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XVIII.—*Moas and Moa-hunters.* By A. DE QUATREFAGES *.

WHEN I published, in the 'Journal des Savants,' a first article upon New Zealand and its inhabitants† we had received in Europe only the first three volumes of the 'Transactions' in which are brought together the works of the learned societies of New Zealand. At that time I had to express my regret that this collection contained only a single very short note relating to the large short-winged birds designated by the common name of *Moas* ‡. This deficiency has since been filled up. The succeeding volumes have brought us numerous memoirs, in which the various questions raised by the history of these birds are treated of. My present object is to give a general summary of these researches, which are very interesting in many respects, avoiding too technical details, for which I can only refer the reader to the writings of MM. Haast, Hochstetter, &c., and especially to those of Sir Richard Owen, which have been classical since their appearance.

I.

We must first of all refer to the most striking feature of the New-Zealand fauna.

The travellers who first landed upon this distant country § were surprised at finding there of Mammalia only a domestic dog and a rat, which the natives hunted as game. Since then two bats of different genera have been discovered ||. The researches of geologists have extended to palæontological times the results furnished by the study of the living animals, and have even rendered them still more strongly marked. No fossil mammal has yet been discovered through the whole

* Translated by W. S. Dallas, F.L.S., from the 'Annales des Sciences Naturelles,' sér. 6, tome xvi.

† In January 1873. The present memoir has also appeared in the same journal (in the numbers for June and July 1883).

‡ "Address on the Moa," by the Hon. W. B. Mantell (Trans. and Proc. of the New Zealand Institute, vol. i. p. 18). Mr. Mantell alone has occupied himself with the general history of the Moas. But it is only just to add that in the same volume Dr. Haast gave a memoir, entirely technical in its nature, in which he published the results of measurements made upon very numerous bones (*ibid.* p. 80).

§ New Zealand was discovered by Tasman on the 13th December, 1642. It was forgotten and in a manner lost for more than a century, and was rediscovered by Cook on the 6th October, 1769.

|| *Scotophilus tuberculatus* (Gray), identical with an Australian species, and *Mystacina tuberculata*, which has hitherto been found only in New Zealand. (Note communicated by M. Alphonse Edwards.)

extent of the lands composing New Zealand. This rendered the exceptions which I have just indicated even still more striking. How are we to interpret the existence of these four isolated species, each representing one of the subtypes of the class, and not preceded by any other belonging to the fundamental group? We have here a strange fact with no analogy elsewhere. Nowhere else do we see a whole class of animals entirely wanting in the fossil faunas and only represented in the existing fauna by an insignificant number of species belonging to distinct orders. On the contrary, there always exist more or less close affinities between the past and the present in the animal creation. We know that these relations are even every day invoked as so many arguments in favour of the transformist doctrines.

The New-Zealand fauna therefore presents a unique exception to one of the most general facts hitherto ascertained. Now it is very difficult to admit the existence of exceptions of this kind. One is therefore naturally led to inquire whether some accidental phenomenon has not intervened here to mask the natural facts—whether this dog, this rat, and these bats really belong to the New-Zealand fauna, whether they are not simply colonists introduced, it matters not how, into a country to which they were originally strangers.

The presence of the Chiroptera might easily be ascribed to a fact of accidental dissemination resulting from a few blasts of wind, as has been demonstrated at the present day in the same regions*. But that of the two terrestrial mammals has long remained unexplained.

To solve this curious problem of zoological geography Sir George Grey has had to discover, translate, and publish the historical songs which have furnished equally precise and curious information upon the first origin of the Maoris. Through him we have learned that on quitting Hawaiki for the new country discovered by Ngahue the emigrant chiefs brought with them the plants and animals of which experience had taught them the utility. The dog and the rat figure in the list of these treasures of the colonist †, and still attest

* *Zosterops lateralis* (Latham), a bird originally inhabiting Australia, has been carried in this way to New Zealand and into Campbell Island. It did not exist in the Chatham Islands until 1861. At this time it appeared suddenly after a storm ('Rapport sur l'exposition faite au Muséum des objets d'histoire naturelle recueillis par MM. de L'Isle et Filhol,' par A. de Quatrefages, 'Archives des missions scientifiques et littéraires,' tome v. p. 24).

† 'Polynesian Mythology,' 1855; 'The Emigration of Turi,' pp. 212, 214; 'The Emigration of Manaia,' p. 228. I have analyzed these documents and all those relating to the same set of ideas in a work entitled

the exactitude of the traditions for the knowledge of which we are indebted to the late Governor of New Zealand. They did not originate in those islands, but they were imported there *.

The Mammalia which did not occur in the natural fauna of this archipelago were to a certain extent replaced by birds belonging to a peculiar type, represented elsewhere by a very small number of species, but which here acquired an absolutely exceptional development. I refer to birds with rudimentary wings and with loose-barbed feathers, incapable

'Les Polynésieniens et leurs migrations,' accompanied by four maps. I only remind the reader that *Hawaiki* here mentioned is one of the Manaiia Islands, and probably Armstrong Island or Bourouti of our atlases.

