BULLETIN OF THE AUCKLAND INSTITUTE AND MUSEUM
No. 1.

THE MOA

A STUDY OF THE DINORNITHIFORMES

BY
GILBERT ARCHEY

PUBLISHED BY ORDER OF THE COUNCIL
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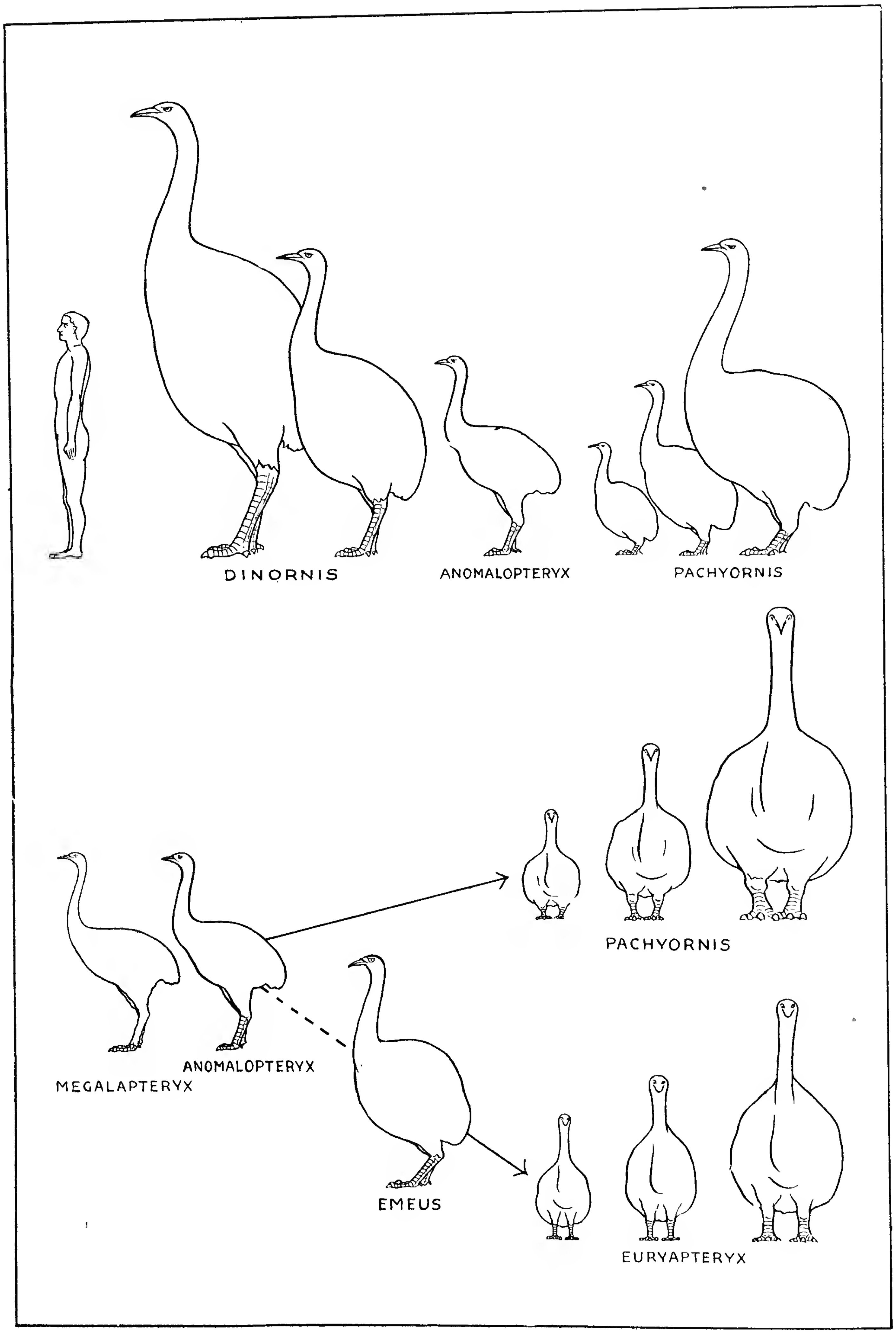
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INTRODUCTION.

It is just over a hundred years since Professor Richard Owen exhibited to the Zoological Society of London part of a large bone from New Zealand brought to him by Dr. John Rule, and, as the result of examining it, declared ". . . . so far as my skill in interpreting an osseous fragment may be credited, I am willing to risk the reputation for it on the statement that there has existed, if there does not now exist, in New Zealand, a struthious bird nearly, if not quite, equal in size to the Ostrich."

Owen's "osseous fragment" has been reinforced by vast quantities of skeletal remains from many sources, and his brief paper of 1840 has been followed by a voluminous literature on the extinct giant flightless birds of this country, a literature of over four hundred contributions from one hundred and eighty authors! Owen, who gave us the foundation and framework of our understanding of the moa; Haast, Hector and Hutton; Lydekker, Parker and Forbes; these are the names that stand in our mind as the leaders in the keen enquiry that followed Owen's first bold deduction. But over a century of discovery and of research and speculation has not been able to establish finality, either in fact or inference, in this fascinating field of study, for each new find or investigation, in solving some problem, has as frequently revealed new uncertainties. Nor can the present study, instigated through the discovery of some new North Island collecting fields yielding the remains of individual birds, pretend to resolve outstanding issues. It is primarily systematic; it has endeavoured to review the material and literature of past investigations, and it includes a detailed study of the new collections and of as much of the older material, including types, as could be located in New Zealand and Great Britain. It is hoped that the changes that have been made in the names of species and their generic grouping may take us a little further towards the desired final classification, but there still remain difficulties in discerning the natural relationships underlying the variability in form and size exhibited among moa bones and skeletons; there are unsolved problems, too, in nomenclature and the fixation of types, and, apart from systematic details of this nature, there still remains room for differences in interpretation of the facts already established.

In 1930 Mr. W. H. Gregory, engineer-in-charge of the Waikaremoana hydro-electric station, discovered moa remains in the caves which occur throughout the outlet barrier-wall of Lake Waikaremoana; following this discovery a collecting excursion was arranged by Mr. F. Crossley Mappin, with Sir Carrick Robertson, Mr. A. T. Pycroft and the writer, to explore the area. Trips were made in 1930, 1931 and 1935, and in the intervening period the high limestone country of the Mangaotaki Valley, the Te Anga Valley and the hill country of Mr. Phillips' property at Marakopa were similarly investigated, all with gratifying results.

In 1932, skeletons were excavated from the sand-dunes at Doubtless Bay and presented to the Museum by Mr. L. J. Matthews and his son, Mr. Geoffrey Matthews. It was in this area that Mr. Matthews senior, thirty years before, had discovered the two moa eggs described by the writer in 1931. Remains from these sandhills have also been presented by Mr. E. T. Frost and Major G. A. Buddle; others from Doubtless Bay and the North Cape district were secured this year by Mr. Pycroft, Mr. H. R. Jenkins, Mr. A. B. Deeming and the writer. A further series was obtained in 1933 from caves on the Mt. Arthur table-land, Nelson, by Messrs. F. Gibbs, H. Kidson, S. W. Street and Wm. C. Davies, who kindly organised the trip for my benefit and participation. During last summer Mr. J. Hodgen discovered remains in a swamp on his property at Pyramid Valley, near Waikare, North Canterbury. The site is being carefully excavated by a Canterbury

Museum party, and, contrary to past experience in swamps, has yielded individual skeletons. I have had the pleasure of joining one Canterbury Museum excursion and have had the advantage, not only of readily given facilities for studying the specimens, but also of helpful discussions with Dr. R. A. Falla, Director of the Museum, concerning them.

Altogether 50 fairly complete skeletons and over 100 partial sets of the bones of individual birds have been secured from these various sources. A study of this material and of the individual skeletons already in other museums in New Zealand and in the British Museum, has made it possible to present a detailed account of certain species, and, by ascertaining the range of variation that occurs, to judge the value of certain characters as a basis for classification.

It will be seen that I am indebted to many friends who have contributed to the assembling of this important material, and I hasten to make my grateful acknowledgment to them all for their help. I am particularly beholden to Mr. Mappin and to Sir Carrick Robertson and Mr. Pycroft, whose enthusiasm, energy and good company through many seasons of assiduous search and collecting among rocks and caves and through fern, supple-jack and brambles, provided a spur, shall I say, and encouragement in pursuing this study. No less than 42 skeletons or individual sets of bones were secured through their explorations. I have made many demands upon my colleagues the directors and curators of all the New Zealand museums for facilities to examine specimens, for the loan of them, and for taking measurements which I had missed during my visits. Mr. J. Grant, Hon. Director of the Wanganui Museum, generously gave me the detailed measurements and calculated proportions of the large number of bones which he and Mr. Shepherd have recovered from the Makirikiri deposit, and Mr. A. Robertson of Wanganui invited me to inspect his considerable collection from the same site and kindly arranged all the specimens for examination and measurement.

I have to acknowledge helpful suggestions and assistance from Dr. R. S. Allan, Hon. Palaeontologist of the Canterbury Museum, and Mr. A. W. B. Powell, of our own museum, in connection with references, problems of nomenclature and fixing of types; Mr. Powell has also drawn plates 6, 8 and 12 to 15 and all the text-figures, as well as giving me helpful advice with regard to the other drawings. Sir William Benham has most obligingly written long detailed replies to my questions about Otago Museum specimens; Miss Dorothea M. A. Bate and her colleagues in the Geological Department of the British Museum have most courteously and readily made available the many specimens from their collections that I desired to examine, and I received a like cordial welcome and help from the late Lord Rothschild and Dr. Jordan at Tring. Nor must I forget to record my indebtedness to many students, including past teachers and friends, whose investigations have been freely drawn upon, particularly in the interpretative portion of this study. Finally, I have to acknowledge the generosity of the Carnegie Corporation of New York, both for the visitor's travelling grant which enabled me to examine the material in Great Britain and for a further grant on my return for visiting the museums in our own country.

TYPES AND NOMENCLATURE.

All who have recently studied the Moa have remarked upon the uncertainty and confusion that exist in the classification of the group. This is partly due to the puzzling manner in which the species grade into one another; but it is equally due to the fact that most of the species have been founded either on single bones, or more frequently and unhappily, on mixed bones, i.e. those not of individual birds, sometimes even on bones from more than one source.

Sir Richard Owen's historic studies were, of necessity, based upon material of this kind whereby he was led in some instances to associate in one species bones which have subsequently been shown to belong to more than one. He himself made certain corrections, and others have yet to be made. Further confusion, it must be said, resulted from his lack of precision in proposing species: they are sometimes indicated in the most casual manner without the nomination of types, with particularly unfortunate results when mixed bones were being examined.

Rules of nomenclature had not been formulated in Owen's time, and their present strict application, by which alone can finality be reached, may in some cases seem to nullify Owen's intention. This is unfortunate; but we have to accept what he actually did rather than what he intended to do. For instance, he intended that his extensive illustrated papers in the Transactions of the Zoological Society should be the means of establishing his species; but frequently the brief advance notices in the Proceedings of the Zoological Society contain adequate descriptions and must therefore be accepted as prior designations. It may thus be necessary to correct, even to criticise certain phases of Owen's systematic work; on the other hand one cannot refrain from paying a tribute to his masterly anatomical analyses and his skill in deducing form and function from skeletal material.

Later workers of the last century unravelled some of the confusion, but in many cases they added to it, partly because they, also, had incomplete and mixed material for study, and partly because the workers were in different countries. Lydekker, in England, had some of Owen's types and the large collections, for the most part of unassociated bones from several localities, in the British Museum. Haast and Hutton had extensive series, chiefly of leg-bones from the swamp deposits of Glenmark, Enfield, Kapua and Hamilton's (the latter in Central Otago), but no early types. I can find no record that Lydekker had actually compared the British Museum material with Owen's types. The latter were supposed to be in the Museum of the Royal College of Surgeons, but they could not be identified there when I examined this collection in 1937,* and I am constrained to make the suggestion that when Sir Richard Owen transferred to the British Museum he may possibly have taken specimens with him to continue his studies, and that the types may therefore still be in the British Museum, unrecognized, and possibly now unidentifiable. Fortunately, there are casts of some of them in the British Museum.

Hutton, having for examination many hundreds of mixed bones from swamps and finding that, although they varied considerably in size and proportion, there was no definite break which might distinguish the groups, established certain species on "points of concentration" in the recorded dimensions, i.e. on dimensions that were strongly represented numerically in his series. Unfortunately he also failed to designate types, and in order to embody these idealistic species I have, where possible, nominated lectotypes from among Hutton's specimens. Nomination of lectotypes is made in the synonymy of the different species concerned.

Parker (1895b) propounded a classification based on skull characters. It is an admirable comparative study of skull anatomy, but as a systematic study suffers from two defects. The skulls were for the most part not from individual skeletons, and were assigned only interpretatively, and sometimes wrongly, to already-described species founded on leg-bones, which, having priority, cannot be ignored. Rothschild (1907) did not introduce any new criteria for the determination of species; he did, however, give names to certain species designated by Parker as species α, sp. β, sp. γ.

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*Sharpe (1891, 424 footnote) reported them missing nearly fifty years ago.

Oliver's classification (1930), which was followed by Lambrecht (1933), is based on the proportionate widths of the leg-bones, and is in line with the evolutionary trend towards increased bulk perceived by Owen (1844b, 241-3, 250; 1873a, 362), who recognized also the classificatory significance of the accompanying decrease in metatarsal length.

It now appears that these principles can be followed only in part; moreover the skull characters as defined by Oliver require adjustment in the light of information derived from newly-found individual skeletons. These, it is believed, disclose the types of skull characteristic of the genera. They also reveal that two subfamilies with widely differing skulls, sterna and phalanges have independently embarked upon identical courses of development of shorter and heavier leg-bones. This hitherto unsuspected parallelism in evolution has, perhaps more than any other factor, obscured the relationships of the genera and species of moa. Re-arrangements will therefore be necessary both on the basis of the characters used and, as is so often tiresomely necessary in a revision, through the fixing of types and priority, according to the Rules of Nomenclature.

Because of the numerous cases in which species have been founded on more than one bone, not being those of an individual, close attention has had to be given to the fixing of types, and in this connection the correct procedure to be adopted is important. Both the present writer (1927, 156) and Oliver (1930, 35) had assumed that the procedure was to fix the first-described bone as the type specimen and to ignore the others as regards that species, but Dr. R. S. Allan has kindly drawn my attention to the undesirability and doubtful validity of this course. My special thanks are due to Dr. Allan: not only has he given me the memorandum he intended to publish on this matter, but he has also handed to me the bibliographical notes and references to the proposals of genera and species that he had brought together. These have enabled me to check my own compilation and have also drawn my attention to references that I should otherwise have overlooked. I have availed myself of his advice on several points in synonymy and have had his co-operation in preparing the undermentioned statement of a problem on type fixation forwarded for an opinion to the International Commission on Zoological Nomenclature.

Returning to type-selection, Dr. Allan's view is that, where a species is based upon more than one bone not being those of an individual, and where the author has failed to designate or indicate a type, all the bones described in the original publication are of equal value and must be treated as co-types or syn-types until a subsequent reviser shall have nominated one of them as a lectotype and thereby given it the status of a holotype. This selection, once made, is not subject to change. To proceed otherwise, Dr. Allan observes, is to do scant justice to earlier workers who have adopted this method, and to reverse decisions made by them after due consideration. With this one can but agree (though I may later have occasion to express a wish that in some cases the selector had chosen other than he did), and, in the absence of rules for selecting the type of a species, the procedure outlined above, based as it is on Rule 31 governing the selection of genotypes, is acceptable and will be followed here.

Arising out of this procedure a new question arose in the case of *Dinornis novaezealandiae* as to whether certain proposals by Owen, made after his original proposal of that species but not in themselves a definite selection of a type, had, or had not, *had the effect* of determining the type specimen, and, thereby, of invalidating Lydekker's subsequent nomination of a lectotype. The case has been presented to the International Commission on Zoological Nomenclature whose opinion is, however, not yet available.

SIGNIFICANT CHARACTERS AND CLASSIFICATION.

Before entering upon detailed descriptions of the genera and species we should discuss two factors that have created uncertainty in classification, (a) the form of the beak, and (b) size and proportions of leg-bones.

(a) **Form of the beak.**

No uncertainty as to identification arises in the case of the wide flat skulls, with broad terminally depressed beaks of the species of *Dinornis* (Pl. 5, fig. 1), nor is there any difficulty in distinguishing either the skulls of *Anomalopteryx* with their large temporal fossae and characteristic narrow beak, or the much smaller, round-contoured skulls of *Megalapteryx.* Identification in these cases has been facilitated by the discovery of sufficient skeletons to establish the correct association of skulls with leg-bones. The uncertainty has arisen in the case of the heavier moas, through the occurrence in swamp and dune deposits of broad-billed and sharp-billed skulls mingled indiscriminately with several kinds of leg-bones, whose proper relations to the skulls, and to one another, the lack of individual skeletons has made difficult to determine.

In 1870 (p. 123, pl. 10) Owen described certain unassociated crania and sharp-pointed beaks as being of *D. elephantopus.* From further unassociated material he referred to *D. crassus,* a skull having both a broad bill, and, if one can judge from the illustration (pl. 11), a collapsed or constricted antrum wall. He assigned to *D. rheides* a sharp-billed skull (pl. 12), (really of *Em. crassus),* and he proposed the name *Dinornis gravis* (p. 141, pl. 14) for a skull lacking a premaxilla but with a broad mandible, which, from his statement that he had here "parts of the skeleton of the same individual bird," we can assume belonged to it. No question of generic grouping was involved in these descriptions.

When Haast (1874) proposed a classification of the group he regarded his *Meionornis* (type *casuarinus)* as having a narrow pointed beak, *Palapteryx (elephantopus)* as having the bill obtusely rounded, and *Euryapteryx* (type *gravis)* as possessing a bill "not so obtuse as the former." Lydekker (1891) included the round-billed skulls in *Emeus* ("the mandible is in the shape of a wide U") and proposed the genus *Pachyornis* (type *elephantopus)* for those with a sharp narrow beak. Parker (1895b) followed the same arrangement, and made the further observation that the broad-billed skulls *(Emeus)* lacked the antrum cavity.

Oliver (1930) reversed this, stating that *Emeus* had a pointed bill and *Euryapteryx* a broad one. This arrangement appeared to be right according to the then known individual skeletons, three only, belonging, apparently, to these genera, i.e., the broad-billed *Eu. ponderosus* from Riverton (Otago Museum), *Eu. kuranui* (Canterbury Museum) and the sharp-billed Amodeo Bay skeleton which the present writer (1927) had described as *C. geranoides* and Oliver referred to *Emeus exilis:* the broad-billed skull of the type of *Em. exilis* Oliver reported as being doubtfully associated with it.

Oliver's grouping, however, ignored the long narrow beaks known to exist on large skulls, i.e. *Pachyornis immanis* of Parker (1894, 224), *P. elephantopus* of Parker (1895b, 375, pl. 60, fig. 22) and *Mesopteryx* sp. β of Parker *(ibid.* 378, pl. 60, figs. 20-21).* Except for the latter these narrow sharp beaks are not certainly associated with their crania, though of one of them Parker had "no doubt that they belonged to the same individual"; moreover they were found with the crania, are appropriate in size to them and much too large for any known species of *Emeus.*

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*Figured by Oliver as "Skull of *Emeus.*"

In the Otago Museum collection there are several perfect skulls, not, however, associated with skeletons, with a broad rounded bill and a collapsed antrum (Pl. 7, fig. 4); *per contra* there are two skulls with a cranium as large as that of the Riverton "*E. ponderosus*" (Hamilton, 1898 = *Eu. gravis* of this paper), but with a pointed bill and an expanded antrum (Pl. 8, figs. 1 and 2). It is not certain in these cases that the beaks belong to the crania, but again they are of the right size and much too large for any known species of *Anomalopteryx* or *Emeus.*

None of the large, sharp-beaked skulls, it will be noted, was found with its skeleton, and the only appropriately sized leg-bones with which they might have been affiliated were of the same size and proportion as those of *Eu. ponderosus* and *Eu. kuranui.* Lydekker (1891a, 316) linked the sharp-beaked skulls with tibiae that were strongly inflected, and with certain very wide metatarsi; it happens that he was mainly right, but he had, at that time, no real grounds for this association, for the type skeleton of *elephantopus*, the species on which he established his sharp-beaked genus *Pachyornis,* is composite, a reconstruction from mixed bones. From a series of small North Island individual skeletons obtained during our own collecting, and from large skeletons secured by Canterbury Museum from the Pyramid Valley swamp, it has now been ascertained that three types of skull can be recognized: (a) sharp-billed, as in *Anomalopteryx,* but rather shorter and broader than in that genus; (b) with a narrow bill moderately rounded at the tip; and (c) with a broad, obtusely rounded bill. (Text-figs. 11a, b, c, p. 45.) These three types of skull adequately separate the genera (a) *Pachyornis,* (b) *Emeus,* and (c) *Euryapteryx,* and are found to be associated with different forms of sterna and also with certain types of leg-bones. The latter, however, present their own problem in classification, i.e. the difficulty, especially marked in the three genera just named, of distinguishing species or genera by measurements of leg-bones.

Size and Proportions of Leg-bones.

The fact is, many leg-bones, taken by themselves, cannot be identified by their size and proportions as being of this or that species or genus, and sometimes even a careful study of their form will not help us. For instance, the three tibiae shown in outline on Plate 13 are almost indistinguishable from one another, yet they belong to three different genera in two separate sub-families. When, however, examination can be made of sets of leg-bones of individual birds, distinguishing characters readily present themselves in the length, and sometimes the proportionate breadth of the femur and metatarsus in relation to the length of the tibia. The three genera included on Plate 13 are *Anomalopteryx, Emeus* and *Euryapteryx;* but, when we come to distinguish the last, *Euryapteryx,* from *Pachyornis,* we are faced with the further difficulty that these two genera not only have the same relative lengths of the three leg-bones, but also exhibit the same range in width of bones, from moderately stout to extremely massive forms. In the North Island the species of *Euryapteryx* are small, and are exactly matched as to relative length and proportions of the leg-bones by like-sized species of *Pachyornis,* while in the South Island the species of both genera are larger and again exhibit an almost identical range of sizes and of attainment of massive proportions in their leg-bones.

At one time, having in mind the exact similarities in leg-dimensions in all these heavy footed moas, and the occurrence together, in the same sand-dune deposits, of sharp and broad-billed individuals with the same sized leg-bones, I had come to regard them as representing species exhibiting sex-dimorphism in the skull, as in *Heteralocha,* the New Zealand *huia.* The accompanying differences in the sterna, however, and slight modifications in the form of the leg-bones, together with the retention of five outer phalanges in the sharp-beaked forms and their reduction to four in the broad-billed (and in *Emeus),* indicated that the birds stand related by these latter characters rather than by similarities in the leg-bones, which are to be regarded as the result of parallel development.

The facts just related, considered in conjunction with others mentioned below, provide the basis of the classification set out in paragraph 8 following.

1. The acceptance of a wide range both in length and proportionate width of the leg-bones of any one species seems to be inevitable; this clearly emerges from the dimensions of 43 individuals of *Anomalopteryx didiformis,* mostly from the North Island, including 15 from the one locality, Lake Waikaremoana, where the conditions indicate that they were approximately contemporary.

2. The relative length to one another of the three leg-bones is a more important criterion for classification than length and breadth of the bones. In the largest moas, *Dinornis,* the metatarsus is well over half the length of the tibia; in all the others it is hardly more than half as long, usually considerably less. A decrease in the length of the femur generally accompanies that of the metatarsus.

3. On the basis of the dimensions and proportions of leg-bones alone, there would, at first sight, seem to be a single line of evolutionary development towards shorter and stouter legs with increased shortening of femur and metatarsus. This apparently single line of development proves to be *double* and *parallel* : i.e. it has taken place in two groups here accorded subfamily rank. These groups are well defined by differences in the form of the skull and beak (4), by the number of phalanges on the outer toe (5) and less clearly by the form of the sternum (6).

4. The tallest moas, *Dinornis,* with long metatarsus, have an exceptionally broad flattened skull with a broad flat beak; the outer toe has five phalanges. These comprise the family Dinornithidae (Oliver 1930). All the others are shorter birds with metatarsi of reduced length and the skulls higher or more rounded in section. The beak also is higher whether it is narrow and sharp, or broad and blunt. These are the family Anomalopterygidae (Oliver *ibid.).*

5. (a) Of the Anomalopterygidae three genera have the normal five phalanges in the outer toe: they comprise the subfamily Anomalopteryginae. They also have skulls with sharp-pointed beaks and with expanded maxillary antra. (Text-fig. 10b, p. 42.) Genera *Anomalopteryx, Megalapteryx* and *Pachyornis.*

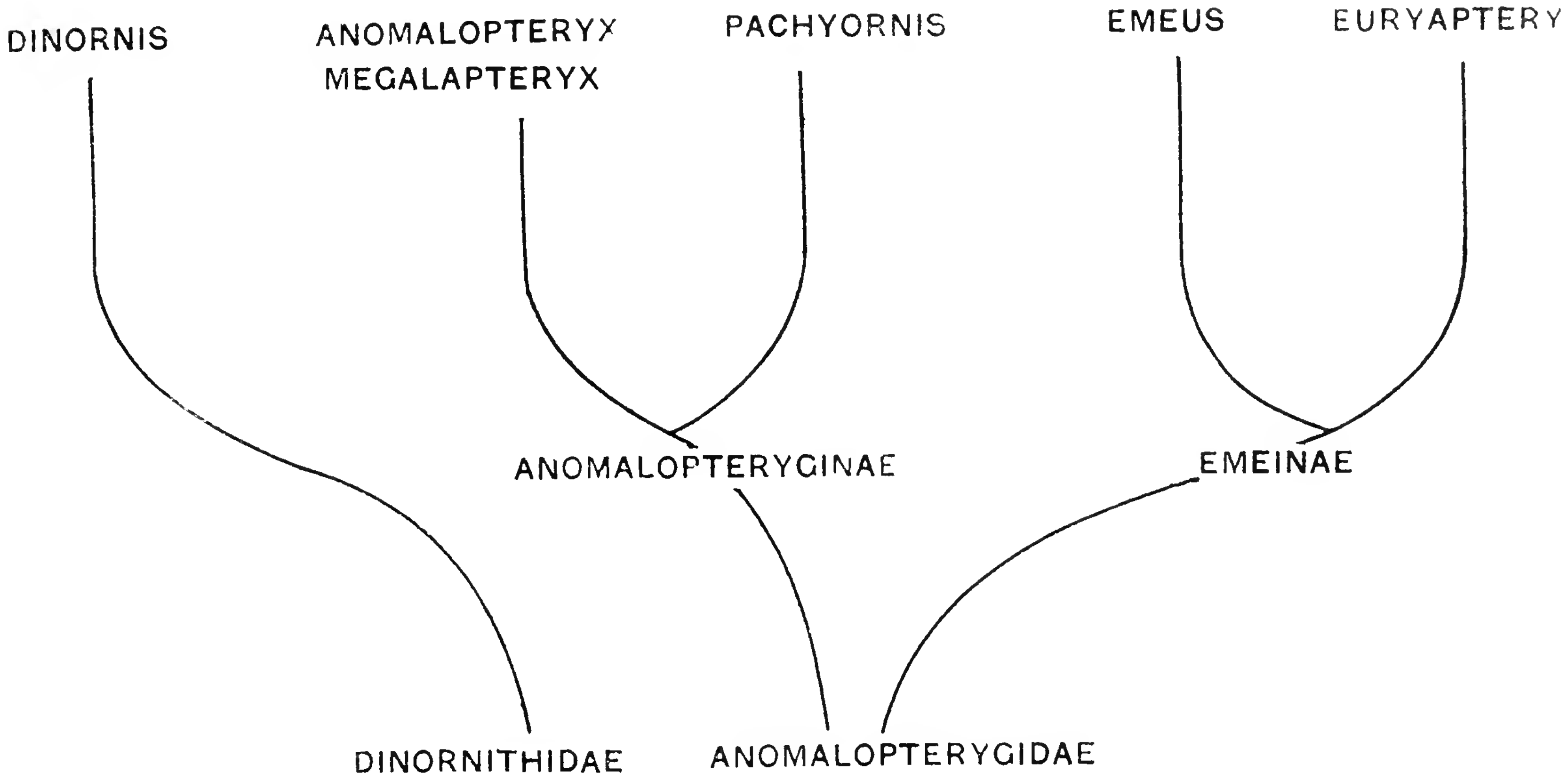
   (b) Two genera of Anomalopterygidae have four phalanges in the outer toe (subfamily *Emeinae):* one of them, *Emeus,* has a narrow beak with a somewhat rounded tip, and with the maxillary antra expanded, but not to the same extent as in the Anomalopteryginae. The other genus, *Euryapteryx,* has a broad beak with a rounded tip and with the maxillary antra collapsed. (Text-fig. 10a.)

6. The sternum is short and broad or moderately broad in the Dinornithidae and Anomalopteryginae; it is long and narrow in the Emeinae.

7. Parallel development of shorter and stouter leg-bones is especially marked as between *Pachyornis* (Anomalopteryginae) and *Euryapteryx* (Emeinae).

8. To repeat : the tall Dinornithidae, with flattened broad skulls and the normal number of phalanges, are regarded as standing apart from the others. In the Anomalopterygidae the genera *Anomalopteryx* and *Megalapteryx* are slenderest, and in this respect, and in their normal number of phalanges, stand nearest to the Dinornithidae. *Pachyornis,* which also retains five outer toe phalanges, exhibits increased stoutness and curvature of the leg-bones (bandy-leggedness) and stoutness of body (broad pelvis and sternum); this is developed to a moderate extent in the small North Island species, but to an amazing degree in the large species of the

South Island. The genus *Emeus* (four outer-toe phalanges) has diverged from the proportions of *Anomalopteryx* only moderately in the direction of shorter and stouter limbs; in skull form however it shows a slight increase in breadth and bluntness of the bill and reduction of the antrum, thus faintly foreshadowing the very broad bill and completely collapsed antrum of *Euryapteryx*. The latter genus has also gone further than *Emeus*, indeed nearly as far as the South Island species of *Pachyornis*, in increased breadth and massiveness of the leg-bones. These relationships may be indicated graphically thus—



We rely, therefore, on structure and form rather than on size, for generic characters; but we still have to depend on differences in size for the separation of species. It will appear that all the specimens of *Anomalopteryx* are included in the one species, except for the fragments of much smaller bones which somewhat precariously sustain *A. antiquus*. Similarly, except for an exceptionally large femur and tibia on which *M. benhami* is founded, all the specimens of *Megalapteryx* are included in one species. There are no specially marked "out-sizes" in the series of North Island skeletons of *Pachyornis* and *Euryapteryx*, yet there are grounds for admitting more than one species in each genus.

In the first place there is, in the North Island skeletons of *Pachyornis* and *Euryapteryx*, a much greater total range in sizes than in those of *A. didiformis*, notwithstanding that they are smaller birds. For instance the range in total length of the three leg-bones in 40 specimens of *A. didiformis* is barely 30% above the smallest total length, whereas it is 38% in the same number of *Euryapteryx* skeletons, and over 40% in specimens of *Pachyornis*. In the second place there is, about the middle of the otherwise even sequence from the smallest to the largest *Euryapteryx* specimens, a small but clearly marked break both in size and proportions of the leg-bones. The very large range in sizes, together with the break in the sequence, is considered to warrant the admission of two species. A precedent for this course may, as Dr. Falla reminds me, be found in the general recognition of *Apteryx haasti* and *A. oweni* as separate species, notwithstanding the intermediates in both size and plumage that occur. Among the smaller specimens of *Euryapteryx* there is an even better separated group of still larger skeletons which are recognized as a third North Island species of this genus. In *Pachyornis* the specimens fall into two distinct size groups, and although this may be due to there being fewer specimens available for measurement, they are accepted as representing two North Island species in this genus also.

In the same way in *Emeus* there is an even graduation of sizes in the specimens attributed to *Em. crassus;* but there is a distinct drop in size to the largest of the next group, which is accordingly identified with *Em. huttonii.* While some of the breaks in the sequence of sizes may ultimately be closed by later discovered specimens, it is considered that in the meantime the differences that exist should be recognized and the corresponding specific names retained.

Note re Synonymy: It will be clear, from what has been said above about the leg-bones in *Pachyornis* and *Euryapteryx,* that many of the previous descriptions of material will have included specimens of both genera under one name. In order to avoid omission of references and at the same time to include under the names here adopted only indubitable references to the species concerned, I have set out, separately under the relevant species, the references that are part *Pachyornis* and part *Euryapteryx.*

DESCRIPTION OF GENERA AND SPECIES.

This section commences with a detailed examination of the skeleton of *Anomalopteryx didiformis,* of which I have 32 individuals of our own collecting and measurements or the published records of 11 other individual specimens. The variation of the different characters will be recorded, and discussed as to the range which may be expected within a species; the relative variation of skull and pelvis as to the leg-bones will be significant in this respect. A brief analysis of fifteen skeletons or partial individuals of *Megalapteryx* will follow, and the material available in the other four genera, *Pachyornis, Emeus, Euryapteryx* and *Dinornis,* will be discussed in the same manner, i.e. dimensions of all individuals known and of types of the species that have been proposed will be set out as evidence for the classification proposed and as conveniently arranged records for future students. I may appear to have given over-full bibliography, synonymy of species and other references, but these details are so scattered and have proved so tedious in the compilation that I feel I should at least make them available.

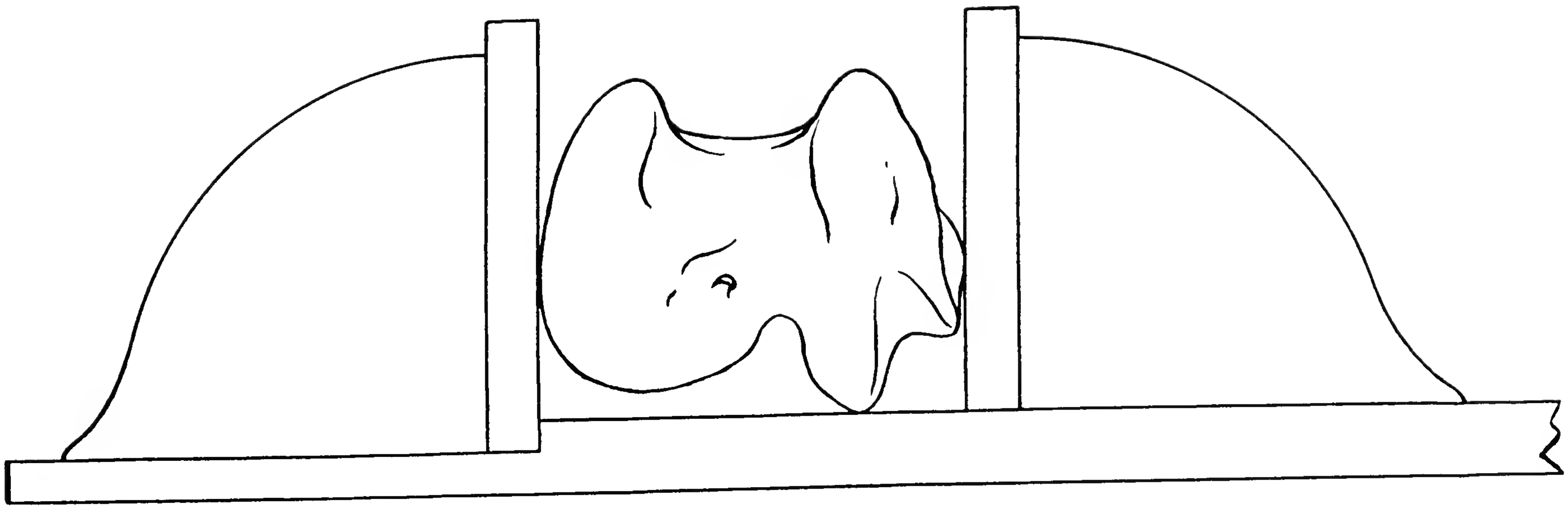
In each species the leg-bones will first be discussed and the remaining characters in the order skull, vertebral column, pelvis and sternum. For brevity the tibio-tarsus and the tarso-metatarsus will be called tibia and metatarsus.

Wherever dimensions of leg-bones are given, either in tables or in the text, they will be in centimetres in the following order.

Length.	Proximal Width.	Middle Width.	Distal Width.	Girth.
17.5	5.75	3.20	7.83	8.1
	32.8	18.2	44.7	46.3

The second line gives the widths as percentages of the length as used by Oliver. I have added the girth, or circumference at the middle of the shaft, not because it is in itself especially significant, but to facilitate comparison with the dimensions supplied by earlier students who not infrequently recorded length and girth only.

The measurements have all been made between uprights and, to measure widths, the bones have been placed at right angles to the direction of the measuring slide (Text fig. 1). The shorter measurements were made to tenths of a millimetre, and the proportions calculated on this basis: this was only because the calipers gave this refinement and it was just as easy to read to two places of decimals as one on the slide-rule by which the proportions were obtained. These dimensions have been given in the tables only to the nearest millimetre, partly because recordings to two decimal places suggest a degree of accuracy that is really quite spurious when the varying shapes of the bones are considered and also because the figures themselves, if given to two places, suggest a greater



Text-fig. 1. Measuring apparatus.

difference than is really significant in one or two tenths of a millimetre. I mention this because, by calculating from the measurements as now adjusted to the nearest millimetre, the results might differ slightly from the *proportions* entered in the table, which were, in fact, calculated from finer detail than is actually recorded.

In the systematic portion, which follows immediately, the necessary nomination of lectotypes is made in the synonymy against the appropriate citation of the species concerned.

Genus *Anomalopteryx* Reichenbach, 1852.

1852	.. .. ..	*Anomalopteryx* Reichenbach, Av. Syst. Vog. p. xxx. Type, by monotypy, *Dinornis didiformis* Owen.
1897	.. .. ..	*Anomalornis* Hutton, Trans. N.Z. Inst., 29, p. 543. Substituted for *Anomalopteryx*, supposed wrongly by Hutton to be preoccupied.

Two species:—

A. didiformis (Owen), in which are included *Dinornis dromaeoides* Owen, *Dinornis parvus* Owen, *Anomalopteryx fortis* Hutton and the metatarsus of *Palaeocasuarius velox* Forbes.

A. antiquus Hutton. p. 29.

Anomalopteryx didiformis (Owen), 1844.

1844	June 5 ..	**Dinornis didiformis:** Owen, Trans. Zool. Soc. London vol. 3, pt. 3, p. 242, pl. 27, figs. 3-6.
		Dinornis dromaeoides: Owen, *ibid,* p. 253, pl. 22, figs. 1, 2; pl. 23, fig. 1. Type: femur from Poverty Bay. No. f.16 in Table of Admeasurements, Owen p. 248; originally in Museum of Royal College of Surgeons. Casts in British Museum (18598, Lydekker p. 267) and Canterbury Museum.
1845	.. .. ..	*Dinornis didiformis,* Owen, Cat. Foss. Org. Remains (Mammalia and Aves) Mus. Roy. Coll. Surg. p. 361.
		Dinornis dromaeoides: Owen, *ibid,* 369.
1869	May	*Dinornis didiformis:* Haast, Trans. N.Z. Inst. 1, pp. 82, 83 (2nd ed. 1875, pp. 23, 24).
1882	.. .. ..	*Dinornis parvus* Owen: Proc. Zool. Soc. for 1882, no. 1, p. 2 *(nom. nud.)*
1883	January ..	**Dinornis parvus** Owen, Trans. Zool. Soc. London, vol. 11, pt. 8, 233, pls. 51-58. Type: Skeleton from Pokororo, Nelson, in the British Museum (A.3, Lydekker, p. 279).
1891	April 25 ..	*Anomalopteryx dromaeoides* : Lydekker, Cat. Foss. Birds Brit. Mus. 266.
		Anomalopteryx didiformis : Lydekker, *ibid,* 275.
		Anomalopteryx parva : Lydekker, *ibid,* 278.
1891	November 13	*Anomalopteryx dromaeoides* : Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, Part III, 430.
		Anomalopteryx didiformis : Sharpe, *ibid,* 432.

1891	November	*Palapteryx dromaeoides* : Hutton (part, femur) N.Z. Journ. Sci. new issue, vol. 1, pt. 6, 248.
		Palapteryx plenus Hutton (part, femur) *ibid,* 248.
		Anomalopteryx didiformis : Hutton, *ibid,* 248.
1892	May	*Palapteryx dromaeoides* : Hutton (part, femur) Trans. N.Z. Inst. 24, 121.
		Palapteryx plenus : Hutton (part, femur), *ibid,* 122.
		Anomalopteryx didiformis : Hutton, *ibid,* 123.
1893	May	**Anomalopteryx fortis** Hutton, Trans. N.Z. Inst. 25, 9. Founded on three metatarsi a tibia and three imperfect femora from Glenmark in the Canterbury Museum. Of the metatarsi only one can now be identified in the Museum collection: it is here selected as the type.
1895		*Anomalopteryx didiformis* : Parker, Trans. Zool. Soc. vol. 13, pt. 11, 378.
		Anomalopteryx parva : Parker, *ibid,* 379.
1897	June	*Anomalornis didiformis* : Hutton, Trans. N.Z. Inst. 29, 547.
		Anomalornis gracilis : Hutton (not of Owen), part : tibia and metatarsus, *ibid,* 546.
1907		*Dinornis dromaeoides* : Rothschild, Extinct Birds, 194.
		Anomalopteryx didiformis : Rothschild, *ibid,* 202.
		Anomalopteryx parvus : Rothschild, *ibid,* 202.
		Palaeocasuarius velox Forbes (part) Rothschild, *ibid,* 220 (metatarsus).
1930		*Dinornis dromaeoides* : Oliver (part), New Zealand Birds, 41.
		Anomalopteryx didiformis : Oliver, *ibid,* 44.
		Anomalopteryx parvus : Oliver, *ibid,* 45.
1933		*Dinornis dromaeoides* : Lambrecht, Handbuch der Palaeornithologie 140.
		Anomalopteryx didiformis : Lambrecht, *ibid,* 143.
		Anomalopteryx parvus : Lambrecht, *ibid,* 144.

The type is a metatarsus from Poverty Bay. It should be in the Museum of the Royal College of Surgeons, but I could not identify it there. A cast of the type is in the British Museum (No. 18595; Lydekker, p. 276); its dimensions and proportions are:

	17.5	5.75	3.20	7.83
=	100	32.8	18.2	44.7

An individual skeleton with a metatarsus of approximately this size and proportions has the following leg dimensions:

Mangaotaki, A.M. 156

Femur	24.0	7.9	3.13	8.1
=	100	32.9	13.0	33.7
Tibia	37.7	10.05	3.34	5.4
=	100	26.6	8.8	14.4
Metatarsus	17.7	5.75	3.1	7.6
=	100	32.5	17.5	42.9

In this species the femur (Pl. 1, fig. 3) is long and of moderate width, not slender as in *Megalapteryx* (fig. 2); seen from the side it is almost straight and only slightly arched upward. The muscle ridges are well developed, but less strongly than in *Dinornis.* On the posterior surface there are two ridges behind the medullary foramen; the outer of these lies immediately behind the foramen, the inner some distance behind. In *Dinornis,* they are nearly opposite each other; in *Emeus* and *Euryapteryx* they are usually confluent, but when they are, as occasionally, separate, their relative position is as in *Anomalopteryx.*

The tibia (Pl. 2, fig. 3) is relatively stouter than in *Dinornis* and *Megalapteryx,* but less stout than in *Emeus;* its outer margin is straight with the proximal third elevated as the fibular ridge; its inner margin is deflected inwardly just above the trochlear bridge, more so than in *Megalapteryx,* less than in *Pachyornis.* The proximal end is expanded and the procnemial crest is strongly deflected outward, following to some degree the direction of the ectocnemial. Except that it is usually straighter and its distal end is less deflected inwardly, it does not differ very much from the tibia of *P. mappini.* In proportionate width the metatarsus (Pl. 3, fig. 3) stands between *Megalapteryx* (fig. 2) and *Emeus* (fig. 5). The femur is considerably longer than the metatarsus, and both bones are longer in proportion to length of the tibia, than in species of *Emeus.*

The 43 skeletons or individual sets of bones that I refer to this species display great variation in size and proportion of all the leg-bones (Table A).* This variation cannot, however, be expressed merely by stating that certain birds are larger and others smaller. Among individuals which, for instance, may have been grouped for their possession of a long tibia, some will be found to have the femur and metatarsus correspondingly long; in others both these bones will be relatively short; or the femur may be long and the metatarsus short, or *vice versa.* This is sufficiently demonstrated by arranging the femora, the tibiae and the metatarsi each in order of length independently of their individual association, and then drawing connecting lines between the bones of individuals (Table 1). The considerable range in size and proportion of the three leg-bones in different individuals indicates the unreliability of a table of dimensions and proportions of a series of any one leg-bone as a basis for the establishment of a species. The table also shows how easily mistakes can be made in attempting to group into species-sets the mixed bones from a swamp deposit.

The extent of variation in the *length* of the leg-bones recorded in Table 1 is as follows:—

	Max.	Mean.	Min.	Range.
Femur	27.5	23.3	20.0	7.5
Tibia	43.4	37.8	32.3	11.1
Metatarsus ..	21.2	17.9	15.7	5.5

A wide range of variation is also found in the *proportionate width* or stoutness of the bones as the following record of maximum and minimum proportionate width (length = 100) shows.†

	Femur.			Tibia.			Metatarsus.		
	Prox.	Mid.	Dist.	Prox.	Mid.	Dist.	Prox.	Mid.	Dist.
Max.	37.5	15.7	43.0	29.4	10.1	16.7	36.1	20.7	49.0
Mean	33.4	13.9	37.6	27.3	8.2	15.2	32.4	18.2	44.0
Min.	29.3	12.1	32.3	25.2	6.4	13.8	28.8	15.8	39.0

Another aspect of this variability is indicated by the range in proportionate width exhibited by ten tibiae of approximately the same length (37.4 to 38.0 cm.).

	Length.	Proximal.	Mid.	Distal.
Max. ..	= 100	28.9	9.35	16.4
Min. ..	= 100	25.3	6.68	14.4

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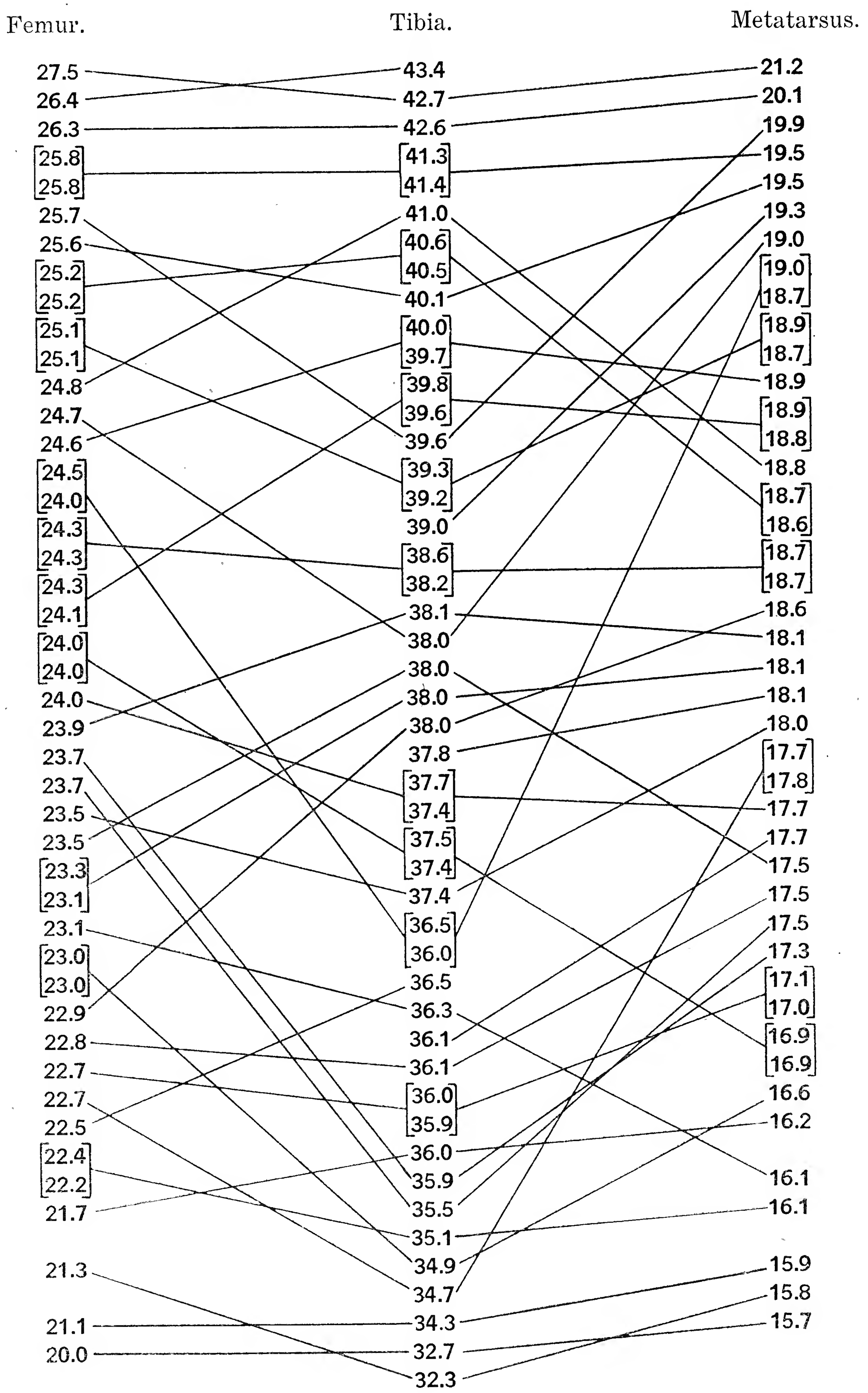
*Tables A to O, giving detailed dimensions and proportionate widths of leg-bones, are together following the plates; Tables 1 to 19, giving other dimensions, are distributed through the text.

†The above maxima and minima are not proportionate widths taken from a single bone; the proximal width may be from one bird, the middle width from another and the distal from still another. Sometimes in an individual (i.e. Tring Museum) the femur will be broad in all dimensions, with the proportions varying considerably in the other bones.

Table 1. *A. didiformis.*

Femora, tibiae and metatarsi each arranged in order of length: the lines connect the bones of individual birds.



We may include, as a further example of the variability in the relative stoutness of the leg-bones of this species, the following details of two individuals from the same locality (e.g. Waikaremoana, A.M. 70 and 71):

	A.M. 70.				A.M. 71.			
F.	25.75	8.46	3.41	9.54	25.15	8.88	3.60	9.38
	= 100	32.8	13.2	37.0	= 100	35.3	14.3	37.2
T.	39.6	11.67	3.30	6.07	39.3	11.17	3.75	6.14
	= 100	29.4	8.3	15.3	= 100	28.4	9.5	15.6
M.	19.9	6.41	3.34	8.24	18.7	6.4	3.68	8.46
	= 100	32.2	16.8	41.4	= 100	34.2	19.6	45.2

It will be seen that A.M. 70 is definitely more slender than 71 in all dimensions except that its tibia has a more expanded proximal end; there are, however, only negligible differences between their skulls, pelves and sterna.

Thus, throughout this series of skeletons, the variation in the leg-bones is not only continuous in a series of any one bone, e.g. femora or tibiae, but it is also haphazard and irregular as between the bones of individuals. An individual with a wide femur may have the tibia narrower and the metatarsus either wide or narrow, while any one bone may be wide in one transverse dimension and narrow in one or both of the others. It should also be noted that Table A includes the dimensions of only those bones which form part of an individual; the inclusion of dimensions of the numerous mixed bones available would show an even finer gradation of variation.

As will be seen later (p. 20) there is considerable variation in size and proportion of skull and pelvis; but I have not found it possible to associate any one type of skull or pelvis with either stout or slender leg-bones. Neither do the specimens from any one locality or area exhibit anything approaching a uniformity in size or proportions such as would warrant the recognition of local subspecies or varieties. The largest and nearly the smallest individuals in my material are from one restricted area, e.g. the Waikaremoana lake-barrier, and the range is nearly as great in the specimens from Mangaotaki in the North Island and Mt. Arthur in the South Island.

It might be suggested that the specimens we are considering represent merely an evolutionary development over a long space of time, and that the smaller forms are of an earlier period than the larger. Time may possibly have seen an increase in size in these birds, but it did not eliminate the smaller ones, for at Waikaremoana all sizes are approximately contemporary. The slip which fissured the sandstone and formed the caves that trapped the moas is of Recent origin (Marshall, 1927), and the birds must have lived subsequent to it. They are even later than immediately after the formation of the caves, for their skeletons lie above the Gisborne pumice layer which later covered the lake-barrier and was washed into the caves. I have no means of estimating the age of the Mangaotaki specimens, which also vary greatly in size.

At all events, it is clear that, on the basis of the size and proportion of the leg-bones, we have here a species exhibiting gradual and continuous variation in all dimensions and proportions. In this extensive range of variation the type of *A. didiformis* occupies a middle place, while the type of *A. parvus* is one of the smallest. There is no break between them, and *A. parvus* is accordingly included here as a synonym of *A. didiformis.* The type of *Dinornis dromaeoides* Owen, a femur from Poverty Bay, also falls well within the range of the femora of *A. didiformis.* The type itself is missing, but there are casts in the British and the Canterbury Museums, and one has only to place the cast alongside the femur of an indubitable *A. didiformis* to recognize that *D. dromaeoides* is identical with it.

I may add that the femur which Owen (T.Z.S. 3, Pl. 24), judged to be that of his *D. didiformis*, is probably that of *Eu. exilis*. Lydekker (1891a, 273) in discussing a cast of this latter femur recognized its distinctness from *didiformis*.

Previous writers, in commenting on the range in sizes of the moas, have suggested that one sex may have been the larger, as the female is in *Apteryx*. Hutton (1892b, 102) pointed out that, if this were so, the species should occur geographically in pairs, but those recognized by him did not do so. I am unable to discern two separate groups in *A. didiformis;* the leg-bones vary evenly as to length, and haphazardly as to relative width; neither can I detect any association of, say, a larger or broader pelvis, or a larger skull, with either the larger or smaller leg-bones. If the sexes were of different sizes, the size-range of the sexes overlapped.

Skull: For dimensions and proportions see Table 2.

Variability in the form and proportion is as marked in the skull as in the leg-bones, but there are sufficient constant characters to enable the skull of *Anomalopteryx* to be readily distinguished from that of the other genera. In general it is moderately wide, with very large temporal fossa and a long tapering sharp-pointed bill.

Viewed from the side (Pl. 4, fig. 3) the roof is evenly arched, sometimes with a slight eminence (single, not double) in line with, or just behind the postorbital processes; the premaxilla is long and curves downward to an acute tip, its lower margin also being slightly downcurved and slightly over-reaching the tip of the mandible. The posterior (paroccipital) margin of the tympanic cavity is oblique, sometimes convex, usually forming an angle with the upper margin, which curves forward and downward to merge anteriorly with the zygomatic process; sometimes, however, the outline of the cavity is an even arch slightly higher than wide. The temporal fossa is wide and deep, the temporal ridge extending from its confluence with the lambdoidal to high up on the roof; it is wider than the orbit; the mid-temporal ridge is always present and is sometimes prominent. The post-temporal fossa is a wide convex area, and the zygomatic process is moderately long and acute. The postorbital process, in lateral view, projects backwards to a greater or less degree. The upper margin of the orbit is usually evenly arched, but is sometimes obtusely angular, or even right-angled where the postorbital process joins the upper margin. The preorbital (lachrymal) curves evenly outwards and downwards, a deep notch near its extremity forming the mesial wall of the lachrymal foramen which is completed ectad and anteriorly by the maxillo-nasal (absent from fig. 3), a narrow slip of bone extending from the nasal along the front of the lachrymal and expanding below to join the maxilla.* In a few cases the outer wall of the lachrymal foramen is completed by further growth of the lachrymal bone itself.

In posterior aspect the skull in *Anomalopteryx* sometimes appears to be broader than in *Emeus,* but this is only because of its lesser height. The supra-foraminal ridge is not much swollen (as, usually, in *Emeus)* and the supra-occipital crest is a narrow, distinctly raised ridge; the supra-occipital pits are small or vague; there is a shallow depression on each side above the paroccipital processes. The outer borders of the paroccipital processes may be sinuate with the lower extremity of the process somewhat pointed, or they may curve evenly to a rounded lower margin; generally they reach to about half way between the levels of the condyle and the mamillar tuberosities. The latter are of moderate size, and separated by a wide arch.

In dorsal view (Pl. 5, fig. 3) the single slight eminence on the roof, if evident, varies in size and position. The lambdoidal and temporal ridges are almost invariably confluent (in one skull there is a separation of 1 mm. on one side only); the temporal ridges may

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*Parker (1895b, 383) had not seen this bone in *Anomalopteryx*, but thought it might be a separate element.

form an even curve or they may converge posteriorly and then turn sharply outward. The post-orbital processes are of moderate size and extend laterally only slightly beyond the squamosal prominences. The beak is long and narrow with a sub-acute tip; its lateral margins are slightly incurved, and this minor feature appears to be constant. Scattered pits, apparently pneumatic, occur above the orbit in all skulls; but there is no occurrence of the median pits, supposedly for crest feathers, that occur in *Dinornis.*

The ventral aspect (Pl. 7, fig. 2) exhibits less variation. The basitemporal platform is of the usual form, with the space across the mamillar tuberosities rather less than (but occasionally the same as) that across the basipterygoid processes. The median longitudinal depression in the platform does, however, vary considerably: it may be scarcely discernible, or a distinct groove deeper at either end. It is least developed in young skulls and its greater depth and distinctness seem to be the outcome of the thickening of the inner wall of the eustachian grooves. The rostrum has a slight constriction at about the middle of its length, and its triangular processes are moderately developed.

The maxillo-jugal arch, formed of the usual three parts, *maxilla, jugal,* and *quadrato-jugal,* is a nearly straight bar, exhibiting only a slight convexity in its posterior portion. In this respect it differs from *Pachyornis* (Pl. 7, fig. 3) in which the maxillo-jugal arch curves markedly outwards. The expanded anterior portion of the maxilla covers a spacious antrum cavity (Pl. 5, fig. 3) which opens posteriorly, usually by a wide round aperture, though occasionally by a narrower flattened, almost slit-like passage. The anterior part of the maxilla is partly overlaid ventrally by a thin triangular expansion of the palatine, the two together forming a maxillo-palatine plate. The three components of the maxillo-jugal arch apparently fuse together early, for in only one of my specimens can the junction between the maxilla and jugal be seen: in this case the jugal covers the maxilla dorsally up to where it abuts against the lachrymal. The jugal also apparently covers

Table 2. Dimensions and proportions of skulls; *A. didiformis.* (See Note top of page 24.)

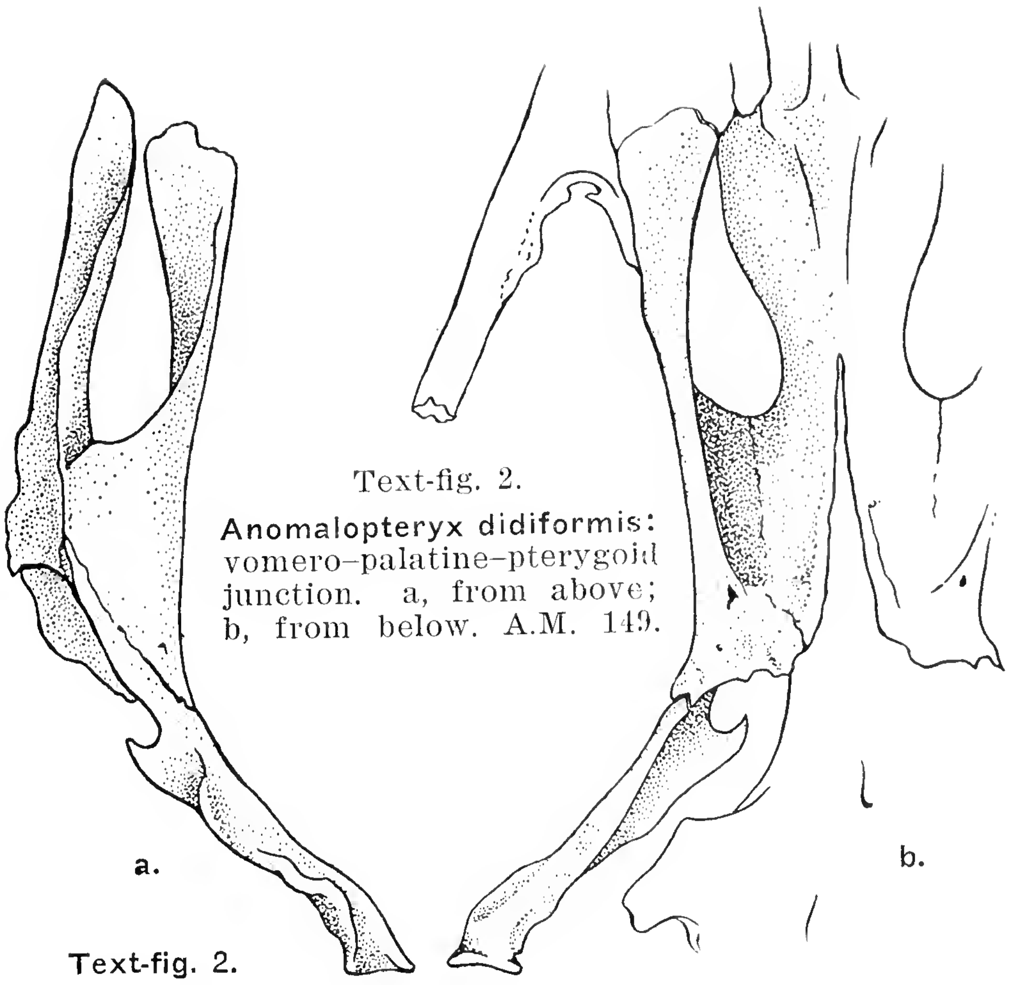
Auckland Museum Collection No.	121	72	70	71	82
Length: total		13.5	14.1	14.1	13.38
Length: paroccipital to preorbital process		8.0	8.0	8.25	7.9
Height of cranium			4.46	4.40	4.40
Width across paroccipital processes	6.37	5.9	5.83	5.94	5.43
Width across squamosal prominences	7.55	6.6	7.00	7.00	6.54
Width across temporal fossae		4.38	4.53	4.57	4.37
Width between temporal ridges		2.64	2.80	2.76	3.05
Width across post-orbital processes	8.08	7.8	7.83	8.04	7.53
Width across pre-orbital processes		4.45	5.04	5.00	4.74
Width of tympanic cavity		1.8	1.99	1.84	1.85
Width of temporal fossa		3.4	3.38	3.30	3.30
Width of orbit		2.8	2.85	3.13	2.90
Space between lambdoidal and temporal ridges		0.0	0.0	0.0	0.0
Proportions (percentage of total length):—					
Height			31.6	31.2	32.8
Paroccipital width		43.8	41.3	42.1	
Squamosal width		49.0	49.6	49.7	49.6
Width across temporal fossae		32.5	32.1	32.4	31.7
Post-orbital width		57.8	55.5	57.0	57.1
% width between temporal ridges: temporal fossae	52.5	60.2	61.8	60.4	69.5
% widths, squamosal: post-orbital	93.4	85.0	89.5	87.1	87.0

the anterior two-thirds of the quadrato-jugal, but I have not been able to discern the exact form of the junction. The quadrato-jugal moiety of the arch is slightly expanded, and its extremity has an inner facet for articulation with the quadrate.

The palatine (Pl. 7, fig. 2): anteriorly the palatine expands horizontally to form a narrow triangle whose outer border fits into a corresponding groove on the ventral surface of the maxilla, the two together forming the maxillo-palatine plate mentioned above. Posteriorly it expands vertically to form a thin triangular lamina which twists mesally to junction with the oblique postero-dorsal margin of the vomer (Text fig. 2b); postero-ectally it effects an oblique junction with the anterior margin of the pterygoid, and posteromesally it sends out a small stout triangular process which fits between, and separates, the posterior ectal border of the vomer and the antero-mesal border of the pterygoid (Text fig. 2b). The vomer and pterygoid, however, join one another above this process (Text fig. 2a). The pterygoid is of irregular shape: from its junction with the vomer and palatine it passes backwards and outwards, effecting at its middle an articulation with the basi-pterygoid processes; posteriorly and ectally it articulates with the lower border of the orbital process of the quadrate. In two of the three perfect skulls I have with the vomer still *in situ,* its slender paired laminae are united anteriorly, where they enclose the rostrum; in the other specimen they are separate anteriorly. Posteriorly they are separate and diverge to make junction with the palatine and pterygoid as described above.

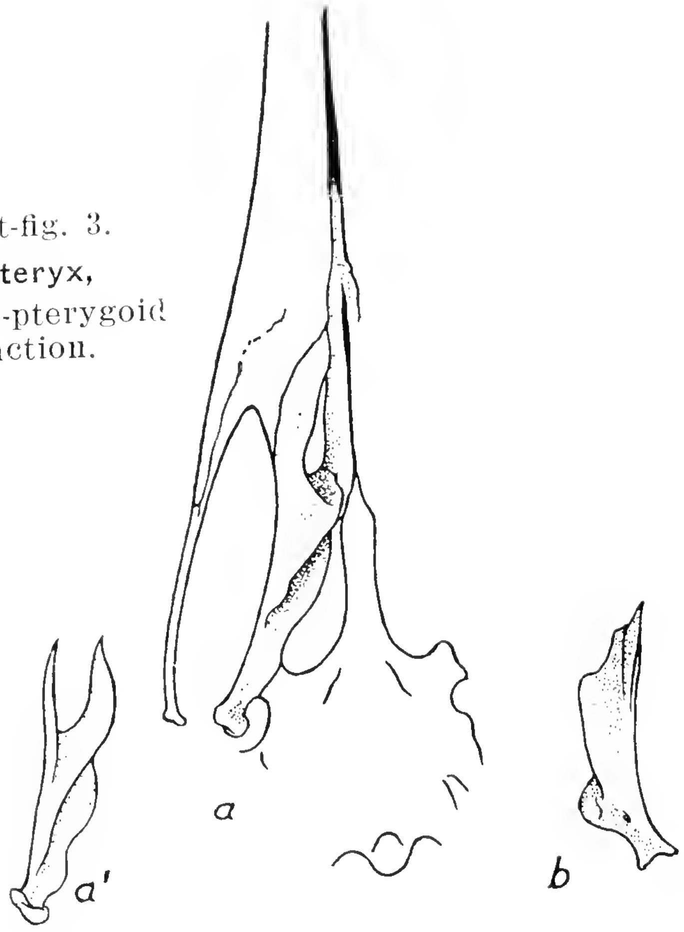
The vomero-palato-pterygoid junction in *Anomalopteryx* agrees with that described by Parker (1895b); it also clearly confirms the close resemblance to the condition in *Rhea* affirmed by Pycraft (1900, p. 262), as against Parker's interpretation. In fact, in the immature skull of *Anomalopteryx* we see clearly that encroachment of the palatine over the vomero-pterygoid junction (Text fig. 2a and b) which is held by Pycraft (pp. 206-7) to indicate the first stage of the evolutionary change from the primitive arrangement in *Dromaeus (Dromiceius)* towards the derived neognathous condition; it is also of significance for the possible phyletic unity of the struthious birds (see p. 84). It may be added

63	55	102	151	150	51	149	66	155	69	89
13.5	13.75	13.0	12.8	12.5	12.8	13.9	13.25	13.5	12.9	14.2
7.63		7.70	7.45	7.4	7.5	8.1	7.75	7.68	7.5	8.2
4.40	4.31	4.47	4.07	4.07	4.2	4.88	4.54	4.4	4.47	4.14
5.46	6.48	5.25	5.52	5.7	5.65	6.06	5.80	5.3	6.29	5.9
6.35	6.70	6.96	6.37	6.1	6.30	6.82	6.60	6.35	6.62	6.95
4.35	4.28	4.18	4.10	3.97	4.12	4.43	4.50	4.32	4.15	4.18
2.37	2.90	2.84	2.64	2.23	2.9	2.78	2.75	2.37	2.66	2.17
7.0	7.26	7.87	7.28	6.9	6.82	7.50	7.15	7.00	7.49	7.36
4.5		4.86	4.30	4.58	4.60	4.59	4.85		4.57	4.22
1.73	1.94	2.06	1.80	2.0	1.92	1.8	1.70	1.75	2.00	1.94
3.22	3.29	3.48	3.1	3.06	3.07	3.6	3.30	3.18	3.25	3.50
2.80		2.91	2.7	2.75	2.37	2.9	2.83		2.60	2.90
0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
32.6	31.3	34.4	31.8	32.55	32.8	35.2	34.4	32.6	34.6	29.25
40.5	47.2	40.4	43.1	45.5	44.1	44.0	43.7	39.3	48.7	41.6
47.0	48.7	53.6	49.5	48.8	49.2	49.0	49.8	47.0	51.3	49.0
32.2	31.2	32.2	32.0	31.8	32.2	31.9	34.0	32.0	32.2	29.5
51.8	52.6	60.7	56.8	55.2	53.3	54.0	54.4	51.8	58.0	51.9
54.5	67.7	67.8	64.4	58.5	70.4	62.7	61.1	54.8	64.1	51.9
90.7	92.2	88.5	87.5	88.4	92.3	90.9	92.3	90.8	88.3	94.3



Text-fig. 2.
Anomalopteryx didiformis:
vomero–palatine–pterygoid
junction. a, from above;
b, from below. A.M. 149.

Text-fig. 2.



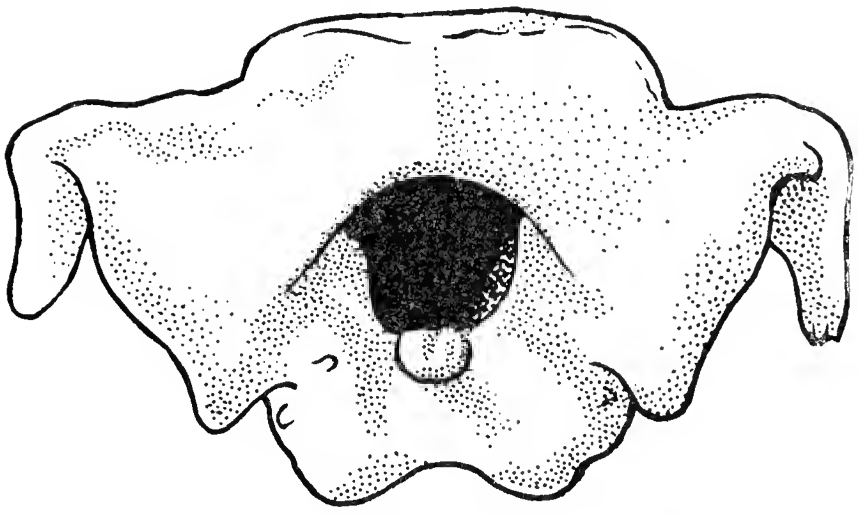
Text-fig. 3.
Apteryx,
vomero-pterygoid
junction.

Text-fig. 3.

that *Apteryx,* which I have been able to study in two immature skulls lent to me by Dr. R. A. Falla (Text fig. 3a, a1, b), also conforms to the general arrangement in *Rhea* and the *Anomalopterygidae,* for, notwithstanding its peculiarity in having the pterygoid bi-pronged anteriorly, it exhibits the same ventral encroachment of the palatine over the junction of the vomer and pterygoid as occurs in the other palaeognathous genera.

The mandible is stout, thus according with the large temporal fossa; seen from above the rami are straight and moderately divergent postad; the symphysis is relatively long and pointed terminally. In lateral view it first curves downward, then upwards, and downwards again at the symphysis.

