149.

both sides, and can admire the richly forest-clad and shapely volcanic cones of Agong and Rinjani that tower into the blue on his right hand and on his left. To "the eastern side of this line," Mr. Wallace writes, "the fauna and the flora, and even the people, are essentially Australian; to the western side, as essentially Asiatic." On crossing this narrow passage from west to east, "we at once meet with those singular birds, the mound-builders (*Megapodidæ*), as well as friar birds and other honeysuckers, cockatoos, and many other groups found only in the Australian regions; while a large number of animals found in every one of the Asiatic islands suddenly disappear. We have no longer any elephants, rhinoceroses, or tigers; none of the carnivora but a common civet cat (probably introduced); none of the insectivora but a small shrew; none of the numerous rodents but one or two squirrels." Yet in the island of Timor, further to the east and near to Australia, one is surprised to discover that, as Mr. Wallace points out, the characteristic mammals of Australia are quite as much wanting as those of Asia. "Birds," he remarks, "however, having the means of passing freely over narrow arms of the sea, have not been excluded, and, notwithstanding the similarity in climate and vegetation to Australia, the birds and insects of Timor more resemble those of Java, Celebes, and the Moluccas." These islands are hundreds of miles apart, and yet have an interchange, according to Mr. Wallace, of many birds and insects; while from Bali and Lombock, which gaze on each other across a narrow arm of the sea, there has been, when the distances apart of the two localities are compared, only a slight interchange. In South America again we have genera of monkeys and birds living in abundance along one bank of a river, which apparently find this comparatively narrow line of water an impassable barrier.

In a paper contributed to *The Fortnightly Review* in May last, I referred to the discovery in the Chatham Islands (near New Zealand) of the sub-fossil remains of birds which were up to that time known to have lived only a few hundred years since in the Mascarene Islands, as confirming the belief that there must have existed in the Southern Seas an extensive continuous land similar to that in the Northern Hemisphere on which the common ancestors of the forms unknown north of the Equator, but confined to one or more of the southern extremities of the great continents, lived and multiplied and whence they could disperse in all directions. "This lost continent," I observed then, "I am constrained to believe from evidence which space does not on the present occasion permit me to adduce, lies in part beneath the southern ice-cap, and it approached to, or included, the Antarctic Islands, as well as extended northward to unite with the southern extremities of South America, perhaps with Africa, and with the Mascarene, the Australian, and the New Zealand con-

tinental islands." The larger evidence to which I then referred I purpose now to lay before the readers of this Review.

We find either still living or preserved fossil in the strata of their Tertiary formations in regions of the Southern Hemisphere so widely apart as the south of South America, the Madagascar region, Australia, and New Zealand, many forms of plants and animals, unknown in the Northern Hemisphere, possessing so many characters in common as to show at once that they are descended from the same stock.

To commence with birds, the distribution of the ostrich group is very remarkable. New Zealand, as it is scarcely necessary to remind the reader, is celebrated for the remains of those extinct giants of the family known as moas. Their bones are found all over the two main islands of which that colony consists, and they might have been gathered in the early years of its settlement by Europeans in vast numbers from off the surface of the ground, especially in the interior of the provinces of Canterbury and Otago, or from the sandy flats of the larger rivers where they had become exposed by the action of the wind. They have also been found in caves, under rock shelters, and in the ancient kitchen middens of the natives, as well as exhumed in enormous quantities from the peat bogs of both islands, where they have been discovered huddled together in crowds of many hundreds. These birds varied very greatly in size, the larger specimens attaining a stature of from ten to twelve feet. They had bones of herculean proportions, and, needless to say, they were quite unable to fly, being, indeed, devoid of wings. Their feathers which, singularly enough, have been preserved to us in considerable numbers, show that each had an after-shaft equal in length to the primary plumes of their contour feathers—forming, as it were, a double feather—a characteristic mark of the ostriches of the Australian region, the emus and cassowaries; and they all possessed, on the metatarsal bone, articular pulleys for three toes instead of two, as the African ostrich has. Australia also included in its bird fauna of ancient days a giant ostrich, the *Dromornis*, and now possesses the emu, while New Guinea reckons at the present time the cassowary—of which one species crosses into Australia—among its wonderful bird inhabitants. In the distant island of Madagascar also there flourished once, though now extinct, a member of the same family, the *Æpyornis*, a giant, if not in height, at all events in the bulk and dimensions of its limbs, which appear to have exceeded those of even the most elephantine of the moas. Yet another stately member, the *Brontornis*, lived in early ages in southern Patagonia, a necessarily flightless bird, which, as we know from its fossil remains, far excelled in stature even the tallest of its New Zealand relatives. This remark-

able group of birds, therefore, we find occupied New Zealand, Australia, Madagascar, and South America—that is, their distribution extended right round, and was practically confined to the lands of the Southern Hemisphere, in which the area that each occupies is seen from a study of the map to be separated from the other by vast stretches of unbridged ocean. Yet a comparison of their skeletons—for of the moa, the *Æpyornis* and the *Brontornis* we have only their fossil bones to judge from—leaves little doubt that they are all ramifications of one branch of the same genealogical tree which flourished in a region which I hope to indicate in the course of this paper, and that they wandered in all directions from a common land by roads which I shall presently attempt to trace.

