Vol. 1. Part II

MEMOIRS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

FOSSIL REMAINS OF LAKE CALLABONNA.

PART II

1. *GENYORNIS NEWTONI*

A NEW GENUS AND SPECIES OF FOSSIL STRUTHIOUS BIRD

BY
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2. The PHYSICAL FEATURES OF LAKE CALLABONA

BY
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WITH THE OBJECT of bringing together, in uniform size, the descriptive matter relating to the Callabonna Fossils the Council of the Royal Society of South Australia have decided to re-issue, in "Memoir" form, two communications dealing with *Genyornis newtoni* which have previously appeared in their Transactions (Vol. XX., pp. 171-211).

By permission of the Editor of "Nature" they also incorporate in the present number the greater part of two articles published in that journal (Vol. L., pp. 184-188 and pp. 206-211), which deal mainly with the Physical Features of the Lake Callabonna region. This section has been independently paged with the view that, on completion of the First Volume of the" Memoirs," it may serve as an appropriate introduction.

In addition to these reprints, the present fasciculus also includes further osteological notes on *Genyornis newtoni*, and it is expected that all the remaining available parts of this fossil will be described in the next issue.

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GENYORNIS NEWTONI

A NEW GENUS AND SPECIES OF FOSSIL STRUTHIOUS BIRD

Preliminary Notice, with Historical References to previous discoveries of Struthious Bird Remains in Australia.

Description of the Bones of the Leg and Foot,* Sternum, Ribs, Coraco-scapula, and Wing Bones.

By E. C. STIRLING, M.D., F.R.S., C.M.Z.S., Director,[t]
and
A. H. C. ZIETZ, F.L.S., C.M.Z.S., Assistant-Director, South Australian Museum.

HISTORICAL REFERENCES

SOME account of the discovery of fossil remains at Lake Callabonna, by one of us, appeared in "Nature," 1894, vol. L., pp. 184 and 206. Since then various circumstances which were alluded to at the time, besides considerable difficulties in connection with the restoration and treatment of the bones, have retarded the development of the discovery and the publication of the results; nevertheless, though the work of dealing with a large mass of material is still far from complete, we find ourselves, at last, in a position to offer to this Society some preliminary notes upon the subject in respect of the remains of the large struthious bird which were found in association with bones of *Diprotodon* and other extinct marsupials.

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*Up to, and inclusive of, the description of the Leg and Foot, this article is a revised re-issue of two communications which have previously appeared in the Transactions of the Royal Society of B.A. (vol. XX., pp. 171 and 211. The remainder is a new contribution. [Read June 5, 1900.]

[t] Justice requires an acknowledgment on my part that to Mr. Zietz belongs the credit not only of having conducted the exhumations at Lake Callabonna, under arduous circumstances, but also of having most successfully carried out the tedious work of the restoration of bones which presented peculiar difficulties in treatment. I must be the first to admit that collaboration on my part has only been made possible by the patient and laborious exercise of Mr. Zietz's skill in this direction.-[E. C. S.]

As, in the course of this paper, reference will have frequently to be made to previous discoveries, in Australia, of bones of the same group of birds it will be convenient to commence our observations by a brief epitome of these.

That work has been materially facilitated by a paper by Mr. Robert Etheridge, junr., who, in a communication to the" Records of the Geological Survey of New South Wales,"*: succinctly reviews the history of the various discoveries of struthious birds in Australia. From this paper we have freely borrowed, and we accordingly express our thanks and acknowledgment.

The first evidence of the former existence of these birds in Australia appears to have been in 1836, when" Sir Thomas Mitchell, F.G.S., Surveyor-General of Australia, discovered in the breccia-cave of Wellington Valley a femur" (13 inches in length), "wanting the lower end, mutilated, and encrusted with the red stalagmite of the cave, which I [Owen] determined to belong to a large bird, probably, from its size, struthious or brevipennate, but not presenting characters which, at that time, justified me in suggesting closer affinities."[t] This femur is figured in Mitchell's work.[tt]

In 1865 or 1866 (the alternative dates are given because both appear in two different notices by the author), at Penola, South Australia, the Rev. J. E. Tenison Woods came into possession of "two tibias and two tarso-metatarsal bones of some extinct and very large bird·"||

There is a, further discrepancy in Mr. Woods' notices of the discovery in respect of the position in which the bones were found, for, in one place, he states that they were found "in sinking a well," and, in another, that they were found" near a native well."§

In a subsequent reference** Mr. Woods provisionally proposed the name of *Dromaius australis* for this bird.

An important part of Mr. Woods' statements concerning it is the expression of his belief in its contemporaneity with man. He says in the first-mentioned notice that "It is ·certainly quite extinct, but appears to have been contemporaneous with the natives, for these bones are marked with old scars, one of which must certainly have been inflicted by a sharper instrument than any in the possession of the natives at present; there were, however, fragments of flint buried with the bones, and a native well about 50 yards away."

We have not been able to examine these bones, nor even do we know what has become - of them. Perhaps they are among those fossils which, we understand, lie hidden in obscurity

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*On Further Evidence of a Large Extinct Struthious Bird *(Dromornis,* Owen) from the Post-Tertiary Deposits of Queensland. R. Etheridge, jun., vol. I., p. 126.

[t]On *Dinornis:* containing a. description of a femur indicative of a new Genus of a large Wingless Bird *(Dromornis australis)* -from a Post.Tertiary Deposit in Queensland, Australia, Trans. Zool Soc., vol. VIII., p. 381; also Extinct Wingless Birds of New Zealand *(Dromornis australis),* Appendix, p. 1.

[tt]Three Expeditions into the Interior of Eastern Australia, 1838, vol. II., pl. 32, fig •. 12 and 13; 1839 ed. pl. 51.

||Report on the Geology and Mineralogy of the South-Eastern District of South Australia by the Rev. J. E. Tenison Woodt {Adelaide, 1886), p. 7

§ *Ibid.*

Nat. History of New South Wales-An Essay (Sydney, 1882), p. 27 quoted from Etheridge, *op. cit).* **

**Proc. Linn. Soc., N.S. W., 1882, VI!., p. 387.

in the Penola Institute, and we propose to investigate the question. If, however, the statement of Mr. Woods concerning the contemporaneity of the bones with man can be substantiated it is one of the greatest· importance as affording, so far as we know, the only direct evidence of the coexistence of man in Australia with the extinct fauna.

Mr. Woods' description of the bones is not very clear, but a certain interpretation of it ends support to the view that the bones in question were those of the bird for which we shall propose' the' generic name *Genyornis.*

In 1869, the late Rev. W. B. Clarke, Government Geologist of New South Wales, announced, both to the *Sydney Morning Herald* (May 20) and to *The Geological Magazine* {vol. VI., p. 383), the discovery of a femur (nearly twelve inches in length) during the digging of a well at Peak Downs in Queensland. As Mr: Etheridge points out there is, in this case also, some discrepancy in the statements; as to the exact position in which the bone was found. This femur was determined by Mr. Krefft, then Curator of the Australian Museum, Sydney, to be that of a *Dinornis.**

A cast of it, with photographs, was transmitted to Professor Owen who described it in detail and founded on it the genus *Dromornis* stating his conclusions as follows :-" I infer that in its essential characters this femur 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 smaller, more slender-limbed, and swifter wingless bird peculiar to the Australian continent."[t]

In 1876, again through the instrumentality of the Rev. W. B. Clarke, a fragment of a pelvis of a large bird, including the left acetabulum, found at a depth of 200 feet, at the Canadian Gold Lead, near Mudgee, N.S. W., was transmitted to Professor Owen, who assigned it to *Dromornis:*[tt] In the same paper he described a portion of a tibia, supposed to have come from a cave at Mt. Gambier, South Australia.‖ This also Professor Owen referred to *Dromornis*, but he remarked "one cannot of course state confidently that it is a bone of the same species as the mutilated femur from the cave of Wellington Valley, or of that of the drift at Peak Downs. in Queensland." We believe that this fragment may be assigned to *Genyornis.*

In the Proceedings of the Royal Society of Queensland, for 1884 (vol. I., p. 23), Mr. De Vis describes a fragment of the proximal end of a femur of a struthious bird that was discovered, with other bones, at King's Creek in the Darling Downs district. In the author's opinion the characters of this fragment justify its reference to the genus *Dinornis*

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* *Sydney Morning Herald*, May 19, 1869. See also Journal and Proceedings R. Soc., N.S. *W.*, vol. :XL, 1877. p. 45,"where the letters of Messrs. Clarke and Krefft are reproduced.

t Trans. Zool. Soc., vol. VIII., p. 383. Extinct Wingless Birds of New Zealand. Appendix, p. 3. :

tt:Trans. Zool. Soc., vol. X., p. 186. Extinct Wingless Birds of New Zealand.' Appendix, p. 6.

‖ This was presented to the British Museum by the Trustees of the Adelaide Museum, 1872.-Brit. Mus. Cat. Fossil Birds, p. 335-6 and he accordingly assigned to its possessor the name *Dinornis queenslandia.* This conclusion has, however, been contested by so competent an authority as Captain Hutton, and it no doubt requires the confirmatory evidence of more complete material.

In 1889 remains of a large struthious bird were found at an old spring, in sinking a well, at a depth of 20 feet from the surface at Thorbindah, near Cainwarra Station, on the Paroo River, Queensland, in association with fragments of bones of kangaroos, *Diprotodon,* and *Dromaeus,* and forwarded to the Government Geologist by Mr. A. S. Cotter. These were described by Mr. Etheridge in the paper to which we have expressed our indebtedness as portions of " the right tibia and left fibula of a large struthious bird, and the right tibia of an emu;" both of the portions of the larger bones were assigned by the author to *Dromornis.*

As to the fragment of tibia, we can have no doubt that it belongs to the same bird as the Mount Gambier and Callabonna fossils; but to this matter we must recur. The fragment, however, believed by Mr. Etheridge to be a part of the fibula, is certainly not any part of that bone in the Callabonna bird, and, indeed, we cannot make it correspond to any part of *Genyornis* which we possess, nor, moreover, does it correspond to any part of any fossil bone with which we' are able to compare it, whether of bird or mammal.

As we are dealing particularly with the larger forms of struthious birds, we do no more than mention, in this place, that fossil fragments of bones, which have been referred to the existing genus *Dromœus*, have been recorded from the Post-Tertiary deposits of the Wellington Caves and other localities. One such fragment, from the Darling Downs, of slightly larger dimensions than the living species *Dromœus novæ-hollandim,* constitutes the type of *Dromauus patriciu*,* which name was accepted by Mr. Etheridge for the fragment found at the Paroo River with the larger bones.t So also a fossil representative of *Casuarius* (stated to be allied to *C. picticollis,* Lydekker, Brit Mus. Cat. Fossil Birds), in the form of a distal portion of the tibio-tarsus, was also obtained in the cave deposits of Wellington Valley.

Up to this point these references are based upon published statements, which have been so conveniently summarised by Mr. Etheridge. We may now add to the list by a notice of some other discoveries in South Australia, which have either not yet been made public or which have only received a passing notice in the current press.

In 1879 the South Australian Museum received, from Mr. R. M. Robertson various collections of fossil bones found near Normanville, South Australia. Amongst these, which included remains of *Diprotodon, Macropus, Phascolomys, Bettongia* and *Thylacoleo,* were a portion of a bird's femur and parts of two or three tibiae. Weare now able to refer all the latter to the Callabonna bird.

In 1889 one of us, in the course of the exhumation of *Diprotodon* bones at Baldina Creek, on the edge of the Eastern Plains, near Burra, South Australia, obtained a considerable portion of a femur, which can also be referred to the same species.

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* "A Glimpse of the Post-Tertiary Avi-fauna of Queensland," Proc. Linn. Soc. N.S. W., 1888, vol. III. [2ud ser.], p. 1291.

t Records Geol. Surv. of N.S.W., *loc. cit.,* p. 133.

Lastly, in 1893, came the discovery, already noticed in "Nature,"* of a large number of bird-bones at Lake Callabonna found in association with those of *Diprotodon* and of other extinct marsupials. To the circumstances of this discovery, so far as it relates to the birds a few further details will be given directly.

For convenience of reference we may now epitomise, in their proper order, the various discoveries of large bird-bones which have been mentioned above.

Date	Locality	Colony	Discover, or Author (in brackets)	Nature of Remains
1836	Wellington Caves	N.S.W	Sir T. Mitchell	Femur, mutilated
1865 or 6	Penola	S.A	Rev. J. E. Tenison·Woods	Two tibiae and two metatarsi
1869	Peak Downs (Dromornis)	Q.	Rev. W. B. Clarke	Femur
1876	Canadian Lead	N.S.W	Mr. Dietz	Portion of pelvis
1876 or 7	Mount Gambier	S.A	(Prof. Owen)	Fragment of tibia
1879	Normanville	. S.A.	Mr. RM. Robertson	Portions of femur and of three tibiae
1884	King's Creek	Q..	(Mr. C. W. De Vis)	Portion of femur
1889	Paroo River	Q	Mr. A. S. Cotter	Portion of tibia: of fibula
1889	Baldina Creek	S.A.	Mr. A. Zietz	Portion of femur
1893	Lake Callabonna	8SA.	{Mr. A: Zietz, Mr. H. Hurst}	Many bones, *vide infra*

GEOLOGICAL AGE OF THE VARIOUS BIRDS REMAINS

As to the geological age of the various bones Mr. Etheridge remarks:- “The femora" (Wellington Caves, Peak Downs and King's Creek) "and the tibia" (Mount Gambier) " coming from what may be generally termed Quaternary deposits may, for argument's sake, be considered of the same geological age. But it is questionable if the pelvis from the Canadian Lead can be so regarded. As previously stated, it was found at a depth of 200 ft. in an auriferous lead of supposed Pliocene age, and it is therefore somewhat premature to class these remains as all of one period. Rather, would it not be better to consider the pelvis from the Canadian Lead as one of the earliest bird remains yet extant on this continent, and of Pliocene age; and those from the other localities as representing a Post-Pliocene period."[t]

As to the Penola remains the discrepancies in Mr. Woods' statements concerning their position have already been alluded to, but the expression of belief from a geologist in the contemporaneity of the bird with the natives and the distinct assertions, in one of his notices of the remains, that they were found" in one of the kitchen-middens of the natives of South Australia," and that" the bones were marked by the scrapings and cuttings of the flint knives of the blacks," at least imply a recent period.[tt]

* *Loc.cit.* t *Op. cit,* p.120 tt Proc, Lin. Soc., NSW., 1882 vol., VII., p. 387

With regard to the Normanville and Baldina Creek fossils we are informed by Mr. Howchin that some uncertainty exists as to whether the deposits in which they were found should be regarded as Pliocene or Pleistocene.

At Callabonna the fossiliferous formation was determined by Professor Tate* to be Pliocene.

THE DISCOVERY OF BIRD BONES AT LAKE CALLABONNA

Some reference was made to the discovery of bird-bones in the papers in " Nature" already referred to, but it may not be ,without interest to add, in this place, a few further details. These we quote in the first person singular as proceeding from the one of us (A.Z.) who personally conducted the operations for their removal.

"The level bottom of Callabonna Lake, the characters of which have been described,[t] shows, in some places, small elevations of about two square feet in size,[tt] formed of concretionary limestone. These, when closely examined, were found to form incrustations for the more solid bird-bones. Around and above these elevations were scattered numerous small smooth pebbles, ‖ which were partly buried in drift-sand. The elevations could still be recognised during the dry season, when the whole bed of the lake was covered with a white saline incrustation.

"The remains of the first two birds found were imperfect skeletons of which only the leg and toe bones (which were underground) could be removed, all the other bones being irretrievably damaged. Subsequently, when the clay bottom of the lake became sufficiently dry and hard for camel riding, I made a flying trip of two days' duration to the north western shore of the lake, about eight miles distant from our camp, where, I was told, bird bones had been noticed in greater number. The result of this trip, however, proved to be unsatisfactory, only a few bones being obtained and these in a very defective state.

" In the course of time, while proceeding with the exhumation of *Diprotodon* fossils near our permanent camp, single bird-bones were frequently found mixed with those of the former animal; but in many cases they were destroyed before they were noticed. This was unavoidable, because, in order to gain access to the large marsupial bones which were to be removed, great masses of clay had to be shifted. and it was in the course of this removal that the accidental damage took place to the smaller and unnoticed bird-bones which were disseminated in the clay. Judging from the frequency with which its remains were found, this bird must have been numerous at the time of its existence. During the second month's operations we discovered a nearly perfect sternum-the only good example obtained-and near to it other parts of a skeleton scattered throughout the clay. All, however, except the

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*" Nature," 1894, vol. L., p. 207

t "Nature," vol. L., p. 187.

tt These elevations are distinguished from those covering the skeletons of Kangaroos and Diprotodons by their smaller size and by the presence of pebbles.

||" Nature," vol. L., p. 208,

sternum where in a very bad condition. In the course of the third month a part of the lake. near our camp, which was, at the time of our arrival, partly under water and too boggy for work, became partly dry, owing to the continuance of dry northerly winds.

"To this place I decided to give a trial with the result that three bird skeletons, besides other fossils, were found lying close together and only a foot below the surface The first bone uncovered was a pelvis, and on following this up we came upon the vertebral column which was, however, in a hopeless state of decay; near the end of this was the lower jaw. Perceiving also, with great delight, parts of the skull, I decided to extract the whole mass of surrounding clay in which it was embedded. The second skeleton was in a similar condition-head only partly recognisable; pelvis good; sternum, both in this and in the previous specimen, broken up into fragments; vertebrae little interrupted as a series, but each individual segment broken into minute fragments which made it impossible to remove them whole. One wing was nearly complete, but the bones of the other were only in fragments; caudal vertebrae in fair condition. The legs of all the birds found were directed downward, and were in a flexed position. The lower end of the tibia-tarsus, the tarso-metatarsal and toe bones were invariably incrusted with hard limestone to the thickness of half an inch, which had to be chipped off, and in the course of r0moval of this crust some bones were injured. The lower ends of the legs extended to a depth of several feet under ground where water was always present. The third bird skeleton was rather incomplete: head in fragments; pelvis imperfect; no sternum; the legs only were in good condition. The remains of these three birds were found within a space of about six square yards and, as they lay on one side, their heads and necks were directed towards the south-west-the deepest part of the lake bed. It may be mentioned that all the bones situated near the surface were always found broken up into innumerable fragments, which was due to the growth of tufts of fibrous crystals.

[We are indebted to (the late) Mr. E. F. Turner, Demonstrator of Chemistry at the University, for the following note on the constitution and formation of these crystals :-The material submitted consists of clay impregnated, and covered, with filiform crystals, which are composed of halite, together with smaller quantities of gypsum, glauberite, and alunite. On saturating the mass of clay with water, and then allowing it to dry, the crystals again appeared on the surface-capillary attraction leading the saturated solution of the above salts to deposit, in the first place, the cubical crystals of common salt and the octahedral crystals of alunite; these then become bound together by the prismatic crystals of glauberite and gypsum, the result being that a protruding mass of filiform crystals is formed.]

"Under atmospheric influences, in which dry conditions of the clay are succeeded by moist, these crystals are alternately formed, in and around the bones, and redissolved; with the result that constant scaling takes place from their surfaces until at last the whole bone crumbles into fine powder. Or, short of this, the infiltration of the bones with so much salt confers on them such hygroscopic properties that, even in an ordinary damp atmosphere, they become moist, and can only be dried with great difficulty; while on the other hand, in the very dry weather of the Australian summer they become brittle to an extreme degree. The shrinkage, on drying, and consequent cracking of the masses of clay, enveloping the bones, also constituted a cause of damage. To give some idea of the extent to which this took place it may be mentioned that a block of clay, containing bones which filled a box about 15 inches square, developed cracks in two places each over an inch in width. Such facts will in some measure explain the difficulties and delays that have been experienced in connection with the restoration of these bones.

"It may perhaps be mentioned in this place that, on one occasion, the white incrustation of saline crystals which then covered the surface of the lake was completely blown off by the force of the wind, leaving bare the natural clay of its bed.

"The appearance on the surface of skeletons, particularly of *Diprotodon,* is, no doubt, to be explained by a singular and recurring action of the wind, which; at certain seasons, blows with great force and frequency on the desiccated surface of the clay itself. *Vide* 'Nature,' vol. L., p. 210.

