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THE MOA IN AUSTRALIA.[1]

RECENT discovery in Lord Howe's Island has proved that post-tertiary Australia extended far to the east of its present shores. Still it remains true that if among the results of inquiry into the past phases of Australian life there be one suggestive of the possible inter-relation of faunas apparently as distinct in history as in location, it is the discovery of a bird identical with the moas of New Zealand, and of others so near akin to them as to have been pardonably mistaken for them by acute observers. Fossils so like moa bones as the latter must necessarily have been, clearly show that the evolution of these grand birds was not initiated in their recent island home, but that it had already made considerable progress in that portion of a far-reaching continent which we now name Australia, when a period was put to the Nototherian age by desolating outflows of lava over the greater part of the land. Having regard to the improbability of birds so organized effecting a passage over sea under any ordinary circumstances, we can hardly escape the further conclusion that New Zealand's entire separation from the continental area was brought about in time not more remote than that era of intense volcanic activity. One is even tempted to surmise, and it appears very possible to do so without absurdity, that it was one among the consequences of that very manifestation of energy. But this is an instance of speaking without book on a question which should be rigorously, as it may be confidently, left for decision in the hands of New Zealand geologists. Cumulative evidence to the same effect, but still more explicit in kind, is yielded by a relic of a true dinornis. From it we gather that the process of evolution had, in the self-same place and time, accomplished more than we could have justly anticipated without such warrant — the production of that more complete departure from the rest of the *Struthionidæ* which we recognize in the moa type. And again, as the "wolves" and "devils" of Tasmania, the "crowned pigeons" of New Guinea, and the "wallabies" of those and other Pacific islands, have been cut off from the common ancestral seat of their genera, so also have the moas.

It is indeed somewhat strange that the notion of the same genus of birds existing at one time in Australia and at a later period in New Zealand should ever have been thought inadmissible, yet it is difficult to see what other conception of the case should have been in the mind of Sir Richard Owen when he spoke of the advent of an Australian moa as "an exceptional extension of a New Zealand genus to Australia." At the same time it is by no means to be regretted that Owen did take this view, and that in consequence he regarded with suspicion any Australian claim to moa rank, however well accredited. It is to the stimulation of his critical faculty by incredulity that we owe the full assurance that there has existed a bird which, though not dinornis, had much in it pertaining to dinornis, a degree of affinity which under the circumstances could not have been overstated, but, as stated, is quite sufficient to show that Australia was the nursery of the sept.

But let us quit generalities for the more immediate object in hand, viz., a brief review of the recorded occurrences of the moa stock in Australian deposits. As if to excite a hope that such occurrences would be frequent, the first of all the extinct birds of Australia to be drawn from those deposits and made known to science was a struthious bird dwarfing in size not only existing cassowaries and emus, but the emu which was contemporary with it. A thigh-bone of this bird was discovered in the year 1836 by Sir Thomas Mitchell in a brecchia cave in Wellington Valley, New South Wales. It was examined by Sir Richard Owen, and figured by him in an appendix to Mitchell's "Three Expeditions into the Interior of Eastern Australia," 1838. At that time, as we are subsequently informed, Owen determined the bone "to belong to a large bird, probably from its size struthious or brevipennate, but not presenting in its femur characters which justified him in suggesting closer affinities." The study of moa bones in after years enable him, he says, to perceive that in some features of importance the cave femur "resembles that bone in the emu rather than in dinornis." We learn further that "the length of this fossil was 13 inches, the breadth of the middle of the shaft not quite 3 inches," — measurements which are noteworthy, as they render it apparent that in its dilated proportions the bone was much more like the dinornis femur than that of the emu, which has a breadth of only $1\frac{1}{4}$ inches to a length of $8\frac{3}{4}$ inches.

