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THE TYPES OF W. R. B. OLIVER'S MOAS AND NOTES ON OLIVER'S METHODS OF MEASURING MOA BONES

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Introduction

W. R. B. Oliver (b. 1883, d. 1957) was the last of a long line of New Zealanders publishing on the systematics of moas to describe new genera, subgenera and species of these extinct birds. His New Zealand predecessors and contemporaries in this field, Julius von Haast, James Hector, F. W. Hutton, Augustus Hamilton, T. J. Parker, H. O. Forbes and Gilbert Archey, publishing between 1863 and 1941, built up and refined a systematic structure for the moas from Richard Owen's basic scheme of two genera and 19 species (as summarized in Owen, 1879, 1883), to the six genera and 20 species (several different from Owen's 19 spp.), of Archey's Auckland Museum monograph of 1941. Owen's fellow countrymen R. Lydekker and W. Rothschild, described (in 1891 and 1907 respectively) an additional new genus and 12 new species of moas from material in the British and other United Kingdom Museums, but none of those named "species" are recognized unequivocally today (see Scarlett, 1972; Cracraft, 1976).

Oliver in his 1949 Dominion Museum bulletin on moas "in the main adopted Archey's scheme of classification" (ibid., 56) but added a new genus, two new subgenera and six new species to the existing systematic structure. He had already described a new species of Euryapteryx in his 1930 book, New Zealand Birds. His new moa taxa can be listed as follows:

Zelornis Oliver, 1949 (type species Euryapteryx exilis Hutton) - a genus close to Euryapteryx Haast, 1874

Mauiornis Oliver, 1949 (type species Pachyornis septentrionalis Oliver) - a subgenus of Pachyornis Lydekker, 1891

Pounamua Oliver, 1949 (type species Pachyornis murihiku Oliver) - a subgenus of Pachyornis Lydekker, 1891

Pachyornis (Mauiornis) septentrionalis Oliver, 1949

Pachyornis (Pounamua) murihiku Oliver, 1949

Pachyornis (Pachyornis) australis Oliver, 1949

Euryapteryx tane Oliver, 1949

Euryapteryx kuranui Oliver, 1930 - regarded by Archey (1941) and Oliver (1949) as a synonym of E. gravis (Owen, 1870)

Dinornis gazella Oliver, 1949

Dinornis hercules Oliver, 1949

In the second edition of his New Zealand Birds in 1955, Oliver made no change to the moa systematic structure (now 7 genera and 28 species) but did not use the Pachyornis subgenera. R. J. Scarlett in his 1972 Canterbury Museum bulletin Bones for the New Zealand Archaeologist was the next New Zealander to review moa systematics. He accepted, with some doubts, all of Oliver's 1949 species except E. tane (which he considered a synonym of E. geranoides Owen), but did not use Zelornis (he synonymized it with Euryapteryx), or the Pachyornis subgenera. Scarlett also, it should be noted, listed (ibid., 21) but did not name a new species of Dinornis ("known ...from one unpublished tibio-tarsus") and a new species of Euryapteryx (" a variable small form...from Stewart Island and the Murihiku area of the South Island"). In the latest review of moa systematics known to me, Cracraft (1976) did not recognize any of Oliver's taxa (specific or generic), and reduced the systematic structure to six genera and 13 species - the lowest number of species recognized since before 1879.

As the status of some (Scarlett, 1972) or all (Cracraft, 1976) of Oliver's new species is now questioned it is important to understand clearly just what type material his new names are based on. Oliver clearly states in his 1949 monograph what the "type" of each of his new species is, but in some cases these types can not be recognized from his text without additional information. In some species, photographic figures published in 1949, which a reader might justifiably assume to be of type material, are not of type material at all and in fact are not recognizable as to locality, collection or registered skeleton from Oliver's text alone. It is important then to go through each of Oliver's new moa species and firmly identify the actual type material and then to identify the actual figured material of each of the new forms. This task is attempted in the first part of this paper. It should be pointed out here that Recommendation 73C of the International Code of Zoological Nomenclature (ICZN, 1964) states that the "full locality, date, and other data on the labels accompanying the holotype" as well as "the collection in which it is situated and any collection - or register - number assigned to it" should be published where possible.

Anyone using Oliver's works on moas is aware of the great importance he gave to the measurement of moa bones, especially leg bones. In 1930 he provided (ibid., 35) an "artificial key to the genera of moas, based on the proportions of the leg bones... To use the key, it is necessary first to take the following measurements of each bone...". By 1949, Oliver, had abandoned (ibid., 56) the "artificial key for the identification of leg bones", but provided "tables of measurements...under each genus, in which any bone can be identified by inspection". He did not explain anywhere in his 1949 monograph just what the four leg bone measurements L, P, M and D used in these tables (e.g. ibid., 86) represent, though it is clear from his earlier work (1930: 35) and from Archey (1941:13) that they must be "length", "proximal width", "middle width" and "distal width" respecitvely. In the 1955 edition of New Zealand Birds, Oliver did not use proportions or width measurements for moa leg bones but gave maximum and minimum lengths for the three main leg bones of each species (ibid., 574 et seq.). In 1930 his dimensions were in centimetres (ibid., viii) for "birds" (including his moa bone measurements, see ibid., 37), but in millimetres for eggs! In 1949 he used millimetres in his moa bone and egg measurement tables though this is not clearly stated

anywhere but merely inferred from text reference (e.g. ibid., 46) and from footnotes to tables (e.g. ibid., 85). By 1955 Oliver was using millimetres for "birds and their eggs" (ibid., 15) including moa eggs, but had reverted to centimetres for moa bone measurements (ibid., 574). Both Archey (1941: 13) and Scarlett (1972) use centimetres consistently throughout their main works on moas and bird bones.

As the LPMD system of moa leg bone measurements is used throughout Oliver's 1949 monograph and was applied by him to the large unpublished collections of moa remains then available in the "Dominion" (now National) Museum, it is important that the methods Oliver used to obtain these measurement should be recorded. The second part of this paper gives an outline of Oliver's methods based on the information given in his 1930 book and on some details provided by him in a letter to W. B. Benham in 1932. Benham (1934), Archey (1941) and Scarlett (1972) each provide additional details useful in understanding Oliver's methods.

"Dominion Museum" register numbers for moa bones were prefixed by the letters "DM". With the change of name to National Museum of New Zealand the prefix has been changed to "NMNZ S", with "S" referring to the Subfossil Bird Register.

THE TYPE SPECIMENS OF OLIVER'S MOA SPECIES

Family EMEIDAE

(Emeidae Bonaparte, 1854, predates Anomalopterygidae Oliver, 1930 - see Brodkorb, 1963:208)

Genus Pachyornis Lydekker

Pachyornis septentrionalis Oliver, 1949 (Figs. 1.1, 1.2)

Pachyornis (Mauiornis) septentrionalis Oliver, 1949:61, figs. 29 (left), 30-34, 35 (left), 36, 37 (left bone of each pair).