"The position of the sternum was always indicated by the presence of the gravel masses, previously mentioned, which rested upon its concave (upper) surface, whether on, or below, the ground. Though a few fragments of birds' bones were obtained before my arrival on the field, nearly all of them were obtained towards the latter part of my stay. Short of an exact enumeration it may be stated that the material obtained comprises about six femora, three only being in really good condition, the others unfortunately much distorted, by pressure, or otherwise injured; the tibio-tarsi, tarso-metatarsi, and toe bones of about a dozen birds, the majority of these being now in an excellent state of completeness and preservation; one almost perfect sternum; one skull a good deal damaged with its hyoid bone, and parts of a second head with the greater portion of it£ lower jaw; one nearly complete wing, with portions of others; two complete vertebral ribs and fragments of others; one set of caudal vertebrae and portions of three pelves-· the latter being much broken, partly by rabbits in camp *(vide'* Nature,' vol. L., p. 210), partly in transit, and partly on account of the presence of the conditions just described."

EXISTING NOMENCLATURE OF THE LARGE AUSTRALIAN FOSSIL STRUTHIOUS BIRDS.

So far as this is concerned the position is as follows :-

The genus *Dromornis* was founded by Professor Owen, on the Peak Downs femur, and the author has, at least provisionally, referred to the same genus the first found femur of the Wellington Caves, the fragment of the pelvis of the Canadian Lead and the portion of the Mount Gambier tibio-tarsus. "The probabilities are," says Professor Owen, in a letter to Mr. Clarke,* "that the femur from the breccia cave of Wellington Valley, that described (from Peak Downs), your portion of a pelvis, and the South Australian tibia are parts of the same genus if not species. It is more convenient and conducive to progress to record. them, until proof of the contrary be had, as parts of *Dromornis australis."* This was somewhat qualified by a later statement already quoted, which very reasonably implied that it must still be an open question as to the specific identity of the Mt. Gambier tibia with the femora of the Wellington Valley and Peak Downs. *

The King's Creek fragment of femur has been assigned by De Vis to the genus *Dinornis* as *D. queenslandiae* .

For the Penola fossils the Rev. J.E. Tenison Woods provisionally proposed the name *Dromaius australis* until more bones should be found, but "since then its remains have been found in other places, and Professor Owen has named it *Dromornis australis."*t

Puttiug aside, as not immediately concerning us, the fossil forms of emeu, *Dromornis australis* and *Dinornis queenslandiae* are thus the only two definitely named species of large extinct Australian struthious birds.

From an examination of the bones of the Callabonna bird, so far as this has proceeded, and, in the first place, from a comparison of its femur with these two named Australian species,tt we believe we may assert that-

1. The femur of the Callabonna fossil differs so considerably from that of *Dromornis* and *Dinornis queenslandiae* that it must be regarded as that of a different bird, and, further, that the differences are sufficiently great to justify the establishment of a separate genus.

2. The Mount Gambier and the Paroo River tibiae, assigned to *Dromornis* by Professor Owen and Mr. Etheridge respectively, are identical with that bone in the Callabonna bird. As to the supposed fragment of fibula from the latter locality, we have already expressed our doubts.

3. Of the portion of the Canadian Lead pelvis, we cannot yet express an opinion, as no comparison has yet been made with that of the Callabonna bird, which latter is, moreover, much damaged, and still in process of restoration.

4. The other South Australian specimens from Normanville and Baldina Creek are identical with corresponding parts of the Callabonna fossil.

Now, as the name *Dromornis* rightly belongs to the Peak Downs femur on which the genus was founded, it becomes necessary to find a name for the Callabonna fossil, whose femur is different, and we propose the name *Genyornis newtoni.*|| The generic term arises from the conspicuous feature afforded by the relatively large size of the lower mandible, which fact, at least, emerges from the, as yet, hardly commenced examination of the skull.

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*Trans. Zoo!' Soc., vol. X., p. 188. Extinct Wingless Birds of New Zealand. Appendix, p. 6.

t Nat. Hist. N.S. W. (Sydney, 1882), p. 27; (quoted from Etheridge) p. 135.

tt. We have to express our acknowledgement to Mr. Etheridge and Mr. De Vis, Curators, respectively, of the Australian and Queensland Museums for forwarding to the South Australiau Museum casts of these two type specimens, and to Mr. Pittman, Director of the Geological Survey of New South Wales, for his courtesy in permitting us to examine the actual specimens from the Paroo River, described by Mr. Etheridge.

|| Tevus, the under jaw. In the specific name we have much pleasure in dedicating this ancient bird to Professor Alfred Newton, F.R.S., Professor of Zoology in the University of Cambridge, whose name has long been intimately and honourably associated with the progress of. ornithology and, from whom both as teacher and friend, one of us has received much personal kindness and encouragement.

Under this name, therefore, we propose to include the various portions of tibiae that, have been hitherto assigned to *Dromornis* leaving the identity of the Canadian Lead pelvis as yet undetermined.

GENYORNIS NEWTONI

A detailed description of the bones of this bird, together with a comparative reference to the other forms with which it may be compared, and the necessary illustrations, are in course of preparation. In the meantime we submit the actual specimens to the Society, and beg to call attention to a few salient features that may give some indications of its characters and of its affinities, particularly with those Australian and New Zealand ratitite birds which are the first to invite comparison.

Femur.-This bone of *Genyornis*, in its bulk and massive proportions, claims comparison with that of the most ponderous of the moas. Though, as will be seen by reference to table 1. the largest examples are nearly five inches shorter, yet, their latitudinal dimensions very nearly equal those of *Dinornis maximus*, Owen, while they considerably surpass those of *Pachyornis elephantopus,* Owen. From the femora of the Dinornithidae that of *Genyornis* is, however, distinguished by the marked absence of prominent ridges and surfaces for muscular attachment that arc often conspicuous features in the former family; by the flatness of the surfaces of the shaft; by the pyriform oval, or almost trilateral, shape of the section, and by the more considerable cuvature of its internal border. It differs also in the more gradual and evenly curved ascent of its superior articular surface, as it recedes from the head to cover the trochanter. Yet notwithstanding, from the great lateral extent of this surface, the elevation of the trochanter, relatively to the head, is as great as or even greater than in the moas, where the ascent of the epitrochanteric surface is abrupt and steep. The femur of G*enyornis* differs also from that of these birds in the presence of a large pneumatic foramen at the topmost part of the posterior surface of the upper expansion of the shaft.* In this respect it resembles the femur of the emeu and ostrich, while it differs from that of the cassowary. Gr'eat differences are also observed in the shape and proportion of the great trochanter.

The inferior extremity is also characterised by its great breadth and, in conformity thereto, the width of the intercondylar groove in the largest examples exceeds by an inch that of the femur of *D. novæ-zealandice (giganteus)*, Owen +

From the femur of *Dromornis* that of *Genyornis* is distinguished by its more massive proportions as shown in Table I., and by some of the above-mentioned characters, such as the shape of the section of the shaft (which in *Dromornis* is a flattened and regular oval); the marked curvature of the internal border; the presence of the pneumatic foramen and the shape and projections of the trochanter with its accessory processes. In one respect there is

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* Captain Hutton has shown that a pneumatic foramen may exist in the Dinornithidae. Trans. and Proc. N.Z. Inst., vol. XXVII., p. 173.

\+ The South Australian Museum does not possess a femur of *D. maximus*.

a resemblance to *Dromornis,* viz., in the gradual and even slope upwards of the superior articular surface towards the trochanter. So far as the mutilated condition of the *Dromornis* femur permits a comparison to be made there are also considerable differences in the details of the inferior extremity-particularly in respect of the contrast between the oblique, deep and narrow popliteal depression in this bone and the wider, shallower and much less well defined cavity as it exists in *Genyornis.*

Whether further remains of the bird to which the fragment of femur, named *Dinornis queenslandim* by De Vis, belongs shall prove it undoubtedly to be a true *Dinornis* or not, the sudden ascent of the trochi:mtel'ic part of the articular surface of this bone in the moas is in m:wked contrast to the feature that has been described for *Genyornis.* A further distinction in *D. queensland£cB* is the considerable fore-and-aft projection of the trochanter which, in a smaller bone, gives a greater width of the postero-external trochanteric surface than in the larger femur of *Genyornis.*

TABLE showing comparative measurements of the femora of *Genyornis newtoni, Dinornis maximus, Pachyornis elephantopus,* and *Dromornis australis.*

	Genyornis newtoni. No. 1.		*Genyornis newtoni.* No.2.		*Genyornis newtoni.* No.3.		*Dinornis maximus.* Owen.		*Pachyornis elephantopus.* Owen.		*Dromornis australis,* Owen.	
	Ins	M	Ins	Mm	Ins	Mm	Ins	Mm	Ins	Mm	In	Mm
Length	13 3/8*	339	13 5/8*	345	13*	322	18 1/4	462	13	329	11 ½*	291
Breadth of proximal end	6 3/8*	161	7 1/8	180	6 3/8	161	6 1/2	164	5_10/12	147	5 ¼*	133
Breadth of distal end.	7*	177	6 3/4	171	6 3/8	161	7 1/2	190	5 11/12	149	5*	126
Circumference at middle	9 ¼*	234	9 1/4	234	8 5/8	218	9 1/2	240	7 3/4	196	6 3/4	171

For convenience of reference the measurements are given both in inches and millimetres.

The asterisk indicates that the measurements so marked are slightly curtailed by reason of abrasion of the bones.

Nos. 1 and 2 of *Genyornis* represent a pair of bones.

The dimensions of *D. maximus, P. elephantopus,* and *Dromornis* are from Professor Owen's Table of admeasurements, Trans. Zool. Soc., vol. VIII., p. 371.

The *Tibio-tarsus,* which, in point of size, may be compared with that of *Pachyornis elephantopus (vide* Table II.), is brought into line with thc Dinornithidae by the presence of a supra-condyloid extensor bridge, but this is, in *Genyornis,* nearly median in position, instead of being near the inner border as in the former family.

The statement previously made, which assigned the Mount Gambier and Paroo River tibiae to *Genyornis* now requires some further explanation. For, in Professor Owen's description of the former fossil, * he states that of the "bridge there is no trace … and

* Trans. Zool. Soc., vol. X., p. 187; also Extinct Wingless Birds of N.Z., Appendix, p. 5.

+. *Op. cit.,* p. 131.

there is no evidence of fracture of the piers of such a bridge. The margins of the groove whence the bridge springs in *Dinornis* are in *Dromornis* broadly convex and entire." And again, in Mr. Etheridge's paper so frequently referred to,+ it is stated, in speaking of the Paroo River fossil, that "The rounded edge of the precondylar groove at that point in the present bone, whence in *Dinornis* the piers of the bony bridge, or oblique bar would spring, are much worn away, and would at first convey the impression that a similar structure had here existed. By following- the general contour of the groove, however, and comparing with this the mechanism in a *Dinornis* tibia it is quite apparent that such a structure could not have existed in the present instance, and that we are therefore dealing with a true *Dromornis* bone." Now the precision of these statements and the sources from which they emanate are of such a character that it requires some assurance to suggest that they have been made in error. Further, we should have ourselves to admit that, had our own notice been based upon some of the Callabonna bones, we should have been compelled to make a similar assertion as to the absence of a bony bar. We have specimens in which the margins of the groove at the site of the bridge are so worn as to leave no trace of the previous existence of such a structure. Fortunately, however, in one specimen the bridge is *in situ* and perfect in its form and attachments; in two others the osseous attachment to one pier is intact though, on the opposite side of the groove, a narrow gap, extending though the whole width of the bar, separates the end from its corresponding pier; in others, though the bridge itself is absent,· the condition of the margins clearly indicates its former existence. Mr. Pittman, Director of the Geological Survey of New South Wales, has very courteously forwarded the Paroo River fragment for our examination, and we find that the appearances presented by the piers in this bone are exactly paralleled by those of some of the Callabonna tibiae. We have, therefore, no hesitation in asserting that the bar was once present in this bone also.

As to the Mount Gambier specimen described by Professor Owen, we are only able to refer to his plate. The margins of the groove where the bridge ought to be are there certainly shown as in a very worn condition, but not more so than in some of our own specimens, while there is so close a correspondence in other details of the bone that we have no doubt of its identity with the tibio-tarsus of *Genyornis*.

In the latter bone the inward deflection of the tendinal groove, which takes place just at the place where it is spanned by the bridge, it is much more abrupt than we find in any of the Dinornithidae. The Callabonna tibia is, moreover, characterised by a very marked inflection of the lower end of the shaft, and particularly by the incurvature of its inner border-these features being markedly in excess of those which obtain in *Pachyornis*. Very conspicuous features of the *Genyornis* tibia are the massive proportions of the cnemial process, the elevation above the articular surface to which it reaches, and the marked recurvature of the ecto-cnemial ridge to the extent of forming what might be appropriately described as a hamular process. In this combination of characters there is a much greater resemblance to the emeu than to the Dinornithidae .

TABLE II.

TABLE showing comparative measurements of the tibio-tarsi of *Genyornis newtoni* and *Pachyornis elephantopus.*

	Genyornis newtoni		*Pachyorninis elephantopus,* Owen	
	Inches	Mm	Inches	Mm
Length	23 3/4	602	24	608
Breadth of proximal end	7 5/8	193	7 5/12	187
Breadth of distal end	4	101	4 1/6	105
Circumference at middle	6 3/4	164	6 5/12	162

The *Genyornis* tibia belongs to one of the larger pair of femora of the preceding table,.. and the measurements of that of *P. elephantopus* are from Owen's table previously referred to.

The *Tarso-metarsus* equals in length that of *Dinornis novm-zealandim (ingens),* Owen, but its latitudinal measurements are superior to the latter, in all respects except in tbat of the width of the distal end. Bevond this relative narrowness of the combined trochlere these elements are, in *Genyornis,* distinguished by their inequality of size-the inner being only half the width of the outer and very slightly shorter, and the outer only two-thirds of that of the mid-trochlea. The surfaces that bound the trochlear interspaces are markedly concave, and there are two perforations through the bone just above the outer trochlear interspace. In these features there is a closer resemblance to the emeu than to the cassowary,* in which latter there is nearly equality of size between the inner and outer trochlear and no perforation in the interspace, while in the former there is a single perforation. In general proportions, however, there is a nearer approach to the latter bird than to the more slender legged emeu. The marked trilateral chara0ter of the transverse section of the upper-half or two-thirds of the bone, and the deep longitudinal grooving of the corresponding anterior surface, constitute conspicuous features and, to some extent, further points of resemblance to both emeu and cassowary. The hypotarsus is thick, prominent and undivided.

No sign of the attachment of a hallux appears.

TABLE III.

TABLE showing comparative measurements of the tar-so-metatarsi of *Genyornis newtoni, Dinornis novæ-zealandiæ (ingens),* Owen, and *D. gracilis,* Owen.

	Genyornis newtoni		*Dinornis novæ-zealandiæ,* Owen (*D. ingens,* Owen)		*Dinornis gracilis,* Owen	
	Inches	Mm	Inches	Mm	Inches	Mm
Length	13 ¾	348	13 ¾	348	13	329
Circumference at middle	5 3/8	135	4 ½	114	4 ¼	107
Breadth (transverse) of distal end	3 ½	88	4 ½	114	4 ¼	107
Transverse breadth at middle	1 7/8	47	1 7/12	40	1 7/12	40
Antero-posterior breadth at middle	1 ½	38	1 ¼	32	1 1/6	30
Breadth of proximal end	3 ¾	95	3 ½	88	3 1/3	84

**Casuarius australia*

The *Genyornis* tarso-metatarsus does not belong to the same bird as the femur and tibio-tarsus. The measurements of the other bones are from Owen's table.

Toes.-The toes of the tridactyle foot are remarkably short in comparison to those of the Dinornithidae, the middle one being only just as long, and the inner and outer hardly more than an inch longer than the respective digits of the emeu. In relative size they conform to the proportions of the corresponding trochlere, and in the great slenderness of the inner toe we have another point of resemblance to *Dromæus*. This digit is further characterised by the lateral compression and great relative length of its proximal phalanx; the length of the three proxin1al phalanges of an average specimen being, as follows :-Inner, 80 mm.; middle, 73 mm.; outer, 65 mm. The phalanges of the middle and outer toes, on the contrary, are characterised by their breadth and depression. The ungual phalanges, in particular, are small, short and flat-features which are in marked contrast with the long, pointed and curved, conical claw-bearing phalanges of the Dinornithidae, or even of those of the emeu and cassowary. In conformity with the shape of the constituent segments (except in th0 case of the inner toe) the surfaces of the phalangeal joints are characterised by their transverse width and low vertical height; by their comparative flatness, and by the insignificance of the depressions for the lateral ligaments-a combination of characters which indicate weakness of the toes, in addition to the shortness and feebleness of the claw-bearing phalanges.

One other important feature remains to be indicated. From all other ratitite forms, and from nearly all other birds, the outer toe of *Genyornis* differs in possessing only four segments in place of five. Of this unusual feature the one of us who gathered the bones assured himself repeatedly by counting them *in situ*.

Sternum.--The restoration of this bone is not yet quite completed, but, so far as can be seen in shape and proportions, it resembles that of the emeu more closely than it does that of the cassowary, while it differs considerably from that of the Dinornithidae. We think we may confidently assert that neither lateral xiphoid processes nor median post-axial notch exist. The actual dimensions may be thus approximately stated :-Extreme length, 12 inches; extreme transverse breadth, allowing for a slight deficiency, 10 inches.

Wing.-By the fortunate recovery of several elements of wings we are able to establish the possession of small appendages of this character for Genyornis. The humerus, radius, ulna, two metacarpals and one phalanx are represented either by complete bones or by fragments. The whole length is approximately 9i inches, and the proportions, on the whole, more nearly those of the emeu than the cassowary.

Head.-As to the skull, of which both specimens obtained are unfortunately in a very dilapidated condition, we prefer not to speak at present, except to indicate its large size. The total length of the skull is 11 1/2 inches, that of a large emeu and ostrich being respectively 6 1/8 and 8 inches.

As concerns the size of the lower mandible, from which feature the bird has received its name, we may mention that the length of the ramus, slightly imperfect at its posterior extremity, is 10 1/8 inches, and its width at the widest part 2 1/2 inches. The symphysial depth is 1 1/2 inches, For a large ostrich and emeu the corresponding measurements are respectively, in inches, 7 1/4, 3 1/4, 5/8; and 5 ¾, 3, 7/16. The transverse span, posteriorly, of the lower mandible is, at least, 6 inches, while that of the ostrich and emeu is 3¼ and 3 inches respectively.

Thus far, in our brief description, we have made comparisons only with Australian and New Zealand struthious birds existing and fossil. Two other extinct forms invite comparison, viz., *Gastornis parisiensis,* from the Eocene beds of Meudon, near Paris, and the *Æpyornis maximus,* of Madagascar; but, for the present, we must content ourselves with saying that, though in that characteristic part-the lower end of the tibia-there are points of resemblance between *Genyornis* and *Gastornis,* yet, so far as can be judged by reference to plates and descriptions, which are our only means of comparison in the case of *Gastornis,* we believe the differences in respect both of the characters of the femur and tibia-tarsus, to say nothing of the difference of geological horizon, are sufficient to preclude even a generic association between the two forms.

Between *Genyornis* and *AEpyornis* there are many conspicuous points of difference; though it is noteworthy that, in point of great breadth as compared to length, the femur of *Genyornis* makes a nearer approach to that of *Æpyornis maximus* than the thighbone of any other bird with which we are acquainted.

REMARKS

Though, in the absence of a careful study of so important a part of the organization as -the head, it is perhaps premature to offer decisive opinions as to the habits of *Genyornis* or of its affinities with existing members of its group, nevertheless the following provisional conclusions appear to be justified by the survey of its remains as far so this has been made.

