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The exhibitor claims to feed his swarm on his own arm, which exhibited a sufficiency of punctures. His whole company may be packed into a shaving-box and put in his coat-tail pocket. He claims to have originated the exhibition forty years ago. Some of the anecdotes in his little pamphlet are amusing enough, and we find the following contributions to the Natural History of the Flea.

“The flea may be easily dissected in a drop of water, and by this means the stomach and bowels may be plainly discovered, with the veins and arteries” (!) Their “amazing motion is performed by means of the great elasticity of their feet, the articulation of which are so many springs, in accordance with the exalted and lofty aspirations of the insect.” And finally, “Take a well fed — (*Cimex*) and a starved flea, and place them under a glass together, and you will be afforded an amusing spectacle. The flea as soon as he perceives the pury condition of the bug will hop upon its back, and, in spite of the latter’s struggles to throw him off, will succeed in extracting the blood from the bug’s body, leaving it in quite a lean condition, while the flea becomes round, plump, and happy, after its beneficial ride.”

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## THE GIANT BIRDS OF NEW ZEALAND.

BY I. C. RUSSELL.

OF the many remarkable additions that New Zealand has made to the various branches of natural science, none have attracted greater attention, or called forth more exclamations of wonder, than the remains of the giant birds that at no very distant day inhabited those antipodal islands.

In order that we may more fully understand the bearings and relations of our subject, let us glance for a moment at the present inhabitants of New Zealand, many of which are very strange and interesting. Aside from the aborigines, who are an offshoot of the ancient Polynesian family, the first feature that attracts our attention is the total absence of land mammals. The dog and a small species of rat are sometimes spoken of as being natives of New Zealand, but they more likely accompanied the aborigines in their wanderings, or were introduced by the earlier voyagers. The reptiles are almost as great strangers in those islands as are the mammals, being only represented by a few species of harmless lizards, which are very plentiful in individ-

uals, however, in many parts of the country. The position filled by the mammals in other lands is there occupied by the feathered tribes, which reached a surprising development, not only in the living, but more markedly in the extinct fauna.

New Zealand is geologically very old, and probably the remnant of a large continent that has now mostly disappeared beneath the sea; its connection with other lands seems to have been severed before the appearance of mammals on the earth. The birds being the highest form of life on the ancient continent, became concentrated on the remaining islands, which retained many unique and peculiar forms unknown in other portions of the globe.

Like all the islands of the southern hemisphere, the shores of New Zealand are visited by immense numbers of the widely-spread sea-birds, including the great albatross, the largest bird that flies. On the land there are many varied and beautiful forms, including, as in other countries, hawks, owls, pigeons, ducks, etc., together with a large number of smaller birds, as thrushes, starlings, and honey-eaters; among the last is found the beautiful tui or parson bird, as it is often called from the two tufts of white feathers on the throat. Besides these there are other remarkable birds, some of which are very poor of flight, and still others that are wingless, which are peculiar to New Zealand, and of special interest.

Among the numerous parrots the most curious is the kakapo, a large green bird, that, contrary to the usual habits of its tribe, lives on the ground, and, having very poorly developed wings, seldom takes to flight; as it is unable to escape from its enemies, or procure its food in the usual way, it remains concealed during the day in the crevices of the rocks, and is most active during the night.

The rails afford a number of interesting species, among which are the weka and the pukeko, as they are called by the natives; these were both very abundant at one time, but are now becoming scarce. The weka, or wood hen, is about the size of a common fowl, of a yellowish-brown color, and inhabits the forest and fern thickets. Its peculiarity is the almost total lack of wings, these being very rudimentary and useless for flight. The weka is the most common of the brevipennate birds of New Zealand, which approach in their habits the character of the lower mammals. The *Notornis* is another wingless rail, that is especially interesting, as but two individuals are known, which are supposed

to be the last of their race; one of these was captured on the west coast of the South Island and is now among the treasures of the British Museum.