The traveller interested in bird life who has spent some time either in South Africa, or in South Australia, or has had the good fortune to land on the shores of Tierra del Fuego, or of one of the Antarctic islands, can scarcely have failed to watch those quaint fish-like birds, the penguins, which are far more at home under the water than they are on the land. They breed in enormous rookeries on some of the more unfrequented southern islands, but they are met with in all parts of the Southern Hemisphere south of forty degrees of south latitude, each island or continent having some species peculiar to itself. One important point in their history is that none of the family have ever been found on the northern side of the Equator, a distribution which has probably been always equally circumscribed within these latitudes, for their earliest fossil remains—osteologically identical throughout the enormous period separating the Eocene from to-day—are known only from, and are, so far as I am aware, confined to the older Tertiary formations of New Zealand and Patagonia. More interesting still, perhaps, and very important from the point of view of the subject of this paper, is the distribution of the *Chionidæ*, a family of beautiful, pure white birds related to the plovers. These Sheath-bills, as they are named, from a conspicuous horny sheath at the base of their bills, are not marine but land birds. They would be incapable of undertaking a journey of any great duration across the sea where they could find nothing to support them; yet they are found, so far as known, in Fuegia and the neighbouring Falkland Islands, but not elsewhere till the far-off Crozet Islands and Kerguelen's Land are reached.

The well-known and brilliantly-plumaged family of the parrots have their chief development in the Australian and Papuan regions and in South America (with a few stragglers extending up into North America), while in South Africa and in India they are but feebly represented. Now, the curious owl-parrots and the keas of New Zealand have a near relationship with the macaws of South America. Mr. Wallace has pointed out that an unusual style of coloration

occurs among the parrots living both in Australia and the Mascarene Islands; and that though in Australia alone species adorned with crests now live, yet within the historical period, such forms occurred in the Mascarene region also—characters, he observes, "too well marked to be considered accidental." In the May number of *The Fortnightly Review* I have already drawn attention to the fact that what now constitutes New Zealand was but a small portion of a once far greater continental island—which I have designated Antipodea—stretching south as far at least as the Macquarie Islands, and embracing all those lying between them and the Chatham Islands, as well as those to the northward as far as New Caledonia, the Fiji, the Friendly, and the Kermadec Islands—a fact deduced from the occurrence on these separated specks of land of a common flora and fauna which could not have arrived there without a land connection. On that occasion also, I spoke of the discovery in the Chatham Islands—an unsubmerged portion of a once larger region—of the remains of two birds, a tall coot (*Fulica*) and a giant wood-hen (*Aphanapteryx*), which had been previously known only from Mauritius, which is also an unsubmerged portion of a greater continental island, comprising Bourbon, Rodriguez, Madagascar, and the Seychelles. The wood-hens, a group of rails entirely unknown in the Northern Hemisphere, are in the Southern Hemisphere absolutely confined to the islands of the Mascarene and of the New Zealand archipelagos, which are separated from each other by nearly half the circumference of the globe. Dr. R. Bowdler Sharpe, speaking not long ago on the "Geographical Distribution of Birds," at the Royal Institution, pointed out additional relationships (so far as their birds are concerned) between these same widely disconnected areas. In the island of Bourbon there lived, till exterminated in comparatively recent times by incursive Europeans, a very peculiar starling with a long, slightly curved bill, the *Fregilupus*, the sole species of its genus, of which one of the very few examples that have been preserved may be seen mounted in the Bird Gallery of the Natural History Museum at South Kensington. It has no near relatives except in New Zealand, where the huia (*Heteralocha gouldi*), a bird equally peculiar and the solitary representative of its genus, forms one of the most interesting species of one of the most peculiar bird faunas of the world. The huia is remarkable in that the shape of the beak differs in the two sexes in a most surprising manner in association with habits unique, I believe so far as yet known, among the feathered tribes. The bill of the male is straight, powerful and sharp; that of the female is in comparison exceedingly slender and strongly curved. The straight-beaked bird breaks up and chips off the bark and wood of trees, in quest of the tunnels of the grubs and insects that form their food; while the closely atten-

dant female is keenly on the alert to thrust in its slender curved forceps—where the beak of its mate is useless—to extract each nutritious morsel when discovered. Both are aberrant forms of their family, and both are on excellent authority considered to be descendants of the same ancestor. In the same two regions also, alone of all the globe, there lived down to recent times, but now extinct (though ornithologists still cling to the hope that a few survivors may yet be holding out in the dense forests of south-west New Zealand), giant and flightless forms of blue water-hens, of two species, the *Aptornis* and the *Notornis*, of which as yet no remains have come to light in the Mascarenes, but are still found in some abundance in the caves and swamps of New Zealand.

The late Mr. W. A. Forbes (who at the time of his death held the post of Prosector to the Zoological Society of London, and had already become distinguished as one of the best anatomists who had filled that most coveted position), a man remarkable for the keenness of his observational powers, for the amount and accuracy of his knowledge, and for the tenacity of his memory in regard to details of structure, investigated shortly before his death the relationships of *Acanthidositta* and *Xenicus*, lively little birds which are year by year becoming rarer in the forests and on the rocky talus slopes among the hills of New Zealand, and discovered that, in their anatomical structure, they have their nearest allies in Australia (and in part of the Indian region), in Madagascar and in South America, but exhibit few affinities with groups elsewhere.