The great size of the femur and tibio-tarsus, no less than of its sternum, indicate its massive build, though there is a strange disproportion between the proportions of the upper leg bones and the relatively slender tarso-metatarsus. Its legs combine a huge femur nearly as massive, in all but length, as that of *Dinornis maximus,* and a tibia equalling that of *Pctchyornis elephantopus* with the relatively slender metatarse of *Dinornis novœ-zealandice .(ingens)* and toes which are insignificant beside those of any of the larger moas. The absence of prominent rough surfaces or ridges for muscular attachment, lead one to assign to it a slow sluggish habit. In height it may be confidently stated to have been from 6 feet· to 6 feet 6 inches, that is if the neck should have been of proportions similar to those of *Pachyornis elephantopus.* With the large size of the head, however, may be correlated .modifications of the neck The small flat ungual phalanges would appear to have borne flattened nails, rather than sharp and powerful claws, which could have been of little service for scratching purposes and with this feature is associated an evident want of strength in the phalangeal joints.

There is reason to believe that the *Diprotodon* may have been a swamp-loving animal which, tapir-like, haunted the shores of the lacustrine areas of Central Australia in Pliocene times, and the association of the remains of *Genyomis* with those of *Diprotodon* suggest that the bird, too, may have had its haunts, and found its food, by the same swamps as its bulky marsupial associates. The thickness of the lower jaw is scarcely commensurate with its great length and depth, and this fact, with the weakness of the toes, suggest that, like the emeu, herbage, rather than roots, may have formed its food.

In the course of our brief description and comparisons it will have been seen that the resemblances to the emeu and, to a less extent, to the cassowary are many and considerable; the presence of the bony bridge being, however, a conspicuous, if not morphologically important, point of difference. Of greater significance is the reduction of the number of segments of the outer toe from the normal five to four, which fact must oppose the view that *Genyornis* stands in the direct ancestral line of the existing Megistanes. For the segment in question once having been dropped it seems impossible that, it should have been re-acquired by the later forms. These facts however not withstanding, the emeu, so far as we have proceeded, would appear to be the nearest ally of the fossil, though there are undoubtedly resemblances, other than in respect to mere bulk, to the Dinornithidae. To these points however we shall have to recur.

As will be seen in Table 1. certain differences in size exist between the femora of two individuals, and these are not confined to that bone; but we do not believe that, either in this respect or in the details of structure, there will be found grounds for thinking that more than one species is represented in the Callabonna collection.

Of its relations to existing forms, other than those of the ratitite type which have been mentioned, it is premature to speak; such facts will emerge with greater certainty and completeness on a study of the head, the restoration of which-a long and tedious task-is approaching completion, though, unfortunately, it is in a very imperfect condition, and the same may be said of the pelvis. In the meantime we believe we have, in this preliminary notice, sufficiently indicated, though in a manner less complete than we could have wished,. the interesting nature of the discovery at Callabonna, not only as affording additional evidence, in so much more complete a form than has hitherto existed, of the wide range in Australia of this race of great extinct birds, but also as bearing upon the phylogenetic relations of the sub-class to which it belongs, as well as possibly on the question of the former distribution of land in the Southern Hemisphere.

These points, however, must be left to a subsequent communication, and, perhaps, to those with ft wider range of knowledge than is possessed by the authors of this paper.

OSTEOLOGY

FEMUR.*

Pl. XIX.

Of these bones three only are in anything like perfect condition. A fourth, though nearly entire, is much flattened by antero-postorior compression, and others are still more distorted or imperfect. That which has principally served as the type for description is No.3 of Table I. Though somewhat smaller than the members of the large pair comprising Nos. 1 and 2, it is in a better state of preservation than either of the latter-indeed, save for slight abrasions affecting the summit of the trochanter and for depressed areas on the upper part of the hinder, and on the lower part of the front surface, the anatomical details are almost perfect.

The head approximately equals, but does not exceed. the proportions of a hemisphere; and the part corresponding to the neck is but feebly defined by a very trifling constriction, which does not, however, involve the superior aspect. The non-articular part of the under surface of the neck, as it ascends, encroaches somewhat on the otherwise nearly hemispherical head. The depression for the round ligament is shallow, and situated well upon the upper surface of the head (pl XIX, fig. 3 A). The superior articular surface, after descending from the summit of the head, ascends, as it recedes outwardly to cover the trochanter, with a very gradual and slightly curved incline [t] (pl. XIX., fig. 2 c-a feature which is in marked contrast to the more abrupt and steeper rise of this process in the Moas. Nevertheless, owing to the great lateral width of the upper extremity of the bone and the consequent length of the incline, the summit of the trochanter, even in its slightly abraded condition, reaches to quite as great a relative height above the head, as in the New Zealand birds.

When a proximal view of the superior extremity is presented (pl. XIX., fig. 3) it will be seen that there is no projection posteriorly of the hinder surface of the trochanter, such as there is both in the New Zealand Moas and in *D. queenslandiw.* Thus, whereas in the last named birds and, to some extent also, in *Dromornis,* the posterior margin of the upper articular surface forms a well-marked indented curve. In *Genyornis*, however, it forms nearly a straight line up to the point where the contour of the trochanter sweeps forward (pI. XIX., fig. 3, *upper border of figure).* The same figure will indicate the manner in which the mass of the trochanter (B) is projected forwards and outwards.

In the Dinornithidae the pre- meets the postero-external trochanteric surface at an acute

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* The order in which the bones are described in this section has been chiefly determined by their condition. The segments of the leg and foot being, generally speaking, in a state that admitted of comparatively easy and speedy repair, it has been more convenient to begin the descriptive osteology with them than with parts of greater taxonomic value. Of the axial skeleton such important portions as the skull and pelvis were so damaged as to require the expenditure of more time and labour than could at first be bestowed upon their restoration. It is hoped, however, that the description of the remaining available parts of *Genyornis* may be completed in the next issue of these Memoirs.

t In pl. XIX., fig. 1, the steepness of the ascent of the trochanteric part of the articular surface is much exaggerated owing to the foreshortening, in the photograph, of the anterior projection of the mass of the trochanter itself.

angle, and the crest, corresponding to their line of union and terminating below in the ectotrochanteric tuberosity, is sharp, prominent and laterally compressed. In *Genyornis*, on the other hand, the conditions may, perhaps, be best described as being such as are produced by the inclination towards one another of two plane, or, at most, of very slightly concave, surfaces (pre- and ecto-trochanteric) at little less than a right angle, the angle along the line at which these two surfaces E:eet being at the same time broadly rounded off, instead of forming a prominent crest. Thus, though the anterior production of the trochanter is considerable, the process lacks the lateral compression, which is a conspicuous feature in all the dinornithine femora to which we have access. An obscurely indicated rough surface, rather than a distinct ecto-trochanteric tuberosity, marks the subsidence upon the shaft of the anterior trochanteric prominence (pl. XIX., fig. 1 E T). The pre-trochanteric surface (pl. XIX., fig. 1 D) is nearly flat, and does not present an oblique line or ridge, nor the conspicuous sub circular area for muscular attachment, which is shown in various dinornithine femora. The latter feature may, however, be represented by an irregular elevation, obscurely represented in pl. XIX., fig. 1, at the junction of the anterior and inferior surfaces of the neck close to the head.

From the absence of production posteriorly of the trochanter, the width of its postero-external surface is relatively less than in the Dinornithidae and, though protuberant and roughly striated externally, it presents no marked depressions or elevations. On the outer surface of the trochanter an obscure, obtusely angular ridge runs from its summit obliquely down wards and backwards.

A feebly marked intermuscular ridge (pl. XIX fig. 1 F) beginning to the inside of the rough surface, which corresponds to the ecto-trochanteric tuberosity (Owen) descends vertically for two inches, and this inclines inwards to merge into a ridge which leads to the front of the ento-condyle. Immediately to the outside of the point where the inclination inwards takes place is a slightly elevated rough surface which is scarcely manifest in the figure.

The posterior surface of the upper expansion of the bone has undergone some amount of distortion by the depression of a considerable area of its outer crust (pl. XIX., fig. 2 G), but other femora show this tract and, indeed, the whole of the posterior surface to have been very flat. The posterior margin of the upper articular surface, as this begins tv rise on to the trochanter, projects considerably so as to form an overhanging ridge. Directly below this ridge is a large deep oval depression (pl. XIX., fig. 2 H) which is clearly a pneumatic orifice. Two large foramina, separated by a bony septum, lead from the bottom of the depression into the interior of the bone.

The shaft is remarkably smooth and, with the exceptions above mentioned, is devoid of the prominent muscular ridges, rough surfaces or elevations that characterise dinornithine femora; particularly, on the posterior aspect, is there an absence of lineæ asperæ. One very small nutrient foramen is present at about the centre of this surface.

A characteristic feature of this bone is the marked curvature of its internal contour (pl. XIX., figs. 1 and 2) in which respect it contrasts with the more open curve in the femora of *Dinornis* and *Drornornis.* The flatness of the posterior surface has been mentioned; to a hardly less extent the anterior and exterior surfaces are flat also, while the inner is rounded. Thus the transverse section in the middle of the shaft is a pyriform oval with the small end corresponding to the inner surface, or it might almost be described as trilateral.

The lower extremity, of which an area of the crust on the front surface has been depressed (pl. XIX., fig. 1 G), is, like the upper, characterised by its great transverse breadth -the smallest of the Callabonna bones exceeding, in this respect, the corresponding measurement of a femur of *Dinornis giganteus* (Owen), in the Museum collection, having a length of 380 mm., while the similar width in the largest approaches to within half an inch of that of *Dinornis maxirnus* (Owen) with a length of 462 mm. Conformably to the great width of the lower extremity is the brea~th of the rotular channel (73 mm.) (pl. XIX., fig. 4 R, C) ,which also slightly exceeds the breadth of this channel in a femur of *D. giganteus* (Owen). At the same time the channel is, in *Genyornis,* relatively shallow. The anterior intercondylar ridge is very slightly indicated (pl. XIX., fig. 4 N), while the posterior is narrow and prominent (pl. XIX., fig. 2, O); the region corresponding to the intercondylar fossa is prominent rather than depressed.

Owing to the gentle inclination of the posterior surface of the shaft, as it leads into the popliteal fossa (pl. XIX., fig. 2 J), this depression is ill defined as to its superior contours, and the external and internal ridges which bound it laterally are broadly rounded, especially the former. The floor of the fossa is flat, but rough, and there are large pneumatic orifices arranged in a row along the lower margin (pl. XIX., fig. 2, *above* 0). The larger depression seen at a higher level is probably accidental, as it does not appear to exist in the other femora. The open and shallow characters of the fossa in this bone contrast with the better defined, oblique, deep, and narrow cavity in *Drornornis.* Commensurate also with the great breadth of the lower end is the width of the ento-condyle (pl. XIX., fig. 4 I C), of which the contour of the posterior margin forms nearly a horizontal line (M) before it dips suddenly to become the internal margin of the posterior intercondyloid notch (K); the contour of this notch forms a U-shaped figure instead of a more open curve.

Of the ecto-condyle (E C) the tibial moiety is also relatively wide, exceeding, in this respect, the corresponding part in *Dinornis giganteus,* and the fibular groove is continued forwards for a considerable distance on to the front of the ecto-condyle; just behind the posterior limits of the groove there is an irregularly elongated ecto-condylar fossa (pl. XIX., fig. 2 P). The depression on the outer surface of the ecto-condyle is inconspicuous, beside that to be observed on most dinornithine birds. The ecto-condyle, moreover, when the bone is held vertically reaches a considerably lower level (1 1/2 inch) than the ento-condyle; thus to place the bone in such a position that the most distal part of each condyle rests upon the same horizontal level involves a very considerable obliquity of the shaft.

Except in respect to size, all the Lake Callabonna femora resemble one another so exactly, that there can be no doubt that they belong to the same species. We have elsewhere expressed the opinion* that two fragments of femora from Normanville and Baldina Creek, S.A., are also to be attributed to the same bird, but it should be stated that, though corresponding with the Callabonna femora in all anatomical details which are available for comparison, the former fragments are parts of bones of distinctly less size than the smallest of the latter, as shown by the fact that their circumference, at the part corresponding to the mid point of the entire bone, is nearly an inch and a half less. In the portion from Baldina Creek, however, enough of the bone exists to permit of a comparison in many detail8, and in these as stated, 110 essential differences can be detected.

TABLE I

SHOWING dimensions of femur of *Genyorns newtoni* compared with those of some other large fossil femora.

	Length.		Breadth of proximal end.		Breadth of distal end.		Circumference at middle.	
	Inches	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.
Genyornis newtoni, No. 1	13 3/8*	339	6 3/8*	161	7	177	9 1/4	234
Genyornis newtoni, No. 2	13 5/8*	345	7 1/8	180	6 3/4	171	9 1/4	234
Genyornis newtoni, No. 3	13*	322	6 3/8	161	6 3/8	161	8 5/8	218
Dromornis australis, Owen	11 ½	291	5 1/4*	133	5	126	6 3/4	171
Dinornis rnaximus, Owen	18 ¼	462	6 1/2	164	7 1/2	190	9 ½	240
Pachyornis elephantopus, Owen	13	329	5 10/12	147	5 11/12	149	7 3/4	196
Æpyornis maximus, Geoffroy	12 5/8	320	6 5/8	170	7 1/2	190	10 5/8	270

For convenience of reference the measurements are given both in inches and millimetres.

* The asterisk indicates that the measurements so marked are slightly curtailed by reason of abrasion of the bones.

Nos. 1 and 2 of *Genyornis* represent a pair of bones-the largest in the collection.

The measurements of *D. maximus* and *P. elephantopus* are from Professor Owen's Table of Admeasurements, Trans. Zool. Soc., vol. VIII., p. 371; those of *Æpyornis* from "Recherches sur la Faune Ornithologique Eteinte des Iles Mascaréignes et de Madagascar," A. Milne Edwards et A. Grandidier, p. 96; and those of *Dromornis* partly from Owen's description (Extinct Wingless Birds of New Zealand, Appendix, p. 2) and partly from a cast.

TIBIO-TARSUS.

Pl. XX. and Pl. XXI., figs. 1-3.

Of these bones two only, viz., those belonging to the large pair of femora, Nos. 1 and 2 of Table I., are undistorted and nearly perfect, having suffered only some abrasion of the procnemial crest; in two others the full length has been preserved, but they are considerably crushed and distorted. In four it has been possible to restore the whole length of the shaft,

Trans. R. Soc., S.A., vol XX., p. 175 and page 44 of this Memoir but the processes of the upper extremity are absent. The remainder, sixteen in number, are represented only by the lower end, usually in good condition, with more or less of the shaft.

The ento-condylar surface of the proximal end (pl. XX., fig. 3, I C) is suboval, and nearly flat in its longer axis which is directed obliquely from behind forwards and inwards. In the shorter axis it is slightly concave.

The ecto-condyle (pl. XX., fig. 3, E c) is smaller in size, markedly convex and oval, with its longer axis nearly at right angles to that of the ento-condyle. An ill-defined intercondylar channel, scarcely to be distinguished in the figure, separates these two surfaces, posteriorly, and follows the contour of the ecto-condyle in a direction forwards and outwards to the ecto-cnemial cavity (pI. XX., fig. 3, J). There is a prominent smooth intercondylar eminence (pl. XX., fig. 3, A), the inner slope of which forms part of the entocondylar surface. The eminence also bounds the intercondylar channel in front and, in part, the cnemial or rotular channel (B) posteriorly. The posterior margin of both articular surfaces overhang the shaft considerably.

In front of the cnemial channel, which is wide and shallow, the massive cnemial process (pI. XX., figs. 1 and 3, pl. XXI., figs. 1 and 2) rises to nearly three inches, measured vertically, above the level of the articular surface, this great height of the process being contributed to by the extension of the upper end of the procnemial ridge (F) above the level of the epicnemial crest (E) (pl. XX., fig. 1, pI. XXI., figs. 1 and 2). The former ridge is thick at its upper part, but soon narrows, as it descends, to a much, laterally, compressed crest (pl. XX., figs. 1 and 3, pl. XXI., fig. 1, F), which, even in its somewhat damaged condition, is very prominent; this is continued down the front of the shaft to a point nearly six inches below its summit. About this point the crest subsides to a low, but still well marked, ridge, which is continued obliquely downwards and inwards till it almost reaches the inner margin of the anterior surface of the shaft at a little below the middle of the bone (fig. 1, K, K). From this level the ridge extends vertically downwards for about four inches, but with diminished prominence, lying just external and parallel to the inner margin of the front surface of the shaft. Finally the ridge again acquires prominence, inclines outwards and eventually becomes continuous with the inner border of the supracondylar extensor groove (figs. 1, 6, L).

The epicnemial crest (using the term to include the whole upper border of the cnemial process, exclusive of the procnemial summit), when viewed proximally, forms an open sigmoid curve (pl. XX., fig. 3, E, E, H), which is so inclined that its lower and outer end is considerably below the level of its upper and inner. The former terminates by a marked backwardly directed curve (H). In fact, the external angle of the cnemial process might be described as forming a backwardly directed hamular process, the inferior border of which forms the beginning of the ectocnemial ridge (pl. XX., fig. 1, pl. XXI., fig. 2, H G). This ridge, or crest, is continued downwards, with an inward trend, to a point which lies about four inches below the point of the hamular process; here it subsides upon the shaft, having at its termination approached to within an inch of the procnemial ridge.

Internally the cnemial process is bounded by a thick and rounded border (pl. XX., fig.

3, pl. XXI., fig. 1, D) formed by the meeting of its posterior surface with the internal·surface of the procnemial crest. This border descends abruptly from the summit of the process, but with an inclination backwards and inwards, On meeting the upper expansion of the bone this descending border becomes continuous with the adjacent, somewhat elevated and ridge-like anterior margin of the inner part of the rotular channel. There is thus no considerable extension of the epicnemial crest beyond, and to the inside of, the procnemial as in the Moas; the latter ridge, in fact, springs from the interior surface of the former quite close to the thick and abruptly descending inner border that has been described.

Owing to the posterior incurvation of the angle formed at the junction of the epicnemiaJ and ectocnemial crests, the ectocnemial cavity, lying between this angle and the outer margin of the ectocondyle, forms a deeply indented bay (pl. XX., fig. 3, J), of which the extremities approach one another to within two and a half inches.

No distinct supra-fibular facet is observable; in fact, when the fibula, which nearly certainly belongs to one of the large pair of tibio-tarsi, is placed in position, the head of the former does not touch that of the latter by nearly half an inch. The fibular ridge begins, as a low rising, two inches below the over-hanging external edge of the ectocondylar surface, the interval being smooth and deeply concave in a vertical direction. An inch and a half below its beginning the ridge widens into a rough and nearly flat elevated surface, of fusiform outline, for articulation with the fibula (pl. XXI., fig. 2, 0, 0). This surface, which is four 'inches long by five-eighths of an inch broad, appears to represent the whole extent of the direct articulation between the two bones. A smooth interval of about an inch succeeds this surface, and below this again an ill-defined, broad, rough ridge that represents the external surface of the shaft, proceeds to the lower outer condyle. The opening of a large nutrient artery, directed distalwards, to which a groove leads from above, lies just behind the lower end of the articular surface that has been described.

On the antero-internal aspect of the upper expansion of the bone an obtusely angulated ridge descends for four inches from the corresponding margin of the articular surface. This ridge terminates in a roughened convex tuberosity (pl. XX., fig. 2, p). The tract between this ridge and the procnemiai crest is nearly fiat, or only very slightly concave; in its upper part where the surface is uninjured; the lower part has suffered some depression from injury.

Above the level of the (lower) fibular articulation the shaft is sub-quadrangular in shape, and at the same time somewhat antero-posteriorly compressed. This latter characteristic continues throughout the rest of the shaft, but below the fibular surface the sub-quadrangular section becomes more of a pyriform oval, the smaller end being external; at the lower end of the bone the section tends to become again somewhat quadrilateral. The lateral width which, at the upper level of the fibular articulation, is 3 1/8 inches, diminishes in the descent to 2 1/2 inches at the narrowest part of the bone, which is 5 inches above its lower end; below this there is a slight increase of width as the shaft expands into the condyles.

There is also a slight diminution of the antero-posterior diameter of the shaft in passing from above downwards.

At a little above the point at which the bone has been described as narrowest, laterally, there begins a marked deflection, inwards, of the lower end of the shaft, and the inflection affects the inner border to a greater extent than the outer. The result is to cause a considerable production inwards of the inner condyle. There is, at the same time, a slight but marked deflection forwards of the lower extremity. These features are shown in the whole length figures of the bone on plate XX.