* New Zealand now possesses mammals which the Europeans have introduced there, and the acclimatization of which has not been without its inconveniences. Our common rat has almost entirely destroyed the rat imported by the colonists from *Hawaiki*, the *Kiore* of the Maoris. As a matter of course the mouse has accompanied it. Our cat has returned to the wild state in this island, and it is probably one of these animals that has been taken for an indigenous species of otter supposed to have been once seen. Our rabbit has multiplied there, as in Australia, to such an extent as to become a plague in the cultivated lands; so much so indeed that a few years ago the Acclimatization Society of Paris received an application for a certain number of weasels, for which 100 francs a pair were offered. They were to have been set free, in the hope that they would multiply and wage war against the rabbits. But it is easy to understand that the remedy might have been worse than the disease. As to the pigs, introduced by Cook in 1769, they are now so numerous and commit such ravages that hunters are expressly engaged to destroy them. Hochstetter tells us that in twenty months three men, hunting over an extent of 250,000 acres, killed no fewer than 25,000 wild pigs, and undertook to kill 15,000 more upon the same ground ('New Zealand,' p. 162). These wild pigs will speedily bring about the complete extinction of the last wingless birds of the country (*Apteryx*), of which they destroy the nests.

In other respects the acclimatization of foreign animals has proceeded in New Zealand with astonishing rapidity. Fourteen species of birds, coming from Europe, Asia, and America, have made themselves a new home in this maritime country. The colonists have transported there not only the sparrows and larks, but also the pheasant and the Californian quail. All these new comers have driven before them the indigenous species, the representatives of which are becoming scarcer and scarcer, while several of them appear to be menaced with a speedy extinction.

We may notice in passing that the invasion of New Zealand by foreign plants has been no less general and no less fatal to the indigenous vegetation. Our cereals and our vegetables everywhere replace the batatas and cause the eradication of the ferns on the roots of which the Maoris fed. Even our *weeds*, transported here involuntarily, have multiplied to such an extent as to extinguish those of the country. "In the plain of Christchurch," writes M. Filhol, "it is in vain to seek—we can no longer find—a Polynesian plant; one might fancy oneself in Beauce" ("Rapport sur l'exposition," &c., *loc. cit.*).

of flight and more or less analogous to the ostrich or the cassowary*. Four or five species of this group still exist in New Zealand. They are known to the natives by the common name of *Kiwi*, and have been placed together by naturalists in the genus *Apteryx*†. They vary in size from that of a fowl to that of a turkey. But the number of extinct species is far more considerable, and among them are some of truly gigantic proportions. It is these vanished species that are called by the common name of *Moa*, borrowed from the language of the Maoris‡.

The first investigations upon this curious chapter of ornithology date from 1830. The illustrious English anatomist, Richard Owen, had received from a Mr. Rule the middle portion of a femur, and from the examination of this single imperfect specimen he drew conclusions which every thing has tended to confirm §. More abundant and more complete

* Beyond New Zealand the ornithological type in question is only represented by four species, each having a very different area of habitat and isolated from the others by vast spaces. These are the ostrich (*Struthio camelus*, Linné), which inhabits almost the whole of Africa and the warm parts of Asia on this side of the Ganges; the nandou, or American ostrich (*Rhea americana*, Lath.), which inhabits South America from Brazil to Patagonia; the emeu, or helmeted cassowary (*Casuarus emeu*, Lath., *Struthio casuarus*, Linné), found only in the Indian Archipelago and principally in the forests of Ceram; and lastly the emou, or helmetless cassowary (*Casuarus nova-hollandia*, Lath.), which appears to have been spread over the whole of Australia, but which the European colonists drive back more and more and will not fail to destroy. [It will be remarked here that M. de Quatrefages refers only to four *species* instead of four *genera*. The number of species is considerably greater, there being three known species of *Rhea*, two species of *Dromæus*, and nine of *Casuarus*. The last-named genus has a much wider range than is indicated above, extending from the Indian Archipelago to the island of New Britain and to Northern Australia.—Tr.]

† These species are *Apteryx australis*, *A. Mantelli*, *A. Owenii*, and *A. Haastii*. A fifth species of large size perhaps exists in the desert regions of the Middle Island. It has even been described by Verreaux, a French natural-history traveller. But he had never seen more than a single skin covered with feathers, of which a Maori chief had made himself a mantle. (Note communicated by M. Alphonse Edwards.)

‡ The Kiwis were in existence at the same time as certain species of Moas. Their bones have been found mixed together in caves and also among the *kitchen refuse*, of which I shall speak hereafter. The Moas, moreover, are not the only birds the species of which have disappeared from New Zealand. Owen has shown that this is also the case with two Rallidæ, of which he makes the genus *Aptornis*. Dr. Haast has described the remains of a large bird of prey, which he has named *Harpagornis Moorei*; it is perhaps the *Weka* spoken of in certain Maori traditions (see "Notes on *Harpagornis Moorei*," by J. Haast, in *Trans. &c.*, vol. iv. p. 192, pls. x. and xi.).

§ Sir Richard Owen made his first communication on this subject to the Zoological Society of London on the 13th November, 1839. He fol-

materials soon enabled him to recognize five distinct species, which he united into the genus *Dinornis*.

Subsequently this number gradually increased to thirteen, and there have been found in these representatives of an extinct fauna more and more marked differential characters. This is so much the case that Dr. Julius Haast, the eminent New-Zealand geologist, has thought it right to form of them four genera, themselves divided into two groups or families*.

It is easy to see that these palæontological discoveries confirm the observations which I have just been making and bring New Zealand under the general rule. This austral country has never produced Mammalia. To make up for this the type of the short-winged birds has been developed there with an abundance and a variety of secondary types such as we meet with nowhere else. There is complete accordance between its fossil and its recent faunas, and these faunas, precisely by the exceptional character which is common to them, furnish another proof of the universality of the laws which everywhere bind together the past and the present of the animal world †.

lowed out his researches chiefly by the aid of the materials sent by Mr. W. Mantell. The results have appeared in the 'Transactions of the Zoological Society' for 1844 and following years.