The variations in the different characters have been indicated generally in the above description, and, as to dimensions and proportions, may be noted more in detail from Table 2. I may add that no variation in any one character has been found in skulls of any particular form or size. A large temporal fossa, for instance, may be present in either a large or a small skull, and greater relative breadth may also occur in a long or a short skull. Similarly in the relation between skull and leg-bones in individual skeletons, it cannot be stated that taller or larger birds have larger skulls—on the contrary a tall bird may have a smaller skull than a shorter one; neither can it be determined that broader skulls, for instance, are associated with stout leg-bones, or indeed with leg-bones of any particular type. The form and size of skull are just as varied and haphazard as to the type of leg-bones with which they are associated, as the three leg-bones are to one another in different individual skeletons. The skull on the mounted skeleton labelled *A. didiformis* in the Dominion Museum has a striking peculiarity in that at the junction of the lambdoidal and temporal ridges there is a deep angular depression on the right side, and a slight depression on the left side (Text-fig. 4). Otherwise this is a typical *Anomalopteryx* skull. This skeleton seems to be composite : the legs are typical of an adult of the species, the pelvis however is immature and small for the skeleton, there are eight instead of six rib-bearing thoracic vertebrae, and the sternum is typical of that of *Emeus.*



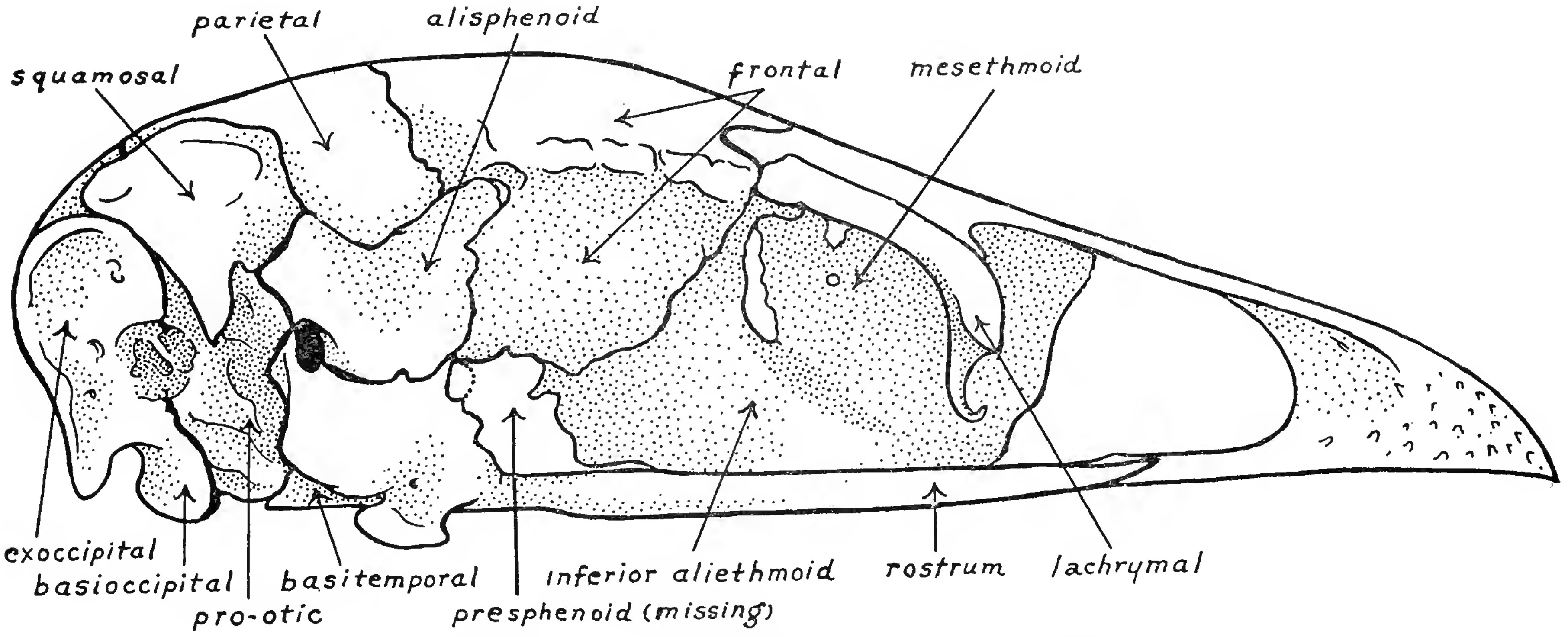
Text-fig. 4. **A. didiformis:** skull of skeleton in Dominion Museum.

Structural elements of the skull.

Two immature skulls and one juvenile have provided the following details of the form and extent of the constituent cranial elements.

Seen from behind the disposition of the bones is as described and illustrated by Parker (1895b, p. 380 et seq. pls. 57 and 59). The condyle is formed medianly by a wedge-shaped portion of the basi-occipital, and dorso-ectally by the exoccipitals. The mamillar tuberosities are composed of basi-occipital, exoccipital and prootic.

On the base of the skull the basioccipital extends further forward than shown by Parker, as he himself suggested that it might; it forms the base of the skull in the prootic region as well as in the occipital and abuts on the basisphenoid and its underlying basitemporal at the posterior basicranial fontanelle.

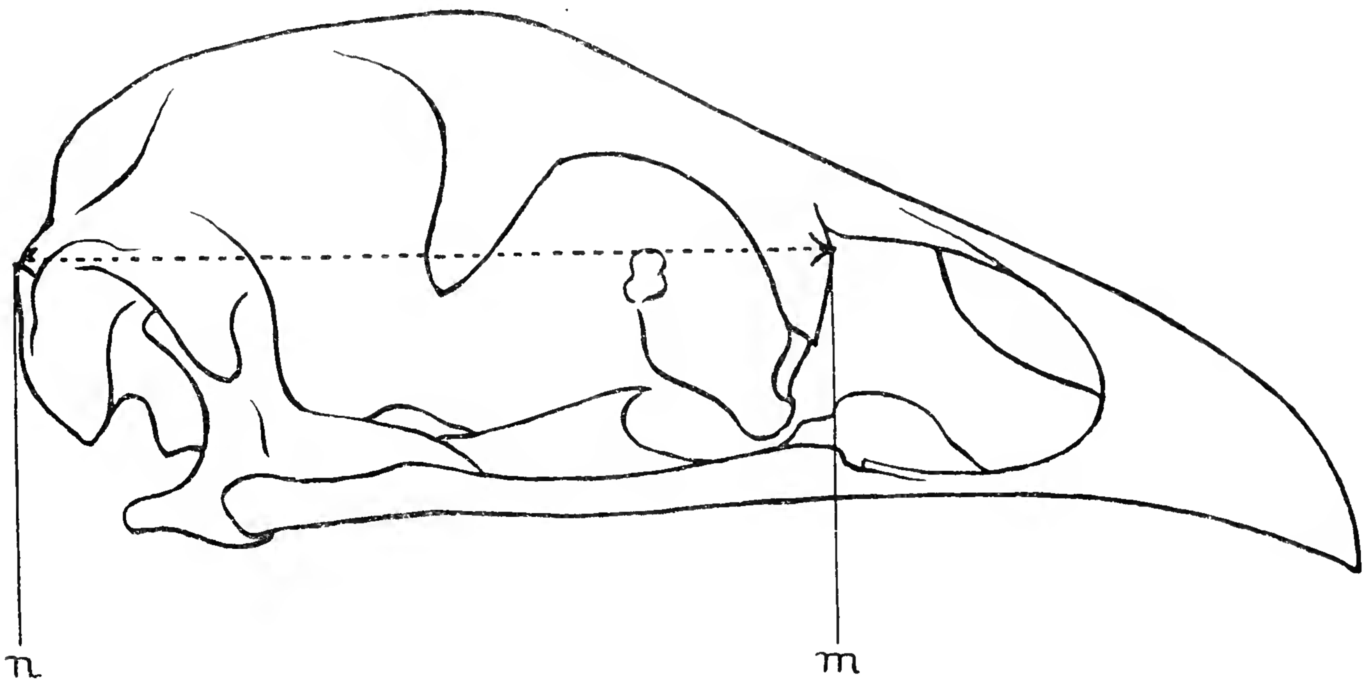


Text-fig. 5. **A. didiformis**: skull of immature.

In lateral view (Text Fig. 5) the relations between the bones differ to some extent from Parker's description. The parietal, supraoccipital, exoccipital and prootic are as he defined them, except that the parietal extends only a short way down the side and meets the alisphenoid by a curved junction. The latter bone is irregularly shaped; it sends a broad extension postero-dorsally to meet the squamosal, and a narrow process antero-dorsally to lie under the lateral projection of the frontal which it joins to form a base for the attachment of the separately ossified post-frontal or post-orbital process. Beneath the squamosal the junction between the alisphenoid and prootic passes downward and slightly forward; at the point where the prootic and basitemporal adjoin, the alisphenoid margin is notched; so is the basitemporal margin, and all three bones form by their recessed margins the *trigeminal foramen*. From this point forwards the lower margin of the alisphenoid is slightly curved and then turns abruptly upwards to effect junction with the posterior margin of the frontal, forming finally the front margin of the narrow antero-dorsal process of the alisphenoid mentioned above. At the junction of alisphenoid, frontal and basitemporal, notches in these bones form the fossa containing openings for the orbito-nasal, the oculomotor nerves and the internal ophthalmic artery (Parker, p. 388). In front of this fossa is the optic foramen, bounded, according to Parker, by the orbitosphenoid above and the presphenoid below. My own juvenile skulls are deficient here, and I am unable to supplement Parker's observations on this point, except to note that the lower margin of the optic foramen seems to be formed, at least in part if not entirely, by an upward prolongation of the basitemporal.

Note: In measuring skulls the total (i.e. overall) length is the basis on which proportionate widths are calculated, i.e. they are recorded as percentages of the total length. There is, however, a practical disadvantage in taking this as a basis in that skulls are so seldom obtained with the beak entire and still fused in position on the cranium. The length from the condyle to the tip of the rostrum is also frequently unobtainable because of abrasion or breaking of the rostrum.

On the other hand the length from the posterior margin of the paroccipital (Text fig. 6, n) to the front of the preorbital (m) is almost always obtainable. In perfect skulls it varies from 58% to 59% (average 58.5%) of the length in *Eu. exilis* and *Eu. curtus,* and from 57.8 to 59.2 (average 58.5%) in *A. didiformis,* so it is not possible to calculate the total length precisely from the known paroccipital-preorbital length. Nevertheless, in all those cases in which the length of a not quite perfect skull is given in the tables, I have used a calculation from the paroccipital-preorbital length as a means of checking the estimate of the total length made by comparison with perfect skulls.



Text-fig. 6. Skull: paroccipital-preorbital length, n . . . m.

Vertebrae: The vertebral column is composed of 21 cervical vertebrae, three cervicothoracic, three thoracic, 18 pelvic and 11 caudal.

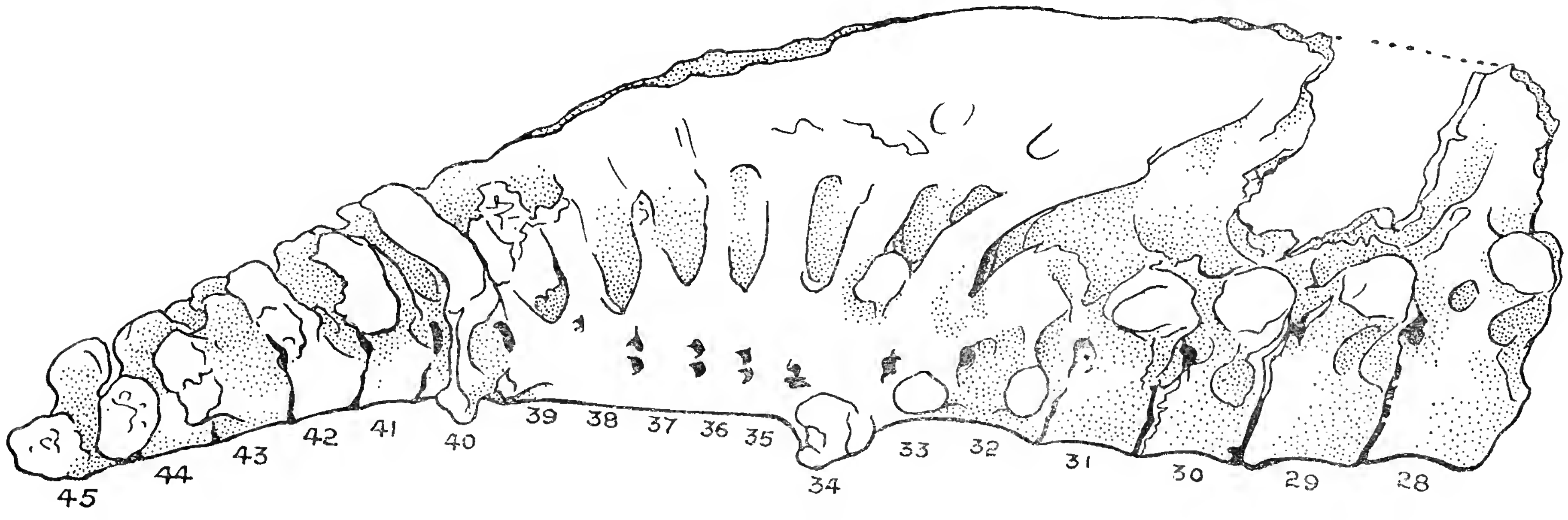
Following the atlas and axis, Nos. 3, 4 and 5, and sometimes 6, present dorsally a subquadrate outline; the neural spine is represented by a pair of small subparallel processes, and there are distinct hyperapophyses. These vertebrae may be termed nape cervicals or nape vertebrae. In those immediately succeeding the nape series there is an abrupt change in the dorsal outline: the anterior, or diapophysial portion is expanded, the middle region is constricted, and posteriorly the elongated diverging post-zygapophyses are separated by a median V-shaped depression; the neural spines are higher and divergent, becoming increasingly so, but at the same time lower in the succeeding cervicals until, from the 17th or 18th, they approach one another again and increase in height, coalescing on 20 and 21 to form a single, high, median neural spine. This single neural process increases in height on the succeeding thoracic vertebrae.

Hyperapophyses, present on the nape vertebrae, may, or may not be present on 6 to 9. The "neural ridge" of Hutton (1894, p. 160) rarely appears as a continuous even ridge; normally a constriction separates the neural spine from the hyperapophysis. The latter are present up to the 24th or 25th. The interzygapophysial canal is a small pore on the nape vertebrae, but it may be occluded on, or absent from, 4, 5 or 6. Thereafter it is present up to 14, 15, 16, or 17, though in one skeleton it is present only up to 10. The interzygapophysial bar which forms the outer walls of the canal increases in width and thickness on the hinder cervicals, finally occluding the canal on or about the 14th to 17th as just described.

The ventral surface of the nape cervicals shows a median hypapophysial ridge, strongly developed on the axis and 3, progressively reduced on 4 and 5, and evanescent on or absent from 6 where parial hypapophyses appear mesally on the base of each parapophysis. The pleurapophyses at first increase in length, becoming long and styliform by the sixth; in succeeding vertebrae they progressively shorten, this being accompanied by an increase in length of the parial hypapophyses, which by the 17th have approached one another closely, uniting on the 18th to form a median hypapophysis again. This median hypapophysis has, therefore, a different structural origin from that on the nape cervicals where it is a median projection from the hinder part of the centrum. The hypapophysis is strongly developed on the remaining cervicals; on the thoracic vertebrae it changes form again, becoming a ridge or keel on the anterior part of the 22nd and 23rd; a notch divides the keel into an anterior and posterior portion on 24 and 25, or on 25 and 26, or the posterior portion alone projects from 26, becoming bifid on 27 with the two resulting knobs standing more widely apart on the pelvic vertebrae 28 and 29.

Of the pelvic vertebrae No. 28 has freely-articulating floating ribs, while 29 and 30 have floating ribs fused to the ilia; 31 to 34 bear transverse processes which extend out to and unite with the ilia. The number of pelvic vertebrae is eighteen (Pl. 11, fig. 3), which is one more than has hitherto been recorded; this makes it accord numerically with the condition in *E. huttonii* (Benham 1934, pl. 7), though there is a difference in grouping of the component series; moreover there is sometimes an extra vertebra present.

Excluding the occasional coalescence of the last thoracic vertebra (27) with the pelvis, there are normally seven pre-acetabular vertebrae (28 to 34). These are followed by four vertebrae (not three as previously described) without transverse processes (35 to 38); the last bears small neural canals higher up on the side than in the others and has thus escaped notice (Text fig. 7, 38). Occasionally it has the pleurapophysis represented by a small splinter-like process (Pl. 11, fig. 3, 38). In the pelvis of A.M. 117, and that of 186, vertebra 35 has transverse processes. The remaining seven vertebrae (39 to 45) have prominent transverse processes extending obliquely to the ilium. Vertebra 46 is occasionally fused to the pelvis, but is more usually a free caudal; counting it as such there are eleven caudals (46 to 56) of which either the last two or the last three are fused together. The foregoing account is based on adult specimens; the condition described is even more clearly determined in immature pelves (Text-fig. 7) with the synsacrum not yet fused to the ilia.



Text-fig. 7. **A. didiformis:** pelvic vertebrae immature.

A formula, such as the following, giving the serial numbers of the vertebrae included in the pelvis or synsacrum, will facilitate indication of the variations that occur in the grouping of the vertebrae. Thus in the formula "28-34 (35-38) 39-45" which sets out the normal condition in *Anomalopteryx*, "28-34" represents the pre-acetabular vertebrae; (35-38) indicates the four acetabular vertebrae which lack transverse processes; and "39-45" the remaining posterior vertebrae with transverse processes; the addition of (46) in brackets would indicate the fusion of the first caudal with the pelvis.

Owen (1883, p. 244), in describing the pelvis of *A. parvus,* also recorded eighteen "sacral" vertebrae. He missed the small eleventh (No. 38); but a misnumbering of the succeeding centra and pleurapophyses gave him an extra centrum, one for which there were no transverse processes. The latter, on his Plate 54, were numbered 11, 12, 13, 14, 16, 17, 18; they should have been 11, 12, 13, 14, 15, 16, 17, or, according to the present finding 12 to 18. He also made a small slip in stating that the pleurapophyses of the 6th and 7th vertebrae were fused into one process, for he had already described them as similar to 4 and 5, as they appear in the illustration. Assuming the small eleventh (38) to be present, and I have never found it absent, the formula for the pelvis of Owen's type of *A. parvus* would be the normal one, i.e. 28-34 (35-38) 39-45. A total number of fifty-six vertebrae in the moa was also given by Hutton (1894, p. 159); but he included twelve caudal. His grouping was:—1-21 cervical; 22-27 thoracic; 28-44 pelvic; 45-56 caudal. The arrangement found in the skeletons I have examined is:—1-21 cervical; 22-27 thoracic; 28-45 pelvic; 46-56 caudal.

In *Anomalopteryx* and in the other genera, there is sometimes an extra pre-acetabular vertebra. It is a true vertebra, having its own neural canals as well as transverse processes. The condition is not due to vertebra 27 having become fused with the pelvis, for it occurs where there is the normal number of 27 free vertebrae; moreover the form of the ribs borne by 28, 29 and 30 is characteristic enough to identify them. In the following formulae I have numbered the interpolated vertebra 33A; this will give the number 34 constantly to the large transverse process which joins the acetabulum anteriorly, and 39 and 40 to the two which unite to join it posteriorly. It will also serve to distinguish the two instances (Nos. 117 and 186 mentioned above) in which the normal 35 has developed transverse processes; in these cases, as will be seen from the formulae, there are only three vertebrae (36-38) lacking pleurapophyses.

Pelvic formula—*A. didiformis.*

Normal	28-34 (35-38) 39-45
A.M. 190	28-34 (35-38) 39-45 (46)
A.M. 117	28-35 (36-38) 39-45 (46)
A.M. 187	28-35 (36-38) 39-45
A.M. 63, 70, 151	28-33A-34 (35-38) 39-45

Finally, to return to the axis and atlas, the following measurements may be of interest.

Auck. Mus. No.	150	151	51	149	66	69
Tibia length	36.4	36.1	36.0	35.9	34.9	34.5
Atlas: height			1.91	2.20	2.18	1.78
width			1.81	2.27	2.14	1.86
Axis: height	2.71	2.6	2.44	3.14	3.07	2.56
width	2.57	2.54	2.50	2.87	2.76	2.59

These dimensions indicate once more that, although there is considerable variation in the size of vertebrae, it does not follow that of the leg-bones. No. 51, for instance, which has larger legs than 66, has a considerably smaller atlas and axis, though its skull is only slightly smaller; curiously, although the atlas of 51 is larger than that of 69, its axis is smaller, yet they fit one another perfectly in each skeleton. There are appreciable differences in the form of the vertebrae also. It may be suggested that differences such as are recorded above are trivial and insignificant; it is to draw attention to this that they have been noted.

Pelvis (Pl. 9, fig. 3; lateral view): The dorsal margin of the ilium presents a gentle even curve which passes anteriorly without angularity into the front margin; this in turn curves round strongly to the ventral border, whence project the short ribs of the 29th and 30th vertebrae. Viewed from above (Pl. 10, fig. 3) the dorsal iliac margins diverge posteriorly, gently at first and then, in the acetabular region, abruptly outwards to form the anterior margin of the escutcheon. The lateral margins of the escutcheon are convex, converging posteriorly; there is, however, a good deal of variation here. Seen from the side (Pl. 9, fig. 3) the upper margins of the escutcheon continue the even curve of the pre-acetabular iliac dorsal margin, and there is no considerable flattening in this area as in *Pachyornis* (fig. 4). The width of the escutcheon is usually about 37% of the total length.

The ischium, narrow anteriorly, widens posteriorly; its dorsal margin terminates slightly behind the end of the escutcheon, the ventral margin terminating some 3 cm. further beyond, the terminal margin thus being oblique. The pubis is a slender curved bar slightly wider distally, terminating in line with the lower margin of the ischium. Pubis and ischium are only moderately divergent laterally in this species; the distance across their extremities is normally about 1.08 times the width at the antitrochanters.

Variation: There is no marked variation in the form or proportion of the pelvis in *A. didiformis.* In three pelves, two of immature birds, the front margins of the escutcheon diverge more gradually from the upper iliac margin, though the escutcheon itself is no less proportionately wide than in the other specimens. The leg-bones to which these three pelves belonged exhibit the usual degree of variation among themselves; that is to say the individuals exhibiting this pelvic variation did not in any way form a separate variant group.

Table 3. Dimensions and proportions of pelves of *A. didiformis.*

Auckland Museum No.	128	117	70	71	51	149	152	66
Length	35.5	35.4	36.9	36.0	34.35	35.5	31.15	
Width at antitrochanters	16.3	15.54	16.1	18.5	14.95	16.5	13.55	13.9
Width at pectineal tubercles		11.35	12.7	13.2	11.1	11.9		
Width of escutcheon	13.0	12.80	13.6	14.0	13.25	12.9	11.5	
Ischium: length				16.3	14.5	16.5	14.7	12.9
width				6.4	5.3	5.5	5.1	
divergence				17.3	16.0	17.8	14.0	14.8
Pubis: length				17.5	17.0	18.5		
width								
divergence				18.0	16.5	18.85		
Proportions: length = 100								
Width at antitrochanters	46.0	43.9	43.6	51.4	43.5	46.4	43.5	
Width of escutcheon	36.6	36.1	36.8	38.8	38.5	36.3	36.9	
Proportion: antitrochanter width = 100 ..								
Divergence of ischia				93.5	107	108	103.5	106.5
Divergence of pubes				97.3	111.2	114		

Sternum. The sternum is usually very badly preserved in both cave and sand-dune skeletons, and the extremities regularly give the appearance of being abraded, so that one may doubt whether they are complete. This applies chiefly to the tips of the median and lateral processes. On the other hand they frequently exhibit so definite a transverse truncation (Pl. 12, fig. 4; cf. Owen 1883a, pl. 55) as to make one hesitate to say that parts have been lost. Bearing this in mind, one may say that, whether the body of the sternum is wider or broader, as it may be in *Anomalopteryx,* it is always deeply concave ventrally, and has relatively short and broad lateral and median processes, the latter with a notch.* The anterior margin, viewed from the front, is strongly curved ventrally; from above it is slightly bowed forward medianly. The pre-costal processes are usually well developed, and the notches for the articulation of the scapulo-coracoid may be distinct or vague, or a notch may be discernible on one side only. In only one of the skeletons is there preserved a bone that may be the scapulo-coracoid; its lower portion is cylindrical and its upper flat or blade-like, but it is evenly curved throughout instead of being bent: it seems too long to be a sternal rib.

There is much variation in form and relative size in the sterna of different individuals. While, generally, the larger sterna are associated with larger leg-bones, the contrary may occur, and a narrow sternum may be associated with stout leg-bones or *vice versa.* There is complete diversity in the size and form of the three costal articular surfaces; no two sterna show the same arrangement and considerable difference may occur on either side of the same bone. The three sternal ribs, or pairs of ribs, also exhibit some diversity, but not of any great extent.

Table 4. Dimensions of five sterna: *A. didiformis.*

	Auckland Museum No.	70	71	55	51	149
	Tibia length	39.6	39.3	37.5	36.0	35.9
A.	Breadth across the pre-costal processes	15.7	15.0	14.8	13.5	12.0
B.	Breadth at anterior end of costal border	11.5	11.9	11.5	11.0	10.2
C.	Width of base of median process, i.e. between the lateral notches	8.3	7.5		7.7	8.1
D.	Distance across outer ends of lateral processes	16.0	14.5	17.0	15.0	16.0
E.	Length from anterior margin to tip of median process	15.5			13.5	15.4
F.	Length from anterior margin to xiphisternal notch	13.5			13.2	13.2
G.	Length from anterior margin to lateral notch	11.0	8.1	9.0	9.5	10.2
H.	Length from precostal to tip of lateral process	15.8	16.0		15.0	15.6

Localities: North Island: Whangarei, Coromandel, Kawhia to Te Kuiti, Rotorua (Hutton), Waikaremoana, Te Aute, Lyall Bay (Hutton), Wanganui.

South Island: Collingwood, Takaka, Nelson, North Canterbury, Hamilton Swamp (Hutton), Southland (Hutton).

Summary. *Anomalopteryx didiformis* may be described as a moa of intermediate size with moderately stout limbs. Its skull has a long sharp beak, a strong mandible and a deep temporal fossa for attachment of the muscle which moved it. Its pelvis is slightly arched throughout its length and relatively slender, and the sternum has the lateral and

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*The "sternum of *Anomalopteryx*" illustrated by Oliver (1930, 45) is that of a species of *Emeus.*

median processes rather shorter and broader than the other genera; its median process is notched. The species exhibits a considerable range of variation in size and proportions of leg-bones, skull and pelvis; but variation in the different structures are so diversely associated in different individuals that no grouping either for sex or locality can be suggested. All ranges of size and varieties of form are found in one very limited area, e.g. the barrier-wall of Lake Waikaremoana, where there is a time-limiting factor in the comparatively recent formation of the caves which trapped them. We have, therefore, to regard these birds as having been, in the geological sense, contemporaneous.

A. didiformis occurred throughout New Zealand (?Westland) chiefly in hilly country, though it has occasionally been found on the coast, but here possibly in association with Maori cooking places.

Anomalopteryx antiquus Hutton, 1892.

1891 .. .. .. "Avian Remains": Forbes, Trans. N.Z. Inst., vol. 23, 366.

1892 May .. .. **Anomalopteryx antiquus** Hutton, Trans. N.Z. Inst., 24, 124. Founded on portions of leg-bones, of which the larger tibia fragment may be regarded as the actual type, from an Upper Miocene or Lower Pliocene deposit at Timaru.

1893 .. .. .. *Anomalopteryx antiqua:* Hutton, Trans. N.Z. Inst., 25, 14.

1893 .. .. .. *Anomalopteryx antiquus:* Forbes, Nat. Sci., 3, 318-9.

1907 .. .. .. *Anomalopteryx antiquus:* Rothschild, Extinct Birds, 202.

1930 .. .. .. *Anomalopteryx antiquus:* Oliver, New Zealand Birds, 46.

1933 .. .. .. *Anomalopteryx antiquus:* Lambrecht, Handbuch der Palaeornithologie, 144.

The identity or relationships of this species cannot be determined with any degree of certainty. On the measurements given by Hutton (1892, p. 125) the tibia would seem to be that of *Eury. curtus,* a species not known to occur in the South Island. But it must be remembered that the given length (30.5 cm.) was estimated from the proximal portion of one tibia and the distal portion of another; if the estimate were increased by only 1 cm. the length would equal that of the smallest *A. didiformis* and the proportionate widths of the bone would be definitely those of *Anomalopteryx*. Furthermore, the metatarsus subsequently described by Hutton (1893, p. 14) has all those details of configuration that have been observed to be characteristic of *A. didiformis* and to distinguish its metatarsus from that of *E. exilis* or *E. curtus* (see p. 58 below). It is therefore desirable to retain the species, regarding it, as suggested by Hutton (1892b, 126) as a small species of *Anomalopteryx* probably ancestral to *A. didiformis.*

Genus *Megalapteryx* Haast, 1886.

1884 .. .. .. *Megalapteryx* : Haast, Trans. N.Z. Inst., 16, 576-7. Type *Megalapteryx hectori* Haast, *nom. nud.*

1885 .. .. .. *Megalapteryx* : Haast, Proc. Zool. Soc., No. 35, p. 541. *Nom. nud.*

1886 .. .. .. **Megalapteryx** : Haast, Trans. Zool. Soc. 12, pl. 5, p. 161. Type, by monotypy, *Megalapteryx hectori* Haast.

1891 .. .. .. Not *Mesopteryx* Hutton, N.Z. Jnl. Sci. new issue, 1, no. 6, p. 248. (Although "*Mesopteryx didinus*" is the only species cited, it is clear, both from the measurements given and the synonymy, as well as from Hutton's subsequent use of the name, that he was confusing *D. didinus* Owen with the prior *D. huttonii* Owen (= *Emeus huttonii,* q.v.)

1892 .. .. .. *Palaeocasuarius:* Forbes, Trans. N.Z. Inst. 24, 189, *nom. nud.*

1907 .. .. .. **Palaeocasuarius:** Rothschild, Extinct Birds, p. 219. Type, by original designation, *Pal. haasti* Rothschild (ex. *Pal. haasti* Forbes, *nom. nud.)*

Birds of about the same height as *Anomalopteryx,* but with straighter and more slender leg-bones and a narrow pelvis. Skull small, beak shorter and less acute than in *Anomalopteryx,* basi-pterygoid processes very slender, antorbitals extending widely laterad. Maxilla with well-developed antrum cavity.

Two species are recognised, *M. didinus* (Owen) which includes the smaller form hitherto separated as *M. hectori* Haast, and a larger species to be named *M. benhami,* at present represented only by a femur and tibia from Mt. Arthur, Nelson district.

Megalapteryx didinus (Owen), 1883.

1882 ..	.. ..	*Dinornis didinus* Owen, Proc. Zool. Soc. for 1882, no. 36, p. 549 *(nomen nudum).*
1883	January ..	**Dinornis didinus** Owen, Trans. Zool. Soc. London, vol. 11, pt. 8, p. 257, pls. 59-61. TYPE: incomplete individual skeleton from Queenstown in British Museum (No. A.16; Lydekker, p. 277).
1884	May	*Megalapteryx hectori* Haast, Trans. N.Z. Inst., 16, 576-7 *nom. nud.*
1885 ..	.. ..	*Megalapteryx hectori* Haast, Proc. Zool. Soc. for 1885, no. 35, p. 541 *(nomen nudum).*
1886	December ..	**Megalapteryx hectori** : Haast, Trans. Zool. Soc. London, vol. 12, pt. 5, p. 161, pl. 30. TYPE: leg-bones of an individual from Takaka in Nelson Museum.
1891	April ..	*Anomalopteryx didina* : Lydekker, Cat. Foss. Birds Brit. Mus., 277.
		Megalapteryx tenuipes Lydekker, *ibid,* 251, fig. 69A. TYPE: imperfect right tibiotarsus from near Lake Wakatipu, in British Museum (No. 49990).
		Megalapteryx hectori : Lydekker, *ibid,* 252.
1891	November 13	*Megalapteryx hectori* : Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, III, p. 428.
1892	May	NOT *Mesopteryx didinus* : Hutton, Trans. N.Z. Inst., 24, p. 131. Hutton here confuses *M. didinus* with *E. huttonii.*
1892	May	*Palaeocasuarius haasti* : Forbes, *nom. nud.* Trans. N.Z. Inst., 24, 189.
		Palaeocasuarius velox Forbes, *nom. nud., ibid,* 189.
		Palaeocasuarius elegans Forbes, *nom. nud., ibid,* 189.
1897	June ..	*Megalapteryx tenuipes* : Hutton, Trans. N.Z. Inst., 29, 546.
		Anomalornis gracilis : Hutton (not of Owen), part (femur), *ibid,* 546.
		NOT *Meionornis didnus* : Hutton, *ibid,* p. 558. Hutton again uses this name for bones which are really of *E. huttonii.*
1897 ..	.. ..	*Anomalopteryx tenuipes* : Andrews, Novitates Zoologicae, 188.
1907 ..	.. ..	*Megalapteryx hectori* : Rothschild, "Extinct Birds", 197.
		Megalapteryx hamiltoni Rothschild, *ibid,* 197. TYPE: left femur from Waingongoro, North Island, in British Museum, No. 32145 (Lydekker, p. 252).
		Megalapteryx tenuipes : Rothschild, *ibid,* 198.
		Megalapteryx huttoni : Rothschild (part), *ibid,* 198. Rothschild repeats Hutton's confusion of *M. didinus* with *E. huttonii.*
		Palaeocasuarius haasti : Rothschild, *ibid,* 220. Founded on leg-bones from Manitoto, in Liverpool Museum : femur indicated as type by Rothschild, p. 219.
		Palaeocasuarius velox : Rothschild, *ibid,* 220. Founded on leg-bones from Manitoto, in Liverpool Museum : femur indicated as type by Rothschild, p. 219.
		Palaeocasuarius elegans : Rothschild, *ibid,* 220. Founded on leg-bones from Manitoto, in Liverpool Museum : femur indicated as type by Rothschild, p. 219.
1930 ..	.. ..	*Megalapteryx didinus* : Oliver, "New Zealand Birds", 42.
		Megalapteryx hectori : Oliver, *ibid,* 43.
1933 ..	.. ..	*Megalapteryx didinus* : Lambrecht, Handbuch der Palaeornithologie, 141.
		Megalapteryx hectori : Lambrecht, *ibid,* 143.

There is less material of *Megalapteryx* available for study than of *Anomalopteryx,* but the assembly of the dimensions of fifteen individual skeletons and of certain unassociated leg-bones (Table B) gives the same picture as that presented by *A. didiformis,* i.e. of a degree of continuous variation in the sizes of each of the three bones, combined with a diversity in the association of bones of various lengths in the different individuals. As was also found to be the case in *Anomalopteryx,* the full range in variation is exhibited by birds from one locality, in this case the limestone plateau which extends between Mt. Arthur and Takaka, west of Nelson; nearly as extensive a range is exhibited by the specimens from Central Otago. This range of sizes may perhaps include two sex groups, but, if so, they cannot be defined, and the largest of the smaller sex must be bigger than the smallest of the other. From these considerations I have concluded that, as with *A. didiformis,* only one species should be recognized.

The dimensions (Table B) reveal the slender proportions of the leg-bones of *Megalapteryx didinus;* they differ considerably in form also from *Anomalopteryx didiformis.* The femur, seen from the side, has a distinct dorsal curvature, which is only just discernible in *A. didiformis;* the proximal face is higher in proportion to its width, and, at the distal end, the rotular cavity is narrower and deeper. The muscle ridges (Pl. 1, fig. 2) are finer than in *Anomalopteryx,* and not much raised. They converge towards the medullarterial orifice, behind which they diverge, the inner becoming rugose and merging with the inner wall of the popliteal depression, the outer remaining fine and disappearing on the outer wall of the depression. The tibia (Pl. 2, fig. 2) is not only straighter, but its proximal end is less expanded ectally, and the procnemial ridge is deflected outwards much less than in *Anomalopteryx.* In the metatarsus (Pl. 3, fig. 2) the proximal face, like that of the femur, is higher in proportion to its width; the distal trochleae, notwithstanding the general slenderness of the bone, are sometimes expanded nearly to the same degree as in *Anomalopteryx.* The length and slenderness of the toes of this species have been remarked by Andrews (1897); it had a well-developed hind toe.

Skull. We have four skulls with individual skeletons of *M. didinus.* That of the type is covered with skin, but certain measurements have been obtained; the others are from specimens taken from Takaka in the Tring, the Dominion and the Auckland Museums. Their dimensions and proportions are set out in Table 5, together with those of the skull on a composite skeleton, with leg-bones in plaster, labelled *A. parvus* at Tring. This latter agrees so exactly with the skull of the complete individual at Tring that I am sure it is of the same species.

The characters with which the *four smaller* of the above five skulls (the type, the Auckland Museum, and the two Tring specimens) agree with one another and differ from skulls of *Anomalopteryx didiformis* are as follows: the few characters in which an observation can be taken from the type are in italics.

1. *Skull slightly smaller,* but of relatively greater height.

Posterior aspect.

2. Swollen supraforaminal ridge and supraoccipital crest.
3. Outer margins of paroccipital processes rounded.
4. Ventral termination of paroccipitals rounded and reaching to only a short distance below condyle.

Lateral aspect (Pl. 4, fig. 2).

5. Posterior (paroccipital) margin of tympanic cavity convex, and continuing evenly, without angular break into the dorsal margin.

Table 5. Skulls: *Megalapteryx didinus.*

	Takaka D.M.	Nelson Tring.	On Skeleton (composite) "parvus" Tring.	Wakatipu TYPE didinus.	Takaka A.M. 120.
Length : total	13.2	12.2		12.2	11.85
Length : paroccipital to preorbital ..	8.0				6.64
Height	4.17	4.2			4.30
Width at paroccipital processes ..	5.56	5.5	5.0		4.90
Width at squamosal prominences ..	6.42	6.5	6.15	5.8	5.80
Width at temporal fossae	4.1	4.5	4.41		4.25
Width between temporal ridges ..	2.3	3.6	3.61		3.50
Width at postorbital processes	6.78	7.3	7.08	6.8	6.75
Width at preorbital processes		4.7			4.37
Width of tympanic cavity		2.0			1.60
Width of temporal fossa		2.6			2.80
Width of orbit		3.2			2.95
Space between lambdoidal and temporal ridges	0.0		0.2		0.3
Proportions : % of length					
Height	31.5	34.42			36.3
Paroccipital width	42.2	45.2			41.3
Squamosal width	48.6	53.2		47.5	48.8
Postorbital width	51.3	59.8		55.7	56.9
Temporal fossae width	31.0	36.85			38.85
% Temporal ridges : fossae	56.1	80.0			82.3
% Squamosal : postorbital	94.5	89.0		85.5	86.0

6. Zygomatic process slender and acute.

Dorsal aspect (Pl. 5, fig. 2).

7. Occipital area more nearly vertical, i.e. not sloping forward as in *Anomalopteryx.*
8. Lambdoidal ridge passes almost straight across instead of forming a double curve as in *Anomalopteryx.*
9. Temporal ridges reaching back to lambdoidals, but not extending far up on to roof of skull.
10. Slight paired eminences on roof in postorbital area.
11. Greater breadth between the supra-orbital ridges.
12. Beak with narrow nasal process, *the end moderately acute and the lateral margins slightly convex,* not concave as in *Anomalopteryx.*

Ventral aspect.

13. A median swelling instead of a depression, on basipterygoid platform.
14. Basipterygoid processes small, slender, projecting obliquely forward; in *Anomalopteryx* they are larger, broader, and project laterally.
15. Antorbitals extending more widely laterad. (Text fig. 8a; cf. 8b, *A. didiformis).*

The maxillo-nasal, present only in A.M. 120, is a fine splinter expanding slightly distally. The lacrymal foramen is contained entirely within the lacrymal in A.M. 120 and Tring specimen, as occasionally in *A. didiformis.*

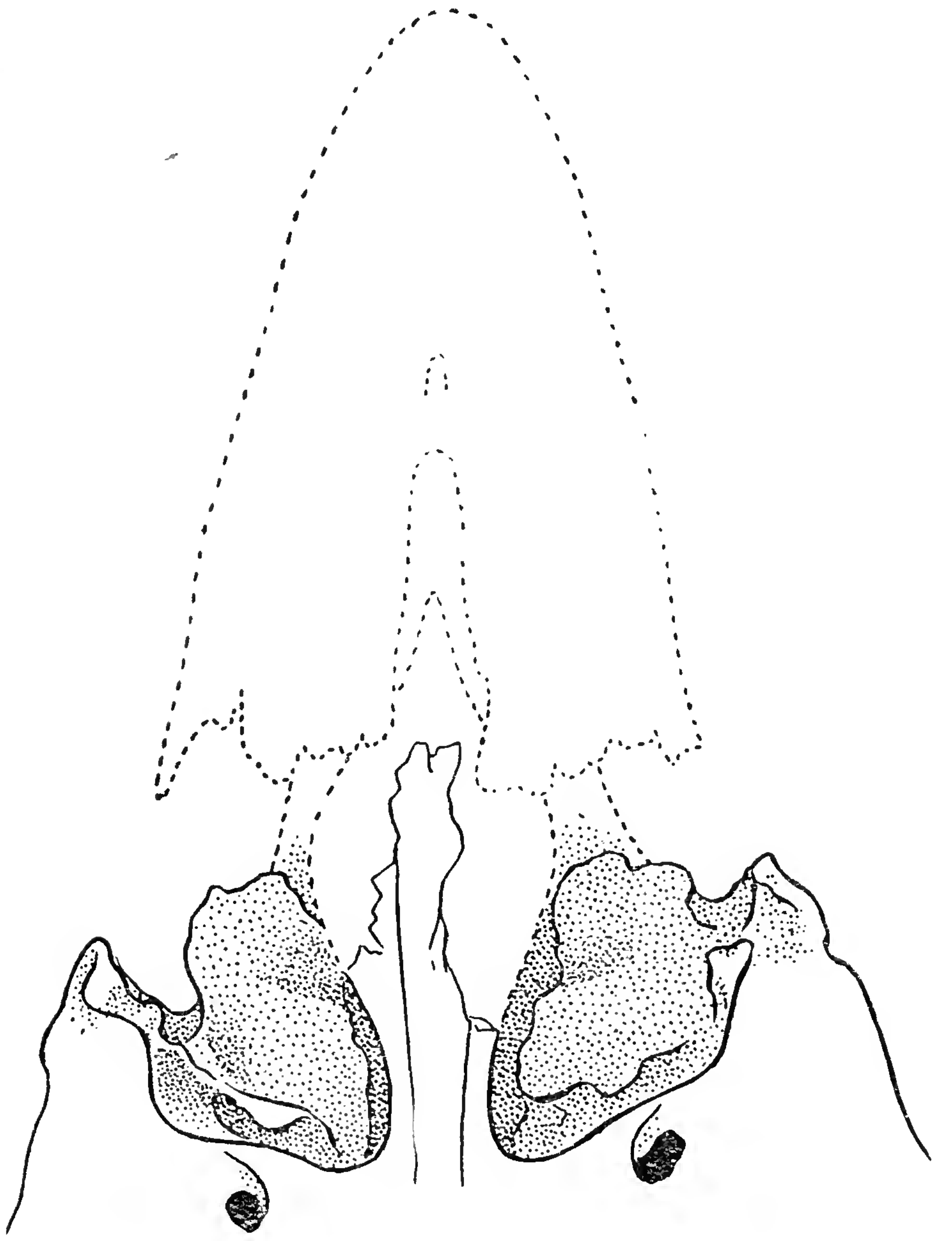
Characters common to skulls of M. didinus and A. didiformis.

i. Post-temporal "fossa" a wide convex band instead of a narrow groove.

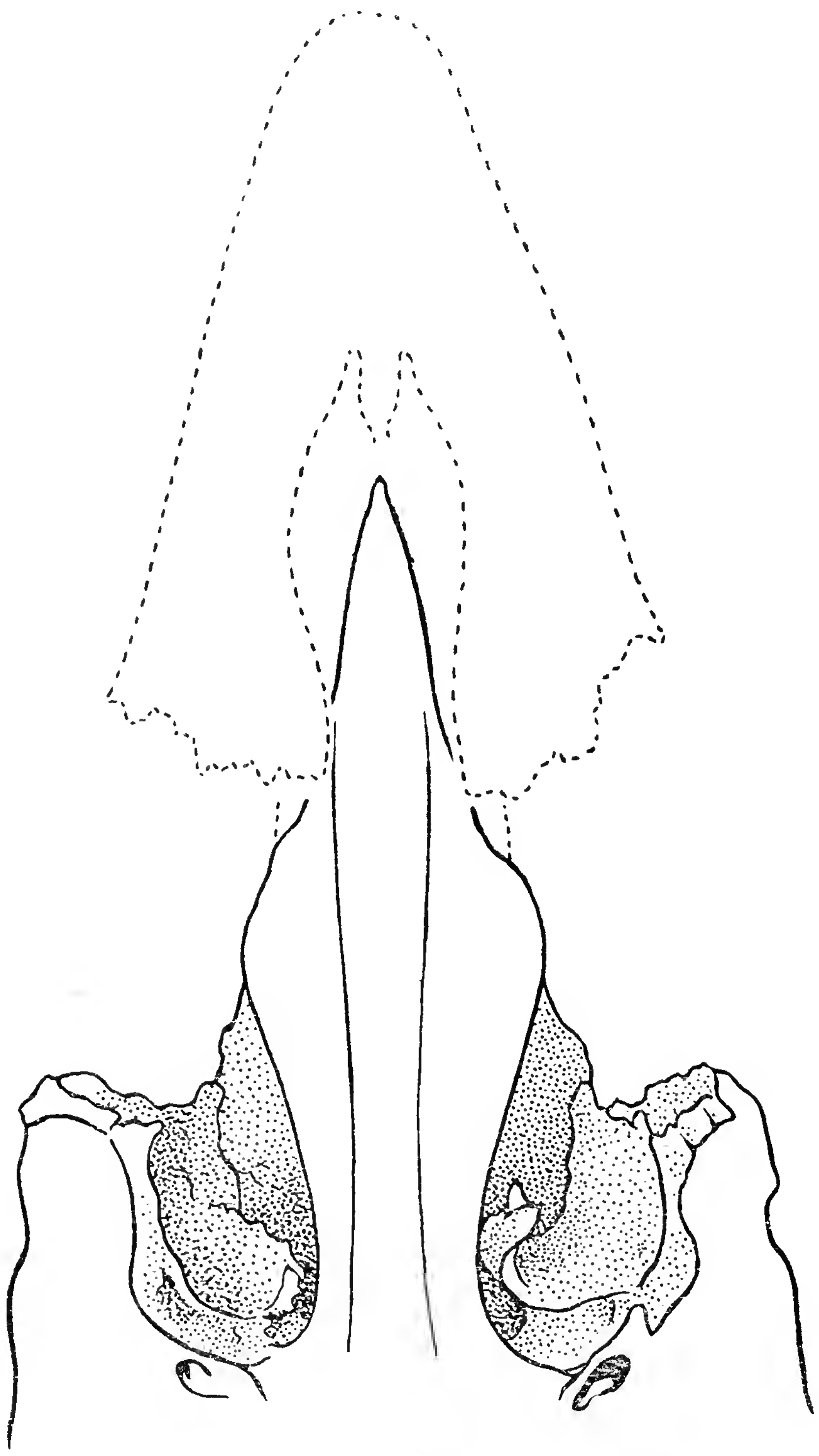
ii. Postorbital processes project backwards.

iii. Maxilla with well developed antrum cavity.

An individual skeleton from Inangahua in the Canterbury Museum has only a much abraded calvarium from which no measurements can be obtained; the only character that can be noted is that in posterior view the lateral margins of the paroccipital processes are strongly convex. Another incomplete skull, of a juvenile skeleton from Mt. Arthur (A.M. 118), agrees with the above-mentioned skulls in respect to features numbered 1 to 9 and 13 to 15; the other characters could not be observed.



Text-fig. 8a. **M. didinus**: skull, ventral view.



Text-fig. 8b. **A. didiformis**: skull, ventral view.

In respect to the features numbered 1 to 5, and 7 to 15, the skull on the Takaka skeleton in the Dominion Museum has the condition obtaining in *Anomalopteryx*, and this almost complete presentation of Anomalopterygian characters makes one wonder if it really was the skull of this particular skeleton; it is certainly exceptionally large for it. Dr. W. R. B. Oliver, Director of the Dominion Museum was, however, given to understand by the person from whom it was bought that there was nothing else in the cave from which it was obtained; moreover both skull and skeleton are sub-immature.

Vertebrae. The vertebrae resemble those of *A. didiformis,* with the following slight difference observed in two specimens. The lateral margins of the nape vertebrae are less constricted at the middle, i.e. the outline is more definitely quadrate; in the immediately succeeding cervicals the zygapophyses are narrower and less divergent posteriorly; and in the middle cervicals (10-17) the double neural spines are larger. The ventral surfaces of the centra are wider, the pleurapophyses are much shorter and wider, and the parial hypapophyses stand further apart on vertebrae 6 to 10, behind which they begin to approach one another again as in *A. didiformis.*

Pelvis. (Pls. 9, 10, 11, fig. 2.) The pelvis is smaller and much narrower than in *A. didiformis,* and the pre-acetabular ilia meet dorsally in a high arched ridge, the curve continuing posteriorly throughout the entire length: in *A. didiformis* the escutcheon is somewhat flattened in lateral view. The ischia and pubes are also slender, and much less divergent caudad than in *Anomalopteryx.*

The vertebral formula differs slightly: there are the usual seven pre-acetabular vertebrae (28-34) ; these are followed, in six pelves, by five (35-39), instead of four (35-38), acetabular vertebrae lacking transverse processes, though 39 has them represented by splinter processes. Nos. 40 and 41 then send transverse processes to meet on the posterior surface of the acetabulum, and the remainder, 42-45, or 46 (the first caudal) in a well ossified specimen (Pl. 11, fig. 2) send their processes more obliquely to the sides of the escutcheon. In the pelvis figured the splinter-like transverse process of 39 joins distally with the process of 40.

The formula is thus 28-34 (35-39) 40-45 *M. didinus*

instead of 28-34 (35-38) 39-45 *A. didiformis.*

This means that there is an extra acetabular vertebra and that 40 and 41 (instead of 39 and 40) send processes laterally to the acetabulum, and 42-45 instead of 41-45 send them obliquely to the escutcheon. This difference is not altogether constant; I have one pelvis with the formula of *A. didiformis.*

Table 6. Pelvis: *Megalapteryx didinus.*

	A.M. 164.	Tring.	A.M. 115.	A.M. 165.	A.M. 166.
Length	33.0	32.0	30.0	32.5	32.0
Width at antitrochanters	14.6	14.0	12.9	15.3	12.3
Width at pectineal tubercles	9.58	10.1	10.7	11.8	9.5
Width of escutcheon	12.0		10.2	11.8	10.6
Ischium length	14.5		12.0	14.3	12.3
Ischium height	5.25		3.65	4.8	3.6
Ischium divergence	14.5		13.7	16.7	11.7
Pubis length	16.0		15.5		15.5
Pubis height			1.5		
Pubis divergence	14.5		17.2		
Proportions:					
% Width at antitrochanters : length	44.2	43.7	43.0	47.0	38.1
Width at escutcheon : length	36.4		34.0	36.4	33.2
Ischium divergence : width at antitrochanters	99.3		106	109	95.1
Pubis divergence : width at antitrochanters	99.3		133		

Sternum (Pl. 12, fig. 3). This may be narrow or broad: the front margin seen from above, is straight and the pre-costal processes project more laterally, or more vertically, in broad or narrow sterna respectively; the narrow sterna are more deeply convex ventrally than the broad ones. The lateral processes are more slender, and extend further behind the median processes than in *Anomalopteryx*. A median notch is present in four sterna; a fifth lacks it, but I am not certain that the median process is entire in this case. The coracoid articular facets are deep in one Auckland Museum sternum, and also in the Tring and Dominion Museum specimens; they are not developed in two others. The facet for the third sternal rib is sometimes separated from the other two. Andrews (1897) does not mention the scapulo-coracoid; it is present in A.M. 120.

Distribution. *M. didinus* had previously been recorded only from the South Island, but leg-bones have recently been secured from the Makirikiri swamp, north of Wanganui. It seems to have been much more restricted in range and numbers than *A. didiformis,* but it was not uncommon on the Takaka tableland and, apparently, in Western Otago. It was possibly a high country species.

Megalapteryx benhami n. sp.

The femur and tibia on which this species is founded are from a cave on the Mt. Arthur table-land, Nelson. They were found together by the writer, but as they were lying among mixed bones (though of other genera) it can only be inferred that they were of the same individual bird. They exceed in size the largest *Anomalopteryx* bones, and are considerably larger than *M. didinus.* They are relatively rather stouter than the bones of *M. didinus,* approaching *Anomalopteryx* in this respect; but the presence of a narrow rotular cavity and fine, clearly defined muscle ridges in the femur, and a scarcely deflected procnemial ridge in the tibia, indicates that the species is of *Megalapteryx.* The femur, although deficient in the middle of the shaft, better exhibits the generic characters and is therefore designated the actual type. It is a pleasure to associate this form with the name of Sir William Benham, F.R.S., whose studies of individual skeletons of moa have materially assisted this review.

The dimensions and proportions of the type femur, and of the tibia which probably belonged to it, are:—

Femur:	29.3	9.2	3.9	9.3	12.5
	= 100	31.4	13.3	31.7	42.7
Tibia:	45.4	10.9	3.9	6.3	10.6
	= 100	24.0	8.6	13.87	23.35

Genus *Pachyornis* Lydekker, 1891.

1891 .. .. .. Pachyornis Lydekker, Cat. Foss. Birds Brit. Mus., 361. Type, by original designation, *Dinornis elephantopus* Owen.

The species of *Pachyornis* differ from those of *Anomalopteryx* and *Megalapteryx* by having the femur and metatarsus shorter in relation to length of the tibia; they also have a stronger inward inflexion of the tibia. The skull has a smaller temporal fossa than in *Anomalopteryx* and the lambdoidal and temporal ridges are usually separated. The beak is sharp-pointed, with its lateral margins, viewed from above, slightly convex. There is a well-developed maxillary antrum. The sternum is broad with widely-diverging lateral processes.

Four species: two, in the North Island, smaller than *Anomalopteryx didiformis* and not exceptionally stout; two larger South Island species developing massive leg-bones. Their relative size is indicated by length of leg-bones as follows:—

			Femur.	Tibia.	Metatarsus.
P. elephantopus (Owen)	max.	..	32.9	59.7	25.5
	min.	..	29.3	45.7	21.0
P. pygmaeus (Hutton)	max.	..	.	40.0 (estimate)	18.0
	min.	..	.	34.0 (estimate)	15.6
P. mappini n. sp.	max.	..	19.4	33.2	15.5
	min.	..	16.1	27.8	12.5
P. oweni (Haast)	max.	..	14.3	26.4	11.6
	min.	..	13.5	22.5	10.1

Pachyornis elephantopus (Owen), 1856.

1856	July 30 ..	**Dinornis elephantopus** Owen, Proc. Zool. Soc. for 1856, pt. 24, p. 54. Founded upon a skeleton in British Museum (Lydekker, p. 322) made up from mixed bones of several individuals found buried in sandhills at Awamoa, Oamaru Point. TYPE: No single bone having as yet been selected as the type, I here designate the left metatarsus of this skeleton as such: it was figured by Owen (see next citation).
1858	September 28	*Dinornis elephantopus:* Owen, Trans. Zool. Soc., vol. 4, pt. 5, p. 149, pls. 43, fig. 1 (femur), 47, fig. 5 (tibia) and 44, fig. 1 (metatarsus, LECTOTYPE).
		Dinornis elephantopus: Owen, *ibid.* pp. 159-64, pls. 46-47 (composite skeleton).
1870	.. .. ..	*Dinornis elephantopus:* Owen, Trans. Zool. Soc., vol. 7, pt. 2, p. 123, pl. 10 (skull).
1875	July	*Dinornis elephantopus* var. **major** Hutton, Trans. N.Z. Inst., 7, p. 274; Table A, opposite p. 278. Founded on three femora, tibiae and six metatarsi from Hamilton Swamp, Otago, in Otago Museum. LECTOTYPE (here designated) metatarsus from the above specimens with the following dimensions:— 23.65 11.7 7.5 14.8 19.0
1891	April 25 ..	*Pachyornis elephantopus:* Lydekker, Cat. Foss. Birds Brit. Mus., 321.
		Pachyornis immanis Lydekker, Cat. Foss. Birds Brit. Mus., 343. TYPE: A metatarsus from the South Island in the British Museum (A. 168).
1891	.. .. ..	*Euryapteryx* **ponderosus** Hutton, N.Z. Jnl., Sci., new iss., vol. 1, no. 6, 249. Average measurements of leg-bones, type not indicated. LECTOTYPE here designated, metatarsus from Hamilton Swamp in Otago Museum with the following dimensions: 20.95 10.0 5.8 12.3 14.8
1892	April ..	**Pachyornis rothschildi** Lydekker, Proc. Zool. Soc. for 1891, no. 33, 479-482. Types: associated right femur, and the two tibiae and metatarsi; locality unknown. Tring Museum.
1892	.. .. ..	*Euryapteryx elephantopus:* Hutton, Trans. N.Z. Inst., 24, 135 (part; Type No. 1).
		Euryapteryx ponderosus: Hutton, *ibid.*, 137, part.
1893	.. .. ..	**Pachyornis inhabilis** Hutton, Trans. N.Z. Inst., 25, 11. TYPE: Incomplete individual skeleton from unknown locality, "probably somewhere in Canterbury" in Canterbury Museum (No. 9.2.23).
		Pachyornis valgus Hutton, Trans. N.Z. Inst., 25, 12. Types: A pair of tibiae from Enfield, in Canterbury Museum, but only one now identifiable.
1894	.. .. ..	*"Pachyornis immanis?":* Parker, Trans. N.Z. Inst. 26, pp. 224, 225 (skull, probably of this species).
1895	.. .. ..	*Pachyornis elephantopus:* Parker, Trans. Zool. Soc., 13, p. 375, pl. 60, figs. 22. Skull, (pl. 8, fig. 3, of this paper).
1907	.. .. ..	*Pachyornis immanis:* Rothschild, "Extinct Birds," 215.
		Pachyornis rothschildi: Rothschild, *ibid.*, 215.
		Pachyornis inhabilis: Rothschild, *ibid.*, 216.
		Pachyornis valgus: Rothschild, *ibid.*, 216.
1930	.. .. ..	*Dinornis novae zealandiae:* Oliver (part), "N.Z. Birds," pp. 39-41.
		Euryapteryx immanus: Oliver, "New Zealand Birds," 52
1933	.. .. ..	*Euryapteryx immanis:* Lambrecht, Handbuch der Palaeornithologie, 150.

The following are part *Euryapteryx gravis.*

1869	.. ..	*Dinornis elephantopus:* Haast, Trans. N.Z. Inst., vol. 1, 85.
		Dinornis crassus Haast, Trans. N.Z. Inst., 1, 86, 87 (No. 16).
1874	June ..	*Palapteryx elephantopus:* Haast, Trans. N.Z. Inst., vol. 6, 427.
1874	July	*Palapteryx elephantopus:* Haast, The Ibis (3), 4, 209.
1875	.. ..	*Dinornis crassus* var. **major** Hutton, Trans. N.Z. Inst., vol. 7, 276-7, Table A, opposite p. 278. Founded on numerous leg-bones not now distinguishable from the following.
		Dinornis elephantopus: Hutton, *ibid.,* 276-7, Table A.
		Dinornis crassus: Hutton (part, femora and metatarsi *maxima) ibid.,* 276-7, Table A.
		Dinornis gravis: Hutton (part, *maxima;* includes types of *Euryapteryx ponderosus* Hutton) *ibid.,* 277, Table A.
1891	November 13	*Pachyornis elephantopus:* Sharpe, Cat. Ost. Vertebr., Mus. Roy. Coll. Surg., London. III., p. 436.
1891	November ..	*Euryapteryx elephantopus:* Hutton, N.Z. Jnl. Sci., new issue, vol. 1, No. 6, p. 249.
		Euryapteryx gravis: Hutton, N.Z. Journ. Sci., new issue, vol. 1, No. 6, 249.
1892	May	*Euryapteryx gravis:* Hutton, Trans. N.Z. Inst., 24, 138.
1896	June ..	*Euryapteryx gravis:* Hutton, Trans. N.Z. Inst., 28, 638, 647.
		Pachyornis immanis: Hutton, Trans. N.Z. Inst. 28, 642, bones from Kapua. *Ibid.* p. 647—bones from Enfield.
		Euryapteryx ponderosa: Hutton, Trans. N.Z. Inst. 28, 638; bones from Kapua.
		Pachyornis elephantopus: Hutton, *ibid.,* 641.
		Pachyornis inhabilis: Hutton, *ibid.,* 642.
		Euryapteryx ponderosa: Hutton, *ibid.,* 647; bones from Enfield.
		Pachyornis elephantopus: Hutton, *ibid.,* 647.
		Pachyornis inhabilis: Hutton, *ibid.,* 648.
1907	.. ..	*Pachyornis elephantopus:* Rothschild, "Extinct Birds," 214.
		Pachyornis ponderosus: Rothschild, *ibid.,* 216.
1930	.. ..	*Euryapteryx elephantopus:* Oliver, N.Z. Birds, 51.
		Euryapteryx ponderosus: Oliver, *ibid.,* 52.
1933	.. ..	*Euryapteryx elephantopus:* Lambrecht, Handbuch der Palaeornithologie, 150.
		Euryapteryx ponderosus: Lambrecht, *ibid.,* 150.

This species was founded upon a skeleton made up of mixed bones, but, as Owen in his description referred especially to the size of the metatarsus (1858a, p. 55), and as it most distinctively exhibits the character of the species, it is appropriate to select it as the type. In fact, the terms in which Owen discussed it (p. 58) might perhaps be regarded as a designation of it as the type. "I had hitherto regarded the metatarse of the *Dinornis crassus* as presenting the most extraordinary form and proportions of all the restored species of huge wingless birds of New Zealand; but it is strikingly surpassed in robustness and in great relative breadth and thickness by the same bone of the present species, which chiefly on that account I have proposed to name *elephantopus.*"

Not many individual skeletons or sets of leg bones have been secured, and only two with the skull. On the other hand, numerous mixed bones have been recovered from swamps, from among which series might be arranged of, say, the tibia, which would seem to indicate varieties or subspecies. But the few individual skeletons we already have are sufficient to indicate that the femora and metatarsi would not conform to the grouping on tibiae, and that small tibiae are sometimes associated with larger femora and metatarsi than those belonging to much larger tibiae (Table C.). A considerable range of sizes is therefore included under the name *elephantopus. P. immanis* was separated by Lydekker as an extremely massive form; but if this is to be recognized it will be known as *P. major* (Hutton).

Hutton (1875) clearly established this name when he said of the discoveries in the Hamilton Swamp: "The excavations have certainly brought to light a variety of *D. elephantopus,* larger and more exaggerated than any yet recorded by Professor Owen or by Dr. Haast." The accompanying dimensions in his Table A opposite p. 278 indicate a bird with the same massive metatarsal proportions as in the metatarsus for which Lydekker subsequently (1891, p. 343) proposed the name *immanis*. The lectotype that I have nominated from among the Hamilton swamp bones in the Otago Museum is slightly shorter than Lydekker's type, but is equally broad.

Oliver (p. 41) included *Pachyornis rothschildi* in *Dinornis novae-zealandiae* on the basis of the length and distal width of the tibia. The type leg-bones, which are those of an individual, are much too abraded for reliable measurements; their form, however (Lydekker, 1891b, pl. 38), is clearly that of *Pachyornis*, whose characteristic inflected tibia appears again in the type leg-bones of *Pachyornis inhabilis* and *P. valgus*.

This feature provides a ready means of separating the tibiae of *P. elephantopus* from those of *Euryapteryx gravis* (Pl. 14); their metatarsi may be distinguished, though less satisfactorily, by a stronger forward projection of the middle distal trochlea with a distinct basal ridge above in *P. elephantopus*, and a lesser and not so abrupt forward projection of the trochlea in *Eu. gravis* (Pl. 14, cf. figs. 1a and 2a). The intercondylar ridge at the proximal end is also usually higher in *elephantopus*. In the smaller North Island species the actual inward inflexion of the tibia is as great in *Euryapteryx* as in *Pachyornis;* but a strongly-developed inner flange near the extensor bridge and the higher intercondylar ridge of the metatarsus in *Pachyornis* form even better means of distinction from *Euryapteryx* (Text-figs. 9a, 9b).

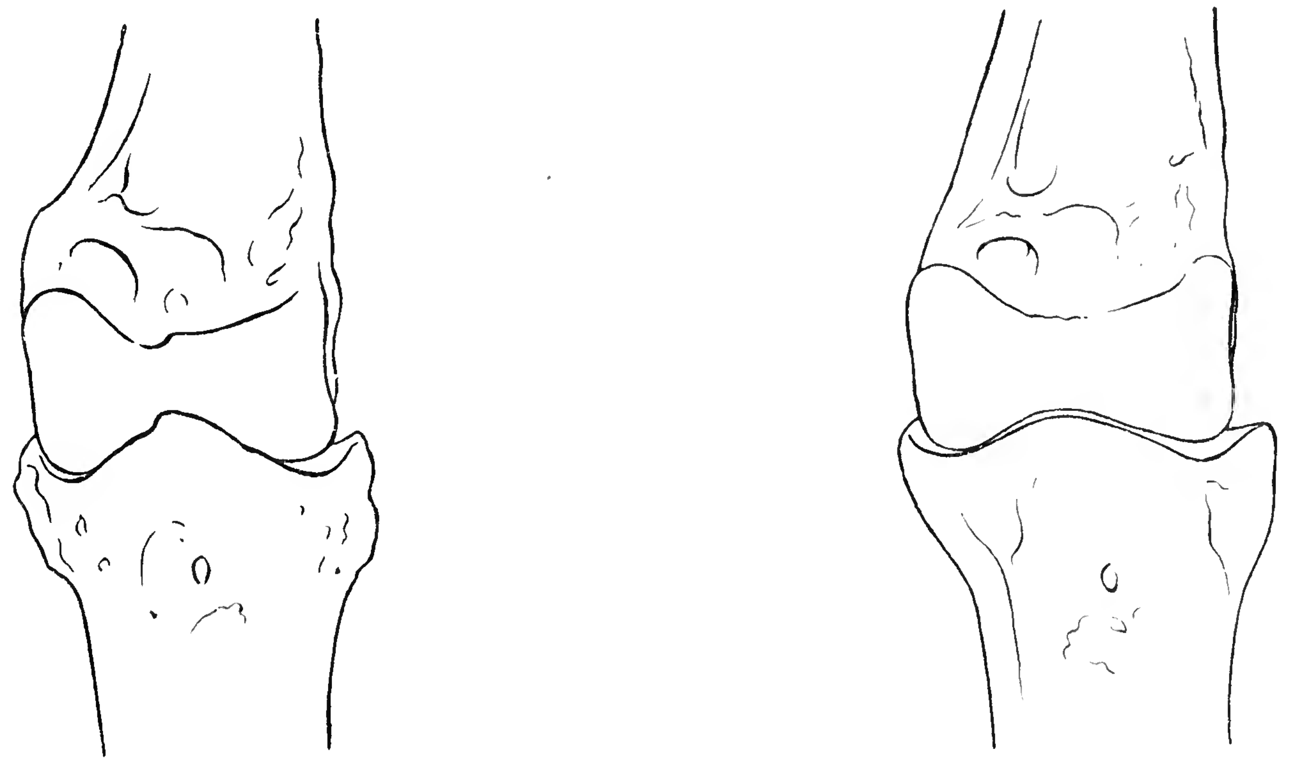


Fig. 9a. **Fig. 9b.**

Text-fig. 9. **P. mappini** (9a); **Eu. exilis** (9b): tibia and metatarsus.

I do not think that a smaller variety *(ponderosus)* of *P. elephantopus* will need to be recognized. In case it should, it may be as well to mention that the basis of *ponderosus*, according to the original synonymy, was bones from Hamilton Swamp described by Hutton (1875) as *D. gravis*. These included an associated tibia and metatarsus, the only two Hamilton Swamp bones that Hutton (p. 275) could say were those of an individual bird. These would have been appropriate for selection as the type of *ponderosus;* but they cannot now be recognized. The bone selected as lectotype is the Hamilton metatarsus in Otago Museum nearest in size to the dimensions of the above-mentioned metatarsus; it happens to have a high intercondylar ridge and is accordingly to be included with *Pachyornis (elephantopus)* rather than *Euryapteryx (gravis)*.

Skull. In identifying large South Island skulls, particularly from among mixed swamp material, the commonest need will be to determine whether a cranium separated from its beak is of *P. elephantopus* or *Euryapteryx gravis*. Comparative details bearing on this point will therefore be as desirable as differences between the species of *Pachyornis* itself.

The description which follows is taken from the skull of the recently-found Pyramid Valley specimen, xxB, in the Canterbury Museum; the figures (Plate 8), however, which were drawn and processed some time ago, are from other sources. The only other skull of this species definitely found with its skeleton is that of the type of *Pachyornis inhabilis,* also in the Canterbury Museum.

In occipital view the skull has a well-arched roof; the supra-foraminal ridge not being swollen, the supra-occipital median crest and the supra-occipital fossae remain well-defined. In these respects *P. elephantopus* resembles *Eu. gravis* and differs from the small North Island species of its own genus. The paroccipital depressions are wide and shallow. The outer border of the paroccipitals is sinuate; the processes extend down to about half way between the levels of the condyle and the mamillar tuberosities; the latter are large, separated by a distinct arch, and are rather more outstanding than in *Eu. gravis.*

In dorsal view the lambdoidal and temporal ridges are separated, and the anterior and posterior lambdoidal ridges enclose a flat triangular area. The temporal ridges encroach upon the occiput and curve backward in a characteristic sweep towards the lambdoidal ridges (Pl. 8, fig. 1), while in *Eu. gravis* (Pl. 6, fig. 3) they extend upward rather than backward, and to a much less extent. The temporal area of the roof is flattened in the Pyramid Valley skull, but is arched or has a double tumidity in other specimens.

In lateral view the posterior, paroccipital, border of the tympanic fossa is convex and curves into the upper border (Pl. 8, fig. 2), whereas in *Eu. gravis* (Pl. 6, fig. 1) the hinder margin is less curved and meets the upper at less than a right angle; in both species the upper border of the fossa is a lobed overhanging ledge. The postorbital process is moderately wide, in other skulls it is narrower; in *Eu.gravis* it is usually very wide. The long acute premaxilla has a large median septum which has a thin semi-transparent central area; in *Eu. gravis* the septum is short and opaque.

In general the skulls of *P. elephantopus* exhibit their differences from *Eu. gravis* in the pre-lambdoidal area; in the occipital area the resemblances are more marked than the differences. In the small North Island species of *Pachyornis,* however, the occipital region resembles that in *Emeus* and differs markedly from the small *Euryapteryx* species which have the occipital characters of the large species.

Sternum and Pelvis. The sternum in three individual skeletons is broad with widely diverging lateral processes. The pelvis also is broad, but does not exhibit such marked differences from *Eu. gravis* as appear between the small North Island species of *Pachyornis* and *Euryapteryx.*

Distribution. P. elephantopus is known so far from Canterbury and Otago only. The heaviest forms (i.e. the types of *major* and *immanis)* were from Otago; these specimens are peculiar in that they appear to have acquired a second coating of bone as though by an overgrowth.

Pachyornis pygmaeus (Hutton), 1891.

1891	November ..	*Euryapteryx pygmaeus* Hutton, N.Z. Jnl. Sci., new issue, vol. 1, No. 6, p. 249. Founded on average measurements of leg-bones, of which a pair of metatarsi from Takaka in Nelson Museum were subsequently (Hutton 1892b, 139) selected as the types.
1892	May	*Euryapteryx pygmaeus:* Hutton, Trans. N.Z. Inst., 24, 139.
1895	.. .. ..	*Mesopteryx* species β : Parker, Trans. Zool. Soc. 13, pt. 11, p. 378, pl. 61, figs. 20, 21.
1897	June ..	*Pachyornis pygmaeus:* Hutton, Trans. N.Z. Inst., 29, 555.
1907	.. .. ..	*Pachyornis pygmaeus:* Rothschild, "Extinct Birds," 217.
1930	.. .. ..	*Euryapteryx pygmaeus:* Oliver, "New Zealand Birds," 53.
1933	.. .. ..	*Euryapteryx pygmaeus:* Lambrecht, Handbuch der Palaeornithologie, 152.

Table 7. Dimension of skulls of *Pachyornis elephantopus*, *P. pygmaeus*; *Eurapteryx gravis*.