Pachyornis septentrionalis Oliver, 1955:574, unnumbered fig. (repeat of fig. 34 of 1949).

Type material

According to Oliver (1949) the holotype is a "portion of skeleton of individual bird" from a limestone cave at Pohue, Hawke's Bay, collected by H. Hill, in the "Dominion" Museum with registration number DM 129 (now to be referred to as NMNZ S. 129). "Pohue" is presumably Te Pohue on the Napier-Taupo road, at a height of about 1465 ft about 29 miles north-west of Napier. H. Hill (1914:345) in a paper on moa remains from the Gisborne-Hawke's Bay area refers to "many specimens of the moa" as having been found "at Pohui, on the Napier-Taupo Road...among the limestone rock-masses and caves that occur along the east valley and deep gorges at the foot of the Te Waka Range". The spelling "Pohue" is used on his map (ibid., 331) and table (ibid., 350) where "several skeletons" are listed as having been collected at Pohue by Mr. Crawford, Mr. King and Hill, in"1890 and onward". A note by Augustus Hamilton among the Hamilton papers on moas in the National Museum records this incomplete holotype skeleton as "some bones of a small Pachyornis found with several incomplete skeletons of Anomalopteryx when cutting a road in the Pohui Bush, 1909. The bones were in a cave exposed during the cutting of a road round a spur to get timber out. When Mr. Hill went to see the place the cave had been filled in.

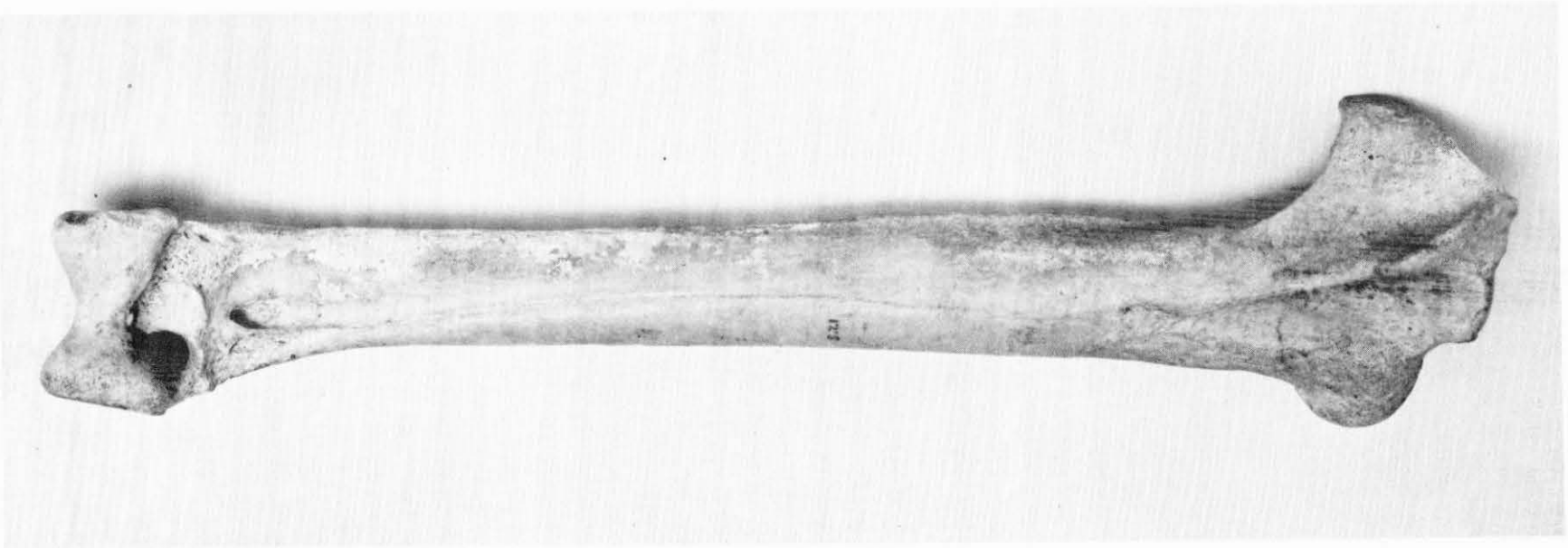

Fig. 1.1 Pachyornis septentrionalis Oliver. Right tibia of holotype from Te Pohue, Hawke's Bay, NMNZ S. 129.