Of the lower expansion the inner condyle projects more, both anteriorly and posteriorly, particularly in the former direction, than the outer (pl. XXI., fig. 3, I C). The whole antero-posterior width of the former is also greater than that of the latter (93 mm. to 73 mm.). In lateral breadth the condyles are nearly equal. Held with the long axis perfectly vertical, the ecto-condyle (E C) reaches a slightly lower level than its fellow (pl. XX., figs. 1, 2).

When the two condyles are held at the same horizontal level their articular surfaces ascend in front to about the same degree, but th8 upward extension of the inner, besides its greater prominence anteriorly, preserves a more uniform width than that of the outer, which latter, as it ascends, becomes reduced to a narrow tract (pl. XX., fig. 4, E C). The superior contour line in front of the conjoined articular surfaces, though sufficiently distinct to form the inferior boundary of the supracondylar space, does not form so marked a ridge as in the Moas. Posteriorly, the corresponding contour line (not very distinctly marked and not distinguishable in fig. 2 of plate XX.) slopes downwards and inwards from the summit of the outer condylar region to that of the inner, where it becomes continuous with the compressed and projecting postero-external ridge in which the inner condyle terminates behind.

When viewed from the distal aspect the intercondylar channels, in front and behind, yield contours, the forms of which are seen in pl. XXI., fig. 3. The same figure shows the greater extent of the anterior production of the inner condyle, but it does not show very conspicuously another character which is to be noticed, viz., the greater lateral width of the combined trochlear surface in front than behind, the last mentioned feature being duo to the fact that as the infero-internal border of the inner condyle sweeps backwards it also inclines outwards trending towards the corresponding border of the other side, the curve of which scarcely departs from a true antero-posterior plane. The degree of curvature of the inferior contour of the trochlear surface is shown in pl. XX., figs. 1, 2, 4.

The greater part of the front of the inner surface of the ento-condyle is occupied by a large gibbous or nearly oval depression of which the margin, anteriorly and inferiorly, comes right up to the edge of the articular surface. (Pl. XXI., fig. 1, Q.) Behind the depression, about midway between the anterior and posterior borders of the condyle, is an obtusely rounded epicondylar tuberosity (R) which is not very prominent, and scarcely projects beyond the plane of the lower border of the condyle.

The external surface of the outer condyle (pl. XXI., fig. 2, E C) is nearly flat, or only very slightly concave, over its whole extent, and possesses no epicondylar tuberosity.

The supra-condylar extensor groove (pl. XX., figs. 1 and 4, *between* M *and* L) may be discerned as commencing about six inches above the condyle on the outside of the ridge (K) described as leading downwards from the termination of the procnemial crest. The ridge is, in fact, continuous with the inner border of the groove. (Fig. 4 KL.)

As the groove descends it deepens, and inclines outwards until it reaches the mid line, at which point it is spanned by the bridge (pl. XX., fig. 4, S). At this level the groove is deflected inwards at a somewhat abrupt angle and, below the bridge, the groove is distinguishable as a broad, shallow canal, which emerges into the wide, but not deep, supra-condylar fossa. Of the borders of the groove, the inner (L) is the more prominent and rugose, and the outer (M) smooth. The bridge itself, median in position and placed very obliquely, stands prominently forward, especially in regard to its lower edge.*

The width of the bridge is 15 mm. at its outer end, from which point the breadth increases towards the inner side, the increase being due to the increasing obliquity of the upper border. Owing to the loss of a small piece which has. been chipped out of the upper border near the inner pier the ·width at this end cannot be exactly stated, but would appear to have been 19 mm. The lower border of the bridge is considerably thicker than the upper and somewhat everted. The lower outlet is oval, and its plane looks downwards and inwards, while the upper outlet forms a shorter, as well as narrower, oval than the lower.

In the canal covered by the bridge is a large pneumatic foramen which encroaches on the outer pier.

Close to the outer edge of the bone, and on a level with the outer pier, is a rough, obtusely conical tuberosity (lI. XX., fig. 4, T). In conformity with the more median position of the bridge, as compared with *Dinornis,* that tract of the lower expansion which lies internal to this structure, is much wider in *Genyornis* than in the New Zealand genus, and the continuation of this tract below the bridge, which forms the incline into the supra-condylar fossa, is in the former broad and somewhat convex transversely, in contrast with the condition in *Dinornis,* where it is pinched into more or less of a ridge. The distance from the middle of the lower border of the bridge to the nearest point to the internal condyle is 28 mm.

The dimensions of one of the large pair of tibio-tarsi are shown in Table II. Owing to the absence, or distortion, of parts of the upper end, it is impossible to state accurately the length in the great majority of specimens. That feature which is most perfectly preserved in nearly all of them is the lower end, and we therefore use the lateral width

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* The bridge is absent in both of the pair of large and nearly perfect tibio-tarsi, of which one has been principally used for illustration, and, in fact, from all but four of the specimens. The details respecting it are therefore taken from another (that represented in fig. 4, pl. XX.), comprising only the lower extremity and part of the shaft. In this the feature in question is perfect except for a small piece which has been chipped out d its upper border. Vide Trans. Roy. Soc. S.A., Vol. XX., p. 185, and p. 52 of this Memoir.

dimension of this for the purposes of comparison III point of size. We find that among 24 tibio-tarsi in which perfection of the lower end permits accurate measurement to be stated, the width varies from four inches, in the largest example, to three and a, quarter in the smallest All but eight have a greater measurement than three and a half inches, and in none of the bones is there any evident sign of an immature condition.

TABLE II

SHOWING dimensions of tibio-tarsus of *Genyornis newtoni* in comparison with those of the tibio-tarsi of *Pachyornis elephantopus,* Owen, and *Æpyornis maximus,* Geoffroy.

	Length.		Breadth of proximal end.		Breadth of distal end.		Circumference at middle.	
	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.	Inches.	Mm.
Genyornis newtoni	23 3/4	602	7 5/8	193	4	101	6 3/4	171
Pachornis elephantopus, Owen	24	608	7 5/12	187	4 1/6	105	6 5/12	162
Æpyornis maximus, Geoffroy	25 1/4	640	7 1/2	190	5 5/16	135	6 1/4	155

The *Genyornis* tibia belongs to one of the large pair of femora of the preceding table. The measurements of that of *Pachyornis elephantopus* are from Owen's tables and of that of *Æpyornis* from the work of Milne Edwards and Gntndidier, previously quoted, p. 93.

FIBULA.

Pl. XXI., figs. 4 and 5.

This bone presents the usual laterally sub-compressed and backwardly produced head, The superior articular surface-that upon which the femur plays-is an elongated oval, slightly concave antero-posteriorly, and nearly flat transversely. It is not coextensive with the whole upper surface of the head, but leaves a non-articular area in front which slopes more abruptly downward and forward. Lying obliquely athwart the internal surface of the head is an elongated depression or groove (pl. XXI., fig. 5, A) which is directed towards the edge of the articular surface of the tibio-tarsu':l, t.hough the absence of a distinct corresponding facet on that bone has been mentioned. Externally the head is also slightly concave in antero-posterior direction,

The upper part of the shaft is sub-compressed in the same dil'ection as the head, but soon becomes sub-circular in section, A little below the head, on the anterior surface, is a small tuberosity. With the commencement of the lower articular surface for the tibio-tarsus, about five inches below the summit, the shaft increases in size, becoming at the same time sub-triangular in section, the outer surface being convex, the postero-internal nearly fiat, and the anterior surface somewhat concave.

The lower articular surface for the tibio-tarsus (fig. 5, B) is an elongated rough area about three inches. in length, which at its upper part is provided at the expense of the internal angle of the, in this situation, trilateral shaft, but as it descends it encroaches more and more upon that surface of the shaft described as postero-internal till it comes to occupy nearly its whole width. A rough oval tuberosity (fig8. 4 and 5, C) is developed upon the posterior border of the shaft a little below the level of the commencement of the articular surface, and below this there is a gradual reduction in the size of the shaft which, moreover, loses its trilateral character. Below the articular surface the shaft assumes the form of a cone, which in most of the specimens tapers rather abruptly to n blunt point. In the longest specimen the taper is more gradual, and the length below the articular surface, in this, is consequently greater.

The length of a large fibula, apparently complete as to its length, and of about the same size as an imperfect specimen belonging to one of the large tibio-tarsi, is 250 mm., while that of the smallest is 215 mm. The antero-posterior diameters of the heads of these two bones, measured obliquely in the direction of the longer axis, are 62 mm. and 50 mm. respectively. Seven fibulae, only, were collected, but these are all in good preservation with the exception of the lower pointed extremity which is broken off in most of them.

TARSO-METATARSUS.

Pl. XXII., figs. 1-4.

The ecto-condylar surface (pl. XXII., fig. 3, E C) is subquadrangular and flat, with a slight slope downwards as it extends outwards. That of the ento-condyle (fig. 3, I C) somewhat exceeds a semicircle in shape; its transverse diameter is about equal to, and the anteroposterior diameter greater than, those measurements in the ecto-condyle. In thc latter diameter it is slightly concave, and in the former greatly so, this character being principally due to the elevation of the inner margin into an elevated lip or crest (A), which rises a little higher than the anterior ento-condylar process and which frequently exhibits a slight degree of externally directed curvature (fig. 1, A). The intercondylar tract, marked at about its centre by a shallow depression, rises in front into an obtusely angulated intercondylar process (fig. 1, B).

On the posterior aspect of the upper extremity there is n single thick, prominent and undivided hypotarsus (pl. XXII., figs. 2 and 3, C) which rises above the articular surface as a sub conical prominence, and reaches to a somewhat greater elevation than the anterior inter-condylar process. The inner surface of the hypotarsus is marked by a shallow groove which begins a little below its summit and curves somewhat forward as it descends. This groove disappears under a broad but thin bridge of bone (fig. 2, D) which covers the opening of the posterior ent-interosseous canal, and below this it continues, more or less distinctly, for some distance down the postero-internal surface of the shaft

The hypotarsus extends, mesially, down the shaft as a broad angular ridge with gradually diminishing elevation, which, however, may be traced to within two inches of the posterior limits of the meso-trochlea. As the ridge subsides a shallow groove commences on its inner side (fig. 2, G), and leads to the inner trochlear interspace.

On the front surface of the upper expansion there is a large interosseous depression, with declivous sides (pl. XXII., fig. 1, E), the upper margin extending to within about an inch and a half of the summit of the anterior intercondylar process (B). At the bottom of this pit are the anterior openings of the interosseous canals. Immediately below this depression, and encroaching upon its inferior slope, is a rough vertically striated surface for attachment of the tibialis anticus (fig. 1, *between* E *and* F). Immediately below this rough surface is the upwardly directed opening of a nutrient artery (F), to which a slight groove leads from below.

Above the large depression into which the interosseous canals open interiorly, the surface of the bone is transversely concave, and below it) also, the whole of the front surface of the shaft is occupied by a wide groove which becomes narrower and shallower as it descends; at a little below the middle of the shaft the groove has disappeared, and the front surface is flat transversely, below this, again, the same surface becomes more and more transversely convex with the increasing prominence of the meso-tarsus. An ill-defined shallow groove on the front surface of the lower third of the shaft, scarcely to be distinguished in the figure, leads to the outer inter trochlear interspace.

On the outer surface of the head there is a prominent, antero-posteriorly flattened keel-like process (pl. XXII., figs 1, 3, H) which commences a little below the outer margin of the articular surface, and extends downwards as a crest, or ridge, for from two to two and a half inches. This crest and its ridge-like continuation forms the posterior boundary of a shallow groove upon the upper part of the outer surface of the ecto-metatarsus.

To the outer side of the hypotarsus is the large posterior opening of the ect-interosseous canal (fig. 2, J). The opening of its fellow on the inner side is, as has been stated, concealed by a bridge of bone. The upper margin of the bridge is above, and the lower below, the revel of the ect-interosseous canal.

Owing to the shape and prominence of the hypotarsus, the upper half of the tarsometatarsus yields a trilateral, indeed almost an equilateral, section, the front surface however being reentrant owing to its deep grooving. With the subsidence of the hypo tarsal ridge, the trilateral section passes into an oval, of gradually increasing transverse diameter, as the shaft descends. In the middle third the postero-external surface is marked by an obscure vertical ridge.

There is no trace of the attachment of a hallux.

Of the three trochleæ (figs. 1 and 2, L, M, K) the median (M) is conspicuously the largest, the external (K) the next in size, and the internal (L) the smallest. The width dimensions being, in a bone 350 mm. long, 43 mm., 31mm., and 14 mm. respectively. Their prominence anteriorly, and production inferiorly, are in the same order, though it is only the meso-trochlea which is produced, and that only to a slight degree, beyond the plane of the anterior surface of the shaft. Posteriorly all three trochleæ are produced to about the same level and to the extent of little more than half an inch beyond the plane of the posterior surface of the shaft immediately above them.

The meso-trochlea is widest at about the level of the tip of the ento-trochlea, the width, however, diminishing considerably from this point both in an upward and backward direction. The articular surface of this segment bears, from front to back, a well-marked median groove, plainly indicated in figs. 1, 2, and 4; its lateral surfaces, especially that on the outer side, are concave. Of the ecto-trochlea the anterior surface slopes backwards as it extends outwards, and bears a very slightly marked shallow groove, barely observable in the figures. Like the meso-trochlea, it diminishes in width from the commencement to the termination of its articular surface; its inner surface is concave, and on its outer surface is a subcircular depression. The small ento-trochlea preserves nearly the same width throughout its length; its anterior surface is con vex transversely; its outer somewhat concave, and, on its inner aspect, is a small, shallow depression. Corresponding to the diminishing width, posteriorly, of the trochleae themselves the trochlear interspaces are wider behind than in front, and that between the middle and outer segment reaches to a higher level than its fellow.

Just above the ecto-trochlear interspace are two foramina, situated vertically above one another; the lower is separated from the summit of the interspace merely by a thin bar of bone,* if while the other perforates the whole thickness of the lower expansion. The anterior orifices of both of these are shown in pl. XXII., fig. 1, N; in fig. 2 the posterior orifice of the upper one, only, is visible (N). The shallow groove, described as existing on the lower part of the front surface of the shaft, leads towards the upper of these foramina, In one specimen, only, a similar foramen exists between the meso- and ento-tarsus just above the internal trochlear interspace at a level corresponding to that of the upper of the two perforations on the other side.

Of the tarso-metatarsi collected twenty-one have been restored to a nearly perfect condition, and for most of these fairly complete sets, though not always natural series, of phalanges can be provided.

TABLE III.

SHOWING comparative measurements of tarso-metatarsi of *Genyornis newtoni, Dinornis novæ-zealandiæ (ingens),* Owen, *Dinornis gracilis,* Owen.

	Length.		Circumference at middle.		Breadth (transverse) of distal end.		Breadth (transverse) at midline.		Antero-posterior breadth at middle.		Transverse breadth of proximal end.	
	Ins.	Mm	Ins	Mm	Ins	Mm	Ins	Mm	Ins	Mm	Ins	Mm
Genyornis newtoni, No 1, largest specimen	14 3/4	374	5 1/2	139	3 7/8	98	1 7/8	47	1 5/8	41	4+	101
Genyornis newtoni, No.2; medium specimen...	13 3/4	348	5:' 8	135	3 1/2	88	1 7/8	47	1 ½	38	3 ¾	95
Genyornis newtoni, No.3; smallest specimen	12 5/8	320	4 3/4	120	3 1/2	88	1 ½	38	1 5/16	33	3 7/8	98
Dinornis novæ-zealandiæ (ingens), Owen	13 3/4	348	4 1/2	114	4 1/2	114	1 7/12	40	1 ¼	32	3 ½	88
Dinornis gracilis, Owen	13	329	4 1/4	107	4 1/4	107	1 7/12	40	1 1/6	30	3 1/3	84

* In a good many specimens this bony bar which forms the inferior boundary of the lower foramen has broken away.

+ Measurement slightly reduced on account of abrasion.

The *Genyornis* tarso-metatarsus (No.1) belongs to the large femur and tibia-tarsus of the preceding tables. The measurements of the Moa bones are from Owen's table.

PHALANGES

Pl. XXII., figs. 1 and 2, 5 and 6.

As recorded in the preliminary notes on this bird,*, while the inner and middle toes possess the usual number of segments-three and four respectively-the outer possesses only four in place of the normal five. Of this fact there can be no doubt, as they were repeatedly counted in situ; and, moreover, amongst the large numbers of sets of phalanges collected, there are none that would supply, or correspond to the missing segment. In this connection it is interesting to note that Captain Hutton mentions *Euryapteryx gravis,* Haast *(=Dinornis gravis, Owen=Emeus gravipes,* Lydekker) and *Euryapteryx ponderosa.,* Hutton, as, also, possessing only four phalanges in the outer toe (Trans. N.Z. Institute, vol. XXVIII., 1895, p. 637).

The extreme lengths of the three proximal phalanges, in a set of bones belonging to a right tarso-metatarsus 14 1/2 inches long, which were selected for description both on account of their perfection and for the fact that all the bones almost certainly belong to one another are as follows :-II., 1,+ 83 mm.; III., 1, 7.J mm.; IV., 1, 68 mm.; the length of the proximal phalanx of the inner toe is thus a characteristic feature of the foot. Besides its great relative length, *Phalanx II*., 1, is further characterised by its comparative slenderness and by the lateral compression of the greater part of the shaft (pl. XXII., figs. 1, 2, II.). Its proximal articular surface forms a regular, concave oval with the long axis vertical (fig. 6, II.). This elongated oval form of the articular surface determines the shape of the section of the proximal part of the shaft in which the lateral compression is most marked. From this distalwards, owing chiefly to the inclination of the superior++. border towards the inferior, the vertical axis of the section gradually diminishes until, just short of the distal articular expansion, the section becomes a figure that would be nearly circular but for some flattening of the inferior surface. The external surface is distinctly flatter than the internal, and on each side of the distal expansion is a shallow depression, that on the internal aspect being the smaller. The distal articulation forms a trochlear surface, of which the convexity, in a vertical direction, forms considerably more than a semicircle; transversely, it is slightly concave in its upper part, and markedly so inferiorly.

Phalanx II., 2, has an almost quadrangular outline when viewed dorsally. The section of the proximal articulation is sub-triangular, of which one angle is superior, and the base opposite somewhat convex and produced further backwards than the dorsal angle

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* Trans. Roy. Soc. of S. A., vol. XX., p. 188, and p. 54 of this Memoir.

\+ For the sake of brevity the ordinal rank of the digit will be indicated by a Roman (italic) numeral, and the number of the phalangeal segment by an ordinary (italic) figure. Thus II., Ill. and IV. will stand for the digits in their order from the inner side, and the expression Phalanx or Ph. II., 1, will indicate the first or proximal phalanx of the inner toe and so on.

++It may be as well to state that the terms superior and inferior are used in the text as indicating position relative to the horizontal plane of the foot regarded as resting flat upon the ground; they will thus, to this extent, have a significance similar to that of dorsal and plantar. Anterior and posterior will similarly imply position in reference to the fore·and·aft axis of the foot.

above it. The upper surface is somewhat saddle-shaped, being slightly concave longitudinally, and convex transversely, while the under surface is slightly concave in both axes. The section in the middle of the bono, thus forms a segment of a circle less than a semicircle. The distal articulation is somewhat crescentiform, of which the inferior margin, corresponding to the concavity, slopes backwards, and encroaches on the under surface of the bone. Small vascular canals exist on both superior and inferior surfaces.

Phalanx II., 3-the ungual phalanx-is a segment of variable length, but usually very short and depressed, slightly curved and obtusely pointed, haying on each side a more or less continuous vascular groove.