Measurements by	*P. elephantopus.*			*P. pygmaeus.*	*Eu. gravis.*					*E. gravis.*			
	Enfield. J. Flett. O.M. G.A.	Enfield. Parker, 1894.	S. Island. Owen, 1870b, Pl. 10.	*Mesopteryx* sp. *β*. T.J.P.	Shag Pt. R. S. Booth. O.M. G.A.	Shag Pt. R. S. Booth. O.M. G.A.	Riverton. *E. ponderosus.* Individual skeleton. G.A.	*Emeus parkeri?* (*Emeus* sp. *γ* Parker.) T.J.P.	Type: *E. kuranui.* G.A.	*E. gravis.* Type.	*Emeus* sp. *α* Lyd. Shag R. G.A.	*Emeus boothi* sp. *α* Parker. G.A.	*Emeus* sp. *β* Parker.
Length: total	17.6		16.5	14.1	14.0	13.8	13.3	13.6	13.1			12.9	
Length: paroccipital-preorbital	9.8		9.5	(8.4)	8.45	8.23	8.7	8.3	8.1	7.63?		8.13	
Length: basipterygoid-rostrum					9.2	9.8	9.8					8.4	
Length: condyle : rostrum			12.7		10.3	10.6	11.1					9.3	
Height	5.34	6.1	5.5	4.7	5.0	4.88	4.87	4.7	4.6		5.0	4.9	4.3
Width at paroccipital processes	6.22	7.3	6.5	5.9	7.0	6.61	6.22	6.7	6.25	6.25	5.6	5.45	5.4
Width at squamosal prominence	9.22	9.6	8.5	7.6	8.2	7.58	7.97	7.5	7.2	7.14	7.8	7.1	7.0
Width at temporal fossae	5.62	5.9	5.7	4.8	5.05	5.15	5.14	5.3	4.8	5.0	5.2	4.7	4.7
Width between temporal ridges	4.06	4.4	5.2	4.1		4.74	4.10	5.0	3.9	4.4	4.4		4.2
Width at postorbital processes	9.60		9.3	9.0	9.0	8.5	8.15	8.0	8.1	8.0	8.5	7.98	8.0
Width at preorbital processes	6.7			5.3		4.4	3.9	4.7	4.25	4.2		3.9	3.9
Width of tympanic cavity	2.4		2.0	2.1	2.25	2.0	2.1	2.0	1.95			2.2	2.0
Width of temporal fossa	2.93	3.0	2.7	2.3	2.62	2.1	2.3	1.7				2.4	2.0
Width of orbit	3.4	3.6		3.2	3.0	3.17	2.8	3.2	3.1			3.0	3.0
% Height : Length	30.4		33.4	33.3	35.7	35.4	36.6		35.2			38.0	
Squamosal width : length			51.5	53.9	58.5	55.0	60.0		55.0			55.1	
Temporal fossa width : length			34.6	34.0	36.1	37.4	38.7		36.7			36.4	
Postorbital width : length			56.5	63.8	64.3	61.7	61.3		61.8			61.8	
Squamosal : paroccipital width			131.0	128.6	117.0	115	128		108.3			131	
Postorbital : squamosal width			109.5	118.4	109.5	112	102		111.5			113	
Paroccipital-preorbital : total length			57.7	59.5	60.3	59.7	65.5		62.0			63.0	
Space between lambdoidal-temporal ridges			1.2	0.9			1.0		0.3				
% temporal ridges : temporal fossae			91.5	85.5		92.0	79.7		78.5				

Having founded this species on average measurements, Hutton subsequently designated a pair of metatarsi in the Nelson Museum from Takaka as the types.

Dimensions of types:—

Right	..	15.5	6.8	3.9	8.3	10.0
	=	100	43.7	25.4	53.3	64.3
Left	..	15.6	6.8	3.9	8.4	10.0
	=	100	43.6	25.3	53.8	64.2

These bones have the raised intercondylar ridge characteristic of *Pachyornis* and represent a South Island species much smaller than *P. elephantopus*. They are of the same length as the metatarsi of the type of the next species, *P. mappini* of the North Island, but are much heavier. Similarly a larger metatarsus in the Canterbury Museum from an unknown (South Island) swamp locality, the only other leg-bone I can confidently identify with this species, reveals a stout heavily built bird (see Table C). I have also included in *P. pygmaeus* the skull which Parker (1895b, pl. 60, figs. 20, 21) designated *Mesopteryx* sp.β. It is considerably smaller than other South Island *Pachyornis* skulls, and, by comparison with the proportion "tibia length: cranium length" noted in individual skeletons of the genus, would have had a tibia about 39 cm. and a metatarsus 18 or 19 cm. in length. In other words, it is appropriate in size to the larger metatarsus just described. The skull is also from the same locality as the types of *pygmaeus,* the Takaka tableland west of Nelson city. The leg bones from Karamu, near Hamilton (North Island) identified as *P. pygmaeus* by the writer in 1927 belong to the next species.

Pachyornis mappini n. sp.

1927	August 15 ..	*Cela geranoides:* (Lydekker); Archey, Trans. N.Z. Inst. 58, 151, pls. 18, 19.
1927	.. .. ..	*Pachyornis pygmaeus:* Archey, Trans. N.Z. Inst., 58, pts. 1 and 2, p. 156.

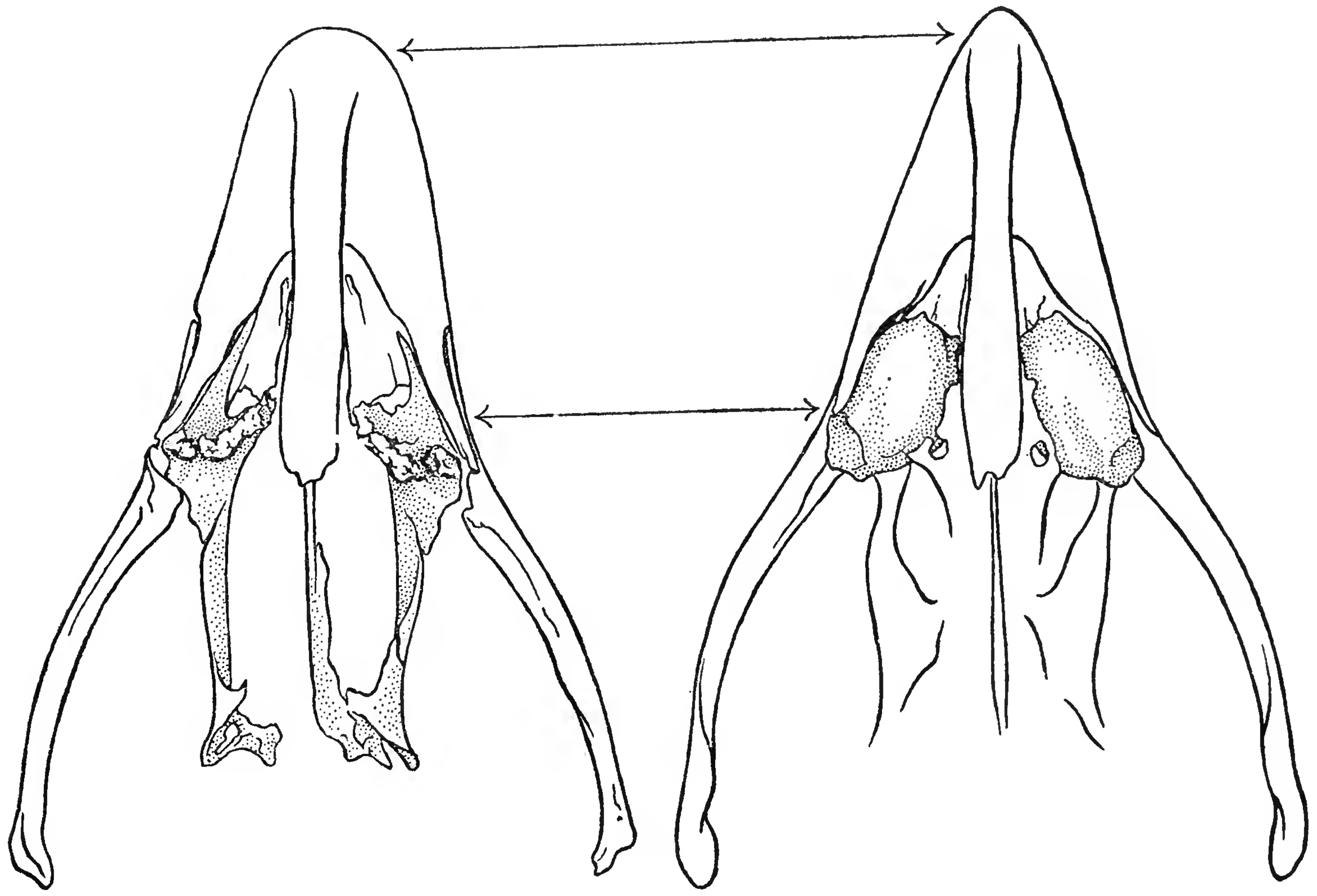
The following references include part *Euryapteryx exilis.*

1891	November ..	*Cela geranoides:* Hutton, N.Z. Journ. Sci. new issue, vol. 1, No. 6, 248.
1892	May	*Cela geranoides:* Hutton, Trans. N.Z. Inst., vol. 24, 126.
1907	November 12	*Cela geranoides:* Rothschild, Extinct Birds, 206.
1930	.. .. ..	*Emeus exilis:* Oliver, New Zealand Birds, 49.
1933	.. .. ..	*Emeus exilis:* Lambrecht, Handbuch der Palaeornithologie, 148.

The type of this species is an almost complete skeleton discovered in 1933 by Mr. F. Crossley Mappin in a cave at Mangaotaki. It is No. 124 in the Auckland Museum collection. It has been a valuable specimen, for it has been the chief means of confirming for the smaller North Island specimens of *Pachyornis* the essential characters of the genus. I have much pleasure in associating Mr. Mappin's name with the species in acknowledgment of the many opportunities he has provided for exploring likely "moa country," and of his own keenness in search of specimens and patient care in recovering them from caves.

The type, which is the largest North Island specimen we have of the genus, was a bird of about the same height as the type of *P. pygmaeus,* but much lighter; the Karamu specimen (Archey, 1927) was more robust, but it also was not as heavy as *P. pygmaeus.* As has already been mentioned, this species, and the still smaller *P. oweni,* do not differ from their size-fellows in *Euryapteryx* by displaying greater inward inflexion of the lower end of the tibia; instead, they have a projecting flange, not found in *Euryapteryx,* opposite the osseous bridge for the extensor tendon (Text-figs. 9a, 9b). The higher proximal intercondylar ridge of the metatarsus in *Pachyornis* is a better-developed difference in these small North Island species than in the larger South Island birds.

The type, also two smaller skeletons from Waikaremoana (A.M. 84 and 85), have excellently preserved skulls. Typical *Pachyornis* skulls, they are miniatures of *"Mesopteryx* sp. β" (i.e. *P. pygmaeus)* except in the occipital region, where they exhibit a distinct swelling of the supra-foraminal margin (Pl. 5, fig. 4) in the manner of the skulls of *Emeus.* They differ from the skulls of *Anomalopteryx* by the sharp beak widening more noticeably posteriorly, by the outward bowing of the maxillo-jugal bar (Pl. 7, fig. 3) and by the considerably more twisted palatines. The maxillary antrum is an expanded bony sac (Pl. 5, fig. 4, Text-fig. 10b), with a wide posterior aperture as in *Anomalopteryx.* Both the type and the Amodeo Bay skull exhibit the same backward sweep of the temporal ridge as in *"Mesopteryx* sp. β," but this is not so marked in the smaller skulls. A.M. 84 and 85. The maxillo-nasal is a long slender splinter-bone lying close-pressed to the front margin of the antorbital (Pl. 4, fig. 4), and expanding below where it fits against the maxilla. Comparing skeletons of equal size in *Pachyornis mappini* and *Euryapteryx exilis,* the skulls of the former are larger (Table 8).



Text-fig. 10. **Eu. exilis** (10a); **P. mappini** (10b): beak and maxillary antrum.

The sternum (Pl. 12, fig. 5) has a broad straight anterior margin and widely diverging lateral processes. In all five skeletons I have the coracoid pits are developed (faintly in A.M. 150) and in four of them there is a small scapulo-coracoid; A.M. 150 from which it is missing is a very incomplete skeleton.

Pelvis. The pelvis in *P. mappini* is considerably flatter dorso-ventrally and relatively wider than in *Anomalopteryx,* and has widely diverging ischia and pubes. Viewed from the side (Pl. 9, fig. 4) the dorsal margin is very slightly arched; the front margin which emerges from the dorsal margin by an unbroken curve forms a sharp angle with the ventral iliac border. Seen from above (Pl. 10, fig. 4) the anterior portions of the ilia show wide concave expansions of subquadrate outline. Immediately behind the projecting ribs belonging to vertebrae 29 and 30, the margins are constricted, forming a narrow waist. The acetabular region is wide and the escutcheon is also wide, with its sub-parallel lateral margins. The proportionate width at the antitrochanters is on the average slightly greater than in *Eu. exilis* or *Anomalopteryx;* the proportionate width of the escutcheon is definitely greater, as also are the posterior divergences of the ischia and pubes.

The dorsal view of the escutcheon in *P. mappini* differs from *Anomalopteryx* in that while in the latter its front margin is formed by the abruptly diverging iliac crests and the lateral margins extend widest anteriorly, in *P. mappini* the iliac margins diverge more gradually and the escutcheon is widest further aft. This greater width posteriorly in the ilium of *P. mappini* is seen more markedly on the ventral side (Pl. 11, fig. 4).

Table 8. Dimensions of skulls, *Pachyornis mappini* and *Euryapteryx exilis.*

	Pachyornis mappini.	*Euryapteryx exilis.*	*Pachyornis mappini.*	*Euryapteryx exilis.*
Auckland Museum No.	124	3	85	360
Total length	12.00	10.70	11.2	10.70*
Length : parocc. to preorbital	7.00	6.15	6.35	5.90
Height	4.00	3.67	4.20	3.90
Width at parocc. processes	5.30	5.06	5.20	5.15
Width at squam. prominences	6.30	5.60	6.08	5.65
Width at temporal fossae	4.56	3.90	4.30	3.80
Width between temp. ridges	3.86	3.26	3.50	3.15
Width at postorbitals	6.77	6.28	6.90	6.20
Width at pre-orbitals	3.56	3.24	3.80	3.20
Width of tympanic cavity	1.75	1.72	1.90	1.65
Width of temp. fossa	2.65	1.78	2.35	1.85
Width of orbit	2.75	2.54	2.40	2.70
% squam. width : length	52.5	52.3	54.3	52.8
% width at temp. foss. : length	38.0	36.4	38.4	35.5
% postorbital width : length	56.4	58.7	61.6	58.0
% temp. ridges width : fossae width	84.6	83.5	81.4	83.0
% parocc.-preorb. length : total length	58.3	57.5	56.7	58.0*

*Estimated.

Table 9. Dimensions of Pelvis: *Pachyornis mappini* and *Euryapteryx exilis.*

	P. mappini.	*Eu. exilis.*	*Eu. exilis.*
Auckland Museum No.	124	3	160
Length	31.9	31.0	29.0
Width at antitrochanters	15.9	15.2	15.0
Width at pectineal tubercles	12.7	11.3	.
Width of escutcheon	14.4	13.0	11.1
Ischium length	16.2	16.0	15.5
Ischium height	5.3	4.0	3.5
Ischium divergence	22.0	20.2	18.0
Proportion %—			
Width at antitrochanters : length	49.2	.	51.7
Width of escutcheon : length	45.1	.	.
Ischium divergence: antitrochanter width	138	132	120

Table 10. Dimensions of Sternum: *P. mappini* and *Eu. exilis.*

	P. mappini.	*Eu. exilis.*	*P. mappini.*	*Eu. exilis.*	*P. mappini.*	*Eu. exilis.*
Auckland Museum No.	Type. 124	Type. Wang. M.	150a	3	84	5
A. Breadth across pre-costal processes ..	14.5	13.9	14.5	13.5	11.3	10.0
B. Breadth at anterior end of costal border	12.5	10.2	11.0	11.0	9.5	7.8
C. Width at base of median process ..	9.5	6.8	7.5	6.5	7.0	5.0
D. Distance between outer ends of lateral processes	21.0	12.8	19.0	15.5	18.5	14.0
E. Length: anterior margin to tip of median process	14.7	14.8	11.5	13.5	.	11.2
F. Length: anterior margin to lateral notch	7.6	.	5.2	8.0	5.4	7.0
G. Length: anterior margin to tip of lateral process	14.8	7.8	13.0	16.0	13.0	14.5

Distribution: North Island generally. Skeletons have been obtained from sand dunes at Doubtless Bay and Coromandel, from caves at Mangaotaki and Waikaremoana, and leg-bones and a skull from the Makirikiri swamp deposit near Wanganui.

Pachyornis oweni (Haast), 1886.

1885 .. .. .. *Dinornis oweni* Haast, Proc. Zool. Soc. for 1885, no. 31, 482. *Nomen nudum.*

1886 .. .. .. **Dinornis oweni** Haast, Trans. Zool. Soc. 12, pt. 5, 171-182, pls. 31-32. Type: by original designation, incomplete skeleton from near Whangarei; in Auckland Museum, A.M. 384.

The following references include part *Euryapteryx curtus.*

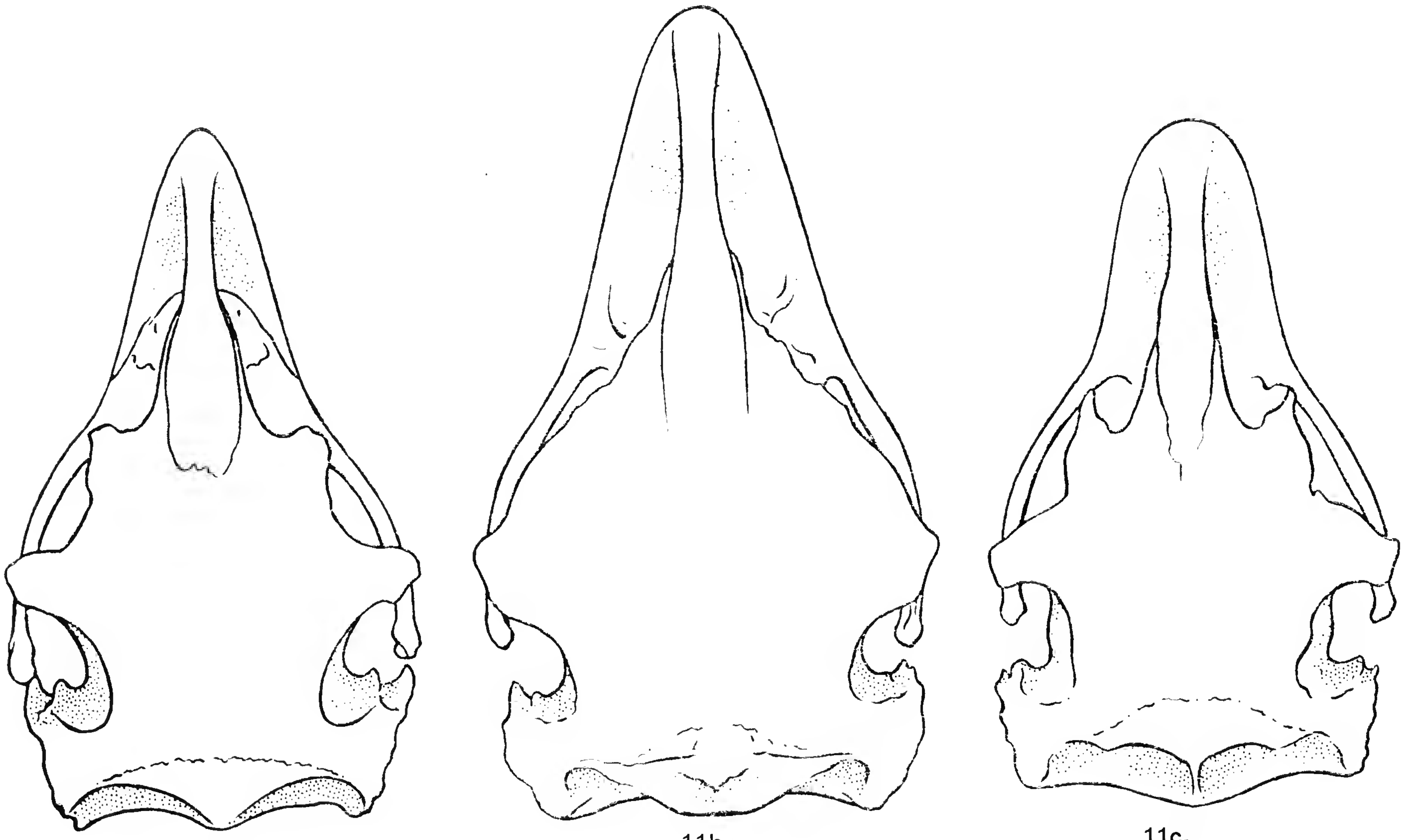
1891 April 25 .. *Anomalopteryx oweni:* Lydekker, Cat. Foss. Birds, Brit. Mus. 280.
Anomalopteryx curta: Lydekker, *ibid,* 281.
1891 November 13 *Anomalopteryx curta:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, III., 433.
1891 November .. *Cela curtus:* Hutton, N.Z. Journ. Sci., new issue, vol. 1, no. 6, 248.
1892 May .. *Cela curtus:* Hutton, Trans. N.Z. Inst., 24, 127.
1893 .. .. .. *Anomalopteryx curta:* Parker, Trans. N.Z. Inst. 25, 2.
1897 .. .. .. *Anomalornis oweni:* Hutton, Trans. N.Z. Inst., 29, 549.
Cela curtus: Hutton, *ibid,* 550.
1907 .. .. .. *Cela curtus:* Rothschild, Extinct Birds, 205.
Cela oweni: Rothschild, *ibid,* 206.
1930 .. .. .. *Anomalopteryx curtus:* Oliver, New Zealand Birds, 46.
Anomalopteryx oweni: Oliver, *ibid,* 46.
1933 .. .. .. *Anomalopteryx curtus:* Lambrecht, Handbuch der Palaeornithologie, 145.
Anomalopteryx oweni: Lambrecht, *ibid,* 145.

Of this species, the smallest of the moas, I have only three incomplete skeletons, including the type, and some sets of leg-bones (Table D). The localities are Pataua, near Whangarei; Tom Bowling and Doubtless Bays, in North Auckland; sand-dunes at Waikawau, Coromandel; and Westmere, a suburb of Auckland. They include quite slender bones, and one, a tibia from unknown locality, that is exceptionally stout. *P. oweni* is the size-fellow of *Euryapteryx curtus,* but is rather smaller.

Genus *Emeus* Reichenbach, 1852*

1852 .. .. .. *Emeus* Reichenbach, Av. Syst. Vög., p. xxx. Type, by monotypy, *Dinornis crassus* Owen.
1852 .. .. .. *Syornis* Reichenbach, *ibid.* p. xxx. Type, *Dinornis casuarinus* Owen.
1874 June .. *Meionornis* Haast, Trans. N.Z. Inst., vol. 6, 426. Type, here selected, *Dinornis casuarinus* Owen.
1874 July .. .. *Meionornis* Haast, Ibis (3), 4, 212.
1891 .. .. .. *Mesopteryx* Hutton, N.Z. Jnl. Sci. new issue, vol. 1, no. 6, p. 248. Type, by monotypy, *Dinornis huttonii* Owen (referred to by Hutton in error as *D. didinus* Owen).

The limb bones of the species of *Emeus* are stouter than those of *Anomalopteryx,* but less stout than in *Euryapteryx*. There are only four phalanges, including the claw, in the outer toe. The skull has a smaller temporal fossa, the temporal ridges reaching neither back to the lambdoidal ridge nor far up on the roof. The beak is less narrow than in *Anomalopteryx*, and rounded at the tip (Text-fig. 11b). The pelvis is flat with widely diverging ischia and pubes.


11a. *Pachyornis mappini.*
11b. *Emeus crassus.*
11c. *Euryapteryx exilis.*

Text-fig. 11.

Two species: separated as to length of leg bones as follows:—

			Femur.	Tibia.	Metatarsus.
E. crassus (Owen)	maximum	..	29.4	52.0	24
	minimum	..	26.5	43.7	20.0
E. huttonii (Owen)	maximum	..	24.4	39.7	18.7
	minimum	..	22.0	35.8	16.3

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*The following prior generic names approach *Emeus* in orthography:—*Eumaeus,* Huebner 1819, Lep.; *Eumaea,* Geyer 1834, Lep.; *Eumaeus,* Koch 1843, Arach.; *Emea,* Leidy 1850, Nemert. As I read the rules, only specific names are to be rejected for vowel and diphthong similarity; if however Article 35 be held to apply to generic names *Emeus* Reichenbach will be replaced by *Syornis* Reichenbach 1852.

Emeus crassus (Owen), 1846.

1846 July	**Dinornis crassus** Owen, Proc. Zool. Soc. for 1846, pt. 14, p. 46. Founded on a femur and metatarsus from Waikouaiti, South Island. LECTOTYPE: metatarsus, nominated by Lydekker (1891a, 307); the present place of deposition is unknown. Cast in the British Museum (A. 186) and the Auckland Museum (A.M. 298).
	Dinornis casuarinus Owen, *ibid*, 47. Founded on two femora, a tibia and a metatarsus from Waikouaiti. LECTOTYPE: tibia, nominated by Lydekker (1891a, 257); its present place of deposition is unknown; Mus. Roy. Coll. Surgeons, or British Museum.
1846 December 28	*Dinornis casuarinus:* Owen, Trans. Zool. Soc. vol. 3, pt. 4, p. 322, pl. 47, fig. 2 (tibia: LECTOTYPE), pl. 46 (femur), pl. 48, fig. 3 (metatarsus).
	Dinornis crassus: Owen, *ibid*, p. 325, pl. 48, figs. 4 and 5 (metatarsus, LECTOTYPE, figure reversed).
1848 April 22	Non *Dinornis casuarinus:* Owen, Trans. Zool. Soc., 3, pt. 5, p. 357 (Skull of *Aptornis*).
1850 or 1852	*Emeus crassus:* Reichenbach, Nat. Syst. Vogel, p. xxx.
	Syornis casuarinus: Reichenbach, *ibid*, p. xxx.
1869 May	*Dinornis casuarinus:* Haast, Trans. N.Z. Inst., 1, 82, no. 1, no. 2 (2nd edn., 1875, 22).
1870 January	*Dinornis rheides:* Owen, Trans. Zool. Soc. 7, pt. 2, 132, pl. 12 (skull).
1875	*Dinornis casuarinus:* Hutton, Trans. N.Z. Inst. 7, 275, skeleton.
	Dinornis crassus: Hutton (part: femur min., tibia max. and min., metatarsus min.), Trans. N.Z. Inst. 7, Table A, opp. p. 278.
1891 April 25	*Anomalopteryx casuarina:* Lydekker, Cat. Foss. Birds Brit. Mus. 257.
	Emeus crassus: Lydekker, *ibid*, 307.
1891 November 13	*Anomalopteryx casuarina:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, III., 428.
	Emeus crassus: Sharpe, *ibid*, 435.
1891 November	*Syornis crassus:* Hutton, N.Z. Journ. Sci., new issue, vol. 1, no. 6, 249.
	Syornis casuarinus: Hutton, *ibid*, 249.
1892 May	*Syornis crassus:* Hutton, Trans. N.Z. Inst. 24, 132.
	Syornis casuarinus: Hutton, *ibid*, 133.
1895 October	*Mesopteryx casuarina:* Parker, Trans. Zool. Soc. vol. 13, pl. 11. Skull.
1896 June	*Meionornis casuarinus:* Hutton, Trans. N.Z. Inst., 28, pp. 636, 646.
	Euryapteryx crassus: Hutton, *ibid*, pp. 638, 647.
1897 June	*Meionornis casuarinus:* Hutton, Trans. N.Z. Inst., 29, 558.
1906 June	*Emeus crassus:* Hutton, Trans. N.Z. Inst., 38, 66.
1907	(?) *Cela rheides:* Rothschild, Extinct Birds, 207.
	Cela casuarinus: Rothschild, *ibid*, 207.
	Emeus crassus: Rothschild, *ibid*, 209.
1930	*Emeus crassus:* Oliver, N.Z. Birds, 48.
	Emeus casuarinus: Oliver, *ibid*, 48.
1933	*Emeus crassus:* Lambrecht, Handbuch der Palaeornithologie, 146.
	Emeus casuarinus: Lambrecht, *ibid*, 147.

The priority of the name *crassus* over *casuarinus* is established by page-precedence. In the Proceedings of the Zoological Society for 1846 the name *Din. crassus* appears on p. 46 without description. On p. 47 the name *Din. casuarinus* appears with mention only of a metatarsus having a feeble depression indicating a back toe; but in the next paragraph we find *crassus* again, this time supported by a statement as to the size and proportions of a metatarsus relative to that of the ostrich. If this be not considered a sufficient description, the precedence of *crassus* is further established in the Table of Admeasurements which extends across pages 48 and 49; here dimensions of the femur of *Din. crassus* are given on p. 48, and of the metatarsus on p. 49, both being in tabular precedence to the dimensions of *Din. casuarinus*, which are also given on p. 49. The first designations of single bones as the type of each species were made by Lydekker (1891, p. 257, p. 307) and, although his selections of the metatarsus for *crassus* and the tibia for *casuarinus* do not facilitate comparison, they must be accepted.

Until last year no complete skeleton of *Emeus crassus* had been secured; the leg bones were known, but the only fairly complete skeletons obtained had lacked a skull. Consequently certain comparisons that have been made of skulls with the "skull of *crassus*" or the "skull of *casuarinus*" have been valueless. Through the gratifying results of the Pyramid Valley swamp excavations by the Canterbury Museum excursions I am now able to provide details from twelve individual skeletons of this species, six of them with well-preserved skulls.

The dimensions recorded (Table F) present us with a repetition of what was observed in *A. didiformis* and other species; i.e. a considerable range of size-variation in skeletons from one locality, together with an indiscriminate association, as to relative length, in the three leg bones of different individuals. The measurements of the designated types of *crassus* and *casuarinus* stand close together in this series, so Lydekker's selection of the metatarsus as the type of the former and the tibia for the latter has at least resulted in the two species being merged. If Owen's cotype femur of *casuarinus* had been fixed as the type, as Oliver regarded it, a smaller slender species, or subspecies might have been admitted, though the femur is not a good means of establishing a species. Oliver (1930) considered the two species as being only doubtfully separate, and I think that the recorded dimensions indicate the propriety of uniting them.

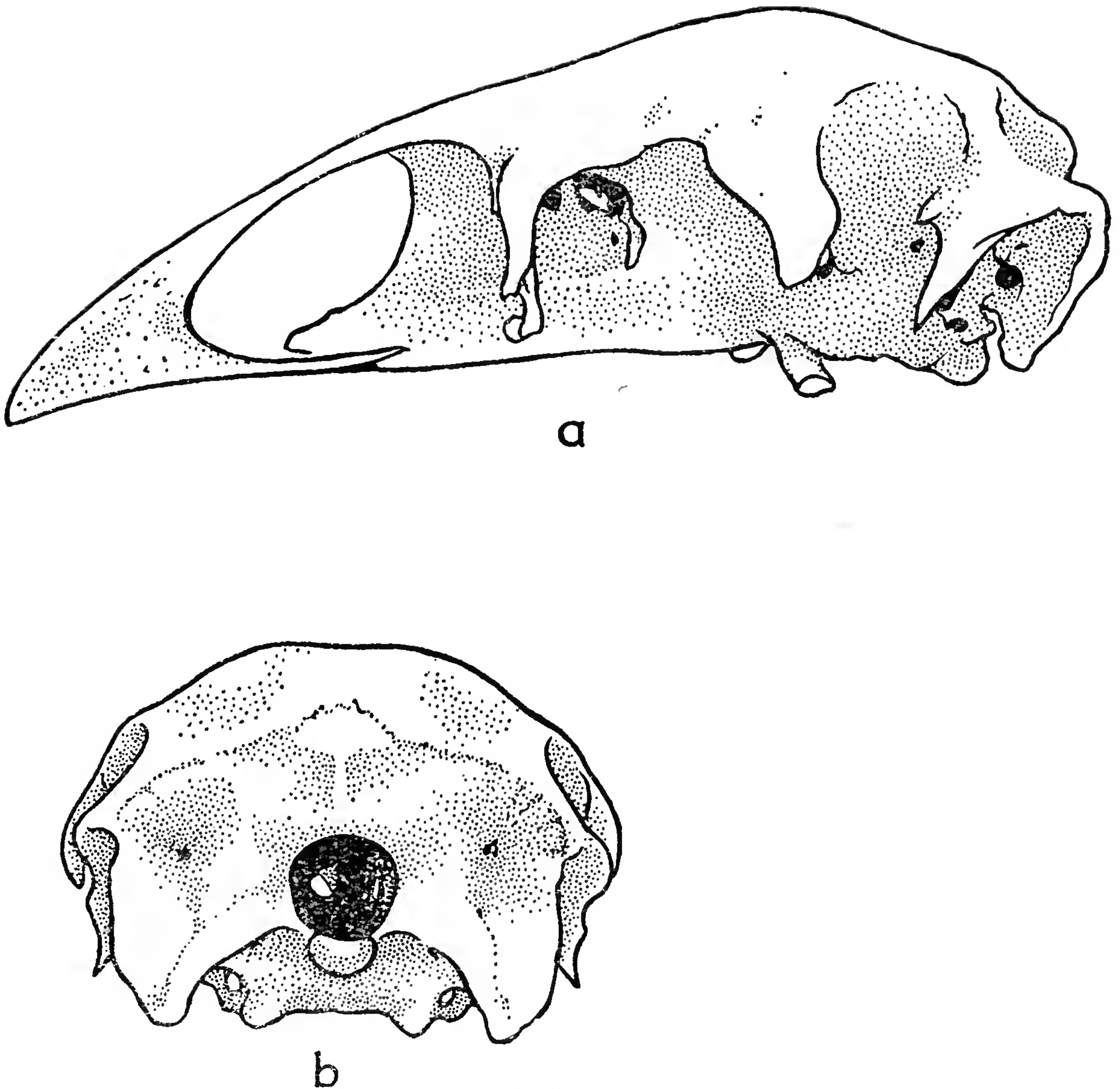
Lydekker (p. 257) considered *casuarinus* to be close to *A. didiformis;* it is true that the largest leg bones of *didiformis* approach the smallest of *casuarinus* in length: in relative width, however, especially of the metatarsus, and, as will be seen, in the form of the skull, the generic differences between these two forms are clearly maintained. Hutton and others have experienced difficulty in separating bones of *Em. crassus* from those of "elephantopus" from mixed swamp material; but, as will be seen below, this difficulty lies rather between *Em. crassus* and *Eu. gravis.*

There is a degree of variation in the pelves of these specimens, and considerable diversity in their sterna; but the skulls are fairly uniform, all having a narrow beak with well-rounded tip.

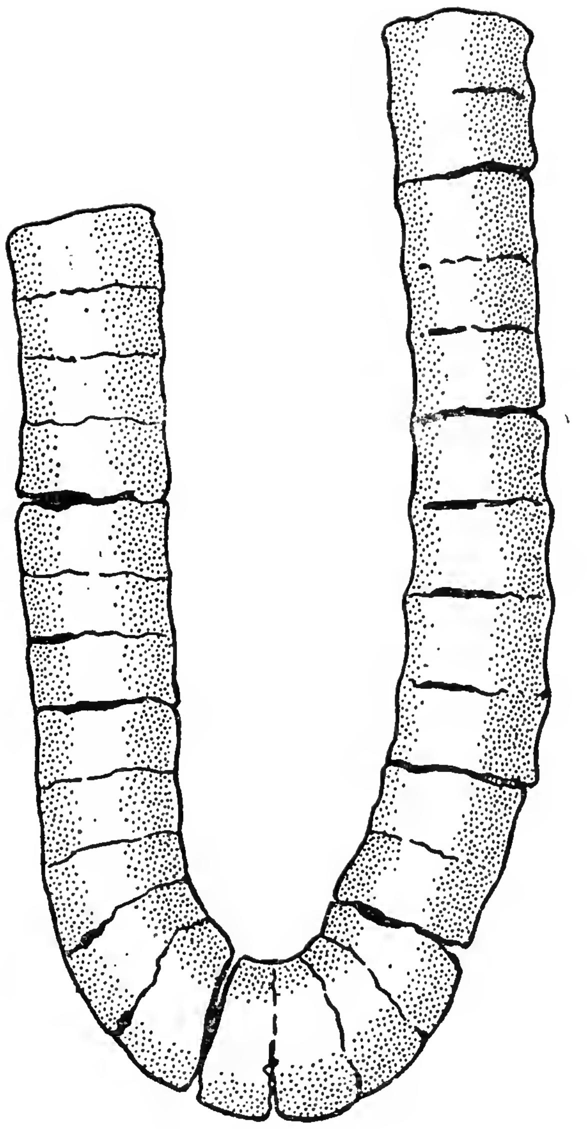
Skulls of Pyramid Valley skeletons: Canterbury Museum VIII B, VIII C, IX A (Text-fig. 12), X B, XIII D, XIII E. (Table 13.)

Except for small details to be noted, all six skulls have the same general form. *In occipital view* the paroccipital processes have a sinuous outer border and terminate below in a rounded point at about the level of, or just short of, the mamillar tuberosities. The latter are small eminences 1.64 to 1.78 cm. apart, separated by a low arch. There is a distinct depression or pit on each side, above and mesad of the paroccipital processes (Text-fig. 12b). The upper margin of the foramen, which is swollen in VIII C, X B, and XIII D, extends obliquely outwards to form a ridge across the paroccipital processes: in XIII D this ridge is not continuous, the paroccipital portion is separate from, and *en echelon* with, the supraforaminal. *In dorsal view* paired double tumidities on the top of the skull in the post-frontal region, and lesser eminences in the pre-frontal region, are a feature of all six skulls. The lambdoidal and temporal ridges are separated by from 0.65 to 1.08 cm., and the narrow space between them extends outwards to form a flat space above the squamosal prominences. The beak is long and tapering, with a narrow rounded tip; the lateral margins are slightly convex.

In lateral view (Text-fig. 12a) the crestal tumidity is marked. The hinder (paroccipital) margin of the tympanic cavity is gently curved or almost straight. The temporal fossa is only slightly wider than the tympanic cavity and definitely smaller than the orbit: it is larger in this species than in *E. huttonii,* but not so large as in *Eu. exilis.* The posterior temporal fossa (the depression in front of the tympanic cavity lying between the inferior



Text-fig. 12. **E. crassus** : skull (C.M. ix A.): **a**, lateral view; **b**, occipital view.



Text-fig. 13. **E. crassus** : tracheal loop.

and posterior temporal ridges) is a narrow groove as in the other species of *Emeus* and in *Euryapteryx*. In *Anomalopteryx* and *Megalapteryx* it is a broad space sometimes even slightly convex. The zygomatic process is long and narrow. The postorbital process extends outwards and bends straight down, or only slightly backward or forward: it ends in a blunt tip: in VIII C the tip (which seems to be a separate centre of ossification) is missing, and the resulting broader abbreviated termination is notched. The front margin of the process is sinuous and the upper margin of the orbit is curved; the hinder and upper margins of the orbit do not form an angle.

No maxillo-nasal process was found in any of these skulls, but, as the vomer, palatine and maxillo-jugal bones were always found separate, the maxillo-nasals may have been lost in the peat. The lachrymal foramen is an open notch: probably the missing maxillo-nasal closed it. The premaxilla is long, tapering and acute in lateral view, though more rounded and with slightly convex sides when seen from above: it is, however, neither so narrow nor so acute at the tip as in *Anomalopteryx*. The maxillo-palatine has been secured in only two of these skulls, in both cases with an expanded antrum opening posteriorly by a circular passage; the same condition obtains in a skull, obviously of this species, from Enfield in the Dominion Museum. The cavity is, however, not so expanded as in the skulls of *Pachyornis mappini* and *P. oweni*, nor is the opening so wide. The mandible is slightly depressed distally and the tip is rounded. *In ventral view* the eustachian tube is wide, deep and straight, though not so wide as in *Euryapteryx*.

In general the skull is relatively low in proportion to its width; the temporal fossae are small, with limited surface for muscular attachment. The mandible is correspondingly slender.

Vertebrae: (C.M. xiii D. ♀ with egg). The axis is similar to that of *A. didiformis* except that the hypapophysis is thicker and only its lower edge is keel-like. *Nape vertebrae:* Nos. 3 to 6 are subquadrate in dorsal view, with bifid neural spine and well-developed hyperapophyses. *Cervical:* No. 6 is of the normal form of the cervicals with narrower posteriorly-diverging post-zygapophyses. The neural spines are elongate on these cervicals, but do not extend on to the post-zygapophyses; hyperapophyses are not developed. The neural spines approach one another again in the middle cervicals, increasing in height, and on 21 there is a high bifid spine; 22 to 24 are missing.

Table 13. Skulls: *E. crassus.*

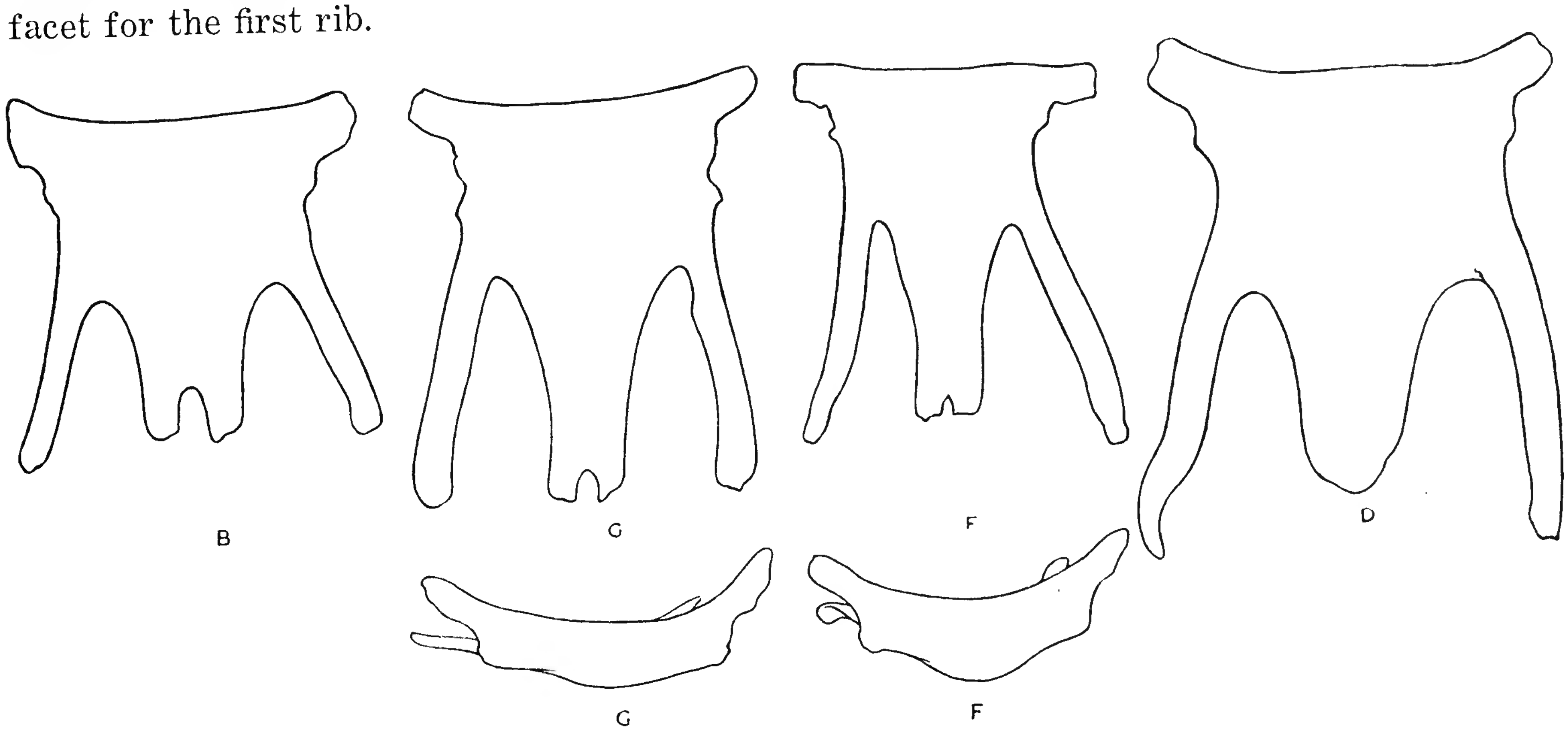
	Mesopteryx casuarina Parker.	C.M. 1939 x B.	C.M. 1939 xiii D.	C.M. 1939 viii C.	C.M. 1939 xiii E.	C.M. 1939 ix A.	C.M. 1939 viii B.
Total length	13.2	13.7	13.6	13.4	13.0	13.0	12.0
Length: parocc. to pre-orbital		7.66	7.37	7.48	7.35	7.3	7.08
Length: basi-rostrum		—	8.5	8.75	9.3	8.57	8.13
Length: condyle-rostrum		—	9.52	9.73	10.1	9.44	9.03
Height	4.1–4.3	4.51	4.5	4.54	4.36	4.14	4.07
Width at parocc. processes	4.5–5.5	5.52	5.37	5.17	5.72	5.22	5.20
Width at squam. prom.	5.8–6.7	6.83	6.64	6.64	6.55	6.46	6.40
Width at temp. fossae	4.3–5.0	5.13	4.94	4.90	4.78	4.8	4.70
Width between temp. ridges	3.9–4.9	4.70	4.68	4.50	4.37	4.16	4.32
Width at post-orbitals	6.5–7.5	7.92	7.82	7.43	7.47	7.1	7.18
Width at pre-orbitals	3.7–4.2	4.25	4.36	4.40	4.25	4.11	4.35
Width of tymp. cav.	1.7–2.1	2.20	1.90	2.03	1.94	1.6	1.76
Width of temp. fossa	1.3–1.7	2.30	1.64	1.52	1.74	2.1	1.86
Width of orbit	2.5–3.1	3.08	2.90	2.93	2.75	2.83	2.72
% Height: length		32.9	33.1	33.8	33.6	31.8	34.0
% Width at squam. prom.: length		50.0	48.8	50.0	50.4	49.5	53.3
% Width at temp. foss.: length		37.5	36.3	37.6	36.8	36.9	39.2
% Width at post-orbitals: length		57.8	57.4	55.5	57.5	54.5	59.8
% Width between temp. ridges: fossae		93.5	94.8	90.0	91.3	86.6	92.0
% Width at squam. prom.: parocc. width		123.8	123.7	128.5	114.5	124	125.3
% Width at post-orbitals: squam. prom. width		116.0	117.7	112.0	114.0	110	112.3
Distance between lambd. and temporal ridges		0.65	0.90	0.86	1.10	0.87	1.08
% length parocc.-preorb.: total length		55.9	54.2	62.5	56.5	56.2	59.0

On the ventral surfaces the median hypapophysial ridge is reduced on 5 and 6, and parial hypapophyses appear on 7. These, as in *Anomalopteryx,* increase in size on succeeding vertebrae, first separating and then approaching again to form, on 20, a single broad process which becomes higher, narrower and longer on 21 and 22. The pleurapophyses have posterior processes from 6; they become longer and styliform in the succeeding five vertebrae, then broadening and shortening on the remaining cervicals. The styliform pleurapophyses in *E. crassus* are shorter and blunter than in either *P. mappini* or *A. didiformis.* In the two dorsal vertebrae present (26 and 27) the median hypapophysis is divided by an arch into an anterior and a posterior portion, the latter being slightly more prominent. All the vertebrae of C.M. xiii D are considerably larger than the corresponding vertebrae of A.M. 124 *(P. mappini)* and 51 *(A. didiformis).* The cervical vertebrae are also wider in proportion to height, especially in the posterior vertebrae.

Ribs: The uncinate processes present are long and narrow. *Tracheal Rings:* There are a few small slender rings with this skeleton, but most are thick, i.e. from 0.4 to 1.5 cm. high, with the walls up to 2 mm. thick. Twenty-seven thick rings have been fused into a narrow loop. (Text-fig. 13.) This also occurs in other skeletons.

Sternum: There is a surprising degree of variation in the form and proportion of the sternum in different individuals of *E. crassus.* Seen from above, the anterior margin is slightly concave; the precostal processes are well-developed, sometimes broad, sometimes narrow. Immediately posterior to the anterior margin the body of the sternum exhibits a pair of antero-lateral concavities or depressions, deeper in some sterna than in others, and marked by large pits or foramina. Behind these the rest of the body of the sternum is evenly concave, the deepest portion being behind the level of the costal border. It is much more concave than in *Eu. exilis.* The lateral margins are concave, or constricted, the sternum being narrowest just behind the costal border; the postero-lateral processes are slender and straight or with a very slight convexity. They are not as stout or as convex as in *Anomalopteryx.*

The median process is long, and may be broad or narrow; in the perfect sterna its end falls short of the ends of the lateral processes. Of the ten sterna examined, three definitely have no median notch, three have a deep notch and the other four are imperfect. The costal articular surfaces exhibit considerable variation as in *Anomalopteryx;* the usual arrangement is:—posteriorly a narrow band extending obliquely across the edge for the third sternal rib; in front of this a deep pit, and in front of the pit a larger obliquely transverse narrow band for the second rib; in front of this is a subcircular facet for the first rib.



Text-fig. 14. **E. crassus** : sterna of Pyramid Valley specimens.

The sterna of C.M. xiii F and xiii G (Text-fig. 14) are unusually long and narrow, and deeply concave, especially F. The median and lateral processes are long and slender and their ends bend down ventrally; this, however, may be due to warping in drying. Both have a median notch. No. xiii F has an extra costal facet behind the depression that normally occurs just behind the third facet; this extra facet also has a depression behind it. A similar condition was noted in *M. didinus* (Pl. 12, fig. 3). The condition of the coracoid facet varies; it may be distinct, shallow or absent; or present on one side and absent from the other.

Pelvis: The pelvis of *E. crassus* is longer and more massive than in *Anomalopteryx* or *Megalapteryx.* The pre-acetabular centra are short and wide, and usually 35 has transverse processes; the acetabular portion of the column is also broad and compressed post-axially though there are generally four vertebrae included therein. The post-acetabular region is very broad and strongly braced with transverse processes extending from 39 (frequently 38) to 46, and, occasionally, 47.

The usual formula is 28-35 (36-38) 39-46 as in *Dinornis.* There is no interpolated pre-acetabular vertebra with transverse processes; but in one case there is 35a lacking a process, and occasionally there are only 28-34 pre-acetabular vertebrae. In only one pelvis did 39 lack transverse processes. C.M. xiii D and xiii F have 47 (first caudal) fused to the pelvis. These variations are recorded in the formulae as follows:

viii B.	28-35	(35a-38)	39-46	or	28-35	(36-39)	40-47
viii C.	28-34	(35-38)	39-46				
ix A.	28-35	(36-38)	39-46				
	28-34	(35-38)	39-46				
x B.	28-35	(36-39)	40-46				
	28-35	(36-38)	39-46				
viii D.	28-35	(36-37)	38-47				
xiii F.	28-35	(36-38)	39-47				
	28-35	(36-37)	38-47				

Table 14. *Emeus crassus:* dimensions of pelvis.

	C.M. viii B.	C.M. viii C.	C.M. x B.	C.M. xiii F.	C.M. ♀ xiii D.
Length	41.1	41.9	37.6	40.6	44.4
Width at antitrochanters	21.9	22.2	22.4	23.0	22.9
Width at pectineal tubercles	15.5	15.5	15.5	17.0	16.7
Width of escutcheon	19.8	17.5	17.2	20.3	18.9
Height of pre-acetabular portion	12.5	11.8	12.0	—	12.5
Ischium length	18.5	17.5	15.0	18.5	22.0
Ischium height	5.5	4.5	6.8	7.0	6.0
Ischium divergence	—	24.7	23.0	24.25	25.4
Pubis length	—	21.7	22.5	27.0	28.0
Pubis height	—	2.1	2.5	3.0	3.5
Pubis divergence	—	29.5	26.5	26.5	27.4
Proportions %—					
Width at antitrochanters: length	53.2	52.9	59.5	—	52.1
Width of escutcheon: length	—	—	45.8	—	—
Ischium divergence: antitrochanter width	—	111	—	—	112.8

Table 15. *Emeus crassus:* dimensions of sternum.

		viii B.	viii C.	ix A.	xiii F.	xiii G.	xiii D.	xiii E.
Widths	A	17.8	17.7	17.5	16.9	19.55	19.85	18.6
	B	12.3	13.5	13.0	12.1	15.0	16.20	14.4
	C	10.5	10.8	10.8	8.0	10.5	11.1	12.0
	D	19.5	19.5	—	18.0	19.0	21.3	—
Lengths	E	16.5	17.0	—	20.5	23.5	21.9	—
	F	9.5	9.1	9.5	10.0	23.5	24.3	—
	G	18.2	17.3	—	23.0	10.5	10.5	14.3
	H	13.0	—	15.5	19.5	21.1	—	—
Depth of notch		3.5	nil	?	1.0	2.4	none	—

Distribution: South Island: Glenmark, Pyramid Valley, Enfield, Kapua, Kia Ora, Waikouiti, Hamilton Swamp. The only North Island bones referable to *E. crassus* are a skull from Martinborough and a tibia from Te Aute in the Dominion Museum, and a tibia from Te Aute in the Canterbury Museum.

Emeus huttonii (Owen), 1879.

1869	May ..	*Dinornis didiformis:* Haast, Trans. N.Z. Inst. 1, pp. 82, 83 (2nd ed. 1875, pp. 23, 24).
1875	July	*Dinornis didiformis:* Hutton, Trans. N.Z. Inst., 7, pp. 275, 279. Leg-bones from Hamilton Swamp, Otago. *Dinornis casuarinus:* Hutton (part). *Ibid*, Table A, minimum, femur and metatarsus.
1879	.. .. ..	**Dinornis huttonii** Owen, Extinct Birds of N.Z., 430. Founded on above leg-bones (*D. didiformis:* Hutton 1875): lectotype nominated below.
1892	May ..	*Mesopteryx didinus:* Hutton (part), Trans. N.Z. Inst. 24, 129.
1893	May ..	**Euryapteryx compacta** Hutton, Trans. N.Z. Inst. 25, 11. Type: a tibia from Enfield, in Canterbury Museum. *Mesopteryx didina:* Hutton, *ibid*, 13.
1895	October ..	*Mesopteryx* species γ Parker, Trans. Zool. Soc., 13, pt. 11, p. 378, pls. 61, figs. 30 and 44, pl. 62, fig. 54. Type: skull on a "skeleton of *M. didina*" in Otago Museum (cf. Benham 1934, p. 92).
1896	June ..	*Meionornis didinus:* Hutton, Trans. N.Z. Inst., 28, pp. 636, 642. Bones from Kapua.
1896	June ..	*Meionornis didinus:* Hutton, Trans. N.Z. Inst. 28, pp. 646, 648. Bones from Enfield.
1897	June ..	*Meionornis didinus:* Hutton, Trans. N.Z. Inst., 29, 559. Bones from Glenmark.
1907	November 12	*Megalapteryx huttonii:* Rothschild (part). "Extinct Birds," 199, pl. 41.
1930	.. .. ..	*Emeus huttonii:* Oliver, "New Zealand Birds," 49.
1933	.. .. ..	*Emeus huttonii:* Lambrecht, Handbuch der Palaeornithologie, 147.
1934	August 20 ..	*Emeus huttonii:* Benham, Trans. Roy. Soc. N.Z., 64, 87, pls. 5-8.

Founded on mixed leg-bones from Hamilton Swamp, Otago (Hutton, 1875). Lectotype, hereby nominated, a right metatarsus with the following dimensions (Otago Museum):

	17.0	6.3	3.7	8.0	10.0
=	100	38.0	18.0	45.0	55.2

The indefinite manner of the proposal of this species has been the cause of considerable confusion.

Hutton (1875) gave the dimensions of two femora, seven tibiae and six metatarsi from Hamilton Swamp, Central Otago, under the name *Dinornis didiformis.* He remarked, "The bones I have arranged under *D. didiformis* belong possibly to a new species. The tibia is well marked and quite distinct,* but the femur and metatarsus that I have associated with it pass almost into *D. casuarinus,* but are rather smaller."

Owen (1879), *after quoting Hutton's remarks as above,* states, "Possibly the *Dinornis* of the South Island, with the tibia characteristic of the *D. didiformis* of the North Island, may need to be noted, for the convenience of naming the bones, as *Dinornis huttonii.*"

Hutton (1892, and again in 1896 and 1897) confused *huttonii* with *didinus (Megalapteryx)*† and Rothschild (1907, as *Megalapteryx huttonii*) perpetuated this misunderstanding. Lydekker made no mention whatever of *huttonii.*

Oliver (1930, p. 49), in recounting how *E. huttonii* had been proposed, states that Owen selected the tibio-tarsus as the type, but this was not the meaning of Owen's phrase, "with the tibia characteristic of the *D. didiformis* of the North Island." Owen was proposing the species on the basis of Hutton's earlier description; having no specimens, he could not do otherwise. Hutton's observations were to the effect that, while the tibia was characteristic of *D. didiformis,* the femur and metatarsus were different; they were stouter, like *D. casuarinus,* but smaller than that species. Now this is exactly what *E. huttonii* is: a species with a tibia hardly distinguishable from that of *Anomalopteryx didiformis,* but with shorter and stouter femur and metatarsus; besides, if we were to regard the tibia as the type we could not satisfactorily separate *E. huttonii* from *A. didiformis.*

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*Obviously Hutton means "quite distinct as *didiformis.*" This is important.

†Benham (1934) has discussed this adequately.

At present there are, in the Otago Museum, only three tibiae from Hamilton Swamp with dimensions approximating to those given by Hutton, and they might be either *didiformis* or *huttonii;* but the femora and metatarsi are, as Hutton said, much stouter, and this is the real basis of Owen's proposal. The selection just made of one of these metatarsi as the type is, therefore, in accordance with the original indication of the characters regarded as distinguishing the species. Benham (1934, p. 93) noted a discrepancy in the dimensions from Hutton for this species as quoted by Oliver and himself. The explanation is that Oliver gave Hutton's maximum figures, while Benham recorded the mean.

Table E, giving the dimensions of *E. huttonii,* reveals the paucity of individual skeletons of this species, and I have considered it advisable to add to the table average measurements recorded by Hutton from Hamilton. Hutton's smallest femur and metatarsus of his "*casuarinus*" Hamilton (1875) also fall here. The Wakapatu specimen described in gratifying detail by Sir William Benham (1934) is the only complete skeleton known of this species, for the Hamilton Swamp mounted specimen, also in the Otago Museum is, Sir William notes, very doubtfully of a single individual. A partial skeleton in good condition has been recovered from Pyramid Valley swamp.

It has already been noted that the skull of the Wakapatu skeleton is small, but, as Benham points out, its shortness is due to the shortness of the beak, and "it may be a few millimetres short of its actual length." I would suggest 10.5 cm. as its approximate true length. The beak is of the moderately rounded type noted in *E. crassus;* the maxillopalatine is missing, so the condition of the antrum cannot be stated; but in an exactly similar skull of unknown locality in the Dominion Museum the antrum is expanded, as it is in the two *E. crassus* skulls from Pyramid Valley that have the maxillopalatine preserved. The Wakapatu skeleton has a narrow sternum and typical Emeine pelvis with a flat escutcheon and with ischia and pubes exhibiting considerable divergence. The pelvic formula, according to Benham, is 28-35 (36-37) 38-46: it is not possible to ascertain, now that the skeleton has been mounted, whether the small vertebra no. 38, with its neural canals set high up and difficult to observe at any time, is present as it is in all other pelves I have examined, but, assuming that it is, the formula would be 28-35 (36-38) 39-47. This supposition is supported by a comparison of the disposition of the transverse processes of the post-acetabular vertebrae with the arrangement in the Pyramid Valley skeletons of *E. crassus* (p. 51).

Distribution: Swamp localities in Canterbury and Otago and sand-dunes at Wakapatu.

Genus *Euryapteryx* Haast, 1874.

Type, herein selected, *Dinornis gravis* Owen.

1874	June	..	*Euryapteryx* Haast, Trans. N.Z. Inst. 6, p. 427.
1874	July ..	..	*Euryapteryx:* Haast, Ibis, ser. 3, vol. 4, p. 213.

Note: *Cela,* used by Reichenbach for *Dinornis curtus,* was not the proposal of a new genus; it was merely assigning *D. curtus* to Mohring's pre-Linnean genus *Cela,* Gesl. Vog. 4, 43, 1752; (cf. Hutton 1895a, 158).

Lydekker stated (p. 298) of his species *Emeus gravipes* that it was "the type species of *Euryapteryx;*" but this species was not included under the generic name at the time of its original publication and cannot therefore be nominated as the type. Of the two species included in the genus by Haast, one, *rheides,* is indeterminate; and I therefore select the other, *Dinornis gravis* Owen, as the genotype.

The species of *Euryapteryx* duplicate these of *Pachyornis* in the sizes, proportions and relative lengths of the leg-bones (Table G); also in occurring as a North Island group of small relatively slender forms and a South Island group of large massive species. They differ from all other genera in having a skull with a broad, round-tipped beak and a collapsed maxillary antrum (Text-fig. 10a, p. 42), and they share with *Emeus* the possession of a narrow sternum and the reduction of the phalanges of the outer toe to four, including the claw joint.

Three size-differentiated North Island species are recognized, but all the South Island specimens are included in one species of which an occasional example has been obtained in the south-eastern portion of the North Island.

Euryapteryx gravis (Owen), 1870.

1870	January ..	**Dinornis gravis** Owen, Trans. Zool. Soc., vol. 7, pt. 2, p. 141, pl. 14. Type, a skull (possibly of an individual skeleton) from the "Kahamin (= Kakanui) River," Otago, at that time in the possession of the Baroness Burdett Coutts.
1872	.. .. ..	*Dinornis gravis:* Owen, Proc. Zool. Soc. for 1872, No. 38, 605.
1873	May	*Dinornis gravis:* Owen, Trans. Zool. Soc., vol. 8, pl. 6; pp. 361-380, pls. 58-61.
1874	June ..	*Euryapteryx gravis:* Haast, Trans. N.Z. Inst. 6, 426.
1874	July	*Euryapteryx gravis:* Haast, "The Ibis," ser. 3, vol. 4, No. 15, 209.
1879	.. .. ..	*Dinornis gravis:* Owen, "Extinct Birds of New Zealand," pp. 347-364, pls. 41, 41a, 42, 42a.
1891	April 25 ..	**Emeus gravipes** Lydekker, Cat. Foss. Birds, British Museum, p. 297. Type: Metatarsus from Kakanui River, Otago, in British Museum (No. A. 1591).
1891	April 25 ..	*Dinornis gravis:* Lydekker, Cat. Foss. Birds, Brit. Mus., 298 (note under *Emeus gravipes).*
		Emeus crassus: Lydekker (part, skull), *ibid.*, p. 311.
1891	November 13	*Emeus gravipes:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg, London, III., 434.
1895	October ..	*Emeus* sp. γ Parker. Trans. Zool. Soc., 13, 379, pl. 61. Skull from Shag Point, in Otago Museum.
		Emeus sp. β Parker. Trans. Zool. Soc. 13, p. 379. Skull on (composite) skeleton named *E. gravis* from Glenmark, in Canterbury Museum.
1898	.. .. ..	*Euryapteryx ponderosa:* Hamilton, Trans. N.Z. Inst. 30, 445.
1906	.. .. ..	*Emeus crassus:* Hutton, Trans. N.Z. Inst., 38, 66 (type of *Eu. kuranui* Oliver).
1907	.. .. ..	**Emeus parkeri** Rothschild, "Extinct Birds," p. 210. TYPE: skull named *Emeus* sp. γ Parker, 1895, p. 379.
		Emeus boothi Rothschild, "Extinct Birds," p. 210. Type: Skull of *Emeus* sp. α Parker, 1895.
		Emeus haasti Rothschild: "Extinct Birds," p. 210. Type: Skull of *Emeus* sp. β Parker, 1895.
		Emeus gravipes: Rothschild, Extinct Birds, 210.
1910	.. .. ..	*Euryapteryx crassa:* Benham. Trans. N.Z. Inst., 42, 354.
1930	.. .. ..	**Euryapteryx kuranui**: Oliver, "N.Z. Birds," 52. TYPE: skeleton from Castle Point (North Island) in Canterbury Museum.
		Euryapteryx gravipes: Oliver, New Zealand Birds, 53.
1933	.. .. ..	*Euryapteryx kuranui:* Lambrecht, *ibid.*, 151.
		Euryapteryx gravipes: Lambrecht, Handbuch der Palaeornithologie, 152.

The references to the figures of the mandible of *D. gravis* in Plate 14 of Trans. Zool. Soc. 7 and Plate 81 of Owen's "Extinct Birds" are very muddled both in the text and the Description of Plates; but a careful reading of the descriptions and of the comparisons with *crassus* and *rheides* makes it clear that, in each of the above two publications, figure 5 is of *rheides* and fig. 6 is of *gravis,* and that the latter has a broad blunt beak.

There is a point to be discussed with regard to this species. *Dinornis gravis* was originally proposed by Owen (1870, p. 141) for a skull, and subsequently (1878, p. 361) leg-bones were described as being of the species. Lydekker assumed that the leg-bones were not those of an individual; he included the skull under *Emeus crassus* (p. 307, 311), and designated the metatarsus as the type of a new species, *Emeus gravipes.*

Owen, however, when describing the skull, had said, "Many characteristic parts of the skeleton of the same individual bird were obtained by William Fenwick, Esq., at the Kahamin (= Kakanui) River, Middle Island, New Zealand, and were presented by that gentleman to Miss A. Burdett Coutts. They were confided to me by that lady for determination in 1867; and the grounds on which I came to the conclusion that they represented a species not previously recognized may be communicated at a future period to the Zoological Society. . . . I give a description of the skull of the new species in the present Memoir." Owen intended to state the specific characters of the new species later, and this he purported to do when, in 1873, he described the leg-bones. Of the latter he said (p. 379), "The specimens of *Dinornis gravis* above described and figured were discovered in the bed of the Kakamai (= Kakanui) River, South Island, by Wm. Fenwick, Esq. I am indebted to the kindness of the Baroness Burdett Coutts for the loan of the specimens."

The skull and leg-bones would therefore appear to be those of one and the same individual, and Lydekker's proposal of a new name for the metatarsus would seem to have been unnecessary. Yet, notwithstanding Owen's explicit statements quoted above, there is still reason, in the nature of the bones themselves, to doubt their individual association. The femur is much longer in proportion to the tibia and metatarsus than in any undoubtedly individual skeleton of *Euryapteryx,* and, judging from Owen's figures, its distal end is too wide to articulate with the tibia; moreover, its proportions accord with those of *Emeus crassus* (cf. xiii. F Pyramid Valley, Table F), and not with those of *Euryapteryx.*

It might be considered that with this doubt before us we should continue to retain *Euryapteryx gravis* (Owen) for the skull and *Eu. gravipes* (Lyd.) for the metatarsus. It is not necessary, however, to prove the individual association of skull and metatarsus; it is sufficient that their specific identity be established and this is satisfactorily confirmed by means of individual skeletons in the Otago and Canterbury Museums.

These show that same association of broad-beaked skulls, narrow sterna and four-jointed outer toes with characteristic form of leg-bones in large South Island birds as is found in much smaller North Island forms. The tibia is less inflected than in same sized species of *Pachyornis,* the metatarsus is usually, though not invariably, less constricted at the middle, has a lower proximal intercondylar ridge and a less abruptly projecting middle distal trochlea.

The metatarsus (type of *Eu. gravipes* Lyd.) is now in the British Museum (No. A. 1591), having been acquired in 1923 from the estate of the Baroness Burdett Coutts; Miss Dorothea M. A. Bate has informed me in a recent letter that the following bones came with it, and are entered in the catalogue as "one of the type specimens":

A.1592—tibio-tarsus, figured Owen, T.Z.S. 8, pl. 59, figs. 1-3.
A.1593—right femur, figured op. cit. pls. 60 and 61.
A.1594—pelvis, described op. cit. p. 369.

Unfortunately I was not aware of the status of A.1591 when I measured it, and thus did not enquire as to whether other bones were associated with it.

Skull. In occipital view (Pl. 6, fig. 2) the skull has a well arched vault; the supra-foraminal ridge is not swollen as in *Emeus crassus,* the supra-occipital median crest and the supra-occipital fossae being consequently better defined. The distance between anterior and posterior lambdoidal ridges varies; there is a depression on each side, above and mesad of the paroccipitals, but it is not deep and pit-like as in *E. crassus.* The paroccipital processes have convex or sinuate outer borders and extend downwards to a varying degree; the mamillar tuberosities also vary in size and distance apart, but are usually less prominent than in *Pach. elephantopus.*

In lateral view (pl. 6, fig. 1) the posterior border of the tympanic cavity is oblique, and may be straight, sinuate, or slightly convex; it meets the upper border at a right angle or less. The upper border projects outwards, forming a ledge above the tympanic cavity; anteriorly it curves evenly forward on to the zygomatic process, which is fairly acute and varies in length. The space between temporal and lambdoidal ridges is from 5 to 10 mm. wide; it continues outward to form a broad flat space above the squamosal prominence. The post-temporal fossa is relatively rather wider and deeper than in *Emeus.* The post-orbital processes are usually proportionately wider than in *Emeus,* with the outer portion projecting straight down vertically or slightly forward. The margin of the orbit is either an even arch, sinuate, or, rarely, forming a wide angle (*Emeus* sp. γ Parker). The orbits face more to the front than in *Emeus.* The lachrymal foramen is formed as usual, by a notch in the antorbital closed anteriorly by the maxillo-nasal. In dorsal view the wide spread of the post-orbitals and the forward aspect of the orbital margin are readily apparent; the anterior portion of the temporal fossa is definitely overhung by the temporal ridge. Sometimes there is a double tumidity on the roof; usually it is a single slight eminence.

Certain skulls with their own beak (from Shag Point in Otago Museum; *Emeus* sp. α Lydekker in British Museum; and *E. kuranui* Oliver in Canterbury Museum) have the premaxilla and mandible short, broad and widely rounded terminally. In the Riverton specimen (pl. 6) the premaxilla is strongly downcurved and the tip abruptly truncated; the mandible is very stout and more depressed terminally than in *Emeus.* These broad-billed skulls have a characteristic maxillo-palatal structure; the palatals are only slightly curved, the maxillo-jugal is stout and nearly straight, meeting the palatal at an acute angle, and there is no antrum cavity.

Pelvis: The pelvis in *Eu. gravis* is larger, relatively broader and more massive than in *Em. crassus.* Its pre-acetabular portion, though short, is not especially splayed laterally, but it is strongly expanded at the acetabulum and antitrochanters. The width at the antitrochanters is nearly half the total length. The pre-acetabular dorsal iliac margin is convex; posteriorly the ilia diverge abruptly, curving outwards to almost right angles with the long axis to form the anterior margins of the escutcheon. The latter is flat, short and very broad, its lateral margins are convex and converge strongly posteriorly. The vertical laminae or sides of the escutcheon are strongly deflected inwards (they slope outwards in *Dinornis).* The ischia are generally, but not always, strongly divergent posteriorly. As with the other genera the formula of the vertebral elements comprising the pelvis varies, i.e.:

28-35 (36-38) 39-47
28-34 (35-39) 40-46
28-35 (36-38) 39-?47
28-35 (36-38) 39-?

Distribution: Eu. gravis, like *Pach. elephantopus,* was common in Canterbury and Otago; it has also been obtained on Stewart Island (Benham 1910) and I have a set of leg-bones from Mt. Arthur tableland, near Nelson. *E. kuranui* Oliver might perhaps have been regarded as a more slender North Island form, but it is matched in slenderness by the Stewart Island specimen (Table H) and the only other North Island specimen is a quite stout metatarsus from Portland Island in the Hawke's Bay Museum.

Euryapteryx geranoides (Owen), 1848.

1848	April 13	*Palapteryx geranoides* Owen. Proc. Zool. Soc. for 1848, p. 1, *nomen nudum*.
		Palapteryx geranoides Owen. *Ibid.*, p. 7, *nomen nudum*. Dimensions given of a skull, but insufficient to identify it except by reference to the paper next cited.
1848	April 22	**Palapteryx geranoides** Owen. Trans. Zool. Soc., Vol. 3, pt. 5, p. 361, pl. 54, figs. 1-5.
1866	July 6	*Non Dinornis geranoides:* Owen, Trans. Zool. Soc. vol. 5, pt. 5, pp. 400-402, pl. 65, figs. 5-6 (femur of *Eu. exilis*); pl. 67, figs. 5-6 (metatarsus of *Eu. exilis*).
1891	.. ..	*Anomalopteryx dromaeoides:* Lydekker (part), Cat. Foss. Birds Brit. Mus., 268 (B.M. right metatarsus, 21793).
1891	April 25	*Non Anomalopteryx geranoides* Lydekker, Cat. Foss. Birds Brit. Mus. 288. *(Eu. exilis).*
1927	August	*Dinornis expunctus* Archey. Trans. N.Z. Inst., 58, 152.

