

## CONCLUSION.

IN bringing to a close the record of the scrutiny and comparison of the evidences of the extinct wingless birds of New Zealand, some relaxation may be condoned by way of indulgence of the faculty of conjecture.

The cause and conditions of the extinction of these birds, discussed in pp. 457-459, may be held to be determined, and, approximately, the date of their disappearance.

But what can be said as to their origin? The first ground which suggests itself as a basis of speculation is, literally as well as figuratively, New Zealand itself. Since no evidence of such birds as those ranging in size from *Notornis* to the maximized form of *Dinornis* have been found in any other part of the globe, the conclusion seems legitimate that the species of those genera, as of *Aptornis* and *Cnemiornis*, did not exist elsewhere, at least on any known existing tract of dry land.

The naturalist, on the discovery and exploration of New Zealand, recognized the rare circumstance that, save the Maori and his dog, no predatory land-animal existed in the islands which could have alarmed or endangered the existence of such birds as form the subject of the present work: nor has any evidence of such enemy been discovered in any stratum or locality of either the North or South Island. It is, indeed, accepted as a notable fact in the geographical relations of living things, that, with the exception of some Bats and shore-haunting Seals, the mammalian class was unrepresented in New Zealand prior to the comparatively recent advent of the Polynesian people. The earliest maritime discoverer may have left the rat. Cook introduced the pig. Colonists have since spread abroad their domesticated mammals. There is no native terrestrial reptile in New Zealand, nor any evidence of an extinct one, which could have alarmed and stimulated an *Aptornis* or a *Dinornis* to the strenuous act of flight, if the ancestors of these birds had ever possessed wings in full functional development. It is true that a raptorial bird of unusual size did coexist with the Moas (pp. 141-150); but the menacing approach of such an enemy would excite a rush into the bush, the cleft, or the cave, not a rise into the medium of which an eagle is master. A swift course on land, or sudden dash or dive in water, would better avail in escape than such inferior flight as a Coot, a Goose, or a Moa could have accomplished if they had possessed such wings as one associates with our idea of a 'normal' bird.

The fact of a range of variety in size has been determined in the individuals of many species. Such variety affecting a *Cereopsis* to the degree shown by *Cnemiornis* would, in a corresponding degree, render the act of flight more difficult and laborious. Consequently if that act were not needed for the acquisition of food it might seldom or never be exercised in the absence of any enemy from which it would offer a way of escape.

By long disuse of the wings, continued through successive generations, those organs would become enfeebled, and ultimately atrophied to a degree affecting their capability to raise the body of the bird in the air.

The legs then monopolizing all the functions of locomotion would attain, through the concomitant frequency of exercise, proportional increase of power and size.

Under these conditions may be comprehended the origin of the great flightless Anserine bird which is entered as a 'species' in ornithological catalogues under the name of *Cnemiornis calcitrans*.

The same course of cogitation leads to the same conclusion as to the origin of *Notornis*, of *Aptornis*, and of *Dinornis*. The tendency to variation in size and proportions, after the reduction of wings to rudiments, leads to the minor modifications, called species, of such flightless genera.

The alternative is to surrender thought upon the mode of origin of such genera and species, and to repose in the conclusion that by some inconceivable miraculous manifestation of organizing force a male and female of *Cnemiornis calcitrans*, of *Notornis mantelli*, and of each species of *Aptornis* and *Dinornis*, were, at some remote and unknown point in time, created, with the fruitful power of propagating their kind; and that it was the pleasure of such Creator to construct their wings, bone for bone, muscle for muscle, nerve for nerve, after the pattern of the organs of flight in the normal birds most nearly allied to them, but, at the same time, to make the wings too small for the purpose of flight in these exceptions to the volant and feathered class.

Moreover, in such hypothetical instances of special creation, the miraculous power has been exercised in the limited area of our planet's surface now represented by New Zealand, and under conditions which rendered the useless appendages of no detriment to the well-being of the created species, until a period when these would, through want of wings, be blotted out of creation.

In illustration of the alternative view of the coming-in of species by the operation of a secondary law, I append to the pages devoted to the wingless or flightless birds of New Zealand brief accounts of similarly crippled birds from other localities.

There was a time when a northern sea-bird, larger than those now breeding in the 'Summer Isles' of the north of Scotland, and elsewhere in northern latitudes, flourished through its powers of obtaining food by diving and swimming, but which had lost its power of flight. It nevertheless possessed wings differing in no respect save in proportional size from those of the type manifested by the smaller existing Awks (*Alca torda*), which still exercise them in flight, and retain them of the due proportions for that act.

The increase of size of *Alca impennis* may be supposed to have been the condition of the discontinuance of the laborious attempts to carry its weight through the air. But the wings continuing to be applied, as in the smaller kinds of Awk, to assist in swimming, were retained of the size and with the proportions and the stunted closely imbricate plumage best adapted to the natatory function.