Phalanx III., 1, is distinguished by the height and breadth of its proximal, and by the breadth and depression of its distal, end. The contour of the proximal articular surface, of which the two principal diameters are nearly equal, is shown in pl. XXII., fig. G, III. Generally a low vertical elevation, present only in the inferior half, indicates a partial division into two facets, of which the inner is rather the larger. From the superior and inferior borders of this surface the upper and under surfaces of the shaft incline towards one another, the inclination being greater in the latter. In the middle of the bone the section is a transversely elongated oval, which becomes more flattened towards the distal end. On the under surface, a little in advance of the articular border, are two rough elevations which leave a shallow trough between them. The distal expansion is almost of the same lateral width as the proximal, but between the two ends the shaft is considerably narrower. The distal articular surface forms a trochlea of which the convexity in a, vertical direction exceeds a semicircle. A shallow median groove which extends in the same direction throughout its whole extent divides it into two convexities of about equal, lateral, width, though, in vertical depth, the inner considerably exceeds the outer. The lateral surfaces of the distal expansion are occupied by depressions, of which the inner is the larger.

Phalanx III., 2, approximates to a quadrangular contour when viewed from above, the length, however, being somewhat greater than the breadth. Its proximal articular surface is ovoid, with the larger end internal. A very slightly marked vertical rising obscurely indicates a division into two facets, both of which are concave vertically. Of these, the inner facet is slightly the larger. The shaft is very greatly depressed, the lateral diameter, just posterior to the distal expansion, being to the vertical as 31 mm. to 9mm. The distal expansion is also characterised by great breadth and small vertical height; its articular surface, which extends further back below than above, forms a trochlea, the groove separating the two convexities being very broad and shallow, and the inner moiety slightly the deeper in a vertical direction. A shallow depression for the lateral ligament exists on the outer side of the distal expansion, but it is only feebly indicated on the inner. There may be one or more nutrient foramina on the under surface.

Phalanx III., 3, is considerably broader than long, in the proportion of 34 mm. to 18 mm., and is, also, much depressed. The proximal articular surface is reniform with the convexity superior and, owing to a slight posterior production of the superior and inferior borders, particularly of the latter, this surface is concave, vertically, in the mid-line, but nearly flat on each side of this. The distal articular surface is sub-reniform, convex vertically, and encroaches slightly upon the inferior surface. The superior surface of the phalanx is rough and somewhat convex transversely, and the inferior is concave in both directions.

Phalanx III, 4.-This ungual phalanx, which forms an irregularly oval, concavo-convex plate, is broader than long, and does not greatly exceed in length that of its predecessor in the series. The plane of its proximal surface is inclined downwards and forwards, so that it encroaches on the under surface of the bone. The anterior border is broadly rounded. Two large vascular channels, the opening of one of which can be seen in fig. 5, enter just above each basal angle, and are directed forwards.

Phalanx IV, 1.-This segment has somewhat the same form as *Ph. III, 1,* on a smaller scale, the widths of the two bones at their middle points being as 21 mm. to 31 mm., and the lengths, as previously quoted, 68 mm. to 74 mm. Its proximal articular surface (pl. XXII., fig. 6, IV.) is concave and sub-triangular with the base inferior, the external angle, at the base, being more prominent than the internal. From each of these angles a rough, rounded ridge is continued forward, on the under surface, for a short distance. The upper surface is convex transversely, the inferior nearly flat, and the section, at its middle, nearly semicircular. The distal expansion is depressed and has an articular surface of a form very like that of *Ph. III, 1,* except that the vertical depths of the two convexities of the trochlea are nearly equal. There is a depression on each of its lateral surfaces.

Phalanx IV, 2, is much depressed, with a contour and form resembling those of *Ph. III, 2*, only of considerably smaller dimensions.

Phalanx IV, 3, is similar in contour and form to *Ph. III, 3*, but much smaller.

Phalanx IV, 4, is a slightly curved, small ungual phalanx, a little longer than broad; rather larger and more obtusely pointed than *Ph. II, 3*. Just in front of the angles at the base are grooves which lead into vascular canals, which continue forwards in the substance of the bone. Smaller vascular perforations exist on both upper and under surfaces.

The segments of *III* can be at once distinguished by the great breadth and depression of all but the proximal end of the first phalanx. Those of *IV* have a general resemblance in form to the corresponding elements of *III*, but are only about two-thirds the width. The greater relative length, slenderness and compression, at once, indicate *Ph. II, 1*. *Ph. II,* 2, has the general contour characters of *Ph. IV,* 2, but has only about two-thirds of the breadth, and has not the same definite trochlea for its distal articulation *Ph. II., 3,* is the smallest and generally the most pointed of the ungual phalanges.

Considered collectively the characteristics of the toes are the depression of the phalanges and of the articulations, with the exception of those with the tarso-metarsus; the length, slenderness and compression of the proximal phalanx of the inner toe; the inconsiderable degree of concavity of the proximal articular surfaces, due in great part to the absence of that production posteriorly of the central part of the superior and inferior borders which exists to a marked degree in the phalanges of the emeu, and to a less, though still to a considerable, extent in the Moas, and which, when present, must contribute materially to the strength of the joints. So also the absence of deep vertical grooving of the distal trochleae and the shortness, depression and feebleness of the ungual phalanges of *Genornis* are additional characters which indicate weakness of the toes and a want of security in the articular connections of their component segments.

STERNUM.
Plate XXIII.

As already briefly noted,* this bone in its shape and proportions bears a closer general resemblance to the sternum of the emeu than to that of the cassowary or than, it may be added, to that of any other of the known ratitite birds. The actual dimensions of the bone as restored are-length, in pre- and postaxial mid-line, 306 nun., breadth at the widest part, viz., at the bases of the costal processes *(procecesses laterales anteriores),* 254 mm., the reduction in either of these axes in consequence of abrasion being probably inconsiderable.

The corresponding measurements in three emeu and three cassowary sterna are as follows :-

			Length mm	Breadth mm
Dromæus novæ-hollandiæ,		No.1, adult	172	133
"	"	No.2, "	146	121
"	"	No.3, young	110	101
Casuarius galeatus,		No.1, adult	207	140
"	"	No.2, "	203	140
"	"	No.3, "	203	127

Excluding the costal borders, which have a maximum width of 40 mm., the thickness of the body of the sternum remains fairly constant at about 20 mm. throughout the preaxial two-thirds. In the hindmost third, or in that part which lies postaxiad of the costal borders, a considerably diminished thickness of from 6 mm. to 8 mm. is also fairly uniform. The degree of transverse curvature at the preaxial border is shown in pl. XXIII., fig. 3, and, largely owing to a marked inflection, dorsad, of the part behind the costal borders, the curvature in the fore-and aft direction is also very considerable, so that the entire bone is basin-like in appearance.+ The ventral surface bears a low, rounded, sub-carinate median rising (pl. XXII!., fig. 1, A), which is most conspicuous in the middle third, where its prominence is accentuated by a slight degree of depression on either side of it or, at least, of less convexity there than elsewhere. From the fact that this rising is much less marked in preaxial as well as postaxial parts; it scarcely becomes evident in the fore-end contour shown in fig. 3. In the sternum of the emeu (adult) there is, in

*Trans. R. 1'0c., S.A., vol. XX., p. 188, and these Memoirs, vol. I., p. 54.

t In the position in which fig. 3 was taken, a part of the inner (dorsal) surface of the hinder portion of the bone would, from this pre- and postaxial incurvature, have appeared as an interior background had this not been intentionally obliterated in order to give distinctiveness to the preaxial contour.

place of this low sub-carinate rising, a diffuse, rounded or boss-like protuberance corresponding to the greater part of the ventral surface, a feature which causes the curvature of that aspect to be more convex in either axis than that of the dorsaI. In the young emeu the sternum lacks this protuberance, and there is thus in the latter a much nearer approach to the approximate concentricity of the two surfaces that exists in *Genyornis.*

In the cassowary *(C. galeatus)* there is some, though a less, degree of protuberance and, in the postaxial third, there is a tendency for this to assume the form of a mesially disposed depressed ridge.

In the one specimen of the sternum of the rhea *(R. americana)* at our disposal the ventral prominence approximates to a depressed keel-like formation, but this becomes a more flattened and broader prominence postaxially.

The presence of the diffuse protuberance in the emeu and, to a less degree, in the cassowary gives to the sterna of both these birds a much greater relative dorso-ventral thickness than in the fossil-in fact, the maximum thickness in the mid-line of a small and immature emeu sternum is as great as that of the fossil; but whereas in the living bird the bone is comparatively light and papery, from the presence of abundant air spaces, the osseous tissue of the fossil bone, though it is to some extent infiltrated with mineral matters, would appear to have been much more dense and solid, as indeed is the case in an old cassowary sternum. The rhea sternum referred to is considerably thinner and still more light and papery than is that of the emeu.

The preaxial border is slightly abraded, but would appear to have presented a wide and very shallow median emargination (pl. XXIII., figs. 1 and 2, B). In this feature the contour is' most nearly approached by that of the sternum of the rhea. A narrower and deeper lateral notch (figs. 1 and 2, c) lies mesiad of each costal process (D). . No representative of a *spina sterni* appears.

The coracoidal articular surfaces (they can scarcely be said to form grooves) (fig. 3, E E) are flat, shallow and widely separated from one another, the outer limits of the surfaces reaching outwards to the bases of the costal processes, while mesially they do not approach within two .and a half inches of the mid-line. The extent of these surfaces, though not very clearly shown, may be recognised in fig. 3 as constituting a dark area on the (observer's) right and a light area on the left between the letters E and E. In respect to the wide separation of the coracoidal surfaces, a resemblance to the conditions seen in the rhea is again evident. A low rising, corresponding to the ventral lip of the comcoidal surface, which may, however, have suffered some reduction by abrasion, is only partially evident. At the external limits of these surfaces are large pneumatic foramina (fig. 3, F).*

The costal processes (figs. 1, 2 and 3, D, D), which have also suffered some damage to their summits, are stout, short and sub-pyramidal in form and, while projecting slightly in advance .of the extreme of the intervening preaxial border, have scarcely any degree of outward inclination. In the adult emeu the costal processes are long, slender, at first

*Owing to the incidence of the light, the foramen is only shown distinctly on the left side.

outwardly directed, then curving ventrad, slightly mesiad and postaxiad ; in the sternum of *Casuarius galeatus* they are very short and directed, for the most part outwardly, though with some amount of recurvature ventrad and postaxiad. The present abraded condition of the processes in the fossil is of course consistent with greater length and possibly some degree of in- or re-curvature in their original condition, but this does not appear, to us, probable.

In the ostrich and rhea the processes are also short, stout and directed, in the former, mainly preaxially but also slightly externally; in the latter they are longer and relatively less stout and directed more outwardly than preaxiad.

The hinder third of the bone was much broken, but has been nearly completely restored except at the lateral edges just postaxiad of the costal borders (pl. XXIII., fig. 2, H, H). hence it is not possible to assert absolutely that lateral xiphisternal processes *(processus laterales posteriores)* were entirely unrepresented, though from the general contour this, too, appears improbable, nor does the appearance of the nearly completely restored postaxial border suggest the existence either of a posterior xiphisternal process or notch.

The dorsal and ventral margins of the costal border (pl. XXIII., fig. 2, H, H), which extends well on to the base of the costal process, are for the most part nearly parallel, but converge somewhat pre- and postaxially. Each pleurostea.l surface is divided by four obliquely directed septa, very obscurely shown in fig. 2, which are relatively narrow when compared to the wide intervening excavations. Damage to the free edges of the septa precludes exact description of their actual articular characters, though there still remain some indications of the existence of convexities at the ventral and dorsal ends of each septum.

In the pleurosteon of a young emeu we observe five septal surfaces, but only four in that of our adult sterna; one of our adult cassowary sterna (*C. galeatus*) shows five and two others four. In the ostrich there arc five and in our single rhea sternum three septa.

RIBS.

Plate XXIV., figs. 10-16.

It has been possible to restore completely two vertebral ribs, both of them from the left side. The larger of the two (fig. 10) has a length, measured along the chord of the curve, from the capitulum to the distal end, of 306 mm. and a maximum breadth at the angle of 30 mm. The corresponding measurements of the shorter (fig. 11) are 255 mm. and 22 mm. The length of the longest vertebral rib of an emeu-the fourth of the series and the first which joins a sternal segment is 147 mm. and the maximum breadth (just distad of the junction of the capitular and tubercular stems) 21 mm.

In the larger specimen the axes of the stems of the Y -shaped proximal end are set to one another at an angle of about 65°, though the actual vertebral border, which their opposed margins define, forms a deeply curved sweep rather than an angular figure. The stem of the capitulum (A) is distinctly longer, but less stout, than that of the tuberculum (B) which latter forms the direct continuation of the shaft of the rib, while the latter diverges from this. Both processes terminate proximally in more or less flattened articular surfaces, and within the angle of meeting is a large pneumatic foramen. Proceeding distad from the point of junction of the two stems the rib-shaft increases considerably in the pre- and post axial breadth and, at the region of greatest width, or about two and a half inches from the junction, forms a distinct "angle" (c). From this point distad the shaft is nearly straight, is flattened on both surfaces and preserves a nearly uniform breadth until within three inches of the end where it at first narrows for a little distance before broadening again progressively to the tip. Here it also increases in thickness. The surface for articulation with the sternal segment is a sub-oval concavity which encroaches considerably on the outer aspect of the extremity.

Besides its inferior length the shorter rib (pl. XXIV., fig. 11) differs from the above in the greater equality, both in length and breadth, of the capitular and tubercular stems. The V-shaped cleft between them is moreover narrower (about 40°) and more angular* in character than in the longer specimen; the "angle" of the rib shaft is here represented only by a gentle curve, nor is there at that point the increased breadth that characterises the other. Damage to the distal end precludes description.

In neither of the two ribs described is there distinct evidence of the attachment of an uncinate process, but this feature is conspicuous in the fragment represented in fig 12 as a distinct roughened emargination (D) of the rib border. This fragment, moreover, is, from its thinness in comparison to its breadth, of a blade-like character the, presumably, outer surface being convex transversely and the inner similarly concave. The emargination appears rather more conspicuously in fig. 13, which fragment, however, has not the blade-like character of the preceding, and similar emarginations appear in other fragments The slender character of the piece shown in fig. 14 indicates its position amongst the "false" ribs.

On the whole, so far as comparison is possible, the fossil ribs, though differing in details, are more like those of the emeu than of any other of the existing ratitite birds.

The sternal ribs are only represented by broken pieces. The least imperfect of these (fig. 15) comprises a length of 65 mm. of its sternal end. This, at the fractured (proximal) end has an oval transverse section which, a little further distad, ·becomes trihedral and continues so to the sternal articular surface, the latter being also more or less triangular in contour. The outer border of this, representing a side of the triangular figure, is produced, distad, considerably in advance of the internal margin which represents a rounded angle; between these borders is a shallow valley which is intersected from within outwards by a slight linear ridge. The actual articular surface is somewhat abraded, but would appear to have been in contact with the surface of the sternal costal septum over the whole of its extent. Fig. 16 represents a smaller fragment also assignable to the sternal series.

CORAC0 - SCAPULA.

Plate XXIV., figs. 1-3.

The shoulder girdle is represented by three small fragments only. one of these, from the left side, comprises a portion of the coraco-scapular junction (pl. XXIV., figs. 1 and 2), with the entire glenoid cavity, and the fragment is at least sufficient to reveal the ratitite features of a very open coraco-scapular angle and complete union of the constituent elements.

The glenoid cavity (C) is deep and nearly semicircular in contour, with a length of 22 mm. between the very prominent coracoid and scapular lips. The transverse breadth at its middle is 13 mm. Damage to the fragment on the border opposite to the glenoid c:wity leaves uncertain the exact disposition of the pre-coracoid region; though the contour of the uninjured part indicates some amount of precoracoidal expansion, but this apparently did not, as in the emeu, assume the form of a prominent preaxially and mesially directed angular process. Whether, as in *Struthio* or to a less degree in *Rhea*, there was any pre-coracoidal extension towards the sternum cannot for the same reason be determined.

The ventral or posterior border of the scapular moiety of the fragment forms a somewhat acutely rounded margin which leads from the hinder lip of the glenoid cavity, while, on the border opposite, the thickness is reduced to a sharp edge.

The very limited portion of the ventral border of the coracoidal moiety that exists intact reveals a considerably greater thickness of bone than in the corresponding margin of the scapular part; nothing remains of the opposite border of this region.

A second fragment, also from the left side, comprises only two-thirds of the glenoid cavity, with about an inch and a half of the adjacent scapular border, and shows no fresh feature. The third specimen referable to the coraco-scapula is a scalpelliform fragment (fig. 3), comprising 95 mm. in length, of the terminal or postaxial end of the scapula. Its fractured extremity displays a flattened oval section, with a longer diameter of 13 mm., and exposes a conformably shaped medullary cavity, in which exist remnants of cancellous tissue. The fragment terminates in a thin blade-like expansion, of which the superior (?) border is nearly straight and the inferior bellied after the manner of a scalpel-blade. The maximum width is 21 mm.

HUMERUS

Plate XXIV., figs. 4-6.

The humerus, represented by one complete and one nearly complete specimen from the right side (pl. XXIV., figs. 4-6), also by the distal ends of two other bones of opposite sides, has a short and, relatively to the radius and ulna, stout shaft, of which the section is sub-oval, the longer diameter being directed from the pre- to the post-axial border. Both extremities, more particularly the proximal, are expanded in a similar direction, and the whole bone, when viewed from the direction of either of these borders, exhibits a gentle sigmoid curvature. Its total length is 89 mm. and the pre- and post-axial breadth, at the middle of the shaft, 14 mm. Of the proximal expansion (figs. 4-6, A) 25 mm. in maximum pre- and post-axial breadth, the pre-axial border is produced into a compressed and well marked, but undeflected, radial crest (figs. 4-6, B), which, however, soon subsides upon the shaft; while its opposite, or ulnar, side is somewhat prominent and considerably thickened ancono-thenally. Thus, when viewed end-on, the contour of the proximal expansion is subpyriform, the smaller end of the figure being pre-axially situated and corresponding to the position of the radial ridge.

Both anconal and thenal surfaces of the proximal end are slightly concave in a transverse direction, and no pneumatic foramen exists here or elsewhere in the bone.

The proximal articular surface (A), of which the outline is coincident with that of the proximal expansion, slopes considerably radiad and distad, the smaller end of this articular surface thus extending on to the end of the radial ridge. Midway between the larger and smaller ends of the pyriform articular contour is a rounded protuberance.

On the radial side of the shaft, midway between the two ends. there is a low, rough tuberosity (figs. 4 and G, C), barely evident in the figures; distad of this the shaft begins to expand evenly into the distal extremity. This, on the anconal side, is transversely convex and on the thenal concave, the latter feature being due to the ridge-like elevation of its pre- and post-axial and, to a less extent, of its distal margins.

The distal articular surface (figs. 4 and 5, D) is undivided, but uneven by reason of the presence of a bluntly conical prominence situated towards the post-axial side.

The second specimen is complete, except for the loss of part of the ulnar border of the proximal end. Its length, if perfect, would have been about the same as, or possibly slightly less than, that of the bone previously described, but its pre- and post-axial breadth is distinctly greater, this dimension being, at the middle of the shaft, 18 mm., as against 14 mm in the former; at the extremities the greater width is even more marked. Correlatively with its stouter character is increased expression of its various ridges and prominences, particularly of the low tuberosity (C). The concavity on the thenal surface of the distal extremity is also more marked, and bordering on this, to the ulnar side, is a very distinct sub-conical prominence.

As indicated by the broken distal fragments, the middle of the shaft, seems to have possessed a smooth - walled, medullary cavity, cancellous tissue being confined to the extremities.

RADIUS.

Plate XXIV., fig. 7.

Two bones, evidently belonging to this segment of the fore-limb, were found in close contiguity to one another, all the other wing fragments having been separately collected. This fact, taken in conjunction with their anatomical features, leads us to believe that the bones in question are the radius and ulna of the same (left) wing. Of these, that considered to be the radius (pl. XXIV., fig. 7) is perfect, except for slight abrasion of its distal articular surface, but its supposed fellow has lost the distal third of its length.