The name *geranoides* has been a source of confusion through its having been given originally to a skull which could not satisfactorily be affiliated with any particular leg-bones. Those of the next species, *Eu. exilis,* have from time to time been attributed to it, but the several individual skeletons we now have of *exilis* show that the *geranoides* skull is much too large for that species. It is, however, definitely of *Euryapteryx*. Finality as to its relationship must await the discovery of an individual skeleton; we have, however, from coastal dune-areas, a few sets of leg-bones (Table G) of *Euryapteryx* (one accompanied by a large broad beak) considerably larger than those of *exilis,* but much smaller than *gravis*. They are indeed appropriate in size to the skull of *geranoides;* moreover another *Euryapteryx* tibia (B.M. 21793; Lydekker, p. 268) of the same dimensions was found at Te Rangatapu, the dune deposit that yielded the type skull. There seems to be good reason for associating the calvarim and leg-bones together and for regarding *Eu. geranoides* (Owen) as the largest of the North Island group of three small species of *Euryapteryx.*

Localities: North Island—Te Rangapatu, Doubtless Bay, Tom Bowling Bay.

Euryapteryx exilis Hutton 1897.

1866	July 6	*Dinornis geranoides:* Owen, Trans. Zool. Soc. vol. 5, pt. 5, pp. 401-2, p. 67, figs. 5 and 6. (B.M. 21706, Lydekker, p. 289).
1891	April 25	**Anomalopteryx (?) geranoides Lydekker**, Cat. Foss. Birds Brit. Mus. 288, fig. 65C, p. 317. Founded on four tibiae from Te Rangatapu, of which that first mentioned, No. 21789x, is here nominated as the TYPE.
1891	November 13	*Anomalopteryx geranoides:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg., 634.
1895	October	*Mesopteryx* sp. α Parker, Trans. Zool. Soc., 13, pt. 11, 378, pl. 61, figs. 28, 41.
1897	June	**Euryapteryx exilis** Hutton, Trans. N.Z. Inst., 29. 552, pl. 48, fig. C. TYPE: Skeleton from Wangaehu, in Wanganui Museum.

See under *Pachyornis mappini* for references part *mappini*.

The retention of *geranoides* Owen as the name for the last species occasions the rejection of *Anomalopteryx geranoides* Lydekker for this, which is also a species of *Euryapteryx*. The next, and only other, name available is *Euryapteryx exilis* Hutton, which is accordingly adopted. The type of *Eu. exilis* is a skeleton from Wangaehu in the Wanganui Museum. Dr. Oliver, who discussed the doubtful association of the skull with this skeleton, and at that time (1930, 49) concluded that the cranium might have belonged to it but not the beak, has since drawn my attention to the fact that the skull at present on the skeleton is not the one figured by Hutton (1897, pl. 47). The latter was a typical *Euryapteryx* skull with a broad beak apparently firmly fused in position.

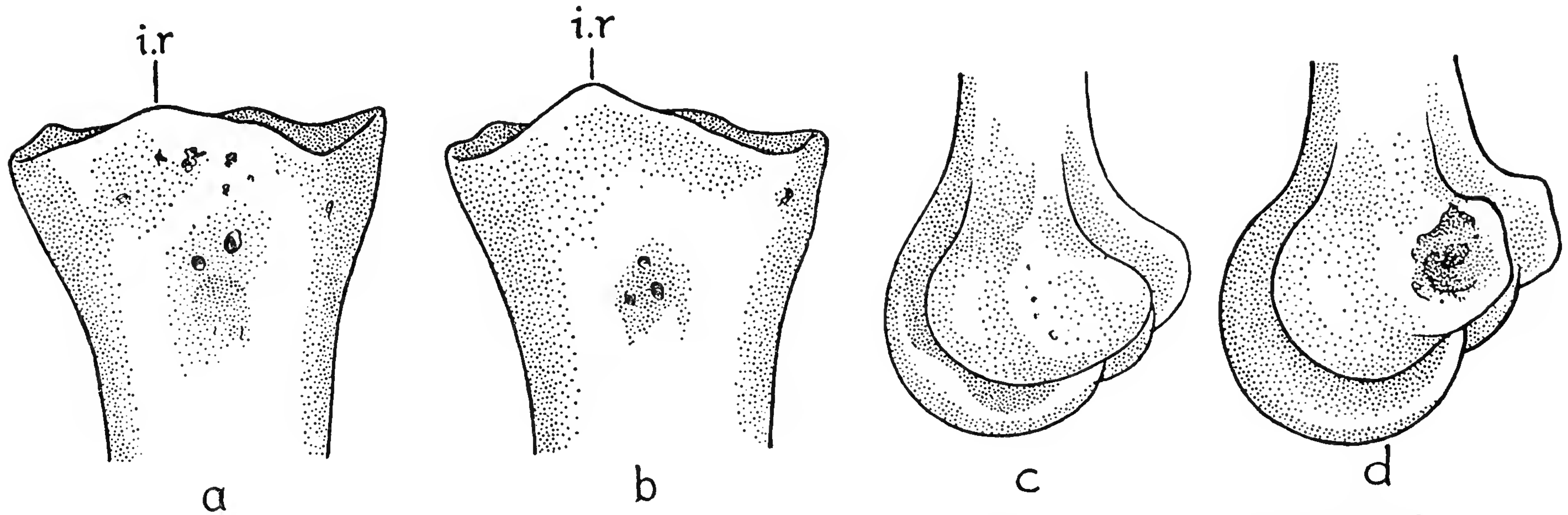
Description:

This species provides as good an example as *Anomalopteryx didiformis* of the undesirability of using dimensions and proportions of a series of only one of the leg-bones in determining species. The Tables of Measurements A and H show that the tibiae of these two species differ but little and by no means constantly; moreover, although tibiae of *exilis* are usually 1 to 2 cm. shorter, relatively narrower at the middle of the shaft and more incurved distally, it is sometimes difficult to decide whether any one isolated tibia is of *A. didiformis* or *E. exilis.* When, however, the associated femora and metatarsi are introduced into the comparison, the relative shortness and greater width of these two bones in *exilis* are immediately apparent.

The average lengths of femur and metatarsus in these two species, expressed as percentages of the length of the tibia, are:—

	F.	T.	M.
E. exilis	59.6	= 100	44.3
A. didiformis	63.1	= 100	45.4

Eu. exilis, like *P. mappini,* was thus a shorter, relatively stouter and more bandy-legged bird than *A. didiformis.* It differed from *P. mappini* by the lack of a tibial flange and by the lower proximal intercondylar rising of the metatarsus. Somewhat similar differences separate the tibia and metatarsus of *Eu. exilis* and *A. didiformis,* i.e. at the proximal end (Text-fig. 15) the inter-condylar ridge *(i.r.)* is higher in *A. didiformis* (15b) and anteriorly it expands and rises to form a swelling on the front of the bone. The distal trochleae are much larger in *E. exilis,* the inter-trochlear spaces being thereby much reduced. Seen from above, the middle trochlea is rather shorter in *A. didiformis,* and the inner and outer trochleae have each a more distinct groove on their distal face. The depression on the ectal surface of both inner and outer trochlea is deeper and subcircular in *A. didiformis* (Text-fig. 15d) and is more of a wide, shallow groove in *E. exilis* (Text-fig. 15c), and, viewed from the side the lower margin of the shaft in *E. exilis* curves gently into the hinder border of the inner trochlea, which is somewhat angular and not evenly curved below. In *A. didiformis* the shaft curves down more quickly and the lower margin of the trochlea is rounded.



Text-fig. 15. **E. exilis** (a, c); **A. didiformis** (b, d): metatarsi, proximal and distal ends.

Skull. Comparing the skulls of this species and of *Eu. curtus* with those of like-sized *Pachyornis* skeletons, the *Euryapteryx* skulls are definitely smaller (Table 8, p. 43). Differences in form are the lack of a pronounced supraforaminal swelling in *Euryapteryx,* in which also the much smaller temporal fossa extends upwards instead of backward as in *Pachyornis;* the wide, round-tipped beak and characteristic maxillo palatal structure in *exilis* and *curtus* have already been noted as characters defining the genus *Euryapteryx.*

In lateral view the dorsal outline in *exilis* usually shows an eminence above the postorbitals, and a lesser one above the pre-orbitals: these, if present, are very slight in *Anomalopteryx,* but may be present in *Pachyornis* (Pl. 4, fig. 4). The lambdoidal and temporal ridges are separated by a space of varying width (3.4 to 7.5 mm.), which continues outwards on to the squamosal prominence as a flat area bounded antero-laterally by a well-developed posterior temporal ridge which separates it from the narrow, concave post-temporal fossa. (In *Anomalopteryx* the confluence of the ridges restricts this supra-squamosal area which the very low posterior temporal ridge scarcely separates from the post-temporal fossa). The posterior and upper margins of the tympanic cavity usually form an angle.

The temporal fossa is very small in *E. exilis;* it is smaller than the orbit. Its lesser encroachment on the roof is indicated by the range of percentages "distance between temporal ridges : width between temporal fossae," from 81.4 to 88.7 (cf. 52 to 70 in *A. didiformis).* The mid-temporal ridge, so prominent in *A. didiformis,* is seldom indicated in *E. exilis.* The post-orbitals project straight down or slightly forward, as in *Pachyornis,* instead of backward in *Anomalopteryx.* Maxillo-nasals are not preserved in any of the skulls of *exilis* or *curtus;* but they are all incomplete specimens from sand-hills, and this small bone would have been one of the first to be lost. It will be recalled that it was well-developed, but discrete, in *Eu. gravis.*

Vertebral Column. The vertebrae in *Eu. exilis* agree with those of *P. mappini* in being narrower than in *A. didiformis.* The nape cervicals have the usual subquadrate dorsal outline; but 3 and 4 are narrower than in *A. didiformis,* as are 5 and 6 also, except in comparison with those individuals in *A. didiformis,* in which 5 and 6 assume the form of the ordinary cervicals (i.e. with long, narrow post-zygapophyses). Otherwise there is the same kind of variation between individuals: i.e. the change from double to single neural spines may occur on either 19 or 20, or the change from parial to median hypapophyses on 18, 19, or 20. In the pelvic vertebrae 28, 29, and sometimes 30, the paired submedian hypapophysial projections stand farther apart than in *Anomalopteryx,* and hypapophyses may also appear vaguely on 40 to 44.

The grouping of the pelvic vertebrae is normally as in *Anomalopteryx,* with variations as indicated in the following formulae:—

TYPE: *E. exilis*	.. ..		28-34	(35-38)	39—broken	
A.M. 3	.. ..		28-34	(35-37)	38-45	
A.M. 160	.. ..	r	28-34	(35-38)	39-46	
		l.	28-35	(36-38)	39-46	
A.M. 83	.. ..		28-35	(36-38)	39-45	(46)

The pelvis in *Eu. exilis* is shorter than in *A. didiformis* and relatively wider. Its dorsal iliac margin (Pl. 15, fig. 2a) is intermediate in curvature between that of *A. didiformis* (Pl. 9, fig. 3) and *P. mappini* (Pl. 15, fig. 1a); the front margin is deeper and more roundly curved than in the other two. Seen from above (Pl. 15, fig. 2b) the ilia anteriorly are again intermediate between *A. didiformis* (Pl. 10, fig. 3) and *P. mappini* (Pl. 15, fig. 1b) in the degree of horizontal splaying of the lower front margin ,and the constriction in front of the acetabulum. The dorsal iliac margins diverge posteriorly, gradually in *Eu. exilis* as in *P. mappini,* not abruptly as in *A. didiformis;* the escutcheon is not particularly wide and its sides converge posteriorly. In ventral view (Pl. 15, fig. 2c) the fused vertebral centra in front of the acetabulum form a shorter, broader mass than in *P. mappini* and *A. didiformis;* the post acetabular column is narrower, with concave longitudinal curvature as in *A. didiformis,* instead of broad and straight or with slightly convex longitudinal curvature *(P. mappini).* The ischia and ilia diverge posteriorly more than in *A. didiformis* and less than in *P. mappini.* The pelvis of *Eu. curtus* differs from that of *Eu. exilis* in size only.

The sternum in *Eu. exilis* (Pl. 12, fig. 6) is narrow, its front margin is slightly concave, the lateral processes show only moderate divergence and the median process is not notched. In only one is there a depression, on one side only, which might represent the coracoid facet; no scapulo-coracoid has been found so far, but the skeletons recovered have been by no means complete.

Distribution. North Island: Wangaehu (Type), Te Rangatapu, Doubtless Bay.

Euryapteryx curtus (Owen), 1846.

1846	July	**Dinornis curtus** Owen, Proc. Zool. Soc. London, pt. 14, p. 48. Type: by subsequent designation (Lydekker 1891a, 281) tibia from the North Island; its present place of deposition is unknown; probably British Museum or Museum of Royal College of Surgeons.
1846	December	*Dinornis curtus* Owen, Trans. Zool. Soc. London, vol. 3, pt. 4, p. 325, pl. 47, figs. 3, 4, 5.
1852		*Cela curtus*, Reichenbach, Nat. Syst. Vogel, p. xxx.
1866		*Dinornis geranoides*: Owen (part: femur) Trans. Zool. Soc. 5, p. 400, pl. 65, figs. 5, 6 (B.M. 21781, Lydekker p. 283).
1871	January	*Dinornis curtus* : Owen, Trans. Zool. Soc. 7, pt. 5, p. 353, pl. 44, figs. 7-10 (metatarsus).

See under *Pachyornis oweni* for references part *Eu. curtus,* part *P. oweni.*

Eu. curtus (Table I) is separated by size only from *Eu. exilis* (Table II). With the exception of the type, which is from an unspecified North Island locality, all the specimens are from Doubtless Bay. The following table indicates the dimensions and proportions of the skull wherein *Eu. curtus* and *P. oweni* differ, i.e. the longer skull in *P. oweni,* its greater preorbital width, the greater width and depth of the temporal fossae and the rather less width of the orbit.

Table 12. Skulls of *P. oweni* and *Eu. curtus.*

	P. oweni.		*Eu. curtus.*			
	Whangarei TYPE.	Doubtless Bay	Doubtless Bay	Doubtless Bay	Doubtless Bay	Doubtless Bay
Auckland Museum No.	384	150a	5	364	180	4
Total length	10.5*	10.45	10.15	10.00	9.75	9.60
Length: parocc. to preorbital	.	5.90	5.93	5.85	5.70	5.55
Height	3.90	3.76	3.70	3.60	3.60	3.37
Width at parocc. proc.	.	4.60	4.80	4.50	4.55	4.36
Width at squam. prom.	5.50	5.40	5.58	5.55	5.37	5.23
Width at temp. fossae	4.15	3.82	3.95	3.95	3.80	3.60
Width between temp. ridges	2.95	3.28	3.37	3.32	3.30	3.14
Width at post-orbitals	6.20	6.16	6.28	6.25	5.75	5.60
Width at pre-orbitals	.	3.17	3.00	3.05	3.05	2.85
Width of tympanic cavity	.	1.60	1.44	1.55	1.34	1.44
Width of temp. fossa	.	2.44	1.86	1.65	1.97	1.72
Width of orbit	.	2.47	2.50	2.50	2.54	2.26
% Squam. width: length	.	51.6	54.9	55.5	55.0	55.5
% Width at temp. foss.: length	.	36.5	38.9	39.5	38.9	37.5
% Post-orbital width: length	.	58.9	61.8	62.5	58.9	58.3
% Temp. ridges width: fossae width	.	85.8	85.3	96.0	86.8	87.2
% Length parocc.-preorb.: total length	.	56.4	58.5	59.3	?	57.8

*Estimated.

Genus *Dinornis* Owen, 1843.

1843 .. .. .. *Dinornis* Owen, Proc. Zool. Soc. for 1843, pt. 11, p. 10. Type, by monotypy, *Dinornis novae-zealandiae* Owen.
Megalornis Owen, *ibid.*, 19 (note of withdrawal, in favour of *Dinornis*, of MS. name ascertained before publication to be preoccupied by *Megalornis* Gray 1841).
1846 .. .. .. *Palapteryx* Owen, Proc. Zool. Soc. for 1846, pt. 14, p. 46. Type, by monotypy, *Dinornis ingens* Owen.
1852 .. .. .. *Movia* Reichenbach, Nat. Syst. Vog., p. xxx. Type, by monotypy, *Dinornis ingens* Owen.
Moa Reichenbach, Nat. Syst. Vog., p. xxx. Type, by monotypy, *Dinornis giganteus* Owen.
1891 .. .. .. *Tylopteryx* Hutton, N.Z. Jnl. Sci., new issue, vol. 1, no. 6, p. 247. Genosyntypes: *D. gracilis* Owen, *D. (Tylopteryx) torosus* Hutton, *D. struthioides* Owen; *D. torosus* is here selected as the *Genotype*.

Owen, in reading to the Zoological Society his paper containing the first description of a species of Moa, used the generic name *Megalornis*. On discovering that the name was preoccupied by *Megalornis* Gray 1841, he wrote to the Society withdrawing it and substituting *Dinornis*. In actual publication in the Proceedings of the Zoological Society, *Dinornis* appears on p. 8 and the note of withdrawal of *Megalornis* on p. 14; the latter therefore has no status or significance in the *Dinornithidae*. Lydekker (1891a, 224 footnote), in stating that *Palapteryx* was founded on two species, *Dinornis ingens* and *D. struthioides*, was referring to Owen's paper in Transactions Zool. Soc., vol. 3, Dec. 1846; but in Owen's earlier paper, Proceedings Zool. Soc., July 1846, only one species, *D. (Palapteryx) ingens*, is mentioned; this is therefore the type species of *Palapteryx*.

Characters of the Genus. Tall moas with long, straight, slender leg-bones; metatarsus longer than the femur, tibia usually more than twice as long as femur; skull broad and flat, beak wide at base, decurved at tip and with a wide flattened median ridge. The occipital region slopes forward more than in the other genera, exposing more of the condyle in dorsal view; a space between lambdoidal and temporal ridges extending outward over the squamosal prominence. Large tympanic cavity and temporal fossa; post-temporal fossa relatively longer than in the other genera; maxillo-palatine enclosing a large antrum cavity with a wide posterior aperture.

Cervical vertebrae relatively longer and narrower than in the other genera, and bearing a single (not bifid) neural spine; vertebraterial canals laterally compressed, becoming narrow slits in the posterior cervicals. Sternum broad; of the two depressed regions near to the anterior margin, that of the left side is always the deeper; lateral processes widely diverging behind, median process well-developed, distinctly notched. The scapulo-coracoid is better developed in *Dinornis* than in the other genera. The coracoid portion is subcylindrical and forms a very wide angle, with the flatter and more slender scapula. It exhibits considerable variety in the form of details: in some cases there is a long shallow depression posteriorly in the coracoid near the scapular junction, but it is so irregular in size and form that I hesitate to indentify it with the glenoid cavity. I have been unable to trace an earlier reference supporting Hutton's statement (1892, p. 120, *Palapteryx*) that a glenoid cavity (and, therefore, possibly a wing-rudiment) is present in *"dromaeoides"* (i.e. *novae-zealandiae*) and *"plenus"* (i.e. *torosus*).

Range of variation in proportionate width of leg-bones (percentages of the length).

		Proximal.	Mid.	Distal.	Girth.
Femur	max.	40	19	44	53
	min.	34	13	36	45
Tibia	max.	26	9	16.5	24
	min.	19	6.4	11.6	17
Metatarsus ..	max.	30	15	42	40
	min.	21	10	26	27

Species of *Dinornis*. Owen described three species of *Dinornis* from North Island leg-bones: *D. novae-zealandiae* about the height of the ostrich, *D. ingens* a considerably larger bird, and the still larger *D. giganteus*. Three similar species occur in the South Island, and the conclusions of students have differed as to whether they were identical with the North Island species. Owen (1846a and 1846c) recognized a heavier South Island form of *D. ingens (Palapteryx ingens* var. *robustus)*; in 1869b he described *D. maximus** and in 1891b Hutton proposed *D. torosus* for the South Island form of *D. novae-zealandiae*. In the latest revision of the group Oliver (1930) has retained *D. giganteus* and *D. maximus* as separate species, but has suppressed *D. robustus* and *D. torosus*. The measurements now recorded for all three species, or pairs of species, reveal that, while leg-bones of the same size and proportion are found in both islands, the South Island birds range to a greater length and are nearly always relatively stouter than the North Island specimens.

The difference is not merely one of general size and proportion: the measurements from mixed bones indicate a greater difference between the metatarsi from the two islands, and study of individual skeletons shows even more clearly that, while the femora and tibiae are frequently of the same, or nearly the same length and proportion in sets from both islands, a marked difference is to be noted in the much more slender metatarsi of the North Island birds. This difference may even be discerned in the North Island tibiae, which, while of approximately the same relative proximal and middle width as South Island tibiae, are narrower at the distal end to conform to the more slender metatarsi which articulate with them. A difference in form also to be noted is that North Island metatarsi, though narrow in transverse middle width, are relatively thicker antero-posteriorly and may thereby have approximately the same girth. It is as if the two outer metatarsal components had been pinched together and the middle one had been squeezed out to the rear. Another difference, almost invariably noted, is the greater spread of the distal metatarsal trochleae in the South Island species.

On account of the above mentioned differences it is proposed to retain the three North Island species as distinct from their South Island representatives, i.e. in the North Island *D. novae-zealandiae*, *D. ingens* and *D. giganteus*, separated from one another by increased height; and, in the South Island, *D. torosus*, *D. robustus* and *D. maximus*, also differing from each other by increased height and distinguished from their North Island size-fellows by ranging to a greater height and by possessing stouter leg-bones, particularly the metatarsus.

Measurements from individual birds and from a large number of leg-bones indicate the following ranges in length of the leg-bones in the different species.

		novae-zealandiae.	*ingens.*	*giganteus.*	*torosus.*	*robustus.*	*maximus.*
Femur	max.	31	35	41	33	36	46.5
	min.	25	32	37	25	33	38.0
Tibia	max.	56	74.5	96.5	65	75	99
	min.	45	62	76	50	69	77
Metatarsus ..	max.	32	42	53	33	42	55
	min.	25	33	43	26	35	41

It is not always possible to define precisely the lengths of leg-bones which separate the species. The limits are selected partly by where the smaller number of bones occur in a continuous series, partly by definite breaks, and in part indirectly from the individual skeletons.

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*By a chance in dates of publication Haast becomes the authority for this name.

For instance, the distinction as to length of tibia between *ingens* and *novae-zealandiae* is readily apparent (i.e. between 62 cm. and 56 cm.), but the metatarsal lengths in a long series of bones run more closely together. Nor do the individual skeletons give us **direct** information, because the smallest metatarsus of an individual of *ingens* is 34.9 cm. and the longest metatarsus of an individual of *novae-zealandiae* is 31.35 cm., while there are unassociated metatarsi of lengths varying from 34.2 to 31.7 cm. Of two small breaks in this intermediate series of metatarsal lengths, that between 33.02 and 31.7 cm. is greater than one between 34.9 and 34.2 cm., and some support for accepting it as the dividing point between the metatarsi of the species may be obtained **indirectly** from the individual skeletons.

Thus, in the individuals of *ingens*, the lowest percentage "metatarsus : tibia" lengths is 53, and 53% of the shortest unassociated *ingens* tibia (62) is 32.8, say 33.

Again, in *novae-zealandiae* individuals, the highest percentage "metatarsus : tibia" lengths is 56, and 56% of the longest *novae-zealandiae* tibia (56) is 31.35.

Too much reliance should perhaps not be placed on this distinction, but it is at least a shade better than an entirely arbitrary one. If it should be maintained, *D. gracilis* Owen will be included under *D. ingens* instead of *D. novae-zealandiae*.

The names used in this paper for the first two species of *Dinornis* are *novae-zealandiae* for the smaller and *ingens* for the larger, but it may be that they should be known respectively as *struthoides* and *novae-zealandiae*. A statement concerning them has been submitted to the International Commission on Zoological Nomenclature, and one would have preferred to wait for the Commission's opinion before publishing. War conditions may, however, delay the Commission's decision and, as the present opportunity of printing may not be available at all if it is deferred, it has been decided to publish at once and to include a note on the point at issue.

The problem centres on fixing the type specimen of *D. novae-zealandiae*, the first moa species proposed by Owen. The name first appeared in Proceedings of the Zoological Society, July 1843, the type material being a femur, a tibia and a metatarsus, not of an individual bird. Owen intended this paper to be merely a preliminary advice of his forthcoming paper in the Transactions of the Zoological Society; but as this advance notice contained a valid, albeit brief, description, it must stand as the formal proposal of the species.

Between whiles Owen had changed his mind. He had discovered that he had bones of two species before him, but, instead of applying the name *novae-zealandiae* to one and a new name to the other, he ignored his earlier proposal and gave entirely different names, *struthoides* and *ingens*, to his two species. The sequence of events in his second paper was as follows:—

1. On p. 244 he clearly indicated the metatarsus of the earlier paper as the type of *D. struthoides*, viz.: ". . . the tarso-metatarsal *m 3* . . . must indicate a second species which I shall call *Dinornis struthoides*."
2. On p. 247 he equally clearly indicated the tibia of the earlier paper as the type of *D. ingens*, thus: "These considerations induce me to regard *t 2* as indicative of a distinct species of *Dinornis* which . . . may be provisionally called '*Dinornis ingens*.' "
3. He then proceeded to describe the femur, and on p. 249 he identified it as being of the same species as the metatarsus, i.e. "The femur *f 12* offers the required correspondence with the metatarsus *m 3* of the *Dinornis struthoides*." It was not, however, a co-type of *D. struthoides*.

The next relevant event was in 1891, when Lydekker (p. 224) selected the tibia (type of *D. ingens*) as the type of *D. novae-zealandiae* Owen, which is quite in order provided Owen's previous proposals had not **had the effect** of fixing the type; this, it is suggested, they may have had, on the principle of type by elimination, as in the selection of the type species of a genus, thus:—

Accepting the three bones as co-types of *D. novae-zealandiae,* Owen's proposal of *D. struthoides* for the metatarsus left the tibia and femur as remaining types. Again, the proposal of *D. ingens* for the tibia leaves the femur alone as type of *D. novae-zealandiae.* If the status of this bone as type, by elimination, of *D. novae-zealandiae* is not affected by Owen's later identification of it with his new *D. struthoides,* the name *novae-zealandiae* will apply to the smaller species with *struthoides* as a synonym, and Lydekker's selection of the tibia of *D. ingens* as type of *novae-zealandiae* will have been invalidated. On the other hand it may be submitted that Owen, by identifying the femur with his new *struthoides,* had left nothing to stand as type by elimination, and that Lydekker's selection of the tibia was therefore in order.

The decision on this question seems to depend upon whether the proposals in any one published paper are to be regarded as a contemporary unity, or as being separate and consecutive acts, ranking by page precedence for priority. Pending the Commission's opinion being given, the alternative designations of these species will be:—

A.		
Smaller species	..	*D. novae-zealandiae*
	Syn.	*D. struthoides*
Larger species	..	*D. ingens*

B.		
Smaller species	..	*D. struthoides*
Larger species	..	*D. novae-zealandiae*
	Syn.	*D. ingens*

In the meantime I have adopted alternative A.

Dinornis novae-zealandiae Owen, 1843.

1843	July		**Dinornis novae-zealandiae** Owen (part). Proc. Zool. Soc. for 1843, pt. 11, p. 8. Type: ? Metatarsus m3 and/or femur f12 from Poverty Bay, at that time in Museum of Royal College of Surgeons.
1844	March		*Dinornis struthoides* Owen, Proc. Zool. Soc. for 1844, pt. 11, no. 129, p. 144, *nomen nudum.*
1844	June	5	**Dinornis struthoides:** Owen, Trans. Zool. Soc. 3, pt. 3, p. 244. Type: Metatarsus, m3, of Owen 1843.
1845			*Dinornis struthoides* : Owen, Cat. Foss. Org. Remains (Mam. and Av.) Mus. Roy. Coll. Surg., p. 369.
1846	December	28	*Dinornis struthoides:* Owen, Trans. Zool. Soc. 3, pt. 4, p. 308, pl. 38, figs. 1-4. Skull.
1891			*Dinornis struthioides:* Lydekker (part), Cat. Foss. Birds, Brit. Mus., 242.
			Anomalopteryx sp. α Lydekker, *ibid.*, 256.
1891	November	13	*Dinornis struthoides:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. III., p. 427.
1891	November		*Dinornis struthioides:* Hutton, N.Z. Journ. Sci., new issue, 1, no. 6, 247.
1892	May		*Dinornis struthioides:* Hutton, Trans. N.Z. Inst. 24, 119.
1897	June		*Dinornis struthioides:* Hutton, Trans. N.Z. Inst., 29, 545.
1907	November	12	*Dinornis gracilis:* Rothschild (part), Extinct Birds, 194.
			Dinornis novae-zealandiae: Rothschild, *ibid.*, 194.
1927			*Dinornis novae-zealandiae:* Archey, Trans. N.Z. Inst. 58, 155.
1930			*Dinornis novae-zealandiae:* Oliver (part), N.Z. Birds, p. 39.
			Dinornis dromioides: Oliver, *ibid.*, p. 41 (bones from Karamu).
1933			*Dinornis novae-zealandiae:* Lambrecht (part), Handbuch der Palaeornithologie, 139.
			Dinornis dromioides: Lambrecht, *ibid.*, 140.

Leg-bones. While the femur of *D. novae-zealandiae* (Pl. 1, fig. 1) is relatively stouter than that of *Anomalopteryx,* the tibia (Pl. 2, fig. 1) and metatarsus (Pl. 3, fig. 1) are definitely more slender, resembling in this respect the tibia and metatarsus of *Megalapteryx.* The tibia is rather less incurved than in *Anomalopteryx,* but not as straight as in *Megalapteryx.* Sometimes the metatarsi are very slender, as in A.M. 328 from Wanganui, a couple of odd bones apparently from a swamp. The muscle ridges on the femur are prominent, broad and rugose; particularly those for the *accessory semi-tendinous* and the posterior part of the *adductor longus,* which lie subparallel to each other instead of diverging as in *Anomalopteryx*. In the metatarsus the outer wall of the intercondylar groove extends backwards for a considerable distance beyond the inner wall, and is broad and rugose; the posterior asperities in the metatarsus are also more marked than in *Anomalopteryx* and *Megalapteryx*. The stoutness of the femur and the length and slenderness of tibia and metatarsus suggest a muscular development for strength and speed in *D. novae-zealandiae* as compared with lightness and speed in *Megalapteryx;* but neither would have been as fast as the existing struthious birds whose metatarsi far exceed those of the moa in relative slenderness and length. For dimensions of leg-bones see Table J.

Skull. The skulls of the species of *Dinornis* are very similar in form, and a description of one *(D. torosus* in this case) will suffice for the genus. It is very broad and flat and has little height in proportion to length and breadth.

Seen from behind, the outer borders of the paroccipital processes are strongly convex, and have a distinct marginal ridge which continues around the lower border, where it demarks a small truncated termination from the main process; this terminal process reaches only to the level of the lower third of the condyle. The mamillar tuberosities are of moderate size and are separated by a wide arch. The median supra-occipital crest is only faintly indicated, and the supra-occipital fossae are correspondingly shallow: each fossa is bounded ectally by a roughened sub-circular eminence for insertion of the *rectus capitis* muscle. The supra-foraminal ridge is not prominent; it is continued outwards and downward on the paroccipital processes. In lateral view (Pl. 4, fig. 1) the hinder (paroccipital) and upper margins of the tympanic cavity form a wide arch which usually continues evenly on to the anterior margin; the zygomatic process is short and broad. The post-temporal fossa is much larger than in the other genera, and the inferior temporal ridge, which forms its anterior margin, is prominent. The temporal fossa extends backwards above the post-temporal fossa, the temporal ridge reaching back to within 5 mm. of the lambdoidal ridge and also extending well up on to the cranial roof. The maxillo-nasal springs from the nasal, and lies along, but is discrete from, the lachrymal; the latter bone completely encloses the lachrymal foramen.

On the dorsal surface (Pl. 5, fig. 1) there is a slight depression between the temporal ridges, a low transverse eminence in the post-orbital region and a depression again in front of the eminence. The post-orbital processes extend widely outward, and their terminations bend down rather abruptly and slightly backward. The hinder margin of the orbit is sinuous, forming a wide angle where it meets the upper margin. In some skulls there are a few shallow pits, possibly for crest feathers, on the upper surface above the orbit. The beak, in dorsal view, is very broad, tapering forward to a broadly rounded tip; the premaxillary ridge is narrow proximally and widens distally. In lateral view the beak is strongly depressed terminally. In ventral view (Pl. 7, fig. 1, *D. maximus)* the skull of *Dinornis* is distinguished from the other genera by the wide lateral extension of the antorbitals. The maxillo-palatine junction is by a wide arch through which a broad flattened passage leads to a large antrum cavity.

Vertebrae. I am not yet certain of the number of vertebrae in *D. novae-zealandiae,* nor of their grouping, for I have not been able to examine a complete skeleton. My Waikaremoana skeleton (A.M. 53) lacks 2 and, apparently 8, but would seem to have had the usual 21 cervical; it also needs two thoracic to make up the normal number, six, of these. The type of *D. torosus* lacks No. 1 and 2, and apparently 6 and 7, and if it does not also want No. 8, it possessed 20 (instead of 21) cervicals; it definitely has seven (instead of six) free dorsals, i.e. 28 is not fused to the pelvis.

The Takaka *D. torosus* in the Dominion Museum also has seven rib-bearing vertebrae, but as this skeleton appears from a photograph to have more than 21 cervicals it is perhaps safer not to base generalities on it. The Tiger Hill *D. robustus* in the Yorkshire Museum is another *Dinornis* skeleton with, apparently, seven "dorsals," but, as in the case of the type of *D. torosus,* it lacks the anterior cervicals, so one cannot say whether the first dorsal in this case is the normal 22 or a modified cervical (21). On the other hand I have a skeleton (A.M. 123) with the normal number (six) of thoracic and with no indication that one may be missing. We have yet to secure a complete vertebral column of this or any other species of *Dinornis.*

As to the form of the vertebrae, the nape cervicals are of the usual subquadrate shape as in e.g. *Anomalopteryx,* but have a *single (not bifid) neural spine;* on the ventral side the median hypapophysial keel is not so pronounced as in *Anomalopteryx.* On the succeeding cervicals the neural spines become double in 8; they stand farther apart on the succeeding vertebrae, but become a single high neural spine again on 20. The post-zygapophyses are longer, narrower and less divergent than in *Anomalopteryx,* while the pleurapophyses are not so long. The parial hypapophyses appear on 8, and have joined to form a median ridge by 19. The vertebraterial canals are compressed laterally, and become narrow and slit-like in the posterior cervicals.

Pelvis. In *D. novae-zealandiae,* (Pls. 9, 10, 11, figs. 1) the pelvis is typical of the genus. It is long and relatively narrow, as in *Anomalopteryx;* the dorsal iliac margin is gently arched anteriorly, flat or concave posteriorly; the ischia and pubes project considerably behind the ilia, the pubis frequently passing behind and fusing with the ischium. In dorsal view its relative slenderness is marked, particularly in the post-acetabular region, the escutcheon being narrow, with subparallel sides, the descending flanges of which slope outwards (cf. inwards in *Anomalopteryx* and *Euryapteryx).* The divergence of the dorsal iliac margins to form the front border of the escutcheon is gradual, not abrupt as in *Anomalopteryx.* In ventral view the broad centra of the anterior pelvic vertebrae give the pre-acetabular region a flat, splayed appearance, more like *Euryapteryx* than *Anomalopteryx;* but the narrow post-acetabular region, and the moderately divergent ischia and pubes are suggestive of the latter genus. As in all species of *Dinornis,* the vertebrae of the acetabular region are clearly indicated by short, flat, acutely pointed paired projections, the transverse processes.

The pelvic formulae indicate the customary variation in the grouping of the constituent vertebral elements:—

28-35	(36-39)	40-46	
28-35	(36-38)	39-46	
28-35	(36-39)	40-46	?47

The "bracing" across to the hinder border of the acetabulum appears pretty constantly to be provided by pleurapophyses from 40 and 41, with No. 39 occasionally participating; but No. 41 is not a constant element in this bracing and may be directed obliquely backwards to the side of the escutcheon.

Sternum. (Pl. 12, fig. 2.) The broad, flat sternum has a straight anterior border which bears distinct and sometimes deep scapulo-coracoid facets (in only one *Dinornis* sternum were they absent). Just behind the anterior margin are two broad depressions, that on the left side being always the deeper, a feature apparently confined to *Dinornis.* The lateral processes are curved and widely diverging, extending well behind the median process; the latter is deeply notched and is separated from the laterals by a wide arch, not an angular notch.

Distribution. North Island: Doubtless Bay, Karamu (Kawhia district), Mangaotaki (Te Kuiti district), Waikaremoana, Haupouri, Poverty Bay (type locality).

Table 16. Skulls of *Dinornis*.

	D. novae-zealandiae.			*D. ingens.*	*D. torosus.*			*D. robustus.*	*D. maximus.*		
	Waikaremoana. A.M. 53.	Waikaremoana. A.M. 107.	Hastings. A.M. 113.	Waikaremoana. A.M. 64.	Takaka. Type. A.M. 352.	Takaka. D.M.	Enfield. C.M. 1/12/45.	Tiger Hill, Otago. Yorkshire Mus.	Riverton. B.M., A.608.	Pyramid Valley. C.M. 1939 xiii A.	Riverton. C.M. 1/2/15.
Total length	17.0		17.3	17.3	17.5	16.9		20.0		23.0	22.8
Length, paroccipital to preorbital ..	9.3	9.7	10.5	10.45	9.5	10.0		11.0		12.45	12.2
Height	4.6	4.6	4.9	5.1	4.9	4.84	4.85	5.2	5.3	5.8	5.3
Width at paroccipital processes ..	7.48	6.84	7.97	8.0	8.2	8.2	8.14	9.6	9.4	11.2	9.96
Width at squamosal prominences ..	8.32	8.2	8.85	9.4	9.3	9.2	9.4	10.65	10.7	12.3	11.48
Width at temporal fossae	5.78	5.85	6.13	6.0	6.2	6.24	6.16	7.14	6.9	7.48	7.48
Width between temporal ridges ..	3.75	3.9	4.0	3.3	4.7	4.5	3.9	5.1	4.3	5.1	4.64
Width at postorbital processes ..	10.9	10.8	12.1	11.0	10.5	10.8	11.2	12.7	13.4	14.75	13.4
Width at preorbital processes	7.3	7.7		7.9	7.9	7.4	8.0	9.3		11.54	9.43
Width of tympanic cavity	1.94	2.25	2.8	2.65	2.3	2.3		2.6		2.9	
Width of temporal fossa	3.5	2.95	3.7	3.3	2.6	3.13		3.7		3.7	4.25
Width of orbit	3.4	3.9	3.7	3.4	3.4	3.44		3.6		3.6	4.6
Proportions %—											
Width temp. ridges : temp. fossae	64.8	66.6	65.2	55.0	75.8	72.1	63.3	71.5		68.2	62.0
Total length											
Width at squamosal prominences..	49.0				53.2	54.5		53.3		53.5	50.3
Width at temporal fossae	34.0				35.5	36.9		35.7		32.5	32.7
Width at postorbitals	64.0				60.0	64.0		63.5		64.2	58.8
Height : length	27.1				28.0	28.7		26.0		25.2	26.2
Distance between temporal and lambdoidal ridges	0.54	0.8	1.00	0.5	0.75	0.65		1.05		0.6	0.57

Table 17. Pelves of *Dinornis*.

(a) *D. novae-zealandiae,* (b) *D. torosus,* (c) *D. ingens,* (d) *D. robustus.*

	(a) A.M. 53. Waikare-moana.	(b) Type. Takaka.	(c) Hastings.	(d) South Island.
Length	34.2	43.0	50.5	53.8
Width at antitrochanters	17.6	20.0	20.9	24.6
Width of escutcheon	12.5	14.0	15.3	19.5
Ischia length	21.5	22.5	23.0	26.0
Ischia divergence	24.0	30.5	26.0	29.0
Pubes length	26.5	30.0		30.0
Pubes divergence	26.0	33.0		31.0
% antitrochanters : length	51.5		41.4	45.7
% escutcheon : length	36.5		30.3	36.2
% ischial divergence : antitrochanters	136.5		124.5	118.0
% pubic divergence : antitrochanters	148.0			126.0

Dinornis ingens Owen, 1844.

1843	July	*Dinornis novae-zealandiae* Owen (part), Proc. Zool. Soc. for 1843, pt. 11, p. 8. Tibia, t2, from Poverty Bay, type of *D. ingens.*
1844	June 5 ..	**Dinornis ingens** Owen, Trans. Zool. Soc. 3, pt. 3, p. 247, pl. 25, figs. 1, 2; pl. 26, figs. 1, 2. TYPE: tibia, t2, from Poverty Bay, at that time in Museum of Royal College of Surgeons.
1852	March 2 ..	*Dinornis ingens:* Owen, Trans. Zool. Soc. 4, pt. 2, p. 59, pl. 23 (skull).
1855	April 11 ..	**Dinornis gracilis** Owen, Proc. Zool. Soc. for 1854, pt. 22, p. 246. Founded on femur, tibia and metatarsus from the North Island, the latter (B.M. 32272) selected by Lydekker (p. 248) as the TYPE.
1856	May 10 ..	*Dinornis gracilis:* Owen, Trans. Zool. Soc. 4, pt. 4, pp. 143-145.
1869	May	*non Palapteryx ingens:* Haast, Trans. N.Z. Inst. 1, 84 (2nd ed. 1875, 25) (= *D. robustus).*
1875	July	*non Dinornis ingens:* Hutton, Trans. N.Z. Inst. 7, 266 (= *D. robustus,* Knobby Range).
1891	April 25 ..	*Dinornis novae-zealandiae:* Lydekker (part, ♂), Cat. Foss. Birds, Brit. Mus. 224.
		Dinornis gracilis: Lydekker, *ibid.,* 248.
1891	November 13	*Dinornis novae-zealandiae:* Sharpe (part), Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, III, p. 424 (no. 2167).
1891	November ..	**Dinornis firmus** Hutton, N.Z. Journ. Sci. new issue, vol. 1, No. 6, 247. Indicated by average measurements, which, according to Hutton (1891b, 114, no. 1), included those of an individual from Poverty Bay, then in possession of Rev. W. Colenso. This is accordingly selected as the type.
		Dinornis ingens: Hutton, *ibid.,* 247.
		Dinornis gracilis: Hutton, *ibid.,* 247.
1892	May	*Dinornis firmus:* Hutton, Trans. N.Z. Inst., 24, 114.
		Dinornis ingens: Hutton, *ibid.,* 114.
		Dinornis gracilis: Hutton, *ibid.,* 116.
1897	June ..	*Dinornis ingens:* Hutton, Trans. N.Z. Inst. vol. 29, 544.
		non *Anomalornis gracilis:* Hutton (not of Owen), *ibid.,* 546 (= part *A. didiformis,* part *M. didinus).*
1907	November 12	*Dinornis ingens:* Rothschild (part), Extinct Birds, 192, pl. 42.
1927	August 15 ..	*Dinornis ingens:* Archey, Trans. N.Z. Inst., 58, 155.
1930	.. .. ..	*Dinornis ingens:* Oliver (part) N.Z. Birds, 39.
1933	.. .. ..	*Dinornis ingens:* Lambrecht (part), Handbuch der Palaeornithologie, 138.

This larger species is better represented in collections than *D. novae-zealandiae.* The type locality is Poverty Bay, and remains have also been found at Kaiwaka (Hawke's Bay), Waikaremoana, Makirikiri (near Wanganui), Mangaotaki (Te Kuiti district), Hastings and Te Aute.

As with *D. novae-zealandiae,* the leg-bones vary considerably both in length and stoutness (Table K), some having very slender tibia and metatarsus; there is, however, no break in the even gradation from stouter to very slender bones. Although we have secured several partial skeletons in our cave-hunting expeditions, only one has had a skull sufficiently well preserved for comparative measurements. The imperfect skulls, however, display all the typical characters of the genus, and are only slightly larger than the skull of *D. novae-zealandiae.*

Table 18.

Sterna: (a) *D. novae-zealandiae,* (b) *D. torosus.*

	(a) A.M. 53. Waikaremoana.	(b) Type. Takaka.
A—Breadth across pre-costal processes	15.5	18.5
B—Breadth at anterior end of costal border	13.5	17.0
C—Width at base of median processes		
D—Distance across outer ends of lateral processes		29.5
E—Length from anterior margin to tip of median process	13.8	19.5
F—Length from anterior margin to xiphisternal notch	10.0	12.0
G—Length from anterior margin to lateral notch	19.0	26.5
H—Length from precostal to tip of lateral process	2.5	1.0

Dinornis giganteus Owen, 1844.

1844	March	**Dinornis giganteus** Owen, Proc. Zool. Soc. for 1844, pt. 11, No. 129, p. 144 (t.1). TYPE: a tibia from Poverty Bay in Mus. of Roy. Coll. of Surgeons (No. 2170). Cast of type in British Museum (No. 18588, Lydekker, p. 225).
1844	June 5	*Dinornis giganteus:* Owen, Trans. Zool. Soc. vol. 3, pt. 3, p. 244, 241, pl. 27.
1869	May	non *D. giganteus:* Haast, Trans. N.Z. Inst. vol. 1, 88.
1878	May	*Dinornis giganteus:* Cheeseman (in Mactier, Trans. N.Z. Inst. 10, 552).
1891		*Dinornis novae-zealandiae:* Lydekker (part, presumed female form) Cat. Foss. Birds, Brit. Mus. 224, 225. (Type of *D. giganteus).*
1891	November 13	*Dinornis novae-zealandiae:* Sharpe (part, i.e. no. 2170) Cat. Ost. Vertebr. Mus. Roy. Coll. Surg. London, III p. 425.
1891	November	**Dinornis excelsus** Hutton, N.Z. Journ. Sci., new issue, vol. 1, no. 6, p. 247. Founded on average measurements, stated subsequently (Hutton 1892) to be of three metatarsi and a tibia from Te Aute of which the latter is here selected as the type. Its present place of deposition is not known.
		Dinornis giganteus: Hutton, *ibid.,* 247.
1892	May	*Dinornis excelsus:* Hutton, Trans. N.Z. Inst., 24, 110.
		Dinornis giganteus: Hutton, *ibid.,* 112.
1895	May	*Dinornis giganteus:* Hector, Trans. N.Z. Inst., 27, 655.
1897	June	*Dinornis giganteus:* Hutton, Trans. N.Z. Inst., 29, 543.
1907	November 12	*Dinornis giganteus:* Rothschild (part) "Extinct Birds," 193.
		Dinornis maximus: Rothschild (part) "Extinct Birds," 192.
1930	August 1	*Dinornis giganteus:* Oliver, N.Z. Birds, 38.
1933		*Dinornis giganteus:* Lambrecht, Handbuch der Palaeornithologie, 137.

The paper in the Proceedings of the Zoological Society for November, 1843, issued in March, 1844, contains a valid proposal of *Dinornis giganteus,* i.e. a name associated with a tibia of given length (two feet eleven inches); and this tibia being the only bone mentioned, is the type. It is preserved in the collection of the Royal College of Surgeons (No. 2170) and there are casts of it in the British Museum (No. 18588 Lydekker, p. 225). This species is known only from a few leg-bones (Table L), among them only three sets or partial sets of bones of an individual bird, and bones from various swamp localities. There is no record of the skull of an individual bird; presumably its skull was rather larger than that of *D. ingens.*

Distribution. North Island. The type locality is Poverty Bay. Other records are Doubtless Bay (North Auckland), Awhitu (Manukau Harbour), Moawhango, Te Aute, Makirikiri (near Wanganui), and Maungaraki Gorge (near Wellington).

Dinornis torosus Hutton, 1891.

1864	.. .. ..	*Palapteryx ingens:* Jaeger, Novara Exped. Geol. Bd. 1, Ab. 2, p. 307; skull probably of this species, though possibly of *D. robustus.*
1869	May	*Dinornis sp.* Haast, Trans. N.Z. Inst. 1, p. 84 (2nd ed. 1875, p. 25), No. 7.
		Dinornis gracilis: Haast, *ibid.,* No. 10.
		Dinornis struthioides: Haast, *ibid.,* No. 11.
1875	July	*Dinornis struthioides:* Hutton, Trans. N.Z. Inst. 7, Tables opposite p. 278.
1891	.. .. ..	*Dinornis struthioides:* Lydekker (part), Cat. Foss. Birds Brit. Mus. 242 (A. 105, p. 243, 32276, etc.).
		Dinornis robustus: Lydekker *ibid.,* 239-240 (B.M. No. 46639-43).
1891	November ..	**Dinornis torosus** Hutton, N.Z. Journ. Sci. new issue 1, No. 6, 247. Indicated by average measurements, including (Hutton 1891b, 118, no. 1) those of a nearly perfect skeleton from Takaka then in possession of Mr. R. I. Kingsley, now in the Auckland Museum (A.M. 352), and here selected as the Type.
		Palapteryx plenus Hutton (part, i.e. tibia and metatarsus) *ibid.,* 248. Founded on average measurements of bones from unspecified South Island localities. The largest tibia recorded in Hutton 1892b, 122, is here selected as the type.
1892	May	*Dinornis torosus:* Hutton, Trans. N.Z. Inst. 24, 117.
		Palapteryx plenus: Hutton, *ibid.,* 122.
1893	May	**Dinornis strenuus** Hutton, Trans. N.Z. Inst., 25, 8. Founded on leg-bones (unspecified) of which average measurements were given. *Lectotype,* here designated a metatarsus from Enfield labelled *strenuus* by Hutton, No. 1.14.13, Canterbury Museum.
1895	October ..	*Dinornis torosus:* Parker, Trans. Zool. Soc. 13, pt. 11, 375.
1896	June ..	*Dinornis torosus:* Hutton, Trans. N.Z. Inst., 28, 634, 642. (Bones from Kapua.)
		Dinornis torosus: Hutton, *ibid.,* 646, 648. (Bones from Enfield.)
1907	November 12	*Dinornis gracilis:* Rothschild (part), Extinct Birds, 194.
		Dinornis novae-zealandiae: Rothschild, *ibid.,* 194.
1930	.. .. ..	*Dinornis novae-zealandiae:* Oliver (part), N.Z. Birds, p. 39.
1933	.. .. ..	*Dinornis novae-zealandiae:* Lambrecht (part), Handbuch der Palaeornithologie, 139.

Hutton's original designation of this species (1891b, 247) was supported by a comparative statement, "Intermediate in size between *D. gracilis* and *D. struthioides,*" supplemented by "average measurements" of leg-bones, pelvis, sternum and skull. His subsequent (1892b, 118) more detailed description was based on only two specimens, No. 1, a nearly complete skeleton from Takaka, property of Mr. R. I. Kingsley, and No. 2, the tibia and femur of an individual from Glenmark in the Canterbury Museum. If the actual and ordinal priority of the details of the Takaka skeleton be not deemed sufficient to fix the type, its selection in this paper (see synonymy) will validate it as such. The type, which is well preserved, is now in the Auckland Museum (A.M. 352): it has the typical South Island sturdiness of the leg-bones and widely spread metatarsal trochleae. Although its pelvis and sternum are both absolutely and proportionately (to tibia length) greater than in specimens of *D. novae-zealandiae,* its skull is very little larger.

Distribution. South Island: Nelson, Canterbury and Otago. Only six sets of the leg-bones of individual birds are known, and the measurements of two of them are incomplete (Table M). *D. torosus* was also scarce in swamp deposits such as Glenmark and Enfield. It may have ranged the hills rather than the lowlands, or its relative lightness may have better preserved it from the swamp hazards which overtook the heavier species.

Dinornis robustus Owen, 1846.

1846	July	*Dinornis ingens* var. **robustus** Owen, Proc. Zool. Soc., pt. 14, p. 48. Founded on a femur and a metatarsus from the South Island, at that time in the Museum of the Royal College of Surgeons but not now identifiable there : the metatarsus is here nominated as the actual type. It was referred to as the type by Lydekker (1892, 230), but not so nominated.
1846	December 28	*Dinornis ingens* var. *robustus:* Owen, Trans. Zool. Soc. 3, pt. 4, pp. 321, 329.
1851	January 1 ..	*Dinornis robustus:* Owen, Trans. Zool. Soc. 4, pt. 1, p. 2, pl. 1 (foot) (Waikouaiti).
1858	September 28	non *Dinornis robustus:* Owen, Trans. Zool. Soc. 4, pt. 5, p. 163; pl. 47 (as *giganteus) (= maximus).*
1864	September 3	*Dinornis robustus:* Allis, T., Proc. Linn. Soc. vol. 8, pp. xliv, 50, 52.
1865	December 5	*Dinornis robustus:* Allis, T., Proc. Linn. Soc. vol. 8, 140.
1865	.. .. ..	*Dinornis robustus:* Dallas, W. S., Proc. Zool. Soc. for 1865, No. 17, 265.
1865	.. .. ..	? *Dinornis ingens:* Stevens, S., Proc. Zool. Soc. for 1865, No. 40, 617 (egg).
1866	June 6 ..	*Dinornis robustus:* Owen, Trans. Zool. Soc. vol. 5, pt. 5, p. 337-358, pl. 53-56 (skull and scapulo-coracoid.)
1869	.. .. ..	*Dinornis robustus:* Owen, Trans. Zool. Soc. vol. 6, pt. 8, 495-96, pl. 88.
		Dinornis robustus: Owen, *ibid.*, 497. Invalid nomination of a type.
1869	May	*Palapteryx ingens:* Haast, Trans. N.Z. Inst., 1, 84 (No. 8). Type of *D. potens* Hutton, 1891.
		Dinornis robustus: Haast, *ibid.*, 88, (No. 21).
1875	July	*Dinornis ingens:* Hutton, Trans. N.Z. Inst., 7, 266.
		Dinornis robustus: Hutton, *ibid.*, 279 (table of measurements, Hamilton Swamp).
1891	.. .. ..	*Dinornis robustus:* Lydekker, Cat. Foss. Birds, Brit. Mus. 233 (bottom of page).
		non ? *Dinornis robustus:* Lydekker, *ibid.*, pp. 239-240, *(= torosus).*
1891	November ..	*Dinornis robustus:* Hutton, N.Z. Journ. Sci., new issue, vol. 1, No. 6, 247.
		Dinornis potens Hutton, *ibid.*, p. 247. Founded on leg-bones from Heathcote in Canterbury Museum (not identified 1939 G.A.).
1892	May	*Dinornis robustus:* Hutton, Trans. N.Z. Inst., 24, 112.
		Dinornis potens: Hutton, *ibid.*, 115.
1895	October ..	*Dinornis robustus:* Parker, Trans. Zool. Soc. 13, pt. 11, p. 375.
1896	June ..	*Dinornis robustus:* Hutton, Trans. N.Z. Inst. 28, 633. (Bones from Kapua.)
		Dinornis robustus: Hutton, *ibid.*, 645. (Bones from Enfield.)
1907	November 12	*Dinornis ingens:* Rothschild (part), Extinct Birds, 193.
1930	.. .. ..	*Dinornis ingens:* Oliver (part), New Zealand Birds, 39.
1933	.. .. ..	*Dinornis ingens:* Lambrecht (part), Handbuch der Palaeornithologie, 138.

Dinornis robustus was founded on a femur and a metatarsus from the South Island (Proc. Zool. Soc. 1846, p. 48, Table of Admeasurements). In 1869 (Trans. Zool. Soc. 6, p. 497) Owen referred to a tibia as the "type of my *Dinornis robustus.*" This tibia, however, was not part of the original material on which the species was proposed; it cannot therefore be selected as the type, and as no bone has since been selected (though Lydekker *referred to* the metatarsus as the type), I now designate the metatarsus as *lectotype.* The present locale of the type specimen is unknown.

D. potens was stated by Hutton to be smaller than *robustus,* but in so describing it he was comparing it, not with Owen's type, but with a larger bone which Owen afterwards referred to as *robustus.* Actually the metatarsus of *potens* is a little larger than the type of *robustus.* The type of *potens* is a set of leg-bones from Heathcote originally described (as *Palapteryx ingens)* by Haast in 1869.

Of this species and its North Island size-fellow one can only repeat what was said in comparing *torosus* with *novae-zealandiae;* that, while specimens of the same size are found in both islands, the South Island form ranges to greater height (Table N) and has the tibia usually, and the metatarsus almost always, relatively stouter and with more expanded distal metatarsal trochleae. The best skeleton known of it is the Tiger Hill specimen in the Yorkshire Museum; excellently preserved, though not quite complete, individual skeletons have already been recovered from the Pyramid Valley swamp. The types of *potens,* also an individual bird, cannot now be identified. *D. robustus* has been found in the South Island from Nelson to Otago.

Dinornis maximus Haast, 1869.

1846	December 28	*Dinornis giganteus:* Owen, Trans. Zool. Soc., 3, p. 320, Table opp. p. 328, pl. 45 (as *gigas*).
1858	September 28	*Dinornis robustus:* Owen, Trans. Zool. Soc., 4, pt. 5, p. 163, pl. 47, figs. 2, 3 (labelled *giganteus*).
1867	.. .. ..	*Dinornis maximus* Owen, Proc. Zool. Soc. for 1867, No. 57, 891; *nomen nudum.*
1869	May	**Dinornis (maximus, Owen?)** Haast, Trans. N.Z. Inst., 1, 87 (2nd edn. 1875, 28). TYPE: femur, tibia and part metatarsus of individual bird from Glenmark Swamp in Canterbury Museum; part of the same individual skeleton as types of *D. maximus* Owen.
		Dinornis giganteus: Haast, *ibid.*, 88, No. 20 (2nd ed. 1875, 29).
1869	June 1 ..	**Dinornis maximus** Owen, Trans. Zool. Soc., vol. 6, pt. 8, 497-500, pls. 89-90. Type: femur, tibia and metatarsus of an individual skeleton from Glenmark Swamp, at that time in the possession of Major J. Michael; casts in the British Museum (A. 161, Lydekker, p. 231) and Auckland Museum. See type of *D. maximus* Haast, *supra.*
1870	.. .. ..	*Dinornis maximus:* Haast, Proc. Zool. Soc. for 1870, No. 4, 53-56.
1879	.. .. ..	**Dinornis altus** Owen, Extinct Birds of New Zealand, 361 (dimensions in table on p. 253), pl. 79, fig. 4. Type: left metatarsus from the South Island in the British Museum (No. 35832, Lydekker, p. 233).
1891	April 14 ..	*Dinornis maximus:* Lydekker, Cat. Foss. Birds Brit. Mus. 229.
1891	November 13	*Dinornis maximus:* Sharpe, Cat. Ost. Vertebr. Mus. Roy. Coll. Surg., London, III, 425.
1891	November ..	*Dinornis altus:* Hutton, N.Z. Journ. Science (new issue), vol. 1, No. 6, 247.
		Dinornis maximus: Hutton, *ibid.*, 247.
		Dinornis validus Hutton, *ibid.*, 247. Established on average measurements; type designated in synonymy of *D. validus* in next paper (Hutton 1892), i.e. individual skeleton from Glenmark Swamp in Canterbury Museum (No. 20 of Haast, Trans. N.Z. Inst., vol. 1, p. 88).
1892	May	*Dinornis altus:* Hutton, Trans. N.Z. Inst., vol. 24, 109.
		Dinornis maximus: Hutton, *ibid.*, 109.
		Dinornis validus: Hutton, *ibid.*, 111.
1895	October ..	*Dinornis maximus:* Parker, Trans. Zool. Soc., vol. 13, pt. 11, 374.
1896	June ..	*Dinornis maximus:* Hutton, Trans. N.Z. Inst., vol. 28, 632. Kapua.
		Dinornis maximus: Hutton, *ibid.*, 646. Bones from Enfield.
		Dinornis maximus: Hutton, *ibid.*, 652. Skeleton from Riverton.
1899	.. .. ..	*Dinornis maximus:* Andrews, Geol. Mag. (4), 6, 395.
1907	November ..	*Dinornis maximus:* Rothschild, Extinct Birds, 192.
		Dinornis altus: Rothschild, *ibid.*, 192.
		Dinornis giganteus: Rothschild (part), *ibid.*, 193.
1930	August ..	*Dinornis maximus:* Oliver, New Zealand Birds, 38.
1933	.. .. ..	*Dinornis maximus:* Lambrecht, Handbuch der Palaeornithologie, 137.

Through delay in publishing a valid proposal of his *Dinornis maximus,* Owen forfeits to Haast the authority for this name. The original proposal, in Proceedings Zoological Society 1867, was a *nomen nudum,* and Owen's full description in Transactions of the Zoological Society (1869) appeared in the month following Haast's notice of the bones of a leg under Owen's name. Haast, apparently, had received word of the proposed name by letter from Owen. Curiously, both proposals were made on the basis of parts of the same individual bird, as explained by Haast in Proc. Zool. Soc. 1870, pp. 53-56. Haast's types are preserved in the Canterbury Museum. Owen's types were at the time of their description the property of Major J. Michael; according to Sir W. L. Buller (1888, p. xxiv) they were later in the Madras Government Museum, but I have been recently advised that they are not represented there now. There are casts of them in the British Museum (A.161; Lydekker, 231) and the Auckland Museum (A.M. 385). Buller (loc. cit.) stated that Haast's types were in his (Buller's) own private collection, but it is unlikely that he would have secured bones collected "on behalf of the Canterbury Museum"; moreover, he describes them as "The corresponding right leg . . . with the phalanges complete," whereas Haast records only a right femur, tibia and part metatarsus which is what the Canterbury Museum now possesses. Their dimensions are slightly less than originally given by Haast and accord more with those recorded by Owen for his portion of the skeleton; this is no doubt due to shrinking, which certainly occurs, as I have ascertained by remeasuring the Pyramid Valley bones after a few months' interval.

D. maximus is well represented by individual skeletons, especially from North Canterbury, which has yielded the type (Glenmark) and six skeletons recently from the Pyramid Valley swamp. The latter, though not complete, are in excellent condition; they present a wide variation, not only in size of the legs (Table O), but in their proportion also, and in the form of the pelvis.

The usual pelvic formula is: 28-35 (36-38) 39-46, with 39 to 41 sending their transverse processes to brace the hinder border of the acetabulum; in 39 the process is sometimes short and fails to join up with 40 and 41. In C.M. xiii b the process of 39 was abbreviated on the left side and complete on the right.

Distribution. *D. maximus* has been recorded only from Canterbury, Otago and Southland, but as the slightly smaller *D. robustus* is known from Nelson (A.M. 353) and Greymouth (Hutton, 1892, 113) it is not unlikely that *D. maximus* also ranged to the West Coast, unless the wetter climate of that area acted as a check to its distribution.

The tall species of *Dinornis* have been credited with attaining a height of 12 feet or more; but the Riverton skeleton of *D. maximus,* as mounted in the British Museum (Andrews 1899), is only 8 feet 6 inches high, and on the same basis (height = 1.54 times total length of leg-bones), the tallest specimens would hardly have exceeded 10 feet, in normal walking height, though they may have been able to reach higher.

EGGS.

Moa egg-shell has been frequently collected, but complete or nearly perfect eggs are few. The shell is very thin in comparison with that of the ostrich or *Aepyornis;* it is formed of two layers, a thin inner series of vertical prismatic columns and a thicker outer layer of horizontal laminae (Hutton 1872a). The surface is smooth, cream in colour and pitted with small round punctures or with larger slit-like pores. Pale green egg-shell has also been found (Hutton 1876, 101, and White 1886, 84).

Prior to the discovery of complete eggs, Mantell had fitted fragments together and provided Owen with material for the description of the egg of *"Dinornis crassus"* (Extinct Birds 1879, p. 318, pl. CXV). It is not at first sight clear as to where this restored egg was found. From the statement in "Extinct Birds" it might be understood that it had been put together by Owen himself from the Waingongoro (North Island) collection sent to England by Walter Mantell in 1848. In plate CXV, however, the restoration appears to consist of over 40 pieces, yet Mantell had collected no more than 36 (G. A. Mantell 1851, p. 121, p. 487, Appendix B) and these were referable to three different species. Even allowing for further breakages in the attempt to fit the pieces together, it is incredible that all the fragments found should fit together perfectly and without hiatus. Owen's further remark (p. 318) should be noted: "Such was the degree of knowledge of the egg-characters of *Dinornis* to which I had got in 1856." This was a year after Walter Mantell visited England and unpacked his Awamoa (South Island) collection in Owen's presence. Writing of this in Trans. N.Z. Inst. 5, 96, Mantell said: "The fragments of egg-shell . . . . after careful washing, I had sorted and having, with some patience, found the fragments which had originally been broken from each other and fitted together, I succeeded in restoring at least a dozen eggs to an extent sufficient to show their size and outline. Six or seven of the best of these I gave to the British Museum after their purchase of the collection . . . ." From the above it would appear that the restored egg described by Owen was from the South Island locality Awamoa; it agrees in length with the other Otago eggs whose dimensions are recorded in Table 19, but its greater diameter does not necessarily mean that it is of a different species (cf. the different diameters of the Doubtless Bay eggs in Table 19). From the Pyramid Valley swamp comes an egg definitely of *Emeus crassus;* it was found lying between the pelvis and sternum of a skeleton of that species.

The Auckland Museum has a collection of egg-shell made by the Hon. W. B. D. Mantell. Although it is labelled "Ruamoa 1852, Duplicate Type collection" in Mantell's handwriting, it is clearly the Awamoa collection which he stated (Trans. N.Z. Inst. 5, 96) to have been "still in my ownership somewhere in England" after he had given certain specimens, including the egg described by Owen, to the British Museum. The covering label includes a letter A. B. C., etc., for each of the twenty-four varieties stated to have been identified, though there are a few extra lots of actual shell. Many of the pieces are stained with ashes, pointing to their having, as Mantell said, come from oven remains. While there certainly are twenty-four *sets* of shells, many with the pieces carefully fitted together by Mantell, I cannot identify more than three *types* of shell:—

1. Thick, usually over 1.3 cm. though pieces only 1.1 cm. thick occur, with the air-pores appearing as coarse slits sometimes so close together as to give a surface like pig-skin.

Table 19. Dimensions of Moa Eggs.

	Condition.	Dimensions.	Species attributed to
Awamoa, South Island. 1852—W. B. Mantell. British Museum. Owen, Extinct Birds, 318, pl. 115	Imperfect	192 x 152 (79)*	*Emeus crassus* *Eu. gravis* or *P. elephantopus*
Kaikoura, South Island. 1859—Fyffe. Rowley Coll. Rowley, Orn. Misc. 3, 244, Owen, Ext. Birds, 318, pl. 117	Perfect	253 x 178 (70.5)	*Dinornis robustus*
Cromwell, South Island. 1866—Dominion Museum. Hector, P.Z.S. 1867, 991	Broken	226 x 155 (69)	*Emeus crassus* or *Eu. gravipes* or *P. elephantopus*
Molyneaux River, South Island. 1901—Otago Museum. Benham, T.N.Z.I, 34, 149	Perfect	195 x 135 (69)	"
Molyneaux River, South Island. 1901—Tring Museum. Benham, T.N.Z.I., 34, 150	Perfect	201 x 138 (69)	"
Miller's Flat, South Island. 1911—Gibson. Otago Museum. Oliver, N.Z. Birds, 32	Perfect	200 x 138 (69)	"
Wairau, Marlborough. 1939—J. Eyles. Dominion Museum.	Broken	194 x 139	"
Pyramid Valley, South Island. 1939—Canterbury Museum.	Restored	179 x 134	*Emeus crassus*
Doubtless Bay, North Island. 1900—Matthews. Auckland Museum. Archey, Rec. Auck. Inst. Mus., 1, no. 2, 113	Perfect	120 x 91 (76)	*Eu. curtus*
Doubtless Bay, North Island. 1900—Matthews. Auckland Museum. Archey, Rec. Auck. Inst. Mus., 1, no. 2, 113	Imperfect	120 x 97 (80)	"
Doubtless Bay, North Island. 1940—Deeming. Auckland Museum.	Broken		"

*Percentage : width to length.

2. Thinner, 1.0 to 1.3 cm., with fewer much finer slits so closed in as almost to disappear, with here and there a few larger circular pits.
3. Less than 1.0 cm. thick, with much finer, more sparsely scattered punctures. Occasionally types 1 and 2 have been put in a single box; there is no statement that they were supposed to comprise pieces from the same egg, but a few pieces fitted together by Mantell show fine markings in one place and coarse markings in another.

There is no green egg-shell (Hutton 1892); all pieces are cream in colour, except where stained by fire and ashes.

The two Doubtless Bay eggs were referred by the writer (1931) to *Eu. curtus* because their shell was of the thinner, more finely punctured variety of the two kinds found there. I am now able to support this identification through finding (Doubtless Bay 1940) two sets of shell fragments of this type definitely associated with skeletons of *Eu. curtus.* This type of shell may, however, be characteristic of *P. oweni* also. Another egg, which when its fragments are fitted together may prove to be fairly complete, was found by Mr. A. B. Deeming near a skeleton of *Eu. curtus* (A.M. 365), though we could not be positive that it belonged to it. It is approximately 12.5 cm. long and has the thin, fine pitted shell of the earlier Doubtless Bay eggs.

Attention is drawn to Hector's correction (1872, 363) of his previous report (1867, 991-2) that the large Kaikoura egg had been found in a Maori burial place in the hands of a human skeleton: the discoverer of the egg, Fyffe, had advised that this was not the case, but that the egg was found in alluvial soil when digging a few feet below the surface. The Wairau egg, however, was found at the feet of a Maori skeleton together with a *rei-puta* tooth pendant and a "spool" necklace (Andersen 1940, 595). The small hole in it is a man-made perforation; drilled holes in moa egg-shell have also been found by Mr. David Teviotdale.

SKIN AND FEATHERS.

Descriptions of dried skin and feathers have been given by Dallas (1865), Hutton (1872; 1876, 101), Hector (1872b) and Owen (1879, 440). The material has usually come from caves, but well preserved feathers have been found fifty feet deep in river sand (Hutton 1872b, 172). The feathers are typical of the Order in their open structure and lack of barbicels; the aftershaft, when present, is about half the length of the shaft. Three colours have been noted: (a) rufous with a dark central area and a lighter tip; (b) brown at the base, becoming lighter distally, with a white tip; (c) reddish-brown with dark brown medianly towards the apex (Hutton 1876, 101). The likelihood that certain species carried a crest of long feathers on the head has been inferred from pits in the skull by T. J. Parker (1893c); it is noted that one sex only would have been so adorned, for other skulls of the species concerned *(D. robustus, A. didiformis* and *"Mesopteryx* sp. β," i.e. *Pachyornis pygmaeus* of this paper) are without it. *Megalapteryx didinus* had the metatarsus feathered right to the toe (Owen, 1883). The metatarsal skin of *D. robustus,* and pads under the toes, were described by Owen (1869a) and by Hutton and Coughtrey (1875) as being raised into rounded papillae, and a coarse roughening of the neck-skin with elevated conical papillae has been noted in *"E. crassus"* by Hector (1872a).

A. Hamilton (1893b, 487) has recorded the finding of a small piece of skin, which he identified as moa-skin, on an old flax mat in Dr. Hocken's collection; according to Owen (1879, 448) Hector also identified moa feathers on a Maori fish hook *of iron* (!) and on a *taiaha* in the Christy Collection; but after close examination Owen could not distinguish these feathers from those of the kiwi.

TRACHEAL RINGS.

I have no complete sets of tracheal rings, but the following details may be noted. In *Dinornis* the upper rings are compressed elliptical, less compressed in *Anomalopteryx* and still less in *Emeus*. The body comprising the ring is higher and flatter from side to side in *Dinornis;* less high, relatively thicker and approaching the round in transverse section in *Anomalopteryx;* in *Emeus* the body is still very thin in transverse section but is higher than in *Anomalopteryx,* especially in the lower rings. There is a loop in the trachea, as illustrated in Text-figure 13 *(Emeus crassus),* in *Eu. exilis* and *Megalapteryx didinus.*

CLASSIFICATION.