* The following is Dr. Haast's classification, which, however, only includes eleven species:—I. Family DINORNITHIDÆ: genus *Dinornis*, including *D. maximus*, *D. robustus*, *D. ingens*, *D. struthioides*, *D. gracilis*; genus *Meionornis*, including *M. casuarinus*, *M. didiformis*. II. Family PALAPTERYIDÆ: genus *Palapteryx*, including *P. elephantopus*, *P. crassus*; genus *Euryapteryx*, including *E. gravis*, *E. rheides* (Proc. Philos. Inst. of Canterbury, March 1874; Address by J. Haast, president; Transactions, &c., vol. vi. p. 426). Dr. Haast, from considerations drawn especially from size, seems disposed to think that he has himself united under the name of *Meionornis casuarinus* two species which will have to be distinguished hereafter. He makes analogous remarks with regard to *Palapteryx elephantopus* (p. 429). Prof. Hutton, Director of the Museum at Otago, has criticized Haast's classification, and denied some of the facts relied upon by his *confrère*. With Owen, he thinks that the Moas form only a single natural family, that of the Dinornithidæ ('Transactions &c., vol. ix. p. 363). Owen and M. A. Edwards only admit the two genera *Dinornis* and *Palapteryx*, the former tridactyle, the latter having a fourth digit, which is short and directed backward.

† The preceding observations apply not only to the history of the New-Zealand fauna, but affect the history of man himself. By themselves they suffice to refute a theory recently put forward by M. P. A. Lesson in a book in other respects filled with important facts and documents, of which three volumes out of four have appeared, namely 'Les Polynésiens, leur origine, leurs migrations et leur langage' (Paris, 1882). The author assumes that the whole of Polynesia, Tahiti, the Sandwich Islands, the Samoa and Tonga Islands, &c. has been peopled by means of migrations;

The number of Moa-bones gathered by the scientific men or by simple amateurs inhabiting New Zealand is very considerable, and it is only just to acknowledge the generosity with which these scientific treasures have been communicated to those whom they might interest, and even divided among the naturalists of the whole world. All the great museums of Europe and America now possess more or less complete specimens of these strange birds. Mr. Mantell, who was one of the first to interest himself in the question, has sent to Sir Richard Owen more than 1000 specimens*.

When the learned geologist of the 'Novara,' M. Hochstetter, wished to dig for himself in the marshes and bone-caves, he found everywhere the most earnest cooperation. It has been the same with our countryman, M. Filhol†.

It is to the kindness and liberality of our New-Zealand *confrères*, and especially of MM. Haast and Hutton, that we

but instead of accepting the Malay Archipelago as the starting-point of the race, he makes *Polynesian man* originate in New Zealand. He thus reverts to the old doctrine of autochthonism, of which the magnificent work of Mr. Hale had already demonstrated the untrustworthiness, and at the same time he places the cradle of the Polynesian islanders upon the land which affords least support to any hypothesis of this kind. I have already briefly examined M. Lesson's theory, and indicated how, independently of the data furnished by the study of the faunas, the historical documents which we owe in part to that author himself, but principally to Sir George Grey, Thomson, Shortland, &c., do not allow of our accepting it ('Hommes fossiles et hommes sauvages,' p. 483). I shall return to this subject when M. Lesson's work is completed.

* Hochstetter, *loc. cit.* p. 182.

† MM. Filhol and de L'Isle were attached as naturalists in 1874 to the expeditions sent out to observe the transit of Venus at St. Paul and Campbell Islands, under the command of Admiral Mouchez and M. Bouquet de Lagrye. Both of them brought back important collections. But M. de l'Isle, being prevented by illness, could not realize all that was promised by his known zeal. More fortunate, M. Filhol fulfilled his mission in a remarkable manner. After having thoroughly explored Campbell Island, he went twice to New Zealand, of which he traversed the principal provinces. He afterwards visited the Fiji Islands, New Caledonia, and the Sandwich Islands, and returned to France by San Francisco. From wherever he went he brought back remarkable collections and most interesting observations. Prof. Hutton, Director of the Museum of Otago, gave M. Filhol for our museum numerous bones of Moas and two complete skeletons, one of *Palapteryx elephantopus*, the other of *P. crassus* ("Rapport," &c., *loc. cit.*).

On his part Dr. Haast has sent us, besides a great number of separate bones, four nearly complete skeletons, which could be mounted, namely of *Dinornis crassus*, *giganteus*, *elephantopus*, and *didiformis*.

The museum also possesses a model in plaster of the magnificent *Dinornis ingens*, collected and reconstructed by Hochstetter and figured in his book, pp. 187 and 188.

are indebted for the magnificent specimens which now figure in the museum. I shall not be reproached for having dwelt upon these facts, and here publicly thanking men who so worthily understand and practise scientific confraternity.

II.

This abundance of materials has enabled us to form a pretty complete idea of what the Moas were. We have been able to reconstruct entire skeletons of several species, and thus to judge of their size and their proportions. On the whole, and notwithstanding the secondary differences which distinguish them, all these birds, as I have already said, resemble the ostrich or the cassowary. The head is small, and nothing in it indicates the existence of a solid crest analogous to that which distinguishes the emeu [*Casuarus*], and has obtained it the name of the helmeted cassowary. The very long neck, at first slender, gradually thickens as it approaches the trunk, as in the cassowary. The skeleton of the body is robust. The sternum alone is comparatively very small and flat. The reduction of this bone, so highly developed in flying birds, is explained here by the smallness of the wings, which are truly rudimentary. On the other hand, all that portion of the skeleton connected with the hinder limbs has acquired exceptional dimensions. The pelvis is massive; the bones of the thigh, the leg, and the metatarsus have enormous heads, and the body of the bone itself is comparatively much thicker than in the living representatives of the type. These characters are particularly marked in *Palapteryx elephantopus*. This bird was a little smaller than our ostriches, and nevertheless in it the metatarsus presents a circumference nearly double that of the same bone in the ostrich and the Cassowary*.