The true wingless birds of New Zealand, however, are the kiwis, of which four species are known; all of these are totally incapable of flight, being, as their scientific name (*Apteryx*) implies, without wings; they have, however, the merest rudiments of wings, that can be felt underneath the feathers. The kiwis, although at one time quite abundant and used by the natives for food, are now the most unique and rarest birds in New Zealand and probably the strangest of living birds. The kiwis are small for the order to which they belong, the *Cursores*, which includes the ostrich, emu, cassowary, etc., the smaller ones being from fifteen to twenty inches high, while the largest, the roaroa (*A. maxima*), is the size of a small turkey. They all have strong, well developed legs, depending on their speed for safety; and long bills, which they thrust among the decayed leaves and fern-roots in quest of the grubs and insects that constitute their food. Like the kakapo, they seek their food at night, as they are then exposed to fewer enemies. As is common with the cursorial birds, the kiwis have a loose, hair-like plumage of a dull brown or gray color. Being without wings or tail they have a very odd appearance, looking like a ball of feathers, to which are appended two stout legs and a long bill. We must not fail to notice the size of the kiwi's egg, which is monstrous when compared with the size of the bird, being about five inches in length and weighing usually over thirteen ounces, or one quarter as heavy as the parent bird. Like the other short-winged birds of New Zealand, the kiwis are fast becoming exterminated, not only by the natives, but also by their new enemies, the dogs, cats, and rats, that have accompanied the white man. Wherever the country has been settled by Europeans the kiwis have disappeared, and are now found only in the wild and little-known region along the west coast of the South Island.

Science in her survey of the earth has shown that, as with the trees and flowers, the various orders of animal life are grouped in distinct geographical provinces, in which certain types predominate. Not only does this grouping hold good for the animals of to-day, but embraces, also, the later geological ages, and shows that the ancient forms frequently far surpassed their modern descendants in size. Thus, in South America, where the little armadillos and the sloths have their home, the

geologist has brought to light the remains of the huge *Megatherium*, that exceeded the elephant in size, and other giant edentates, that inhabited the same land in Tertiary times. In the same marked manner the marsupials which inhabit Australia and Tasmania, to the exclusion of higher forms of life, were preceded by animals of the same structure, but greatly exceeding in size the kangaroo and the wombat of to-day. The same connection holds good between the living and extinct carnivores of Asia, and with the ruminants of North America. In New Zea-



(Fig. 1.) *APTERYX* AND *DINORNIS* OF NEW ZEALAND.<sup>1</sup>

land we find the little wingless kiwi preceded by a host of giants bearing the same general form, but whose ponderous frames approached that of the elephant in their development; huge wingless birds, many of them being ten or twelve feet in height, and far exceeding in size and strength the African ostrich, the largest of living birds. These giant birds, that surpass in strangeness the fabulous rocs of Arabian story, were plentiful in New Zealand at no very distant time, and are known to the natives as the moa, and have been grouped by science in two genera, *Dinornis* and *Palapteryx*.

<sup>1</sup> From Tenney's *Elements of Zoölogy*.

It was the writer's good fortune while stationed at Queenstown, N. Z., in connection with the United States Transit of Venus Expedition, to obtain some of the interesting remains of these huge birds from a cave that we discovered on one of the lower mountains overlooking Lake Wakatipu. Immediately back of Queenstown rises a hill, as it is called in that land of snowy mountains, over two thousand feet high; separated from Mount Ben Lomond by a deep narrow valley, the sides of which are very steep, in some places forming beetling cliffs that are inaccessible even to the wild goats. It was on the side of this narrow valley, eighteen hundred feet from the base of the hill, that the Moa Cave, as we named it, was found. Soon after arriving at Queenstown we heard of the existence of a cave on that portion of the hill and, procuring a guide, we visited it. This cave extended into the side of the hill for a distance of fifty or seventy-five feet, but we found little in it of interest, except a few feathers, which we believe on good authority to be those of the extinct moa, indicating that this cave was very likely inhabited at one time by that bird. Proceeding up the hill to search for other caves, we soon came to a long crevice in the rock, from two to three feet wide, the sides of which were overgrown with ferns; upon parting these and looking down, I could see the bottom of the cave, which descended obliquely, and there to my great delight I saw a large bone projecting from the dirt, some twenty feet below. I lost no time in descending the crevice and securing the prize, which I found to be a huge metatarsal bone of *Dinornis robustus*, measuring 17.5 inches in length, and 6.8 inches in circumference at the smallest portion of the shaft; on further search its companion was found, also a large portion of the tibia and some of the vertebræ of the same individual. Although careful search was made we were unable to find the remaining bones of the skeleton, and were at a loss to know what had become of them. These bones were all well preserved, and seemed to have lost a great part of their animal matter.