Owen always regarded the moas as belonging to one family, the *Dinornithidae,* in which he admitted two genera, *Dinornis,* supposed to lack the hind toe, and *Palapteryx (D. ingens)* having evidence of its presence. Reichenbach (1852), who proposed a separate genus for each of Owen's species, included *Cela, Emeus* and *Syornis* in the *Casuarinae,* placing the other moa genera with the Ostrich and the Rhea in the *Struthioninae.* In 1874 Haast established the families *Dinornithidae* and *Palapterygidae,* but the distinction between them fails, as all moas are now known to possess a hind toe.

Lydekker (1891a) reverted to one family with five genera, *Dinornis, Megalapteryx, Anomalopteryx, Emeus* and *Pachyornis,* a course independently followed by Hutton (1891b), though with more genera, i.e. *Dinornis* (with sub-genus *Tylopteryx), Palapteryx, Anomalopteryx, Cela, Mesopteryx, Syornis* and *Euryapteryx.*

T. J. Parker (1893b, 1895b) proposed the recognition of three sub-families: *Dinornithinae (Dinornis); Anomalopteryginae (Pachyornis, Mesopteryx* and *Anomalopteryx);* and *Emeinae (Emeus),* but the interpretation of skull characters on which his classification is based, besides being in itself inadequate, has been found to require modification. Later classifications by Forbes (1900) and Rothschild (1907) both accepted the single family, the former recognizing six genera and the latter seven.

Oliver (1930)* introduced a surer basis for classification in his recognition of the paramount distinction between the tall, slender, flat-skulled *Dinornithidae* and the shorter, stouter, round-skulled *Anomalopterygidae;* this arrangement has been followed here, though with modifications as to the differentiating cranial and pelvic characters, and with a different arrangement of genera in the Anomalopterygidae.

DIAGNOSES.

Order Dinornithiformes.

Skull with broad occipital region, large temporal fossae, small orbits and large olfactory cavities; beak wide at the base, broadly rounded or narrow at the tip. Occipital condyle pedunculate, separated by a fossa from the well-defined basitemporal platform; mamillar tuberosities usually prominent, basipterygoid processes well developed; rostrum long, with triangular expansions anteriorly below which fit the maxillary antra, which may be expanded or contracted. Large tympanic cavity overhung by a prominent squamosal prominence with zygomatic process acute or blunt. Postorbital and preorbital processes prominent, the latter formed by the lachrymal notched below to form the inner moiety of the lachrymal foramen, whose outer wall is supplied by the maxillo-nasal. Vomers thin paired vertical plates which may meet anteriorly, divergent posteriorly where they fuse with the palatines below and the pterygoids above; palatines thin vertical plates

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*Buick (1931) and Lambrecht (1933) each followed Oliver, the former adding *D. robustus* for the naive reason that the South Island species of this size ought to be distinct from that of the North Island!

twisted mesad posteriorly to join the vomers and the pterygoids; the latter articulate also with the basipterygoid processes. Premaxilla strong, with elevated nasal process, and with separated processes posteriorly articulating with the maxilla and the palatine : in older, well-ossified specimens the palatine processes extend inward to fuse below the rostrum. Mandible strong, symphysis ridged below and deflected downward.

Vertebrae : 21 cervical, the first six with expanded neural platform, 6 dorsal, 18 pelvic and 11 caudal; the grouping varies in the pelvic region. *Sternum* broad and flat, the body ossified from two centres; pre-costal processes short and broad, lateral (xiphoid) processes long and divergent, median process notched or entire, coracoid facets variable. *Pelvis* broad, especially in acetabular and post-acetabular region, ischia and pubes laterally divergent and separate, though the ischium and pelvis of one side may be fused by bone growth in old specimens. Pectoral girdle when present reduced to small scapulo-coracoid; it is questionable if wing-vestiges persisted.

Limbs heavy : Femur only slightly curved anteriorly, the great trochanter rises above the head, distal end very wide with broad rotular surface and deep popliteal depression. Tibia with expanded cnemial process, and with a bony bridge completing a canal for the extensor tendon. Metatarsus exceptionally variable in length and relative width throughout the order; interosseous canals opening separately on posterior surface and by a single opening in front. A sesamoid bone posteriorly between the tibia and metatarsus; hind toe apparently present in all genera.

Feathers of open structure lacking barbicels; the aftershaft when present about half the length of the shaft.

Family Dinornithidae.

Tall moas with the femur less than, and the metatarsus more than, half the length of the tibia, and with the skull very wide and dorso-ventrally compressed; beak very wide and much downcurved distally. Sternum with the left anterior depression more marked than the right; coracoid facets usually distinctly marked. Scapulo-coracoid present. Nape vertebrae with neural spine single; cervicals with vertebraterial canals laterally compressed. Outer toe five-jointed.

Genus *Dinornis* Owen.

Characters as for the Family.

Six species; the South Island trio distinguished from that of the North Island by the greater relative breadth of the leg-bones, particularly the metatarsus, and by the attainment of greater average height. Three species in each island separated by differences in height.

North Island.	South Island.
D. novae-zealandiae Owen.	*D. torosus* Hutton.
D. ingens Owen.	*D. robustus* Owen.
D. giganteus Owen.	*D. maximus* Haast.

Family Anomalopterygidae.

Shorter and usually stouter moas with the femur more than, and the metatarsus less than, half the length of the tibia, and with the skull less broad and of greater height than in the Dinornithidae. Scapulo-coracoid much reduced or absent; coracoid facet of sternum usually less distinctly marked than in Dinornithidae. Nape vertebrae with bifid neural spine; vertebraterial canals of cervicals not laterally compressed.

Sub family **Anomalopteryginae.**

Outer toe with five phalanges. Skull with pointed beak, maxillary antrum expanded. Sternum short and wide to very wide.

Genus *Anomalopteryx* Reichenbach.

Skull with large temporal fossa; temporal ridge extending high on to roof and backwards to lambdoidal ridge. Beak long and straight; sides of premaxilla slightly concave; mandible large. Antorbitals not diverging widely; basipterygoid processes large, sternum short and moderately wide.

Two species separated by size—

A. didiformis (Owen). Larger, both islands.
A. antiquus Hutton. Smaller, South Island.

Genus *Megalapteryx* Haast.

Legs slender, skull small with small temporal fossa and less stout beak. Temporal fossa of skull small, but reaching back to lambdoidal. Antorbitals diverging widely; basipterygoid processes small. Sternum small, not very wide.

Two species, separated by size—

M. didinus (Owen). Smaller. Mainly South Island.
M. benhami n. sp. Larger. South Island.

Genus *Pachyornis* Lydekker.

Skull with beak narrowing anteriorly to a sub-acute tip, its sides slightly convex. Temporal fossa not so large as in *Anomalopteryx*, extending upwards and backwards, usually not reaching the lambdoidals. Sternum broad with widely diverging lateral processes. Legs stout to very stout; tibia strongly inflected at distal end.

Four species, separated by size and relative stoutness—

P. elephantopus (Owen). Largest and very stout. South Island.
P. pygmaeus Hutton. Smaller, very stout. South Island.
P. mappini n. sp. Still smaller, moderately stout. North Island.
P. oweni (Haast). Smallest, less stout. North Island.

Sub family **Emeinae.**

Outer toe with four phalanges. Skull with small temporal fossa; beak narrow or broad with rounded tip; maxillary antrum slightly reduced or completely collapsed. Sternum narrow.

Emeus Reichenbach.

Skull with swollen supraforaminal ridge; beak narrow with rounded tip; maxillary antrum slightly reduced. Legs moderately wide.

Two species, separated by size—

Em. crassus (Owen). Larger. Both islands; rare in the North.
Em. huttonii (Owen). Smaller. South Island; doubtfully in the North.

Euryapteryx Haast.

Skull with supraforaminal ridge not swollen; beak wide with broadly rounded tip; maxillary antrum collapsed. Legs wide to very wide.

Four species, separated by size—

Eu. gravis (Owen). Largest. Mainly South Island.
Eu. geranoides (Owen). Smaller. North Island.
Eu. exilis Hutton. Still smaller. North Island.
Eu. curtus (Owen). Smallest. North Island.

DEVELOPMENT AND DISTRIBUTION OF SPECIES.

While it is hoped that this study will have thrown some light on the relationships between the families and genera of moas, it is realized that it may still be questioned whether too many or too few species have been admitted, and that the size-limits on which they have been determined are somewhat arbitrary. I have, however, endeavoured to show why any particular course has been followed in the present arrangement.

Fewer species are admitted here than have been previously recognized. It will be remembered, however, that Hutton (1892b) and Rothschild (1907) both found, in the striking external differences between the uniform-sized species of Cassowary, warrant for the recognition of several species within the great range in size and proportions of moa bones. Species of moa marked by external characters may certainly have existed, but distinguishing characters have now to be found in the remains that are left to us, i.e. the skeleton, and it is submitted that both the even and continuous gradation in size and proportionate thickness in a series of any one bone remarked by earlier workers, and the promiscuous and haphazard association of large and small bones in individual skeletons from the same locality recorded in this paper, make it difficult to define limits between many of the species that have been proposed. It will be noted, moreover, that each locality group examined, no matter in what genus, displays the same extent of variation in length and proportion combined with diversity in the association of large and small bones in different individuals, and this, it is held, indicates in each case a group of birds of diverse size living and breeding together; in other words, a natural species. Furthermore, a big range in size is not abnormal in the struthious birds. Lydekker (1895, 558) mentions the male ostrich standing up to 4ft. 10ins. at the back instead of the usual 3ft. 8ins., and the few dimensions I have been able to record in Table P show considerable variation in size and proportion of leg-bones in the emu as well as the ostrich.

Nevertheless a score of species seems in itself a surprising number for one small area to maintain. The possibility that the considerable range in size in species of moa may include overlapping differences in size between the sexes has been discussed in connection with the leg-bones of *A. didiformis* (p. 19). It may be recalled that Hutton (1896c) noted the occurrence of egg shell with the smaller of the two Riverton skeletons of *D. maximus,* and observed that, as the remains appeared from their position to have been of drowned, rather than of sitting birds, the smaller egg-bearing one might be accepted as a female. The supposed smaller size of the female cannot, however, be inferred from the Pyramid Valley remains, for the egg-bearing skeleton of *Emeus crassus* (xiii D) is the fourth largest of that species found in this locality.

The development of so many species of large birds in a relatively small area is, as Hutton (1891b, 148) has expressed it, "a remarkable fact, unparalleled in any other part of the world." Hutton, who recognized more genera than are admitted here, suggested that they might have originated by isolation on separated land areas during a Miocene depression; specific differences, he thought, had arisen "since the formation of Cook Strait, and most of the species must be due solely to variation without isolation."

The distribution of the genera represented in the present classification hardly indicates differentiation on isolated subdivisions of a depressed area, for, with the exception of *Emeus,* they are pretty evenly distributed throughout the whole country. The rare occurrence of *Emeus* in the North Island is curious in that, as interpreted here, it would have been ancestral to *Euryapteryx,* which has a nearly even two-island distribution.

With regard to species-differentiation, it seems clear that the North and South Islands have been two distinct, if not separated areas; witness the small but readily perceptible differences between North and South Island species of *Dinornis,* and the well-defined North and South Island groups of species of *Pachyornis* and *Euryapteryx.* If Cook Strait had been the barrier separating the incipient species it would have contained all the species equally, and each genus would have had approximately equal northern and southern species or species-groups. But the groups are not equal. Excluding *A. antiquus* of an earlier geological period, we find *Anomalopteryx* with Dominion-wide distribution, and, apparently, not divided into inter-island varieties. *Meg. didinus,* a mainly western South Island species (Wakatipu, Westland and west Nelson), extended to the south-western side of the North; on the other hand *Eu. gravis,* common on the eastern lowlands of the South Island, reached the south-eastern side of the North. Apparently the barrier between the islands was neither complete nor indiscriminate as a water barrier should be for a flightless bird; it is not even an old barrier, having been formed, according to King (1939), by lateral displacement as recently as late-Pliocene times.

A dominant topographical feature of much longer standing in this region is the main mountain divide which ran through the narrow isthmus connecting the two islands; this, it is suggested, could have provided a semi-pervious, selective barrier to moa distribution. Thus it would have been more readily traversed by the tall, active species of *Dinornis,* and by *Anomalopteryx,* which seems pretty definitely to have favoured hilly country; on the other hand the mountain isthmus would have been less frequented by the heavier forms, *Emeus, Pachyornis* and *Euryapteryx,* and this would explain the more strongly differentiated inter-island groups of species in *Pachyornis* and *Euryapteryx;* finally the western upland South Island species *Meg. didinus* would have been kept to the west of the North Island, and the eastern lowland South Island species *Eu. gravis* could have reached the North Island's south-eastern shore.

The outstanding developmental trends in the moas were the attainment of great height in *Dinornis,* the southern concentration of massive forms in *Pachyornis* and *Euryapteryx,* and markedly continuous variation both in size and proportional width of leg-bones between the species of one genus. Hutton more than once commented on the difficulty of distinguishing between the leg-bones of *crassus* and "elephantopus" (= *Eu. gravis);* but this difficulty becomes less puzzling with the recognition of parallel development of stout legs in *Pachyornis* and *Euryapteryx.*

Hutton (1891, 149) considered this continuous variation to have been due to an abundance of food, absence of carnivorous mammalian enemies and a resulting inoperation of natural selection, i.e. failure to eliminate intermediate forms. Oliver (1930), having regard to the direction of species-evolution, has instanced it as an example of orthogenesis, i.e. "the multiplication of species . . . not so much due to chance variations . . . fixed by natural selection as of a quality innate in the stock which causes the organisms to continue development along certain lines" (p. 29).

I should be satisfied with the term orthogenesis as a purely descriptive one, provided the suggestion of an innate quality or automatic runaway process is eliminated from it. Evidence for the theory of orthogenesis is usually found in the progressive specializations found in fossil sequences, e.g. Tithanotheres and sabre-toothed tigers (Wells, Huxley and Wells, p. 482, 485), creatures whose living conditions are known only inferentially and by no means in detail. On the other hand, we have little difficulty in relating the structural specializations of Recent animals to particular environmental conditions, as, for instance, the great size of pachydermatous mammals to the fat pastures which they range. In these cases, it may not unreasonably be supposed that the attainment of a certain size had conferred some degree of immunity from attack by carnivores, and that elimination, or limitation, of this controlling factor had left the creatures free to attain whatever size the abundance of food made possible. The moa also enjoyed a plenitude of food and, through isolation, immunity from attack, and it is in these environmental conditions rather than in supposed innate orthogenetic forces that we may find the likely cause of their attainment of inordinate bulk. Oliver does consider environmental factors

(p. 30), suggesting that isolation in different environmental regions had been a condition of differentiation of species. I would again agree that differentiation may be related to the geographical regions, upland, lowland and coastal, but am unable to see, in the ill-distinguished species of moa, the effect of isolation. If there is one thing clear about the moa it is that the limits between species are not clear, and this to the writer suggests varied environmental conditions without complete isolation.

It may be questioned whether climate was a direct differentiating factor, though no doubt it operated indirectly. If it had operated directly, a larger moa population might have been expected in the warmer North, whereas it is the colder South Island that seems to have supported the greater numbers. Relative humidity might have been a direct influence : the eastern side of the South Island, where apparently the moa was most numerous, is the driest part of New Zealand, and in this connection it will be remembered that the struthious birds elsewhere favour arid, or at least dry, conditions. Climate and topography together, however, have produced marked differences in plant covering in different areas of New Zealand, and the dense forests of the North Island stood in marked contrast to the extensive open grasslands of the South. It was in the latter that the moa abounded, particularly the massive forms whose ungainly bulk would probably have caused them to favour the lowlands, leaving the higher tussock and scrub country to the more slender species, e.g. of *Anomalopteryx* and *Megalapteryx,* and probably of the tall *Dinornis* also, despite the latter's frequent occurrence in swamp deposits. The marked variation in the stoutness of the limbs, together with the progressive shortening of the metatarsus in the heavy species, is obviously connected with locomotion, and seems inevitably to be related to ponderous progression along the lowlands rather than to active roving over the hills. And might we not here find a possible explanation of the large temporal fossa and mandible in *Anomalopteryx* and *Dinornis,* much larger than in the species of *Emeus* and *Euryapteryx,* which would have found softer pasture in the lowland swamps? A further possibility is that the collapsed maxillary antrum cavity in *Euryapteryx* is the outcome of a swamp habitat; but its expanded condition in *Pachyornis elephantopus,* and its reduction in the plains-dwelling *Rhea* (T. J. Parker, 1895b, 403), stand against this explanation.

In Africa, Australia and South America, the struthious birds were, and still are, in competition with predatory mammals, and were thereby restricted to one type of habitat and to one line of bodily development, which included the retention of a measure of speed. In New Zealand the moa suffered no such restriction, and was therefore able to exploit a wider range of habitat and correspondingly to develop a greater variety of physical forms.

PHYLOGENY OF THE DINORNITHIFORMES.

Turning from developmental trends within the Dinornithiformes to the phylogeny of the order as a whole, we encounter a group of problems inherent in the evolution of birds and reptiles and the origin of flight, subjects which, in recent years, have engaged the attention of several writers.

Four inter-related problems present themselves:

1. Are the moas, kiwis, ostriches, rheas, emus and cassowaries of monophyletic origin, or has each group evolved independently by degeneration from flying birds?
2. Are they really degenerate fliers, or have they never attained flight at all?
3. How, in this connection, did flight arise: was it from an arboreal, air-planing pro-avian reptile, or from a swift cursorial form with an "air-rowing" fore-limb?

4. Following this, to the ancestors of which reptilian order are we to look for the fore-runners of birds?

P. R. Lowe (1928a, 1935, etc.) and G. Heilmann (1926) agree in finding the closest resemblances to birds among the theropodous dinosaurs, particulary the Coelurosaurs; both also find the possible common ancestors of birds and Coelurosaurs in the Pseudosuchia or further back in the Eosuchia.

Nopcsa in 1907, and again in 1923, put forward the view that birds had evolved from "bipedal, long-tailed cursorial reptiles which, during running, oared along in the air by flapping their free anterior extremities." He pointed out that planing fliers utilise a patagium which must extend between fore and hind limbs, a condition incompatible with the bipedalism of birds; he noted that the Dinosaurs, which he regarded as the ancestors of birds, were primarily and solely bipedal; and he submitted that the free dorsal vertebrae, the long narrow pelvis, and the fused metatarsals of the Dinosaurs, *Archaeopteryx* and struthious birds are not only primitive basic characters, but also those associated with the swift cursorial habit that ultimately led to flight. Heilmann (1926) considers that the proavian was an arboreal air-planing creature. Like Nopcsa, he sees in *Archaeopteryx* many proto-avian features, but not evidence of a cursorial habit: instead he regards the structure of its fore-limb, especially the free prehensile pollex and, in the foot, the long opposable hallux, as proof of arboreal habits. He is unable to accept Beebe's (1915) feathered Tetrapteryx planing stage, partly because he cannot discern the pelvic wings in *Archaeopteryx* or in the chicks he has investigated of certain species, and partly because he believes, as Nopcsa held for a patagium, that it would be ill adapted for the bipedal habit of *Archaeopteryx*. It may be relevant to note here that while we have no instances of the cursorial habit giving rise to flight in other vertebrate groups, there are examples of both planing and true flight in arboreal reptiles and mammals.

Lowe's primary study (1928a and 1935) is the relationships and phylogeny of the Ratites, and although he necessarily considers the ancestry of birds he does not directly discuss the origin of flight. His investigations have led him to the conclusion that the Struthiones, as he prefers to call them, are not only of monophyletic origin, but that they diverged from the proto-avian stem after the acquisition of downy feathers which conserved heat and raised body temperature, but before flight had been attained. He thus regards the Struthiones as an early offshoot, specializing in cursorial locomotion, from the ancestral stock. He also considers that Penguins are another early independent pre-volant specialization, this time for an aquatic life.

Lowe adduces evidence from many aspects of bird structure and habit in support of his conclusions, and includes, as relevant to the question of the primary flightlessness of the Struthiones, a discussion of characters held to indicate the primitiveness and the phyletic unity of the group. He cites as primitive characters the delayed union of the cranial sutures, the palaeognathous palate, the large basipterygoid processes, the form of the quadrate and the non-development of a pygostyle; and he presents, as characters found only in the Struthiones and indicating their common relationship, the intestinal caeca opening together into the rectum*, the lack of a tufted oil-gland, the perforation of the accessory femoro-caudal muscle by the sciatic nerve (Garrod, 1873, 643), the nesting habits and the habits of forward kicking and of falling forward on the breast, producing thereby a sternal callosity.

It is, however, in the distribution and structure of the feathers and the condition of the pectoral girdle and wing that Lowe finds chief support for the view that the

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*Owen (1879) describes them as opening separately in Apteryx; this condition also obtained in a specimen which Mr. E. G. Turbott kindly examined for me recently.

this, we submit, is a wrong emphasis, for the first metacarpal was free in only two out of seven specimens illustrated by Parker, and metacarpals II and III were fused in them all: the important thing is that all the Struthionids, including *Apteryx*, have the metacarpals normally fused, which would seem to be an unnecessary keying-up (to use Lowe's term) or integration of the manus bones for simple air-rowing.* A further point, this time in connection with the penguins, also regarded by Lowe as derived from pre-volant pro-aves: the flipper bones in penguins are fused as in a wing; but in no other vertebrate paddle, mammalian or reptilian, are the limb-bones so fused, and the only reason for fusion in the penguins would seem to be a former functioning of the limb as a wing.

Lowe affirms that the Struthionids lack a pygostyle, or have it developed just sufficiently for cursorial requirements; but one wonders how the tail would have become shortened at all in cursorial pre-volants when even the primitive flying *Archaeopteryx* had a long tail, and when, judging from the Coelurosaurs, the Kangaroos, and Frilled Lizards, an exceptionally long tail seems to be a requirement of cursorial bipedalism. In any case there is a definite pygostyle in the moas, as in other ratites, and Gregory's understanding of the shortened tail in this group as typically rhipiduran and carinate-derived seems amply warranted.

I am unable, however, to follow Dr. Gregory when he questions the validity of Lowe's derivation of the neognathous palate from the palaeognathous: he cites thereon only our ignorance of the palates of *Archaeopteryx* and Cretaceous birds, and makes an unsupported suggestion that the evolution of these parts might have proceeded in the other direction, with the tinamous representing the first stage of the loss of the schizognathous condition. On the other hand he makes no reference to the positive evidence quoted by Lowe from Pycraft*, who not only indicates (1900), in the comparative morphology of the palate in the Ratites, the possible stages of the change from the simple palaeognathous to the neognathous condition (by the palatines extending across the vomero-pterygoid junction), but also demonstrates (1898, p. 973) this to have taken place in the development of the penguin, and further notes (p. 975) that "this (palaeognathous) condition obtains more or less perfectly for a short time in the life-history of many, if not all, Carinatae."

I have wondered whether the point is of prime importance here, unless one were concerned to deny the phyletic unity of the Struthiones, for it is conceivable that the ratites might still be primitive in many respects although derived from an early volant stock. Gregory does not discuss Lowe's evidence for the phyletic unity of the Struthiones, an aspect which seems to be of some importance as implying an early divergence of the group as a whole from proto-carinate ancestors.

In a discussion following Dr. Gregory's paper, Dr. Robert Cushman Murphy contests the conclusions drawn by Lowe from details of feather-structure in the ratites. He cites the mutant poultry strain known as "silky-fowl," in which the feathers "show similar peculiarities to those of ostrich-like birds," as indicating that the struthious feather may be a simplified form of the normal carinate hook-barbed feather. He also refers to the inference by Davenport (1906) that all struthious feathers are mutants of ordinary feathers. One imagines that Lowe's reply would be that they might just as reasonably be regarded as a mutant reversion to a primitive condition; but he makes no reference to Gregory and Murphy's paper in the restatement of his views in the Ibis for 1935.

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*Heilmann (p. 29) draws attention to the partial interlocking of metacarpals II and III in Archaeornis; and Nopcsa (1907, 235) regards fusion of the carpal elements as a requisite for flight.

*Pycraft's papers are, however, included in the list of "Literature Cited."

Struthiones have never attained the power of flight. As to the feathers, he holds that, in their more uniform distribution with small embryonic apteria, and in their individual structure, i.e. their lack of interlocking hamuli or barbicels, their entirely non-pennal nature, the corresponding absence of the teleoptylic phase of carinate birds and the well-developed aftershafts, we see, not the results of degeneration, but, instead, a primitive pre-volant condition such as is found in the chicks or juveniles of carinates.

In like manner Lowe interprets the shoulder-girdle and fore-limb of the struthious birds as primitive. He agrees that wing-degeneration and even loss *(Dinornis,* etc.) have occurred, but not necessarily from a volant ancestor; he instances the reduced and compacted fore-limb of the coelurosaurs *Struthiomimus* and *Ornitholestes* as indicating the type of "air-rowing" fore-limbs that might be expected to develop among primitive birds in association with swift cursorial progress; he points to the similarity of the broad coracoid and the very wide scapulo-coracoid angle in bipedal dinosaurs and struthious birds; he also quotes the instance recorded by T. J. Parker (1892) of a free first metacarpal in an *Apteryx* wing, interpreting this as being homologous with the free metacarpals of the cursorial Coelurosaurs; finally he draws attention to the early appearance (Eocene) and wide distribution of ostriches as further evidence for the primary and primitive status of the struthionids.

Lowe's conclusions have been contested by Gregory and Murphy (1934) who accept as essentially right the older view that "the ratite birds are the, in some respects degenerate, in others specialized, descendants of proto-carinate ancestors." Gregory and Murphy have met most of the points raised by Lowe, but not all; hence the following comments which it is hoped will not further confuse an already intricate issue.

With regard to Lowe's belief that the early (Eocene) appearance of Struthionids discounts the likelihood of their being derived from carinates, Gregory cites *Hesperornis,* of undoubted carinate ancestry, which nevertheless had already in the Cretaceous lost the sternal keel and all of the wing except a long, fragile, functionless humerus. Lowe considers that the undivided condition of the coraco-scapular bar in the developing ostrich embryo typifies a primary reptilian-derived condition, homologous to that found in such primitive reptiles as *Euparkia* and *Ornithosuchus,* and includes in this morphological comparison "not only the Ostrich but . . . the rest of the Palaeognathae, not to mention such primitive avian and flightless types as *Diatryma* in which we get a similar fusion of these two bones." He refers to W. K. Parker's studies (1868) which show the bar undivided in the embryo ratites, but divided in the embryonic carinates, but Gregory regards this difference as a normal embryonic foreshadowing of the adult condition and of no special phylogenetic significance. As to *Diatryma,* Matthew and Granger (1917, p. 319) classified it as euornithic and related to the modern *Cariama* of South America, and Gregory draws attention to the import of this struthionic shoulder girdle with a wide scapulo-coracoid angle in a carinate-derived flightless bird.

Gregory also challenges Lowe's claim that the Struthionids never had a sternal keel and that the pectoral girdle is primitive by referring to Heilmann's (1926) identification of the sternal crest with the primitive reptilian episternum or interclavicle which the Struthionids have certainly lost; he asks how the embryonic ostrich pectoral girdle can be regarded as primitive in the complete absence of paired clavicles and an interclavicle?

Turning to the wing, Gregory contrasts the complete fusion of the metacarpals in the ostrich and other ratites with the quite distinct fingers in the bipedal Coelurosaurs with which Lowe seeks to establish relationship. Here we may recall Lowe's citation, mentioned above, of the record by Parker of an occasional free first metacarpal in *Apteryx;*

It should not be forgotten that it is just as much an inference to say that struthious feathers are degenerate as to say they are primitive: moreover the evidence on this point is by no means unequivocal. On the one hand we have the points raised by Murphy and on the other the evidence adduced by Lowe, but not discussed by Murphy, from Chandler (1906)* and Ewart (1921), that the double-shafted condition of the struthious feather is primitive and is to be seen also in the neossoptile phase of flying birds whose adult feather is a specialization of one of the two primary shafts. Lowe urges, therefore, that, if the struthious feather had reverted, by degeneration, to a primitive bipartite condition, there should be some "vestigial" evidence of this degeneration.

The problem involves not only the general question as to how much can be lost without trace in degenerative evolution, but the more particular one as to whether feather-degeneration from the carinate towards the struthious condition can, or does, occur in association with the loss of flight. Lowe himself has presented some evidence on this point, but his interpretation of it as supporting his own view is difficult to accept.

The Inaccessible Island flightless Rail *Atlantisia rogersi* exhibits a less highly developed condition of barbule hooklets than an ordinary Rail, e.g. *Rallus.* "What we actually find in fact is a phase of evolutionary development more or less half way between the down barbule and the volant barbule" (Lowe 1928b, 107). Lowe suggests that this condition may be, not secondary due to degeneration accompanying loss of flight, but primary; i.e. that *Atlantisia* had never acquired the power of flight, and that *Ocydromus* (i.e. *Gallirallus), Aptornis* and *Diaphorapteryx* might be, or have been, in similar case! Lowe promises some "evidence derived from the ontogeny of the wing which seems to point to the conclusion that the rails, as a group, may in the past have been slow to acquire the power of full flight, or even of flight in moderate perfection, while some like the fossil forms mentioned may never have acquired it at all." In the meantime, however, we may remember that *Atlantisia* and *Gallirallus, Aptornis* and *Diaphorapteryx,* have typical, though reduced, volant wing-structure, a distinct sternal keel, and, in the living forms, development in no inconsiderable degree of feather hooklets. The difficulty in understanding the supposed partial and non-functional acquisition of these features in members of a typically volant order reverts our attention to the older explanation of degeneration and to the possibility, even the likelihood or inevitability, of partial or complete loss of structures associated with varying degrees of disuse.

In brief we find in the struthious birds the palaeognathous palate with other skull-characters and the double-shafted feather signifying a primitive status; we also observe certain characters (lack of tufted oil-gland, relations of sciatic nerve to accessory femoro-caudal muscles) and habits (nesting, forward-kicking and breast crouching) possessed by all genera and indicating their phyletic relationship. While we can accept these characters as signifying a related group of primitive birds, only one of them, the double-shafted feather, suggests directly, though not inevitably, that the group is primarily flightless. On the other hand we cannot overlook the fused fore-limb digits: they comprise a vestigial character which, notwithstanding Lowe's advocacy of the relationship of the struthionid to the coelurosaurian fore-limb, is, in the present writer's opinion, explicable only as indicating a former volant function.

It is considered, therefore, that the available evidence indicates:—

(a) That the struthious birds are a related group, related that is through their possession of a primitive palaeognathous palate and certain other characters and habits not necessarily primitive, and

(b) that they are descended from a proto-carinate stock that had gained a measure of flight (cf. Pycraft 1900, 260).

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*I have not had access to Chandler's paper, nor to Davenport's.

It is still not certain, however, whether they had lost the power of flight as a group and had, as flightless birds, become distributed as we now know them, or whether each had independently become flightless in its separate area of distribution. Nor can it be said that any greater certainty invests the question, now to be considered, as to how and when the moas, or the struthious birds in general, attained their present distribution.

ADVENT OF THE MOA; DISTRIBUTION OF PALAEOGNATHAE.

It is not proposed to present a historical resumé of all the discussions on this subject; it will suffice to recall the conclusions in Hutton's important review (1892b) and to refer to other papers as occasion arises.

Hutton (pp. 145-7), after quoting Wallace's view (Island Life, p. 450) that the ratites had spread southward from the Northern Hemisphere, and noting that if this were so the migration into New Zealand must have occurred a very long time ago, put forward the alternative suggestion of a southern origin and distribution of the Australasian ratites. Observing that the Dinornithidae and *Apteryx* still retained the hind toe and a primitive unspecialized pelvis with separated ischia and pubes, he suggested that they might stand nearest to the ancestral type, and that the ancestors of *Dromaeus* (= *Dromiceius*) and *Casuarius* had reached Australia and New Guinea by a one-way land bridge from northern New Zealand. The ancestors of the moas and *Apteryx*, he thought, might have been South American relatives of the Crypturi that had reached New Zealand by flight while the ratites of America, Africa and Asia probably had had a separate origin from those of Australasia. Hutton did not pursue the latter suggestion.

It will be seen that the factors involved in the problem are those of zoological relationship, space and time. Thus we may endeavour to determine by a study of comparative structure which of the Palaeognathae is most primitive and represents most nearly the supposed ancestral form, and we may consider the areas from which the stock may have been derived, its centre, or centres, of development and means of distribution, together with the geological periods during which alternative migration routes may have been open. We shall probably find the evidence conflicting, and our conclusions may be either a choice between alternatives or an admission that information to warrant even a "judicious speculation" (Tucker 1938) is lacking.

The Ancestral Struthious Type?

Hutton (1892b) derived his conclusion that *Apteryx* and the Dinornithiformes were the least specialized of the struthious birds from their retention of the hind toe and the primitive condition of their pelvis and sternum. Eight years later Pycraft (1900), after an exhaustive study of skeletal and internal anatomy, concluded that *Dromiceius* was the least differentiated of the genera, and, with *Casuarius,* stood nearest to the ancestral stock.

It is chiefly in the grouping of the palatal elements that Pycraft finds primitive characters in *Dromiceius* and *Casuarius* : in these genera the vomer fuses terminally with the anterior end of the pyterygoid, the palatine meeting this junction by a direct, but loose, attachment. The palato-pterygoid connection in *Struthio* is similar, but the vomer is reduced and falls far short of the junction. In the other struthious genera a new factor is introduced by the palatines encroaching ventrally across the vomero-pterygoid junction. Here, then, we have a grouping of *Dromiceius, Casuarius* and *Struthio* typifying the primitive condition, with *Rhea,* the Crypturi, *Apteryx* and the Dinornithiformes exhibiting a development towards the neognathous palate. Pycraft, emphasizing the specialized bipronged anterior end of the pterygoid in *Apteryx,* regards it as standing apart from the other genera; but this condition may well be adaptive, i.e. related to the broadening of all the palatal elements in this genus; moreover, it does not differ greatly from the pterygoid in *Anomalopteryx,* as is shown in Text-figs. 2 and 3, p. 22, both drawn from immature specimens. The difference that does occur is probably merely the result of the vertical twisting of the palatal elements into a subparallel position in *Anomalopteryx.* It is agreed, however, that, with regard to palatal structure, *Dromiceius, Casuarius* and *Struthio* exhibit the primitive or fundamental palaeognathous type, while the other genera have already taken the first steps towards the evolution of the neognathous palate. In two other skull features the grouping of genera is not the same : e.g. *Apteryx* and the Dinornithiformes lack the orbital process of the lachrymal, while the Dinornithiformes and *Rhea* alone possess a distinct maxillo-nasal. These characters may not hold the same significance as the palatal, but they must be considered, together with other structural features.

For instance, the pelvis in *Apteryx,* the Dinornithiformes and the Crypturi, is primitive in respect to the separated ischia, pubes and post acetabular ilia (not *Apteryx).* In *Dromiceius, Casuarius, Rhea* and *Struthio* the post-acetabular ilia are narrow and approximated to one another, and the ischia and pubes are either bowed inwards, or fused medianly or with one another. Pycraft discounts the approximation of the post-acetabular ilia in *Struthio* by noting that they are still held off from the neural spines of the vertebrae by the lateral processes; but they are only just so held apart, and the general form approaches more closely that in *Rhea* than *Dinornis.* The pelvis in *Aepyornis* is primitive, as in *Dinornis;* the palate of this form is not yet known, so its position is difficult to judge. Its skull, however, bears several resemblances to that of *Dinornis* (Andrews, 1896, 382).

It is suggested in passing that the length and narrowness of the pelvis in *Dromiceius, Struthio* and *Rhea* may be related to their more rapid cursorial powers, i.e. that the similarities (which are not exact) may be the result of convergent or parallel development. The significance of the loss of the hind toe (and of the reduction to two toes in *Struthio)* should be noted here, i.e. as conducive to speed, together with that of the retention of the hind toe in *Apteryx* and the moas. With regard to the sternum we find the New Zealand genera standing together in contrast to *Dromiceius* and *Casuarius,* with *Struthio* and *Rhea* equally agreeing and disagreeing with each group and with one another.

Finally, in internal anatomy, the caeca, which Lowe (1928a) stated open into the rectum by a common orifice in all Struthiones, actually have separate openings in *Rhea* (Pycraft 1900, p. 250, fig. 7) and in *Apteryx* (Owen 1879, pl. IV) ; the genera also differ considerably in the relative length of the caeca. In respect to the structural details of the trachea, *Rhea* stands by itself, *Struthio* and *Apteryx* form one group and the Casuariidae another (W. A. Forbes, 1881).

In review it can hardly be said that any one ratite genus retains primitive characters and lacks specialization to a degree entitling it, more than any other genus, to be regarded as approaching the ancestral type, still less to be the form from which the others had actually been derived. It seems hazardous even to suggest an outline of genetic relationship between the genera except to note that *Dromiceius* and *Casuarius* belong to the one order and that there is undoubted affinity between *Apteryx* and the moas. We are, therefore, not really very well equipped on anatomical grounds to formulate conclusions as to the original stock of the struthious birds; indeed the relationship between the South American and Neozelanic genera, if held established on palatal structure, creates distributional difficulties of its own, as will be seen.

The alternatives that present themselves are:—

(a) The survival in the Southern Hemisphere of a widely distributed proto-Carinate stock which became flightless independently in each area.

(b) The origin in the northern hemisphere of a flightless stock which spread by various routes to the southern.

(c) The origin of a flightless stock in one southern area and its distribution by southern routes to others.

As has already been seen, none of the genera can be indicated as an ancestral form, and the indications are towards a polyphyletic rather than a monophyletic divergence from the proto-carinate ancestor.

A northern origin, which might find support in the possible relationship between *Struthio* and the Casuariiformes, and in the Europo-Asiatic occurrence of early Tertiary Struthionidae, would, as Hutton observed, involve a migration to the south prior to the development of placental mammals, prior even to the appearance in Australia of marsupials which would otherwise have arrived in New Zealand with the first ratites. A northern origin is by no means impossible, but it involves also the independent evolution, in two diverging streams (*Rhea* and Crypturi to South America, and *Apteryx* and the moas to New Zealand), of the "proto-neognathous" palatal structure. The latter difficulty is equally inherent in the theory of polyphyletic origin from a surviving southern proto-Carinate stock. The alternative is a diphyletic origin, i.e. an Ethiopo-Australian branch with unmodified palaeognathous palate and a South American-Neozelanic branch with a "proto-neognathous" palate; this would involve the migration of the latter by an antarctic land route either from South America to New Zealand or *vice versa*.

The postulation of such a land connection between South America and New Zealand is not necessary merely to explain the distribution of ratites; it has been upheld by almost every student of southern palaeogeography since it was first suggested by Hooker in 1847, and the evidence for it has been collated more than once (Hedley 1895, Benham 1902b, Chilton 1909, Osborn 1910, and Cockayne 1928). Oliver, however (1925), has reaffirmed the earlier view of a mainly northern origin of New Zealand flora and vertebrate fauna; he holds the Southern Beech, *Nothofagus,* to be barely separable from *Fagus,* which he thinks may itself be represented in the southern hemisphere; he does not admit that the numerous floral resemblances between southern lands include any definite plant associations, considering rather that the relative numbers of such plants as are common to two or more areas indicate periodical trans-oceanic migrations. In accordance with his conclusions as to plant relationship he infers (1925, p. 137; 1930, p. 29) that the ancestors of the moas and kiwis were birds of northern origin which had become isolated here.

As to *Fagus* and *Nothofagus,* it has been recently demonstrated (Cranwell 1939) that these two genera differ considerably in the form and character of their pollen grains; furthermore Cockayne (1928, 413) strongly affirms that plants of subantarctic distribution and character are "no mere waifs and strays, but a definitely systematic and especially ecological group," sharing with the palaeozelanic element "the power for the most part to endure a fair amount of cold," (p. 417), which the Malayan element does not. Skottsberg (1915, 1934, 1935), too, upholds the theory of a Cretaceous or early Tertiary Antarctic flora distributed by land-bridges, not necessarily contemporary, to Australia, South Africa (?), New Zealand and South America. More recently Copeland (1939) has concluded that Antarctica has been the centre of distribution for more than half of the living ferns, and Florin (1940, 92) affirms that "Antarctica has played an important role in the development and distribution of the southern group of conifers."

At least one of these land-bridges, the "Scotia Arc" from Cape Horn to Graham Land, is supported by direct evidence, i.e. by (i), the relationship of Seymour Island (Graham Land) Oligocene plants to Patagonian, Australian and New Zealand living plants (Dusen 1908), and (ii), by the difference between the foraminiferan fauna of the

Weddel Sea and that of the Scotia-Bellinghausen Seas, which Earland (1934, 24) has interpreted as being due to the persistence of this island chain as a continuous land-barrier until comparatively recent geological times. The Seymour Island fossil plants are themselves evidence for a sufficiently mild Oligocene climate for plant and animal life in Antarctica, and local evidence for an early or mid-Tertiary warm period is furnished by the occurrence in Otago of remains of a sub-tropical rain forest, including *Agathis (Agathoxolon)* (Evans 1937) and by warm-water mollusca in Waiheke Beds (Lower Miocene) recorded by Powell and Bartrum (1929).

Land extension in New Zealand occurred in late Cretaceous and earliest Tertiary (Benson 1923), though connections to lands north and south would hardly have been contemporary. It was followed by a long period of depression, but by the time the land rose again (Mid-Pliocene) the climate had become cooler (Powell, 1931, 90) and Antarctica had probably ceased to support much life. There is, moreover, zoological evidence, in the Tertiary and Recent Molluscan faunas and their distribution (Marwick 1926), that Antarctica ceased to contribute to the New Zealand fauna early in the Tertiary.

We may therefore not unreasonably find in the earlier land expansions a means for the supposed distribution of the South American and New Zealand ratites from, or *via,* Antarctica, particularly as these extensions occurred during the most likely period of the origin and development of the group. Whatever the system of land-connections may have been, by elevation and depression, or by Wegener's continental drift, it seems to have brought South America and New Zealand closer together than other southern lands: on this point ratite distribution agrees with floral and other faunal evidence. Marsupial distribution, however, is anomalous, for these animals occur, or have occurred, in South America and Australia; Oliver (1925, 128) suggests that South American and Australian marsupials are not closely related; there is, moreover, strong fossil evidence for northern development and distribution of the group.

Notwithstanding apparent anomalies, what does seem clear is the agreement in the relationships and southern distribution of the South American and New Zealand ratites with what is found in many other groups, and it would seem that a habitable Antarctic continent in late Cretaceous or early Eocene offers a possible, or even likely, area for their origin, or a route for their southern distribution.

DEVELOPMENT AND EXTINCTION.

A long period, almost the whole of the Tertiary, elapses between our hypothetical introduction of the ancestral moas into New Zealand and their first occurrence as fossils, i.e. *Anomalopteryx antiquus* in the upper Miocene or lower Pliocene (Hutton 1893b) and *D. robustus* (= *D. ingens* of this paper) described by Marshall (1919) from Nukumaru (mid Pliocene), to which I can add a characteristic toe-bone of *D. ingens* from a Nukumaruan bed near Hastings. The scarcity of pre-Pleistocene fossils is not surprising, for there are few terrestrial Tertiary deposits in New Zealand, and of the marine only the Nukumaruan was laid down in shallow water. The occasional moa footprints that have been disclosed (see Benham 1913) are of Pleistocene age.

Evidently the genera and species were defined by the Pliocene, but we have no means of determining to what extent differentiation was the outcome of ranging over an extensive, and presumably varied, continental habitat, or of isolation on restricted areas during periods of subsidence (Hutton 1892b). In this connection we may note that no moa remains have been found on the Chatham Islands or on the subantarctic islands that stand as remnants of a former wide extension of New Zealand. These are small areas, however, and have been separated from the mainland long enough for the development of local species of most of the land birds, time enough for considerable geological changes and for the total disappearance of moas if they or their ancestral types had previously existed here. As to later development, Hutton inferred from the number of species he recognized and their classification, that considerable differentiation had followed the separation of the two islands. The present study confirms the inter-island differentiation of species, but points to a mountainous or upland isthmus rather than Cook Strait as the separating feature.

It is clear that the moa existed in large numbers throughout the Pleistocene; its remains have been found in the thick alluvial deposits of the South Island brought down during or immediately following glacial times (Haast 1872b), as well as in the swamp-filled hollows subsequently excavated in them (Glenmark, Haast 1872; Hamilton, Hutton 1875, Booth 1875, 1877; Enfield and Kapua Hutton 1896 a and b); every cave that could entrap a moa seems to have taken its toll, and they have been found in many sand-dune deposits. Notwithstanding this abundance, rapid extinction seems to have been the moa's fate. To what extent was this due to natural causes or to the hand of man?

New Zealand has experienced considerable changes in climate during the whole period of the moa's existence, from the warm early Tertiary to the much cooler Nukumaruan and Castlecliffian which heralded the Pleistocene glaciation. The latter, however, did not necessarily produce a continuous ice-sheet, nor did it extend to the North Island (Marshall, 1910; Speight, 1911). Glaciation was followed by a return to temperate conditions. The moa survived, even flourished, through all these climatic changes, and it would seem that we must look to causes other than climate for its extermination, unless we can discern some factor dependent upon climatic conditions that may have affected it adversely. What light does the mode of occurrence of moa remains throw on this question?

The most prolific sources of moa remains were the South Island swamp deposits. At Glenmark it was estimated that over a thousand birds had been buried, and many hundreds were represented in the remains recovered at Hamilton* and at Kapua and Enfield. In these deposits the bones were free from stream abrasion, but were inextricably mixed together; stones, both small and large, were among them and were considered to include gizzard stones and boulders entangled among roots that had rotted away, the whole deposit being interpreted as an accumulation of moa-bodies (not separated bones) and tree-debris washed in by floods.

Rather different conditions were reported from Te Aute (A. Hamilton, 1889): here, in two instances, while most of the bones were found lying in great confusion, the larger leg-bones were in a vertical position, with the tibia and metatarsus in their natural attitude. Both of these spots were at the end of a spur running into the swamp, and Hamilton confidently inferred a swamp-crossing or passage where birds had occasionally been bogged. An interesting additional point was the "unaccountable absence of skulls and neck-bones." At Waikouaiti legs and feet were similarly found *in situ* by W. Mantell (G. A. Mantell, 1850b).

The Pyramid Valley swamp in North Canterbury now being excavated by the Canterbury Museum has also yielded skeletons with the leg-bones and feet in position as the bird stood, and with the other bones in some confusion above them; in several cases the head and neck were missing. Most of the birds have occurred apart from one another, so that individual skeletons have been recovered. Full sets of gizzard-stones and remains of food are preserved with some, and in one case (C.M. xiiiD) a practically complete egg lay crushed between the sternum and pelvis; this has been skilfully restored by Mr. Edgar F. Stead. Without wishing to anticipate the full report that our Canterbury Museum colleagues will issue on this important site, I may perhaps be permitted to

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*This is not the present North Island town; it is south of Ranfurly, in Otago, and is now called Orangapai.

observe that the conditions so far revealed indicate, not an accumulation of drowned birds as at Glenmark and Hamilton, but the bogging of birds that had ventured on to the swamp, as at Te Aute. The scavenging of hawks or even the attacks of the extinct eagle *Harpagornis* may possibly account for the missing heads and necks in both places.

Related possibly to the Glenmark deposits are the occurrences, reported by Hector (1872a), Murison (1872), Booth (1875), and Pyke (1890) of individual skeletons lying on the surface of the plains in Otago, all either at the level of the old lake terraces, or at a lower level only where streams debouched from the hills on to the present plain. Here again we can envisage flood conditions depositing some bodies on the lake bed near stream-entrances and floating others up to its edge.

Speight (1911) in discussing the post-glacial climate of Canterbury has shown that arid steppe-like conditions in the glacial period gave way to a moist climate or pluvial period which brought down the material for the river terraces and was accompanied by a considerable extension of forest (see also Speight, 1917). This again was followed by modified steppe conditions, with shrinking of forest and extension of tussock-land. The same succession of steppe-forest-grassland has also been disclosed by a pollen-analysis of peats by Miss L. M. Cranwell (1938).

Floods of the post-glacial period may therefore have drowned moas in considerable, though not necessarily catastrophic numbers, for the swamp deposits were probably the accumulation of time. While the floods took toll, especially among young birds, as the remains attest, and probably destroyed lowland breeding areas, the rains themselves may have been to the moas' disadvantage; other struthious birds inhabit arid or semi-arid regions, and, it will be recalled, lack a tufted oil gland, though we have no knowledge about that in the moa. Another adverse factor may have been the extension of the forest during the pluvial period. It is well known that the moa penetrated into the forest—they were entrapped in caves far into the bush; but I take leave to question whether the Maori would have exterminated them if they had lived in considerable numbers deep in our vast forests. Possibly they wandered in in search of food, but bred in more open situations. Bearing on this point, Mr. Norman H. Taylor, of the Geological Survey, informs me that, throughout his soil-survey investigations of the past ten years, he has found moa gizzard stones to be very common in North Auckland, rare in the central area of the North Island, and almost entirely absent from the Rotorua district. Further, in North Auckland, gizzard stones are few where tree-root pits are prominent, especialy where the pits still contain humus indicating recent forest, but on the older open gum-lands where the pits have been smoothed and levelled by long weathering, they are much more numerous.

From food remains secured in the Pyramid Valley swamp, Miss R. Mason (letter 6/4/40) has identified the seeds of matai *(Podocarpus spicatus)* a well-known forest tree, as well as those of *Myoporum laetum, Nertera, Carmichaelia* and *Gaimardia,* plants of the open country or swamp. In connection with this, Miss L. M. Cranwell observes that in the heart of the forest matai seeds occur too high up for moas to have secured them unless they were gathered from the ground, but that they would hang on lower branches of trees on the outskirts of the bush. Mr. C. E. Foweraker, of Canterbury College, advises that matai seeds are common in the swamp itself, and not particularly numerous in the gizzard contents he examined. The chief material in the gizzards was grass, not, however in a condition to be identified. No insect remains could be found.

Hector (1872, 119) mentions bush tracks or passages of suitable size for moas (though one wonders why even only ten years of disuse had not obscured them by re-growth), but even these would not have extended far, and there is strong probability that the moa was a bird of the open scrub and grassland in contrast to the kiwi, which in accordance with its cryptic forest habitat became reduced in size, though suffering less wing-degeneration than the moa.

It is conceivable therefore that in the South Island the combined effect of floods, a wet, though not necessarily cold, climate, and an extension of forest would have been to the moa's disadvantage and reduced its numbers. In the North Island the climate was equally wet; at all events dense forest extended continuously over a great area, the only open districts being the central plateau, where the forest was buried by the Taupo pumice showers, and certain areas in southern Hawke's Bay (letter from Mr. Norman H. Taylor). The moa does not seem to have re-occupied the central plateau; at least no surface remains have been found there, and it probably existed in numbers only along the coastal areas. It is probable, therefore, that humidity and the accompanying growth of dense forest reduced the moa population in the North Island, or at least restricted its increase and extension there.

But however adversely these conditions may have affected the moa they by no means exterminated it, for we have undoubted evidence of its survival up to the time of human occupation. The question that remains is: how long did it survive the arrival of man; was it still here when the Maoris of the traditional fleet migration of about 1350 A.D. reached these shores; did it survive within the personal experience of their descendants whom Captain Cook found here in 1769, or even of the first Europeans? The evidence on the question is for the most part ethnological rather than zoological and geological, being derived from the traditional lore of the Maori and from several undoubted occurrences of moa remains in Maori ovens in a manner indicating that the moa was hunted and eaten by man.

Archaeological Evidence.

Direct evidence from excavations was first given by the Rev. R. Taylor (1846; Waingongoro), by W. B. Mantell (Waingongoro; see G. A. Mantell, 1848a, and b; and Awamoa, W. B. Mantell 1848), and by Cormack (Opito Bay; see Owen 1856a), but no estimate was made as to the antiquity of the deposits, though Mantell subsequently (1869) gave his opinion that extermination of the moa must have taken place within a very short period after the appearance of man.

Haast (1870, and in greater detail 1872a), from a study of camp-sites at the mouth of the River Rakaia, placed extermination centuries ago by a pre-Maori race using primitive tools of flaked stone; later investigations at Moa-bone Point Cave (1875a) showed him that the moa-hunters possessed polished implements, but his first conclusion that their deposits were very old was strengthened by the occurrence here of a thick sterile layer capped by a purely shell-fish midden lying above them. In the same year Haast (1875c) described the Shag Point deposits in North Otago, and again distinguished an upper shellfish midden from a lower moa-hunter deposit the antiquity of which was indicated by a subsidence of the whole area by at least three feet since it was laid down. Hutton (1876b) found no evidence of this subsidence at Shag Point, but Haast (1877) reaffirmed it, giving more details of the levels concerned. Recently Skinner (1924b) confirmed the subsidence noted by Haast, but Teviotdale (1932) reverted to Hutton's view, though he ascribes considerable antiquity to the site.

Meanwhile inland moa-hunter remains in Otago had been described by Hector (1872a) and by Murison (1872), the former in a rock shelter, and the latter in ovens along the bank of the Puketoitoi creek; flaked chert tools were found in both places, with polished implements as well at Puketoitoi. Hamilton (1895b) also reported an inland moa-hunter shelter on the Old Man Range.

In 1873 W. B. Mantell again described the deposits at Waingongoro and Awamoa, but stated that he had no fixed theory as to whether they were ancient or recent; in the same year the Rev. R. Taylor (1873) also recalled his earlier discoveries (1846) and mentions that, on a second visit with Sir George Grey in 1866, he was surprised to find many more skeletons uncovered by the winds, which had also laid bare a lower stratum of sand.

Caution must be used, however, in drawing conclusions from beach deposits, for not all occurrences of human remains and those of the moa on the same sand dunes are evidence of contemporaneity. A. McKay (1879b, 134) clearly distinguished on Miramar Peninsula a lower stratum of consolidated sand containing moa bones and egg-shell from an upper wind-deposited layer supporting Maori middens, and H. Hill (1914, 343) records a like distinction between moa deposits and human remains on the East Coast, North Island, where, he says, there is no evidence of the use of the moa for food. Recent observations at Doubtless Bay also indicate that the presence of moa remains among oven stones and midden shells is not necessarily proof that the Maori cooked and ate the moa.

On these sand-hills, which Mr. Pycroft and I examined recently, moa-bones and egg-shell were seen everywhere among scattered midden material and *hangi* stones; close investigation, however, showed the association to be secondary. On their eastern side the sand-hills are for the most part intact and capped by an undisturbed layer of close-packed midden-shell, but their shoreward sides have been eroded by the present prevailing westerly wind to a steeper slope now covered by scattered shells and oven-stones which have clearly fallen from the midden above. Moa remains lie among these scattered shells, sometimes quite high up, but they are never found in the undisturbed midden. They occur as individual skeletons, and they lie *in*, not *on*, the underlying slope, which is of a darker coloured, more consolidated sand than the upper midden-crowned layer; this lower layer also contains the fossil shell *Succinea archeyi* (Powell 1933), and, at one spot, we found a rather badly preserved skull of the extinct crow, *Palaeocorax moriorum*. In extensive depressions in the sandhills vast quantities of moa egg-shell lie scattered among the midden shell, but while the midden material is most abundant at the top of the slope and diminishes downhill, the egg-shell is concentrated below and peters out up-slope three feet below the midden cap. The area appears formerly to have been a lagoon or estuary, separated from the sea by what we may call the older dunes. The moas frequented the shores of this lagoon, nested perhaps, and died there, though some very low-lying remains may have been washed into the estuary from upstream. There is no evidence, however, that the birds were ever disturbed by man. In time a seaward line of sandhills was built up outside the old dunes, ultimately covering them, and on these new sandhills the Maori had cast his midden waste. No moa remains are found on or in these outer sandhills, and those Mr. Pycroft and I collected had, according to Mr. E. T. Frost, of Te Hapua, weathered out of the underlying stratum since he had last visited the site and collected all the then visible bones four years previously. Thus wind-erosion has resulted in the midden material being scattered down the new slope, forming a secondary or false association with the much older moa remains from time to time exposed.

The discovery of moa remains and Maori tools on the Pataua dunes near Whangarei by Thorne (1876) was the first indication of the moa having lived in the North Auckland peninsula. Thorne was of the opinion that the moas had been the victims of Maori aggression, but his description of the site reveals conditions similar to those just described from Doubtless Bay, i.e. the occurrence of the moa-bones in a "hardened brown sand" disclosed by the blowing away of the upper layer in which Maori remains had been interred. Oven-stones and tools were lying on the consolidated surface, but the moa-bones were embedded in it. A similar relation between old and new dunes occurs at Kawau Bay, Coromandel Peninsula, where we collected a skeleton from the underlying compacted sand in 1930.

This distinction between older moa remains and much later midden deposits in North Auckland introduces a certain measure of doubt as to the Waingongoro deposits in South Taranaki, especially as described in Taylor's second paper (1873), in which he records his surprise, on revisiting the site with Sir George Grey in 1866, at finding as many bones on the dunes as when he had collected there in 1843. His account of this latter expedition, i.e. that "... all worked in good earnest, and no one more heartily than the Governor; it was quite amusing to see His Excellency grubbing up the old ashes and carefully selecting what he thought worth carrying away," may perhaps suggest enthusiastic haste in collecting rather than careful observation. In this connection there is a marginal note in W. B. D. Mantell's handwriting in the Wellington Philosophical Society's copy of the Quarterly Journal of the Geological Society, vol. 4, against the account of his observations given by his father (G. A. Mantell, 1848c, p. 229). He notes, in reference to Rev. R. Taylor's finding of bones indiscriminately thrown together as if from a feast "totally unproved," and that, north of Wanganui, he himself had found a skeleton with the bones in their natural position and that "the bird had evidently died there and decayed undisturbed." On the other hand he notes "right" against his father's report of his having found "Moa's, dog's and human bones promiscuously intermingled" (G. A. Mantell 1848c, 234), a condition affirmed again in his own account of the Waingongoro excavations (W. B. Mantell 1873), wherein he expressed his conviction that the moa had been killed, cooked and eaten there.

A. McKay, too (1879a) concluded, though on not very satisfactory grounds, that bones found at Taradale were the remains of food.

In the South Island clearer proof of the contemporary existence of man and the moa was obtained from Monck's Cave, near Sumner (Meeson 1890; Forbes 1891b); but the cave had been sealed for many years, possibly centuries, so its date is uncertain. Forbes' conclusion that the moa-hunter culture of the cave was Maori, and not of another race, was upheld by Skinner (1924a), who found the same for the Moa-bone Point cave deposits (1923), where, however, according to Haast (1875a) and McKay (1875), a considerable time had elapsed between the early moa-hunting Maoris and the later shellfish eaters. The considerable age of the South Island moa-hunters' deposits appears again from Teviotdale's (1924) careful and detailed investigations at Shag Point. Teviotdale found the moa-bones distributed through the midden-refuse from top to bottom, lying in one instance immediately above a layer of fish-scales, and in another above a dog skull; he also found clear evidence of carcases having been flung down together. His discovery of artificially drilled holes in moa egg-shell has already been mentioned. Teviotdale (1924 and 1932) and Skinner (1924b) both agree that the human culture associated with these moa remains was typically Polynesian, and did not differ significantly from that of Otago natives at the time of the first British occupation. Skinner observes that while no definite date can be assigned to these deposits, the subsidence of the land since that time (many ovens are now well below high-water mark) and the general appearance of the excavations suggest considerable antiquity, a conclusion supported by Teviotdale's more recent excavations at Papatowai (1937, 1938, a and b), where large trees have grown over the area since the deposits were laid down. As to species, all the South Island forms were included in the oven debris, though *Em. crassus* and *"Eu. elephantopus"* were in preponderance; there were relatively few of *Dinornis, Anomalopteryx* and *Megalapteryx.*

Maori Tradition.

While archaeological evidence points to a considerable lapse of time since moa-hunter deposits were laid down, Maori tradition appears to contribute more conflicting opinion as to the bird's ultimate survival. The earliest enquirer from Maori sources, Polack

(1838), wrote: "The natives added that *in times long past they received the tradition* that very large birds had existed." He thought these birds might still live in the remote parts of the South Island, but, as he himself realized, the stories which occasioned this suggestion contained much that was fanciful. Even more definitely Colenso (1844a, p. 89) affirmed that the otherwise rich and detailed body of Maori tradition gives us nothing about the moa save fabulous stories; Grey (1870), criticising a general statement to this effect by Haast (1870), said that allusions to the moa were found in native poetry, but the Rev. J. W. Stack (1875) pointed out that the word *moa,* which is the eastern Polynesian word for a fowl, appeared only seven times in Grey's Polynesian Mythology (1855), five times without reference to a bird (i.e. as a name or a word contraction), and that the only significant saying was "Lost (or hidden) as the moa"; this was in an old chant indicating that the moa had passed into tradition long ago. Furthermore, from his own knowledge of the legends of South Island Maoris, Stack had (1872) recorded that the last-arriving Maori tribes, the Ngai Tahu 250 years before, had no traditions of the moa, and that the earlier tribes, the Ngati-mamoe and Waitaha, had only vague and meagre legends about it. Another recorder of South Island tales, the Rev. J. F. H. Wohlers (1875, 1876) was not told one word about the moa, unless the story of the huge man-eating bird be a vague reference to it; but the diary of the Rev. J. Watkin (1841), quoted by Teviotdale (1932) records fables of long-extinct monster birds.

Grey was followed by Maning (1876), McDonnell (1889), White (quoted by Travers 1876) and Field (1894), all with stories purporting to be derived from legends, but without evidence as to source and accuracy. Some included most improbable tales of men still living who claimed to have eaten the moa, and to have hunted it, though by such unlikely means as running it down by relays of chasers (McDonnell); Field added word of the existence of a moa-feather head-dress, but Buller identified it as of cassowary feathers, evidently one of the well-known Torres Strait Islands circlets. Other details include natural history errors such as statements that the moa had no hind toe, that it flapped its wings as it ran, and that it stood on one leg, though in this particular we have to accept the possibility that the moa differed from other struthious birds. Precise details of hunting methods have been recorded by J. White, but the hunting chants that went with them have, he says (1925, 172) been long forgotten!

To these reports of recent existence are opposed those of Haast (1878) who was told by an old Maori, Morehu, that the moa had disappeared long ago; and of Colenso (1880, 81), from an east coast chief, that his forefathers had heard of the moa, which anciently had been burnt up by the "fires of Tamatea," but that they had never seen its body, only its bones. Colenso adds similar accounts from Ngati Porou and Urewera chiefs, and also observes that in the few scattered allusions to the moa among the 900 poems in Grey's "Polynesian Mythology" there is no reference to hunting and feasts; he considered that both Grey and White had given too ready acceptance to present-day Maori stories, which, he said, were not from reliable old tradition, but had been built up from European enquiries and interpretations. Such an assertion is not easy to check, but the Wairarapa moa legend given by Downes (1926, 36) may be what Colenso had in mind. Here the Maoris are said to have burnt the country and stampeded the moas into the swamp where they perished. Apart from the unlikelihood of the natives, well-known game preservers, being so stupid as to destroy a rich supply of food, or even to leave the birds they had hunted to rot in the swamps, the story appears to be a recasting of the explanations offered by Europeans who did not realize that Pleistocene or even early Recent swamp deposits long antedate human occupation. Colenso's opinion also finds support in Mair's important statement (1890) that, in the thousands of pages of native land court evidence he had transcribed, evidence in support of claims to lands and full of interminable details from tradition of hunting all kinds of creatures, there was "not one word about the moa," neither was there any reference to it in all the ancient *karakia* (chants) dealing with hunting and trapping. Mair thought it inconceivable that the Maori records should contain no details, nor even references to the moa if he had known and hunted it; indeed the Maniopoto chiefs had told him directly, "We do not know anything about the moa. though perhaps our ancestors did." Another indication of the Maori's lack of knowledge of the moa is in W. B. D. Mantell's manuscript "Notes of a journey to Waingongoro for moa-bones, 1847," in the Alexander Turnbull Library, Wellington. "After supper had a long talk with the Maoris about the bones. Showed them Owen's plates, which enlightened them. After a general discussion it was decided they were the bones of cows drowned at the Deluge of Noah." On the other hand, there is the story recorded by Graham (1919) that Rangi-hua-moa, who lived in 1675 according to the genealogy, received her name from the last feast of moa eggs in her district; I suggested to Mr. Graham that this story might have been brought forward from an earlier ancestress, but he knows of no prior bearer of the name in the genealogies.

Other Maori legends state positively that the moa disappeared long ago. Wanganui folk (Best 1896) said it had lived only in times long past, when their ancestors slew many mythical monsters; Beattie (1915, 107, 135; 1918, 150; 1919, 50) gives separate South Island statements that it was killed out by the very early tribes; and the poem recorded by Davies and Pope (1907, 46, 53) says that, at Reporoa, Tamatea destroyed them "with ancient, magic, all-consuming fire."

In all this conflicting opinion the issue rests, as Hutton (1892b) pointed out, on the reliability of the native stories as ancient tradition, and in this connection it will be observed that those records which are indubitably free from the influence of leading questions and interpretation by European enquirers, i.e. those of the early missionaries and the native land court records, give no indication of survival to even moderately recent times.

The native attribution of the destruction of the moa to the "fires of Tamatea" is of interest, and it is not impossible that this may refer to a natural phenomenon—to one of the great volcanic showers that have emanated from the central north island. Grange (1931) has shown that showers from the Taupo eruption had burnt and buried trees fifty miles to the south-east, i.e. at Te Pohue, and he considers (letter to the writer, 6/5/40) that it probably destroyed forest at Waikaremoana. It is not suggested that this particular shower caused the fires of Tamatea—it was far too long ago; but Burrell's shower on Mt. Egmont occurred only four or five hundred years ago (Oliver 1931) and, as Dr. Grange considers (letter 7/7/40) that the Kaharoa shower, the last pre-European eruption in the Rotorua district, may have occurred approximately 1,000 years ago, it could well have been within early Maori experience. Tregear (1895, 585) suggests that the legend of fires of Tamatea may have been brought by the Maoris from Polynesia and localized here; but the story as independently recorded by H. Hill (1914, 340) says: "The fire was not the same as our fire, but embers were sent by Rangi," i.e. the god of the sky. The Taupo showers are mentioned to draw attention to the fact that even such a destructive agency did not permanently eliminate the moa; in some of the Waikaremoana caves, skeletons lay above at least one layer of pumice. This Dr. Grange has kindly identified for me as probably of the Gisborne shower, which was followed by two showers, one of which, the Taupo shower, also fell at Waikaremoana. It do not know whether the moa returned to the extensive plains around Lake Taupo after these eruptions; the only specimen that I have from the district is a partial skeleton found by Mr. E. Earle Vaile in the bank of a deep stream cutting near Reporoa, and I have no record of surface finds, or of gizzard stones, and it will be remembered that Mr. N. H. Taylor found none during his close examination (soil survey) of this area.

Numerous occurrences of bones on the surface, particularly in Otago, have been held to prove recent survival; but these bones decayed and disappeared very quickly after discovery, and, as Hutton pointed out (1892b, 165-7), if the birds of which they were the remains had lived an equally short time ago, reliable Maori tradition must be full of authentic details of habits of the moa and of its being hunted. But references are vague and legendary, and we must therefore regard the surface remains as very old, having been long preserved just below the ground until European burning and cultivation brought them to the surface and exposed them to rapid decay. With regard to the preservation of desiccated skin, flesh and feathers in certain Central Otago caves, Hutton may again be followed in attributing this to the generally dry climate experienced by that district. The preservation of human remains recorded by Pyke (1890) is a striking illustration of this.

In final consideration of the probable date of extinction of the moa, it is necessary to take into account the stages of occupation of the land by the Maori. We know that the great fleet migration from Tahiti of about 1350 A.D. was preceded by Toi's smaller party (c. 1150 A.D.) and that Kupe's voyage of discovery had taken place two hundred years before that. The traditions vary as to whether Kupe found prior inhabitants, but they agree that he took the much-prized greenstone, also moa bones, back with him. It is unlikely that he himself would have even discovered greenstone, let alone have acquired knowledge of its qualities and potentialities, on a brief visit; more probably he obtained it from people already here. Uncertainty in tradition as to earlier folk is not unlikely; the colonists of this country who have a place in Maori and Polynesian history are those who, having discovered the land, were able to send back word of their new country and an invitation to their kinsmen to follow them. Other successful outward voyagers who failed to make the return journey would have been simply written off by their kin at home as lost at sea, and it is by no means unlikely that the first arrivals here were of this category.

Now it is patent that, to a native race provided with only a few tropical food plants, the North Island would offer better scope for settlement than the South, and that both the first arrivals and the successive waves of immigrants would endeavour to settle there. The population would increase rapidly in the North Island, more slowly in the South, where less means of sustenance would have maintained smaller tribal groups. We have already noted that with regard to moa population the reverse was probably the case, that their numbers were greater on the extensive South Island grasslands than around the coastal borders of the heavily forested North. We therefore see the likelihood of the fewer North Island moas being actively hunted and their eggs consumed (Murison, 1872) by the rapidly increasing invaders, and exterminated within a few generations of the first arrivals, so that by the time the historical fleet-migrants reached the land only traditions of the bird would reach them. Nor would the new arrivals be at pains to preserve the legends of those whom they were supplementing or absorbing. Later, when these new northerners had in turn penetrated in force to the South Island, the moa would have been long exterminated by the first waves of the Waitaha folk (Teviotdale, 1932, 118), and tradition of it would have faded into uncertainty.

Thus some measure of agreement may be established between the geographical conditions endured by the moa, the history of Maori occupation, reliable native tradition and the results of archaeological investigation, all pointing to the final extermination of the moa by the earliest Polynesian immigrants a considerable time ago, first in the North Island and later in the South, and probably before the arrival of the immediate ancestors of the present Maori tribes in the Fleet migration of 600 years ago.

SUMMARY.

The examination of a considerable number of recently collected skeletons and of sets of bones of individual birds of the genus *Anomalopteryx,* of approximately contemporary existence in one locality (caves in the Lake Waikaremoana outlet barrier), indicates a species exhibiting not only great range in size and proportionate width of leg-bones, but also a haphazardness as to the relative size of the femur, tibia and metatarsus in different individuals. This is also confirmed in a smaller series collected from caves in the Mangaotaki district (west of Te Kuiti) and in a larger series of individuals of another genus *(Euryapteryx)* from the sand-hills of Doubtless Bay. The observed range and irregularity in variation are accepted as criteria for defining the species by wide limits as to size. Lists of measurements of all available skeletons and sets of bones of individuals, and of the types of previously proposed species (Tables 1 to 19 and A to P), and detailed descriptions of skulls, pelves and sterna of the different species are submitted in support of the classification proposed. Descriptions of the discrete basic cranial elements exhibited in immature skulls are given, chiefly for *Anomalopteryx didiformis,* adding to, and modifying in some particulars, the descriptions of T. J. Parker (1895b).

The classification of genera on the size and proportionate width of leg-bones has been replaced by one derived mainly from characteristics of the skull, sternum, pelvis, form of the leg-bones and proportionate length of the three bones of the leg (p. 11).

The **Dinornithidae** are characterised by a long metatarsus and a wide flattened skull with a broad triangular beak (genus *Dinornis).*

The **Anomalopterygidae** have a short metatarsus and a higher, more rounded skull with a narrower, though not necessarily a sharp beak. Within this family the subfamily *Anomalopteryginae (Anomalopteryx, Megalapteryx* and *Pachyornis)* retain the five outer toe-joints and have a sharp-pointed beak and an expanded maxillary antrum, while the sub-family *Emeinae* have only four outer toe-joints, a round-tipped beak and slightly reduced *(Emeus)* or altogether collapsed *(Euryapteryx)* antrum. Altogether six genera are represented and twenty species: a synopsis appears on p. 77.

The origins of the Palaeognathae are discussed, in particular the view of P. R. Lowe (1928) that they are derived from an early avian stock that had never possessed pennal feathers nor acquired the power of flight; the conclusion offered is that the struthious birds, possessing in common a primitive palaeognathous palate and certain other characters and habits, are a related group, and that they are descended from a proto-carinate stock that had gained some measure of flight.

Within the Palaeognathae, the Dinornithiformes and Apterygiformes are regarded as allied but not closely, while these two stand closer to the Rheiiformes than to the Struthioniformes and Casuariiformes. For this South American-New Zealand relationship, marked even more definitely in other faunal and in floral associations, the necessary land connections may be found *via* the Antarctic Continent in late Cretaceous or early Tertiary times. Although fossil remains of the moa are not found earlier than the mid-Pliocene (Nukumaruan), the few known for this period indicate the full attainment already of dinornithic characters and the development of species that survived until the Recent.