Professor Huxley many years ago, in a remarkable paper, read before the Zoological Society of London, on the "Classification of the Gallinaceous Birds," pointed out that they fall into two great groups, the one broadly occupying the Northern Hemisphere, and the other the Southern Hemisphere—Australasia and South America; thus dividing the globe into two regions which he felicitously termed Arctogæa and Notogæa. The Notogæan section of these birds comprises according to him the mound-builders or megapodes (*Megapodidæ*) in Australia and Papuasia, and the curassows or guans (*Cracidæ*) in South America, both of which possess structural peculiarities in common, pointing to the fact that, though they now form different and easily distinguishable families occupying distant areas of the globe, they sprang from the same stock.

The relationships of the groups above referred to as distributionally confined to the Southern Hemisphere, are such as can be made out by a trained eye without going very far below the surface; they are classified by characters either externally apparent or recognisable by an examination of their osteology or their coarser anatomy. But we have evidence of the same affinities existing between the fauna of the same dissociated portions of the globe derived from a deeper

source than these. It is but a year or two since Science had to mourn in the death of Professor W. K. Parker the loss of the very foremost of English morphologists, and one whose knowledge of the anatomy—especially of the cranial structure—not only of birds but of most of the vertebrates, from their embryo onwards, was unrivalled. In one of those numerous erudite papers, lit up with brilliant thoughts and analogies expressed in deeply poetic language—unexpected in a subject so abstruse—and superbly illustrated by his own hand, which he communicated to the Zoological, the Linnean, and the Royal Societies of London throughout his life, he has published his labours on the embryology of some of the birds most typical of Australia — its piping-crows, its warblers, and wood-swallows. He devoted himself especially to the investigation of the cranial constitution of birds from the very early stages of their existence, for he believed that "the outward form of the *face* gives the key-note to the whole bird—the head and face rule all things else; and every modification in the organs of progression must be in correlation with that deeper change which has taken place in the storied and labyrinthine walls of the head." He has unfolded their lineage as surely as if he had witnessed its growth through the vistas of the past by watching the laying together of each separate element before "nature with her cementing osteoblasts had obliterated their individuality." His penetrating eye detected the existence and recognised the significance to their pedigree of those structures, useless to the individual save that each new life must inexorably ascend by all the stairs its sires have climbed before it, which within the secrecy of the egg appear but for an hour, and vanish as if they had never been. The pedigree of the Australian piping-crows arises, he finds, from the same stock as the South American creepers (*Dendrocolaptidæ*); that of the wood-swallows oscillates between the ground-thrushes (*Pitta*) of the Malayan Archipelago and the South American ant-thrushes; while the affinities of the Australian warblers are with the wood-warblers (*Mniotiltidæ*) of South America, all of them declaring their affinity with forms in the Southern and not in the Northern Hemisphere—with groups whose homes are not on land areas continuous with their own, but in regions separated by wide seas, and at their furthest limits apart.

Such is the singular disconnected distribution of many undoubtedly related groups of birds, of which I shall presently proceed to offer an explanation.

Before doing so, I wish to refer shortly to other sections of the animal kingdom. It is well known that Australia is the great home of those lowly mammals, the marsupials—the survivors of a family whose ancestry dates back to the Trias, a period to be reckoned

only in ages, each perhaps of thousands of centuries. They are remarkable, as an Order, for containing "isomorphs," or groups that have the form and habits of many of the various other orders of the animal kingdom. The kangaroo rats, for instance, assume the outward form of our common rats and mice; others, such as the beautiful flying phalangers, resemble the insectivora; while yet others, as the "Tasmanian devil," are large, carnivorous, and wolf-like. Besides the Austro-Malayan region (which is a part of the Australasian realm), no region of the globe now contains any representative of those implacental animals, except the South American forests (from which two species have wandered into North America). The present marsupials, however, of South America (the opossums) exhibit wide differences from those now living in Australia; it is, therefore, not improbable that their ancestry must be traced from forms once living, but now found fossil only, in North America. The singular implacental animals now living in Australia are but the remnants of a much more extensive order; for there vanished at a comparatively recent geological period other marsupials still more remarkable, especially for their gigantic size. Of these the *Diprotodon* attained to the proportions of a rhinoceros or a hippopotamus, and the *Nototherium* to that of a tapir; while the *Thylacoleo* was a gigantic carnivore that probably preyed on the titanic kangaroo of its own time, an animal twice as tall as the largest "old man" kangaroo (*Macropus giganteus*) of to-day which has been known to measure nearly six feet from the point of the nose to the root of the tail. The interest of these remains has largely increased through the discoveries of South American palæontologists who have quite recently disinterred most unexpected treasures from the early Tertiary formations of Patagonia, the first-fruits, there can be little doubt, of a large harvest of remains, which will certainly shed, as those already obtained have done, a flood of light on the pedigree of many of the vertebrata. Among these treasures not the least important are the remains of marsupials closely related to the *Diprotodon*, the *Thylacoleo*, and the "Tasmanian devil," which in the Pliocene age flourished in Australia in such abundance.