On continuing our exploration, we found that the cave first discovered joined another and still deeper one; into this we descended with the aid of a rope, and, groping our way along for about a hundred feet, were rewarded by finding more bones of the moa. In the extreme end of this cave and mingled with dirt, that had evidently fallen from above, we obtained a number of bones belonging to two or three individuals. As the cave at this point was quite narrow, the earth had to be carried back to

a wider portion, which, together with the small space in which to work, made the task difficult; we were rewarded, however, by finding a well-preserved femur of a smaller species of moa, probably *Dinornis didiformis*, and also a perfect sternum, perhaps belonging to the same skeleton, measuring seven inches in length by five in breadth, formed of a single strong, somewhat curved plate of bone, without any indication of a keel, thus forming a striking contrast with the strongly keeled sternum of the eagle and other birds of flight. The most interesting relics that were found in the cave were fragments of the egg-shell of these same birds; the largest piece was about five inches long by three in breadth, and but slightly changed by its long stay in the cave; these fragments were about the twentieth of an inch thick, and covered irregularly with punctures. The largest piece being placed upon an ostrich egg shows it to have belonged to a very much larger egg. A nearly perfect egg of the moa, discovered some years ago, was about ten inches long by seven in breadth, so large that "a hat would make a good egg-cup for it."

In addition, we found in our Moa Cave some small, slim bones which are probably portions of the skeleton of a kiwi; and also an imperfectly ossified bone, about an inch long, lying with the fragments of egg-shell; this we were inclined to think belonged to the "chick" that was once inside of the moa's egg, the fragments of which we had obtained.

The cave where these bones were found was one of a series of nearly parallel rents, that followed for some distance the base of a precipice some two or three hundred feet high, and had evidently been formed by the falling away of a portion of the hillside, which is composed of mica-schist. That the bones were introduced from above, either by being washed in, or by the birds falling into the crevices, seems evident, for the caves were too narrow and too difficult of access to be inhabited by a bird as large as the moa. That some of the bones fell from above is clearly shown by the fact, that one huge femur had been caught between the side of the cave and a fragment of rock which had fallen in but was too large to reach the bottom; this bone was held so firmly that it was with considerable difficulty we secured it.

There is little doubt that the moa roamed over those mountains after they had received their present form, and the finding of their remains in such an inaccessible place, shows that huge as those birds were, they yet possessed considerable activity, for

it was no easy climb, even for a person accustomed to the work, to reach our moa cave. We also heard of a cave in which moa bones had been found, at a still greater elevation among the Hector Mountains, on the east shore of Lake Wakatipu. Other moa bones were obtained from a cave, but a few feet above the waters of the lake and lower than some of the lake terraces.

The former existence of gigantic birds in New Zealand was first made known in 1839, when a few fragments of their remains found their way into the hands of scientific men in England. Not long afterwards, Mr. Walter Mantell made his well-known discovery of moa bones on the east coast of the South Island. This extensive collection passed into the possession of the British Museum, and furnished Professor Owen with the material for his splendid study of these remains, which were grouped under two genera, *Dinornis* and *Palapteryx*, and these again subdivided into numerous species. The specific distinctions are somewhat difficult to trace, as the bones vary in size; the smallest metatarsal bone in our collection measures 7.5 inches in length and 3 inches in least circumference, while the corresponding measurements of the metatarsal bone of *Dinornis giganteus* are 18.5 and 5.5 inches respectively, — the tibia of the same bird being three feet in length; between these limits there is an almost complete gradation in the size of the species.

In later years numerous discoveries of these remains have been made, both on the North and South Island, and from deposits along the shore that are swept by the tides, to an elevation of five thousand feet or more amid the Southern Alps.