Differentiation of species is regarded as having arisen, not through isolation on areas separated by submergence, but in response to varied environmental conditions over the area as a whole. The greater inter-island divergence of species in the heavy moas is attributed to the semi-pervious, selective nature of a long-standing mountain isthmus (later broken by Cook Strait) which obstructed their inter-island passage while permit-

ting that of the taller, slenderer types. The continuous and extensive variation in size and proportion of all species may be related to the easy conditions, abundance of food, and absence of predatory enemies, which permitted the attainment of any size and proportion that food abundance made possible without the elimination of intermediate forms. By way of comparison it is noted that the retention of speed has been a limiting factor with regard to the development of varieties among other struthious birds which must meet the competition of predatory mammals.

Destruction of moas in considerable numbers occurred during a pluvial period following the Pleistocene glaciation. The pluvial conditions themselves and the accompanying extension of forest areas in this period may separately or conjointly have been to the disadvantage of the moa, but they did not prevent its survival until the advent of man a thousand years or more ago. It is probable that at this time the more extensive grassland of the South Island supported a greater moa population than the heavily forested North Island; for agricultural reasons, however, the incoming Polynesians would first occupy the North Island, where the small moa population would be quickly exterminated.

Archaeological evidence, especially in the South Island, confirms the taking of the moa and its eggs for food by man, but the deposits are of considerable antiquity: it is pointed out that certain associations, or occurrences together, of moa bones and Maori midden material are secondary, and have resulted from the erosion of younger overlying sand-hills and the consequent mingling of their midden material with much older moa remains. Maori tradition is found to be vague and contradictory as to the time of extinction of the moa; but the accounts recorded by the earliest missionaries, before European investigation and speculation had spread knowledge of it among the Maoris are regarded as the more reliable; they also agree with the archaeological evidence that the moa disappeared a very long time ago. On the whole the indications are that the earliest human occupants quickly exterminated the moa, first in the North Island and later in the South, and that it had disappeared before the great fleet migration of 1350 A.D. brought to these shores the ancestors of the present Maori tribes, whose legends have preserved vague accounts obtained from the earlier Polynesian folk believed to have already been in occupation of the land for some generations.

Priority of Names Proposed for Genera and Species of Dinornithiformes.

Names admitted in the present classification are in **BOLD TYPE.**

Date.	Proposal.	Publication.	Present Attribution.
1843 July ..	**Dinornis** Owen (*D. novae-zealandiae* Ow.)	P.Z.S. 1843, 8	**Dinornis**
	Dinornis **novae-zealandiae** Owen	P.Z.S. 1843, pt. 11, 8	**D. novae-zealandiae** Owen
	Megalornis Owen (name withdrawn)	P.Z.S. 1843, 19	*Dinornis*
1844 March ..	*Dinornis* **giganteus** Owen	P.Z.S. 1844 pt. 11, 144	**D. giganteus** Owen
1844 June 5 ..	*Dinornis* **didiformis** Owen	T.Z.S. 3, pt. 3, 242	**A. didiformis** (Owen)
	Dinornis struthoides Owen	,, ,, 244	*D. novae-zealandiae* Ow.
	Dinornis **ingens** Owen	,, ,, 247	**D. ingens** Owen
	Dinornis dromaeoides Owen	,, ,, 253	*A. didiformis* (Ow.)
1846 July ..	*Palapteryx* Owen (*D. ingens* Ow.)	P.Z.S. 1846, pt. 14, 46	*Dinornis*
	Dinornis **crassus** Owen	,, ,, 46	**Em. crassus** (Owen)
	Dinornis casuarinus Owen	,, ,, 47	*Em. crassus* (Ow.)
	Dinornis **curtus** Owen	,, ,, 48	**Eu. curtus** (Owen)
	Dinornis ingens var. **robustus** Owen	,, ,, 48	**D. robustus** Owen
1848 April 22 ..	*Palapteryx* **geranoides** Owen	T.Z.S. 3, pt. 5, 348	**Eu. geranoides** (Ow.)
1851 Jan. 1 ..	*Dinornis rheides* Owen	T.Z.S. 4, pt. 1, 8	Indeterminate
1852	**Emeus** Reichenbach (*D. crassus* Ow.)	Av. Syst. Nat., p. xxx	**Emeus**
	Syornis Reichenbach (*D. casuarinus* Ow.)	,, ,, ,, ,,	*Emeus*
	Anomalopteryx Reichenbach (*D. didiformis* Ow.)	,, ,, ,, ,,	**Anomalopteryx**
	Movia Reichenbach (*D. ingens* Ow.)	,, ,, ,, ,,	*Dinornis*
	Moa Reichenbach (*D. giganteus* Ow.)	,, ,, ,, ,,	*Dinornis*
1855 April 11 ..	*Dinornis gracilis* Owen	P.Z.S. 1854, pt. 22, 246	*D. ingens* Ow.
1856 July 30 ..	*Dinornis* **elephantopus** Owen	P.Z.S. 1856, pt. 24, 54	**P. elephantopus** (Owen)
1869 May ..	*Dinornis* **maximus** Haast	T.N.Z.I. i, 87	**D. maximus** Haast
1869 June 1 ..	*Dinornis maximus* Owen	T.Z.S. 6, pt. 8, 497	*D. maximus* Haast
1870 Jan. ..	*Dinornis* **gravis** Owen	T.Z.S. 7, pt. 2, 141	**Eu. gravis** (Owen)
1874	*Meionornis* Haast (*D. casuarinus* Ow.)	T.N.Z.I. 6, 426	*Emeus*
	Euryapteryx Haast (*D. gravis* Ow.)	T.N.Z.I. 6, 427	**Euryapteryx**
1875 July ..	*D. crassus* var. *major* Hutton	T.N.Z.I. 7, 276	*E. crassus* (Ow.)
	D. elephantopus var. *major* Hutton	T.N.Z.I. 7, 279	*P. elephantopus* (Ow.)
1879	*Dinornis altus* Owen	E.B.N.Z. 361	*D. maximus* Haast
	Dinornis **huttonii** Owen	E.B.N.Z. 430	**Em. huttonii** (Owen)
1883 Jan. ..	*Dinornis parvus* Owen	T.Z.S. 11, pt. 8, 233	*A. didiformis* (Ow.)
	Dinornis **didinus** Owen	T.Z.S. 11, pt. 8, 257	**M. didinus** (Owen)
1884	**Megalapteryx** Haast (*M. hectori* Haast)	T.N.Z.I. 16, 576	**Megalapteryx**
1884 May ..	*Megalapteryx hectori* Haast	T.N.Z.I. 16, 576	*M. didinus* (Ow.)
1886 Dec. ..	*Dinornis* **oweni** Haast	T.Z.S. 12, pt. 5, 171	**P. oweni** (Haast)
1891	*Megalapteryx tenuipes* Lydekker	C.F.B.B.M. 251	*M. didinus* (Ow.)
1891 April 25 ..	*Anomalopteryx geranoides* Lyd.	,, 288	*Eu. exilis* (Hutt.)
	Emeus gravipes Lyd.	,, 297	*Eu. gravis* (Ow.)
	Pachyornis Lyd. (*D. elephantopus* Ow.)	,, 316	**Pachyornis**
	Pachyornis immanis Lyd.	,, 343	*P. elephantopus* (Ow.)
	Pachyornis rothschildi Lyd.	,, 481	*P. elephantopus* (Ow.)
1891 Nov. ..	*Dinornis excelsus* Hutton	N.Z. Jn. Sci., new iss., No. 6, 247	*D. giganteus* Ow.
	Dinornis validus Hutton	,, ,, ,,	*D. maximus* Haast
	Dinornis firmus Hutton	,, ,, ,,	*D. ingens* Ow.
	Dinornis potens Hutton	,, ,, ,,	*D. robustus* Ow.
	Tylopteryx Hutton (*D. struthioides* Ow.)	,, ,, ,,	*Dinornis*
	Dinornis **torosus** Hutton	,, ,, ,,	**D. torosus** Hutt

Date.	Proposal.	Publication.	Present Attribution.
1891 Nov.	*Palapteryx plenus* Hutton	N.Z. Jn. Sci., new iss., No. 6, 248	*D. torosus* Hutt.
	Mesopteryx Hutton (*D. huttonii* Ow.)	,, ,, ,,	*Emeus*
	Euryapteryx ponderosus Hutton	N.Z. Jn. Sci., new iss., No. 6, 249	*P. elephantopus* (Ow.)
	Euryapteryx **pygmaeus** Hutton	N.Z. Jn. Sci. 1, No. 6, 249	**P. pygmaeus** (Hutton)
1892 April	*Pachyornis rothschildi* Lydekker	P.Z.S. for 1891, 479	*P. elephantopus* (Ow.)
1892 May	*Anomalopteryx* **antiquus** Hutton	T.N.Z.I. 24, 124	**A. antiquus** Hutt.
1892	*Palaeocasuarius* Forbes *nom. nud.*	T.N.Z.I. 24, 189	*Megalapteryx*
1893 May	*Dinornis strenuus* Hutton	T.N.Z.I. 25, 8	*D. torosus* Ow.
	Anomalopteryx fortis Hutton	T.N.Z.I. 25, 9	*A. didiformis* (Ow.)
	Euryapteryx compacta Hutton	T.N.Z.I. 25, 11	*E. huttonii* (Ow.)
	Pachyornis inhabilis Hutton	T.N.Z.I. 25, 11	*P. elephantopus* (Ow.)
	Pachyornis valgus Hutton	T.N.Z.I. 25, 12	*P. elephantopus* (Ow.)
1897 June	*Anomalornis* Hutton (vice *Anomalopteryx)*	T.N.Z.I. 29, 543	*Anomalopteryx*
	Euryapteryx **exilis** Hutton	T.N.Z.I. 29, 552	**Eu. exilis** Hutt.
1907 Nov. 12	*Megalapteryx hamiltoni* Rothschild	Extinct Birds, 197	*M. didinus* (Ow.)
	Emeus boothi Rothschild	,, ,, 210	*Eu. gravis* (Ow.)
	Emeus haasti Rothschild	,, ,, 210	*Eu. gravis* (Ow.)
	Emeus parkeri Rothschild	,, ,, 211	*Eu. gravis* (Ow.)
	Palaeocasuarius Rothschild (*Pal. haasti* Roth.)	,, ,, 219	*Megalapteryx*
	Palaeocasuarius haasti Rothschild	,, ,, 220	*M. didinus* (Ow.)
	Palaeocasuarius velox Rothschild	,, ,, 220	*M. didinus* (Ow.)
	Palaeocasuarius elegans Rothschild	,, ,, 220	*M. didinus* (Ow.)
1927 Aug. 15	*Dinornis expunctus* Archey	T.N.Z.I. 58, pt. 1, 2, 152	*Eu. geranoides* (Ow.)
1930	*Euryapteryx kuranui* Oliver	N.Z. Birds 52	*Eu. gravis* (Ow.)
1941	*Megalapteryx* **benhami** Archey	Bull. Auck. Inst. Mus. 1	**M. benhami** Ar.
	Pachyornis **mappini** Archey	Bull. Auck. Inst. Mus. 1	**P. mappini** Ar.

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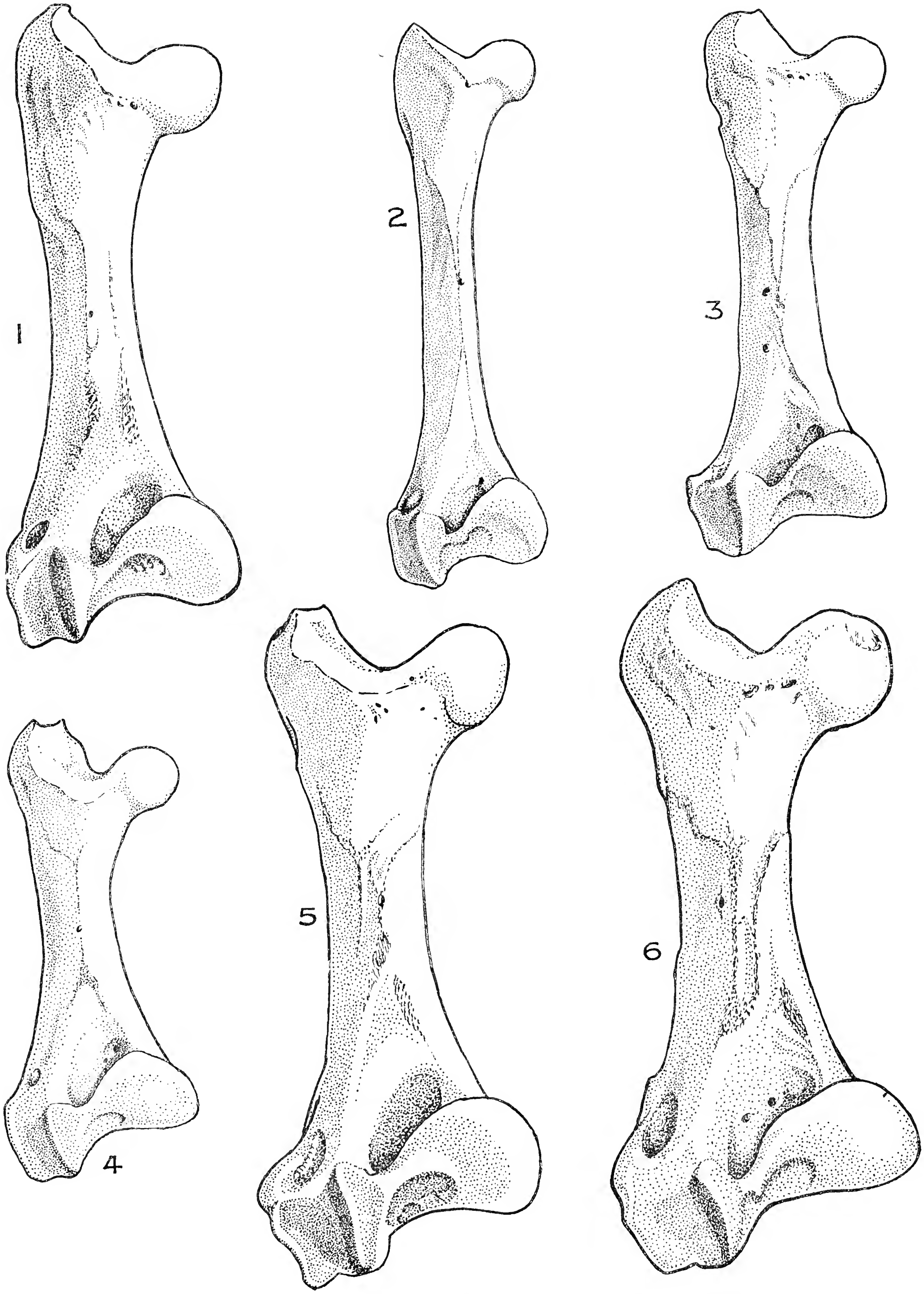
INDEX

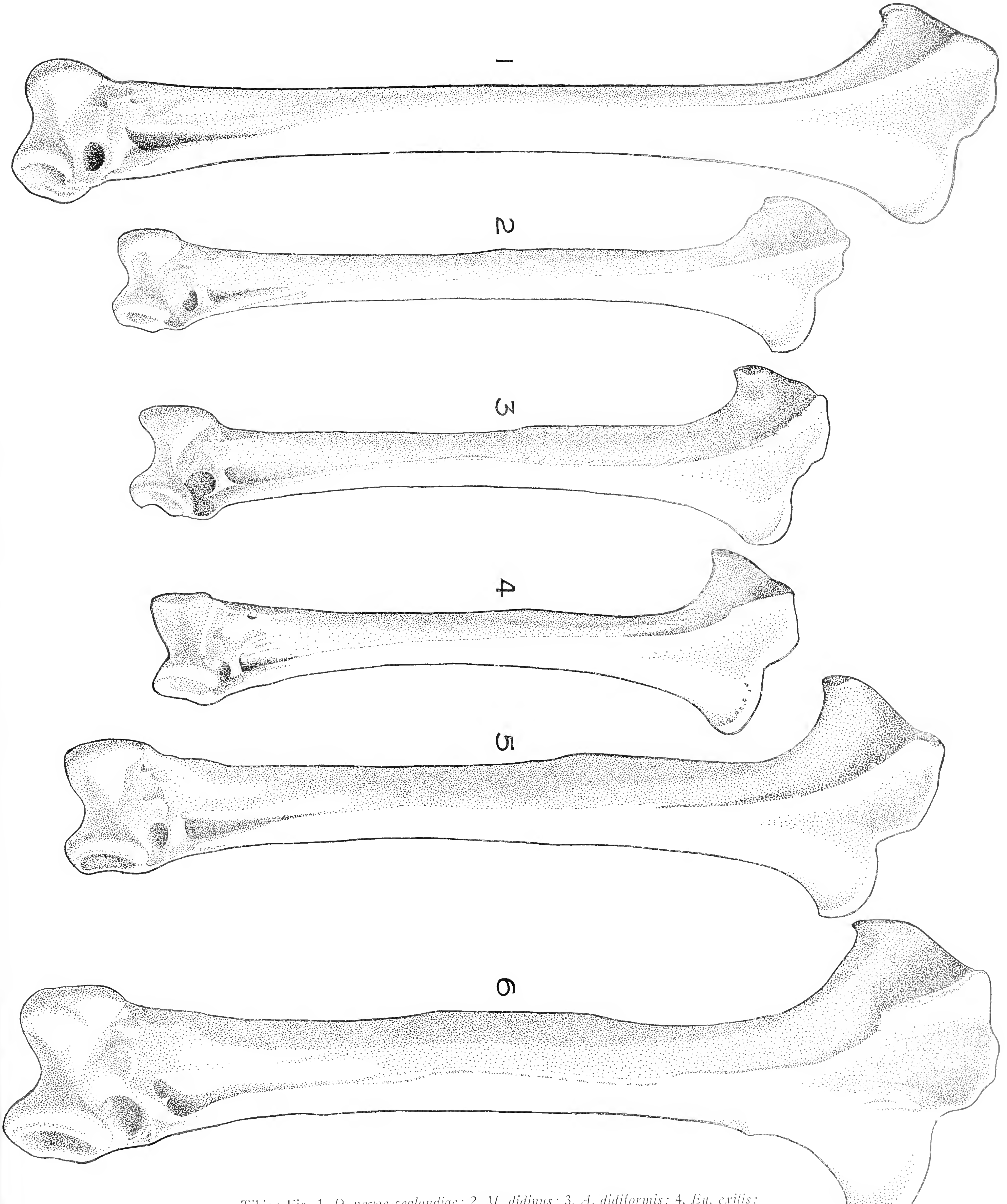
Note: Names of genera and species of moa are followed, in brackets, by the name adopted in this study. References to the names of leading students (i.e. Owen, Hutton, Haast, etc.) do not include the many details in synonymy and descriptions of species.

PLATE 1.



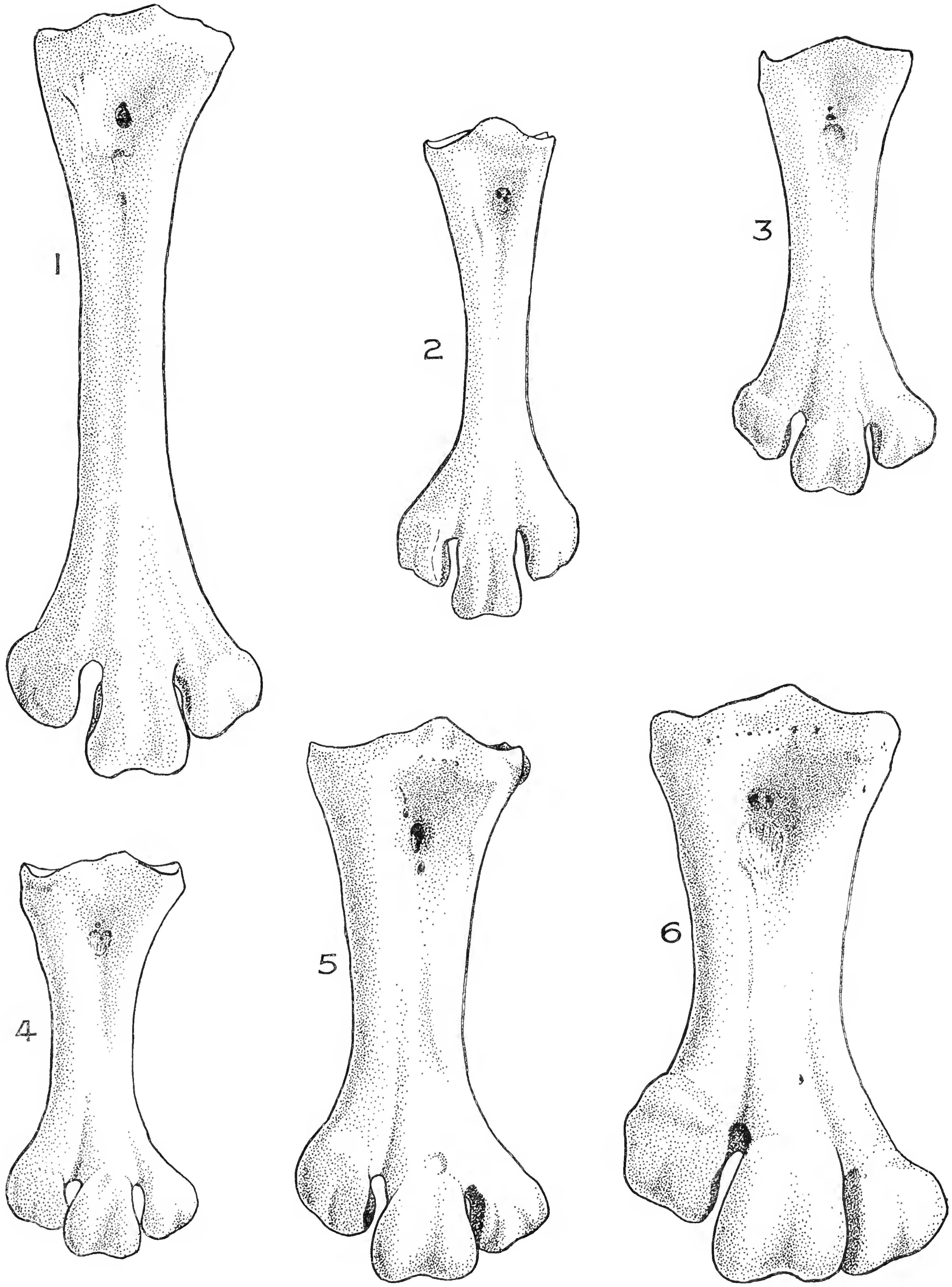
Femur: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *Eu. exilis*; 5, *Em. crassus*; 6, *Eu. gravis*.

PLATE 2.

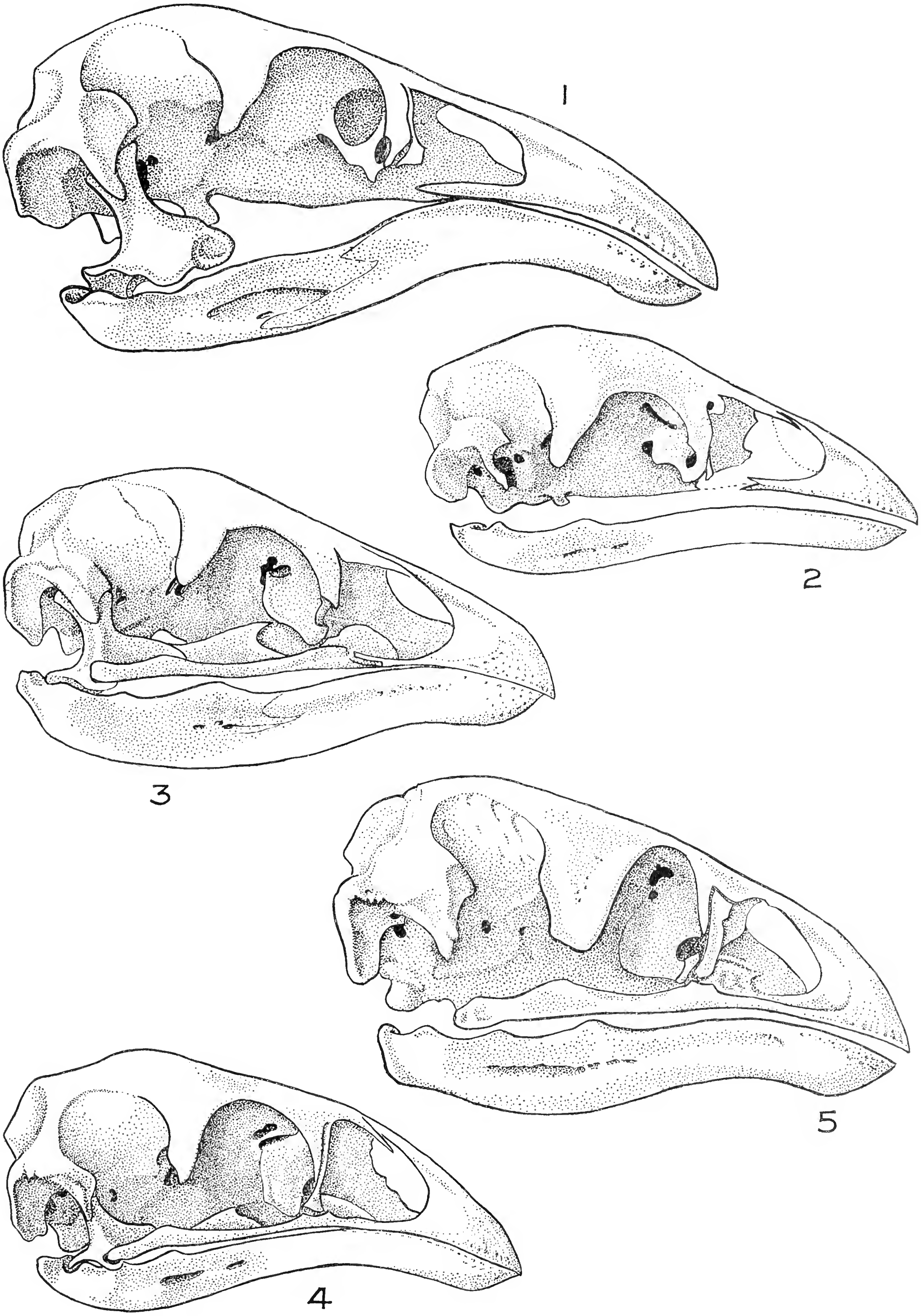


Tibia: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *Eu. exilis*; 5, *Em. crassus*; 6, *Eu. gravis*.

PLATE 3.

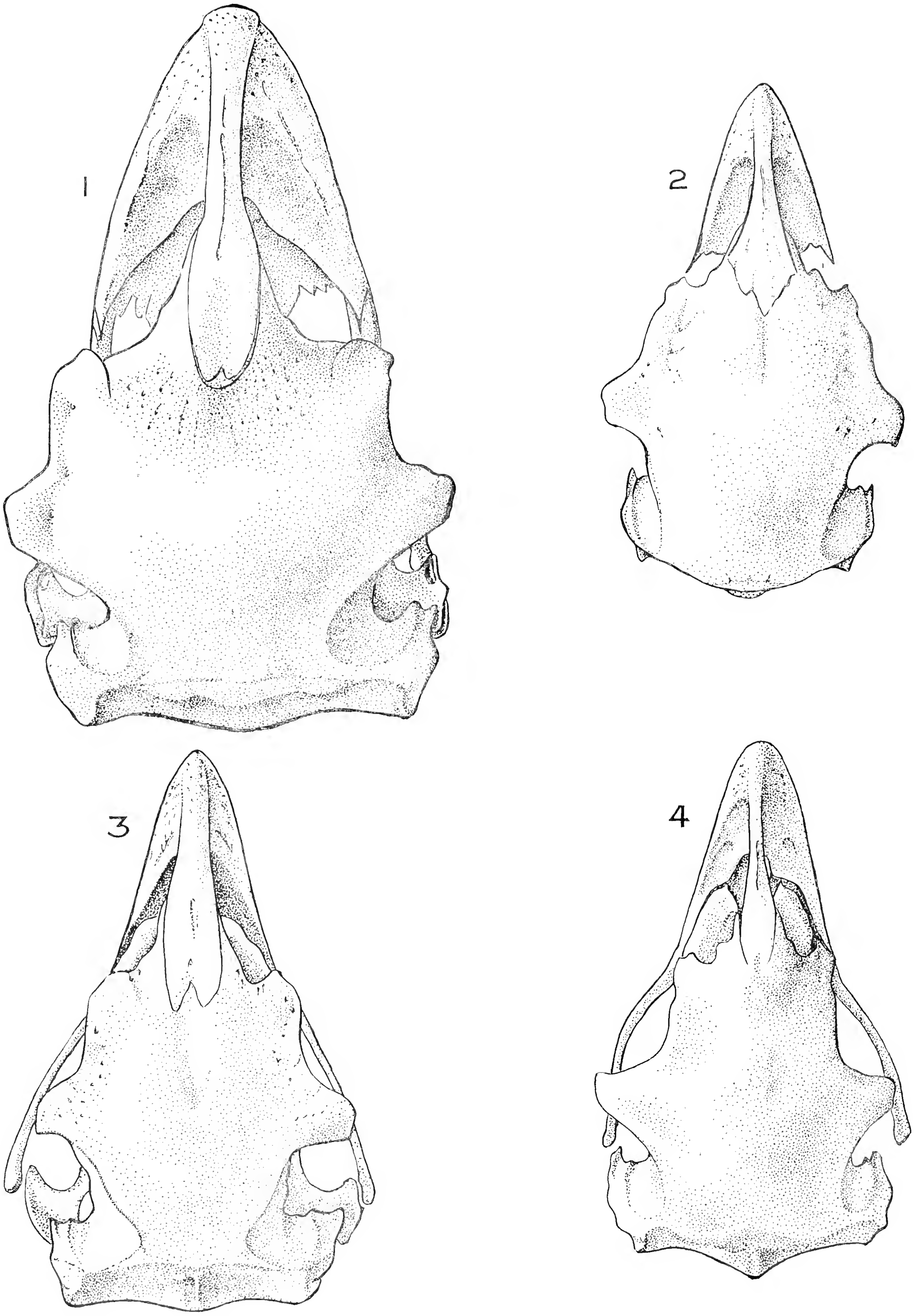


Metatarsus: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *Eu. exilis*; 5, *Em. crassus*; 6, *Eu. gravis*.



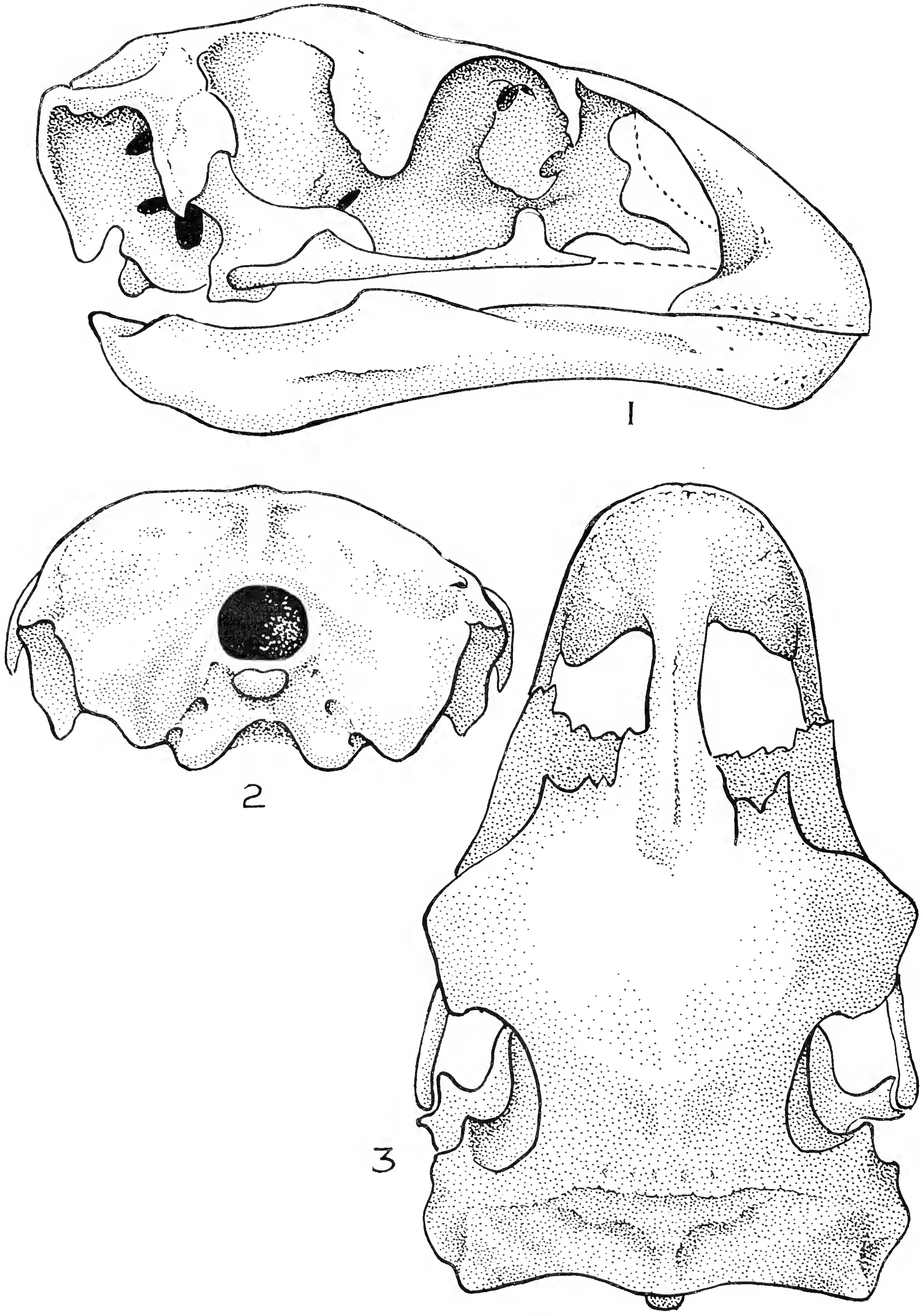
Skull: Fig. 1, *D. torosus;* 2, *M. didinus;* 3, *A. didiformis;* 4, *P. mappini;* 5, *Eu. gravis.*

PLATE 5.



Skull: Fig. 1, *D. torosus;* 2, *M. didinus;* 3, *A. didiformis;* 4, *P. mappini.*

PLATE 6.

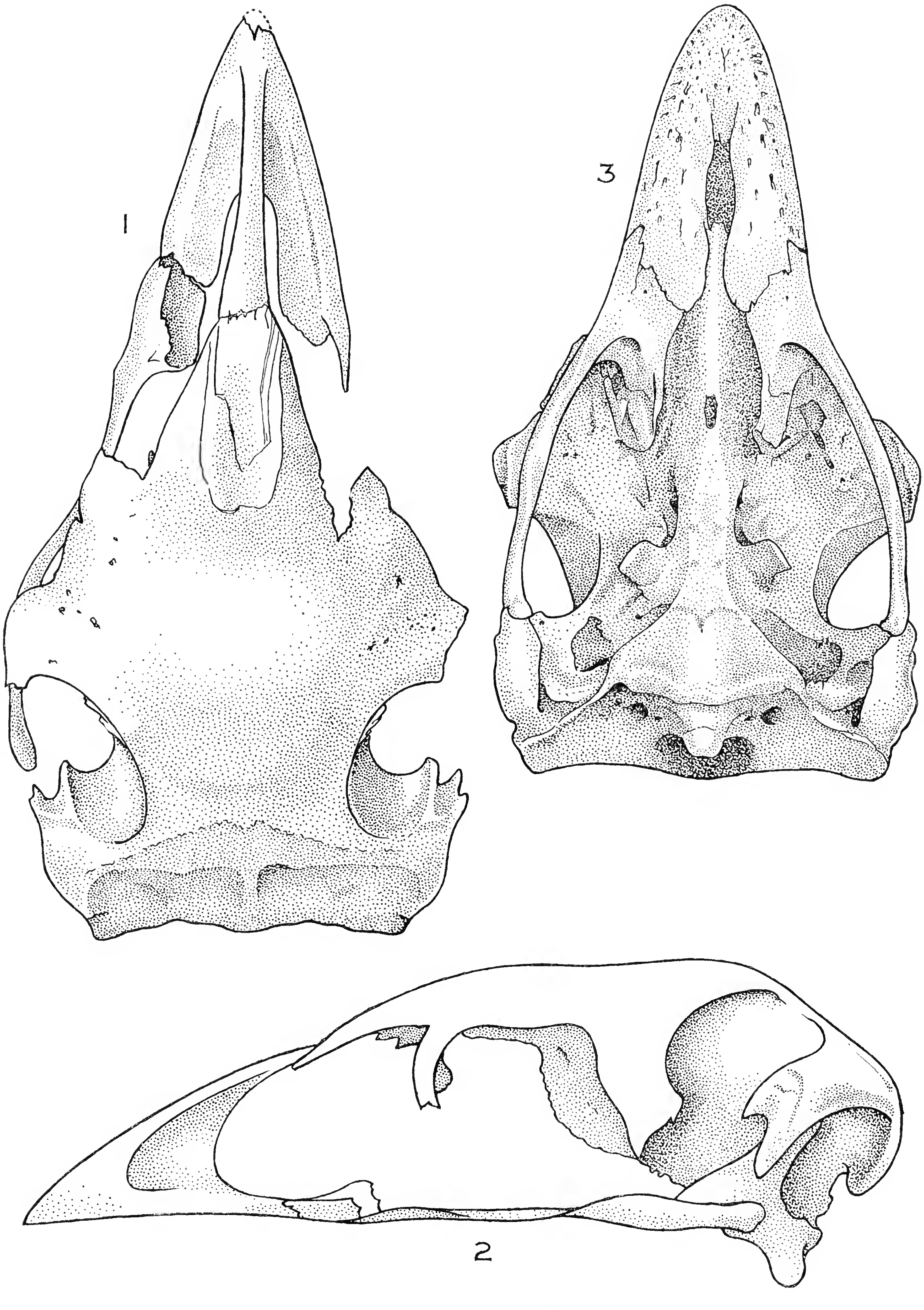


Skull: Figs. 1-3, *Eu. gravis*, Riverton. Otago Museum.

PLATE 7.

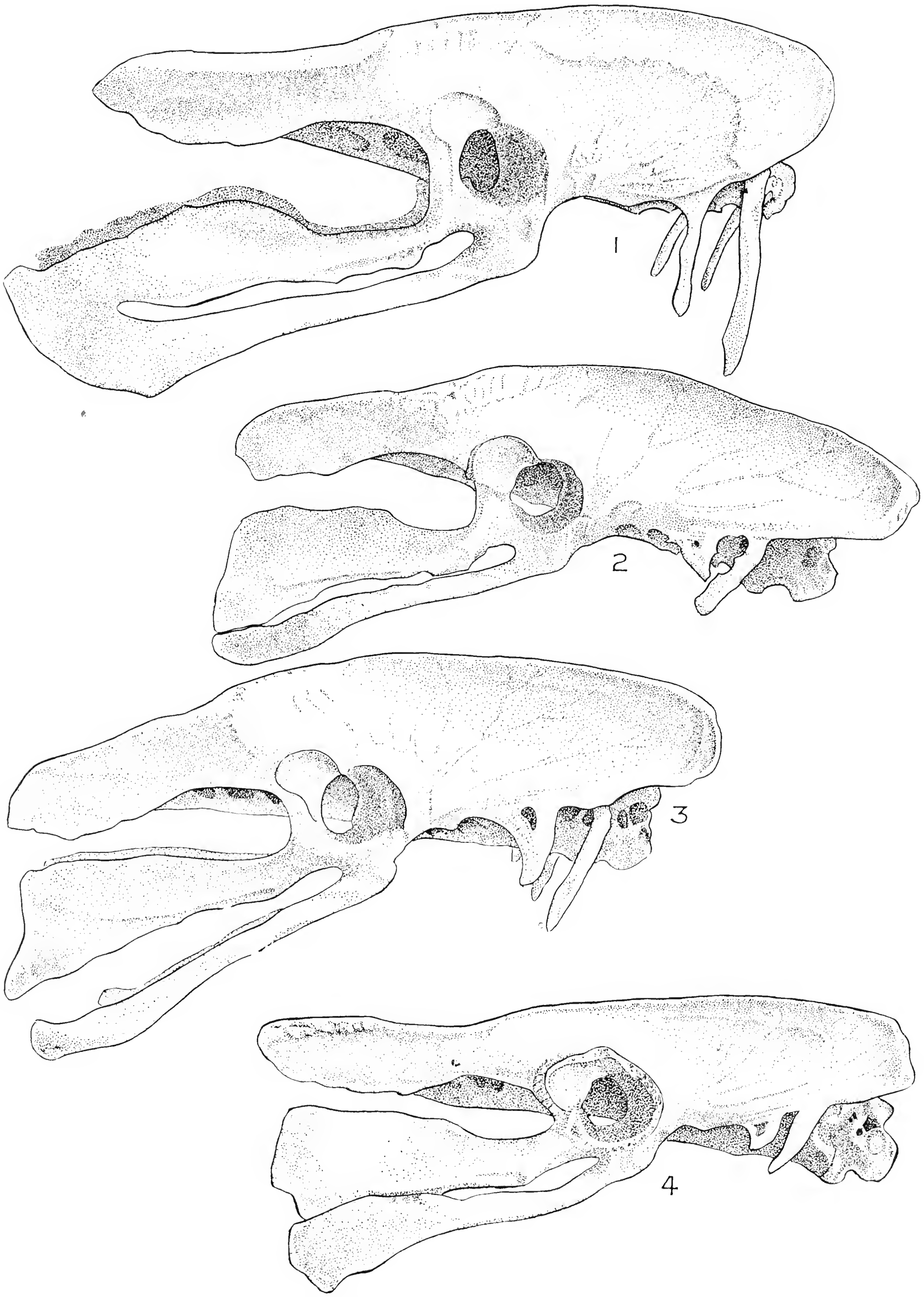
Skull: Fig. 1, *D. maximus;* 2, *A. didiformis;* 3, *P. mappini;* 4, *Eu. gravis.*

Plate 8.



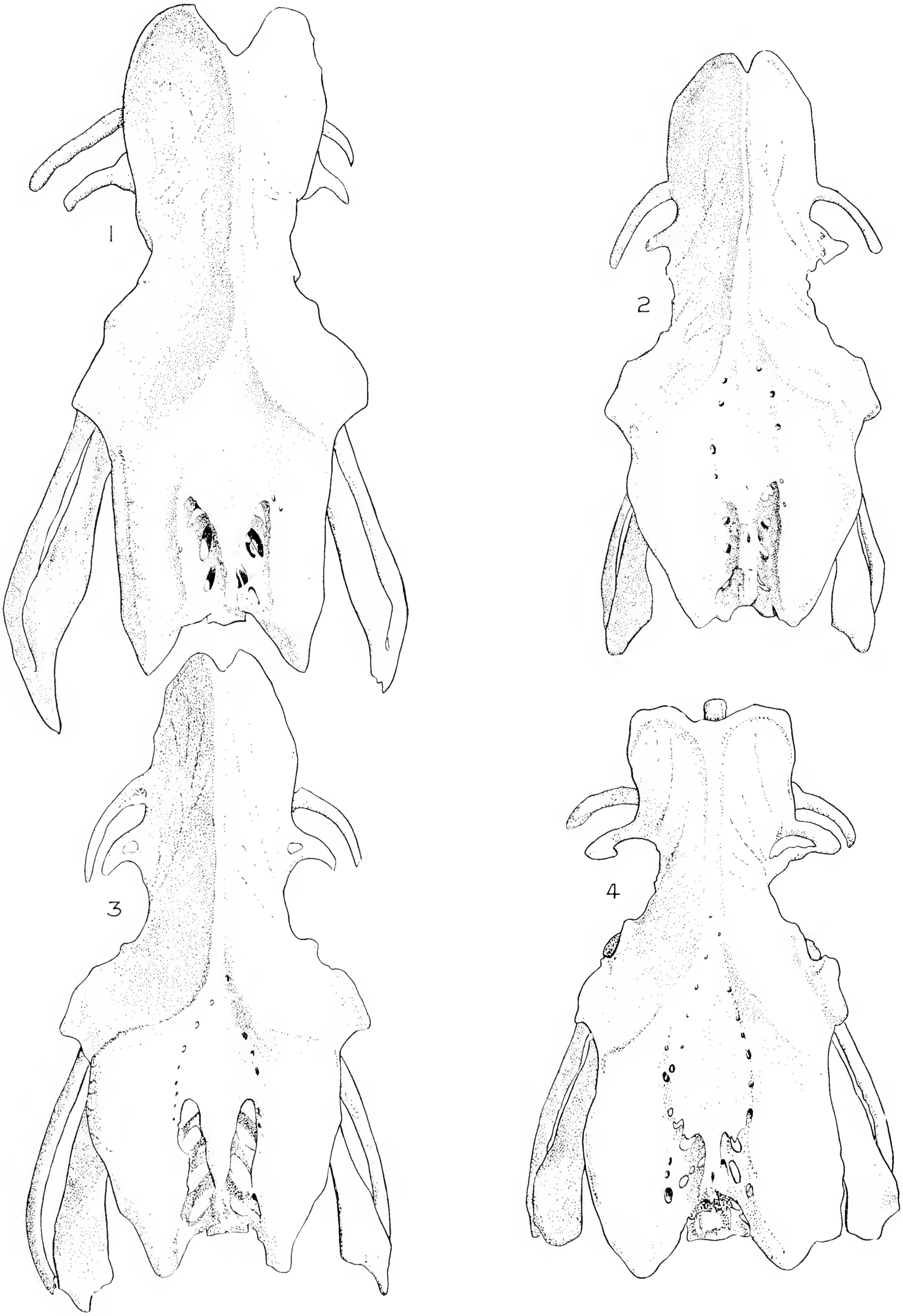
Skull, *Pachyornis*. Figs. 1, 2, skull from Enfield, Otago Museum. Fig. 3, skull from Enfield, "*Pachyornis elephantopus*" Parker 1895b, pl. 60, fig. 22.

Plate 9.

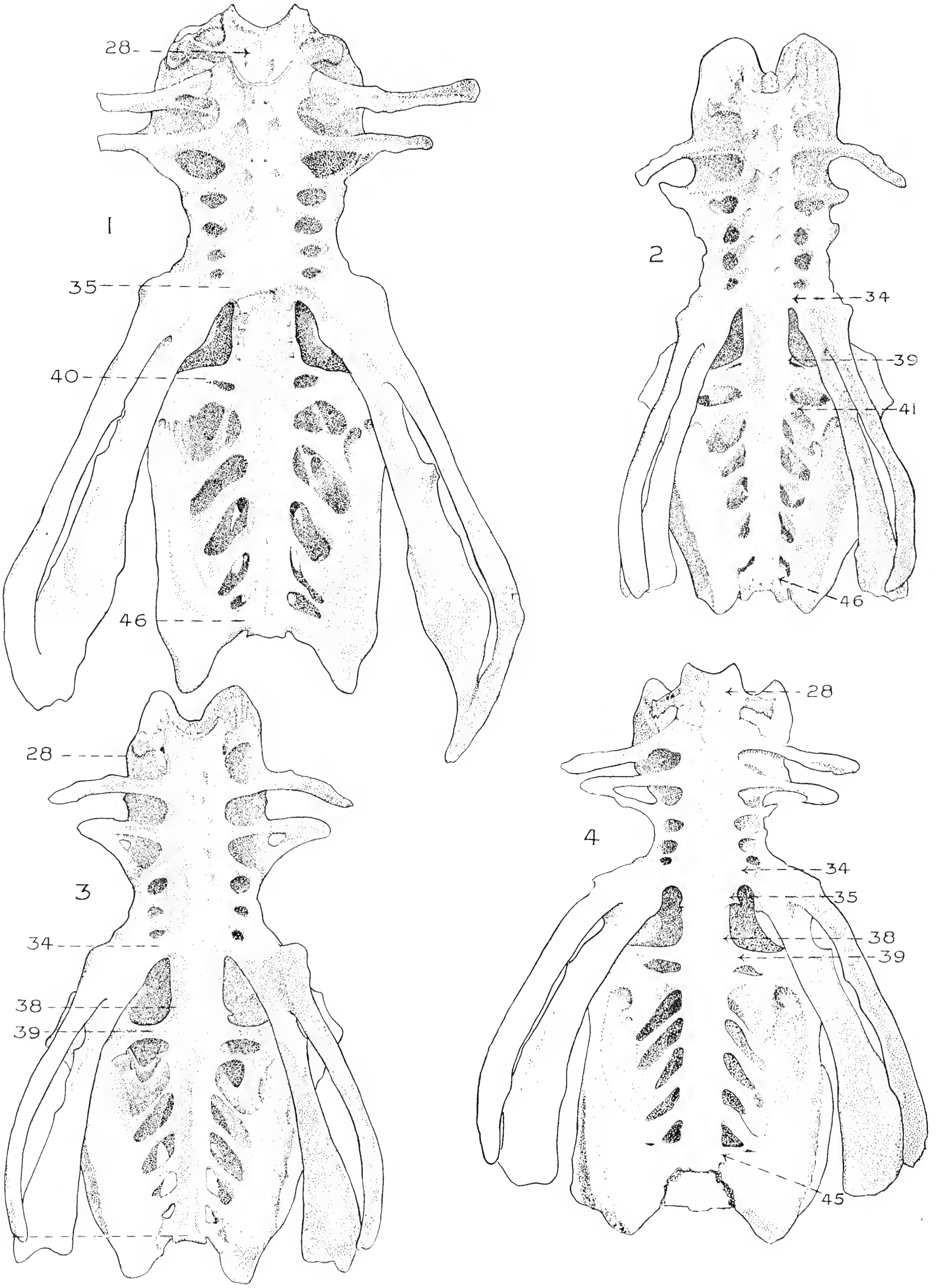


Pelvis: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *P. mappini*.

PLATE 10.

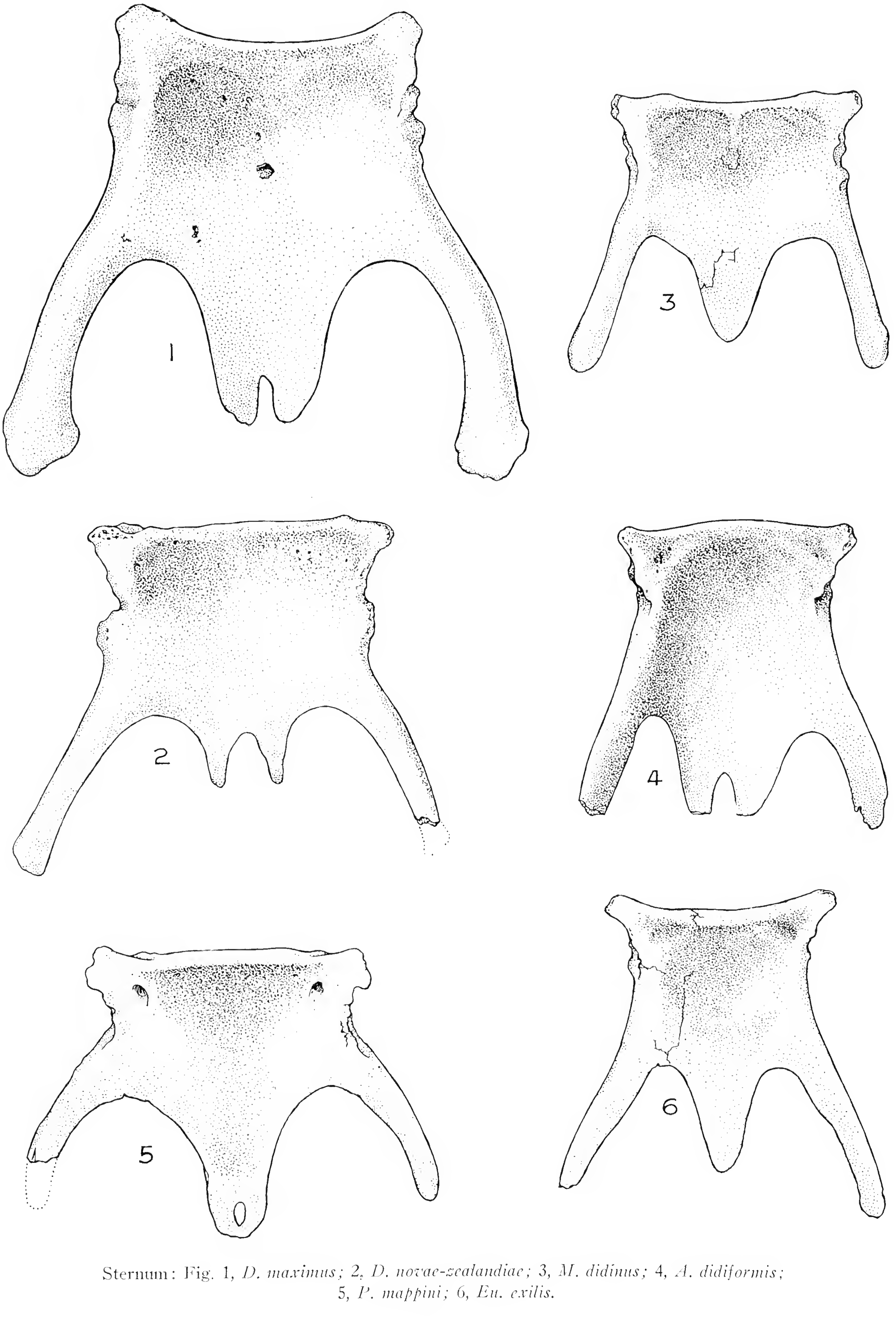


Pelvis: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *P. mappini*.

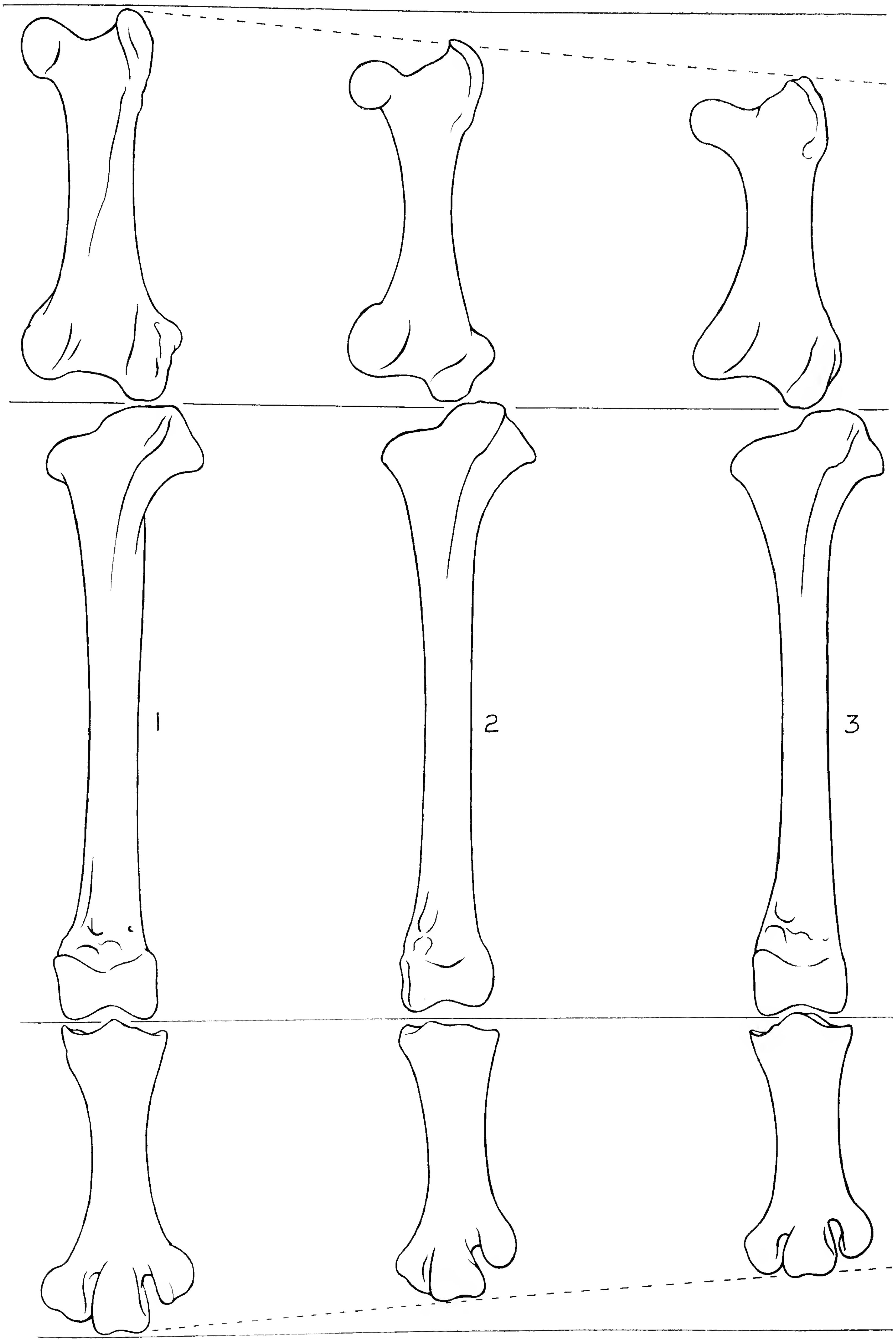


Pelvis: Fig. 1, *D. novae-zealandiae*; 2, *M. didinus*; 3, *A. didiformis*; 4, *P. mappini*.

PLATE 12.

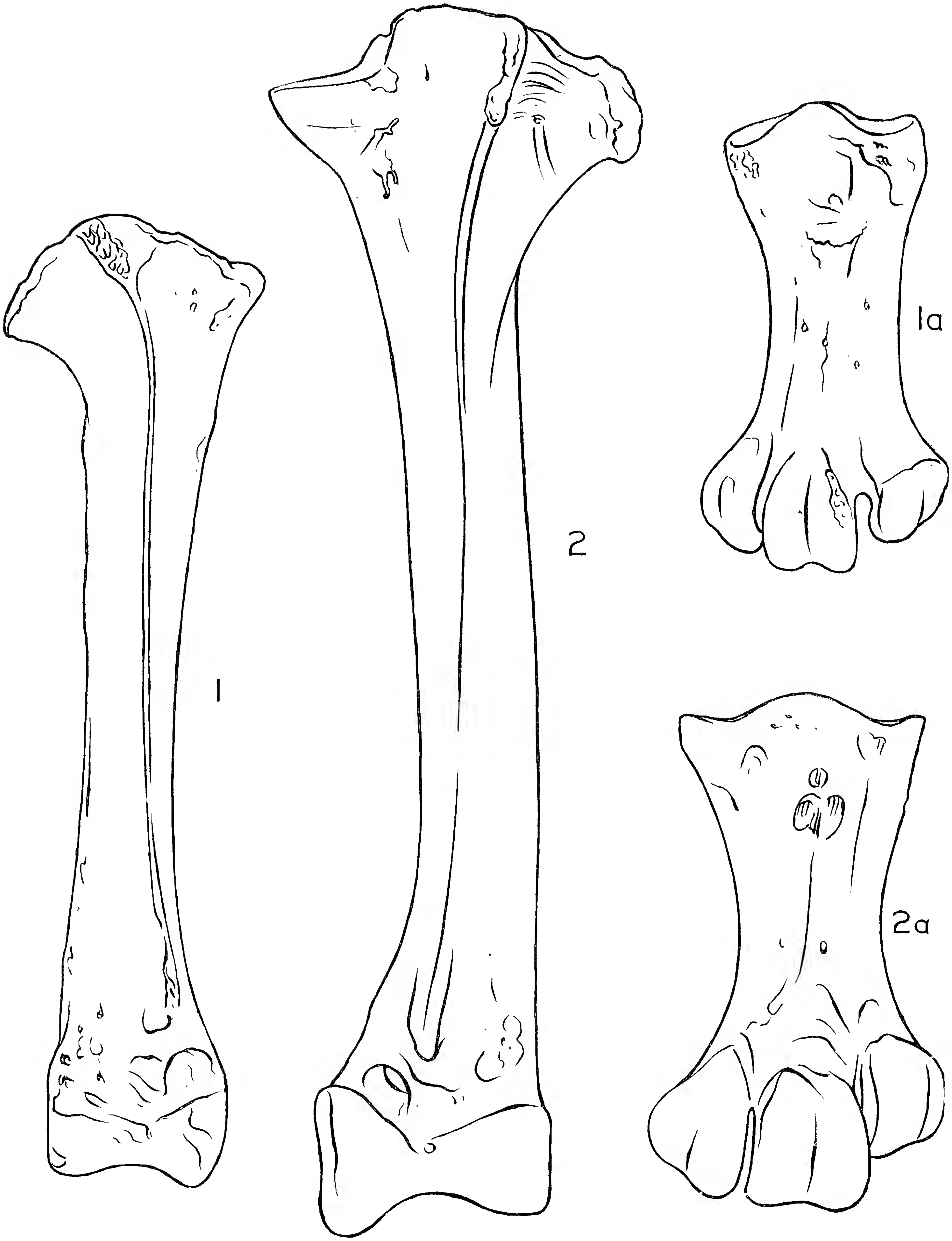


Sternum: Fig. 1, *D. maximus;* 2, *D. novae-zealandiae;* 3, *M. didinus;* 4, *A. didiformis;* 5, *P. mappini;* 6, *Eu. exilis.*



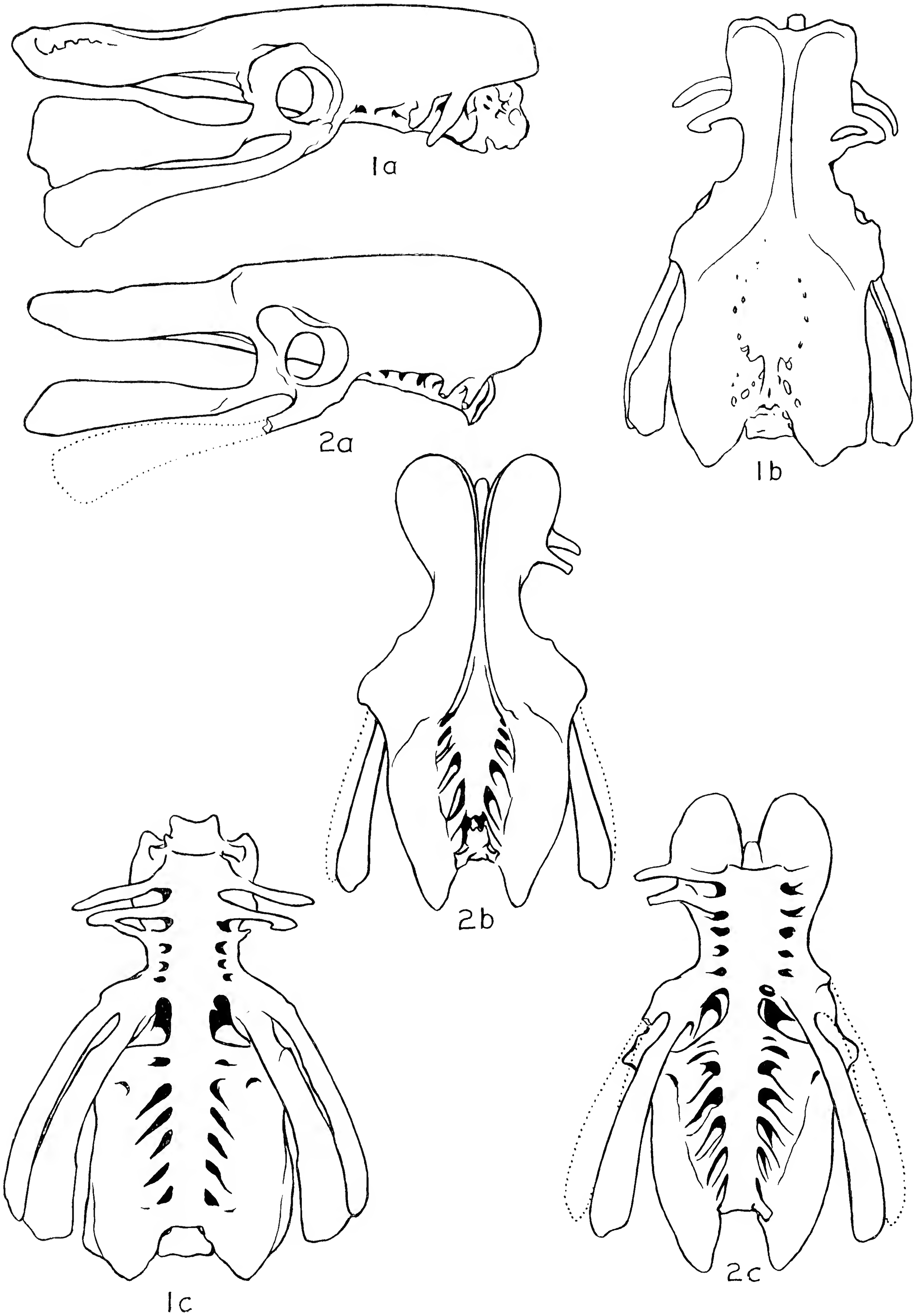
Sets of leg-bones of individual. Fig. 1, *A. didiformis;* 2, *Em. huttonii;* 3, *Eu. geranoides.*

PLATE 14.



Tibia and metatarsus: Figs. 1, 1a, *Eu. gravis* (after Owen, T.Z.S., 8, pls. 59, 58); 2, 2a. *P. elephantopus* (after Owen, T.Z.S., 4, pls. 47, fig. 5, and pl. 44, fig. 1).

PLATE 15.



Pelvis: Figs. 1a, 1b, 1c, *Pachyornis mappini*; 2a, 2b, 2c, *Euryapteryx exilis*.

NS OF LEG-BONES.

s, except a few in lighter type.

erbury Museum; O.M., Otago Museum; B.M., British Museum; W.M., Wanganui Museum.

x *didiformis.*

	Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
.	33.2	13.0	36.1	39.7	25.8	7.9	14.6	21.8	.	.	.	.	60.7	.
9.3	33.8	13.3	33.4	40.7	.	9.1	14.6	24.6	30.6	16.4	42.4	43.8	64.5	49.7
.	.	.	.	.	.	.	.	.	32.7	18.3	44.2	.	.	.
9.3	33.8	13.0	36.5	39.6	.	8.0	15.7	22.5	30.8	17.7	41.2	46.3	61.7	47.0
9.9	35.0	14.8	37.1	44.2	28.2	9.9	15.3	26.3	33.9	19.7	42.7	49.8	62.2	47.6
9.4	34.8	14.1	.	43.0	26.3	8.9	14.7	23.7	.	.	.	.	.	.
.	34.7	14.1	35.6	.	27.3	8.9	14.8	.	35.5	17.9	.	.	62.3	49.5
9.1	35.9	15.9	34.6	47.2	.	8.6	.	23.7	.	18.5	42.0	48.9	60.5	46.0
9.4	37.2	15.0	38.6	44.4	26.6	8.6	14.7	24.4	32.5	19.4	44.3	50.1	62.2	46.3
.	.	14.4	38.6	.	27.1	9.0	14.9	.	32.5	19.5	44.5	.	.	.
.	37.1	15.0	38.6	.	30.4	9.2	15.5	.	36.2	18.8	46.6	.	63.8	48.6
8.7	32.9	12.7	35.3	42.0	26.6	8.5	14.3	22.9	31.3	17.6	40.5	46.2	61.8	47.6
.	33.4	13.0	35.6	.	26.1	8.5	14.2	.	31.3	17.5	40.4	.	.	.
8.6	32.8	13.2	37.0	39.2	29.4	8.3	15.3	22.6	32.2	16.8	41.4	43.2	65.0	50.0
8.7	32.8	13.2	37.3	38.8	29.4	8.2	15.2	22.7	32.3	16.8	41.8	43.9	65.0	50.0
9.5	35.3	14.3	37.2	44.1	28.4	9.5	15.6	26.5	34.2	19.6	45.2	50.7	64.0	47.5
9.6	35.4	14.5	37.9	44.2	28.9	9.6	15.6	26.1	33.9	19.4	44.7	50.6	.	.
8.6	.	.	.	.	.	8.0	15.6	23.3	32.2	17.6	42.0	44.6	.	49.3
8.6	37.5	15.0	35.8	44.0	27.2	7.9	16.1	21.5	34.1	18.0	44.1	46.0	63.6	49.0
.	37.0	14.8	36.2	.	27.4	7.9	15.7	.	34.3	17.8	45.0	.	.	.
.	37.0	14.8	36.2	.	29.0	7.5	14.2	.	.	20.7	47.9	.	62.9	43.5
8.6	36.2	15.7	35.8	46.1	26.8	6.7	15.0	25.0	33.1	17.3	45.0	45.3	65.0	50.0
.	35.8	14.8	37.8	44.4	.	.	.	.	.	.	.	.	.	.
.	37.4	14.6	43.0	.	26.3	8.9	14.4	.	35.6	20.7	45.4	.	61.8	41.6
8.2	30.7	12.4	32.9	38.2	25.6	8.6	.	23.6	31.5	17.4	41.5	45.6	62.7	47.5
8.1	34.2	13.5	35.6	.	25.8	9.2	16.4	25.3	34.1	16.9	43.5	44.6	61.3	47.6
.	35.0	13.8	35.9	.	.	.	.	.	34.6	16.9	43.9	.	.	.
.	34.1	14.5	38.2	.	26.0	8.8	14.4	.	32.2	17.2	43.0	.	60.2	49.0
8.3	31.3	13.3	33.9	40.3	.	.	.	.	34.6	18.5	.	47.8	.	.
.	31.4	13.3	34.2	.	.	.	.	.	.	18.3	42.8	.	.	.
.	.	.	.	.	32.5	8.4	15.4	.	34.2	19.0	44.4	.	.	47.5
8.4	32.9	13.0	33.7	40.7	26.6	8.8	.	23.6	32.5	17.5	42.9	47.5	63.6	47.3
.	.	.	.	.	27.0	8.9	14.4	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	32.8	18.2	44.7	.	.	.
8.5	35.2	14.5	37.4	42.9	28.9	9.0	15.5	24.0	35.1	19.3	43.6	50.1	64.1	45.2
8.5	35.7	14.7	37.4	42.9	28.4	8.8	15.6	24.0	35.5	19.5	43.7	50.0	.	.
8.0	29.3	13.4	32.3	42.1	26.6	9.3	15.6	24.6	34.4	17.6	44.5	44.5	62.9	48.1
8.0	34.6	12.6	36.3	40.8	25.2	8.6	15.3	24.6	29.3	15.8	39.0	42.1	65.7	52.0
.	37.0	12.6	36.0	41.7	25.9	8.6	14.8	.	30.1	16.0	40.1	.	.	.
.	35.7	13.4	38.3	43.2	28.1	9.1	15.0	25.2	.	.	.	.	61.7	.
7.9	31.2	11.2	32.8	37.6	24.4	8.4	14.3	22.8	33.5	18.6	44.0	49.0	63.7	44.3
7.6	34.0	12.7	.	40.4	27.4	8.5	14.6	23.3	32.0	16.7	41.7	43.5	63.1	48.4
.	34.6	12.4	37.2	.	27.4	8.3	14.5	.	32.0	16.7	41.7	.	.	.
7.6	.	.	.	.	26.1	8.2	15.3	22.4	33.6	16.6	40.7	43.0	.	49.0
8.2	32.8	13.2	34.5	41.8	25.9	8.5	13.8	23.1	32.0	19.0	43.2	48.3	61.1	47.2
.	.	.	.	.	26.1	8.6	14.2	.	31.8	19.0	42.1	.	.	.
8.7	37.8	14.0	36.6	46.5	26.1	8.9	14.7	24.7	37.0	18.7	42.2	53.7	60.3	45.2
8.6	37.3	13.9	36.8	45.5	25.9	8.9	15.0	24.5	37.0	18.7	42.5	53.6	.	.
8.2	36.0	13.2	34.7	43.1	25.9	8.7	15.3	24.0	33.8	18.1	45.1	47.4	66.0	48.0
.	.	.	.	.	27.1	8.8	15.4	.	33.8	18.1	45.1	.	.	.
8.1	33.3	13.2	36.0	39.8	27.9	8.9	16.7	23.6	36.0	18.0	43.1	46.2	67.3	49.7
8.1	.	.	.	.	28.4	8.7	16.6	23.7	35.5	17.9	42.8	46.2	.	.
7.9	.	12.7	35.2	39.8	27.3	8.3	15.1	23.4	33.4	18.8	46.6	44.0	64.0	46.3
.	.	12.8	35.1	.	.	8.2	15.1	.	33.4	19.0	45.5	.	.	.
7.6	30.0	13.5	32.6	40.5	26.2	8.7	15.2	23.4	32.5	17.8	41.6	45.7	65.8	47.6
.	30.0	13.5	32.2	40.5	.	8.7	15.2	23.4	.	.	.	.	.	.
8.0	33.2	12.5	36.1	39.6	27.7	8.1	16.1	22.5	33.1	17.2	43.9	45.0	65.3	51.0
.	34.8	13.7	31.1	.	.	.	.	.	33.4	18.6	40.8	.	.	.
7.4	.	.	.	.	26.3	8.0	14.1	22.4	31.6	17.3	42.1	46.4	.	.
7.4	36.2	13.1	36.7	40.7	26.3	8.0	14.1	22.4	31.5	17.7	42.5	46.3	61.5	46.5
.	.	.	.	.	.	6.4	14.4	.	32.0	17.6	41.9	.	.	49.8
.	.	.	.	.	.	.	.	.	32.2	19.2	44.4	.	.	.
.	.	.	.	.	.	.	.	.	32.5	19.1	44.1	.	.	.
.	32.6	12.8	36.1	.	.	.	14.0	.	28.8	17.0	49.0	.	61.7	48.6
.	34.7	14.0	.	.	27.1	8.7	15.3	.	32.5	19.1	42.0	.	65.3	48.6
.	34.0	13.8	36.0	.	27.8	8.7	15.3	.	32.4	19.0	40.5	.	.	.