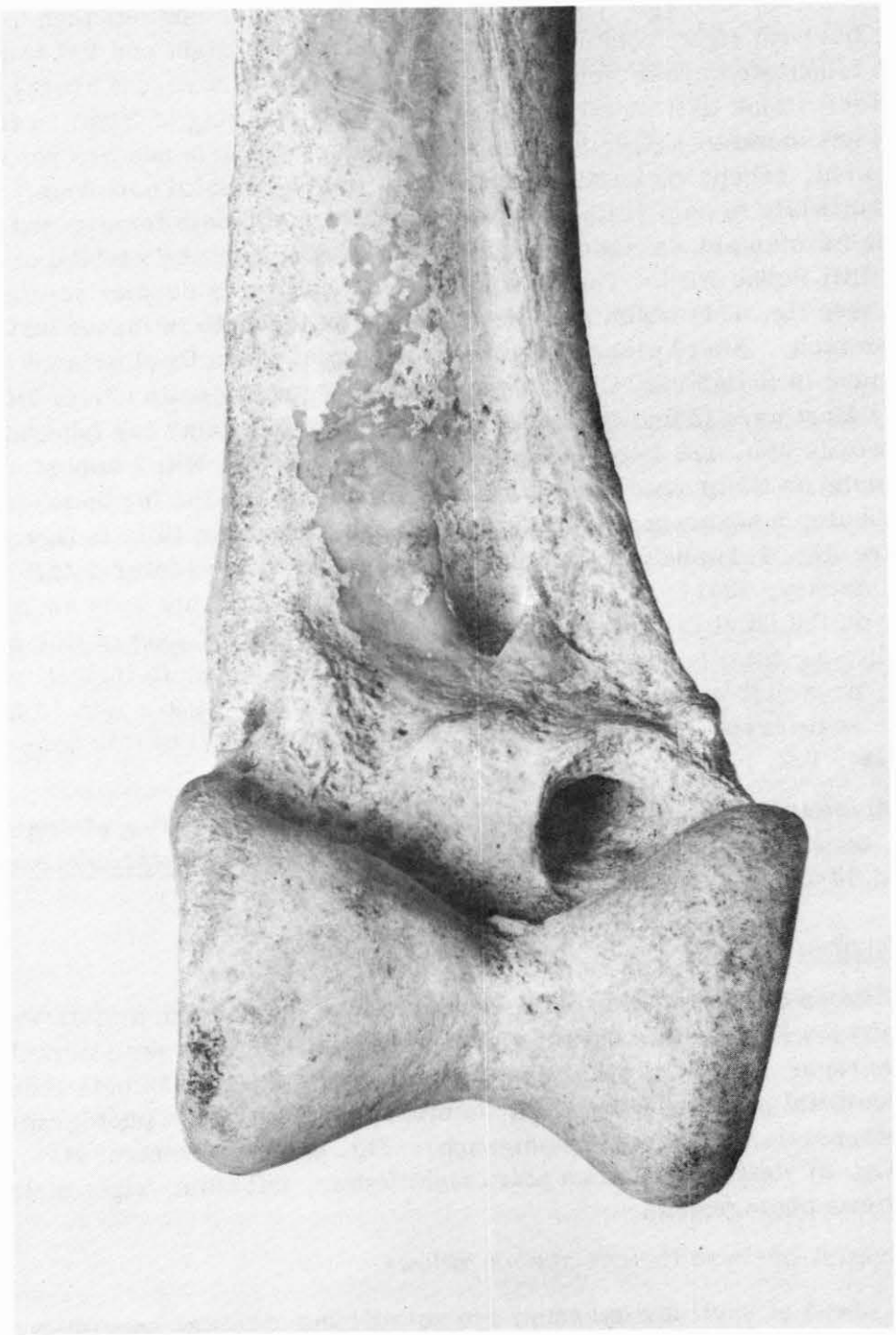

Fig. 1.2 Pachyornis septentrionalis. Distal part of right tibia of holotype.

The holotype has been catalogued as "9 bones", though the tag labels attached have the words "7 bones" inexplicably written on them, and these are as follows: sternum (with left lateral process missing but xiphoid process complete), pelvis (damaged posteriorly, with both pubes and left ischium missing, but with right ischium present and detached), right and left femora (left with trochanter crest alongside head sheared off in a recent break), right and left tibiae (left mostly covered with a thin coating of lime), a fibula, right and left metatarsi (i.e. 9 bones in 10 pieces). The bones are somewhat immature but, except for parts of the pelvis, in a very solid condition. Their colour is offwhite to pale yellow brown. The sternum, both femora and the right tibia have an old and faded label written in script on the surface of each reading "Hill Pohue HB". The principal leg bones have a number written on the shaft (see fig. 1.1) which appears to be the total length in inches and decimals of an inch. All 10 pieces have the following modern label printed on their surface in indian ink "DM 129 Pachyornis septentrionalis Oliver HOLOTYPE". Most have in addition a brown "Dominion Museum" tag label attached with the words "No. 129 Pachy. septentrionalis TYPE H. Hill 7 bones" in Oliver's hand on its printed front face and, in the case of the leg bones other than the fibula, measurements on the back face. The right tibia is figured here entire (fig. 1.1) and with the distal portion shown in greater detail (fig. 1.2; cf. Archey, 1941: fig. 9a). The measurements of this bone as given by Oliver on the label in the system explained in the second part of this paper, are as follows: total length 320 mm (cf. "12.5" presumably in inches, written on shaft", proximal width 85 mm, middle width 28 mm, distal width 48 mm. There are some irregular and thin lime patches on the shaft of this bone as shown in fig. 1.2.

As Oliver included only the Pohue skeleton under his heading of "type" material, none of the other specimens he referred to P. septentrionalis on pp. 61 and 63 can be considered as paratypes.

Original figures

The figures of this species published by Oliver in 1949 are as follows: fig. 29 (left) lower mandible dorsal view photograph; fig. 30 skull dorsal view photograph; fig. 31 skull lateral view photograph; fig. 32 palate drawing; fig. 33 preorbital plate drawing; fig. 34 sternum ventral view photograph; fig. 35 (left) pelvis dorsal view photograph; fig. 36 pelvis ventral view photograph; fig. 37 (left bone of each pair) right femur, left tibia, right metatarsus, anterior views photographs.

The origins of these figures are as follows:

Figs. 30-34 of skull and sternum are not attributed to any specimens in their captions and associated text, but the original photographs and drawings of these figures are labelled AM. 84 (a skeleton from Waikaremoana in the Auckland Museum) in Oliver's manuscript notes on moas in the National Museum. Details of this skeleton are given on page 61 of Oliver (1949), and fig. 34 of the sternum is captioned as from "Waikaremoana Auckland Museum" when republished in Oliver (1955) unnumbered on page 574.

Fig. 29 of the lower mandible is probably from the same Auckland Museum specimen but is not attributed in the caption and is not identified in Oliver's manuscript notes.

Fig. 35 of a pelvis labelled with the letter "R" is not attributed in the caption but is labelled Wanganui Museum on the original photograph. Oliver's manuscript notes imply that the letter "R" may stand for the locality "Riverlands".

Fig. 36 is definiately the holotype pelvis and is labelled as such in the caption.

In fig. 37 the femur and tibia can be recognized as holotype bones from characteristic marks on the bones themselves, and the metatarsus is probably holotypic as well but this can not be demonstrated with certainty.

Present status

Oliver distinguished P. septentrionalis from P. mappini Archey by its smaller size (e.g. femur length 161-192 mm compared with 181-224 mm) and by the "leg bones usually being proportionately more slender" (1949:61, 59). Scarlett (1972:21) lists P. septentrionalis as a separate species but suggests that it may represent merely the smaller members of the earlier described Pachyornis mappini. Cracraft (1976:197) regards P. septentrionalis as a synonym of P. mappini. He shows statistically that the leg bones of "P. septentrionalis" are smaller, but are not relatively more slender, than those of P. mappini. Cracraft considers that the two skeletal groupings covered by these two names "probably represent different sexes" and considers the separation of P. septentrionalis from P. mappini Archey as "unwarranted ... until firm evidence can be offered that they are distinct" (ibid., 198).

Pachyornis murihiku Oliver, 1949

Pachyornis sorenseni Oliver, 1944, Dominion Newspaper, Wellington, 17 May 1944 (invalid publication of nomen nudum).

Pachyornis (Pounamua) murihiku Oliver, 1949:67, fig. 41-46.

Pachyornis murihiku Oliver, 1955:574.

Type material

The holotype is described by Oliver as a "full-grown but not quite mature ...skeleton from Greenhills, near Bluff Hill, Southland" (1949:67) found by "Mr. Black in 1939 among sand-dunes" (1949:14) and now in the Southland Museum, Invercargill. The skeleton could not be found in the Southland Museum in the recent past (fide Scarlett, 1972:21, repeated in Cracraft, 1976: 196) but is now confirmed (August 1977) as present in the collections of the Museum with the registered number E 73210. Greenhills is a locality on the Invercargill-Bluff road and railway at the head of Bluff harbour, 12 miles from Invercargill, 5 miles from Bluff, with an altitude of 20 ft above sea level. No other bones were referred to this species by Oliver in 1949 or 1955.