One of the most remarkable deposits yet discovered was at Hamilton, Otago, where from an area of about seven hundred square feet, three and one half tons of moa bones were obtained, for the Otago Museum. As a great number of bones were too much decayed to be collected, this amount indicates only about one half of the total quantity contained in this limited deposit. These bones were found literally packed down in bulk, entirely separated from each other, and mixed indiscriminately throughout the deposit. The place in which they were found seems at one time to have been a lagoon surrounding a spring, to which the moas resorted in great numbers, the bones of those that died being scattered and trampled down by the living birds. Together with the moa bones were found the remains of an extinct goose, and also of an eagle that once lived in New Zealand. The reason for the moas collecting and dying in such numbers at this



one locality is obscure ; it has been suggested by Mr. Booth, the discoverer of the fossils, that it was owing to a refrigeration of climate, the birds collecting in this spring for warmth as the winters became more cold. Dr. Hochstetter also obtained, during his visit to New Zealand, valuable moa skeletons from limestone caves in the South Island. These skeletons were found beneath deposits of stalagmite, and were entire, showing that these birds inhabited the caves and had retired there for refuge when death overtook them. Together with these skeletons the ossified rings of the trachea were found, and also little heaps of smoothed pebbles, "moa-stones," which had been swallowed by the moa to assist digestion, in the same manner as the domestic fowl swallows sand and gravel.

The remains of these gigantic birds are not only found in caves and recent river deposits, but also scattered over the surface of the country ; although it is somewhat uncommon to find them thus exposed at the present time, yet in the early days of the colonists they were quite abundant, and the little heaps of "moa-stones" were frequently found beneath the ferns. Some years since Dr. Hector observed, near Lake Wakatipu, over thirty skeletons of the moa lying at the foot of a cliff, in the shelter of which they seem to have sought refuge from the storm that destroyed them.

Remains of moa bones, and also fragments of the egg-shells of the same birds have been found, showing the action of fire, and mingled with the charred bones of men and dogs in the ancient kitchen-middens of the New Zealanders. The large bones are also found broken open as if to obtain the marrow ; and the egg-shells have been found in the graves of the aborigines. Many other facts have been brought to light by the scientific men who have labored in New Zealand, proving that the moa still existed on those islands after their settlement by man, who introduced a new and higher element into the "struggle for existence" that resulted in the extermination of the moa.

There is but little doubt that the moa, which was once so abundant in New Zealand, furnished the principal food of the natives as they increased and occupied the land. This is the more evident when we remember that those islands furnish little that is sufficiently nutritious to serve as food for man. Nothing like the delicious berries and larger fruits that abound in our own country are found in New Zealand. The food of the natives, at the time of the discovery of those islands, was confined to a kind

of sweet potato, which they had brought with them in their emigration, the succulent root of a fern (*Pteris esculenta*), which, although abundant, is exceedingly indifferent food, together with shell-fish. To these were added the flesh of birds, especially of the "mutton bird" (*Puffinus tristis*), and of seal and fish; then, too, the scanty board was filled out with human flesh. It is not without reason, therefore, that a bird so large, and furnishing so much food as the moa, should be eagerly sought after by the Maoris, and, being unable to fly, and unlike the ostrich, having no desert to flee to, soon became extinct.

The suggestion of Hochstetter that it was only after the extermination of the moa, and the consequent scarcity of animal food, that the New Zealanders were driven to cannibalism, is full of significance.

There are uncertain indications that New Zealand was inhabited by an older people than the present aborigines, a race of "black fellows," as the Maori traditions state, who were exterminated by the more warlike Polynesians. Some consider this older race as the true moa hunters, who exterminated those giant birds many hundred years ago; the active search that is now being made in the ancient cave dwellings of New Zealand, it is expected, will throw more light on this interesting subject.

The adventures of the New Zealand moa hunters, armed with spears and implements of stone, to whom the use of the bow was unknown, must have equaled in wildness and danger the struggles of the Neolithic hunters of Europe with the cave bear or the fierce aurochs. What wild, weird scenes those deep valleys of the Southern Alps must have witnessed, when, after the successful hunt, the natives gathered about their camp-fires, that lit up their dark tattooed faces and shone on the strange vegetation around, to feast on the flesh of the moa, or partake of its huge eggs, roasted on the hot stones of the oven!