DIMENSIONS AND PROPORTIONS OF LEG-BONES.

All measurements are from individual skeletons, except a few in lighter type.

References: A.M., Auckland Museum; D.M., Dominion Museum; H.B., Hawke's Bay Museum; C.M., Canterbury Museum; O.M., Otago Museum; B.M., British Museum; W.M., Wanganui Museum.

TABLE A. *Anomalopteryx didiformis.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Waikaremoana. A.M. 72	26.4	8.8	3.4	9.5	10.5	43.4	11.2	3.4	6.4	9.5	.	.	.	.	.	33.2	13.0	36.1	39.7	25.8	7.9	14.6	21.8	.	.	.	.	60.7	.
Pataua. A.M.	27.5	9.3	3.6	9.2	11.2	42.7	.	3.9	6.2	10.5	21.2	6.5	3.5	9.0	9.3	33.8	13.3	33.4	40.7	.	9.1	14.6	24.6	30.6	16.4	42.4	43.8	64.5	49.7
Glenmark. Leetotype *fortis.* C.M.	.	.	.	.	.	.	.	.	.	.	20.8	6.8	3.8	9.1	.	.	.	.	.	.	.	.	.	32.7	18.3	44.2	.	.	.
Mt. Arthur. A.M. 121	26.3	8.9	3.4	9.6	10.5	42.6	.	3.4	6.7	9.6	20.1	6.2	3.6	8.3	9.3	33.8	13.0	36.5	39.6	.	8.0	15.7	22.5	30.8	17.7	41.2	46.3	61.7	47.0
Mangaotaki. A.M. 184	26.0	9.1	3.8	9.6	11.5	41.8	11.8	4.1	6.4	11.0	19.9	6.7	3.9	8.5	9.9	35.0	14.8	37.1	44.2	28.2	9.9	15.3	26.3	33.9	19.7	42.7	49.8	62.2	47.6
Mangaotaki. A.M. 128	25.8	9.0	3.6	.	11.1	41.4	11.1	3.7	6.1	9.8	.	.	.	.	9.4	34.8	14.1	.	43.0	26.3	8.9	14.7	23.7	.	.	.	.	.	.
	25.8	8.9	3.6	9.2	.	41.3	11.3	3.7	6.1	.	19.5	6.9	3.5	.	.	34.7	14.1	35.6	.	27.3	8.9	14.8	.	35.5	17.9	.	.	62.3	49.5
Waikaremoana. A.M. 148	24.8	8.9	3.8	8.6	11.7	41.0	.	3.5	.	9.7	18.8	.	3.5	7.8	9.1	35.9	15.9	34.6	47.2	.	8.6	.	23.7	.	18.5	42.0	48.9	60.5	46.0
Mt. Arthur. A.M. 114	25.2	9.4	3.8	9.7	11.2	40.6	10.8	3.5	6.0	9.9	18.7	6.1	3.6	8.3	9.4	37.2	15.0	38.6	44.4	26.6	8.6	14.7	24.4	32.5	19.4	44.3	50.1	62.2	46.3
	25.2	.	3.7	9.7	.	40.5	11.0	3.6	6.0	.	18.6	6.1	3.6	8.3	.	.	14.4	38.6	.	27.1	9.0	14.9	.	32.5	19.5	44.5	.	.	.
Mangaotaki. A.M.	25.6	9.5	3.8	9.9	.	40.1	12.2	3.7	6.2	.	19.5	7.0	3.7	9.1	.	37.1	15.0	38.6	.	30.4	9.2	15.5	.	36.2	18.8	46.6	.	63.8	48.6
Mt. Arthur. A.M. 117	24.3	8.0	3.1	8.6	10.1	39.8	10.6	3.4	5.7	9.1	18.8	5.9	3.3	7.6	8.7	32.9	12.7	35.3	42.0	26.6	8.5	14.3	22.9	31.3	17.6	40.5	46.2	61.8	47.6
	24.1	8.0	3.1	8.6	.	39.6	10.3	3.4	5.6	.	18.9	5.9	3.3	7.6	.	33.4	13.0	35.6	.	26.1	8.5	14.2	.	31.3	17.5	40.4	.	.	.
Waikaremoana. A.M. 70	25.7	8.5	3.4	9.5	10.1	39.6	11.7	3.3	6.1	9.1	19.9	6.4	3.3	8.2	8.6	32.8	13.2	37.0	39.2	29.4	8.3	15.3	22.6	32.2	16.8	41.4	43.2	65.0	50.0
	25.7	8.5	3.4	9.6	10.0	39.5	11.6	3.2	6.0	9.0	19.8	6.4	3.3	8.3	8.7	32.8	13.2	37.3	38.8	29.4	8.2	15.2	22.7	32.3	16.8	41.8	43.9	65.0	50.0
Waikaremoana. A.M. 71	25.1	8.9	3.6	9.4	11.1	39.3	11.2	3.7	6.1	10.2	18.7	6.4	3.7	8.5	9.5	35.3	14.3	37.2	44.1	28.4	9.5	15.6	26.5	34.2	19.6	45.2	50.7	64.0	47.5
	25.1	8.9	3.7	9.4	11.1	39.2	11.4	3.7	6.1	10.2	18.9	6.4	3.7	8.5	9.6	35.4	14.5	37.9	44.2	28.9	9.6	15.6	26.1	33.9	19.4	44.7	50.6	.	.
Waikaremoana. A.M. 82	.	.	.	.	10.5	39.0	.	3.2	6.1	9.1	19.3	6.2	3.4	8.1	8.6	.	.	.	.	.	8.0	15.6	23.3	32.2	17.6	42.0	44.6	.	49.3
Waikaremoana. A.M. 60	24.3	9.1	3.6	8.7	10.6	38.6	10.5	3.0	6.2	8.3	18.7	6.4	3.4	8.4	8.6	37.5	15.0	35.8	44.0	27.2	7.9	16.1	21.5	34.1	18.0	44.1	46.0	63.6	49.0
	24.3	9.1	3.6	8.8	.	38.2	10.5	3.0	6.0	.	18.7	6.4	3.3	8.3	.	37.0	14.8	36.2	.	27.4	7.9	15.7	.	34.3	17.8	45.0	.	.	.
Unlocalized: prob. individual. A.M.	24.3	9.1	3.6	8.8	.	38.6	11.2	2.9	5.8	.	16.8	.	3.5	8.0	.	37.0	14.8	36.2	.	29.0	7.5	14.2	.	.	20.7	47.9	.	62.9	43.5
Mangaotaki. A.M. 188	24.7	8.9	3.9	8.8	11.4	38.0	10.2	2.5	5.7	9.5	19.0	6.3	3.3	8.5	8.6	36.2	15.7	35.8	46.1	26.8	6.7	15.0	25.0	33.1	17.3	45.0	45.3	65.0	50.0
Poverty Bay. Type *dromaeoides*	23.6	8.5	3.5	8.9	10.5	.	.	.	.	.	.	.	.	.	.	35.8	14.8	37.8	44.4	.	.	.	.	.	.	.	.	.	.
Locality? Tring Mus.	23.5	8.8	3.4	10.1	.	38.0	10.0	3.4	5.5	.	17.5	6.2	3.6	7.9	.	37.4	14.6	43.0	.	26.3	8.9	14.4	.	35.6	20.7	45.4	.	61.8	41.6
Collingwood. C.M. 3.4.12	23.9	7.6	3.1	8.2	9.5	38.1	9.7	3.3	.	9.0	18.1	5.7	3.1	7.5	8.2	30.7	12.4	32.9	38.2	25.6	8.6	.	23.6	31.5	17.4	41.5	45.6	62.7	47.5
Te Anga. A.M. 153	23.3	8.0	3.1	8.3	9.7	38.0	9.8	3.5	6.2	9.5	18.1	6.2	3.1	7.9	8.1	34.2	13.5	35.6	.	25.8	9.2	16.4	25.3	34.1	16.9	43.5	44.6	61.3	47.6
	23.1	8.1	3.2	8.3	.	.	.	.	.	.	18.2	6.3	3.1	8.0	.	35.0	13.8	35.9	.	.	.	.	.	34.6	16.9	43.9	.	.	.
S. Is. coll Haast. ? indiv. A.M. 134	22.9	7.8	3.3	8.1	.	38.0	9.9	3.3	5.5	.	18.6	6.0	3.2	8.0	.	34.1	14.5	38.2	.	26.0	8.8	14.4	.	32.2	17.2	43.0	.	60.2	49.0
Waikaremoana. A.M. 63	24.7	7.7	3.3	8.4	10.0	.	.	3.4	5.7	8.9	17.3	6.0	3.2	.	8.3	31.3	13.3	33.9	40.3	.	.	.	.	34.6	18.5	.	47.8	.	.
	24.7	7.9	3.3	8.4	.	.	.	.	.	.	17.3	5.7	3.2	7.5	.	31.4	13.3	34.2	.	.	.	.	.	.	18.3	42.8	.	.	.
Awamarino. A.M.	.	.	.	.	.	37.8	9.6	3.2	5.8	.	18.1	6.2	3.4	8.0	.	.	.	.	.	32.5	8.4	15.4	.	34.2	19.0	44.4	.	.	47.5
Mangaotaki. A.M. 156	24.0	7.9	3.1	8.1	9.8	37.7	10.0	3.3	.	8.9	17.7	5.7	3.1	7.6	8.4	32.9	13.0	33.7	40.7	26.6	8.8	.	23.6	32.5	17.5	42.9	47.5	63.6	47.3
	.	.	.	.	.	37.4	10.1	3.3	5.4	.	.	.	.	.	.	.	.	.	.	27.0	8.9	14.4	.	.	.	.	.	.	.
Poverty Bay. Type *didiformis*	.	.	.	.	.	.	.	.	.	.	17.5	5.7	3.2	7.8	.	.	.	.	.	.	.	.	.	32.8	18.2	44.7	.	.	.
Waikaremoana. A.M. 55	24.0	8.6	3.5	9.0	10.3	37.5	10.8	3.4	5.8	9.0	16.9	6.1	3.3	7.4	8.5	35.2	14.5	37.4	42.9	28.9	9.0	15.5	24.0	35.1	19.3	43.6	50.1	64.1	45.2
	24.0	8.5	3.5	9.0	10.3	37.4	10.6	3.3	5.8	9.0	16.9	6.0	3.3	7.4	8.5	35.7	14.7	37.4	42.9	28.4	8.8	15.6	24.0	35.5	19.5	43.7	50.0	.	.
Waikaremoana. A.M. 78	23.5	6.9	3.2	7.6	9.9	37.4	10.0	3.5	5.8	9.2	18.0	6.2	3.2	8.0	8.0	29.3	13.4	32.3	42.1	26.6	9.3	15.6	24.6	34.4	17.6	44.5	44.5	62.9	48.1
Castle Rocks. O.M.	24.5	8.5	3.1	8.9	10.0	36.5	9.2	3.1	5.6	9.0	19.0	5.6	3.0	7.4	8.0	34.6	12.6	36.3	40.8	25.2	8.6	15.3	24.6	29.3	15.8	39.0	42.1	65.7	52.0
	24.0	8.9	3.0	8.7	10.0	36.0	9.3	3.1	5.3	.	18.7	5.6	3.0	7.5	.	37.0	12.6	36.0	41.7	25.9	8.6	14.8	.	30.1	16.0	40.1	.	.	.
Mangaotaki. A.M. 126	22.5	8.0	3.0	8.5	9.7	36.5	10.3	3.3	5.5	9.2	.	.	.	.	.	35.7	13.4	38.3	43.2	28.1	9.1	15.0	25.2	.	.	.	.	61.7	.
Castle Rocks. C.M. 3.4.3	23.1	7.2	2.6	7.6	8.7	36.3	8.8	3.0	5.2	8.2	16.1	5.4	3.0	7.1	7.9	31.2	11.2	32.8	37.6	24.4	8.4	14.3	22.8	33.5	18.6	44.0	49.0	63.7	44.3
Mangaotaki. A.M. 151	22.8	7.7	2.8	.	9.2	36.1	9.9	3.1	5.3	8.4	17.5	5.6	2.9	7.3	7.6	34.0	12.7	.	40.4	27.4	8.5	14.6	23.3	32.0	16.7	41.7	43.5	63.1	48.4
	22.8	7.9	2.8	8.5	.	36.1	9.9	3.0	5.2	.	17.5	5.6	2.9	7.4	.	34.6	12.4	37.2	.	27.4	8.3	14.5	.	32.0	16.7	41.7	.	.	.
Waikaremoana. A.M. 150	.	.	.	.	.	36.1	9.4	3.0	5.5	8.1	17.7	5.8	2.9	7.2	7.6	.	.	.	.	26.1	8.2	15.3	22.4	33.6	16.6	40.7	43.0	.	49.0
Mangaotaki. A.M. 51	22.7	7.5	3.0	7.9	9.5	36.0	9.3	3.0	5.0	8.3	17.0	5.4	3.2	7.3	8.2	32.8	13.2	34.5	41.8	25.9	8.5	13.8	23.1	32.0	19.0	43.2	48.3	61.1	47.2
	.	.	.	.	.	35.9	9.4	3.1	5.1	.	17.1	5.4	3.3	7.2	.	.	.	.	.	26.1	8.6	14.2	.	31.8	19.0	42.1	.	.	.
Locality ? O.M. C.34.11	21.7	8.2	3.0	7.9	10.1	36.0	9.4	3.2	5.3	8.9	16.2	6.0	3.4	6.8	8.7	37.8	14.0	36.6	46.5	26.1	8.9	14.7	24.7	37.0	18.7	42.2	53.7	60.3	45.2
	21.7	8.1	3.0	8.0	9.9	35.9	9.3	3.2	5.4	8.8	16.2	5.9	3.4	6.9	8.6	37.3	13.9	36.8	45.5	25.9	8.9	15.0	24.5	37.0	18.7	42.5	53.6	.	.
Waikaremoana. A.M. 149	23.7	8.5	3.1	8.2	10.1	35.9	9.7	3.1	5.5	8.6	17.3	5.8	3.1	7.8	8.2	36.0	13.2	34.7	43.1	25.9	8.7	15.3	24.0	33.8	18.1	45.1	47.4	66.0	48.0
	.	.	.	.	.	35.8	9.7	3.1	5.5	.	17.3	5.8	3.1	7.7	.	.	.	.	.	27.1	8.8	15.4	.	33.8	18.1	45.1	.	.	.
Nuhaka. D.M.	23.7	7.9	3.1	8.6	9.4	35.2	9.8	3.0	5.9	8.3	17.5	6.3	3.2	7.5	8.1	33.3	13.2	36.0	39.8	27.9	8.9	16.7	23.6	36.0	18.0	43.1	46.2	67.3	49.7
	.	.	.	.	.	35.5	10.1	3.1	5.9	8.4	17.5	6.2	3.1	7.5	8.1	.	.	.	.	28.4	8.7	16.6	23.7	35.5	17.9	42.8	46.2	.	.
Mangaotaki. A.M. 152	22.4	.	2.8	7.9	8.9	35.1	9.6	2.9	5.3	8.2	16.1	5.4	3.0	7.5	7.9	.	12.7	35.2	39.8	27.3	8.3	15.1	23.4	33.4	18.8	46.6	44.0	64.0	46.3
	22.2	.	2.8	7.8	.	34.9	.	2.9	5.3	.	16.2	5.4	3.1	7.4	.	.	12.8	35.1	.	.	8.2	15.1	.	33.4	19.0	45.5	.	.	.
Waikaremoana. A.M. 89	23.0	6.9	3.1	7.5	9.3	34.9	9.2	3.1	5.2	8.2	16.6	5.4	3.0	6.9	7.6	30.0	13.5	32.6	40.5	26.2	8.7	15.2	23.4	32.5	17.8	41.6	45.7	65.8	47.6
	23.0	6.9	3.1	7.4	9.3	34.9	.	3.1	5.2	8.2	.	.	.	.	.	30.0	13.5	32.2	40.5	.	8.7	15.2	23.4	.	.	.	.	.	.
Waikaremoana. A.M. 66	22.7	7.6	2.8	8.2	9.0	34.7	9.6	2.8	5.6	7.8	17.7	5.9	3.1	7.8	8.0	33.2	12.5	36.1	39.6	27.7	8.1	16.1	22.5	33.1	17.2	43.9	45.0	65.3	51.0
Mangaotaki. A.M. 155	21.5	7.5	2.9	6.7	.	.	.	.	.	.	16.3	5.4	3.0	6.8	.	34.8	13.7	31.1	.	.	.	.	.	33.4	18.6	40.8	.	.	.
Waikaremoana. A.M. 69	.	7.7	2.7	.	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.7	7.4	.	.	.	.	26.3	8.0	14.1	22.4	31.6	17.3	42.1	46.4	.	.
	21.1	7.6	2.8	7.8	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.8	7.4	36.2	13.1	36.7	40.7	26.3	8.0	14.1	22.4	31.5	17.7	42.5	46.3	61.5	46.5
Waikaremoana. A.M. 82	.	.	.	.	.	33.5	.	2.1	4.8	.	16.7	5.3	2.9	7.0	.	.	.	.	.	.	6.4	14.4	.	32.0	17.6	41.9	.	.	49.8
Hangatiki. A.M. 102	.	.	.	.	.	.	.	.	.	.	16.6	5.3	3.2	7.4	.	.	.	.	.	.	.	.	.	32.2	19.2	44.4	.	.	.
	.	.	.	.	.	.	.	.	.	.	16.5	5.4	3.2	7.3	.	.	.	.	.	.	.	.	.	32.5	19.1	44.1	.	.	.
Nelson. Type *parvus.* B. M.	20.0	6.6	2.6	7.3	.	32.7	.	.	4.6	.	15.9	4.6	2.7	7.8	.	32.6	12.8	36.1	.	.	.	14.0	.	28.8	17.0	49.0	.	61.7	48.6
Waiau. C.M. 3.4.11	21.3	7.4	3.0	.	.	32.3	8.7	2.8	4.9	.	15.7	5.1	3.0	6.6	.	34.7	14.0	.	.	27.1	8.7	15.3	.	32.5	19.1	42.0	.	65.3	48.6
	21.3	7.4	2.9	7.7	.	32.3	9.0	2.8	5.0	.	15.8	5.1	3.0	6.6	.	34.0	13.8	36.0	.	27.8	8.7	15.3	.	32.4	19.0	40.5	.	.	.

DIMENSIONS AND PROPORTIO

All measurements are from individual skeleton

References: A.M., Auckland Museum; D.M., Dominion Museum; H.B., Hawke's Bay Museum; C.M., Cant

TABLE A. *Anomaloptery*

	Femur.					Tibia.					Metatarsus.			
	L	P	M	D	G	L	P	M	D	G	L	P	M	D
Waikaremoana. A.M. 72	26.4	8.8	3.4	9.5	10.5	43.4	11.2	3.4	6.4	9.5	.	.	.	.
Pataua. A.M.	27.5	9.3	3.6	9.2	11.2	42.7	.	3.9	6.2	10.5	21.2	6.5	3.5	9.0
Glenmark. Lectotype *fortis*. C.M.	.	.	.	.	.	.	.	.	.	.	20.8	6.8	3.8	9.1
Mt. Arthur. A.M. 121	26.3	8.9	3.4	9.6	10.5	42.6	.	3.4	6.7	9.6	20.1	6.2	3.6	8.3
Mangaotaki. A.M. 184	26.0	9.1	3.8	9.6	11.5	41.8	11.8	4.1	6.4	11.0	19.9	6.7	3.9	8.5
Mangaotaki. A.M. 128	25.8	9.0	3.6	.	11.1	41.4	11.1	3.7	6.1	9.8	.	.	.	.
	25.8	8.9	3.6	9.2	.	41.3	11.3	3.7	6.1	.	19.5	6.9	3.5	.
Waikaremoana. A.M. 148	24.8	8.9	3.8	8.6	11.7	41.0	.	3.5	.	9.7	18.8	.	3.5	7.8
Mt. Arthur. A.M. 114	25.2	9.4	3.8	9.7	11.2	40.6	10.8	3.5	6.0	9.9	18.7	6.1	3.6	8.3
	25.2	.	3.7	9.7	.	40.5	11.0	3.6	6.0	.	18.6	6.1	3.6	8.3
Mangaotaki. A.M.	25.6	9.5	3.8	9.9	.	40.1	12.2	3.7	6.2	.	19.5	7.0	3.7	9.1
Mt. Arthur. A.M. 117	24.3	8.0	3.1	8.6	10.1	39.8	10.6	3.4	5.7	9.1	18.8	5.9	3.3	7.6
	24.1	8.0	3.1	8.6	.	39.6	10.3	3.4	5.6	.	18.9	5.9	3.3	7.6
Waikaremoana. A.M. 70	25.7	8.5	3.4	9.5	10.1	39.6	11.7	3.3	6.1	9.1	19.9	6.4	3.3	8.2
	25.7	8.5	3.4	9.6	10.0	39.5	11.6	3.2	6.0	9.0	19.8	6.4	3.3	8.3
Waikaremoana. A.M. 71	25.1	8.9	3.6	9.4	11.1	39.3	11.2	3.7	6.1	10.2	18.7	6.4	3.7	8.5
	25.1	8.9	3.7	9.4	11.1	39.2	11.4	3.7	6.1	10.2	18.9	6.4	3.7	8.5
Waikaremoana. A.M. 82	.	.	.	.	10.5	39.0	.	3.2	6.1	9.1	19.3	6.2	3.4	8.1
Waikaremoana. A.M. 60	24.3	9.1	3.6	8.7	10.6	38.6	10.5	3.0	6.2	8.3	18.7	6.4	3.4	8.4
	24.3	9.1	3.6	8.8	.	38.2	10.5	3.0	6.0	.	18.7	6.4	3.3	8.3
Unlocalized: prob. individual. A.M.	24.3	9.1	3.6	8.8	.	38.6	11.2	2.9	5.8	.	16.8	.	3.5	8.0
Mangaotaki. A.M. 188	24.7	8.9	3.9	8.8	11.4	38.0	10.2	2.5	5.7	9.5	19.0	6.3	3.3	8.5
Poverty Bay. Type *dromaeoides*	23.6	8.5	3.5	8.9	10.5	.	.	.	.	.	.	.	.	.
Locality? Tring Mus.	23.5	8.8	3.4	10.1	.	38.0	10.0	3.4	5.5	.	17.5	6.2	3.6	7.9
Collingwood. C.M. 3.4.12	23.9	7.6	3.1	8.2	9.5	38.1	9.7	3.3	.	9.0	18.1	5.7	3.1	7.5
Te Anga. A.M. 153	23.3	8.0	3.1	8.3	9.7	38.0	9.8	3.5	6.2	9.5	18.1	6.2	3.1	7.9
	23.1	8.1	3.2	8.3	.	.	.	.	.	.	18.2	6.3	3.1	8.0
S. Is. coll Haast. ? indiv. A.M. 134	22.9	7.8	3.3	8.1	.	38.0	9.9	3.3	5.5	.	18.6	6.0	3.2	8.0
Waikaremoana. A.M. 63	24.7	7.7	3.3	8.4	10.0	.	.	3.4	5.7	8.9	17.3	6.0	3.2	.
	24.7	7.9	3.3	8.4	.	.	.	.	.	.	17.3	5.7	3.2	7.5
Awamarino. A.M.	.	.	.	.	.	37.8	9.6	3.2	5.8	.	18.1	6.2	3.4	8.0
Mangaotaki. A.M. 156	24.0	7.9	3.1	8.1	9.8	37.7	10.0	3.3	.	8.9	17.7	5.7	3.1	7.6
	.	.	.	.	.	37.4	10.1	3.3	5.4	.	.	.	.	.
Poverty Bay. Type *didiformis*	.	.	.	.	.	.	.	.	.	.	17.5	5.7	3.2	7.8
Waikaremoana. A.M. 55	24.0	8.6	3.5	9.0	10.3	37.5	10.8	3.4	5.8	9.0	16.9	6.1	3.3	7.4
	24.0	8.5	3.5	9.0	10.3	37.4	10.6	3.3	5.8	9.0	16.9	6.0	3.3	7.4
Waikaremoana. A.M. 78	23.5	6.9	3.2	7.6	9.9	37.4	10.0	3.5	5.8	9.2	18.0	6.2	3.2	8.0
Castle Rocks. O.M.	24.5	8.5	3.1	8.9	10.0	36.5	9.2	3.1	5.6	9.0	19.0	5.6	3.0	7.4
	24.0	8.9	3.0	8.7	10.0	36.0	9.3	3.1	5.3	.	18.7	5.6	3.0	7.5
Mangaotaki. A.M. 126	22.5	8.0	3.0	8.5	9.7	36.5	10.3	3.3	5.5	9.2	.	.	.	.
Castle Rocks. C.M. 3.4.3	23.1	7.2	2.6	7.6	8.7	36.3	8.8	3.0	5.2	8.2	16.1	5.4	3.0	7.1
Mangaotaki. A.M. 151	22.8	7.7	2.8	.	9.2	36.1	9.9	3.1	5.3	8.4	17.5	5.6	2.9	7.3
	22.8	7.9	2.8	8.5	.	36.1	9.9	3.0	5.2	.	17.5	5.6	2.9	7.4
Waikaremoana. A.M. 150	.	.	.	.	.	36.1	9.4	3.0	5.5	8.1	17.7	5.8	2.9	7.2
Mangaotaki. A.M. 51	22.7	7.5	3.0	7.9	9.5	36.0	9.3	3.0	5.0	8.3	17.0	5.4	3.2	7.3
	.	.	.	.	.	35.9	9.4	3.1	5.1	.	17.1	5.4	3.3	7.2
Locality ? O.M. C.34.11	21.7	8.2	3.0	7.9	10.1	36.0	9.4	3.2	5.3	8.9	16.2	6.0	3.4	6.8
	21.7	8.1	3.0	8.0	9.9	35.9	9.3	3.2	5.4	8.8	16.2	5.9	3.4	6.9
Waikaremoana. A.M. 149	23.7	8.5	3.1	8.2	10.1	35.9	9.7	3.1	5.5	8.6	17.3	5.8	3.1	7.8
	.	.	.	.	.	35.8	9.7	3.1	5.5	.	17.3	5.8	3.1	7.7
Nuhaka. D.M.	23.7	7.9	3.1	8.6	9.4	35.2	9.8	3.0	5.9	8.3	17.5	6.3	3.2	7.5
	.	.	.	.	.	35.5	10.1	3.1	5.9	8.4	17.5	6.2	3.1	7.5
Mangaotaki. A.M. 152	22.4	.	2.8	7.9	8.9	35.1	9.6	2.9	5.3	8.2	16.1	5.4	3.0	7.5
	22.2	.	2.8	7.8	.	34.9	.	2.9	5.3	.	16.2	5.4	3.1	7.4
Waikaremoana. A.M. 89	23.0	6.9	3.1	7.5	9.3	34.9	9.2	3.1	5.2	8.2	16.6	5.4	3.0	6.9
	23.0	6.9	3.1	7.4	9.3	34.9	.	3.1	5.2	8.2	.	.	.	.
Waikaremoana. A.M. 66	22.7	7.6	2.8	8.2	9.0	34.7	9.6	2.8	5.6	7.8	17.7	5.9	3.1	7.8
Mangaotaki. A.M. 155	21.5	7.5	2.9	6.7	.	.	.	.	.	.	16.3	5.4	3.0	6.8
Waikaremoana. A.M. 69	.	7.7	2.7	.	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.7
	21.1	7.6	2.8	7.8	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.8
Waikaremoana. A.M. 82	.	.	.	.	.	33.5	.	2.1	4.8	.	16.7	5.3	2.9	7.0
Hangatiki. A.M. 102	.	.	.	.	.	.	.	.	.	.	16.6	5.3	3.2	7.4
	.	.	.	.	.	.	.	.	.	.	16.5	5.4	3.2	7.3
Nelson. Type *parvus*. B. M.	20.0	6.6	2.6	7.3	.	32.7	.	.	4.6	.	15.9	4.6	2.7	7.8
Waiau. C.M. 3.4.11	21.3	7.4	3.0	.	.	32.3	8.7	2.8	4.9	.	15.7	5.1	3.0	6.6
	21.3	7.4	2.9	7.7	.	32.3	9.0	2.8	5.0	.	15.8	5.1	3.0	6.6

TABLE B. *Megalapteryx didinus.* *M. benhami.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Mt. Arthur. A.M. 164	25.4	.	3.0	7.5	9.7	42.7	8.4	3.0	5.1	8.5	18.9	5.3	2.8	7.4	7.5	.	11.8	29.7	38.2	.	7.0	11.9	19.9	27.7	14.6	39.0	39.6	59.4	43.4
	.	.	.	.	.	42.5	8.8	3.0	5.1	8.5	19.0	5.2	2.8	7.5	.	.	.	.	.	20.8	7.0	12.0	20.0	27.3	14.7	39.4	.	.	.
Type *Palaeocasuarius elegans*	27.3	8.2	.	8.6	.	40.6	.	.	5.1	.	19.8	.	3.8	8.4	.	30.2	.	31.6	.	.	.	12.5	.	.	19.2	41.7	.	67.0	48.8
Mt. Arthur. Tring Mus.	26.5	7.3	3.1	8.8	10.0	40.5	10.2	3.0	6.6	8.3	19.0	5.8	3.0	8.0	8.0	27.6	11.7	33.2	37.7	25.1	7.3	13.8	20.5	30.8	15.7	42.3	42.2	65.4	46.9
	26.7	.	3.0	8.0	10.0	40.5	10.1	3.1	6.6	8.3	19.0	5.8	3.0	8.2	8.0	.	11.2	33.3	37.4	25.0	7.6	13.8	20.5	30.8	16.0	43.3	42.2	.	.
L. Wakatipu. Type, *M. tenuipes*	25.3	.	.	8.2	.	40.5	.	.	4.4	.	.	.	.	.	.	.	.	32.4	.	.	.	10.8	.	.	.	.	.	62.5	.
Waingongoro. Type *hamiltoni.* B.M.	25.2	7.6	3.3	7.6	.	.	.	.	.	.	.	.	.	.	.	30.2	12.9	30.2	.	.	.	.	.	.	.	.	.	.	.
Queenstown. Type *didinus.* B.M.	.	.	.	.	.	40.0	9.5	3.1	6.6	.	18.8	6.3	3.8	.	.	.	.	.	.	23.7	7.9	16.5	.	33.5	20.2	.	.	.	47.0
	.	.	.	.	.	40.0	9.5	3.1	.	.	.	.	.	.	.	.	.	.	.	23.8	7.8	.	.	.	.	.	.	.	.
Mt. Arthur. A.M. 115	.	.	.	.	.	.	.	.	.	.	18.4	5.7	2.9	7.6	.	.	.	.	.	.	.	.	.	30.9	15.8	41.3	.	.	.
	.	.	.	.	.	.	.	.	.	.	18.2	5.6	2.9	7.6	.	.	.	.	.	.	.	.	.	30.9	15.9	41.7	.	.	.
Type *Palaeocasuarius velox*	24.1	7.0	.	6.3	.	.	.	.	.	.	[17.8	.	3.8	7.6	.]	28.9	.	26.3	.	.	.	.	.	[.	21.4	42.8	.]	Metatarsus = *didiformis*	
Mt. Arthur. A.M. 165	.	.	.	.	.	38.6	7.7	2.5	4.9	7.1	17.8	4.9	2.5	6.6	6.6	.	.	.	.	20.0	6.4	12.6	18.4	27.9	14.1	37.2	37.1	.	46.1
	24.3	6.7	2.4	6.9	8.0	38.7	7.8	2.5	4.9	7.1	.	.	.	.	.	27.6	9.7	28.4	33.0	20.1	6.6	12.6	18.4	.	.	.	.	62.7	.
L. Wakatipu. B.M.	22.8	.	.	6.7	.	37.8	.	.	4.7	.	.	.	.	.	.	.	.	29.3	.	.	.	12.4	.	.	.	.	.	59.0	.
Old Man Range. O.M.	22.6	6.1	3.1	.	.	37.4	8.9	3.0	4.8	.	17.3	5.0	3.1	7.3	.	26.9	13.7	.	.	23.8	7.6	13.0	.	28.9	17.8	42.5	.	60.5	46.2
Inangahua. C.M. 8.1.8	.	.	.	.	.	36.5	8.1	2.6	4.9	.	17.4	4.7	2.8	5.5	.	.	.	.	.	22.3	7.1	13.6	.	33.4	16.1	31.6	.	66.4	44.8
	24.4	6.8	2.4	7.0	.	36.8	8.2	2.7	5.0	.	16.5	4.8	2.5	6.8	.	28.0	10.0	28.6	.	22.2	7.2	13.3	.	29.1	15.4	41.0	.	.	.
Mt. Arthur. A.M. 166	24.5	7.1	2.5	7.0	8.4	36.9	8.1	2.6	5.1	7.4	16.4	4.9	2.6	6.8	6.9	29.0	10.0	28.5	34.3	21.9	7.1	13.8	20.1	29.1	15.5	41.5	.	66.4	44.5
Mt. Arthur. A.M. 120	24.1	7.1	2.6	7.5	8.1	35.9	8.2	2.5	5.0	6.8	16.3	5.0	2.7	7.0	6.4	29.6	10.8	31.2	33.6	22.8	6.9	16.7	19.0	30.6	16.6	42.9	39.2	.	.
Takaka. Type *hectori*	20.5	5.3	2.1	5.6	.	35.0	6.8	2.1	4.1	.	14.6	4.3	2.2	5.7	.	25.8	10.5	27.3	.	19.4	6.8	11.8	.	29.2	15.2	38.9	.	57.1	41.6
Aniseed Valley. D.M.	21.0	6.2	2.6	7.0	8.0	34.0	7.5	2.6	5.0	.	17.0	5.3	2.7	6.6	7.1	29.7	12.3	33.4	38.1	22.1	7.6	14.8	.	31.2	15.9	38.8	41.7	61.8	50.0
Type *Palaeocasuarius haasti*	21.6	5.7	.	.	.	.	.	.	.	.	17.8	.	2.9	7.0	.	21.3	.	.	.	.	.	.	.	.	16.4	39.2	.	.	.
Takaka. D.M.	20.7	6.7	2.5	6.7	.	34.1	7.9	2.6	4.4	.	16.5	4.7	2.6	6.2	.	32.4	12.1	32.5	.	23.1	7.6	12.9	.	28.7	15.7	37.7	.	60.7	45.4
	20.7	6.7	2.5	6.7	.	34.1	8.1	2.6	4.4	.	16.5	4.8	2.6	6.2	.	32.4	12.1	32.5	.	23.7	7.6	13.0	.	29.1	15.7	37.7	.	.	.
Mt. Arthur. Type *M. benhami.* A.M.	29.3	9.2	3.9	9.3	12.5	45.4	10.9	3.9	6.3	10.6	.	.	.	.	.	31.4	13.3	31.7	42.7	24.0	8.6	13.9	23.3	.	.	.	.	64.5	.

TABLE C. (a) *Pachyornis elephantopus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Femur.	Metatarsus.
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Tibia = 100.	
South Is. B.M. A. 168. Type, *immanis*	.	.	.	.	.	.	.	.	.	.	25.5	13.0	8.1	16.7	19.8	.	.	.	.	.	.	.	.	50.9	31.7	65.6	78.2	.	.
South Island. C.M. 9.1.14	32.9	12.9	6.1	15.5	19.2	57.4	17.4	6.0	11.4	16.5	24.2	11.7	6.9	13.2	17.3	39.2	18.7	47.1	57.4	30.3	10.5	19.8	28.8	48.3	28.5	54.5	71.3	57.0	42.0
Awamoa. Type, teste Owen	.	.	.	.	.	.	.	.	.	.	23.9	.	6.5	13.8	.	.	.	.	.	.	.	.	.	.	27.1	57.7	.	.	.
Awamoa. Type, teste Lyd.	.	.	.	.	.	.	.	.	.	.	23.5	11.2	6.1	13.5	16.7	.	.	.	.	.	.	.	.	47.6	26.0	57.4	70.2	.	.
Hamilton. O.M. Lectotype *major*	.	.	.	.	.	.	.	.	.	.	23.6	11.7	7.5	14.8	19.0	.	.	.	.	.	.	.	.	49.5	31.7	62.5	80.5	.	.
Pyramid Valley. C.M. xx B.	32.3	14.0	6.1	15.7	.	56.7	18.0	5.8	10.4	.	23.2	10.6	6.0	13.3	.	43.5	18.9	48.7	.	31.4	10.2	18.4	.	45.7	26.0	57.4	.	57.0	41.0
Locality ? Type *rothschildi*	28.0	.	6.4	13.0	.	55.9	.	.	7.4	.	21.6	.	5.3	12.7	.	Much abraded bones								.	.	.	.	.	.
Waitaki. O.M.	30.0	12.9	5.7	15.5	17.4	53.6	16.0	5.0	9.5	14.2	23.1	10.5	5.8	13.4	15.2	43.0	19.1	51.0	56.7	29.8	9.4	17.7	26.6	45.4	25.1	58.0	68.6	56 0	43.0
Canterbury. C.M. Type *inhabilis*	29.3	13.5	5.2	12.9	.	49.6	15.0	4.5	9.1	.	22.0	9.3	5.2	11.6	.	45.9	17.7	43.9	.	30.0	9.1	18.4	.	42.4	23.5	52.7	.	59.0	44.0
Hamilton. O.M. Lectotype *ponderosus*	.	.	.	.	.	.	.	.	.	.	21.0	10.0	5.8	12.3	14.8	.	.	.	.	.	.	.	.	48.0	27.7	53.7	70.5	.	.
Enfield. C.M. Type *valgus*	.	.	.	.	.	45.7	14.3	4.3	8.4	.	.	.	.	.	.	.	.	.	.	31.3	9.4	18.3	.	.	.	.	.	.	.

TABLE B. *Megalapteryx didinus.*
M. benhami.

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Mt. Arthur. A.M. 164	25.4	.	3.0	7.5	9.7	42.7	8.4	3.0	5.1	8.5	18.9	5.3	2.8	7.4	7.5	.	11.8	29.7	38.2	.	7.0	11.9	19.9	27.7	14.6	39.0	39.6	59.4	43.4
	.	.	.	.	.	42.5	8.8	3.0	5.1	8.5	19.0	5.2	2.8	7.5	.	.	.	.	.	20.8	7.0	12.0	20.0	27.3	14.7	39.4	.	.	.
Type *Palaeocasuarius elegans*	27.3	8.2	.	8.6	.	40.6	.	.	5.1	.	19.8	.	3.8	8.4	.	30.2	.	31.6	.	.	.	12.5	.	.	19.2	41.7	.	67.0	48.8
Mt. Arthur. Tring Mus.	26.5	7.3	3.1	8.8	10.0	40.5	10.2	3.0	6.6	8.3	19.0	5.8	3.0	8.0	8.0	27.6	11.7	33.2	37.7	25.1	7.3	13.8	20.5	30.8	15.7	42.3	42.2	65.4	46.9
	26.7	.	3.0	8.0	10.0	40.5	10.1	3.1	6.6	8.3	19.0	5.8	3.0	8.2	8.0	.	11.2	33.3	37.4	25.0	7.6	13.8	20.5	30.8	16.0	43.3	42.2	.	.
L. Wakatipu. Type, *M. tenuipes* ..	25.3	.	.	8.2	.	40.5	.	.	4.4	.	.	.	.	.	.	.	.	32.4	.	.	.	10.8	.	.	.	.	.	62.5	.
Waingongoro. Type *hamiltoni*. B.M.	25.2	7.6	3.3	7.6	.	.	.	.	.	.	.	.	.	.	.	30.2	12.9	30.2	.	.	.	.	.	.	.	.	.	.	.
Queenstown. Type *didinus*. B.M. ..	.	.	.	.	.	40.0	9.5	3.1	6.6	.	18.8	6.3	3.8	.	.	.	.	.	.	23.7	7.9	16.5	.	33.5	20.2	.	.	.	47.0
	.	.	.	.	.	40.0	9.5	3.1	.	.	.	.	.	.	.	.	.	.	.	23.8	7.8	.	.	.	.	.	.	.	.
Mt. Arthur. A.M. 115	.	.	.	.	.	.	.	.	.	.	18.4	5.7	2.9	7.6	.	.	.	.	.	.	.	.	.	30.9	15.8	41.3	.	.	.
	.	.	.	.	.	.	.	.	.	.	18.2	5.6	2.9	7.6	.	.	.	.	.	.	.	.	.	30.9	15.9	41.7	.	.	.
Type *Palaeocasuarius velox*	24.1	7.0	.	6.3	.	.	.	.	.	.	[17.8	.	3.8	7.6	.]	28.9	.	26.3	.	.	.	.	.	[.	21.4	42.8	.]	Metatarsus = *didiformis*	
Mt. Arthur. A.M. 165	.	.	.	.	.	38.6	7.7	2.5	4.9	7.1	17.8	4.9	2.5	6.6	6.6	.	.	.	.	20.0	6.4	12.6	18.4	27.9	14.1	37.2	37.1	.	46.1
	24.3	6.7	2.4	6.9	8.0	38.7	7.8	2.5	4.9	7.1	.	.	.	.	.	27.6	9.7	28.4	33.0	20.1	6.6	12.6	18.4	.	.	.	.	62.7	.
L. Wakatipu. B.M.	22.8	.	.	6.7	.	37.8	.	.	4.7	.	.	.	.	.	.	.	.	29.3	.	.	.	12.4	.	.	.	.	.	59.0	.
Old Man Range. O.M.	22.6	6.1	3.1	.	.	37.4	8.9	3.0	4.8	.	17.3	5.0	3.1	7.3	.	26.9	13.7	.	.	23.8	7.6	13.0	.	28.9	17.8	42.5	.	60.5	46.2
Inangahua. C.M. 8.1.8	.	.	.	.	.	36.5	8.1	2.6	4.9	.	17.4	4.7	2.8	5.5	.	.	.	.	.	22.3	7.1	13.6	.	33.4	16.1	31.6	.	66.4	44.8
	24.4	6.8	2.4	7.0	.	36.8	8.2	2.7	5.0	.	16.5	4.8	2.5	6.8	.	28.0	10.0	28.6	.	22.2	7.2	13.3	.	29.1	15.4	41.0	.	.	.
Mt. Arthur. A.M. 166	24.5	7.1	2.5	7.0	8.4	36.9	8.1	2.6	5.1	7.4	16.4	4.9	2.6	6.8	6.9	29.0	10.0	28.5	34.3	21.9	7.1	13.8	20.1	29.1	15.5	41.5	.	66.4	44.5
Mt. Arthur. A.M. 120	24.1	7.1	2.6	7.5	8.1	35.9	8.2	2.5	5.0	6.8	16.3	5.0	2.7	7.0	6.4	29.6	10.8	31.2	33.6	22.8	6.9	16.7	19.0	30.6	16.6	42.9	39.2	.	.
Takaka. Type *hectori*	20.5	5.3	2.1	5.6	.	35.0	6.8	2.1	4.1	.	14.6	4.3	2.2	5.7	.	25.8	10.5	27.3	.	19.4	6.8	11.8	.	29.2	15.2	38.9	.	57.1	41.6
Aniseed Valley. D.M.	21.0	6.2	2.6	7.0	8.0	34.0	7.5	2.6	5.0	.	17.0	5.3	2.7	6.6	7.1	29.7	12.3	33.4	38.1	22.1	7.6	14.8	.	31.2	15.9	38.8	41.7	61.8	50.0
Type *Palaeocasuarius haasti*	21.6	5.7	.	.	.	.	.	.	.	.	17.8	.	2.9	7.0	.	21.3	.	.	.	.	.	.	.	.	16.4	39.2	.	.	.
Takaka. D.M.	20.7	6.7	2.5	6.7	.	34.1	7.9	2.6	4.4	.	16.5	4.7	2.6	6.2	.	32.4	12.1	32.5	.	23.1	7.6	12.9	.	28.7	15.7	37.7	.	60.7	45.4
	20.7	6.7	2.5	6.7	.	34.1	8.1	2.6	4.4	.	16.5	4.8	2.6	6.2	.	32.4	12.1	32.5	.	23.7	7.6	13.0	.	29.1	15.7	37.7	.	.	.
Mt. Arthur. Type *M. benhami*. A.M.	29.3	9.2	3.9	9.3	12.5	45.4	10.9	3.9	6.3	10.6	.	.	.	.	.	31.4	13.3	31.7	42.7	24.0	8.6	13.9	23.3	.	.	.	.	64.5	.

TABLE C. (a) *Pachyornis elephantopus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Femur.	Metatarsus.
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Tibia = 100.	
South Is. B.M. A. 168. Type, *immanis*	.	.	.	.	.	.	.	.	.	.	25.5	13.0	8.1	16.7	19.8	.	.	.	.	.	.	.	.	50.9	31.7	65.6	78.2	.	.
South Island. C.M. 9.1.14	32.9	12.9	6.1	15.5	19.2	57.4	17.4	6.0	11.4	16.5	24.2	11.7	6.9	13.2	17.3	39.2	18.7	47.1	57.4	30.3	10.5	19.8	28.8	48.3	28.5	54.5	71.3	57.0	42.0
Awamoa. Type, teste Owen	.	.	.	.	.	.	.	.	.	.	23.9	.	6.5	13.8	.	.	.	.	.	.	.	.	.	.	27.1	57.7	.	.	.
Awamoa. Type, teste Lyd.	.	.	.	.	.	.	.	.	.	.	23.5	11.2	6.1	13.5	16.7	.	.	.	.	.	.	.	.	47.6	26.0	57.4	70.2	.	.
Hamilton. O.M. Lectotype *major* ..	.	.	.	.	.	.	.	.	.	.	23.6	11.7	7.5	14.8	19.0	.	.	.	.	.	.	.	.	49.5	31.7	62.5	80.5	.	.
Pyramid Valley. C.M. xx B. ..	32.3	14.0	6.1	15.7	.	56.7	18.0	5.8	10.4	.	23.2	10.6	6.0	13.3	.	43.5	18.9	48.7	.	31.4	10.2	18.4	.	45.7	26.0	57.4	.	57.0	41.0
Locality ? Type *rothschildi*	28.0	.	6.4	13.0	.	55.9	.	.	7.4	.	21.6	.	5.3	12.7	.	Much abraded bones								.	.	.	.	.	.
Waitaki. O.M.	30.0	12.9	5.7	15.5	17.4	53.6	16.0	5.0	9.5	14.2	23.1	10.5	5.8	13.4	15.2	43.0	19.1	51.0	56.7	29.8	9.4	17.7	26.6	45.4	25.1	58.0	68.6	56 0	43.0
Canterbury. C.M. Type *inhabilis* ..	29.3	13.5	5.2	12.9	.	49.6	15.0	4.5	9.1	.	22.0	9.3	5.2	11.6	.	45.9	17.7	43.9	.	30.0	9.1	18.4	.	42.4	23.5	52.7	.	59.0	44.0
Hamilton. O.M. Lectotype *ponderosus*	.	.	.	.	.	.	.	.	.	.	21.0	10.0	5.8	12.3	14.8	.	.	.	.	.	.	.	.	48.0	27.7	53.7	70.5	.	.
Enfield. C.M. Type *valgus*	.	.	.	.	.	45.7	14.3	4.3	8.4	.	.	.	.	.	.	.	.	.	.	31.3	9.4	18.3	.	.	.	.	.	.	.

TABLE C. (b) *Pachyornis pygmaeus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
South Island. C.M.	.	.	.	.	.	39 (estimated)					18.0	7.7	4.9	10.1	.	.	.	.	.	.	.	.	.	43.0	27.2	56.0	.	.	.
Takaka. Nelson Mus. Types	.	.	.	.	.	34 (estimated)					15.5	6.8	3.9	8.3	10.0	.	.	.	.	.	.	.	.	43.7	25.4	53.3	64.3	.	.
	.	.	.	.	.	.	.	.	.	.	15.6	6.8	3.9	8.4	10.0	.	.	.	.	.	.	.	.	43.6	25.3	53.8	64.2	.	.

TABLE D. (a) *Pachyornis mappini.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Amodeo Bay. A.M.	19.5	.	3.0	8.0	10.8	35.5	11.0	2.9	5.5	8.4	15.6	6.0	3.1	7.2	8.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Locality ? prob. indiv. D.M. 12 ..	19.5	7.5	3.3	8.1	10.2	35.0	10.4	3.4	5.8	8.9	13.5	5.9	3.2	6.5	8.3	38.4	16.9	41.5	52.3	29.7	9.5	16.6	25.4	43.7	23.8	48.2	61.5	54.4	38.6
Mangaotaki. A.M. 124. Type ..	20.3	7.9	3.3	8.5	10.3	33.6	9.9	3.1	5.9	8.3	15.6	5.8	3.3	7.6	8.4	38.9	16.0	41.7	50.7	29.5	9.1	17.6	24.7	.	.	.	.	.	.
	19.7	8.1	3.3	8.6	.	33.0	10.0	.	.	.	15.5	5.7	3.3	7.6	.	40.8	17.1	43.5	.	30.2	.	.	.	.	.	.	.	.	.
Karamu: Archey, 1927. A.M. 387 ..	19.5	.	3.4	9.1	11.0	33.3	10.5	3.3	5.7	9.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Locality ? Gisborne. A.M. 132 ..	18.1	7.1	3.0	7.7	9.4	32.5	9.4	2.8	5.4	7.9	14.5	5.8	3.0	7.2	7.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. A.M. 210	.	.	.	.	.	31.0	8.8	.	4.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bay of Plenty. A.M. 146	.	.	.	.	.	30.9	.	2.6	4.8	7.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. A.M. 367	.	.	.	.	.	30.6	8.2	2.4	4.4	6.5	13.7	4.6	2.2	5.9	5.9	.	.	.	.	27.0	7.7	14.4	21.2	33.6	16.1	43.1	43.1	.	45.0
Waikaremoana. A.M. 85	16.8	6.4	2.6	6.3	8.2	29.0	.	2.5	4.5	6.9	13.4	4.6	2.7	6.1	6.9	37.8	15.4	37.7	48.9	.	8.5	15.6	23.8	33.9	19.7	45.5	51.5	58.0	46.3
	16.8	6.2	2.6	6.4	.	29.0	8.0	2.5	4.5	.	.	.	.	.	.	37.2	15.7	37.9	.	27.5	8.5	15.6	.	.	.	.	.	.	.
Waikuku Beach. A.M. 29	16.1	6.5	2.5	.	7.9	28.7	.	2.6	4.7	7.2	13.0	5.1	2.5	6.0	6.8	40.3	15.5	.	49.0	.	9.2	16.3	25.0	39.2	19.2	46.4	57.3	56.1	47.7
	16.1	6.5	2.6	6.8	.	.	.	.	.	.	.	.	.	.	.	40.3	15.5	42.5	.	.	.	.	.	.	.	.	.	.	.
A.M. 305	17.6	6.7	2.6	6.9	8.5	28.5	7.9	2.4	4.7	7.0	13.7	5.0	2.5	6.2	6.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hukerenui. A.M. 234	.	.	.	.	.	28.5	7.7	2.4	4.2	7.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	.	.	.	.	.	27.9	7.9	2.6	4.6	7.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Whangarei. A.M. 226	.	.	.	.	.	27.9	.	2.6	4.8	7.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Waikaremoana. A.M. 84	16.2	6.1	2.7	6.5	8.0	27.3	7.9	2.2	4.1	6.9	12.7	4.6	2.4	5.8	6.5	37.8	17.2	40.0	49.2	29.0	8.2	15.1	25.2	36.2	19.1	45.6	51.2	59.4	46.4
	.	.	.	.	.	27.2	7.9	2.3	4.2	.	12.7	4.6	2.4	5.8	.	.	.	.	.	29.2	8.5	15.7	.	36.4	19.1	45.8	.	.	.

TABLE D. (b) *Pachyornis oweni.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Westmere. A.M. 185	.	.	.	.	.	26.3	7.5	2.3	4.3	6.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Locality ? A.M. 144	.	.	.	.	.	26.0	.	2.4	4.2	6.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Locality ? A.M. 144a	.	.	.	.	.	.	.	.	.	.	11.6	4.4	2.1	.	5.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pataua. A.M. 384. Type	14.3	6.0	2.2	4.8	6.5	24.3	6.3	1.9	3.7	6.2	11.3	4.0	2.1	5.0	5.5	34.1	15.4	33.6	46.6	26.1	7.8	15.4	25.5	35.6	18.2	44.6	48.2	59.0	46.3
Doubtless Bay. A.M. 154	13.5	4.8	1.8	5.1	6.3	23.3	6.5	1.8	3.3	5.5	10.5	3.8	2.0	4.9	5.5	36.2	13.7	38.0	46.7	28.0	7.9	14.2	23.6	36.3	19.2	46.7	52.5	58.0	45.0
Locality ? A.M. 178	.	.	.	.	.	23.0	6.8	2.4	3.9	6.3	.	.	.	.	.	.	.	.	.	29.6	10.2	16.9	27.6	.	.	.	.	.	.
Tom Bowling Bay. A.M. 179	.	.	.	.	.	.	.	.	.	.	10.1	3.5	2.0	4.4	5.3	.	.	.	.	.	.	.	.	34.3	19.1	42.7	52.0	.	.

TABLE E. *Emeus huttonii.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Pyramid Valley. C.M. viii A.	24.4	9.0	3.3	9.8	11.0	39.7	11.1	3.3	6.4	9.9	18.7	6.8	3.7	8.3	9.7	37.0	13.3	40.2	46.0	28.0	8.3	16.1	25.0	36.4	19.7	44.5	52.0	62.0	47.6
Enfield. C.M. Type *compacta*	.	.	.	.	.	38.6	11.7	3.9	6.1	.	.	.	.	.	.	.	.	.	.	30.2	10.1	15.8	.	.	.	.	.	.	.
Hamilton. Hutton 1875—max.	22.9	8.6	.	8.9	12.2	38.6	11.4	.	6.3	10.4	18.4	6.3	3.7	8.1	10.2	37.6	.	38.9	53.3	29.5	.	16.3	26.9	34.3	20.1	44.0	55.5	.	.
mean	22.9	8.4	.	8.9	12.1	37.5	10.9	.	5.6	9.8	17.1	6.2	3.5	8.1	9.9	36.7	.	38.9	52.8	29.0	.	14.9	26.1	36.2	20.4	47.3	57.8	.	.
min.	22.9	8.2	.	8.9	11.9	36.8	10.7	.	5.1	9.1	16.9	5.7	3.2	7.9	9.5	35.8	.	38.9	52.0	29.1	.	13.9	24.7	33.7	18.9	46.8	56.2	.	.
Hamilton. O.M. Lectotype	.	.	.	.	.	.	.	.	.	.	17.0	6.3	3.7	8.0	10.0	.	.	.	.	.	.	.	.	37.0	21.8	47.0	59.0	.	.
Wakapatu. O.M. Benham, 1935	22.4	8.1	3.2	8.9	11.5	35.8	9.7	3.5	5.5	9.0	16.3	6.2	3.0	7.4	9.0	36.0	14.2	39.7	.	27.0	9.7	15.3	25.2	38.0	18.0	45.0	55.2	62.6	45.6

TABLE F. *Emeus crassus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Pyramid Valley. C.M. v.	29.4	.	4.5	.	13.2	51.9	14.5	4.2	8.7	.	23.6	9.3	4.8	11.9	.	.	15.2	.	45.0	27.9	8.1	16.7	.	39.0	20.5	50.3	.	56.6	45.5
Waikouaiti. Type *crassus*	.	.	.	.	.	.	.	.	.	.	22.1	8.5	4.7	10.2	11.8	.	.	.	.	.	.	.	.	38.5	21.5	46.1	53.5	.	.
Pyramid Valley. C.M. xi	28.7	11.9	4.5	12.6	14.1	49.3	14.0	4.3	7.7	11.8	22.0	8.5	4.5	10.2	11.9	41.5	15.7	43.8	49.3	28.4	8.7	15.6	23.9	38.6	20.6	46.3	54.0	58.0	44.5
	28.9	11.6	4.5	12.8	14.1	49.3	14.0	4.4	7.7	12.0	22.0	8.4	4.5	10.2	11.9	40.0	15.5	44.2	49.0	28.4	8.8	15.6	24.3	38.6	20.6	46.5	54.0	.	.
Locality ? Redpath Mus. Montreal	27.0	10.3	5.0	11.4	.	48.5	15.0	4.0	7.3	.	23.0	8.7	3.9	11.1	.	38.1	13.5	42.2	.	30.9	8.2	15.0	.	37.8	17.0	48.2	.	.	.
Pyramid Valley. C.M. xiii G.	28.5	11.6	4.3	12.4	14.9	48.3	13.9	4.8	7.5	12.6	21.5	8.1	4.9	10.4	12.7	40.7	14.9	43.5	52.3	28.9	10.0	15.5	26.1	37.6	23.0	48.4	59.0	58.5	44.6
	28.4	11.4	4.2	12.4	14.9	.	.	.	.	.	21.5	8.0	4.9	10.5	12.7	40.1	14.9	43.6	52.4	.	.	.	.	37.3	23.0	48.8	59.3	.	.
Waikouaiti. Type *casuarinus*	.	.	.	.	.	48.3	14.0	4.4	7.4	12.1	.	.	.	.	.	.	.	.	.	28.9	9.1	15.3	24.9	.	.	.	.	.	.
Pyramid Valley. C.M. ix A.	26.2	9.5	3.8	10.6	13.0	47.9	12.3	4.0	6.9	10.5	21.5	7.8	4.0	9.4	10.6	37.4	14.6	40.4	49.0	25.6	8.3	14.4	21.9	36.2	18.3	43.5	49.0	54.0	45.0
Pyramid Valley. C.M. xiii D.	29.1	11.5	4.4	12.6	13.9	47.4	14.3	4.4	7.9	11.7	.	.	.	.	.	39.4	15.1	43.3	47.8	30.2	9.2	16.6	24.8	.	.	.	.	.	.
♀ with egg	28.0	11.6	4.3	12.4	13.9	47.2	14.2	4.4	8.0	11.7	22.9	8.6	4.8	11.2	12.2	40.0	14.8	42.7	47.9	30.1	9.4	16.9	24.8	37.6	20.8	48.9	53.3	61.5	48.3
Pyramid Valley. C.M. viii C.	27.4	10.4	3.9	11.6	13.1	47.3	12.9	4.0	7.6	10.9	21.8	8.1	4.4	10.3	11.4	37.8	14.2	42.2	47.7	27.3	8.5	16.1	23.0	37.3	20.1	47.2	52.3	58.0	46.0
Pyramid Valley. CM. i	25.3	10.2	3.8	10.6	12.0	46.7	12.0	3.9	7.2	10.7	20.4	7.6	4.5	9.2	11.3	40.5	15.1	41.9	47.7	25.7	8.3	15.4	22.9	37.2	22.0	45.1	55.4	54.2	43.6
Pyramid Valley. C.M. x B.	27.0	10.4	4.2	11.6	14.0	46.2	12.3	4.6	7.6	12.0	21.3	8.3	4.6	9.9	12.1	38.4	15.5	43.0	51.8	26.7	9.9	16.4	26.0	39.0	21.6	46.5	56.8	58.5	46.1
	26.9	10.4	4.2	11.4	14.0	46.3	12.4	4.5	7.6	11.9	21.3	8.3	4.7	9.9	12.2	38.8	15.7	42.5	52.2	26.8	9.7	16.4	25.7	39.0	22.0	46.5	57.2	.	.
Pyramid Valley. C.M. viii B.	27.1	10.8	4.0	11.8	13.6	45.8	13.5	4.3	7.3	11.9	20.7	8.1	4.5	10.1	11.3	39.9	15.0	43.7	50.0	29.4	9.3	15.9	25.9	39.1	21.7	48.8	54.4	59.0	45.0
	27.0	10.8	4.0	11.6	13.6	45.4	13.2	4.3	7.4	11.6	20.7	7.9	4.4	10.1	11.5	40.5	15.0	43.0	50.0	29.0	9.4	16.2	25.5	38.2	21.2	48.8	56.0	59.5	45.5
Dunedin. O.M.	26.2	8.9	.	11.2	13.7	45.7	13.1	.	6.2	10.7	20.1	7.9	4.3	9.4	11.7	34.1	.	42.9	52.4	28.6	.	13.5	23.3	39.2	21.5	46.9	58.0	57.2	43.8
Pyramid Valley. C.M. xiii E.	28.0	10.3	4.2	11.5	13.6	45.5	13.1	4.5	7.5	11.7	21.3	8.1	4.5	9.9	11.7	37.0	15.2	41.3	48.5	28.8	9.8	16.5	25.9	38.1	21.0	46.6	55.0	61.6	46.8
	27.9	10.4	4.2	11.7	13.7	45.7	12.9	4.3	7.5	11.8	21.2	8.0	4.5	9.9	11.6	37.2	15.2	41.8	49.0	28.3	9.5	16.4	25.8	37.7	21.1	46.6	54.8	.	.
Pyramid Valley. C.M. xiii F.	27.8	10.5	4.3	11.7	14.1	45.6	13.8	4.2	7.0	11.6	21.4	7.6	4.5	10.0	11.7	37.8	15.5	42.1	50.7	30.5	9.2	15.3	25.5	35.5	21.0	46.7	54.6	61.0	46.7
	27.8	10.5	4.2	11.8	14.3	45.5	13.6	4.2	7.1	11.7	21.4	7.7	4.5	10.1	11.7	37.8	15.3	42.4	51.4	29.9	9.3	15.6	25.7	36.0	21.0	46.7	54.6	.	.
Pyramid Valley. C.M. xii	26.3	10.7	4.0	11.4	12.5	43.7	12.6	4.0	6.9	11.0	20.8	7.5	4.2	9.7	11.0	40.5	15.2	43.5	47.5	28.3	9.1	15.8	24.6	36.0	20.2	46.5	52.7	60.5	47.0
	26.5	10.6	4.0	11.4	12.5	43.7	12.7	4.0	6.9	11.0	20.8	7.5	4.2	9.5	11.0	40.0	15.1	43.0	47.2	28.6	9.1	15.8	24.6	36.0	20.2	45.5	52.7	61.2	47.8

TABLE E. *Emeus huttonii.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Pyramid Valley. C.M. viii A. ..	24.4	9.0	3.3	9.8	11.0	39.7	11.1	3.3	6.4	9.9	18.7	6.8	3.7	8.3	9.7	37.0	13.3	40.2	46.0	28.0	8.3	16.1	25.0	36.4	19.7	44.5	52.0	62.0	47.6
Enfield. C.M. Type *compacta* ..	.	.	.	.	.	38.6	11.7	3.9	6.1	.	.	.	.	.	.	.	.	.	.	30.2	10.1	15.8	.	.	.	.	.	.	.
Hamilton. Hutton 1875—max. ..	22.9	8.6	.	8.9	12.2	38.6	11.4	.	6.3	10.4	18.4	6.3	3.7	8.1	10.2	37.6	.	38.9	53.3	29.5	.	16.3	26.9	34.3	20.1	44.0	55.5	.	.
mean ..	22.9	8.4	.	8.9	12.1	37.5	10.9	.	5.6	9.8	17.1	6.2	3.5	8.1	9.9	36.7	.	38.9	52.8	29.0	.	14.9	26.1	36.2	20.4	47.3	57.8	.	.
min. ..	22.9	8.2	.	8.9	11.9	36.8	10.7	.	5.1	9.1	16.9	5.7	3.2	7.9	9.5	35.8	.	38.9	52.0	29.1	.	13.9	24.7	33.7	18.9	46.8	56.2	.	.
Hamilton. O.M. Lectotype	.	.	.	.	.	.	.	.	.	.	17.0	6.3	3.7	8.0	10.0	.	.	.	.	.	.	.	.	37.0	21.8	47.0	59.0	.	.
Wakapatu. O.M. Benham, 1935 ..	22.4	8.1	3.2	8.9	11.5	35.8	9.7	3.5	5.5	9.0	16.3	6.2	3.0	7.4	9.0	36.0	14.2	39.7	.	27.0	9.7	15.3	25.2	38.0	18.0	45.0	55.2	62 6	45.6

TABLE F. *Emeus crassus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Pyramid Valley. C.M. v.	29.4	.	4.5	.	13.2	51.9	14.5	4.2	8.7	.	23.6	9.3	4.8	11.9	.	.	15.2	.	45.0	27.9	8.1	16.7	.	39.0	20.5	50.3	.	56.6	45.5
Waikouaiti. Type *crassus*	.	.	.	.	.	.	.	.	.	.	22.1	8.5	4.7	10.2	11.8	.	.	.	.	.	.	.	.	38.5	21.5	46.1	53.5	.	.
Pyramid Valley. C.M. xi	28.7	11.9	4.5	12.6	14.1	49.3	14.0	4.3	7.7	11.8	22.0	8.5	4.5	10.2	11.9	41.5	15.7	43.8	49.3	28.4	8.7	15.6	23.9	38.6	20.6	46.3	54.0	58.0	44.5
	28.9	11.6	4.5	12.8	14.1	49.3	14.0	4.4	7.7	12.0	22.0	8.4	4.5	10.2	11.9	40.0	15.5	44.2	49.0	28.4	8.8	15.6	24.3	38.6	20.6	46.5	54.0	.	.
Locality ? Redpath Mus. Montreal ..	27.0	10.3	5.0	11.4	.	48.5	15.0	4.0	7.3	.	23.0	8.7	3.9	11.1	.	38.1	13.5	42.2	.	30.9	8.2	15.0	.	37.8	17.0	48.2	.	.	.
Pyramid Valley. C.M. xiii G. ..	28.5	11.6	4.3	12.4	14.9	48.3	13.9	4.8	7.5	12.6	21.5	8.1	4.9	10.4	12.7	40.7	14.9	43.5	52.3	28.9	10.0	15.5	26.1	37.6	23.0	48.4	59.0	58.5	44.6
	28.4	11.4	4.2	12.4	14.9	.	.	.	.	.	21.5	8.0	4.9	10.5	12.7	40.1	14.9	43.6	52.4	.	.	.	.	37.3	23.0	48.8	59.3	.	.
Waikouaiti. Type *casuarinus*	.	.	.	.	.	48.3	14.0	4.4	7.4	12.1	.	.	.	.	.	.	.	.	.	28.9	9.1	15.3	24.9	.	.	.	.	.	.
Pyramid Valley. C.M. ix A.	26.2	9.5	3.8	10.6	13.0	47.9	12.3	4.0	6.9	10.5	21.5	7.8	4.0	9.4	10.6	37.4	14.6	40.4	49.0	25.6	8.3	14.4	21.9	36.2	18.3	43.5	49.0	54.0	45.0
Pyramid Valley. C.M. xiii D. ..	29.1	11.5	4.4	12.6	13.9	47.4	14.3	4.4	7.9	11.7	.	.	.	.	.	39.4	15.1	43.3	47.8	30.2	9.2	16.6	24.8	.	.	.	.	.	.
♀ with egg	28.0	11.6	4.3	12.4	13.9	47.2	14.2	4.4	8.0	11.7	22.9	8.6	4.8	11.2	12.2	40.0	14.8	42.7	47.9	30.1	9.4	16.9	24.8	37.6	20.8	48.9	53.3	61.5	48.3
Pyramid Valley. C.M. viii C. ..	27.4	10.4	3.9	11.6	13.1	47.3	12.9	4.0	7.6	10.9	21.8	8.1	4.4	10.3	11.4	37.8	14.2	42.2	47.7	27.3	8.5	16.1	23.0	37.3	20.1	47.2	52.3	58 0	46.0
Pyramid Valley. CM. i	25.3	10.2	3.8	10.6	12.0	46.7	12.0	3.9	7.2	10.7	20.4	7.6	4.5	9.2	11.3	40.5	15.1	41.9	47.7	25.7	8.3	15.4	22.9	37.2	22.0	45.1	55.4	54.2	43.6
Pyramid Valley. C.M. x B.	27.0	10.4	4.2	11.6	14.0	46.2	12.3	4.6	7.6	12.0	21.3	8.3	4.6	9.9	12.1	38.4	15.5	43.0	51.8	26.7	9.9	16.4	26.0	39.0	21.6	46.5	56.8	58.5	46.1
	26.9	10.4	4.2	11.4	14.0	46.3	12.4	4.5	7.6	11.9	21.3	8.3	4.7	9.9	12.2	38.8	15.7	42.5	52.2	26.8	9.7	16.4	25.7	39.0	22.0	46.5	57.2	.	.
Pyramid Valley. C.M. viii B. ..	27.1	10.8	4.0	11.8	13.6	45.8	13.5	4.3	7.3	11.9	20.7	8.1	4.5	10.1	11.3	39.9	15.0	43.7	50.0	29.4	9.3	15.9	25.9	39.1	21.7	48.8	54.4	59.0	45.0
	27.0	10.8	4.0	11.6	13.6	45.4	13.2	4.3	7.4	11.6	20.7	7.9	4.4	10.1	11.5	40.5	15.0	43.0	50.0	29.0	9.4	16.2	25.5	38.2	21.2	48.8	56.0	59.5	45.5
Dunedin. O.M.	26.2	8.9	.	11.2	13.7	45.7	13.1	.	6.2	10.7	20.1	7.9	4.3	9.4	11.7	34.1	.	42.9	52.4	28.6	.	13.5	23.3	39.2	21.5	46.9	58.0	57.2	43.8
Pyramid Valley. C.M. xiii E. ..	28.0	10.3	4.2	11.5	13.6	45.5	13.1	4.5	7.5	11.7	21.3	8.1	4.5	9.9	11.7	37.0	15.2	41.3	48.5	28.8	9.8	16.5	25.9	38.1	21.0	46.6	55.0	61.6	46.8
	27.9	10.4	4.2	11.7	13.7	45.7	12.9	4.3	7.5	11.8	21.2	8.0	4.5	9.9	11.6	37.2	15.2	41.8	49.0	28.3	9.5	16.4	25.8	37.7	21.1	46.6	54.8	.	.
Pyramid Valley. C.M. xiii F. ..	27.8	10.5	4.3	11.7	14.1	45.6	13.8	4.2	7.0	11.6	21.4	7.6	4.5	10.0	11.7	37.8	15.5	42.1	50.7	30.5	9.2	15.3	25.5	35.5	21.0	46.7	54.6	61.0	46.7
	27.8	10.5	4.2	11.8	14.3	45.5	13.6	4.2	7.1	11.7	21.4	7.7	4.5	10.1	11.7	37.8	15.3	42.4	51.4	29.9	9.3	15.6	25.7	36.0	21.0	46.7	54.6	.	.
Pyramid Valley. C.M. xii	26.3	10.7	4.0	11.4	12.5	43.7	12.6	4.0	6.9	11.0	20.8	7.5	4.2	9.7	11.0	40.5	15.2	43.5	47.5	28.3	9.1	15.8	24.6	36.0	20.2	46.5	52.7	60.5	47.0
	26.5	10.6	4.0	11.4	12.5	43.7	12.7	4.0	6.9	11.0	20.8	7.5	4.2	9.5	11.0	40.0	15.1	43.0	47.2	28.6	9.1	15.8	24.6	36.0	20.2	45.5	52.7	61.2	47.8

DIMENSIONS AND PROPORTIONS OF LEG-BONES.

All measurements are from individual skeletons, except a few in lighter type.

References: A.M., Auckland Museum; D.M., Dominion Museum; H.B., Hawke's Bay Museum; C.M., Canterbury Museum; O.M., Otago Museum; B.M., British Museum; W.M., Wanganui Museum.