The name Pachyornis sorenseni used for this skeleton by Oliver in some of his manuscript notes, and on some photographs, in the National Museum is deliberately published here so that its status can be discussed. It was used in a newspaper article on the Greenhills skeleton published in the Dominion on 17 May 1944, so it might be regarded as having priority over the name

P. murihiku used for the same skeleton but published first in 1949. Under Article 8 (2) of the International Code of Zoological Nomenclature (ICZN, 1964), however, it is clear that the 1944 use of the name P. sorenseni was not a valid publication as the newspaper was clearly not "issued for the purpose of scientific, public, permanent record". Regardless of whether the 1944 publication is valid or not, the name was a nomen nudum (under Article 13 (a) of the Code) when it appeared in 1944 as it was not accompanied by an indication of characters differentiating it from other species and as such was not available for systematic use.

Details of original discovery

No details of the original finding of the Greenhills skeleton have been published. Oliver was so concerned about the combination of characters in this skeleton that he wrote to the Director of the Southland Museum (Mr. J. H. Sorensen) on 28 June 1940 (National Museum file 9/1/8) to say that it "contains features quite different from those of any other described species. It agrees mostly with Emeus; but the sternum is quite different from those of any other species of Moas. The pelvis, too, is different, having a narrow escutcheon sloping outwards on either side. The upper mandible, too, is very steep; but I do not regard this as an important character... Is there any doubt about the sternum belonging to the rest of the skeleton? As far as I can judge from other species of Moas, the broad sterna are associated with broad bills". Sorensen replied on 2 July 1940 saying "I have interviewed the finder [of the Greenhills skeleton] and he is quite definite in his statement that the bones are from one bird only. He came across the pelvis showing out of the sand after a high wind, carefully removed the larger bones, noted that the vertebrae were coiled back over the rest of the skeleton, and wishing to save all the smaller bones, constructed a frame covered with fine netting and so sieved the balance out. As already mentioned, the bones of a seal were lying very close to the moa, and this accounts for the presence of a few foreign bones with the rest. I have no reason to doubt any part of the story at all and now know the finder fairly well... From my knowledge of the finder, locality, and the story of the finding I am of the opinion that the sternum belongs to the bird in question".

Original figures

The figures of this species published by Oliver in 1949 are as follows: figs. 41-42 skull dorsal and lateral views; fig. 43 sternum ventral view: figs 44-46 pelvis dorsal, lateral and ventral views. All are photographs and all are attributed in their captions to the holotype skeleton from Greenhills.

Present status

Oliver considered that "the skeleton possesses such distinctive features in the skull, sternum and pelvis, that I have no hesitation in giving it both a subgeneric and specific name" (1949:67). In size range of leg bones P. murihiku fitted between the smaller North Island P. mappini Archey and the larger South Island P. elephantopus (Owen), being distinctly closer to the former species (1949:59). Scarlett lists P. murihiku without systematic comment (1972:21), while Cracraft (1976:196) places it firmly as a synonym

of P. elephantopus regarding it as only "slightly smaller" than the known range of that species. As the species was based on a single "immature individual", Cracraft doubted whether the described morphological differences between the two named forms could be accepted as valid without additional specimens.

Pachyornis australis Oliver, 1949

Mesopteryx species b Parker, 1893:4, pl. 1.

Mesopteryx species B Parker, 1895:378, pl. 60 figs. 20, 21.

Emeus (not specifically identified) Oliver, 1930: two unnumbered figs. on p. 47.

Pachyornis pygmaeus (Hutton). Archey, 1941:41.

Pachyornis (Pachyornis) australis Oliver, 1949:70, figs. 47-52, ?fig. 53.

Pachyornis australis Oliver, 1955:575.

Type material

The holotype is a "skull and 20 vertebrae found by A. McKay in 1879 in a cave on the Salisbury Tableland, head of Takaka River, Nelson" in the National Museum, registered number DM 26, now to be known as NMNZ S. 26 (Oliver, 1949:70). The "Salisbury Tableland" is commonly referred to as the "Mt. Arthur Tableland", though neither name appears on published Lands and Survey maps of the area. The locality is a limestone mesa at the eastern end of the Peel Range, north-west of Mt. Arthur on the Arthur Range, lying between Mt. Arthur and the Cobb Reservoir. Tableland is a trig station at 4086 ft and the Salisbury Hut is on one of the north-flowing tributaries of the upper Takaka River. McKay (1879:131) describes this specimen as "part of a skeleton, comprising the head, neck and fore part of the trunk, in a fine state of preservation" but does not give any further details of its discovery.

The holotype skull and lower mandible are labelled "HOLOTYPE DM. 26" in several places but no vertebrae are now associated with this specimen. There are numerous unlabelled and unlocalized moa vertebrae in the National Museum collections but none are obviously the missing set from the holotype of P. australis. The skull is in good condition but has a distinctively-shaped dark scar (visible in all photographs) repaired with some waxy material in the centre of the dorsal surface of the cranium. The general colour of the bone varies between offwhite and yellowish-brown.

Two crania in the Southland Museum (one from Greenhills), are referred to P. australis by Oliver and some of the smaller leg bones listed under P. elephantopus in the tables of measurements are regarded as "possibly" belonging to the new species (Oliver, 1949:74). A sternum from the Southland Museum and a pelvis from the Nelson Museum are listed as P. australis with a question mark in Table 2 (ibid., 85). As Oliver regarded only the Salisbury Tableland skull and vertebrae as "type" material none of the other specimens can be regarded as paratypic.

Published figures

The holotype skull, described by Oliver (1949:72) as "one of the only two perfect skulls of moas that I have ever seen", was figured in three different publications before Oliver based his species P. australis on it. Parker (1893:pl. 1) gave a dorsal view photograph to show the pattern of pits on the cranium which he interpreted as indicating the original presence of a frontal feather crest, a possible male-only feature. He later (1895:pl. 60 figs. 20, 21) published very fine, natural size, dorsal and ventral view engravings (the best figures available of this specimen) in a general work on moa cranial morphology. Parker considered it "one of the most perfect" skulls "ever discovered" (1895:378) and thought that it must "belong to a species the skull of which has not hitherto been described" as it did not correspond with any of the figures or descriptions he had met with. He referred to it as Mesopteryx species b in 1893 and species B in 1895. Oliver (1930:47) used a dorsal and a lateral view photograph of this same specimen to illustrate the skull form of the genus Emeus but he did not specifically identify the skull in caption or text.