The radius (fig. 7) is a slender styliform bone, 93 mm. in length, tapering evenly and gently towards the distal end and having a slight degree of curvature, of which the convexity is towards the ulna. The proximal end (E) is moderately expanded, and bears a sub-oval, flat articular surface for the humerus, the plane of which, by a slope towards the ulnar side, is set obliquely to the long axis of the bone. On the ulnar side of the proximal end, and contiguous to the humeral articular surface, there is some indication, obscured however by slight abrasion of the existence of a small facet for abutment against the head of its fellow-bone. To this succeeds distally for a short distance a flattened or even slightly depressed area, but within half an inch of the extremity there commences on this -the ulnar or convex side- a low, linear, longitudinal ridge; this, most marked at its origin, is more or less traceable to the distal end, in which region it again becomes more prominent. On the preaxial side the radius is longitudinally concave and slightly convex transversely in the proximal region, markedly so towards the tapering distal end.

The articular characters of the distal end, which is reduced to very small dimensions, are obscured by abrasion, but these appear in a second specimen now to be mentioned.

This latter, believed also to be a left radius, though it is so devoid of any salient features that there is difficulty in assigning it to a definite side, is like that described in respect to its tapering styliform characters, but it is of very slightly greater length (97 mm.) and with so little curvature that it is almost straight. The degree and character of the proximal expansion resemble those of the preceding bone, but the humeral articular surface is distinctly, though slightly, convex; and the longitudinal ridge on the ulnar aspect is practically non-existent, save for the distal fourth of the length of the bone. The actual extremity is here uninjured, and forms a very small convex and unexpanded articular surface.

ULNA.

Plate XXIV., fig. 8.

The single fragment (65 mm. in length), representing the proximal two-thirds of what is considered to be the left ulna, is a part of a somewhat stouter bone than the radius, and like the latter it tapers, though with considerably less curvature, towards the distal end. The head (fig. 8, F), of larger size than that of its fellow-bone, bears, proximally, a pyriform, nearly flat, or only very slightly concave, surface for the humerus, which has a marked slope radiad. On the radial side of the head, contiguous to the humeral surface, is a small but perfectly distinct facet for abutment against the head of the radius.

As in the latter bone the head is succeeded distally by a small flattened or slightly depressed area, to which succeeds a short ridge-like rising (fig. 8, H) consisting of two small longitudinally juxtaposed tubercles. This, when the ulna is placed in what appears to be correct apposition with the radius, stands in opposition to, and indeed might have almost, if not quite, touched, the proximal part of the corresponding ridge that has been mentioned in connection with the ulnar surface of the radius.

The fracture towards the distal end exposes a smooth walled medullary cavity.

CARPUS

No bones assignable to this segment were collected, nor is there any anatomical evidence that points to their separate existence.

METACARPUS.

Plate XXIV., fig. 9.

This segment of the wing (44 mm. in length) is represented by two curved (thenad) and largely synostosed elements, which are relatively thick at the base and taper towards the distal ends (pl. XXIV., fig. 9). Of these the more radially situated (J), or that corresponding to the second metacarpal, is considerably stouter, slightly longer and more curved, than the representative of the third metacarpal element (K). In the more perfect of the only two specimens obtained of this segment the bones are fused (proximally) for rather less than half their length, but in the other and less complete example they are united for almost their whole length.

A small depressed angular process (L) springing from the preaxial side of the base of the larger bone appears to represent the pollicial metacarpal.

A minute but apparently uninjured wedge-shaped nodule, not shown in the plate, which was found *in situ* close to the termination of the second metacarpal, may represent a consecutive phalarix, though the want of exact precision in its fit does not enable us to be sure of this point.

REMARKS ON THE BONES OF THE WING

In the following table the relative length proportions of the wing segments of *Genyornis* are compared with the corresponding measurements in some existing ratitite forms.

	Length (in mm.) of the			Length of humerus is to that of antibrachium as 100 is to
	Humerus	Radius	Ulna	
Genyorni newtoni	89	93	Incomplete	104.5
Dromœus novæ-hollandiæ	98	69	74	72.4
Rhea americana	272	190	198	71
Casuariss galeatus	81	46	54	60
Apteryx bulleri	43	21	22	51
Struthio camelus	348	114	115	33

It will be seen from the foregoing table that in *Genyornis* only of these ratitite forms does the length of the antibrachium exceed that of the humeral segment; the nearest approach to this condition amongst the living members occurring in the emeu, though here the humerus is still the longer bone. With much greater absolute length the relative proportions in the rhea are very similar to those of the emeu.

So far, however, as the general features of the humerus are concerned that of the fossil is more comparable to the shorter stouter bone of the cassowary than to this more slender element in the emeu.

The pneumatic foramen, of which as we have said no trace exists in the fossil humerus, is, in two pairs of bones from the cassowary *(C. galeatus)*, very large in three and small in the fourth. Out of three humeri of the emeu a foramen is present in one of a pair and absent in its fellow as well as in the third specimen.

By their comparatively slender and styliform characters the radius and ulna of the fossil invite comparison with these bones in the emeu rather than in the cassowary, where they are relatively short and stout; but on the other hand the fairly well developed proximal end of the fossil ulna and the presence of some part, at least, of what may be regarded as representing an interosseous ridge are features which are better expressed in the latter bird.

In the carpus of the ostrich and rhea both radial and ulnar carpal bones are present. We also find both existing in *Casuarus galeatus** though the *ulnare* is here reduced to very small proportions, and whereas the *radiale* is directly and completely interposed between the radius and metacarpus the former lies almost entirely on the ulnar side of the ulno-metacarpal joint. In the emeu neither bone is present.

As has been mentioned, no constituent referable to the carpus of *Genornis* was found and, although bones of this small size might easily have been overlooked in collecting, there are no features which in any way suggest that they ever had any separate existence.

In the more or less complete synostosis of the representatives of the second and third metacarpals (to the base of the larger and more radially situated of which is fused an aborted representative of a pollex) the manus of *Genyornis* bears a resemblance to the conditions which obtain in the cassowary, and in these respects materially differ from those of the single elongated metacarpal ,of the emeu, though even here there may be evidence, in a thin "splint-like" projection on the postaxial side of the proximal part of the ulna, that the single bone represents the third as well as the second element.

If the small flattened nodule found associated with the distal end of the combined metacarpals be a phalangeal segment this part of the manus has suffered even greater reduction than in the cassowary, in which latter there is a single short but stout phalanx articulated to the index metacarpal.

On the whole the comparison, for what it is worth, of the wing of *Genyornis* with that of other ratitite form yields greater resemblances to this member in the cassowary than in the emeu.

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* In Newton's" Dictionary of Birds," under article "Skeleton," p, 859, it is stated that this cassowary possesses one carpal bone only, but we find the arrangement as described above in three wings; in a fourth both appear to have been present and lost.

EXPLANATION OF PLATE XIX

Genyornis newtoni

FEMUR (Left), (p57)

All figures are half size

Fig. 1. Anterior surface.
Fig. 2. Posterior surface.
Fig. 3. End contour of proximal extremity.
Fig. 4. End contour of distal extremity.
In figs. 3 and 4 the upper margin corresponds to the posterior surface.

LETTER REFERENCES.

A	Depression for round ligament.
B	Trochanter.
C	Trochanteric articular surface.
D	Pre- trochanteric surface.
E	Ecto-trochanteric surface.
EO	Ecto-condyle.
E, T	Ecto-trochanteric tuberosity.
F	Intermuscular ridge.
G, G	Accidentally depressed areas.
H	Pneumatic foramen.
IC	Ento-condyle.
J	Popliteal fossa.
K	Posterior intercondylar notch.
L	Fibular groove.
M	Posterior border of ento-condyle
N	Anterior intercondylar ridge.
O	Posterior intercondylar ridge.
P	Ecto-condylar fossa.
RC	Rotular channel.

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2

3

4

Ernest Gall, Photo-Illustrator, 11, Alma Chambers, Adelaide.

EXPLANATION OF PLATES XX AND XXI

Genyornis newtoni.

TIBIO-TARSUS AND FIBULA (pp. 60 and 65).

All the figures are of half size.

PLATE XX.

TIBIO-TARSUS (RIGHT).

Fig. 1. Anterior surface.
Fig. 2. Posterior surface.
Fig. 3. End contour of proximal surface.
Fig 4. Anterior surface or distal end of another and rather smaller specimen in which the extensor bridge has been preserved.

PLATE XXI

TIBIO-TARSUS (RIGHT), figs. 1-3, and FIBULA (LEFT), figs. 4 and 5.

Fig. 1. Internal surface of Tibio-tarsus.
Fig. 2. External surface.
Fig. 3. End contour of distal extremity; the upper margin of the figure corresponds to the anterior surface.

A Intercondylar eminence.
B Rotular or cnemial channel.
C Cnemial process.
D Inner border of cnemial process.
E Epi-cnemial crest.
EC Ecto-condyle (of both upper and lower ends).
F Pro-cnemial crest.
G Ecto-cnemial crest.
H Hamular process of ecto-cnemial crest.
IC Ento-condyle (of both upper and lower ends).
J Ecto-cnemial cavity.
K Continuation of pro-cnemia! crest.
L Inner border of extensor groove.
M Outer border of extensor groove.
O Articular surface for Fibula.
P Tuberosity.
Q Ent-epicondylar depression.
R Ent-epicondylar tuberosity.

Fig. 4. External surface of Fibula.
Fig. 5. Internal surface.

LETTER REFERENCES.

A Depression on inner side of head (upper articular surface).
B Distal articular surface.
C Tuberosity.


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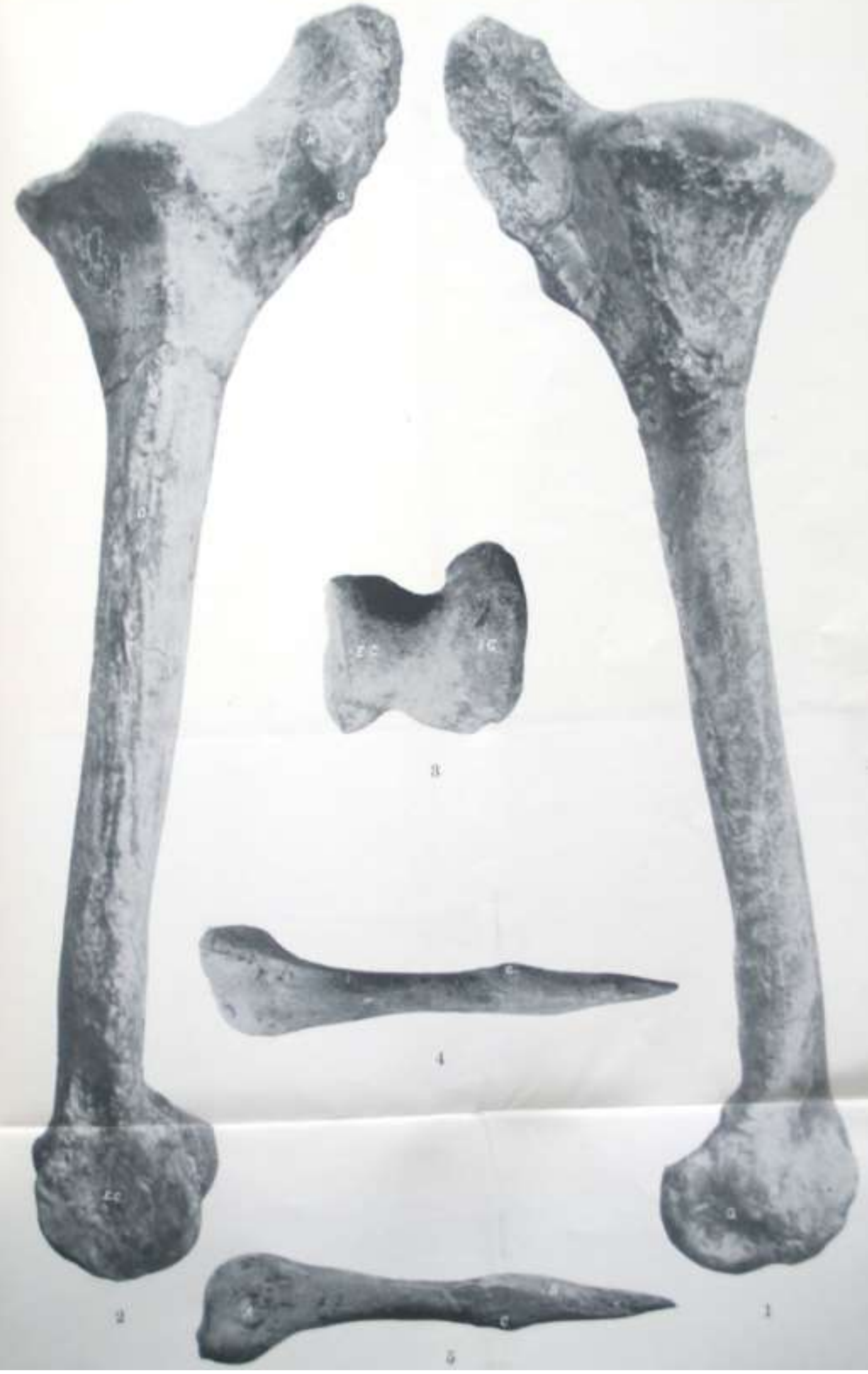
PLATE XXI

For explanation and letter references, vide those to previous plate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EXPLANATION OF PLATE XXII

Genyornis newtoni

TARSO-METATARSUS AND PHALANGES (Right) (pp 66 and 67)

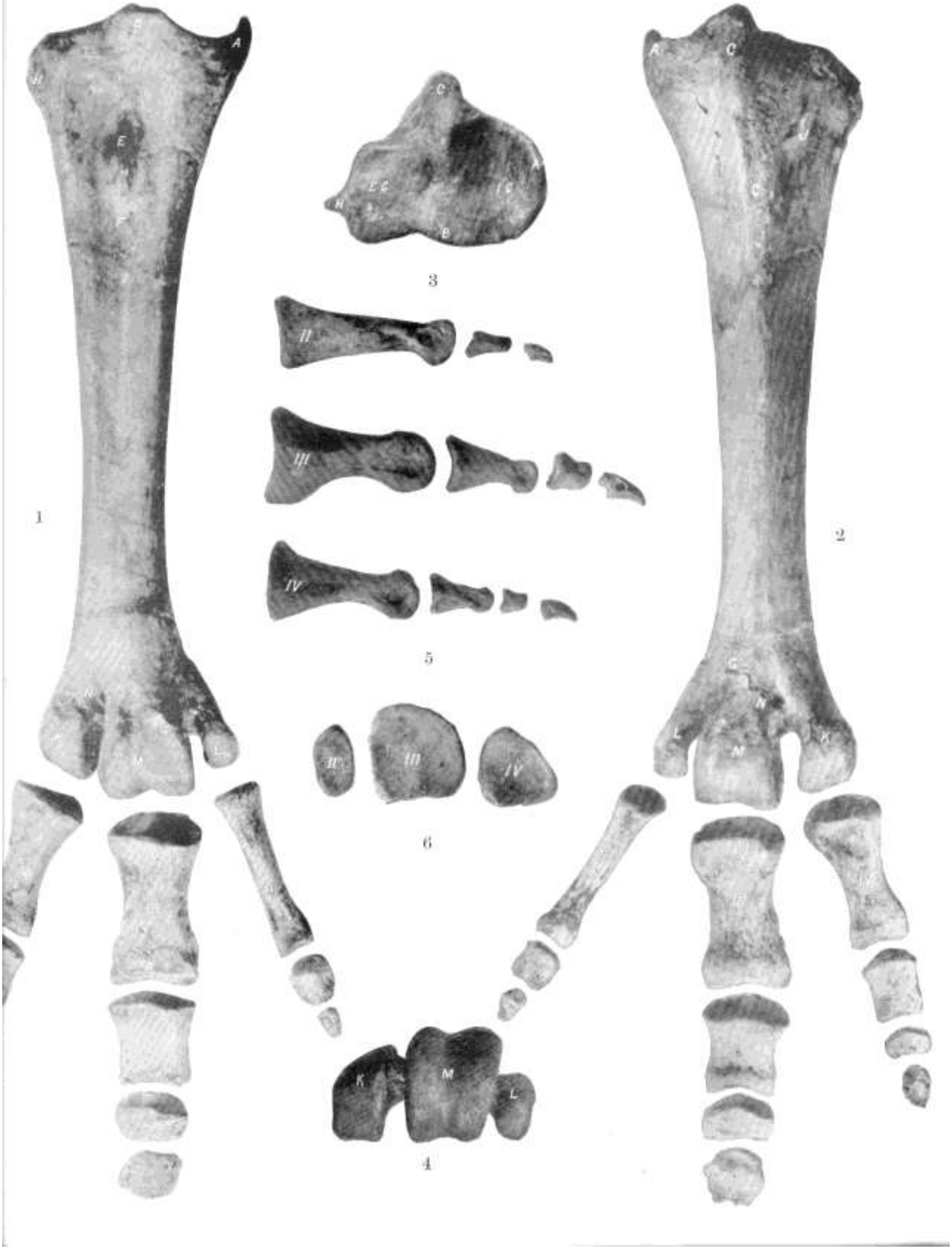
All figures are of half size

Fig. 1. Anterior surface of Tarso-metatarsus with dorsal surfaces of Phalanges.
Fig. 2. Posterior surface of Tarso-metatarsus with plantar surface of Phalanges.
Fig. 3. End contour of proximal extremity of Tarso-metatarsus. The upper margin corresponds to the posterior surface.
Fig. 4. End contour of distal extremity of Tarso-metatarsus. The upper margin corresponds to the anterior surface.
Fig. 5. Contours of proximal ends of proximal Phalanges. The upper margins correspond to the dorsal surfaces.
Fig. 6. Outer surfaces of Phalanges arranged in serial order.

LETTER REFERENCE

A Elevated lip of ento-condyle.
B Anterior intercondylar process.
C Hypotarsus.
D Bridge covering posterior ent-interosseous canal.
E Anterior interosseous canal.
EC Ecto-condylar surface.
F Nutrient arterial foramen.
G Groove on posterior surface leading to inner intertrochlear interspace.
H Keel-like process on outer side of upper extremity.
IC Ento-condylar surface.
J Posterior act-interosseous canal.
K Ecto-trochlea.
L Ento-trochlea.
M Meso-trochlea.
N Foramina above ecto-trochlear interspace.
II Proximal phalanx of inner toe.
III Proximal phalanx of middle toe.
IV Proximal phalanx of outer toe.

The other phalanges of each toe are placed in their proper relative order.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EXPLANATION OF PLATE XXIII

Genyornis newtoni

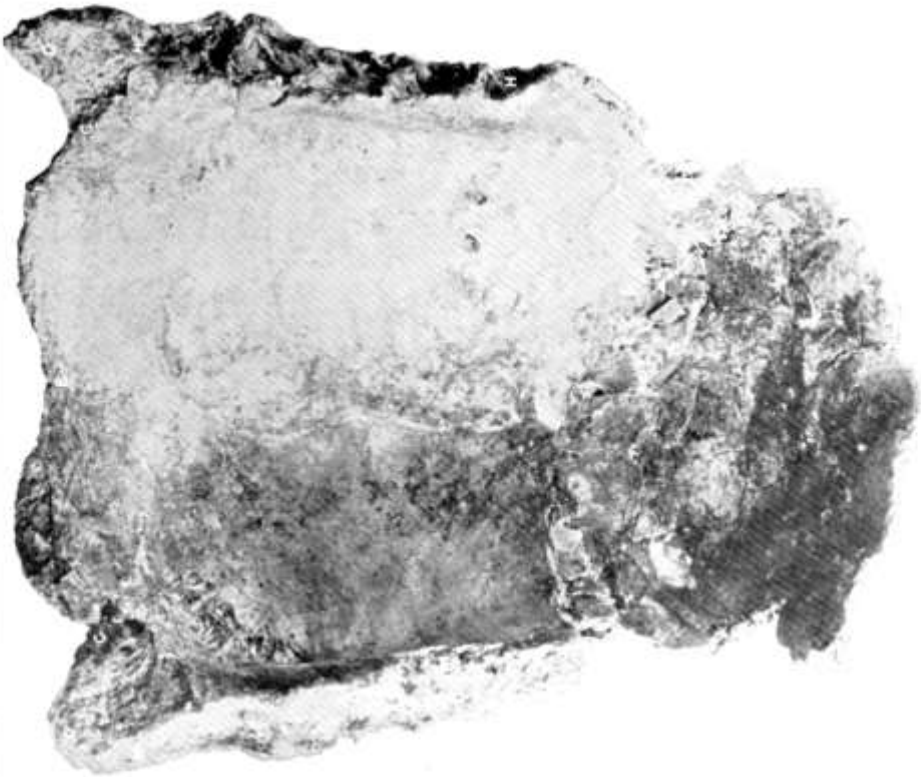
STERNUM (p 72

All figures are half size

Fig. 1. Ventral surface
Fig. 2. Dorsal surface.
Fig. 3. Preaxial border.