Turning for a moment to still another group of the vertebrata, we find that, in such widely separated spots as New Zealand, Patagonia, and the Falkland Islands, there occur identical species of different families of fresh-water fishes. The southern salmon (*Haplochitonidæ*) and the southern pikes (*Galaxiidæ*), which are unknown north of the Equator, and which could not traverse the wide expanse of sea dividing them, are common to all of these localities. Our highest authority on ichthyology, Dr. A. Günther, F.R.S., of the British Museum, has shown that between the fresh-water fishes of Africa and Australia there is, though not an extensive yet an unmistakable

affinity; while, with many points of close resemblance between them, the African and the South American genera are distinct, which indicates "that the separation of these continents must have been of old date."

Mr. Wallace has, in his great work on *The Distribution of Animals*, pointed out how insects, as a whole, show a decided inter-relation between Australia and South America. Indeed, he believes that the *Buprestidæ*, a family of brilliantly metallic beetles, had their original development in temperate Australia, and spread thence; while of the longicorn beetles (so named from the long antennæ they possess) several genera are common to South America, Australia, and New Zealand, indicating that there must have been some means of communication between these countries other than at present. Both the families of insects I have mentioned are wood-borers, living on soft or decaying trees, in which also their larvæ are developed, and necessarily requiring for their growth and differentiation, throughout the area of their dispersal an extensive and wooded region—a genial Antarctic continent, not merely a series of far separated islands as stepping-stones.

Now if we turn to the plants of the Southern Hemisphere, and confining our attention to those not, or but slightly ranging with the north of the Equator, we find they present the same problems for solution as the fauna offered. Of the charming saxifrage family there are two tribes (*Escallonieæ* and *Cunonieæ*) which are peculiarly restricted to the south of the Equator. They contain between them thirty-five genera, of which two only cross that boundary; the remaining thirty-three genera are distributed to New Caledonia, New Zealand, Australia (with Tasmania), the Mascarene Islands, and South America, areas, as we have seen above in the case of the fauna, occupied by related forms, though separated from each other by wide seas. Of the forty-nine genera and nine hundred and fifty species of the *Proteaceæ*, the whole, with the infinitesimal exception of twenty-five species which pass to the north of the line, are distributed across the same regions, with the addition of South Africa. The genus *Cryptocarya* of the *Persaceæ* is common to New Zealand, South Africa and South America, while among the genera of other families we find some occurring in Africa, or Madagascar and Australia; some in Tasmania and South America only; while others crop up in South Africa and Australia, or New Zealand; or in New Zealand and South America only. During my travels in the Eastern Archipelago I discovered growing wild in the forests of Java a large colony of *Petræa arborea*, an arboreal species of the *Verbenaceæ*, which at the end of last century (1792) was found by Smith and Wiles on the *Providence* expedition, in Timor also. This genus was previously supposed to be entirely confined to the South American

continent; and yet another near relative, *Petræo-vitex*, has still more lately been obtained in the islands of Buru and Amboina.

Now as to the explanation of these instances of singularly disconnected distribution of so many plants and animals, the highest authorities are by no means agreed. Nor is it a question that can be finally settled while our information on many points necessary to its solution is so fragmentary. Year by year, however, new discoveries are mending the imperfections of our records, while continued sifting of the evidence already gathered is gradually eliminating what is unreliable and establishing more firmly that which is trustworthy. So far as his latest opinions have been expressed, Mr. Wallace, our highest authority on geographical distribution, holds that the presence of these numerous genera and species of the same families or groups of plants and animals in Australasia, in the Mascarene Islands, or in South Africa, and in South America, can be sufficiently explained as the remnants of ancient types once spread over the Northern Hemisphere, whose lands are practically continuous, driven southward along these continents by the pressure of more specialised types, and now finding refuge in these widely separated southern lands. No one can differ from Mr. Wallace on this subject without great diffidence, and certainly no one can feel a profounder admiration, even veneration, than the present writer (who has followed in so many of his footsteps in the archipelago he has made famous, with his fascinating book as his best guide and companion) for the opinions and writings of this most distinguished *doyen* of our naturalists. Still, I cannot persuade myself that this explanation covers all the instances of discontinuous distribution—of *forms unknown in the Northern Hemisphere*—which have been adduced in the foregoing pages. It seems too extraordinary to be credible that it should alone have been the same forms that have survived the vicissitudes of climate and food during their long migrations through the deserts and forests of Asia, Malaya, and Australia to reach New Zealand; of Europe and Africa to reach The Cape and Madagascar; and of North and South America to arrive in Patagonia, and even in the Antarctic islands; and that scarcely a single representative of their line should have survived north of the Equator. Nor does the explanation that has also been offered of the occurrence of the same genera and species in those remote regions—that they have been the result of independent development—appear to me to be more satisfactory; for the chances against the same genus or species becoming developed independently at various times in three or four distinct regions of the globe, under different conditions and latitudes, and only in the southern extremities of the great continents, are enormously great.