The figures published by Oliver in 1949 are as follows: figs. 47-49 photographs of skull dorsal, lateral and ventral views; figs. 50-52 drawings of palate, preorbital plate and junction of antorbital and lacrymal (lateral and front views of junction on one fig.); fig. 53 a photograph of the dorsal view of a pelvis captioned as "Pachyornis australis (?)". Figs. 47-49 are captioned "Salisbury Tableland" and the original photographs of figs. 47-49 and the original drawings of figs. 50-52 in Oliver's manuscript notes are all labelled as from the holotype skull. In the original photograph of fig. 53 the pelvis is labelled "Nelson Museum" in Oliver's manuscript notes and is clearly not type material. It is presumably the pelvis whose measurements are listed as P. australis with a question mark in Table 2 on page 85 of Oliver (1949).

Present status

Scarlett (1972:21) regarded P. australis as a possible variant of the South Island P. elephantopus (Owen) the "most variable of all Moas". It is firmly synonymized with P. elephantopus "one of the more common species of moas" by Cracraft (1976:196). Cracraft compared the holotype skull of P. australis with "a large series of skulls of P. elephantopus and can find no significant differences that can be regarded as being of specific value". He could match the distinctive characters attributed by Oliver to the skull of "P australis" within a series of skulls of P. elephantopus in the National Museum collections and several skulls in the collections referred by Oliver to P. elephantopus were of comparable size (i.e. at the lower end of the size range of P. elephantopus). Cracraft found that crania of this common South Island moa species exhibited considerable variability in shape and in the development of processes and muscle scars.

Genus Euryapteryx Haast

Euryapteryx tane Oliver, 1949

Euryapteryx exilis Hutton. Archey, 1941:57 (part).

Euryapteryx tane Oliver, 1949:105, figs. 73-78.

Euryapteryx tane Oliver, 1955:577.

Type material

The holotype is a skeleton from Doubtless Bay in the Auckland Museum, registered number AM. 3. Doubtless Bay is in the north of the North Auckland Peninsula, north-east of Kaitaia. The bone deposits in the consolidated sands of the sandhills are described in some detail by Archey (1941:93) and to a lesser extent by Oliver (1949:16).

The holotype skeleton includes at least the following parts: skull (but no lower mandible), sternum, pelvis; femur, tibia and metatarsus (both right and left). Descriptions and measurements of these elements are given in Archey (1941:49, table H) and Oliver (1949:105, tables 8-10). The bones are labelled "3" as can be seen in Oliver's photographic figures.

As Oliver included only the one skeleton under his heading of "type" material none of the other specimens he referred to E. tane on p. 105 can be considered as paratypes, especially as he thought some could possibly belong to the species he considered to be "Zelornis exilis".

Original figures

The figures of this species published by Oliver in 1949 are as follows: figs. 73-75 skull dorsal, lateral and ventral view photographs; fig. 76 pelvis ventral view photograph; fig. 77 sternum dorsal view photograph; fig. 78 preorbital plate drawing. All the photographs are attributed to the Doubtless Bay holotype in their captions and the original of the drawing in Oliver's manuscript notes in the National Museum is labelled as being made from the holotype specimen.

Present status

Oliver considered that "the characters of the type specimen " of E. tane "are just those of E. curtus, the only difference being in size, E. tane being larger, though the size difference is less marked in the skull than in the remainder of the skeleton" (1949:105). He placed four species in the genus Euryapteryx. In order of increasing size these were E. curtus (Owen) and E. tane (both known from the North Island only), E. geranoides (Owen) and E. gravis (Owen) both known from both North and South Islands. In his closely similar genus Zelornis, Oliver placed two species - the smaller North Island Z. exilis (Hutton) and the larger South Island Z. haasti (Rothschild). He saw "a kind of parallel evolution in the two genera" (ibid., 103) with the only constant differences between them being in the form of the premaxilla and mandible of the skull (ibid., 101), each genus consisting of a series of species of different sizes forming an "evolutionary line" (ibid., 118) with the largest species of each genus (E. gravis and Z. haasti) showing close resemblances from "what appears to be covergence" (ibid., 103). He was "quite unable to give a definition either by form or measurements to separate the leg bones of E. gravis from those of Z. haasti" (ibid., 110).

Scarlett (1972:21) regarded Zelornis as a synonym of Euryapteryx and listed five of the six species recognized by Oliver - E. curtus, E. exilis, E. geranoides (including E. tane as a synonym), E. gravis and E. haasti (which might be a broad-billed subspecies of E. gravis). He thought the first three "species" would be united eventually as the gaps in the size ranges between them were closed, but added a sixth "variable small form" of Euryapteryx as an unnamed new species from Stewart Island and the "Murihiku area" of the South Island.

Cracraft (1976:198-199) reduced this systematic grouping of six so-called "species" to two sexually dimorphic species — Euryapteryx curtus (with Z. exilis and E. tane as synonyms) from the North Island and E. geranoides (with E. gravis and Z. haasti as synonyms) present on both North and South Islands. He could not distinguish cranial material referred by Oliver to Zelornis from Euryapteryx at the generic level, and as E. tane only differed from Z. elilis in cranial features the two could be considered conspecific. Multivariate analysis of leg bone measurements substantiated the separation of an E. exilis (including E. tane) population from an E. curtus population but the statistics of the combined sample give coefficients of variation for bone lengths which indicate to Cracraft that (as in the case of Pachyornis mappini/septentrionalis and E. geranoides/gravis) the difference is one of sexual size dimorphism.

Euryapteryx kuranui Oliver, 1930

Emeus crassus (Owen). Hutton, 1906:66.

Euryapteryx kuranui Oliver, 1930:52.

Euryapteryx gravis (Owen). Archey, 1941:54, 56.

Euryapteryx gravis (Owen). Oliver, 1949:108, fig. 85.

Euryapteryx gravis (Owen). Oliver, 1955:578.

Type material

The holotype is "a complete skeleton discovered at Castle Point by Mr. Merideth-Kaye in 1905, and now in the Canterbury Museum" (Oliver, 1930: 52). The finding of the skeleton and a description of the main elements present is given in a paper by Hutton (1906:66). He describes it as "an imperfect skeleton of a moa...received from Mr. C. K. Meredith-Kaye...found in sand by Mr. Meredith-Kaye's son, on his run, about eighteen miles south of Castle Point, on the east coast of Wellington Province. With the exception of the legs and feet, the bones are brittle and much broken...it was a full-grown bird, but the twenty-eighth vertebra was not anchylosed to the pelvis ...The sternum is much broken...The pelvis is very imcomplete...The third and ungual phalanges of the right outer toe are diseased and there is an osseous growth at the distal end of the right femur".