Ultimately came the great destroyer on the scene of life; and all recorded evi-

dence goes to gain the verdict that the extirpation of the species (*Alca impennis*) was the work of man.

Assuming a secondary law of the origin of species, the conditions of the characters of *Alca impennis* are explicable on the Lamarckian hypothesis of the 'modus operandi' of such law. Rejecting a secondary cause in favour of a primary one, the original pair of *Alca impennis* were miraculously made in close conformity with the type of *Alca torda*, but with wings too small for the body and too feeble for effecting flight, such disproportion being the condition, on a coming event, of the destruction of the species.

In the same view is added to the 'Appendix' of the present work a brief notice of two species of terrestrial birds which, like *Dinornis*, have become extinct within the historical period, viz., the Dodo of the Island of Mauritius, and the Solitaire of the Island of Rodriguez. It will be helpful in the present speculation to determine how far the conditions of existence and of extinction of these wingless birds resemble those of the analogous species in New Zealand.

Both *Didus* and *Pezophaps* surpassed in size the existing species of birds to which they bore the nearest affinity. Each genus was restricted, like *Dinornis*, to a limited tract of land. No evidences have been discovered in either Mauritius or Rodriguez of contemporary predatory animals, from the assaults of which a large bird would be impelled to escape by a rapid flight.

Each of these richly wooded tropical islands affords abundant subsistence to vegetarian and omnivorous birds, and each, prior to the advent of geographical discoverers, was destitute of creatures able or desirous to destroy such birds. If the food was wholly, or chiefly, on the surface, the power of traversing such surface would be of as much advantage to the bird as to the herbivorous quadruped. As flight calls for more effort than course, so cursorial progression would be more commonly practised in such happy islands for obtaining the daily food. The advent or proximity of a known element of danger might excite the quicker mode of motion; the bird would then betake itself by a hurried flight to a safer locality. If, however, these insular birds had never known a foe, the stimulus to the use of the wings would be wanting in species needing only to traverse the ground in quest of food. In the case of New Zealand, for example, the roots of wide-spread ferns, rich in farinaceous and amylaceous principles, tempting the birds to pluck, would stimulate such development of bone and muscle of the neck as is noted in pp. 407-420; or, if greater force was needed for the uprooting, the habit of scratching the food out of the ground would lead to excessive development of the muscles of the leg and foot. So such daily habitual exercise of legs and feet by unscared Rasorials would lead in successive generations to such developments of hind limbs as the Dodo and Solitaire present.

We recognize in the stunted wings of the Dodo, as in the skull and the rest of the skeleton, evidences of its affinity to the Dove family (*Columbacei* or *Gemitores*). The framework of the anterior limbs conforms, save in size and in the prominence of the

processes for muscular attachments, to the scapula, coracoid, furculum, brachial and antibrachial bones, carpus, metacarpus, limited number of digits, and their extremely modified phalanges, of the perfect instrument of flight in truly winged birds.

The minor modifications of the volant mechanism characteristic of the *Columbacei* are as plainly demonstrable in *Didus* and *Pezophaps* as are those of the Coots in the minor modifications of the useless wings of *Notornis*, and those of the Geese in the like modifications of the useless wings of the *Cnemiornis*—‘useless,’ in such instance, referring to the act of flight.

These comparisons and considerations lead me to regard the Dodo as a degenerate dove. It exemplifies the origin of a species agreeably with the partially applied hypothesis of Buffon <sup>1</sup>, and through the way of operation of the secondary law of the origin of species suggested and advocated by Lamarck <sup>2</sup>.

The same course of argument which has been suggested by the impennate Awk of northern shores and the flightless Doves of the Mascarene Islands applies, as we have seen, to the Moas of New Zealand. But in these the degree of atrophy, which seems to have been carried to total loss, of the limb-appendages of the scapulo-coracoid arch implies the operation of the influence of disuse through a period of pre-Maori æons greatly exceeding the time during which the Lamarckian law has operated on the Casowary, the Rhea, and the Ostrich.

In reference to the subject of the foregoing speculation, another hypothesis has, however, been propounded, viz. that birds are transmuted and advanced Dinosaurs, and that the feathered, hot-blooded, quick-breathing class made its first step in life-promotion from the naked, cold-blooded, slow-breathing reptiles, under the low form of *Struthiones* or *Cursorcs*, as yet incapable of flight <sup>3</sup>.

According to this view the Dodo is a predecessor of the Crown Pigeon, the *Notornis* of the Coot, the *Cnemiornis* of the Goose, and the *Dinornis* of some, as yet, unknown winged form, unless the course of evolution, through the Moas, has come to an untimely end.

Alleged facts of embryology have been adduced in support of this idea, and the assertion has been hazarded that “if the whole hind quarters, from the ilium to the toes, of a half-hatched chicken could be suddenly enlarged, ossified, and fossilized as they are, they would furnish us with the last step of the transition between Birds and Reptiles; for there would be nothing in their characters to prevent *us* from referring them to the *Dinosaurs*.”