It has hitherto been laid down as a fundamental law in geo-

graphical distribution, that the areas inhabited by a given species, and in considerable measure likewise by the same genera, are or have been continuous with each other. The conclusion has been forced upon us, therefore, that there must once have existed in the southern ocean a land area common to the terminations of the great continents, extensive enough to afford room for the development of the ancestors of so many forms of life absent from the Northern Hemisphere; and that it was very genial in climate and clad with vegetation sufficiently luxuriant to support so varied a fauna. In studying the Southern Hemisphere on a globe, on which the natural relations of land and water are evident, and tracing out the continental shelf surrounding the existing Antarctic land within the contour of the two-thousand-fathom line, so far as it is known, I was surprised to observe that the land that would result from such an elevation of the Antarctic sea-floor, would explain the perplexing distribution of the southern fauna and flora. It was also evident that a continent so formed would not interfere with the opinions entertained by so many of our highest geological authorities and oceanographers, that the beds of the great oceans are troughs, and the great meridianal land masses are buckles (in parts at one time dry and at another submerged) of the earth's crust, both of which have practically been permanent since primeval times, or to quote Mr. Darwin, that "where our oceans now extend, oceans have extended from the remotest period of which we have any record; and where continents now exist large tracts of land have existed, subjected, no doubt, to great oscillations of level since the Cambrian period."

The boundaries of this continent of *Antarctica*, as I have proposed to designate it, would have united Patagonia, New Zealand (as part of such a large continental island as I have described and named Antipodea, on page 6), Tasmania with East Australia, and that old island-continent (joined, perhaps, by a narrow commissure, for a longer or shorter time, to East Africa), which Dr. Sclater long ago named Lemuria, to a circumpolar land greater than at present by extensive independent peninsulas, between which the Atlantic, the Pacific, and the Indian Oceans extended almost as far south as they do now. It will be observed that South Africa is excluded in this view from actual contact with this southern continent. That it did not remain so long as the others in direct connection with Antarctica, seems indicated by the presence of so aberrant a form of the struthious family in that country as its ostriches, which possess on their tarso-metatarsal bones two articulatory trochleæ only, thus reducing their's to a two-toed instead of a three-toed foot, as is found in the moas, the *Æpyornis*, the cassowaries, the emus, and the *Brontornis*. The loss of this toe points unquestionably to a very long isolation

of the ostrich from intermarriage with the more normal members of its order. The African ostriches also differ from the eastern members of the family, in having no after-shaft to their contour feathers, a character in which they agree with the rheas of South America, a group to which the African ostriches are more closely, though still very distantly, related than perhaps to any of the others. It would seem highly probable also that the connection between South America and Africa was severed at a very early period—an assumption supported by the distribution of the fresh-water fishes of Patagonia and South Africa, which, though indicating, as Dr. Günther has so well elucidated, by the undoubted affinities between them, a previous approximation of the two regions, yet in the distinctness of their genera plainly speaks of a long disseverance. The boundaries of this Antarctic continent, which I have indicated, would have enclosed all the circumpolar land and the islands in the Southern Sea. Actual, apart from deductive, evidence for the existence of a greater extension of land in this region is of course very limited, yet it is not altogether absent.

No visitor to the Chatham Islands can fail to be struck by the number of lakes and tarns that everywhere dot the landscape. Nor can he travel far without remarking that the surface of the ground is covered by a continuous layer of peat, which is in many places forty to fifty feet deep, and in some still unfathomed. It is in general solid enough to permit safe traffic over it, but extensive areas are covered with unsuspected wet bogs extremely dangerous to a pedestrian unacquainted with the country. The time required for the accumulation of this enormous deposit may be imagined when it is remembered that it takes several feet of sphagnum—the moss of which peat is chiefly composed—as seen growing on the surface of the bog, to form one inch of dense black peat at its bottom. Everywhere throughout those peat bogs trunks of trees, larger than and of a different sort to those that now grow in the islands, lie entombed. They are the remains of ancient forests which have succumbed "to the chilling effects of the wet bog-mosses in their upward growth." The woods that now or did recently (for they are fast disappearing before the demands of the agriculturist) cover the ground, are but the latest of a succession of forests already swallowed up, that had in turn taken possession of the land, wherever the water had drained away and the growth of the mosses ceased.[1] The antiquity of these islands is proved by the fact that in different places the more ancient of these peat-beds have become consolidated into lignite. This account of the surface features of the Chatham Islands might serve

(1) The reader is referred to a very interesting little volume on *British Mosses*, where their relation to ancient forests is dealt with, by the Right Hon. Sir Edward Fry, and to his paper in the *Proceedings* of the Royal Institution, 1892.

equally for those of Kerguelen's Land, which also abounds in large bogs, in lakes and great pools in the hills, and in fiords—all evidences of great antiquity, of glaciation probably, and certainly of very extensive subsidence. In the Auckland Islands also occur bogs and beds of bituminous peat; while both in the Crozets and in Kerguelen's Land fossil trunks of large trees have been found, all distinctly pointing to the existence of extensive and varied forests on these now sleet-swept, bare inhospitable lands. The prevalent features of the present flora of Kerguelen are Fuegian, many of the species in both regions being identical or nearly related; while others are common to Tasmania, and still others to one or more of the unsubmerged fragments of Antipodea (New Zealand and its surrounding islands), and some to all these three regions, one fern being common to Kerguelen and the Cape of Good Hope. To Kerguelen's Land and to Marion Island sixteen hundred miles west of it, is confined a still more remarkable genus of plants, known as *Pringlea*. It is very distinct, is without near relatives, and is the survivor of a flora unknown in any other part of the globe. Its seeds are perishable, and on this account it is very unlikely that it has been conveyed by birds from one island to the other; and is, therefore, with high probability indigenous to both. Its distribution to those isolated spots, and various "phenomena, besides, common to the three archipelagos—Kerguelen, Crozets, and Marion—favour," in the opinion of Sir Joseph Hooker and other high botanical authorities, the "inference . . . . that these constitute the wrecks of either an ancient continent or an archipelago extending further westwards," on which the progenitors of their once existing, or still surviving, endemic flora became developed.