R. J. Scarlett informs me (in litt., 4 August 1977) that the skeleton is registered in the Canterbury Museum as AV 9285 and now consists of the following bones: cranium, premaxilla, 1 quadrate, 19 vertebrae (nos. 10-28, fide Hutton, 1906), 7 caudal vertebrae, pygostyle, 76 trachial rings, sternum,

18 (plus 4 broken) ribs, pelvis; right and left femora, tibiae, fibulae and metatarsi; front toes complete and a right hallux. A few gizzard stones and 3 pieces of egg shell were found with the skeleton and are in the Canterbury Museum. Hutton regarded the presence of the latter as "showing that the bird was a female, for the place in which the skeleton was found precludes us from supposing that it might have been a male sitting on an egg" (1906:66). Scarlett and the present writer regard the sex of the skeleton, in the absence of additional evidence, as in doubt.

Castlepoint (now written as one word) is on the east coast of the Wairarapa, 45 miles north-east by road from Masterton. Moa bones and egg shell have often been found in coastal sand dunes along this part of the east coast of the North Island (e.g. Brodie, 1950).

As Oliver states in 1930 that E. kuranui is "founded" on the Castlepoint skeleton and refers no other individually identifiable bones to this species, there is no paratypic material. The leg bone measurements given under the heading 'B' are described as Hutton's "average measurements" of leg bones from Te Aute (ibid., 54) rather than measurements of individual bones from that swamp site. In 1949 Oliver refers to the Castlepoint skeleton as the "type skeleton" (ibid., 108) and calls the skull from this skeleton the "type of E. kuranui" in the caption to fig. 85. He gives measurements of the skull, sternum, pelvis and leg bones of the holotype on pages 113, 114 and 116.

Published figure

The only published figure of any part of the holotype skeleton of E. kuranui is Oliver's fig. 85 of 1949 which is a photograph of the skull in lateral view.

Present status

Both Archey (1941) and Oliver (1949, 1955) listed E. kuranui as a synonym of the largest species of Euryapteryx they recognized, E. gravis (Owen). Archey placed all South Island specimens of this genus in E. gravis but considered that "an occasional example has been obtained in the south-eastern portion of the North Island" (ibid., 54), while Oliver recorded E. gravis from the southern North Island and from "throughout" the South Island (1949:112). Both authors were conscious of the relatively small size of the Castlepoint skeleton within the range they accepted for E. gravis. Archey thought that "E. kuranui Oliver might perhaps have been regarded as a more slender North Island form" of E. gravis "but it is matched in slenderness by the Stewart Island specimen" of his table H (1941:56). Oliver (1949:110) saw E. gravis as consisting of specimens showing "two distinct sizes of skulls". To the smaller size range "belong the types of E. gravis, E. boothi and E. kuranui", to the larger belong Pyramid Valley Euryapteryx material such as skeleton XXD (now in the National Museum) studied and measured by Oliver.

Neither Scarlett (1972) nor Cracraft (1976) mention Oliver's "E. kuranui". As explained in the "Present status" section of Euryapteryx tane, Cracraft recognizes only two species in the genus Euryapteryx, the larger being E. geranoides (Owen), which includes both E. gravis and Zelornis haasti as synonyms.

Family DINORNITHIDAE

Genus Dinornis Owen

Dinornis gazella Oliver, 1949

Dinornis gazella Oliver, 1949:166, fig. 136 (left).

Dinornis gazella Oliver, 1955:585.

Type material

The holotype is a "pelvis from Te Aute" in the National Museum, registered number DM 107 now to be known as NMNZ S. 107, "much smaller than that of novaezealandiae" (Oliver, 1949:166, 164; note, here and elsewhere in this paper the specific name novaezealandiae has been corrected under the International Code of Zoological Nomenclature to read as one word). The locality "Te Aute" refers to the swamp deposit in Hawke's Bay, investigated by Hamilton (1889) and described by Oliver (1949:8). This deposit was somewhere to the east of Te Aute College on the Woodville-Napier road about 18 miles south of Hastings. The exact position of the deposit is unknown to the writer, but Park (1888, a reference not included in the standard moa bibliographies) and Buick (1931) locate the site in a drain cut through the Patangata swamp near the west bank of the Tukituki (or Waipawa) River.

The holotype pelvis is shown on the left of Oliver's fig. 136. The bone is strong and firm, dark brown in colour with traces of grey mud in all broken surfaces. In the hand the bone appears "heavy and semi-mineralised" as Oliver describes bones from the Te Aute swamp in his manuscript notes. Both pubes are broken off, the median iliac crest is broken away and the posterior part of the escutcheon is irregularly broken on both sides. On the right dorsal surface of the escutcheon (visible in Oliver's fig. 136) there is an old damaged paper label attached reading "Dinornis sp. Te Aute, Napier" in faded script. On the ventral surface there is a modern label "Dinornis gazella HOLOTYPE DM. 107 TE AUTE" printed on the bone in indian ink. Finally there is a brown "Dominion Museum" tag label attached with the words "No. 107 Dinornis gazella Oliver HOLOTYPE Te Aute. A. Hamilton 1888".

As Oliver included only the Te Aute pelvis under his heading of "type" material none of the other specimens he "associated" with D. gazella on pages 166-167 can be considered as paratypes.

Original figure

The only published figure of the holotype pelvis is in Oliver's 1949 fig. 136. Although not referred to as the type, the left hand pelvis in this photograph is captioned "Dinornis gazella, Te Aute" and is clearly a dorsal view of S. 107 from the obvious and distinctive damage and the old label on the right side of the escutcheon.

Present status

Oliver (1949:164) recognized eight species in the genus Dinornis with the North Island D. gazella distinctly smaller than all the others. Its pelvis was described by Oliver as "a miniature of the typical pelvis of the larger

species of Dinornis" and the leg bones referred to it (especially femur S. 108 from Te Aute) as being "in form...exactly like that of Dinornis novaezealandiae but much smaller" (ibid., 166). In spite of this complete reliance on size range for species limits, Oliver firmly believed that "not until good series of individual skeletons, including the skulls, are available, will we be able satisfactorily to define the species of Dinornis and their distribution" (ibid., 164). We still move towards this "satisfactory" stage.

Scarlett (1972:21) listed Oliver's eight species of Dinornis and added an unnamed new species from the South Island "known as yet from only one unpublished tibio-tarsus". In contrast Cracraft (1976:201) reduced this complex of species to four, one restricted to each island and two found on both islands. These were (in order of increasing size), the North Island D. struthoides Owen (with D. gazella as a synonym) the South Island D. torosus Hutton, D. novaezealandiae Owen (with D. ingens Owen, D. robustus Owen and D. hercules Oliver as synonyms), from both North and South Islands, and D. giganteus Owen (with D. maximus as a synonym) also from both islands. Cracraft (1976:202) found that the size difference between the few bones Oliver placed in D. gazella and material of D. struthoides (referred to by Oliver as "D. novaezealandiae") were "slight...and the variation exhibited by the combined sample of struthoides and gazella is easily within the range of a single spcies". The small series of D. gazella leg bones from Te Aute were "nearly equal in length" to a sample of D. struthoides but had "thinner shafts". This Cracraft believed to be "entirely related to age" as the D. gazella bones were of immature individuals (ibid., 202).