TABLE A. *Anomalopteryx didiformis.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Waikaremoana. A.M. 72	26.4	8.8	3.4	9.5	10.5	43.4	11.2	3.4	6.4	9.5	.	.	.	.	.	33.2	13.0	36.1	39.7	25.8	7.9	14.6	21.8	.	.	.	.	60.7	.
Pataua. A.M.	27.5	9.3	3.6	9.2	11.2	42.7	.	3.9	6.2	10.5	21.2	6.5	3.5	9.0	9.3	33.8	13.3	33.4	40.7	.	9.1	14.6	24.6	30.6	16.4	42.4	43.8	64.5	49.7
Glenmark. Leetotype *fortis*. C.M.	.	.	.	.	.	.	.	.	.	.	20.8	6.8	3.8	9.1	.	.	.	.	.	.	.	.	.	32.7	18.3	44.2	.	.	.
Mt. Arthur. A.M. 121	26.3	8.9	3.4	9.6	10.5	42.6	.	3.4	6.7	9.6	20.1	6.2	3.6	8.3	9.3	33.8	13.0	36.5	39.6	.	8.0	15.7	22.5	30.8	17.7	41.2	46.3	61.7	47.0
Mangaotaki. A.M. 184	26.0	9.1	3.8	9.6	11.5	41.8	11.8	4.1	6.4	11.0	19.9	6.7	3.9	8.5	9.9	35.0	14.8	37.1	44.2	28.2	9.9	15.3	26.3	33.9	19.7	42.7	49.8	62.2	47.6
Mangaotaki. A.M. 128	25.8	9.0	3.6	.	11.1	41.4	11.1	3.7	6.1	9.8	.	.	.	.	9.4	34.8	14.1	.	43.0	26.3	8.9	14.7	23.7	.	.	.	.	.	.
	25.8	8.9	3.6	9.2	.	41.3	11.3	3.7	6.1	.	19.5	6.9	3.5	.	.	34.7	14.1	35.6	.	27.3	8.9	14.8	.	35.5	17.9	.	.	62.3	49.5
Waikaremoana. A.M. 148	24.8	8.9	3.8	8.6	11.7	41.0	.	3.5	.	9.7	18.8	.	3.5	7.8	9.1	35.9	15.9	34.6	47.2	.	8.6	.	23.7	.	18.5	42.0	48.9	60.5	46.0
Mt. Arthur. A.M. 114	25.2	9.4	3.8	9.7	11.2	40.6	10.8	3.5	6.0	9.9	18.7	6.1	3.6	8.3	9.4	37.2	15.0	38.6	44.4	26.6	8.6	14.7	24.4	32.5	19.4	44.3	50.1	62.2	46.3
	25.2	.	3.7	9.7	.	40.5	11.0	3.6	6.0	.	18.6	6.1	3.6	8.3	.	.	14.4	38.6	.	27.1	9.0	14.9	.	32.5	19.5	44.5	.	.	.
Mangaotaki. A.M.	25.6	9.5	3.8	9.9	.	40.1	12.2	3.7	6.2	.	19.5	7.0	3.7	9.1	.	37.1	15.0	38.6	.	30.4	9.2	15.5	.	36.2	18.8	46.6	.	63.8	48.6
Mt. Arthur. A.M. 117	24.3	8.0	3.1	8.6	10.1	39.8	10.6	3.4	5.7	9.1	18.8	5.9	3.3	7.6	8.7	32.9	12.7	35.3	42.0	26.6	8.5	14.3	22.9	31.3	17.6	40.5	46.2	61.8	47.6
	24.1	8.0	3.1	8.6	.	39.6	10.3	3.4	5.6	.	18.9	5.9	3.3	7.6	.	33.4	13.0	35.6	.	26.1	8.5	14.2	.	31.3	17.5	40.4	.	.	.
Waikaremoana. A.M. 70	25.7	8.5	3.4	9.5	10.1	39.6	11.7	3.3	6.1	9.1	19.9	6.4	3.3	8.2	8.6	32.8	13.2	37.0	39.2	29.4	8.3	15.3	22.6	32.2	16.8	41.4	43.2	65.0	50.0
	25.7	8.5	3.4	9.6	10.0	39.5	11.6	3.2	6.0	9.0	19.8	6.4	3.3	8.3	8.7	32.8	13.2	37.3	38.8	29.4	8.2	15.2	22.7	32.3	16.8	41.8	43.9	65.0	50.0
Waikaremoana. A.M. 71	25.1	8.9	3.6	9.4	11.1	39.3	11.2	3.7	6.1	10.2	18.7	6.4	3.7	8.5	9.5	35.3	14.3	37.2	44.1	28.4	9.5	15.6	26.5	34.2	19.6	45.2	50.7	64.0	47.5
	25.1	8.9	3.7	9.4	11.1	39.2	11.4	3.7	6.1	10.2	18.9	6.4	3.7	8.5	9.6	35.4	14.5	37.9	44.2	28.9	9.6	15.6	26.1	33.9	19.4	44.7	50.6	.	.
Waikaremoana. A.M. 82	.	.	.	.	10.5	39.0	.	3.2	6.1	9.1	19.3	6.2	3.4	8.1	8.6	.	.	.	.	.	8.0	15.6	23.3	32.2	17.6	42.0	44.6	.	49.3
Waikaremoana. A.M. 60	24.3	9.1	3.6	8.7	10.6	38.6	10.5	3.0	6.2	8.3	18.7	6.4	3.4	8.4	8.6	37.5	15.0	35.8	44.0	27.2	7.9	16.1	21.5	34.1	18.0	44.1	46.0	63.6	49.0
	24.3	9.1	3.6	8.8	.	38.2	10.5	3.0	6.0	.	18.7	6.4	3.3	8.3	.	37.0	14.8	36.2	.	27.4	7.9	15.7	.	34.3	17.8	45.0	.	.	.
Unlocalized: prob. individual. A.M.	24.3	9.1	3.6	8.8	.	38.6	11.2	2.9	5.8	.	16.8	.	3.5	8.0	.	37.0	14.8	36.2	.	29.0	7.5	14.2	.	.	20.7	47.9	.	62.9	43.5
Mangaotaki. A.M. 188	24.7	8.9	3.9	8.8	11.4	38.0	10.2	2.5	5.7	9.5	19.0	6.3	3.3	8.5	8.6	36.2	15.7	35.8	46.1	26.8	6.7	15.0	25.0	33.1	17.3	45.0	45.3	65.0	50.0
Poverty Bay. Type *dromaeoides*	23.6	8.5	3.5	8.9	10.5	.	.	.	.	.	.	.	.	.	.	35.8	14.8	37.8	44.4	.	.	.	.	.	.	.	.	.	.
Locality? Tring Mus.	23.5	8.8	3.4	10.1	.	38.0	10.0	3.4	5.5	.	17.5	6.2	3.6	7.9	.	37.4	14.6	43.0	.	26.3	8.9	14.4	.	35.6	20.7	45.4	.	61.8	41.6
Collingwood. C.M. 3.4.12	23.9	7.6	3.1	8.2	9.5	38.1	9.7	3.3	.	9.0	18.1	5.7	3.1	7.5	8.2	30.7	12.4	32.9	38.2	25.6	8.6	.	23.6	31.5	17.4	41.5	45.6	62.7	47.5
Te Anga. A.M. 153	23.3	8.0	3.1	8.3	9.7	38.0	9.8	3.5	6.2	9.5	18.1	6.2	3.1	7.9	8.1	34.2	13.5	35.6	.	25.8	9.2	16.4	25.3	34.1	16.9	43.5	44.6	61.3	47.6
	23.1	8.1	3.2	8.3	.	.	.	.	.	.	18.2	6.3	3.1	8.0	.	35.0	13.8	35.9	.	.	.	.	.	34.6	16.9	43.9	.	.	.
S. Is. coll Haast. ? indiv. A.M. 134	22.9	7.8	3.3	8.1	.	38.0	9.9	3.3	5.5	.	18.6	6.0	3.2	8.0	.	34.1	14.5	38.2	.	26.0	8.8	14.4	.	32.2	17.2	43.0	.	60.2	49.0
Waikaremoana. A.M. 63	24.7	7.7	3.3	8.4	10.0	.	.	3.4	5.7	8.9	17.3	6.0	3.2	.	8.3	31.3	13.3	33.9	40.3	.	.	.	.	34.6	18.5	.	47.8	.	.
	24.7	7.9	3.3	8.4	.	.	.	.	.	.	17.3	5.7	3.2	7.5	.	31.4	13.3	34.2	.	.	.	.	.	.	18.3	42.8	.	.	.
Awamarino. A.M.	.	.	.	.	.	37.8	9.6	3.2	5.8	.	18.1	6.2	3.4	8.0	.	.	.	.	.	32.5	8.4	15.4	.	34.2	19.0	44.4	.	.	47.5
Mangaotaki. A.M. 156	24.0	7.9	3.1	8.1	9.8	37.7	10.0	3.3	.	8.9	17.7	5.7	3.1	7.6	8.4	32.9	13.0	33.7	40.7	26.6	8.8	.	23.6	32.5	17.5	42.9	47.5	63.6	47.3
	.	.	.	.	.	37.4	10.1	3.3	5.4	.	.	.	.	.	.	.	.	.	.	27.0	8.9	14.4	.	.	.	.	.	.	.
Poverty Bay. Type *didiformis*	.	.	.	.	.	.	.	.	.	.	17.5	5.7	3.2	7.8	.	.	.	.	.	.	.	.	.	32.8	18.2	44.7	.	.	.
Waikaremoana. A.M. 55	24.0	8.6	3.5	9.0	10.3	37.5	10.8	3.4	5.8	9.0	16.9	6.1	3.3	7.4	8.5	35.2	14.5	37.4	42.9	28.9	9.0	15.5	24.0	35.1	19.3	43.6	50.1	64.1	45.2
	24.0	8.5	3.5	9.0	10.3	37.4	10.6	3.3	5.8	9.0	16.9	6.0	3.3	7.4	8.5	35.7	14.7	37.4	42.9	28.4	8.8	15.6	24.0	35.5	19.5	43.7	50.0	.	.
Waikaremoana. A.M. 78	23.5	6.9	3.2	7.6	9.9	37.4	10.0	3.5	5.8	9.2	18.0	6.2	3.2	8.0	8.0	29.3	13.4	32.3	42.1	26.6	9.3	15.6	24.6	34.4	17.6	44.5	44.5	62.9	48.1
Castle Rocks. O.M.	24.5	8.5	3.1	8.9	10.0	36.5	9.2	3.1	5.6	9.0	19.0	5.6	3.0	7.4	8.0	34.6	12.6	36.3	40.8	25.2	8.6	15.3	24.6	29.3	15.8	39.0	42.1	65.7	52.0
	24.0	8.9	3.0	8.7	10.0	36.0	9.3	3.1	5.3	.	18.7	5.6	3.0	7.5	.	37.0	12.6	36.0	41.7	25.9	8.6	14.8	.	30.1	16.0	40.1	.	.	.
Mangaotaki. A.M. 126	22.5	8.0	3.0	8.5	9.7	36.5	10.3	3.3	5.5	9.2	.	.	.	.	.	35.7	13.4	38.3	43.2	28.1	9.1	15.0	25.2	.	.	.	.	61.7	.
Castle Rocks. C.M. 3.4.3	23.1	7.2	2.6	7.6	8.7	36.3	8.8	3.0	5.2	8.2	16.1	5.4	3.0	7.1	7.9	31.2	11.2	32.8	37.6	24.4	8.4	14.3	22.8	33.5	18.6	44.0	49.0	63.7	44.3
Mangaotaki. A.M. 151	22.8	7.7	2.8	.	9.2	36.1	9.9	3.1	5.3	8.4	17.5	5.6	2.9	7.3	7.6	34.0	12.7	.	40.4	27.4	8.5	14.6	23.3	32.0	16.7	41.7	43.5	63.1	48.4
	22.8	7.9	2.8	8.5	.	36.1	9.9	3.0	5.2	.	17.5	5.6	2.9	7.4	.	34.6	12.4	37.2	.	27.4	8.3	14.5	.	32.0	16.7	41.7	.	.	.
Waikaremoana. A.M. 150	.	.	.	.	.	36.1	9.4	3.0	5.5	8.1	17.7	5.8	2.9	7.2	7.6	.	.	.	.	26.1	8.2	15.3	22.4	33.6	16.6	40.7	43.0	.	49.0
Mangaotaki. A.M. 51	22.7	7.5	3.0	7.9	9.5	36.0	9.3	3.0	5.0	8.3	17.0	5.4	3.2	7.3	8.2	32.8	13.2	34.5	41.8	25.9	8.5	13.8	23.1	32.0	19.0	43.2	48.3	61.1	47.2
	.	.	.	.	.	35.9	9.4	3.1	5.1	.	17.1	5.4	3.3	7.2	.	.	.	.	.	26.1	8.6	14.2	.	31.8	19.0	42.1	.	.	.
Locality ? O.M. C.34.11	21.7	8.2	3.0	7.9	10.1	36.0	9.4	3.2	5.3	8.9	16.2	6.0	3.4	6.8	8.7	37.8	14.0	36.6	46.5	26.1	8.9	14.7	24.7	37.0	18.7	42.2	53.7	60.3	45.2
	21.7	8.1	3.0	8.0	9.9	35.9	9.3	3.2	5.4	8.8	16.2	5.9	3.4	6.9	8.6	37.3	13.9	36.8	45.5	25.9	8.9	15.0	24.5	37.0	18.7	42.5	53.6	.	.
Waikaremoana. A.M. 149	23.7	8.5	3.1	8.2	10.1	35.9	9.7	3.1	5.5	8.6	17.3	5.8	3.1	7.8	8.2	36.0	13.2	34.7	43.1	25.9	8.7	15.3	24.0	33.8	18.1	45.1	47.4	66.0	48.0
	.	.	.	.	.	35.8	9.7	3.1	5.5	.	17.3	5.8	3.1	7.7	.	.	.	.	.	27.1	8.8	15.4	.	33.8	18.1	45.1	.	.	.
Nuhaka. D.M.	23.7	7.9	3.1	8.6	9.4	35.2	9.8	3.0	5.9	8.3	17.5	6.3	3.2	7.5	8.1	33.3	13.2	36.0	39.8	27.9	8.9	16.7	23.6	36.0	18.0	43.1	46.2	67.3	49.7
	.	.	.	.	.	35.5	10.1	3.1	5.9	8.4	17.5	6.2	3.1	7.5	8.1	.	.	.	.	28.4	8.7	16.6	23.7	35.5	17.9	42.8	46.2	.	.
Mangaotaki. A.M. 152	22.4	.	2.8	7.9	8.9	35.1	9.6	2.9	5.3	8.2	16.1	5.4	3.0	7.5	7.9	.	12.7	35.2	39.8	27.3	8.3	15.1	23.4	33.4	18.8	46.6	44.0	64.0	46.3
	22.2	.	2.8	7.8	.	34.9	.	2.9	5.3	.	16.2	5.4	3.1	7.4	.	.	12.8	35.1	.	.	8.2	15.1	.	33.4	19.0	45.5	.	.	.
Waikaremoana. A.M. 89	23.0	6.9	3.1	7.5	9.3	34.9	9.2	3.1	5.2	8.2	16.6	5.4	3.0	6.9	7.6	30.0	13.5	32.6	40.5	26.2	8.7	15.2	23.4	32.5	17.8	41.6	45.7	65.8	47.6
	23.0	6.9	3.1	7.4	9.3	34.9	.	3.1	5.2	8.2	.	.	.	.	.	30.0	13.5	32.2	40.5	.	8.7	15.2	23.4	.	.	.	.	.	.
Waikaremoana. A.M. 66	22.7	7.6	2.8	8.2	9.0	34.7	9.6	2.8	5.6	7.8	17.7	5.9	3.1	7.8	8.0	33.2	12.5	36.1	39.6	27.7	8.1	16.1	22.5	33.1	17.2	43.9	45.0	65.3	51.0
Mangaotaki. A.M. 155	21.5	7.5	2.9	6.7	.	.	.	.	.	.	16.3	5.4	3.0	6.8	.	34.8	13.7	31.1	.	.	.	.	.	33.4	18.6	40.8	.	.	.
Waikaremoana. A.M. 69	.	7.7	2.7	.	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.7	7.4	.	.	.	.	26.3	8.0	14.1	22.4	31.6	17.3	42.1	46.4	.	.
	21.1	7.6	2.8	7.8	8.6	34.3	9.0	2.7	4.9	7.7	15.9	5.0	2.8	6.8	7.4	36.2	13.1	36.7	40.7	26.3	8.0	14.1	22.4	31.5	17.7	42.5	46.3	61.5	46.5
Waikaremoana. A.M. 82	.	.	.	.	.	33.5	.	2.1	4.8	.	16.7	5.3	2.9	7.0	.	.	.	.	.	.	6.4	14.4	.	32.0	17.6	41.9	.	.	49.8
Hangatiki. A.M. 102	.	.	.	.	.	.	.	.	.	.	16.6	5.3	3.2	7.4	.	.	.	.	.	.	.	.	.	32.2	19.2	44.4	.	.	.
	.	.	.	.	.	.	.	.	.	.	16.5	5.4	3.2	7.3	.	.	.	.	.	.	.	.	.	32.5	19.1	44.1	.	.	.
Nelson. Type *parvus*. B. M.	20.0	6.6	2.6	7.3	.	32.7	.	.	4.6	.	15.9	4.6	2.7	7.8	.	32.6	12.8	36.1	.	.	.	14.0	.	28.8	17.0	49.0	.	61.7	48.6
Waiau. C.M. 3.4.11	21.3	7.4	3.0	.	.	32.3	8.7	2.8	4.9	.	15.7	5.1	3.0	6.6	.	34.7	14.0	.	.	27.1	8.7	15.3	.	32.5	19.1	42.0	.	65.3	48.6
	21.3	7.4	2.9	7.7	.	32.3	9.0	2.8	5.0	.	15.8	5.1	3.0	6.6	.	34.0	13.8	36.0	.	27.8	8.7	15.3	.	32.4	19.0	40.5	.	.	.

TABLE G. (a) *Euryapteryx gravis.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Riverton. O.M.	31.5	12.3	4.9	13.0	16.7	52.0	15.0	4.8	8.2	13.5	21.7	8.9	5.5	11.8	13.6	39.3	15.8	41.5	53.2	28.8	9.3	15.8	26.0	41.2	25.3	54.4	62.6	60.0	42.0
Mt. Arthur. A.M.	30.4	12.3	4.8	12.9	16.6	.	.	.	.	.	22.7	9.2	5.4	12.2	14.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stewart Is. O.M. Benham 1910	27.4	11.3	4.8	12.7	15.5	51.2	14.5	4.8	8.9	13.7	22.2	9.0	4.8	11.5	13.2	41.3	17.5	46.4	56.6	28.3	9.4	17.4	26.8	40.5	21.6	51.8	59.4	54.0	43.0
Pyramid Valley. C.M. xx D.	29.7	12.7	5.2	13.5	.	50.6	15.3	4.8	8.5	.	21.8	8.9	5.4	12.1	.	42.7	17.5	45.4	.	30.2	9.5	16.8	.	40.8	24.7	55.5	.	58.7	43.1
Castle Pt. C.M. Type *kuranui*	26.8	9.9	4.7	12.2	15.2	47.0	14.6	4.6	7.9	13.2	20.5	9.0	4.9	10.8	12.2	36.9	17.5	45.5	56.3	31.0	9.8	16.8	28.1	42.6	23.4	52.5	59.4	57.0	43.0
Waikaremoana. A.M. 388	.	.	.	.	.	47.0	13.5	4.7	7.9	12.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Kakanui. B. M. Type	27.9	10.5	4.3	11.7	14.4	43.8	13.5	4.1	7.9	12.1	19.7	8.1	5.3	10.6	12.7	37.6	15.4	41.7	51.5	30.9	9.3	18.0	27.4	41.3	26.9	53.7	64.6	64.0	45.0
Type *gravipes*, measured G.A.	.	.	.	.	.	.	.	.	.	.	19.6	8.3	5.2	10.5	12.7	.	.	.	.	.	.	.	.	42.3	26.7	53.3	65.0	.	.

TABLE G. (b) *Euryapteryx geranoides.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Tom Bowling Bay. A.M. 37	23.1	9.0	4.1	10.3	.	41.1	.	3.8	6.8	.	17.5	7.3	4.1	8.5	10.1	39.0	17.8	44.6	.	.	9.2	16.5	.	41.7	23.4	48.5	57.7	56.0	42.5
Tom Bowling Bay. A.M. 32	22.0	9.0	4.2	9.5	.	38.5	11.0	3.6	6.0	.	.	.	.	.	.	40.9	19.3	43.1	.	28.5	9.4	15.3	.	.	.	.	.	57.1	.
Doubtless Bay. A.M. 182	21.7	7.9	3.2	8.6	.	37.7	10.2	2.9	5.7	.	16.4	6.1	3.3	7.9	.	36.4	14.8	39.8	.	27.0	8.1	15.2	.	37.0	20.0	48.2	.	57.5	43.5
Te Rangatapu. B.M. 21793; Lyd. 268	.	.	.	.	.	36.5	10.9	4.0	6.1	.	.	.	.	.	.	.	.	.	.	29.8	10.9	16.7	.	.	.	.	.	.	.

TABLE H. *Euryapteryx exilis.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Doubtless Bay. A.M. 6	20.5	7.9	3.4	8.1	9.9	34.7	9.5	3.0	5.6	8.2	15.2	5.8	3.1	7.1	7.9	38.5	16.5	39.5	48.4	27.3	8.6	16.1	23.6	38.0	20.0	45.7	51.9	59.0	43.9
	20.5	8.0	3.4	8.3	.	34.4	9.6	3.1	5.4	.	15.2	5.9	3.1	7.1	.	39.0	16.5	40.7	.	27.8	9.0	15.6	.	38.6	20.1	46.4	.	.	.
Doubtless Bay. A.M. 169	20.4	7.9	3.0	8.1	9.4	34.5	9.5	3.0	5.3	7.7	14.9	6.0	3.1	6.2	8.0	38.7	14.9	40.0	46.1	27.5	8.6	15.3	22.3	39.9	20.7	41.2	53.6	59.1	43.2
	.	.	.	.	.	.	.	.	.	.	15.1	6.0	3.1	6.2	.	.	.	.	.	.	.	.	.	39.9	20.7	40.8	.	.	.
Doubtless Bay. A.M. 20	20.9	6.7	3.1	8.1	9.3	34.5	9.6	3.0	5.1	7.8	.	.	.	.	.	32.1	14.8	38.8	44.0	27.8	8.6	14.9	22.6	.	.	.	.	60.5	.
Type. *A. geranoides* Lyd. (C.F.B. 289, B.M. 21789x)	.	.	.	.	.	34.4	10.3	3.1	5.7	.	.	.	.	.	.	.	.	.	.	30.0	9.1	16.5	.	.	.	.	.	.	.
D. geranoides Owen 1866b (B.M. 21706, Lyd. 289)	.	.	.	.	.	.	.	.	.	.	15.2	5.9	3.4	7.5	.	.	.	.	.	.	.	.	.	38.8	22.4	49.4	.	.	.
Doubtless Bay. A.M. 171.2	19.0	7.2	3.1	7.5	9.2	34.4	9.3	3.0	.	7.8	.	.	.	.	.	38.9	16.3	39.4	48.5	27.0	8.5	.	24.6	.	.	.	.	55.2	.
Doubtless Bay. A.M. 171.3	19.8	.	3.2	8.1	9.6	34.3	9.1	2.8	.	7.4	.	.	.	.	.	.	16.4	40.9	48.5	26.6	8.3	.	21.6	.	.	.	.	57.7	.
	19.7	8.0	3.3	8.1	.	.	.	.	.	.	.	.	.	.	.	40.6	16.7	41.1	.	.	.	.	.	.	.	.	.	.	.
Wangaehu. W.M. Type	20.0	7.3	2.8	7.8	9.6	34.1	9.2	2.8	4.8	8.2	14.2	5.7	3.1	6.7	7.9	36.5	14.2	39.1	48.2	27.0	8.0	14.0	24.0	40.0	22.0	46.9	55.1	58.7	41.7
Measured G.A.	20.0	7.2	2.8	7.8	9.6	34.3	9.1	2.8	4.8	8.0	14.2	5.7	3.1	6.8	7.9	36.0	14.2	39.0	48.2	26.5	8.0	14.0	23.4	39.8	22.0	47.9	55.6	.	.
Doubtless Bay. A.M. 167	20.3	7.8	3.3	8.6	9.7	34.0	9.8	2.9	5.8	7.7	15.7	6.5	3.3	7.5	8.2	38.3	16.4	42.2	47.7	28.9	8.5	17.0	22.6	41.4	21.3	47.7	52.2	60.0	48.8
	20.3	7.8	3.3	8.5	.	33.8	9.9	2.9	5.8	.	15.5	6.5	3.3	7.4	.	38.3	16.4	41.8	.	29.4	8.6	17.1	.	41.9	21.6	47.6	.	.	.
Doubtless Bay. A.M. 3	19.7	7.9	3.1	8.3	9.4	33.7	9.8	2.8	5.6	7.4	14.7	6.0	3.0	.	7.5	40.1	15.7	42.0	47.5	29.1	8.4	16.6	21.9	40.8	20.7	.	50.9	58.4	43.6
	19.7	7.9	3.2	8.2	.	33.5	9.8	2.8	5.5	.	14.8	6.0	3.0	7.0	.	40.1	16.2	41.8	.	29.3	8.4	16.3	.	40.7	20.6	47.3	.	.	.
Waiotapu. A.M. 83	20.3	7.9	3.4	8.0	10.2	33.5	.	3.0	.	8.2	15.0	5.6	3.2	7.0	8.3	38.8	16.6	39.5	50.2	.	8.9	.	24.5	37.3	21.5	46.6	55.4	60.7	44.7
	20.3	7.9	3.3	.	10.1	.	10.0	3.0	5.3	8.2	.	.	.	.	.	38.8	16.7	.	50.0	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. A.M. 171.1	.	.	.	.	.	33.5	9.6	3.0	.	8.2	15.4	.	3.5	7.2	8.7	.	.	.	.	28.6	8.9	.	24.5	.	22.5	.	56.3	.	46.1
Doubtless Bay. A.M. 377	20.6	8.4	3.4	8.5	10.0	33.5	9.8	2.9	5.7	8.0	15.3	6.1	3.2	7.4	8.1	40.8	16.5	41.3	48.5	29.4	8.8	17.0	23.8	39.9	20.9	43.4	53.0	61.5	45.6
Doubtless Bay. A.M. 157	.	.	3.4	8.0	9.9	33.4	9.7	2.9	5.3	7.7	14.9	5.8	3.2	7.6	8.0	.	.	.	.	29.0	8.7	15.9	23.0	39.0	21.8	51.2	53.7	.	44.5
Doubtless Bay. A.M. 172	19.7	7.8	3.0	7.9	9.5	33.4	9.1	2.8	.	7.6	14.7	5.9	3.2	7.2	8.0	39.6	15.4	40.3	48.3	27.3	8.5	.	22.8	40.0	21.5	49.0	53.7	59.0	44.0
Doubtless Bay. A.M. 373	19.8	7.7	3.0	7.9	9.5	33.1	9.4	2.9	5.2	7.7	15.0	5.5	2.9	6.5	7.7	38.9	15.4	39.9	48.0	28.4	8.8	15.7	23.2	36.5	19.6	43.3	51.3	59.8	45.3
Doubtless Bay. A.M. 170	19.6	7.5	.	8.0	9.4	33.0	9.1	2.8	5.1	7.4	14.5	5.7	3.0	6.9	7.7	38.2	.	40.8	48.0	27.6	8.4	15.6	22.4	39.3	21.0	47.7	53.2	59.4	43.9
	19.6	7.6	3.0	8.0	.	.	.	.	.	.	14.5	5.7	3.1	7.0	.	38.7	15.5	40.8	.	.	.	.	.	39.5	21.1	48.1	.	.	.
Doubtless Bay. A.M. 160	19.6	7.7	3.0	8.0	9.2	32.8	9.4	2.9	5.2	7.5	.	.	.	.	.	39.3	15.5	41.1	47.0	28.0	8.9	15.8	22.9	.	.	.	.	59.7	.
Doubtless Bay. A.M. 360	19.9	7.3	3.0	8.1	9.1	32.6	9.0	2.7	5.4	7.3	14.3	5.7	3.1	6.7	7.9	36.7	15.1	40.7	45.8	27.8	8.3	16.6	22.4	39.8	21.7	46.8	55.2	61.0	43.9
Doubtless Bay. A.M. 168	19.5	7.1	3.1	7.8	9.5	32.5	9.5	2.8	5.0	7.5	.	.	.	.	.	36.8	15.5	40.0	48.8	29.2	8.6	15.5	23.1	.	.	.	.	62.0	44.0
	19.5	7.0	3.1	.	9.5	.	.	.	.	.	14.3	5.5	3.2	7.4	8.2	36.0	15.5	.	48.8	.	.	.	.	38.4	22.4	51.7	57.2	.	.
Doubtless Bay. A.M. 362	18.6	7.4	3.0	7.6	8.5	31.9	8.9	2.7	5.5	7.1	14.3	5.8	.	7.1	.	39.8	16.1	40.8	45.7	27.9	8.5	17.2	22.2	40.6	.	49.7	.	58.3	44.7
Doubtless Bay. A.M. 382	.	.	.	.	.	30.6	8.8	2.7	5.4	7.3	14.4	5.9	3.1	6.7	7.8	.	.	.	.	28.9	8.9	17.6	23.8	41.0	21.5	46.5	54.2	.	45.6
Doubtless Bay. A.M. 372	18.6	7.2	3.2	7.9	9.5	30.5	8.7	2.6	5.0	7.1	.	.	.	.	.	38.8	17.2	42.5	51.0	28.6	8.5	16.4	23.2	.	.	.	.	61.0	.

TABLE I. *Euryapteryx curtus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Doubtless Bay. A.M. 4	17.9	.	2.7	7.0	7.8	28.6	8.1	2.4	4.8	6.4	13.6	5.2	2.8	6.4	7.3	.	14.9	38.7	44.0	27.9	8.4	16.7	22.1	37.9	20.6	47.0	53.8	62.2	47.0
	17.9	6.4	2.7	7.0	.	28.6	8.1	.	4.6	.	.	.	.	.	.	35.5	14.9	38.7	.	28.1	.	15.9	.	.	.	.	.	.	.
Doubtless Bay. A.M. 23	17.8	6.4	2.6	7.0	7.8	28.9	8.0	2.3	4.7	6.4	13.9	5.1	2.9	6.5	7.3	35.5	14.5	39.2	43.7	27.7	8.2	16.4	22.2	36.7	20.6	46.8	52.5	62.1	48.0
	17.8	6.4	2.6	.	.	.	.	.	.	.	13.9	5.1	.	6.5	.	35.9	14.5	.	.	.	.	.	.	36.4	.	46.6	.	.	.
North Island. Type *curtus*	.	.	.	.	.	28.6	8.2	.	5.1	7.4	.	.	.	.	.	.	.	.	.	28.8	.	17.8	25.8	.	.	.	.	.	.
Doubtless Bay. A.M. 177	17.7	6.4	2.7	7.0	8.1	28.4	7.7	2.4	4.6	6.8	.	.	.	.	.	36.2	15.2	39.5	45.7	27.1	8.4	16.3	24.0	.	.	.	.	62.7	.
Doubtless Bay. A.M. 23a	17.1	.	2.6	6.7	8.0	28.3	7.7	.	4.6	6.6	11.2	4.5	2.3	5.2	6.1	.	15.5	39.2	46.7	27.3	.	16.2	23.7	40.9	21.2	46.9	54.5	60.3	39.2
Doubtless Bay. A.M. 381	18.0	6.6	2.9	7.0	8.7	28.1	8.0	2.4	4.5	6.6	.	.	.	.	.	36.6	16.1	38.0	48.3	28.5	8.7	16.0	23.5	.	.	.	.	64.0	.
Doubtless Bay. A.M. 370	16.9	6.5	2.8	7.0	8.6	27.5	7.7	2.5	4.4	6.5	12.9	5.1	2.8	6.2	7.1	38.2	16.8	41.0	50.9	28.0	9.4	16.1	23.6	39.5	21.8	48.0	55.0	61.5	47.0
	16.7	6.4	2.8	6.9	8.5	27.4	7.8	2.4	4.4	6.4	12.9	5.1	2.8	6.2	7.1	38.8	16.7	41.4	50.7	28.5	9.3	16.2	23.4	39.5	21.8	48.0	55.0	61.7	47.0
Doubtless Bay. A.M. 173	16.7	6.2	2.5	6.5	7.3	27.0	.	2.1	4.5	5.7	.	.	.	.	7.0	37.1	15.0	38.9	43.7	.	7.9	16.6	21.2	.	.	.	.	59.2	.
Doubtless Bay. A.M. 161	16.9	.	2.4	6.7	7.5	26.8	7.5	2.2	4.3	6.0	12.6	4.8	2.5	5.9	6.4	.	14.3	39.8	44.3	27.9	8.3	16.1	22.4	37.9	19.6	46.8	50.7	63.2	47.0
	16.9	.	2.5	6.7	.	26.8	.	2.2	4.3	.	.	.	.	.	.	.	14.3	39.8	.	.	8.1	16.1	.	.	.	.	.	.	.
Doubtless Bay. A.M. 355	16.7	6.2	2.4	6.7	7.3	26.7	.7.6	2.2	4.4	5.9	12.8	4.9	2.6	5.9	6.7	37.1	14.2	40.3	43.7	28.5	8.4	16.5	22.1	38.3	20.6	46.1	52.4	62.5	48.0
Doubtless Bay. A.M. 368	16.8	6.0	2.6	6.5	7.6	26.6	7.7	2.4	4.4	6.3	12.5	4.6	2.8	6.1	7.2	35.7	15.5	38.7	45.2	28.9	9.0	16.5	24.0	36.8	22.4	48.8	57.7	63.2	47.0
Doubtless Bay. A.M. 5	16.2	6.0	2.4	6.4	7.3	26.5	7.1	.	4.2	6.3	12.5	4.7	2.6	5.7	6.8	37.0	14.6	39.8	45.1	26.7	.	16.0	23.8	38.0	21.0	46.0	54.4	61.1	47.1
	16.2	5.8	2.4	6.4	.	26.5	7.1	.	4.2	.	12.5	4.7	.	5.7	.	35.4	14.8	39.5	.	26.5	.	16.0	.	38.0	.	46.0	.	.	.
	.	5.7	.	7.4	.	26.5	7.4	2.3	4.2	6.5	.	.	.	.	.	.	.	.	.	28.3	8.8	15.9	24.6	.	.	.	.	.	.
Doubtless Bay. Odd bones	15.8	4.8	2.5	6.3	7.3	26.4	7.6	2.2	4.3	5.9	12.4	4.8	2.5	5.7	6.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. Odd bones	15.7	5.1	2.3	5.4	6.8	26.3	7.5	2.2	4.4	5.9	12.3	4.8	2.5	5.8	6.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. Odd bones	15.6	5.5	2.4	6.1	7.3	26.2	7.1	2.1	4.2	5.9	12.2	4.2	2.2	5.5	6.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. A.M. 370a	.	.	.	.	.	25.6	6.7	2.1	3.8	5.7	11.9	4.4	2.4	5.3	6.1	.	.	.	.	26.4	8.4	14.8	22.3	37.0	20.2	45.0	51.3	.	46.5
Doubtless Bay. A.M. 191	14.9	5.1	2.1	5.7	6.8	25.4	6.7	2.0	3.7	5.7	11.1	3.9	2.0	5.0	5.5	34.5	14.1	38.2	45.7	26.3	8.1	14.6	22.4	35.1	18.0	45.0	49.0	58.6	43.6
	14.9	5.1	2.1	5.7	.	25.2	6.7	2.0	3.7	.	11.0	4.0	2.0	5.0	.	34.4	14.2	38.4	.	26.5	8.1	14.6	.	35.7	18.3	45.2	.	.	.
Doubtless Bay. A.M. 180	16.0	5.9	2.5	.	7.5	25.2	7.1	2.4	4.2	6.3	12.3	4.6	2.6	5.7	6.7	36.7	15.6	.	47.0	28.2	9.5	16.6	25.0	37.2	20.8	46.7	54.7	63.4	49.0
Doubtless Bay. A.M. 174	15.3	.	2.5	6.0	7.5	24.9	7.0	2.0	4.1	5.6	12.0	4.6	2.0	5.6	6.4	.	16.3	39.0	49.0	28.1	8.2	16.6	22.5	38.1	21.0	46.4	53.3	61.4	48.1
Doubtless Bay. A.M. 176	.	.	.	.	7.5	24.8	7.2	2.1	4.2	5.9	12.0	4.5	2.4	5.7	6.2	.	.	.	.	29.2	8.3	17.1	23.8	38.0	19.7	47.7	51.7	.	48.3
Doubtless Bay. A.M. 378	14.9	5.5	2.2	5.8	6.9	24.8	6.6	2.0	4.0	5.4	11.4	4.4	2.2	5.1	5.5	36.9	15.1	38.9	46.3	26.6	8.1	16.1	21.8	38.6	19.3	45.2	48.2	60.6	46.3

TABLE J. *Dinornis novae-zealandiae.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Single bones, maxima	28.5		(Mangaotaki)			56.0		(Doubtless Bay)			31.7	8.7	3.8	10.2	10.2	.	.	.	.	.	.	.	.	27.6	12.0	32.2	32.4	.	.
Poverty Bay. Type *novae-zealandiae*	.	.	.	.	.	.	.	.	.	.	30.5	8.1	3.9	9.7	11.2	.	.	.	.	.	.	.	.	26.5	12.8	31.9	36.7	.	.
Poverty Bay. Owen 1843c, part	27.9	10.6	4.0	10.8	14.0	.	.	.	.	.	.	.	.	.	.	37.8	14.3	38.7	50.0	.	.	.	.	.	.	.	.	.	.
Mangaotaki. A.M. 225	28.5	10.8	4.4	11.8	13.5	.	.	.	.	.	30.1	8.2	4.0	10.5	10.9	38.0	15.7	41.3	47.3	.	.	.	.	27.2	13.4	34.8	36.2	.	.
Doubtless Bay. A.M. 22	27.8	10.6	3.9	11.0	13.3	56.0	13.5	3.8	7.3	10.6	31.3	8.1	3.5	10.4	9.7	38.1	14.0	37.0	47.8	24.2	6.8	13.0	18.9	25.8	11.1	33.1	31.0	49.5	56.0
	.	.	.	.	.	55.6	13.7	3.9	7.3	10.7	.	.	.	.	.	.	.	.	.	22.8	7.2	13.1	19.3	.	.	.	.	.	.
Waikaremoana. A.M. 53	27.6	9.6	4.2	9.9	12.2	52.6	12.3	3.7	6.7	10.4	28.2	7.3	3.2	9.7	9.1	34.6	15.1	35.9	44.2	23.4	7.0	12.7	19.8	25.9	10.9	34.3	32.3	52.2	53.5
	27.5	9.5	4.1	10.0	12.2	52.6	12.3	3.7	6.7	10.3	28.0	7.5	3.1	9.6	9.0	34.6	15.0	36.5	44.4	23.4	7.0	12.7	19.6	26.7	11.2	34.1	32.1	.	.
Wanganui. A.M. 328	.	.	.	.	.	.	.	.	.	.	28.4	6.7	2.9	8.7	8.1	.	.	.	.	.	.	.	.	23.8	10.4	33.2	28.4	.	.
Wanganui. A.M. 328	.	.	.	.	.	.	.	.	.	.	27.2	6.5	2.7	7.9	7.7	.	.	.	.	.	.	.	.	24.1	9.9	29.0	28.3	.	.
Haupouri. H.B. Mus.	25.0	.	3.6	9.5	11.4	52.0	11.5	3.5	6.3	9.9	27.0	7.1	3.4	9.1	9.3	.	14.6	38.0	45.6	22.1	6.7	12.2	19.1	26.3	12.6	33.7	34.4	48.0	52.0
Waikaremoana. A.M. 103	26.5	9.4	4.3	10.0	12.9	51.1	11.2	3.5	7.2	10.2	28.5	7.3	3.3	9.7	9.2	35.4	16.1	37.7	48.7	21.9	6.9	14.5	20.0	25.6	11.5	33.9	32.2	52.0	56.0
Karamu, prob. indiv. A.M.	.	.	.	.	.	48.4	10.2	3.6	6.5	9.9	25.6	7.0	3.0	8.5	8.8	.	.	.	.	21.1	7.4	13.4	20.5	27.3	11.6	33.0	34.8	.	53.0
Single bones, minima	25.0		(Haupouri)			48.4		(Karamu)			24.6	6.6	3.2	8.3	9.0	.	.	.	.	.	.	.	.	26.8	13.2	33.7	36.6	.	.

TABLE K. *Dinornis ingens.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Poverty Bay. Type *ingens*	.	.	.	.	.	74.3	16.6	4.9	9.1	.	.	.	.	.	.	.	.	.	.	22.2	6.6	12.3	.	.	.	.	.	.	.
Mangaotaki. A.M. 346	34.7	12.8	5.4	13.3	.	74.0	16.1	5.6	9.9	.	.	.	.	.	.	37.2	15.5	38.7	.	21.8	7.5	13.3	.	.	.	.	.	47.0	.
Hastings. A.M. 113	34.0	12.4	4.5	13.5	15.6	73.7	15.8	4.8	9.5	12.9	41.7	9.8	4.1	12.5	11.4	36.4	12.9	40.0	45.8	21.4	6.5	12.8	17.5	23.6	9.9	30.0	27.4	46.1	56.5
Poverty Bay. Type *firmus*	36.8	.	.	.	19.0	73.7	.	.	.	15.9	41.2	.	.	.	14.2	.	.	.	51.6	.	.	.	21.6	.	.	.	34.5	49.9	56.0
Mangaotaki. A.M. 123	33.2	12.0	4.7	14.2	15.8	73.4	16.4	5.1	10.5	13.2	.	.	.	.	.	36.0	14.0	42.7	47.5	22.3	6.9	14.3	18.0	.	.	.	.	45.3	.
North Island. A.M. 262	35.8	13.2	5.4	15.2	18.3	73.0	17.3	5.4	9.6	15.2	41.1	10.4	5.1	12.8	14.5	36.5	15.1	41.5	51.1	23.7	7.4	12.9	20.6	25.2	12.5	31.1	35.3	49.0	56.2
Kaiwaka. H.B.	33.5	.	5.4	13.5	16.5	72.0	15.3	5.4	8.9	15.1	38.5	9.7	4.3	11.3	12.7	.	16.1	38.2	46.7	21.3	7.3	12.4	21.0	27.8	11.2	29.3	33.0	46.5	53.5
Waikaremoana. A.M. 80	34.3	11.7	5.6	13.5	18.2	71.9	15.0	5.3	9.3	15.0	.	.	.	.	.	34.1	16.3	39.3	53.0	20.2	7.4	12.9	20.8	.	.	.	.	47.7	.
Waikaremoana. A.M. 64	35.0	13.1	6.0	14.0	17.6	71.2	16.2	5.0	9.5	14.4	.	.	.	.	.	37.4	17.0	40.0	50.3	22.8	7.1	13.3	20.2	.	.	.	.	49.2	.
Waikaremoana. A.M. 96	33.4	12.3	5.4	13.3	16.0	67.9	15.6	5.3	9.1	14.3	37.5	9.8	4.4	11.5	12.7	36.8	13.1	39.8	49.0	22.9	7.9	13.4	21.0	26.2	11.8	31.6	34.0	49.2	55.2
	.	.	.	.	.	67.6	16.0	5.3	9.0	.	.	.	.	.	.	.	.	.	.	23.6	7.9	13.3	.	.	.	.	.	.	.
Patangata. A.M. 263	.	.	.	.	.	67.4	14.5	4.6	8.6	12.7	35.4	8.7	3.7	11.0	10.4	.	.	.	.	21.5	6.8	12.7	18.8	24.6	10.4	31.1	29.4	.	52.5
Waikaremoana. D.M.	35.0	12.3	5.1	14.2	16.1	66.7	15.0	4.8	9.0	12.9	37.0	9.3	4.1	12.6	12.0	35.1	14.6	40.6	46.0	22.4	7.2	13.5	19.3	25.2	11.1	34.0	32.4	52.5	55.4
Mangaotaki. A.M. 183	31.5	.	4.4	13.6	15.8	66.0	.	5.3	9.2	14.3	34.9	10.2	4.4	11.6	12.0	.	14.1	43.2	50.2	.	8.1	13.8	21.7	29.2	12.6	33.1	34.4	47.8	53.0
	.	.	.	.	.	66.0	15.6	5.3	9.2	14.2	34.9	10.2	4.4	11.6	12.0	.	.	.	.	23.6	8.1	13.8	21.5	29.2	12.6	33.1	34.4	.	.
Waikaremoana. A.M. 61	34.0	.	5.0	12.7	15.0	66.0	14.0	4.5	8.4	12.4	36.7	9.3	3.8	11.0	10.9	.	14.7	37.5	44.1	21.2	6.8	12.7	18.8	25.3	10.9	30.0	29.7	51.5	55.6
North Island. Type *gracilis*	.	.	.	.	.	.	.	.	.	.	33.0	8.5	4.0	10.8	10.8	.	.	.	.	.	.	.	.	25.6	12.1	32.7	32.7	.	.

TABLE L. *Dinornis giganteus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Te Aute. Lectotype *excelsus*	.	.	.	.	.	96.5	.	.	.	17.8	.	.	.	.	.	.	.	.	.	.	.	.	18.4	.	.	.	.	.	.
Te Aute, Hutton 1892b, *excelsus*	.	.	.	.	.	.	.	.	.	.	50.8	.	.	.	15.9	.	.	.	.	.	.	.	.	.	.	.	31.2	.	.
Makirikiri, Wang. Mus. mtd. skel. composite	38.2	13.7	6.7	15.5	.	94.7	19.1	6.9	10.8	.	48.1	11.9	5.5	14.8	.	35.9	17.5	40.6	.	20.2	7.3	11.5	.	24.7	11.4	30.8	.	.	.
	38.0	13.8	6.6	16.0	.	94.0	19.3	6.8	11.3	.	45.7	11.2	5.4	14.3	.	36.3	17.4	42.1	.	20.5	7.2	11.5	.	24.2	11.8	31.3	.	.	.
Makirikiri, Wang. Mus. prob. indiv.	41.1	15.7	5.8	16.1	20.1	90.7	.	7.1	10.9	19.2	52.5	12.0	5.5	14.5	16.2	38.2	14.2	39.1	48.8	.	7.8	12.0	21.2	22.8	10.6	27.6	30.8	45.0	58.0
	.	.	.	.	.	90.8	.	7.1	10.8	19.2	53.0	11.7	5.6	14.6	16.1	.	.	.	.	.	7.8	11.9	21.2	22.1	10.6	27.6	30.4	.	.
Poverty Bay. Type *giganteus*	.	.	.	.	.	88.7	19.4	6.0	9.7	.	.	.	.	.	.	.	.	.	.	21.6	6.8	11.0	.	.	.	.	.	.	.
Poverty Bay. Owen 1844b, 241, m1	.	.	.	.	.	.	.	.	.	.	47.0	.	4.9	12.9	14.0	.	.	.	.	.	.	.	.	.	10.4	27.6	29.8	.	.
Poverty Bay. Owen 1844b, 241 f1	40.6	.	.	.	18.4	.	.	.	.	.	.	.	.	.	.	.	.	.	45.3	.	.	.	.	.	.	.	.	.	.
Doubtless Bay. A.M 363	36.0	.	.	.	.	82.4	16.8	5.5	9.8	15.6	46.8	10.7	4.6	13.7	12.9	.	.	.	.	20.4	6.7	11.9	18.9	22.9	9.8	29.2	27.5	44.0	56.8
Moawhango. ?indiv. Oliver, p. 38	38.0	15.1	6.3	14.4	.	81.6	18.7	5.7	11.1	.	45.2	11.3	4.4	14.0	.	39.7	16.6	37.8	.	22.9	7.0	13.6	.	25.0	9.7	30.9	.	46.0	55.0
?Hawke's Bay. H.B.	38.5	13.7	5.3	14.6	18.0	79.5	15.9	5.4	9.5	14.4	50.8	11.2	5.6	13.4	15.7	35.6	14.1	37.9	46.8	20.0	6.8	11.9	18.7	22.0	10.9	26.4	30.9	48.5	64.0
Awhitu. Cheeseman 1878. AM. 223	.	.	.	.	.	79.3	.	6.2	11.1	18.6	44.7	11.9	5.7	14.7	16.4	.	.	.	.	.	7.8	13.9	23.4	26.6	12.8	32.9	36.7	.	56.4
Doubtless Bay. A.M. 2	37.5	15.0	6.6	.	.	75.9	.	5.9	10.2	16.4	47.0	11.0	5.1	.	.	40.0	17.4	.	.	.	7.8	13.4	21.6	23.4	10.8	.	.	49.5	62.0

TABLE M. *Dinornis torosus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Mt. Arthur. A.M. 122	33.0	12.8	5.1	14.2	15.3	65.0	15.4	4.5	9.3	12.2	33.4	9.9	4.5	12.0	11.9	38.8	15.1	43.1	46.5	23.7	6.9	14.3	18.6	29.8	13.5	35.9	35.8	50.8	51.5
Timaru. B.M. 46639-43. Lyd. 240	32.3	11.8	5.2	12.3	.	64.7	15.0	4.6	9.1	.	32.5	9.5	5.0	11.9	.	36.3	16.1	38.0	.	24.1	7.1	14.1	.	29.2	15.4	36.6	.	50.1	50.4
Glenmark. Haast 1869, no. 7	31.3	.	.	.	16.3	63.0	.	.	.	13.2	32.8	.	.	.	11.9	.	.	.	52.0	.	.	.	21.0	.	.	.	36.7	49.8	52.0
Takaka. Type *torosus*. A.M. 352	29.5	12.1	5.1	12.8	16.0	60.5	13.6	4.8	8.6	13.1	31.5	9.1	3.8	11.3	10.3	41.0	17.4	43.5	54.2	22.5	7.9	14.3	21.7	28.9	12.1	35.8	32.7	48.4	52.0
	29.5	12.0	5.2	12.8	15.9	60.5	13.6	4.9	8.7	13.2	31.4	9.1	3.8	11.1	10.3	40.7	17.6	43.5	54.2	22.5	8.0	14.4	21.8	29.0	12.0	35.3	32.8	.	.
Takaka. D.M. Oliver, p. 41	29.6	10.3	4.8	12.3	.	60.5	14.0	4.5	8.1	.	30.4	9.0	3.9	10.8	.	34.8	16.2	41.6	.	23.2	7.4	13.4	.	29.6	12.8	35.5	.	48.9	50.3
Hamilton, S.I. Hutt. 1875. max.	31.0	11.2	.	12.2	14.6	59.7	14.5	.	7.6	.	31.8	9.3	4.8	12.7	12.9	36.2	.	39.4	47.1	24.3	.	12.7	.	29.2	15.1	40.0	40.6	.	.
Glenmark, Haast 1869, no. 10	28.9	.	.	.	13.7	58.4	.	.	.	11.9	32.0	.	.	.	11.7	.	.	.	47.5	.	.	.	20.4	.	.	.	36.5	49.5	54.8
South Is. B.M., A. 105, Lyd. 243	28.7	.	.	.	.	58.3	.	.	8.8	.	.	.	.	.	.	.	.	.	.	.	.	15.1	.	.	.	.	.	49.2	.
Hamilton, S.I. Hutton 1875, mean	29.2	10.4	.	11.2	14.4	56.8	14.10	.	7.4	.	29.2	8.4	4.3	11.7	11.7	36.0	.	38.4	49.3	24.8	.	13.0	.	28.8	14.7	40.0	40.0	.	.
South Is. *strenuus* Hutt. averages	26.7	8.9	4.3	10.2	.	55.9	13.5	4.3	7.9	.	28.1	8.6	4.1	11.7	.	33.3	16.2	38.1	.	22.8	7.3	14.1	.	30.7	14.4	41.5	.	.	.
South Is. Lectotype *strenuus*. C.M.	.	.	.	.	.	.	.	.	.	.	27.9	8.9	4.0	11.1	10.6	.	.	.	.	.	.	.	.	31.9	14.5	39.8	38.0	.	.
South Is. *Pal. plenus* Hutt. max.	25.4	[Femur is of			10.2	54.6	Lectotype			11.7	26.9	.	.	.	10.2	*A. didiformis*			40.0	.	.	.	21.3	.	.	.	37.7	.	.
average	24.1	*A. didiformis*]			9.1	53.3	.	.	.	10.7	26.4	.	.	.	9.6				37.9	.	.	.	20.4	.	.	.	36.2	.	.
min.	22.9	.	.	.	8.1	52.6	.	.	.	9.6	26.0	.	.	.	9.5				35.6	.	.	.	18.4	.	.	.	36.5	.	.
Enfield. C.M. 1.14.2 ? pair	.	.	.	.	.	54.3	13.8	4.0	8.8	11.1	.	.	.	.	.	.	.	.	.	25.4	7.5	16.4	20.4	.	.	.	.	.	.
1.14.14	.	.	.	.	.	54.2	13.8	4.1	8.9	11.3	.	.	.	.	.	.	.	.	.	25.2	7.6	16.5	20.9	.	.	.	.	.	.
Glenmark. C.M.	28.8	10.9	14.7	12.5	14.5	.	.	.	.	.	26.7	.	3.8	9.7	10.0	37.8	16.6	43.3	50.0	.	.	.	.	.	14.0	36.4	37.4	.	.
Hamilton, S.I. Hutt. 1875. min.	27.9	10.2	.	10.2	14.2	52.6	13.2	.	7.0	.	26.0	8.1	3.8	10.9	10.2	36.6	.	36.6	50.9	25.1	.	13.3	.	31.2	14.6	42.0	39.2	.	.

TABLE N. *Dinornis robustus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
Hamilton. C.M. 1.9.5	36.1	13.6	5.8	15.2	18.5	Enfield, C.M. 1.7.26					41.0	11.9	4.6	15.5	13.0	37.7	16.4	42.1	51.3	Enfield				29.2	12.7	35.5	31.8	.	.
Castle Rock. Hutton 1892b	33.0	.	.	.	19.7	75.4	.	.	.	16.5	38.1	.	.	.	13.7	.	.	.	59.5	.	.	.	21.9	.	.	.	36.0	43.8	50.5
Heathcote. Types *potens*	36.0	.	.	.	19.3	74.9	.	.	.	15.2	38.3	.	.	.	14.5	.	.	.	53.5	.	.	.	20.4	.	.	.	37.8	48.2	51.2
Enfield. C.M. 1.9.1	.	.	.	.	.	74.5	17.0	5.7	10.5	15.6	.	.	.	.	.	.	.	.	.	22.8	7.6	14.2	20.9	.	.	.	.	.	.
Timaru. B.M., A11, Lyd. 228 ..	Not given by Lydekker					73.6	.	.	9.7	.	Not given by Lydekker					.	.	.	.	.	.	13.2	.	.	.	.	.	.	.
Pyramid Valley. C.M. 1939/3 ..	.	.	.	.	.	73.2	17.0	5.5	10.3	15.0	38.9	11.1	4.9	14.2	13.4	.	.	.	.	23.2	7.5	14.1	20.2	28.5	12.5	36.5	34.4	48.4	53.2
	35.5	13.2	5.5	14.8	17.6	73.2	17.0	5.6	10.3	15.0	39.0	11.2	4.9	14.3	13.4	37.2	15.5	41.7	49.7	23.2	7.7	14.1	20.5	28.7	12.5	36.6	34.3	.	.
Pyramid Valley. C.M. xA	35.2	13.7	5.2	14.9	16.3	72.0	16.0	4.8	10.5	12.9	40.0	11.0	4.7	13.7	12.5	39.0	14.7	42.3	46.3	22.2	6.6	14.6	17.9	27.5	11.7	34.2	31.2	48.8	55.5
	35.3	13.6	5.2	15.0	16.3	71.9	16.0	4.7	10.6	12.9	40.0	11.2	4.6	13.9	12.5	38.5	14.7	42.5	46.2	22.2	6.5	14.8	17.9	28.0	11.5	34.8	31.2	.	.
Glenmark. C.M. mtd. not indiv. ..	33.6	.	5.8	14.6	17.6	71.5	15.7	5.3	10.5	14.3	37.2	10.2	4.6	14.1	12.8	.	17.3	43.5	52.4	22.0	7.5	14.7	20.0	27.5	12.4	37.9	34.4	.	.
Nelson. A.M. 353	35.0	13.6	5.9	14.9	18.4	71.0	17.3	5.8	10.8	16.1	42.0	11.0	5.4	13.3	15.4	38.8	16.8	45.4	52.6	25.4	8.2	15.2	22.7	26.2	12.8	31.7	36.7	49.3	59.2
South Is. Type *robustus*	.	.	.	.	.	.	.	.	.	.	36.8	10.8	4.6	14.0	14.0	.	.	.	.	.	.	.	.	29.4	13.1	38.1	38.1	.	.
South Is. Owen 1846e, *robustus* ..	34.9	13.7	.	14.8	18.0	.	.	.	.	.	.	.	.	.	.	39.3	.	42.4	51.5	.	.	.	.	.	.	.	.	.	.
Knobby Ra. Hutt. and Coughtrey 1875b	36.6	.	.	14.4	18.4	70.3	15.4	.	10.4	14.6	38.1	11.4	5.1	14.4	.	.	.	39.3	50.5	22.0	.	14.7	20.8	30.0	13.3	37.8	.	52.0	54.0
Tiger Hill. Yorkshire Mus.	35.3	13.7	5.5	15.3	.	69.0	17.0	5.5	10.6	.	38.5	11.2	5.0	14.2	.	38.8	15.5	43.3	.	24.6	7.9	15.3	.	29.2	13.0	37.1	.	50.8	55.4
	34.9	13.7	5.5	15.3	.	69.0	17.7	5.5	10.7	.	38.5	11.3	5.0	.	.	39.3	15.8	43.8	.	25.6	7.9	15.5	.	29.3	13.0	.	.	.	.

TABLE O. *Dinornis maximus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.				Tibia = 100.	
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G	Femur.	Metatarsus.
South Island. Type *altus*	.	.	.	.	.	.	.	.	.	.	54.6	13.3	6.5	18.4	16.1	.	.	.	.	.	.	.	.	24.4	12.0	33.7	29.4	.	.
Glenmark. Type *maximus* Haast ..	46.5	17.1	6.8	18.8	23.1	99.0	21.0	7.2	12.5	20.9	.	.	.	.	.	36.8	14.6	39.5	49.7	21.2	7.3	12.6	21.3	.	.	.	.	47.4	52.5
Glenmark. Type *maximus* Owen ..	47.0	17.4	6.7	18.9	23.5	99.0	21.5	7.6	12.6	21.3	51.8	14.0	7.5	17.3	20.3	37.0	14.3	40.2	50.0	21.7	7.7	12.7	21.5	27.0	14.5	33.3	38.9	47.4	52.2
Pyramid Valley. C.M. xiii C. ..	43.7	17.2	6.9	19.4	22.0	92.4	21.4	7.5	13.4	19.9	48.2	13.6	6.1	18.2	16.5	39.4	15.8	44.5	50.4	23.2	8.2	14.5	21.5	28.2	12.7	38.0	34.2	47.3	52.2
	43.7	17.1	6.8	19.3	22.0	92.1	21.5	7.7	13.5	20.3	48.3	13.8	6.3	18.4	16.8	39.2	15.5	44.3	50.4	23.3	8.4	14.6	22.0	28.6	12.9	38.1	34.7	.	.
Glenmark. C.M. mtd. ? indiv. ..	43.5	.	6.6	16.5	20.8	91.2	17.1	6.5	12.2	18.2	53.3	12.8	6.4	17.0	18.3	.	15.6	38.0	47.7	18.8	7.3	13.4	20.0	24.0	11.9	31.8	34.3	.	.
Glenmark. C.M. 1.4.3	.	.	.	.	.	.	.	.	.	.	51.5	12.0	5.8	15.8	.	.	.	.	.	.	.	.	.	23.4	11.3	29.4	31.2	.	.
Glenmark. B.M. A.162, Lyd. 231 ..	38.7	15.1	6.8	15.3	20.5	90.5	19.0	6.7	11.5	19.0	47.0	11.5	6.8	15.0	18.7	38.9	17.4	39.4	53.0	21.0	7.4	12.7	20.9	24.4	14.5	32.0	39.9	42.8	52.0
Pyramid Valley. C.M. 1939	.	.	.	.	.	89.8	19.0	6.3	12.8	18.5	49.4	13.2	5.7	17.3	15.8	.	.	.	.	.	7.1	14.2	21.1	26.8	11.5	34.7	32.0	.	55.0
	.	.	.	.	.	.	.	.	.	.	48.8	13.2	5.8	17.1	15.8	.	.	.	.	.	.	.	.	27.0	11.8	35.1	32.3	.	.
Glenmark. Type *validus*	41.9	15.4	6.4	17.7	19.2	88.9	19.4	6.5	12.0	18.0	48.0	11.5	6.0	16.0	16.9	36.8	15.5	42.2	45.8	21.5	7.4	13.5	20.2	23.9	12.6	33.3	36.5	46.7	53.4
Riverton. Hutt. (1896e. II) B.M. A603	40.6	14.5	6.6	17.9	.	88.9	20.1	6.6	10.8	.	49.5	12.4	5.6	16.3	.	35.7	16.2	44.0	.	22.6	7.4	12.1	.	25.0	11.3	32.9	.	45.7	55.7
Pyramid Valley. C.M. 1939/6 ..	41.5	16.7	6.6	17.4	22.0	87.9	18.9	6.1	12.6	16.8	45.0	13.4	5.8	16.2	15.6	40.0	15.8	41.8	53.0	21.5	6.9	14.3	19.1	29.8	12.9	36.0	34.6	47 2	51.2
Pyramid Valley. C.M. xiii A. ..	41.7	15.8	6.3	17.3	21.2	87.0	19.7	6.8	12.6	18.3	46.7	13.5	5.9	16.6	16.0	37.9	15.2	41.5	50.8	22.6	7.9	14.5	21.1	28.9	12.6	35.5	34.3	48.0	53.7
	41.5	15.7	6.3	17.2	21.2	86.7	19.5	7.0	12.4	18.6	46.9	13.4	5.9	16.8	16.0	37.8	15.1	41.5	51.1	22.5	8.1	14.3	21.4	28.7	12.6	36.0	34.2	.	.
Riverton. Hutton 1896c I. C.M. ..	39.1	.	6.6	16.0	.	87.6	20.1	6.9	10.4	.	44.5	11.7	6.1	16.5	.	35.0	16.9	41.0	.	23.8	7.9	11.9	.	26.3	13.7	37.1	.	44.6	50.1
Riverton. C.M. 1.2.15 (G.A.) ..	39.5	15.2	6.5	17.1	20.5	86.6	19.5	6.6	11.1	19.3	44.6	11.8	6.1	16.7	16.6	38.4	16.5	44.2	52.0	22.7	7.7	12.8	22.3	26.5	13.7	37.2	37.6	45.6	51.5
	.	.	.	.	.	86.5	19.8	6.7	11.3	19.3	44.1	11.8	6.1	16.7	16.6	.	.	.	.	22.9	7.8	12.9	22.3	26.9	13.9	37.9	37.7	.	.
Shag Valley. O.M.	38.0	14.2	6.5	15.9	20.3	84.5	18.5	6.0	11.2	16.2	42.5	12.4	5.9	15.3	15.7	37.5	17.2	41.8	53.5	21.9	7.1	13.2	19.2	29.2	14.0	36.0	37.1	45.0	50.3
Pyramid Valley C.M. xiii B	39.6	15.9	5.9	17.3	18.9	83.5	19.0	5.5	11.3	15.7	45.2	11.8	5.3	16.0	14.8	40.2	17.8	43.7	47.9	22.8	6.6	13.5	18.8	26.2	11.8	35.4	32.7	47.5	54.1
	.	.	.	.	.	84.2	.	5.7	11.4	15.8	45.2	11.7	5.3	16.0	14.8	.	.	.	.	.	6.8	13.5	18.8	25.6	11.7	35.3	32.7	.	.
Broken River. D.M. ? indiv.	.	.	.	.	.	83.0	.	6.0	10.3	16.4	42.0	11.3	5.5	14.2	14.9	.	.	.	.	.	7.2	12.5	19.8	27.0	13.1	33.8	35.5	.	.
Waikouaiti. B.M. 32039-42 (G.A.)..	38.8	.	5.9	.	18.9	82.9	19.4	6.3	11.2	17.2	43.0	11.4	6.0	16.0	16.3	.	15.3	.	48.7	23.4	7.6	13.6	20.4	26.5	13.9	37.2	37.9	47.0	51.9
	38.7	15.7	6.2	17.0	18.7	81.4	19.8	5.7	11.6	15.5	43.0	10.9	6.1	16.0	16.5	40.6	15.9	43.8	48.5	24.3	7.0	14.3	19.1	.	14.1	37.2	38.4	.	.
Kapua. Tring Mus. ? indiv.	40.5	16.6	7.7	17.7	.	82.5	19.5	6.8	11.8	.	43.0	12.2	6.1	16.5	.	41.0	19.0	43.7	.	23.6	8.2	14.4	.	28.3	14.2	38.5	.	49.0	52.1
Pyramid Valley. C.M. 1939/2 ..	39.7	14.0	6.0	16.3	19.3	81.3	19.1	6.1	12.1	16.3	41.0	12.4	5.7	15.8	15.5	35.2	14.9	41.1	48.6	23.5	7.5	14.8	20.0	30.2	13.9	38.5	37.8	49.0	50.5
	39.6	14.0	6.0	16.1	19.4	81.0	19.0	6.1	12.1	16.2	40.6	12.4	5.7	15.8	15.5	35.3	15.2	40.6	48.9	23.4	7.5	14.9	20.0	30.5	14.6	38.9	38.1	.	.
Sumner. C.M. ? indiv.	40.0	15.5	6.6	16.3	20.2	80.5	18.6	7.1	12.2	19.1	42.1	12.3	6.3	17.1	16.5	38.8	16.5	40.7	50.5	23.1	8.9	15.1	23.7	29.2	15.1	40.5	39.2	.	.
Glenmark. C.M. mtd. "*robustus*"..	39.0	.	6.4	16.7	20.7	78.0	18.0	5.8	11.7	16.2	42.5	11.6	5.6	15.0	15.0	.	16.4	42.8	53.2	23.1	7.5	15.0	21.2	27.3	13.3	35.3	35.3	.	.
Waikouaiti. Owen 1846e. "*giganteus*"	40.6	15.2	.	15.9	19.7	88.9	19.0	.	10.2	16.5	45.7	11.4	5.5	15.2	15.2	36.6	.	38.2	47.3	21.5	.	11.5	18.6	25.1	12.1	33.4	33.4	.	.

TABLE P. (a) *Struthio camelus.*
(b) *Dromiceius novae-hollandiae.*

(a) *Struthio camelus.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.			
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G
Australian Museum. S.941	31.4	11.1	.	10.2	.	55.0	11.8	.	7.0	.	47.4	7.6	.	.	.	35.4	.	32.5	.	21.4	.	12.7	.	16.0	.	.	.
	31.4	11.0	.	10.1	.	55.0	11.9	.	7.0	.	47.5	7.4	.	.	.	35.0	.	32.1	.	21.6	.	12.7	.	15.6	.	.	.
Australian Museum. S.491	30.8	10.5	.	10.2	.	52.7	11.9	.	7.0	.	45.5	7.4	.	.	.	34.1	.	33.1	.	22.6	.	13.3	.	16.2	.	.	.
	31.3	10.5	.	10.2	.	52.9	11.9	.	7.0	.	45.3	7.4	.	.	.	33.5	.	32.6	.	22.5	.	13.2	.	16.4	.	.	.
South African Museum	30.5	.	.	9.4	.	51.1	.	.	6.7	.	44.7	7.2	.	.	.	.	.	30.8	.	.	.	13.1	.	16.2	.	.	.
Australian Museum. S.7365	29.3	10.2	.	10.0	.	48.0	12.3	.	7.2	.	46.1	7.8	.	.	.	34.8	.	34.8	.	25.6	.	15.0	.	16.9	.	.	.
	29.9	10.7	.	10.0	.	51.0	12.6	.	7.1	.	46.0	7.7	.	.	.	35.8	.	33.5	.	24.7	.	13.9	.	16.7	.	.	.
Australian Museum. 4118	27.3	10.1	.	10.0	.	.	.	.	.	.	41.0	6.9	.	.	.	37.0	.	36.6	.	.	.	.	.	16.8	.	.	.
	27.5	10.0	.	9.3	.	49.7	11.5	.	6.8	.	41.0	6.8	.	.	.	36.4	.	33.8	.	23.1	.	13.7	.	16.6	.	.	.
Transvaal Museum	27.7	9.5	.	9.2	.	49.0	.	.	6.6	.	42.0	7.0	.	.	.	34.3	.	33.3	.	.	.	13.5	.	16.7	.	.	.
Australian Museum. S.1253	27.8	10.2	.	9.4	.	49.0	11.4	.	7.0	.	43.2	7.1	.	.	.	36.7	.	33.8	.	23.3	.	14.3	.	16.5	.	.	.
	27.9	10.2	.	9.4	.	48.9	11.4	.	7.0	.	43.1	7.1	.	.	.	36.6	.	33.7	.	23.4	.	14.3	.	16.5	.	.	.

(b) *Dromiceius novae-hollandiae.*

	Femur.					Tibia.					Metatarsus.					Femur length = 100.				Tibia length = 100.				Metatarsus length = 100.			
	L	P	M	D	G	L	P	M	D	G	L	P	M	D	G	P	M	D	G	P	M	D	G	P	M	D	G
Australian Museum. 13244	24.3	6.8	.	8.1	.	46.5	9.9	.	5.3	.	40.4	5.4	.	5.6	.	28.0	.	33.4	.	21.3	.	11.4	.	13.6	.	13.9	.
	24.2	6.9	.	8.1	.	46.7	9.9	.	5.2	.	41.0	5.6	.	5.5	.	28.5	.	33.4	.	21.2	.	11.3	.	13.6	.	13.4	.
Australian Museum. 655	22.8	6.7	.	7.7	.	45.1	9.0	.	4.9	.	38.0	5.2	.	5.3	.	29.4	.	33.8	.	20.0	.	10.9	.	13.7	.	14.0	.
	22.7	6.8	.	7.8	.	45.6	9.5	.	5.0	.	38.0	5.2	.	5.3	.	30.0	.	34.4	.	20.4	.	11.0	.	13.7	.	14.0	.
Australian Museum. S.257	24.1	6.6	.	7.5	.	45.1	9.5	.	5.3	.	40.7	5.4	.	.	.	27.4	.	31.2	.	21.1	.	11.7	.	13.3	.	.	.
	24.2	6.8	.	7.4	.	45.2	9.7	.	5.1	.	.	.	.	.	.	28.1	.	30.6	.	21.5	.	11.6	.	.	.	.	.
Australian Museum. 1515	23.4	6.4	.	7.8	.	43.6	9.3	.	5.0	.	40.1	5.2	.	5.0	.	27.3	.	33.4	.	21.3	.	11.5	.	13.0	.	12.5	.
	23.2	6.5	.	7.6	.	42.9	9.3	.	5.0	.	40.1	5.2	.	5.0	.	27.8	.	32.5	.	21.7	.	11.6	.	13.0	.	12.5	.
Nat. Mus. Melb. R.1815	23.8	5.7	.	7.1	.	.	.	.	.	.	39.6	5.5	.	5.5	.	24.0	.	29.8	.	.	.	.	.	13.9	.	13.9	.
Nat. Mus. Melb. R.4240	22.8	6.2	.	7.0	.	40.3	8.0	.	4.6	.	37.5	5.1	.	5.1	.	27.2	.	30.7	.	19.8	.	11.4	.	13.6	.	13.6	.
Australian Museum. 6246	21.8	5.9	.	7.1	.	39.0	8.2	.	4.8	.	38.9	.	.	4.9	.	27.0	.	32.6	.	21.0	.	12.3	.	.	.	12.6	.
	21.8	5.6	.	7.0	.	39.6	8.4	.	4.9	.	38.0	.	.	4.9	.	25.6	.	32.0	.	21.2	.	12.5	.	.	.	12.9	.
Nat. Mus. Melb. R.4238	22.5	6.4	.	7.0	.	37.4	8.5	.	5.0	.	35.4	5.4	.	5.3	.	28.4	.	31.1	.	22.5	.	13.2	.	15.3	.	15.0	.