The size varied in a very noticeable manner in the different species of Moas. The smallest (*Meionornis didiformis*) was only 3 or 4 feet (0·97–1·30 m.) in height†. These were therefore very inferior to the ostrich, the size of which varies from 6 to 7 feet (1·95–2·27 m.). But *Palapteryx ingens* was precisely of this same size; *Dinornis robustus* was 8 to 9

* Hochstetter, *loc. cit.* p. 138.

† I borrow all these numbers from Hochstetter's table of measurements (*loc. cit.* p. 198). That learned traveller seems to have judged of the size not by measuring the distance from the beak to the extremity of the feet, but by supposing the bird in repose in its position of equilibrium, the neck inclined forward and presenting a double curvature, just as he has represented *Palapteryx ingens*, the entire skeleton of which is at Vienna (*loc. cit.* p. 188).

feet (2·60–2·92 m.) high, and *Dimornis maximus* raised its head to 9 or 10 feet (2·92–3·25 m.) from the surface of the ground. Thus it exceeded by nearly a metre our largest ostriches. According to Thomson, cited by M. Alphonse Edwards in an unpublished work which he has been kind enough to communicate to me, there even existed individuals 13 to 14 English feet (4·0–4·25 m.) in height.

By comparing a great number of bones of adult individuals of the same species, Dr. Haast has ascertained that they always formed two series of slightly different size. He has attributed this inequality to sex, and, guided by what occurs in the *Apteryx*, he regards the larger bones as having belonged to females*.

Besides the osseous remains of Moas, there have been discovered fragments of eggs and even some entire eggs, most of which, unfortunately, have been broken. But it has been possible to restore a considerable number†. These eggs, of a pale yellow colour‡, are dotted over with hollow points and little grooves§. Their volume was considerably greater than that of the eggs of the ostrich, but without equalling in this respect those of *Apyornis*||. In one of them the bones of

* Address ('Transactions' &c. vol. vi. p. 428).

† Mr. Mantell alone has reconstructed a dozen of these eggs, which he has for the most part divided between the British Museum and the Museum of the Royal College of Surgeons. Among these specimens, which testify so strongly to the address and patience of the author, there are some which contain no less than 200 or 300 pieces brought together ("On Moa-beds," 'Transactions' &c. vol. v. p. 94).

‡ [The fragments of egg-shell which accompanied the York specimen were of a dark green colour; the pale yellow specimens must have been bleached.—Tr.]

§ "On the Microscopical Structure of the Egg-shell of the Moa," by Capt. F. W. Hutton ('Transactions' &c. vol. iv. p. 166, pl. ix. figs. 1–5). The shell of the egg, about 1·75 millim. (0·07 inch) in thickness, consists of two layers. The outer one is formed by lamellæ parallel to the surface, the inner one by a kind of prisms perpendicular to the former. Other observers speak of these eggs as being perfectly smooth. It may be, perhaps, that the little grooves in question here are due to the action of grains of sand driven by the wind. We know, in fact, that this action is exerted even upon rocks much more resistant than egg-shells, and this fact has been demonstrated precisely in New Zealand.

|| *Apyornis maximus* inhabited Madagascar. It was destroyed by the hand of man, but we do not know at what period. The eggs and some bones were described for the first time by Isidore Geoffroy Saint-Hilaire ('Comptes Rendus,' 1851, tome xxxii. p. 101, and Ann. des Sci. Nat. sér. 3, tome xiv. pp. 206 and 213). M. Alphonse Edwards, having received fresh materials, has produced a very complete memoir upon this species ('Recherches sur la faune ornithologique des îles Mascareignes et de Madagascar,' p. 85, 1873). From the investigations of this naturalist it appears that *Apyornis* approached the Moas, although presenting characters proper to make it the type of a family probably including three

a young foetus were found, and Dr. Hector has been able to compare them with those of an embryo of the emou [*Dromæus*] of the same age *. It is interesting to find that, even at this period of life, the principal differential characters are distinctly marked, and that the pelvis, the bones of the leg, &c. are much more voluminous in the Moa than in its near relative from New Holland.

Lastly, isolated feathers of Moas belonging to various parts of the body have been collected from time to time at different places, as also even portions of the skeleton, to which muscles, tendons, shreds of skin, and feathers still adhered in a remarkable state of preservation†. I shall revert hereafter to the consequences to be drawn from these facts. I only speak of them here to complete the description of these birds.

Prof. Hutton has investigated the feathers found in two localities in the midst of bones of Moas. These feathers belonged to the same species. They were as fresh and their colours were as bright as if they had just been pulled out. But all were broken except a single one, of which he gives a figure ‡. The total length is 16 centim. (6 inches). The tube is only 5 or 6 millim. ($\frac{1}{4}$ inch) long, and bears two very slender

species. In particular the bones of the metatarsus were still stouter and more massive than even in *P. elephantopus*. Its height must have been about 2 metres. Its eggs, several of which are in existence, have a capacity of more than 8 litres, and represent in volume six ostrich eggs and 148 hen's eggs.