How long these birds have been extinct is as yet unsettled. The fact that the bones are found so plentifully, often lying exposed on the surface of the ground, and also the fresh condition of many of the remains, some of which still retain the dried muscles and feathers attached, show that the moa lived at a very recent date, geologically speaking. The Maoris, however, with whom we conversed while in New Zealand, although some of them were cannibals in their youth, had never heard of these birds as living, not even through the traditions of their ancestors. Some of the old legends of the natives, still extant, do contain,

however, references to the moa ; it is stated that their long plumes excelled in beauty the crest of the white heron, which is so highly prized by the Maoris.

That the moa not only inhabited New Zealand in great numbers, but also exhibited great variety among themselves, is shown by the differences in the size of the vast number of remains that have been collected. While the larger bones of *Dinornis elephantopus* were short and exceedingly thick and ponderous, the femur measuring nearly eight inches in circumference at the smallest portion of the shaft, the corresponding bones of *D. gracilis* were longer and comparatively slim, indicating a bird of more elegant proportions. The largest of the moas, *D. giganteus*, that stood full ten feet high in its natural position, and could reach to a much greater height, presents a great contrast to the smallest of these birds with which we are acquainted, which could not have been taller than a large turkey.

We have but to greatly exaggerate in our fancy the general form of the wingless and tailless kiwi, to have an accurate idea of their ancient representative. The moa was not furnished, however, with the long, slim bill that the kiwi uses so adroitly in probing the earth in quest of worms, but possessed a much shorter and stronger bill, indicating a more strictly vegetable diet. Its principal food was, probably, the root of the *Pteris esculenta*, which it could easily tear up with its powerful claws.

Besides the various species of *Dinornis* and *Palapteryx*, the remains of numerous other fossil birds have been found, not approaching these in size, however ; they include species of *Apteryx*, penguin, albatross, parrot, goose, etc., showing that the feathered tribes have long been the rulers in New Zealand.

During the past few years so much interest has been taken in these fossils that they have found their way into nearly every public museum in the world. Next to the colonial museums of New Zealand, the finest collection of moa skeletons is to be found at the American Museum in Central Park, which consists of a large number of mounted skeletons of different species, including the giant of them all, the *Dinornis giganteus*, the skeleton of which stands about ten feet high ; this colossal bird, if living and striding along the muddy shore of some sheltered bay, would leave tracks in the mud as huge as those which excite the wonder of the geologist from the triassic sandstone of Connecticut and New Jersey. Other skeletons of the moa may be seen at the Smithsonian Institution in Washington, and in the Geological Museum of the School of Mines, Columbia College, New York.

While considering the extinct birds of New Zealand, it may not be uninteresting to our readers to turn their attention briefly to the island of Mauritius, the home of the dodo, which is situated about a thousand miles eastward of the coast of Africa, and together with its associated islands presents many features analogous to the life of New Zealand. The Dutch navigators, while making their earlier voyages to the Indies by the new passage around the Cape of Good Hope, found on this uninhabited island large numbers of the clumsy, wingless birds that have received the name of the dodo. This bird which was related in structure to the pigeons, was of about fifty pounds in weight; being totally incapable of flight and very clumsy, it fell an easy victim to the sailors, who killed it in great numbers. Owing to the persecution of man and also, probably, to the depredations of the animals that accompanied him, the dodo soon became exterminated. The only records of its existence which remain are a few of its bones, and the rude drawings and descriptions in the books of the Dutch navigators, together with two or three pictures supposed to have been painted from life. The dodo furnishes the best-known example of the extermination of a species through the agency of man.

Those who would place the extinction of the moa so far in the past will do well to consider the case of the dodo, that, as we have seen, abounded on its native island scarcely two centuries ago, but of which we now know but little more than we do of the moa.

Madagascar, also, had its huge wingless bird, the *Æpyornis*, that equaled or even exceeded in size the largest of the moas. On the island of Rodriguez another colossal bird, the solitaire, was found, which, like the dodo, has been exterminated by man, and the same fate has befallen other allied birds on the Isle of Bourbon.

It is remarkable that all these huge wingless birds, including also the ostrich and the rhea, are confined to the southern hemisphere, and still more strange that so many of the largest and most interesting of them should be found only on the widely-separated islands of the Indian and Pacific oceans. When and how they came to those isolated islands, or from what ancient forms of life derived, can only be known when the caves and recent rock formations of those islands shall have been explored, and the fragments of the ancient history of these beings deciphered and translated by the geologist.