I am barred, however, from joining the biologists indicated by the plural pronoun,

<sup>1</sup> ‘Histoire Naturelle,’ tom. xiv. p. 311, 4to, 1876. Buffon does not enter into the conditions of degeneration of parts.

<sup>2</sup> ‘Philosophie Zoologique,’ 2 vols. tom. i. chaps. iii., vi., vii., 8vo, 1803. On the influence of exercise and of disuse in altering the proportions of parts and organs.

<sup>3</sup> Prof. Huxley, ‘Quarterly Journal of the Geological Society,’ vol. xxvi. p. 29.

by the following facts. The greater number of the sacro-vertebral attachments of the chick's ilium, in whatever degree enlarged and fossilized, would lead me to refer it to the avian, not the reptilian type. I should also note the presence in the ischium of an obturator process wanting in the Dinosaur, and the absence of a pectineal process in the chick's pubis, present in the bone of the Dinosaur, and, further, the parallelism and backward extension of both pelvic bones in the chick, contrasted with their downward extension and divergence in the Dinosaur.

In further testing the embryological ground evoked, I find the differences between the half-hatched chick and the full-grown Dinosaur grow and multiply as the comparison proceeds. The distal epiphysis of the chick's tibia is not only larger and more complex than that of the Dinosaur, but it articulates, not with one of four tarsal bones, but with the proximal epiphysis of a compound metatarsus. The fibula of the chick ends in a point at some distance above the ankle-joint, whilst in the Dinosaur its distal end expands, is parallel with that of the tibia, and has an epiphysis which articulates with a calcaneum<sup>1</sup>. I should further note the backward direction of the innermost or first toe (1.) in the chick, and contrast it with the parallel position of that toe with the forwardly directed second toe in the Dinosauria, before committing myself to a reference of an embryo bird to that order. If the entire skeleton of an immature bird of any order, whether volant or not, were enlarged to the dimensions of that of a Dinosaur, the characters of the few dorsal and caudal vertebræ, of the many cervical vertebræ, and of the skull, the absence of an anterior pair of limbs with fore paws organized to be applied to the soil and to take their share in the support and progression of a long and bulky trunk, with the massive head of a Dinosaur, would be decisive against the reference of such imaginary gigantic chick to any known representative of a terrestrial order of reptiles. In no birds are the sacral vertebræ so few as in Dinosauria; and in those birds which, from the embryonal proportions of the wings, their great size and terrestrial habits, are adduced to exemplify Dinosaurian origin and affinity, the number of the sacral vertebræ ranges from seventeen (*Dinornis*) to twenty (*Struthio*). I may refer to my 'Monograph' above cited for an analysis of the grounds of ascription of a bipedal mode of locomotion to the Dinosauria, in further support of the idea of their ancestral relationship to winged birds through the terrestrial gigantic forms of the feathered class.

In now submitting the grounds on which the view of the origin of the flightless or wingless birds by way of degeneration from antecedent winged forms is preferred, I fully appreciate the limited application of the Lamarckian hypothesis in the exposition of the secondary law of the origin of organic species.

But I would add that, without knowing or pretending to know the ways of operation of such secondary cause, the vast increase of knowledge-stores of biological phenomena

<sup>1</sup> See 'Monograph on the Fossil Reptilia of the Kimmeridge Clay;' in the volume of the Palæontographical Society issued in 1875, p. 84, fig. 16. "*Dinornis* chick and *Scelidosaur*."

makes it as hard to comprehend them intelligibly in any degree, on the assumption of primary or direct creation of species, as it was difficult for Copernicus to understand and explain the vast accession of astronomical facts in his day, on the belief of the subservient relation of sun to earth, of the posteriority of the creation of the luminary to that of the light-receiver, and of their respective relations of motion, as then held. To the objection, how, on his assumption of the diurnal rotation of the earth, loose things remained on its surface, Copernicus could offer no explanation. Neither has the biologist been able, as yet, to explain how the *Ramphorhynchus* became transmuted into the *Archeopteryx*. It is open, of course, to deny such change, or that the feathered class has been, in any way, a development of an unfeathered one. But if speculation on the origin of Aves by secondary law be allowable, the extinct volant forms of the Reptilia offer a much more likely point of departure than the extinct heavy quadrupedal and terrestrial forms of the cold-blooded class. And if we restrict our survey to a narrower field, where conditions of life and of structure are surer and more abundant, and so speculate on the genesis of *Didus* or *Dinornis*, guiding or reigning the roaming fancy by facts, the geographical limitation of such ornithicnitoid species, and their primitive association exclusively with creatures of which they could have no dread, suggest the more obvious and intelligible hypothesis of derivation from antecedent birds of flight, whose wings they still show more or less aborted, according to Buffon's principle of transmutation by degeneration—with a progressive pre-dominance of the legs over the wings, ultimately resulting, agreeably with the Lamarckian view, in a maximization of the terrestrial and abortion of the aerial instruments of locomotion.