* "On recent Moa-remains in New Zealand," by James Hector ('Transactions' &c. vol. iv. pl. vi. figs. 3, 4). The same plate gives drawings of the eggs of the moa and of the emou (*Dromæus*), reduced to one third the natural size (figs. 1, 2).—Letter from Mr. T. M. Cockburn Hood to Dr. Hector ('Transactions' &c. vol. vi. p. 387).

† "Address on the Moa," Extracts, by the Hon. W. B. Mantell (Transactions &c. vol. i. p. 19); "On some Moa-feathers," by Capt. F. W. Hutton (*ibid.* vol. iv. p. 172); "On recent Moa-remains in New Zealand," by James Hector, M.D., F.R.S. (*ibid.* vol. iv. p. 110). Analogous facts are often referred to in other memoirs, and I shall have to return to them.

[It is curious that throughout the articles published in New Zealand on the Moa, there is scarcely any mention of the finest and most interesting Moa-skeleton in existence, namely that of *Dinornis robustus* in the museum at York, and M. de Quatrefages also says nothing about it. And yet this specimen not only is a nearly perfect skeleton of an individual bird, but its bones were in part united by ligaments and covered with skin, which bore the bases of feathers; parts of the skin of the foot were preserved, and much dried muscle was attached to some of the bones. With the skeleton were some bones of young chicks and a few fragments of green eggs.—See Thomas Allis, in Journ. Linn. Soc. vol. viii. pp. 50 & 140; R. Owen, "On *Dinornis*, nos. ix. & xi.," Trans. Zool. Soc. vols. v. & vi.; and W. S. Dallas, Proc. Zool. Soc. 1865.—Tr.]

‡ *Loc. cit.* pl. ix.

stems, the barbs of which, although furnished with barbules, remain separate from each other. These barbs, which are at first very short, attain a length of about $2\frac{1}{2}$ centim. (1 inch), and the feather terminates with a rounded margin. The first two thirds from the base are of a more or less reddish brown, which gradually passes into black, while the rounded extremity is of the purest white. Prof. Hutton points out that these characters approximate the Moas to the American and Australian brevipennate birds rather than to the African ostrich*.

As a matter of course, however, all the Moas had not the same plumage. The discoveries of Mr. Taylor White in this respect furnish a confirmation of what was easy to foresee. In the cave of Mount Nicholas he found feathers of a pale yellowish-brown colour, darker at the margins. Some were of a blackish brown. The feathers from another cave, near Queenstown, were of a reddish brown and marked with a dark brown streak towards the extremity of the stem†. Thus we know, at least partially, the plumage of three species of Moas‡.

The feathers which I have just described came no doubt from the middle or posterior region of the body. The precious specimen described and figured by Dr. Hector shows the modifications presented in this respect by the anterior dorsal region and the neck§. This includes seven vertebræ, the first dorsal, and the six lowest cervicals, united by their ligaments, and retaining upon one side their muscles and integuments. The author believes that the neck of this Moa was 18 English inches in circumference at its base.

Upon the portion of this specimen corresponding to the first dorsal vertebra, the skin is seen to be covered with large conical papillæ which nearly touch each other, and give the whole the appearance of a rasp. A certain number of these papillæ bear double-stemmed feathers of a reddish-chestnut colour, furnished with barbs like those of the preceding feathers, but the longest of which are at the utmost 2 inches long. The papillæ diminish in size and the feathers in length on arriving at the level of the cervical vertebræ. Soon the feathers appear to be reduced to mere hairs, and they disappear entirely upon about half the specimen. There the papillæ are much smaller and are distinctly separated from each other.

* *Loc. cit.* p. 173.

† *Loc. cit.* p. 114, pl. v., with five figures.

‡ "Notes on Moa-caves in the Wakatipu District," by Taylor White ('Transactions' &c. vol. viii. p. 97).

§ Note added to the preceding by F. W. Hutton (*ibid.* p. 101).

Taking into account these various data and the characters distinguishing the Brevipennes inhabiting the other regions of the globe, we may form a very precise idea of what these large species of Moas were like. They presented the general form of the emeu [=Cassowary], but upon a much larger scale. Like this, they had the greater part of the neck naked; but they were destitute of the characteristic crest, and in this respect resembled the emou [*Dromæus*]. Very probably the legs were naked and the body was covered with silky plumes, in which darker or lighter and more or less reddish tints of brown predominated, variegated with black and white, at least in some species.

Documents, to which I shall have to return further on, enable us to complete this picture, and make known to us the mode of life of these strange birds*. The Moas were sluggish and stupid animals, as is shown by a proverb which is repeated at the present day†. They were essentially sedentary and went about in pairs accompanied by their young. No doubt they sometimes disputed the field on which they were seeking the same food, for the Maoris still, in speaking of a struggle between two pairs of combatants, say—"Two against two, like the Moas." Their nests were formed of various dried grasses and fragments of ferns simply brought together into a heap. They ate various species of plants growing upon the borders of the woods and marshes, the young shoots of certain shrubs, &c.; but their principal food appears to have been the root of a species of fern which they dug up either with the beak or with the feet. To assist in the trituration of these articles of food, the Moas, like many other birds, swallowed small pebbles, which, when rounded and polished by friction in the stomach, acquire a peculiar aspect and are still called Moa-stones by the natives, who know them well‡. But this very polish rendered them unfit for the service which the bird expected from them, and then he disgorged them just as do the ostrich and the emou§

* Letter from Mr. John White to Mr. Travers ('Transactions' &c. vol. viii. p. 81). Mr. Travers informs us that his correspondent has occupied himself for more than thirty-five years in collecting all possible information upon the past of the Maoris, that he has been initiated by their priests into all the mysteries of indigenous knowledge, so that he knows the history of their race better than the natives themselves.