On a former page it was predicated that if such an austral continent ever did exist, it must have been blessed with a very genial, if not a tropical, climate capable of supporting extensive forests and other luxuriant vegetation fit to harbour and nourish the marsupials, the birds, and the insects, found in these southern regions. That such extensive forests did exist in far southern latitudes requires no more proof than the occurrence of the fossil tree-stems in Kerguelen's Land and in the Crozets; while I shall now try to show that the genial climate of which I have spoken once prevailed in these islands.

It is to the late Dr. James Croll that we owe the first satisfactory account of the astronomical and physical causes on which climate depends—especially in reference to the causes of the glacial epochs, which he proved to be, in that hemisphere, due to the occurrence of winter when its pole was turned away from the sun at the same time that the earth during its greatest eccentricity was at its furthest distance in its orbit from the source of heat. Sir Robert Ball, who has

made some important additions to this theory (by establishing mathematically the different percentages of heat that are received in the summer and in the winter of each hemisphere) emphatically asserts, as a mathematician, that it is of the essence of the astronomical theory that "the glaciation over the hemisphere shall be simultaneous," and if it were not so "it would seem wholly impossible to offer an explanation of the phenomena by any physical cause known to us." On the other hand, "viewing the two hemispheres each as a whole it is most important to observe that their respective glaciations were *not* simultaneous," indeed "if it could be shown that the Ice Ages in the two hemispheres were concurrent, the astronomical doctrine would have to be forthwith abandoned." "It is also of the essence of the astronomical theory," he maintains, "that a glacial epoch in one hemisphere shall be accompanied by a genial epoch in the other, and that, after certain thousands of years, the climatic conditions of the two hemispheres shall become interchanged—that the ice shall leave . . . and the regions that it has abandoned shall become clothed with luxuriant vegetation." Since the duration of the eccentricity of the earth's orbit, when once it supervenes, endures through a period in which the rotation of the line of the equinoxes round the eclipse may take place more than once, "clusters of ice ages and genial ages" may have followed each other before each period of high eccentricity which originated them, passed away. "Each hemisphere is plunged alternately into extremely glacial and extremely genial conditions, and though, no doubt, during the transition, there may be centuries during which intermediate conditions will prevail, yet such periods can hardly be said to have resembled the normal conditions of the globe such as that which it now enjoys." [1]

Many authorities are of opinion that great subsidences of land are natural concomitants of a glacial period, and that it naturally follows that the accumulation of ice at one pole must abstract and pile up a large amount of water, and thus cause land in the opposite hemisphere to be uncovered.

During the continuance, therefore, of the glacial epoch in the Northern Hemisphere, there must have existed over the Southern Hemisphere an extremely genial epoch, during which there is no doubt that, wherever land existed, it was clothed with a luxuriant vegetation, and that its boundaries would be enlarged from the causes just spoken of. This vegetation would, doubtless, not be less varied and tropical than that which flourished in high northern latitudes in Miocene times, and which was still a remarkably temperate flora within eight and a quarter degrees of the North Pole, and it is evident that it could harbour, and on it there could

(1) These various extracts are from *The Cause of the Ice Age*, by Sir Robert Ball.

develop the ancestors of the fauna and flora whose descendants are now scattered across all the southern regions of the globe. That an extensive land did exist not dissimilar to that described in a former page, seems to me almost an inevitable deduction from the distributional facts adduced above—especially in regard to the insects, the marsupials, the birds, and the plants. Of this mass of evidence, the distribution—to shortly recapitulate—of the three trochleaed struthious birds in all the great regions; the *Aphanapteryx*, the blue gallinules, the starlings, and the crested parrots in Antipodea and Lemuria; the fresh-water fishes of Australia and America;—none of them northern forms—is, to me at least, evidence not otherwise explicable. But none of that evidence seems to me to testify with greater weight than the embryological and anatomical data, which I have quoted from the writings of those distinguished workers, Parker and Forbes, two men of the highest authority in their science, inasmuch as it has been detected, not in the superficial characters only, but deep down in structures whose similarity cannot but proclaim genetic relationship, through ancestors who have now vanished, and whose homes must have been on a land common to, and in connection with, those widely separated regions which their descendants now occupy. The necessity for the existence of a land surface in the Antarctic Ocean was recognised and has been expressed by Mr. Darwin. "New Zealand is plainly," he says, "related to South America, which though the next nearest continent is enormously remote, yet this difficulty disappears in the view that New Zealand, South America, and the other southern lands have been stocked in part from the Antarctic islands when they were clothed with vegetation during a warmer Tertiary period."[1] Dr. Blanford, in his well-known address to the Geological Society of London, in 1890, gave it as his opinion that "if the difficulty about the depth of the intervening ocean is overcome"—and such a continent as I have sketched out in the rough, whose shores, more or less, followed the two-thousand-fathom line, presents no insuperable bathymetrical difficulties to acceptance—"there is no improbability in the suggestion that at some period of geological history, an important continent, having connections with South America, South Africa, and New Zealand, may have occupied the Antarctic area." Throughout his wonderful papers on the embryology of the bird's skull, Professor Parker[2] constantly perceives and insists on the necessity of dividing birds into northern and southern forms: "in the south the most struthious types, and in the north the highest"—and he expresses his belief that our bird groups are "as important for study in their geographical distribution as in their taxonomy or their morphology."