Dinornis hercules Oliver, 1949 (fig. 1.3)

Dinornis hercules Oliver, 1949:174, fig. 140 (2nd from left), 141 (2nd and 3rd from left), 142 (2nd from left).

Dinornis hercules Oliver, 1955:588, unnumbered fig. (repeat of part of fig. 141 of 1949) tibia on right.

Type material

The holotype is described by Oliver (1949:174) as being "a tibia from Coonoor (DM. 217) in the Dominion Museum. Length 747, breadth proximal 179, mid 59, distal 110 mm". In fig. 141 the third tibia from the left is described in the caption as "D. hercules, Coonoor" but not labelled as "type". It is a right tibia with writing showing across the shaft which can not be read in the published photographic figure. Prints of this photograph in Oliver's manuscript notes in the National Museum, and the figure of this tibia in Oliver's 1955 volume (1955:588), show that the label reads "COONOOR CAVE NI NZ 1914 DM. 217". This right tibia is thus the holotype. When examined in the Museum's collection by the writer in 1959 the holotype was found broken completely in two about one third of the way down the shaft and somewhat more worn at both ends than shown in the original photograph. The break was carefully repaired with plaster and as the whole bone was rather chalky it was given a coating of synthetic resin. In the process of cleaning and repair the original written label was removed and a new label written along the shaft in indian ink reading "HOLOTYPE Dinornis hercules Oliver 1949 COONOOR

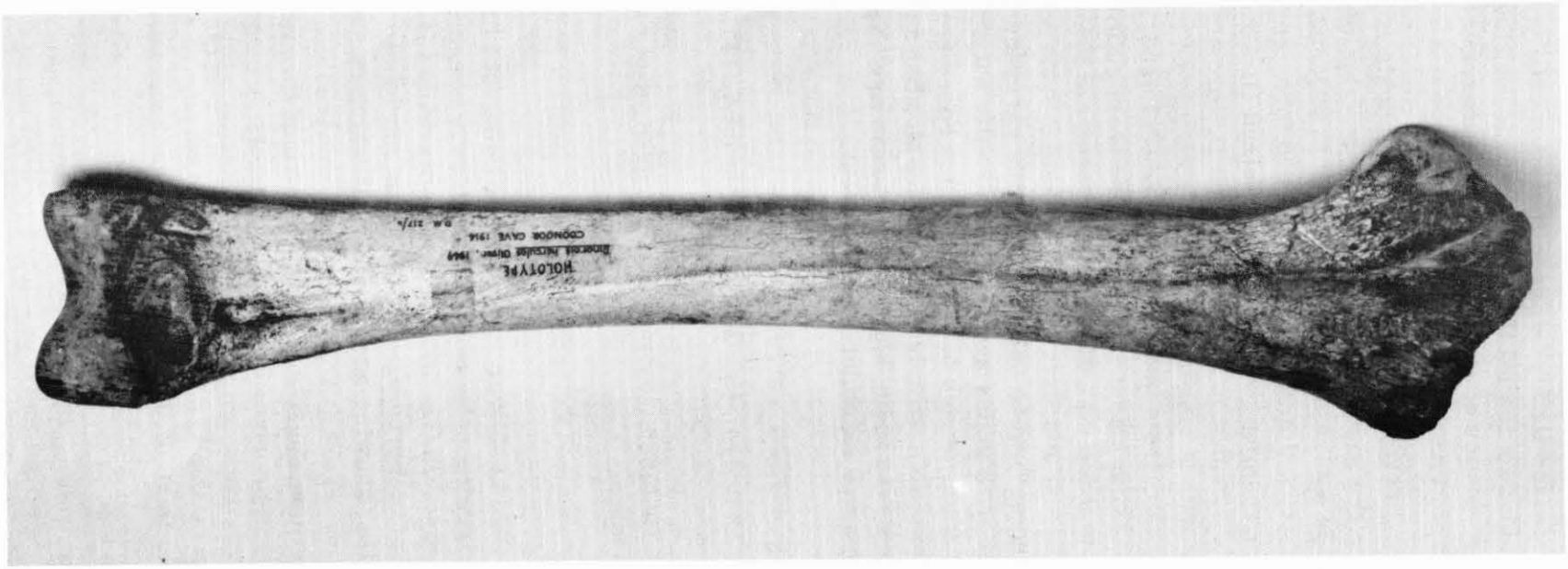

Fig. 1.3 Dinornis hercules Oliver. Right tibia, holotype, from Coonoor Cave, Wairarapa, NMNZ S. 217/a.

CAVE 1914 D.M. 217/a" (now to be known as MNNZ S. 217/a). A red square was painted on the shaft just below this label. The bone was originally pale yellow but is now light yellowish-brown in colour. Fig. 3 in the present paper shows the holotype as it now appears. Its measurements (taken by the writer) are now length 740, breadth proximal 172 +, mid 58, distal 108 mm.

There is also a left tibia in the National Museum collections labelled DM 217. It is identified as D. hercules and comes from the Coonoor Cave. It is now labelled DM 217/b and has Oliver's measurements on the tag label 741, 176, 57 and 105 + mm. As Oliver included only the right Coonoor tibia under his heading of "type" material" this left tibia and the other bones Oliver "associated" with this species in 1949 (p. 174) can not be considered as paratypes.

Some of the bones in the Museum collections listed by Oliver in 1949 as D. hercules have the manuscript name "coonoorensis" written in pencil in Oliver's hand on their tag labels. This name is deliberately published here, in a non-binomial fashion and without "indication" so that it is not an available name under the International Code of Zoological Nomenclature. This allows its relationship to the specific name hercules Oliver to be firmly established. It is clear that "coonoorensis" was considered, but not adopted, by Oliver as a possible specific name for the taxon he validly named Dinornis hercules in 1949.

Coonoor Cave is on property held by Mr. M. Conway in 1914 at Coonoor on the western side of the Puketoi Range in the northern Wairarapa, about 15 miles by road south of Dannevirke. For a description of the site and an account of the species found in the 1914 excavations see Oliver (1949:14, figs. 11, 16).