Thirty-three years elapsed before any further light was thrown upon a problem which was sufficiently obscure. It then issued from the Peak Downs, near the centre of Queensland, where in 1869 a well was being sunk. The workmen passed through thirty feet of the residuum of basaltic decomposition, the "black soil" characteristic of "downs" country, then through 150 feet of drift pebbles and bowlders. Lying on one of the bowlders, at 180 feet from the surface, they met with a short thick femur, which was happily preserved from the usual fate experienced by such finds, and, more happily, passed into the hands of the well-known geologist, the Rev. W. B. Clarke. In concert with Mr. G. Krefft, then curator of the Australian Museum, Mr. Clarke compared it with the moa bones, with the result that he felt himself justified in announcing the discovery in the *Geological Magazine* of that year in a letter entitled, "Dinornis an Australian Genus." At Sir R. Owen's solicitation a cast of this bone was sent to him by the trustees of the Australian Museum, and this, in 1872, formed the subject of a communication from Owen to the Geographical Society. After pointing out at length the characters in which this femur resembles dinornis and dromæus (emu) respectively, the examiner decides "that in its essential characters it resembles more that bone in the emu than in the moa, and that the characters in which it more resembles dinornis are concomitant with and related to the more general strength and robustness of the bone, from which we may infer that the species manifested dinornithic strength and proportions of the hind limbs combined with characters of closer affinity to the existing more slender limbed and swifter wingless bird peculiar to the Australian continent." To the bird represented by the fossil Owen gave the name "dromornis," a name significant of his conception of the paramount affinity displayed by its femur. If with that judgment a succeeding observer finds it impossible to completely harmonize his own conclusion, and says so, it is because in this case compulsion rides rough-shod over peril. That the dromornis bone has important features which relate it to the emu rather than to the moa is a position which is unassailable, but that these alone are its "essential" characters is a postulate, and one that has no right to command assent. Essential they are among the dromæan features of the bone; but of the compound dromornis bone as a whole they form but a part of the essentials. The absence of the air-duct communicating with the interior of the bone, a characteristic dinornithic feature, seems quite as important as a structural index to habit as the dromæan set of the head of the bone; and, being strictly dinorthic, it is not "related to the general strength

[1] By C. W. De Vis, M.A., in the New Zealand Journal of Science for May, 1891.

and robustness of the bone," but to its comparative solidity. Again, the "dinornithic strength and proportions of the hind-limbs" is a reminder which should carry more weight than it was probably intended to bear, but is nevertheless but a partial statement of the fact, for it leaves out of consideration the great difference in the relative proportions of the bone under examination. It is not that the bone is altogether larger or smaller in the same ratios of length and breadth, but in different ratios, the dromornis and dinornis ratio being much the same. The dromornis femur is but one-third longer than that of the emu, yet its shaft is twice as thick transversely, and its upper end is more than twice as broad. With such bones the bird would probably have the general appearance, the gait, and habits of a moa rather than those of an emu. In short, dromornis exhibits at the least an intermediate form between the moa and the emu, probably a nearer approximation to the former than to the latter.

After another interval of fifteen years a third dinornithic bone was picked up in King's Creek, on the Darling Downs, by Mr. Daniels, and by him presented, with other contemporaneous fossils, to the Queensland Museum. This again presents the upper end of a thigh-bone, but minus the upper part of the great trochanter, which appears to have been shorn off by the abrading action of drift sand while the bone projected from the bed of a watercourse; in other respects it is in excellent preservation. Repeated comparison of this bone with species of dinornis, with dromornis, casuarius, dromæus, struthio, and rhea, has removed from the mind of its describer all doubt of the former existence of the typical moa in Australia. To him it appears to resemble as closely any one of the femurs from New Zealand as any two of these, specifically different, resemble each other, a view which of course implies the absence from it of features notably present in the emu bone. The most important of these is one to which reference has already been made. The "head" of the bone, or that hemispherical projection which fits into the corresponding cavity of the hip-bone, stands out prominently in the moas, in consequence of the neck behind it being somewhat long and of considerably diminished diameter; whereas in the emu the neck is short and thick, so that the limits of the head, especially on its upper surface, are less distinguishable. In this feature, easier to recognize by inspection than by description, dromornis agrees with the emu, while the Queensland moa exhibits the comparatively slender neck and well-defined head of its New Zealand successors. It is not necessary at this moment to insist upon the value of the several characters which aid in the generic identification of this bone with dinornis; they are to be found by any one sufficiently interested in the matter in the "Proceedings" of the Royal Society of Queensland for 1884. To others a recapitulation of them would be tedious.