(1) *Origin of Species*, vol. ii. p. 190. 1888.
(2) *On Aegithognathous Birds. Transactions* Z. S., vol. x.

Professor Parker constantly adduces also instances of the relationship of the birds of the eastern with those of the western side of Notogæa. "If these instances," he says, "of changed forms in the eastern Notogæa, corresponding to unchanged (or less changed) types in the western Notogæa, can be shown to be common, it will go far towards the establishment of a true theory of dispersion and modification of types. If not, if every zoological species has been created as it is now, fenced in by laws that cannot be broken, 'a hedge set about it and all that it hath,' then I trust, for the sake of true science, that this glamour will soon be removed from our eyes, and that we shall not be lured on further after evolutional 'Will o' the Wisps.'" This bond of organic community must have been by a land area in the southern seas, which with considerable probability occupied the region which I have designated Antarctica. It seems to me that such geological evidence as the occurrence of fossil penguins in the Eocene of both Patagonia and New Zealand, and of marsupials and dinornithine ostriches in the early Tertiaries of South America, of *Dinornis* and *Æpyornis* in New Zealand and Madagascar, point to the existence of southern land—doubtless with elevations and subsidences between—at least from the close of Secondary times. But it is impossible, at least yet, to determine whether the fauna and flora of which remnants exist in the present southern continents and islands, are the result of the development and dispersal during the genial period corresponding to the last of the northern alternating clusters of glacial and genial periods during the latest high orbital eccentricity, or partly of the first of these or of a combination of both and of similar former vicissitudes. It seems established on palæontological evidence that in the Northern Hemisphere, during the early part of the Tertiary period, the climate was tropical in the middle of Europe, and that in the Miocene we have this climate extending not only to the limits of the north temperate zone, but a luxuriant temperate flora flourishing up to nearly eighty-two degrees of north latitude. It seems difficult, too, to believe, if we compare all the conditions now existing at both poles under the present low eccentricity of the orbit, that such a genial climate as just described could have prevailed at so high a latitude except under the conditions that would necessitate a glacial epoch at its antipodes. So that, if we accept the astronomical theory, we must believe that during the northern Miocene period there was a glacial epoch in the Southern Hemisphere, of which the rock striation and moraines in Africa, the moraines in Australia, New Zealand, and South America, may perhaps be the result. That there was at this time a force driving southern and tropical forms to the north is strongly corroborated by the distribution of the fossil *Sirenia* (now, and probably always, exclusively confined to the tropics) of which there are twelve

genera and twenty-seven species ranging from the tropics up to sixty degrees of north latitude in the Eocene and Miocene of Europe, Asia, and North America.[1] The remains of southern forms of birds, such as parrots and trogons, not infrequent in the Oligocene and Miocene strata of Europe may not unlikely have been migrants driven from the south before the same impelling force. That there has been such a northward migration is also evidenced by the occurrence of so many plants belonging to New Zealand, Australia, and some of the Antarctic islands isolated on the peaks of New Guinea and of Borneo. We must caution the reader, however, against supposing that the southern formations which have been named Eocene and Miocene, &c., are necessarily synchronous with those so named in the Northern Hemisphere. All that can be affirmed is that those systems which contain a similarity of succession of their fossils (especially their marine organic remains) are homotaxial, that is, the order in which they appeared on the earth has been similar.

This much, however, may be accepted as mathematically demonstrated, that during the glacial epoch of the northern hemisphere, while the high eccentricity of the earth's orbit lasted, there was an extremely genial age over the continent, the probability of whose existence we have shown to be high, and that its fauna and flora, of which some examples have been cited, were eventually expelled from their southern paradise on the passing away of the northern glacial epoch by the slow increase of the southern cold, which has gradually reached to but no further than its present condition towards glaciation, owing to the decrease of the eccentricity of the orbit and by the extensive subsidences of the land, due probably both to the ice accumulation round its pole and to the enormous amount of volcanic disturbance of which the whole region appears to have been the theatre.

Now, as to the explanation of these anomalies of distribution in the southern hemisphere, the arrangement of land which I have outlined above will, I think, account for them not less satisfactorily than that by an entirely northern centre of dispersion. Mr. Wallace holds that "the three most important south temperate land areas—south temperate America, South Africa, and Australia—have in all probability always been as widely separated from each other as now," and "that it is unnecessary to suppose any land connection to explain the resemblance between their animal and vegetable inhabitants," as he considers that the northern continuous land was the origin of them all, and that they spread meridianally south. That many forms of life did thus reach Notogæa "under pressure" of glacial epochs and "of more specialised types" it is impossible to

(1) Dr. H. Woodward, F.R.S., in the *Geological Magazine*, p. 423. 1885.
(2) *Island Life*, p. 527.

doubt. But, as I have already remarked, this explanation will not account for marks of heredity seen in such southern groups as the piping-crows of Australia and the dendrocolaptine birds of America, and the many other instances in the same category enumerated by Professor Parker. That their original ancient progenitor *may* have come from the north is, of course, *possible*, but the characters that prove a common parentage—in forms now so diverse—could not have arisen in birds living so far apart as Australia and South America, without, I believe, a large common land area on which the progeny of the original parents could develop and spread over.