† Extracts from a letter from F. L. Maning, Esq., relative to the extinction of the Moas ('Transactions,' &c. vol. viii. p. 102). The author translates the Maori proverb by the words, "as inert (ngoikae) as a Moa."

‡ 'Hochstetter,' p. 186.

§ "Note on Discovery of Moas and Moa-hunters' Remains at Patana River, near Wangarey," by J. Thorn, jun. ('Transactions,' &c. vol. viii.

[*Dromæus*]. These stones were not always of the same nature, and varied with the localities*.

III.

The details that I have just given assume not only that man and the Moas were contemporaneous, but also that the disappearance of the latter is of recent date. Such, in fact, is the conclusion to which we are led by the results of a regular inquiry pursued in New Zealand for nearly forty years by a great number of investigators and distinguished naturalists. Nevertheless, until the last few years it was quite permissible to harbour doubts on the subject. One of the most authoritative of New-Zealand geologists, Dr. Julius Haast, has pronounced most absolutely in a very different sense. While accepting as demonstrated the coexistence of man and the Moas at a very distant epoch answering to our prehistoric times, he denies that the Maoris themselves ever knew these great birds†.

On the other hand, Mr. W. Mantell, to whom his numerous researches justly give an authority upon this point, has distinctly and repeatedly expressed the opposite opinion, and believes that these large Brevipennes were hunted and exterminated at a comparatively recent epoch by these very Maoris‡.

Lastly, Mr. Stack, who is accepted by his *confrères* as a very competent judge, has adopted an intermediate opinion. He regards the belief in the recent destruction of the Moas as inadmissible, but does not wish to throw it back into a very distant past§.

p. 85). A certain number of these Moa-stones have been collected and appear in the museum at Auckland, and no doubt in other collections in New Zealand.

* Haast, *loc. cit.* p. 73.

† "Moas and Moa-hunters: Address to the Philosophical Institute of Canterbury, 1871," by Julius Haast ('Transactions,' &c. vol. viii. p. 66, 1872). Dr. Haast has maintained his original opinion in other memoirs, and in the work that he has published under the title of 'Geology of the Provinces of Canterbury and Westland, New Zealand,' 1879.

‡ "On the fossil Remains of Birds collected in various Parts of New Zealand by Mr. Walter Mantell of Wellington," by Gideon Algernon Mantell, LL.D., F.R.S. (Quart. Journ. Geol. Soc. vol. iv. p. 225, 1848); "Address on the Moas:" Extracts by W. B. Mantell ('Transactions' &c. vol. i. p. 18, 1869). However, in this latter paper Mr. Mantell seems disposed to throw further back the epoch of the destruction of the Moas, in consequence of the obscurities in the traditions which he has been able to collect upon the subject. Mr. White's letter already cited, and to which I shall revert, fully answers this objection.

§ "Some Observations on the Annual Address of the President," by the Rev. J. W. Stack ('Transactions' &c. vol. iv. p. 107).

To show how the question has become elucidated, and justify the point of view which I have adopted, it is necessary to enter into some details.

The bones of Moas have been met with under the most different conditions of deposition. Sometimes they simply rest upon the surface of the ground, or are scarcely covered by a few centimetres of sand*. But usually they are found buried at various depths in the sands of the seashore, in the alluvia of the rivers, in the marshes, and also in caves. The quantity of these remains accumulated in restricted spaces is sometimes very remarkable.

In digging canals for the drainage of a marsh at Glenmark there were obtained the remains of 144 adult and 27 young birds†. I might cite many other examples, but I confine myself to a summary of the details given by Mr. Booth of the discovery made by him at Hamilton, in a small half-dried lagoon‡.

Having been informed of the discovery of a few bones, he opened a first pit of 4 feet square, and obtained from it fifty-six femora with a proportionate quantity of other bones. Regular diggings were then organized. It was ascertained that the deposit to be worked formed a sort of irregular crescent, measuring 40 feet from one point to the other, and 18 feet across at the middle, with a depth of from 2 to 4 feet. In this restricted space were collected about $3\frac{1}{2}$ tons (more than 8500 kilogrammes) of bones, and those who took part in the work estimated the number of Moas accumulated in this estuary at more than 400.

These bones were very unequally preserved. A great number fell into paste at the least contact. Hence they had not all been deposited at the same period. But in consequence of the conditions of interment the Hamilton swamp could not furnish certain data as to the relative age of the deposits. It is otherwise with the caves, which were scientifically excavated

* Dr. Hector, *loc. cit.* p. 115; Dr. Haast, *loc. cit.* p. 103; Rev. J. W. Stack, *loc. cit.* p. 109; Rev. R. Taylor ('Transactions' &c. vol. v. p. 97). Those bones which were seen in great numbers scattered over the ground have rapidly disappeared. Mr. Stack endeavours to explain their persistence for centuries by saying that the Maoris carefully preserved the jungles, which, on the contrary, the European colonists have caused to disappear. The latter, by destroying this shelter, have facilitated the action of atmospheric agents and have thus brought about the disappearance of these bones, which had hitherto remained intact. I think it useless to point out what, in this interpretation of the facts, has but little foundation and is opposed to daily experience.

† Haast, *loc. cit.* p. 89.