LETTER REFERENCES.

A	Median ventral sub-carinate ridge.
B	Median preaxial emargination.
C	Lateral preaxial notch.
D	Costal process.
E, E	Coracoidal articular surface.
F	Pneumatic foramen.
H, H	Costal border.



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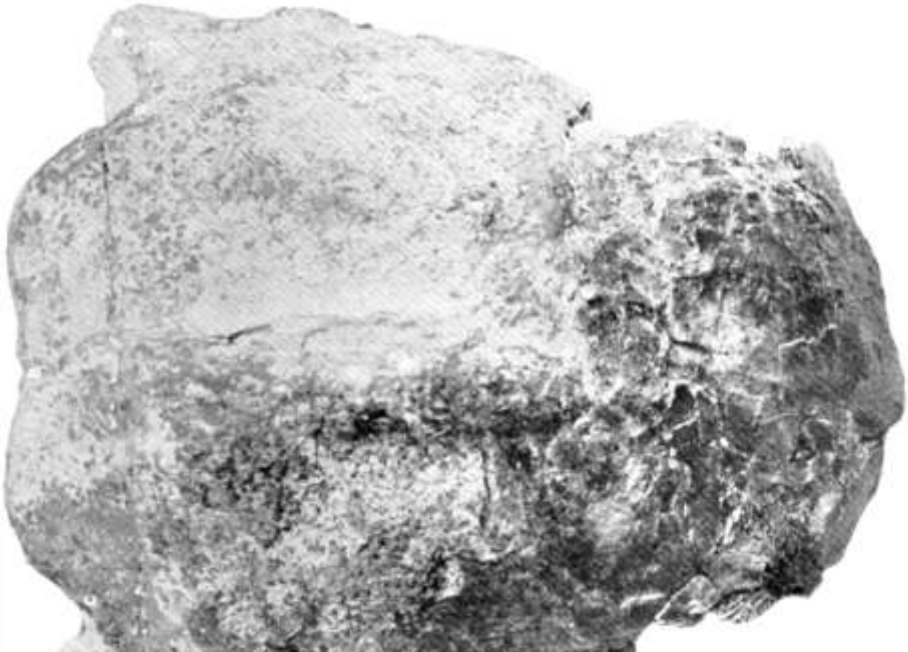

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EXPLANATION OF PLATE XXIV

Genyornis newtoni

CORACO-SCAPULA, WING BONES, RIBS

All figures are half size

CORACO-SCAPULA (p. 76).

Figs. 1-3.

Fig. 1. Fragment comprising part of left coraco-scapular junction, outer aspect.
Fig. 2. Posterior or ventral aspect of the same.
Fig. 3. Distal portion of the Scapula.

LETTER REFERENCES.

A Coracoid portion of coraco-scapular junction.
B Scapular portion.
C Glenoid cavity.

WING BONES (P 76)

Fig. 4. Right Humerus, anconal surface.
Fig. 5. Right Humerus, thenal surface.
Fig. 6. Right Humerus, radial border.
Fig. 7. Left Radius, anconal surface.
Fig. 8. Left Ulna, anconal surface.
Fig. 9. United Metacarpals (left), anconal surface.

LETTER REFERENCES

A Humerus, proximal end (the letter is placed on the articular surface).
B Humerus, radial crest.
C Humerus, tuberosity.
D Humerus, distal articular surface.
E Radius, proximal end.
F Ulna, proximal end.
H Ulna, linear tuberosity.
J Second Metacarpal.
K Third Metacarpal.
L First Metacarpal remnant.

RIBS (p. 74).

Figs. 10-16

Fig. 10. Vertebral rib (left).
Fig. 11. Smaller vertebral rib (left).

Fig. 12 } Fragments of vertebral ribs showing emargination for attachment of uncinate process
Fig. 13 }

Fig. 14. Fragment of "false" rib.

Fig. 15 }Sternal ends of sternal ribs
Fig. 16 }

LETTER REFERENCES

A Stem of capitulum.
B Stem of tuberculum.
C "Angle" of rib.
D Emargination for attachment of uncinate process.


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THE
PHYSICAL FEATURES OF LAKE CALLABONNA*

By E. C. STIRLING, G.M.G., M.A., M.D., F.R.S., G.M.Z.S.,
Director South Australian Museum.

Plate A

(Read July 3, 1900)

[By permission of the Editor, for which the Author desires to record his acknowledgment and thanks, the following article is, with some modification, reprinted from" Nature," vol. I., pp. 184 and 206.]

THE LAKE EYRE BASIN

As has often been observed, those who might form their estimate of the physical geography of the interior regions of South Australia from an inspection of its maps alone would come to very erroneous conclusions. The numerous and, often, immense areas marked as lakes, and the plentiful streams which appear to supply them, deserve their names on rare occasions only. Ordinarily the lakes are shallow, mud-bottomed or salt-encrusted claypans only, and the rivers dry water-courses, or it may be, even, that no definite channels for the latter are recognisable amidst the flats which in flood time they overflow. Only after the heavy tropical rains, which at too rare intervals descend to these latitudes, do the rivers run for a brief period and the lakes contain water, though for some time afterwards; the deeper parts of the water-courses may remain as water-holes, or chains of water-holes, of greater or less size and permanence. Those, however, who have only seen the river channels dry can have little idea of what torrents they may become under such circumstances. The flood-waters of the Barcoo or Cooper some few years ago spread over a breadth of from forty to fifty miles on its way to reach Lake Eyre. Lake Eyre itself has occasionally been filled, and is then a vast inland

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*It may be well to state, perhaps, that the so-called Lake in which the fossils were found has been hitherto usually spoken of as Lake Mulligan. That name, however, has never been officially conferred or recognised, and, indeed, it will not be found on any of the maps of South Australia. There prevails a very proper sentiment, unfortunately not always carried into action, that the native names of localities should as far as possible be retained. In this particular instance the euphonious native name Callabonna, which applies to a large watercourse leading into the Lake and to an adjoining sheep run, seemed appropriate in all respects, save that the association of sound and idea might erroneously suggest the possession of scenic beauties by an area which is not only waterless, but also almost unsurpassable for barrenness and utter desolation. The name suggested by the writer, however, has been approved by the South Australian Executive, and in future the locality is to be known officially as Lake Callabonna, and will be so called in the following notes.

sea over a hundred miles long and fifty broad, and when full of water might well have suggested, as it actually did suggest, great possibilities of internal navigation.

The area of these inland lakes presents roughly a division. into a Western system, comprising Lake Gairdner and numerous adjacent smaller claypans; a Central, of which Lake Eyre, Lake Eyre South and Lake Torrens are the chief members; and an Eastern comprising, in their order from north to south, Lakes Gregory, Blanche, Callabonna and Frome. These three systems have no direct communication with one another-in fact, they are separated by more or less elevated ground.

From the fact of some of the early explorers, in proceeding northwards, having struck the apparently unending margins and impassable beds of the huge claypans either of Lake Torrens, of Lake Eyre, or of those of the Eastern group, all of them were for some time supposed to be continuous and to form one great lacustrine surface. Indeed, for many years a familiar feature on the maps of Australia was an immense crescentic or horse-shoe shaped lacustrine area, with its two horns, formed by the present Lakes Torrens and Frome, directed southwards. Eventually the progress of discovery enabled this horse-shoe to be broken up into the constituents now separately delineated as Lakes Torrens, Eyre, Gregory, Blanche, Callabonna and Frome. It is easy to see, on reference to a recent map, how great the chances were that explorers, having once passed into the unknown enclave of this great system of claypans, should have had their further progress checked at the shores of one or other of them.

The constituents of the Eastern system, witt which we are more immediately concerned, form a chain of clay-pans connected by intervening channels and, together, they present a curve with its concavity directed towards the west. The whole of the series is, according to the most recent maps, included between the meridians of longitude 138^0 50' and $140^0$20' east of Greenwich and the degrees of south latitude 31^0 12' and 28^0 50'.

On those rare occasions when the flood-waters of the Barcoo come down. in sufficient volume, from the immense area which it drains in South-Western Queensland, they overflow into the large effluent channel known as Strzelecki, which leaves the main river bed at Innamincka-a place of melancholy memory in the history of Australian discoveries, for close by the present settlement lie the remains of the ill· fated Burke who perished in 1861, after a successful transit of Australia-and they may then fill Lakes Gregory and Blanche. The latter lake, indeed, was filled in 1892, when its waters remained fresh for six months. A channel from the Strzelecki leads into Lake Callabonna, and I am informed that this depression also was filled from the same source some years ago, a statement which is supported by the presence upon the sandhills of numerous fragments of the eggs of fresh-water fowl and of bones of water rats *(Hydromys).* On the older maps Lake Callabonna was depicted as a northerly extension of Lake Frome-and, indeed, these two are actually connected by a channel-but whether water has ever been known to flow from one into the other I have not been able to learn.

There is, however, compensation for the unpromising physical features of Lake Calla bonna in the fact that its bed proves to be a veritable necropolis of gigantic extinct marsupials and birds which have apparently died where they lie, literally, in hundreds. The facts that the bones of individuals are often unbroken, close together and, frequently, in their proper relative positions *(vide* pI. A, fig. H), the attitude of many of the bodies and the character of the matrix in which they are embedded, negative any theory that they have been carried thither by floods. The probability is, rather, that they met their death by being entombed in the effort to reach food or water, just as even now happens in dry seasons, to hundreds of cattle which, exhausted by thirst and starvation, are unable to extricate themselves from the boggy places that they have entered in pursuit either of water or of the little green herbage due to its presence. The accumulation of so many bodies in one locality points to the fact of their assemblage around one of the last remaining- oases in the region of desiccation which succeeded an antecedent condition of plenteous rains and abundant waters. An identical explanation has been suggested by Mr. Daintree* in his "Notes on the Geology of the Colony of Queensland."

Lake Callabonna, the description of which is, in its main features, applicable to its kindred claypans, has a length of over fifty miles. About ten miles wide at its northern extremity, it narrows to four or five at the site of the recent excavations, which is some fifteen miles to the southward, and becomes still further constricted in the remainder. Its shores, especially on the Eastern side, are as yet imperfectly surveyed, nor have, I believe, any levels been taken of its bed. Possibly, like Lake Eyre, it may actually be below the sea level, but in any case it is relatively low-lying, for water-courses lead into it on three sides. The Mount Hopeless, Yerila, Woratchie, Hamilton, Parabarana and Pepegoona Creeks, all of which rise in the Flinders Range. enter it on the western side; and the Callabonna and Yandama Creeks, rising in the Grey Range, on the east. Though these only run after heavy rain, they may then bring down a considerable quantity of flood-water. As already indicated, water can flow into the Lake at the northern end by the Moppa-Collina Channnel from the Strzelecki. The occasional character of the surrounding country may be best appreciated by reference to some of the names given by the early explorers and settlers, such as Mount Hopeless, Dreary Point, Illusion Plains, Mount Deception, Mirage Creek, which tell their own story of drought, difficulties and disappointments.

Speaking generally, the bed of the Lake is a great flat claypan, depressed but very little below the surrounding country (pl. A, fig. 1). In the neighbourhood of the fossiliferous area, however, this prevailing flatness is broken by the existence of an aggregation of dunes or hillocks of fine drift sand, not exceeding thirty feet in height, having their ridges running more or less north and south or at right angles to the direction of the prevailing easterly winds. These dunes are so far discontinuous that, did the Lake contain a very few feet of water, they would be converted into a number of irregularly shaped sand islets.

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*Quart. Journ, Geol. Soc., vol XXVIII., 1872, p. 275

From a foot to eighteen inches below their surface is a layer of loosely compacted sand-rock, in which were found the bivalve *Corbicula desolata*, Tate, now lying in the Cooper River system, and the univalve *Coxiella gilesi,* Angas sp. *(Blanfordia stirlingi*, Tate).

The sand-dune area is about four miles long from north to south and about three miles wide. The camp of the working party was at first pitched on the east side of the most southerly hillock, but the extreme exposure of the site to the prevailing winds and sandstorms soon compelled a change to the opposite side. Northwards of the sandhills, as far as the eye can reach, the whole Lake-bed is an unbroken fiat expanse, covered with gypsum crystals of all sizes, from which the reflection of the bright sunlight causes a painful glare to the eyes. The greatest distance in this direction reached by members of the working party was eight miles. Here there are·a number of brackish springs in the bed of the Lke, each surrounded by a fringe of bulrushes *(Typha angustifolia)*, and on the way thither a peculiar oval mound was passed, consisting of an interior mass of black soft mud, covered by a greyish crust, the whole structure quaking on pressure like a jelly. The size was about twelve feet long by eight broad and four high.

South of the camp is another flat expanse on which water very readily collects even after a light fall of rain When this is dry the surface is white, from the presence of a saline efflorescence, probably sulphate of sodium. To the east and west the group of sandhills are separated from the mainland by salt-encrusted flats which, in dry weather, are passable for camels and even for light vehicles, but extraordinarily boggy and sticky after rain.

There are a few shallow water-courses near the camp, the general direction of which is from north to south, and in some parts of these salt water stands permanently. The soft black mud which forms their bed contains in many places much decomposing vegetable matter, and often stinks horribly from the evolution from it of sulphuretted hydrogen gas. In one place there is, in the bed of the water-course, a round black-looking hole standing full of water, which gave no bottom with soundings at 2.1 feet.

After a continuance of dry weather the flats around the camp become coated with a white amorphous saline crust, having the peculiarity that it does not form on surface tracks, and as these then appear dark amidst the surrounding white ground, the scene suggests with singular force the appearance of footprints on a snowfield. On the other hand, whenever water, collected after rain in tracks and other indentations, has evaporated, which very soon takes place under the influence of the strong dry winds of the locality, there are left behind large flat glistening prismatic crystals of sodium sulphate, which in excess of dryness crumble into a fine white powder.

Scarcely any vegetation relieves the prevailing desolation beyond stubbly samphire plants *(Salicornia)* which grow in patches upon the sandhills, and rarely exceed two feet in height. Judging by the unusual thickness of their stems, some of these bushes must be very old. A few scattered and still more stunted bushes of the same plant grow upon the intervening fiats. To the north and south of the sandhills not a bush relieves the unbroken monotony of the level white crystalline surface.

On the western side, not far from the margin of the Lake, are the Mulligan Springs, where a station hut was formerly in occupation, but this has been for some time abandoned. The adjacent country is now under pastoral lease to the Beltana Pastoral Company, whose holding extends continuously to the westward for a distance of 150 miles. The eastern spurs of the Flinders Range, the highest summits of which reach an elevation exceeding 3,000 feet, approach to within about twenty miles of the Lake; and, at Paralana, on the eastern slope of the Range, there are hot springs. Callabonna Station, belonging to Messrs. Ragless Brothers, borders the Lake on the east, and consists chiefly of sandy plains which stretch to, and beyond, the boundary of New South Wales. The station-house stands on Callabonna Creek, about four miles from the Lake and six from the camp. Further south is the Muloowurtina Station, belonging to Mr. D. McCallum. The distance from Adelaide in a direct. line is about 400 miles, but to reach the Lake by the ordinary routes necessitates a journey by rail of about that length and an additional 150 to 200 miles by road, according to the route selected. The whole journey thither occupies five to six days, or longer in bad seasons.

Such are the physical characters of this uninviting region; its geological features will be afterwards considered.

During many years and from many parts of South Australia, notably from the Lake Eyre District, the South Australian Museum has from time to time received teeth and fragments of Diprotodon bones, which were occasionally associated with fragmentary remains of macropods, crocodiles, turtles and large birds.

Amongst such donations were some teeth and portions of the lower jaw sent to us, in 1885, by Mr. John Ragless, which were found by his son, Mr. F. B. Ragless, in a water course at a depth of five feet, about two miles east of the margin of Lake Callabonna and. about twelve miles north-east of the place where the more recent discoveries have been made. It was not, however, until 1889 that the Museum obtained a fairly perfect skull and several other bones in their entirety from Baldina Creek, near Burra, a locality about a hundred miles due north of Adelaide. In the same year, from fragments found at Bundey, in the same district, we were able to restore, incompletely, another skull considerably smaller than the former. A little later a third, but more imperfect, skull was found at Gawler, 25 miles north of Adelaide.

Since the first discovery of Diprotodon remains in the Wellington Caves by Sir Thomas Mitchell, in 1830, teeth and bones of this animal have been found over an extensive area, which extends from the Gulf of Carpentaria to Victoria and from the Darling Downs to the Lake Eyre Basin. They have also been found at Kimberley in North-Western Australia and to the west of the head of the Great Bight, so that this great marsupial appears to have had an immense range and to have probably wandered over the whole Continent of Australia.

The existence of bones in the actual bed of Lake Callabonna was made known to Mr. F. B. Ragless on the l0th January, 1892, by an intelligent aboriginal, who described them as being very large and numerous, and two days afterwards .Mr. Ragless himself visited the locality which afterwards became the seat of operations. A few days later the place was visited by John Meldrum, who had been for some months in Mr. Ragless's employ and by him some fragments were brought to Adelaide. These facts having been brought under the notice of the Museum authorities, Mr'. H. Hurst, who had previously had some experience in geological and paleontological work in Queensland, was commissioned to inspect and report. The promising nature of the report of this gentleman ultimately led to the despatch to the Lake of a party under his charge in .January, 1893.

Operations under Mr. Hurst's superintendence were continued for four months, during which time a considerable amount of material was obtained. Towards the end of June, however, the work, having been previously interrupted by rain, had to be finally discontinued in consequence of a heavy fall, and Mr. Hurst, with one of his party, returned to Adelaide, bringing with him as many bones as could be carried in a "buck-board" buggy.

At this stage it appeared desirable for various reasons that the work of excavation should be continued under the direction of a responsible Museum Officer, and accordingly, at the desire of the Board of Governors, I left for the field on the 11th August, 1893, in company with Mr. Zietz, the Assistant-Director, and another member of the Museum staff. 'On our arrival at Lake Callabonna, Mr. Hurst (who had by that time returned to the camp) resigned his appointment as well as another member of his original party.

As the result of Mr. Hurst's labours a quantity of bones were shortly despatched to Adelaide. Soon after our own arrival a fall of rain, though not exceeding half an inch in amount, was sufficient to cause considerable sheets of water to collect on the low-lying flats, to fill up the holes which had been excavated, and to render the clay surface of the Lake, at the best of times very soft and sticky, so boggy that further work on the field became for a time impossible. Further, it became a matter of great difficulty for the camels to pass over to the mainland for the requisite supplies, and it was occasionally necessary to remove their loads and dig them out of the glue-like mud in which they had sunk nearly to their bellies.

In consequence of the rain it was a fortnight before excavations could be properly resumed; meanwhile, being obliged by other duties to return to Adelaide, I left the camp in charge of Mr. Zietz, the other members of the party being three assistants and a cook, with two Afghans in charge of five camels. The absence of all feed near the camp rendered it necessary that these latter should have their encampment on the eastern shore, at a distance of about two miles and a half.

The number of the party thenceforth remained unchanged.

Without the camels, which were lent to us by the liberality of the South Australian

Government, it would have been quite impossible to carryon the work. By them meat, which sometimes went bad before the day ,was out, had to be brought a distance of six miles from Callabonna Station and water from the same place, until, with the advance of summer, the station supply fell short, when it became necessary to send to a well at a still greater distance; every stick of firewood, also, had to be fetched several miles. From the ravages of rabbits, of which there will be more to say directly, it was difficult to keep the camels in sufficiently good condition for their work, and each journey for wood and water generally required two days.