Unfortunately the identification has not yet been supported by further testimony, a circumstance which can hardly be thought surprising when the extreme slowness with which dinornithic remains have been brought to light is borne in mind: three bones in over half a century has been the rate of discovery hitherto. Adding to these three others from which no precise information can be derived, viz., two ribs provisionally referred to dromornis, and the shaft of a femur too imperfect for determination, but certainly not dromornis, and in all probability not dinornis, all the fossils of this kind known to the writer have been mentioned. In a fairly numerous collection of bones of contemporary birds the paucity of such fossils is conspicuous, but it would hardly be safe to infer from that circumstance that the birds themselves were rare. The most we can say is that they were not among the ordinary frequenters of the lower levels in which the ossiferous drifts of the period were accumulating. It is therefore with sustained eagerness that every fresh tribute of bones is received and inspected, since the hope is always present that they may contain some further proof of the reality of the Queensland moa, as convincing to others as it would be welcome to the assertor.

Be it at the same time observed that there is no reason why a greater amount of proof should be demanded in this case than in others. There is no inherent improbability involved by it so great as to justify inordinate doubt, since the passage of dromornis into dinornis is not so long and difficult a matter as to require for its accomplishment a new home and a geological remove. The only objection to be raised against it is that it confirms and accentuates the antecedent difficulty created by dromornis itself,—the difficulty of accounting for the presence of moas in New Zealand under their lately existing circumstances. It is not a mystery that they should have been there at all, since it is anything but incredible that a subsidence of ten or twelve thousand feet should — during a geological age which has seen the whole Australian fauna profoundly changed — have taken place in an area liable to volcanic disturbance, such as we see effects of in Australia and feel the throes of in New Zealand. Before that subsidence, Mount Cook, from a height about equal to the Cordilleran peak of elevation, Aconcagua, would have looked down and over continuous land as far as the snow-capped mountains of Queensland, the view unhindered by the intervening peak of Lord Howe's Island,— the refuge of Meiolanian reptiles once in communication with their kinsfolk in Australia. The true difficulty is not the isolation of New Zealand from Australia, but the strange isolation of the moas from all other forms peculiar to Australian life. Why should their stock alone have escaped to an eminence of the sinking surface, or alone been introduced into the insulated land, or alone survived some change in its life-conditions fatal to the rest? The moa in New Zealand is the question that calls for an explanation; and in proof that it does call for an explanation, and is not to be dismissed as a voiceless phantasy, we point to dromornis followed (structurally) by dinornis in Australia, and we wait for its solution in the work of New Zealand's naturalists.

DESTRUCTIVE LOCUSTS.

SINCE the great "grasshopper years" of 1873–76 there have been frequent outbreaks of comparatively local species, as well as a few cases in which small swarms of the Rocky Mountain locust have flown out into the subpermanent region and have occasioned some damage for a year or so. The most notable cases have been the outbreaks of the lesser migratory locust in New Hampshire in 1883 and 1889, the extraordinary multiplication of the devastating locust in California in 1885, the increase of local species in Texas in 1887, the multiplication of a chance swarm of the Rocky Mountain species in a restricted locality in Minnesota in 1888, and last year's damage in Idaho by several non-migratory species combined.

For a number of years the first and second reports of the United States Entomological Commission, which contained the results of the labors of the commission upon the Rocky Mountain locust, have been out of print, and yet with every renewed alarm caused by locusts there has been a great demand upon the entomological division of the United States agricultural department for information, which could only be supplied by correspondence or by publishing the information in local newspapers. For a time the demand was filled by supplying the annual report of the department for 1877, which contained bodily the chapters upon remedies from the first commission report. The supply of this document was also soon exhausted.

The fact that Mr. Bruner, in his last summer's trip to Idaho, investigated the latest rumors, and found that considerable damage was being done, and that the farmers were not acquainted with even the most rudimentary measures for protection and remedy, showed the necessity of publishing a condensed and practical account of the species which become seriously injurious from time to time, and of republishing in as brief form as possible the matter on remedies and preventives from the reports mentioned. The result is the publication by the government of a bulletin on "Destructive Locusts," prepared by Professor C. V. Riley, government entomologist. This bulletin is, in fact, a reproduction of matter already published but now inaccessible for dissemination, and which, from its nature, has a permanent value, together with such additional facts as subsequent experience has revealed. It contains no technical matter whatsoever, and the farmer will be able to recognize the different species from the figures which accompany the consideration of each.

The portion which relates to remedies, while drawn up for use against the Rocky Mountain locust, will apply in large part to