‡ "Description of the Moa-swamp at Hamilton," by B. S. Booth ('Transactions' &c. vol. vii. p. 123, pl. v.).

by Hochstetter. Here very distinct layers, separated by a bed of stalagmite, contained different species. At the top was *Meionornis didiformis*, at the bottom *Palapteryx elephantopus*. The bones of the former seemed to be still fresh, those of the latter were semi-fossilized. This diversity of aspect corresponded with differences of chemical composition, itself connected with more or less advanced alteration. The quantity of organic matter found in the bones of Moas which have been analyzed has proved very variable. It is sometimes only 10 per cent. ; but sometimes, also, it rises to 30 per cent. —a proportion almost exactly the same as is met with in fresh bones of the ostrich*.

Hochstetter, arguing from his own personal observations and from some previously known facts, approximated to the opinions of Dr. and Mr. W. B. Mantell. He thought that the extinction of the Moas could not be thrown back several thousand years†. He regarded their existence as alone capable of explaining the development which the population of New Zealand had attained‡, and attributed the origin of anthropophagism to the deficiency of animal food resulting from their extermination§. He consequently identified the existing race of Maoris with the hunters of the Moas.

To sustain a very different doctrine Dr. Haast especially appeals to geology. The bones of Moas, he says, occur principally in the beds which were formed during the glacial period or immediately after it||. Having himself collected a certain number of these bones *in situ*, it seems to him to be demonstrated that these large birds represented, in New Zealand, the gigantic quadrupeds which inhabited the northern hemisphere during the post-Pliocene period. Hence he does not hesitate to refer the existence of the Moas to an epoch as far from the present time as that of the mammoth, the rhinoceros, cave-lion, and cave-bear, the remains of which are found in European Quaternary deposits ; and he asserts that if the Moas survived these times, geologically so different from ours, they were nevertheless speedily annihilated¶.

It will be seen that Dr. Haast seems to assume not only the analogy of the glacial phenomena which took place in New Zealand and in Europe, but also their contemporaneity. We have to do here with geology proper, and questions of this kind are out of my province. Nevertheless, even accepting these two propositions as true, and reasoning by analogy,

* Hochstetter, *loc. cit.* p. 190.

† *Ibid.*

‡ *Loc. cit.* p. 194.

§ *Loc. cit.* p. 196.

|| *Loc. cit.* p. 68.

¶ *Loc. cit.* p. 75.

we might at once raise some grave objections to the consequences which Dr. Haast draws from them with regard to the antiquity of the extinction of the Moas.

It is very true that the great Mammalia mentioned by Dr. Haast no longer exist and are known to us only by their remains. But with them lived other species which survived them, and are even still living. The monks of St. Gall still ate the urus in the fifteenth century; the reindeer, in Pallas's time, descended in winter to the shores of the Caspian Sea; the aurochs and the elk still inhabit Poland; the chamois, the ibex, and the marmot are close to us. Why should all these species of Moa have been condemned to perish with the geological period that witnessed their appearance?

Dr. Haast no doubt would object to me that the European Mammalia of which I have mentioned the names, and others which it is useless to enumerate, have generally migrated either in longitude or in altitude. But, even without bringing the action of man into play, this change of habitat was imposed upon them by the transformation of the nature of the climate. This had become *continental*, instead of *insular* as it was in glacial times. In New Zealand this was not the case. Whatever may have been the movements of elevation or depression of its land*, it remained isolated in the middle of the sea, and its climate cannot have varied, at least in the lower regions, except within very narrow limits. Dr. Haast himself, although starting from other data than those indicated by me, insists upon considerations of the same kind, and shows very well that, in this great island, the extension of the glaciers by no means involves the existence of a climate much more rigorous than that of the present day†. The general conditions of existence remaining the same, what reason can the New-Zealand palæontologist give for regarding the extinction of all the Moas as necessary?

In all his writings, published to the present day, which have come to my knowledge, Dr. Haast maintains the general opinions indicated above‡. It would seem that they have

* The 'Transactions of the New Zealand Institute' contain several memoirs explanatory of the glacial phenomena of which New Zealand was the theatre. I need not dwell upon these, and I shall only call attention to those of MM. Travers and Dobson, who, in expounding their own views, have summed up those of their *confrères* (see "Notes on Dr. Haast's supposed Pleistocene Glaciation of New Zealand," by W. F. L. Travers, vol. vii. p. 409, and "On the Date of the Glacial Period," by A. Dudley Dobson, *ibid.* p. 440). But, upon this question, Dr. Haast's work upon the geology of the Provinces of Canterbury and Westland should especially be consulted.

† *Loc. cit.* p. 72.

‡ Besides the "Address," above cited, Dr. Haast has published, in the

for him the value of axioms capable of serving as a criterion—so much so that positive or negative facts have no value in his eyes, or rather cannot really have taken place, except they agree with his theory. If we speak to him of more or less complete skeletons found upon the ground side by side with a little heap of Moa-stones, which would seem to indicate that the bird died upon the spot and has never been buried, he declares that he cannot believe that these bones could have resisted the influence of atmospheric agents for hundreds if not thousands of years*. If we speak to him of the recollections preserved by the natives with regard to the existence of the Moas, their external characters, their mode of life, and the means employed in killing them, he replies, that the most civilized Europeans have no traditions relating to the mammoth and the rhinoceros, and that an inferior race which has attained only to a condition corresponding to that of our neolithic populations cannot have preserved any relating to an epoch separated from them by an immense number of years†. He adds that distinguished men have vainly inquired into the traditions in question‡. He refers particularly, like Dr. Colenso, to the fables which, in New Zealand as everywhere else, have become mixed up with the recollection of actual facts in the memory of peoples§. He connects what is said of the Moas with vague reminiscences of Cassowaries brought by the Maoris from their original country||, or with information furnished by occasional emigrants¶. The examination of the *ovens*, exactly like those of the present islanders, and of the remains of repasts containing bones of Moas, furnishes him with a demonstration of the contemporaneity of certain men with those birds** ; but the former, in his eyes, were an absolutely savage population, knowing only how to chip and not to polish stone. If some