When, in the course of a fortnight after the rain, the ground had sufficiently dried to permit of the excavations being resumed, operations were commenced by Mr, Zietz at a place about a mile north·west of the camp from which his predecessor, Mr. Hurst, had obtained a number of bones. The subsequent yield, however, was inconsiderable ill quantity, and such as were found were much broken and decomposed. They represented, however, a variety of species-odd bones of large and small Diprotodons, of the large wombat (*Phascolonus gigas),* * of kangaroos and of birds, all these being sometimes mixed together in great confusion; or it might be that the bones of apparently a single Diprotodon, even in previously unopened ground, were widely separated and broken, the fractures being sharp and the missing pieces not discoverable.

This locality was consequently abandoned in favour of parts nearer the camp; from these good results were continuously obtained, and amongst them one apparently nearly complete Diprotodon skeleton, which was found in ground that had been tramped over hundreds of times in going to and fro between the camp and the more distant workings. Here also the remains of four birds+ were found lying close together. It may be mentioned that underground bones were usually discovered by probing with a wire rod, the sense of touch easily detecting the impact even with those that were soft.

The Lake bed in the fossiliferous area adjacent to the camp comprises what appears to be one of its most low-lying parts. Its superstratum is a layer of stiff yellowish clay of variable depth, but usually of not less than about a foot in thickness, not of uniform character, but marked by streaks of veins of a rusty colour, containing much fine sharp sand, due apparently to surface cracks having been fined up with drift-sand.

In some places this veining is so irregular and contorted as to give the clay a marbled appearance. On drying the. clay separates readily, along these streaks, into quadrangular or polygonal masses, somewhat after the manner of coal.

Beneath this superstratum is a layer of unctuous blue clay, of about two feet in thickness, resting upon a band of coarse sharp sand beneath which no bones were ever found by Mr. Zietz. Below the sand the same blue clay occurs again for an undetermined depth, and

* *Vide* Trans. R. Soc. of South Australia, vol. XXII!., p. 123.

\+ *Genyornis newtoni*. Vide Trans, R. Soc, of S. A., vol. XX., pp. 171 and 191; also these Memoirs, vol. I. (part 2), p. 41.

shows in parts a laminated structure, with salt-water lying in the interlaminar spaces. The greatest depth actually reached in digging was between six and seven feet.

On physical analysis this clay yielded 15-20 per cent. of fine sharp quartz-sand, while an approximate chemical analysis, kindly made for me by the late Mr. Turner, Demonstrator of Chemistry in the University, yielded the folIowing results :-

	Per cent
Water	13
Silica	40
Calciulll ca,rbonate	8.5
Alumina and iron	11.3
Magnesia	l 5
Alkaline chlorides and sulphates (mainly sodium sulphate)	25.7
Total	100.0

In the dry state numerous minute crystals of suiphate of calcium were visible ill the clay.

In the least low-lying parts of the area saltwater is reached at from two and a half to three feet; in the most depressed it remained permanently on the surface during the whole period of the excavations, which extended over the dry months of August, September, October, and November. In parts which are neither the highest nor the lowest the surface clay remains merely damp, and it was in ground of this character that the bones in best condition were found, provided that the underlying water did not approach the surface too nearly. In such cases and in the very low places where the water remained permanently on the surface it was impossible to excavate on account of the excessive inflow into the holes.

GEOLOGY

For what I have to say under this head I must express my obligations to my colleague, Professor Tate, whose observations in Australia have now extended over many years and have covered a large area. He has recently summarised the whole history of its geological progress in a very able inaugural presidential address to the Australasian Association for the Advancement of Science,* and I have had no hesitation in quoting freely from this and froom other writings of so competent an observer.

There appears to be no doubt, both from geological and biological reasoning, that in the Upper Cretaceous period a great part of Central Australia was covered by a sea which extended from the Gulf of Carpentaria to the Great Bight, and so divided the continent into· an eastern and western moiety. Following this, an upheaval of the sea-covered area took place, succeeded by a denudation of the Cretaceous deposits. Unequal movements of depression then brought about lacustrine conditions on portions of the now uplifted bottom of the old sea strait and, in other portions, permitted of the admission of the waters of the ocean.

* Adelaide, 1893

Finally a general upheaval, followed by utter desiccation, placed the deposits of the period just concluded in nearly the condition in which we now find them.

The system of existing lakes which have been mentioned in an earlier part of this article are evidently the shrunken remainders of the much larger lacustrine area of Pliocene times -a condition which demanded for its existence a much greater rainfall than now exists. The region of Lake Eyre was then, as now, the centre of the inland continental drainage. Towards this depression are directed many dry watercourses, of which those of the Macumba, Finke, Cooper and Diamantina are the chief. For miles around extends an area of sandhills, separated by loamy interspaces, which are litoral sandbanks marking the successive changes in the contraction of the waters. Within its basin the Pliocene sands and loams have yielded further proof of its lacustrine origin in the remains of Diprotodon, turtle, crocodile, and ceratodus.

In Professor Tate's opinion, Lake Torrens may have belonged to a lacustrine area, distinct from that of Lake Eyre, at least, with the existing contour of the country, a submergence of at least 400 feet would be necessary before the two systems could be connected.

Such a subergence would also unite in a vast inland sea the whole of the lake region around Lake Eyre and to the westward of Lake Torrens. A very much less considerable submergence would connect Lake Eyre with Lake Frome and the lakes to the north of it. Much of the Murray Desert to the eastward of Overland Corner and perhaps the whole Riverine region was at this time a lacustrine area, though probably disconnected from those of Lakes Eyre and Torrens.

The following table, based on Mr. Hurst's report and revised by Professor Tate, represents approximately the classification of the formations of the district :-

RECENT.-Loose sand, generally forming low ridges; sandhills or dunes overlying in places the Pliocene beds.

PLIOCENE.-Lake Callabonna; fossiliferous formation. Bands of unctuous blue clay, containing abundant quantities of saline minerals and concretions of carbonate of lime; thin seams of sand; inflorescent deposit of salts upon the surface. Fossils.-Extinct mammalia, birds, a fresh-water mollusc *(Pntamopyrgu sp.),* Entomostracans and a few plants of living species *(Charæ* and *Callitris robusta).*

MESOZOIC-(a) "Desert sandstone" or Post-Cretaceous (hard quartzites or porcellanized sandstone, gritty sandstones and conglomerates). *Fossils*-Dicotyledonous leaves. *(b)* "Rolling downs" formation or Upper Cretaceous; shales with fossiliferous limestone bands.

AZOIC.-Metamorphic schists; clay slates, mica, talc and hornblende slates, metamorphic and intrusive granite and greenstone.

The Pliocene formation in which the extinct marsupials occur does not appear to be restricted to the present houndaries of the Lake, as wells, sunk a considerable distance from the present shore, have yielded fragments of bone in exactly the same formation, thereby showing that the lacustrine area, in Pliocene times, occupied a larger area than at present.

The Mesozoic formation is limited upon the surface to a line of outcrops along the eastern slope of the Flinders Range. At Parabana, Pepegoona, Hamilton, and Paralana Creeks these beds occur as the edges of an immense mesozoic basin which underlies Lakes Frome and Callabonna. The detritus of this formation forms the stony table-lands and plains·of the country, and the, so-called, stony deserts of the early explorers have their origin in the same formation.

The Azoic rocks are restricted to the Flinders Range and are of doubtful age. These rocks were pierced by the Government boring party at Lake Frome several years ago, while boring through the Post-Tertiary and Mesozoic formations in search of artesian water.

FOSSILIFEROUS AREA

The area that has been more or less well explored is not more than a mile long by about half to three-quarters of a mile wide, but this forms but a small portion of the fossiliferous ground. Bones were dug up at the springs lying in the Lake bed eight miles to the north of the camp and were observed on the surface in a very weathered condition all along the track thither. In fact Mr. Zietz informs me that traces of bones and teeth exist on the surface in almost every part of the Lake he examined. Nor, as has been said, are they restricted to the present boundaries of the Lake.

SURFACE SKELETONS

One very remarkable feature is the existence of surface skeletons indicated by the presence of concretionary limestone or travertine, which has formed for the bones a sort of cast elevated a few inches above the surrounding level. In some cases the relative position of the bones has been preserved to such an extent that the limestone now presents a striking outline of the form of the skeleton (pL. A, fig. 2). Usually in such cases the animal is lying on its side, with the head and limbs plainly visible and more or less extended. The actual osseous substance has, in many of the bones of these surface skeletons, completely disappeared, but not, however, in all cases; some of them, usually the limb-bones, are more or less imperfectly preserved and devoid of concretion. Several of these surface skeletons existed near the camp at the time of my visit, but Mr. Zietz informs me that after the drying up of the rain which then fell they were no longer visible, having been covered up by the general saline encrustation, which has previously been spoken of.

CONDITON OF THE BONES

The condition of the bones varied very much -some were so friable that they crumbled into powder and could not be removed; others, usually in moist places, were wet, soft and of the consistency of putty. Curiously enough, for reasons which were not clear, some bones from wet places were firm and hard, while others, from ground that was comparatively dry, were soft. As a rule those in best condition came from localities which, without being too wet, were moderately damp. The bones, thus varying in condition and consistency, required very different methods of preparation. The greatest difficulty was undoubtedly due to the circumstance that the bones were saturated with what was practically a concentrated saline solution. In fact, all their cavities were so filled with this fluid that it was necessary to allow a considerable time for it to drain away. In other cases the bones were encrusted and impregnated with gypsum crystals. From such causes the bones became in dry weather brittle and liable to break or crack, and in damp weather difficult to dry. Very careful and patient methods of treatment had consequently to be adopted and will still be necessary until the salt is removed.

When dry the fractured surfaces adhere strongly to the tongue, and an approximate chemical examination by the late Mr. Turner of a clean piece of Diprotodon bone gave the following composition :-

Substance dissolves almost entirely in dilute hydrochloric or nitric acids. Contains

Moisture	3.76 per cent.
Organic matter...	7 4
Inorganic matter, mainly phosphate of lime, with some carbonate	88.84
Total	100

POSITION AND ATTITUDE OF SKELETONS

The heads were pointed towards all directions and the remains of different animals frequently much mixed. Where, however, the bones of an individual were lying in juxtaposition they preserved fairly constant relations to one another .. The vertebrae, for instance, often formed a more or less continuous series or were broken up into segments, of which the constituents were in such close apposition that they could be removed entire. These bones and the head, which was often much laterally compressed as if by pressure, were usually lying either in their proper position with the dorsal surfaces uppermost or were turned over on their sides. The pelvis was usually horizontal; of the ribs, some were *in situ,* others either widely separated from their fellows or several firmly welded together. The limbs, almost invariably at a greater depth than the rest of the skeleton, had their various segments greatly flexed. The feet were deepest of all. This attitude, together with the frequent approximation of the bones of individual skeletons is, as has been observed, strongly suggestive of death *in situ* after being bogged (pl. A, fig. 3). A very similar attitude was assumed by the camels on the occasions when they got bogged in crossing from the sand islets to the main land.

Besides the Diprotodon remains,* which form the great bulk of the material obtained, there were collected also a certain number of bones of one or more large kangaroos, including an apparently nearly complete skull, having a length of 83 cm. The large wombat (*Phascolonus gigas)* has already been mentioned, but its remains were not numerous. Of

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* For what can be said at present concerning the number of species of Diprotodon represented, see Memoirs R. Soc. of S.A., vol. 1. (part 1.), pp. 2-4).

Nototherium, so far as we are aware, no traces were found, and the same may be said of Thylacoleo, though careful search for these was constantly made. Bones of the latter animal have, however, been found in other parts of South Australia associated with Diprotodon remains.

No indication whatever was met with of the contemporaneous presence of man.

The four birds whose remains were found close to the camp had their heads all pointing to the south-west, that is towards the part of the lake-bed considered to be the deepest, but their bones, especially the ribs and short bones, were much broken and mixed together. The larger bones, however, were well preserved, and in one skeleton the cervical and dorsal vertebrae formed a continuous series. It was unfortunately only possible to secure two heads, and these, though apparently entire, were so soft, fragile and broken that they had to be set immediately in a half mould of plaster of paris.

The position of the bird remains were here, as elsewhere, indicated by the presence of circular surface patches of "gizzard-stones," consisting of coarse sand and small siliceou. pebbles, not exceeding three-quarters of an inch in diameter, the surfaces of which were smooth and worn as if by attrition.

The stones comprised in one entire patch weigh fourteen ounces, and include examples of siliceous-sandstone, jasper, claystone (blackened on the outside), black quartz, clear quartz, chalcedony, together with a few fragments of blue, brittle clay with worn edges. These stones are not now found on the Flinders Range, but are characteristic of the great Central Australian plain formation which extends from the Lake Eyre basin across the continent to the Gulf of Carpentaria.

Such pebbles occurred either scattered or in groups at curious places in the Lake, and were the only stones of any kind to be found anywhere on its surface. The only shell found in the clay matrix of the bones was a minute fresh-water mollusc *(Potamopyrgus sp.).* Three fruits, however, of a Callitris, determined by Professor Tate to be *C. robusta,* a species now living, were found embedded in the same blue clay, and some fructifications of *Charœ* were washed out of it.

In addition to the above-mentioned forms there were collected a few small bones and fragments, both mammalian and avian, of species not yet determined.

FOOD REMAINS

Associated with the skeletons of Diprotodon, in a relative position which corresponded with that of the abdominal cavity, were occasionally found loosely aggregated globular masses of what were judged to be the leaves, stalks, and smaller twigs of some herbaceous or arboreal plants. The fragments are very uniform in length, thickness and character, rarely exceeding an inch in length or a line in thickness. They are solid, often irregularly branched, frequently retaining portions of the bark, and have their ends often frayed or crushed, as if by the action of teeth. Microscopic examination showed the structure of the sclerenchyma tissue to be well preserved, and gave clear indication of the existence of dotted ducts, but I could find no trace of leaves that might have suggested a diagnosis.* Judging from this entire absence of leaves and from the degree of maceration, or entire absence, of the bark, these masses probably represent the contents of the intestines. No traces of coprolites were, however, anywhere met with.

METEOROLOGY

Arriving at the camp on the 16th of August, the Museum party experienced fine weather, but very cold nights for about a week. Strong winds-mostly south-easterly, but veering in all directions, and increasing in strength for about twenty-four hours, and eventually subsiding-then became of frequent occurrence. Later on, towards the end of October, these gales, now usually, from northerly quarters, increased in force and frequency; beginning at any time in the day, and lasting twelve to eighteen hours, they carried dense clouds of fine sand from the dunes and pulverised saline matter from the Lake, which were most irritating to the eyes.

In November these gales blew almost continuously and with still greater force, raising sandstorms so dense that it was impossible to see more than a few yards, and work was consequently impossible. Empty cases and even the bones laid out to dry were blown about the camp, sometimes to a distance of a hundred yards. The nights were intensely dark. Heavy clouds to the northwards often seemed to threaten for rain, but none came for some days. These clouds appeared to divide at the northward end of the Lake, to travel southwards on each side of it, and then to unite again. Mr. Ragless, at Callabonna, was convinced that in some way or another the Lake-bed was an obstacle which the rain-clouds from the west did not readily pass. During the day the heat was often intense, the thermometer in the tent rising frequently to 110° F., or not unfrequently even to 120°, but the nights were still comparatively cool. Innumerable flies were in the daytime a constant and maddening source of annoyance to man and beast, and so tortured the camels that the margin of their eyelids became quite raw. About the middle of November there was heavy rain for eighteen hours, and a week later a severe sandstorm from the west, followed by a sharp thunder-shower, in which an inch fell in a quarter of an hour, and its impact on the surface of the Lake was so heavy that it could be heard at Callabonna Station, six miles distant. A fortnight later a second severe sandstorm from the west was followed by another heavy shower. Just previous to the latter rain large flocks of the Australian swift *(Cypselus australis)*, locally called rainbirds, and considered to be a sure sign of heavy rain, passed over the Lake. On one night only was there a fog, which was of such peculiar denseness that the candle in the tent threw hardly any light, and its flame appeared surrounded by a yellow halo.

Previous to heavy weather immense numbers of nocturnal insects came round the camp fire at night, and a large collection of them was made.

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* As mentioned elsewhere in these Memoirs (vol. I., p. 36), samples of these remains of food (or excrement) were, at the suggestion of the late Ba.ron von Mueller, submitted to Professor Radlkofer, of Munich, who reported of them that they consisted of the stems and twigs of plants belonging chiefly to the order Salsolacere, or to the allied orders Amarantacere or Nyctaginere.

XIV

RABBITS

During November the camp became almost unbearable from the stench produced by the dead carcases of rabbits which had come to drink of the waters of a very brackish, in fact salt, spring at the base of the sandhill, about a hundred yards from camp. Round this they died after drinking, or else perished after crawling for shelter into the tents and empty boxes. It became part of the routine of the camp to bury upwards of fifty bodies every night, but still the nuisance was hardly lessened. The rabbits also caused many bones to be broken by crawling under them in search of the little pools of salt water which dripped from them as they were laid out to dry. In their frantic search for water they bit holes in the water-bags in camp and, on the mainland, gnawed the stems and roots of the "needle-bush," a species of Hakea. In one night at Callabonna Mr. Ragless killed 1,400 with poisoned water, and what with drought and the ravages of these pests, which stripped the scanty bushes of every green leaf till they were nothing more than bundles of bare sticks, the surrounding country presented an appearance of desolation that defies description.

Under such circumstances of heat, sand and effluvia, it is not surprising that the health of the party suffered eventually from ophthalmia and gastro-intestinal complaints, and, indeed, it was chiefly this which led to the breaking up of the camp at the end of November for the time being.

It would be an unworthy omission if I finally omitted to acknowledge the cheerfulness and skill with which Mr. Zietz performed his duties under somewhat arduous and depressing circumstances; indeed, whatever satisfactory results may have been achieved by this expedition they are most chiefly due to his indefatigable zeal in the interests of paleontology and of the Museum. To him also I owe many of the facts related in this communication. To the Messrs. Ragless our best thanks are due for their kindness and hospitality to members of the party at various times, and for many necessary articles supplied, sometimes, I fear, at their own inconvenience. Our great obligation to the Government of South Australia for the loan of camels, granted through the mediation of the Surveyor-General, -the late Mr. Goyder, I have already acknowledged.

For the preceding notes I can only claim that they comprise but a rough and imperfect epitome of the physical features of the fossiliferous area and of the conduct of the Museum party's operations. As has been already stated, until the whole of the specimens have been unpacked, cleaned, mended, examined, and compared no complete summary of the paleontological results can be given. It must further be remembered that the South Australian Museum still suffers under the general retrenchment imposed upon all Government institutions by recent financial exigencies, and this during a period when its limited staff-barely sufficient for routine work-is called upon to deal with, for it, an unprecedented mass of material, to say nothing of the fact that, within the same period, it has been also called upon to remove and rearrange the whole of its collections in its new and more commodious building. I mention these facts as a plea for some indulgence for the delay that must inevitably take place before the full scientific results can be made known.

With this expedition to Lake Callabonna must ever be associated the nam of the late Sir Thomas Elder, G.C.M.G., a gentleman who was conspicuous amongst Australian colonists for the support he so frequently and so munificiently displayed in the interests of education and exploration in his adopted country. Had it not been- for a timely and generous contribution from him to the straightened funds of the Museum the exploration could only have been very inadequately carried out. Even as it is, much remains to be done, not only in this partially explored and promising bed of Lake Callabonna., but in many other localities. It is to be hoped, therefore, that the South Australian Museum mayy be soon put in such a position that it may.be able to resume its investigations in this direction. For the present, however, it can only be regretted that its exiguous means renders any such undertakings quite impossible.

EXPLANATION OF PLATE A

Fig. 1. View, looking south-west, showing part of the flat saline expanse of Lake Callabonna, with the western shore just visible as a dark streak. The elevation in the foreground is the top of the sand-dune at the foot of which, on the further side, somewhat to the right of the erect figure, the camp was situated. The vegetation is stubbly samphire *(Salicornia)*. The bulk of the fossils were obtained on the flat to the (observer's) right of the erect figure on the sand-dune.

Fig. 2. Surface skeleton of *Diprotodon australis* (vide p. x.).

Fig. 3. Skeleton of *Diprotodon australis* in process of excavation. The head appears in the right foreground; the right humerus is extended to the (observer's) left; a stick crosses, and is bound to, the pelvis, and the tail is seen resting on a white patch.

Fig. 4. Head of *Diprotodon australis*, partially exposed, lying in the clay matrix.

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