Mr. Wallace believes also that the ancestral forms of the marsupials and monotremes reached *West* Australia (which for a long period in secondary and primary times was separated off as an island from East Australia, an arm of the sea uniting the Banda and the Antarctic Seas) from the north, through Java and the intervening islands or land in that sea. Their fossil forms have, however, been chiefly found in East Australia, or if found in West Australia, they occur in strata certainly of no greater age. If such, indeed, were the route of their southward march, it is remarkable that throughout the extensive regions over which they passed, not a single individual has survived, not even in Timor, an island of like vegetation and climate to Australia, and that nearest to West Australia; while marsupials and monotremes are represented abundantly on the northern and eastern Papuasian islands, with which West Australia, as Mr. Wallace believes, was *not* at that period in connection. That these groups may have originated in Antarctica and spread into Australia *via* its Tasmanian peninsula, since fossils presenting many affinities with the Australian forms have recently been discovered in Patagonia, appears to me a not less satisfactory explanation of their distribution. Their absence so far from New Zealand is not more difficult to account for than their entire absence in the land which, according to Mr. Wallace, they traversed. Again, as regards the dispersal of the ancestors of the struthious birds, Mr. Wallace believes that they reached East Australia from New Guinea, with which it was united across Torres Strait; and that the emus, the cassowaries, the *Dromornis*, and the moas are their descendants. If the forms with a three-trochleaed metatarsus (from South America, Madagascar, and New Zealand) had been developed on a southern land, they could, on their dispersal and northern trek, have reached the region where they now are with as much ease as by the route supposed by Mr. Wallace. The earliest strata in which the fossil remains of both the Northern and Southern Hemisphere struthious birds have been found have been determined as Eocene, but whether these were really contemporaneous periods in the north and in the south, and which is the older, it is impossible to tell, so that

their migrations may have been quite as likely from the south as from the north; indeed, the struthious type of bird is, according to Professor Parker, essentially Notogæan. The African ostrich has been isolated from its congeners in the south for a long period of time through the disconnection of Africa from Antarctica, and has become specialised and lost its third metacarpal trochlea and the toe it carried. Since its isolation it has spread over Africa northwards, but it once lived in Miocene times in Greece, in Persia, and in the Siwalik region of India. Again, in New Zealand and in East Australia we find a great similarity in the *genera* of their plants, while the *species* they possess in common are comparatively few, which is what might be expected in regions unconnected with each other except through a common land at some distance—the Antarctic continent I have predicated. No other explanation except a common southern land will satisfy the distribution of the *Aphanapteryx*, the blue water-hens and the starlings of the Mascarene and the New Zealand regions—groups of birds which are unknown on the north side of the Equator.

As is well known, there live in the Galapagos Islands, on the Equator, off the West Coast of America, giant tortoises of which one of the most remarkable facts about them is their zoological isolation. They have no relations with any of the forms of their own order on the neighbouring continent. In several of the Mascarene Islands there lived when they were first visited by Europeans enormous numbers of equally giant tortoises—of which a few still survive—also in as complete isolation as the Galapagos species, for they can claim no relationship with the tortoises of the nearest land, Africa. Yet, strange to say, the tortoises of Aldabra and Madagascar indicate the closest affinity with those of the Galapagos Islands. This extraordinary and seemingly inexplicable case of distribution receives, in my opinion, its easiest explanation by supposing that their ancestral home was in Antarctica, whence, forced by cold and the submergence of the land south of them, they travelled north by diverging tracks, wandering the one along the west coast of America, and the other towards Lemuria, where, having reached islands without foes, they have prolonged their years beyond those of their fellows which have died out everywhere else.

It is not necessary to suppose—and, moreover, it is very improbable—that all these continental southerly peninsulas were contemporaneously connected with Antarctica. It is impossible otherwise to account for the presence, for instance, of the same South American forms in Australia and their absence in New Zealand; for Mascarene forms in the New Zealand region and not in Australia or Africa or elsewhere. So long as we are unacquainted with the orography of the submerged southern continent, with its mountain and river

barriers, and the order of the making and breaking of its various commissures, we can hardly hope to account satisfactorily for all the anomalies of the southern distribution, none of which, however, are inexplicable when the inevitable elevations and subsidences due to the vast physical disturbances, of which we have abundant evidence all over the region, are considered.

Shortly, therefore, it is highly probable that an extensive continent existed in the Southern Hemisphere, on which many forms of terrestrial life originated, and had there the original centre of their development and dispersal; that Professor Huxley's division of the globe, according to the distribution of its life, into a northern and into a southern land must be accepted as its two primary biological divisions, from whose centres of development at both poles the wanderings of the fauna and flora were regulated by cold and warm periods, and by the elevation and flooding of one part of the continental plateau after another; and that from their advances and retreats across the Equator, and their journeyings from east to west, according to the geographical features of the region and its meteorological conditions on which their existence depends, resulted the present wonderful distribution of life on the globe which forms so fascinating a study to all who commence it.

HENRY O. FORBES.