‘Transactions of the New Zealand Institute,’ the following memoirs upon the same subject:—in vol. iv. 1872, “Additional Notes,” p. 90; “Third Paper on Moas and Moa-hunters,” p. 94, pl. vii.; in vol. vii. 1875, “Researches and Excavations carried on in and near the Moa-bone Point Cave, Sumner Road, in the Year 1872,” p. 54; “Notes on an Ancient Native Burial-place near the Moa-bone Point Cave, Sumner,” p. 54, pls. iii. & iv.; “Notes on the Moa-hunter Encampment at Shag Point, Otago,” p. 91; “Results of Excavations and Researches in and near the Moa-bone Point Cave, Sumner Road (Postscript),” p. 528.

Dr. Haast has also maintained his theory and the consequences which he derives from it in his book entitled, ‘Geology of the Provinces of Canterbury and Westland, New Zealand,’ 1879.

* “Address,” p. 71.

† *Ibid.* p. 75.

‡ *Ibid.* p. 76 *et seqq.*

§ *Ibid.* p. 76.

|| *Ibid.* p. 77.

¶ *Ibid.* p. 106.

** *Ibid.* p. 82.

polished *haches* have been found mingled with the ancient kitchen-middens, this, he declares, is because they were lost or intentionally hidden in modern times, long after the hunters of the Moas had disappeared*. The latter, he says repeatedly, never had any thing in common with the Maoris who occupied New Zealand at the time of the arrival of the Europeans.

I think I have sufficiently indicated the mode of reasoning and the nature of the arguments employed by Dr. Haast. I shall not follow him here into the discussion of a number of subjects upon which he touches, but which are only indirectly connected with the principal question. However, I think I ought to quote literally the conclusions with which he terminates his third memoir †:—

“1. The different species of the *Dinornis* or Moas began to appear and flourish in the post-Pliocene period of New Zealand.

“2. They have been extinct for such a long time that no reliable tradition as to their existence has been handed down to us.

“3. A race of *Autochthones*, probably of Polynesian origin‡, was contemporary with the Moa, by whom the large wingless birds were hunted and exterminated.

“4. A species of wild dog was contemporaneous with them, which was killed and eaten by the Moa-hunters.

“5. They did not possess a domesticated dog.

“6. This branch of the Polynesian race possessed a very low standard of civilization, using only rudely chipped stone implements, whilst the Maoris, their direct descendants§, had, when the first Europeans arrived in New Zealand, already a high state of civilization in manufacturing fine polished stone implements and weapons.

“7. The Moa-hunters, who cooked their food in the same manner as the Maoris of the present day do, were not cannibals.

“8. The Moa-hunters had means to reach the Northern Island, whence they procured obsidian ||.

* *Ibid.* pp. 85, 104.

† Third paper, ‘Transactions’ &c. vol. iv. p. 106.

‡ It is difficult to understand the association of ideas which Dr. Haast here wishes to express.

§ Here, again, Dr. Haast’s idea is not easy to understand. Throughout he carefully distinguishes the existing Maoris from the Moa-hunters. Here he seems to regard the former as being the grandsons of the latter.

|| Dr. Haast’s investigations were made principally in the province of Canterbury, which is in the South Island.

"9. They also travelled far into the interior of this island to obtain flint for the manufacture of their primitive stone implements.

"10. They did not possess implements of nephrite (green-stone)*.

"11. The polishing process of stone implements is of considerable age in New Zealand, as more finished tools have been found in such positions that their great antiquity cannot be doubted, and which is an additional proof of the long extinction of the Moas."

Thus Dr. Haast here appears to be absolute in every thing, and it is with an appearance of absolute certainty that he asserts or denies facts. But we shall see that he has himself been obliged to go back over some of these propositions and to recognize that some of them are not well founded. Nevertheless the general convictions of the learned geologist have not been shaken on this account, and we shall have to inquire whether this persistence is justified.

[To be continued.]

XIX.—*On the Presence of Eyes and other Sense-Organs in the Shells of the Chitonidæ.* By H. N. MOSELEY, M.A., F.R.S., Linacre Professor of Human and Comparative Anatomy in the University of Oxford.

ON examining a specimen of *Schizochiton incisus*, preserved in spirit amongst a number of other animals dredged by Captain W. Chimm, R.N., in the Sulu Sea, in H.M.S. 'Nassau' in 1871, and by him presented to the Anatomical Department of the Oxford University Museum, I was astonished to remark on the shells certain minute, highly refracting, rounded bodies arranged in rows symmetrically; they struck me at once as resembling eyes, and further examination proved that such is really their nature. On searching for eyes on the shells of other Chitonidæ I found them present in the majority of the genera, differing, however, in each genus more or less in structure and arrangement.

The eyes in the Chitonidæ are entirely restricted to the outer surface of the shells on their exposed areas (tegmentum), not extending at all on to the laminae of insertion (artacula-

* It is with this stone, often called *jade*, that the Maoris fabricated their stone clubs, *haches*, and various ornaments. It was of great value in their eyes, and often plays a part in their legends. Upon this point I have given some details, borrowed from Sir George Grey, in a book entitled 'Les Polynésiens et leurs migrations.'