Original figures

The figures of Dinornis hercules published by Oliver in 1949 are as follows: fig. 140 (second femur from left) right femur posterior view; fig. 141 (second and third tibia from left) left tibia (with proximal end missing) and right tibia, both anterior view; fig. 142 (second metatarsus from left) right metatarsus anterior view. All are photographs. The femur in fig. 140 has the number DM 216 written on it (clearly visible in a print of this photograph in Oliver's meanuscript notes) and comes from Coonoor Cave; its measurements are given in Table 31 (ibid., 180). The broken left tibia in fig. 141 can be recognized as DM 114 in the National Museum collections and comes from Te Aute as stated in the caption. There are two holes drilled through this figured specimen, one proximally and one distally (the latter clearly visible as a black spot in fig. 141). There is an obvious open longitudinal crack on both anterior and posterior faces along the central half of the shaft. The measurements of this tibia are given in Oliver's table 31. The right tibia in fig. 141 is the holotype as established above. The metatarsus in fig. 142 can be recognized as a bone labelled DM 216 in the National Museum collections (there are six Dinornis bones from Coonoor registered under the same aumber DM. 216). The figured metatarsus is clearly labelled as from Coonoor on its shaft and in the figure caption. Its measurements are given in Oliver's table 31. The three "associated" leg bones discussed here are

now labelled as "figured" specimens of D. hercules. All register numbers are now to be prefixed by MNNZ S. instead of DM if used in publication.

Present status

As outlined above in the Dinornis gazella section, Oliver recognized eight species in the genus Dinornis. He gives his reasons for describing D. hercules as a new species as follows (1949:164): "A study of the series of bones in the Dominion Museum shows that both giganteus [the biggest North Island species in Oliver's system] and maximus [the biggest South Island species] as generally understood are probably compound. Each consist of tall birds with straight-shafted tibiae and of shorter birds with curved-shafted tibiae. In maximus this distinction is not well-marked; but in giganteus, as shown in fig. 141, the difference is so great that I have thought it advisable to found a new name for the shorter bird and trust that individual skeletons someday will turn up to support my conclusions. Hutton's name excelsus was applied to a tall bird [and is thus a synonym of giganteus sensu strictu] so I have founded a new specific name, hercules, with a tibia from Coonoor as type". He explains his term "curved-shafted" tibia as saying on page 174 that the shaft in D. hercules "is straight on the outside but conspicuously curved on the inside" (see Oliver's fig. 141 and fig. 3 in the present paper).

In Oliver's view D. hercules was the second to biggest of the five North Island Dinornis species (ibid., 164). It was larger on average than the relatively common North Island D. novaezealandiae Owen (N.B. Oliver used the name D. ingens for this species but as explained in Scarlett, 1972:20, and Cracraft, 1976:202, the name D. novaezealandiae must be used for birds referred by Archey and Oliver to D. ingens, and the name D. struthoides for birds referred by these authors to D. novaezealandiae). Large specimens of that species (referred to as "long type" in table 30, ibid.:179) overlap the D. hercules range but were "very much more slender than the same bones of D. hercules" (ibid., 171). D. hercules was smaller (by definition) than the largest North Island species, D. giganteus Owen.

Scarlett (1972:21) thought D. hercules might "prive to be only a bow-legged variant of Dinornis giganteus", while Cracraft (1976) firmly synonymized it with his D. novaezealandiae (see discussion under "Present status" section of D. gazella). He found it closer in size to that species than to the bigger D. giganteus. He was able to compare the type of D. hercules to other species of Dinornis and in his opinion (1976:203) "the differences in stoutness and the curvature of the shaft of the type are attributable to individual variation".

Summary of present status of the moa species described by W. R. B. Oliver (following Cracraft, 1976)

Pachyornis septentrionalis is a synonym of P. mappini Archey.

Pachyornis murihiku and P. australis are synonyms of P. elephantopus (Owen).

Euryapteryx tane is a synonym of E. curtus (Owen).

Euryapteryx kuranui is a synonym of E. geranoides (Owen).

Dinornis gazella is a synonym of D. struthoides Owen.

Dinornis hercules is a synonym of D. novaezealandiae Owen.

NOTES ON OLIVER 'S METHODS OF MEASURING MOA BONES

The Origin of the LPMD System used by Oliver (1949)

The first extensive paper published on moa measurements in New Zealand appeared in the first volume of the Transactions of the New Zealand Institute in 1869. In it, Haast used the following four measurements (in inches and decimals of an inch) when discussing leg bones: "Length of bone/ Grith of proximal end/Girth of shaft, thinnest part/Girth of distal end" (ibid. 82). This is the local forerunner of Oliver's LPMD system, though it uses girths rather than widths.

Owen in his 1879 memoir re-presented the moa measurements he had published since the 1840s. Altering the order somewhat, the first system he used (ibid. 78) was as follows "Length/Breadth of middle of shaft/Thickness or antero-posterior diameter of ditto/Circumference [of middle]/Breadth/of distal end", while the latest ibid., 253) was "Length/Breadth, transverse, of proximal end/Breadth of middle of shaft/Circumference of middle of shaft/ Breadth, transverse, of distal end". The latter is a LPMD system with the girth (or "circumference") at the middle added. In 1875 Hutton presented measurements of "two or three hundred" moas from the Hamilton swamp in Otago arranging them "according to the dimensions given by Professor Owen" (ibid. 274) in his papers. Hutton used the second system quoted here from Owen's memoir adding "Thickness middle" to give a six measurement system.

In the 1880s A. Hamilton, working in Napier, had special labels printed which he glued on to moa leg bones from Te Aute and other sites in the southern North Island. They were individually printed for femur, tibia and metatarsus with spaces left for a series of measurements. Labels for the latter element read "METATARSUS OF [blank for name]/Length/Circumf./Breadth, distal/ Breadth, middle/Thickness, middle/Breadth, prox." within an oblong border. These are still present on several bones in the main National Museum collections and on other bones transferred to the National collections from the Napier Museum in the 1950s. Hamilton wrote the locality along the bottom of the label outside the border but the ink used has faded badly and these labels are now fragile and difficult to read.

Hutton in 1892 used a leg bone ratio consisting of "the length (L) divided by the girth (G) at the middle of ths shaft" (ibid. 106), and later (1897 :545) gave leg bone measurements under the headings "Length/Prox. Width/Mid. Width/Distal Width". These are clearly the LPMD headings of Oliver's 1949 moa bulletin.

In the first edition of New Zealand Birds (1930:35), Oliver used the following measurements for moa leg bones: "total length between parallels... greatest width of proximal end...greatest width at middle of shaft...greatest width at distal end" and these descriptions can be taken as indicating his methods of obtaining his figures. For the key based on leg bones proportions, P, M and D were "expressed in terms of the length taken as 100" (ibid. 35). In a letter to Professor W. B. Benham dated 21 January 1932 (actually dated "1931" but it is clear that this is a typing error — the letter is in answer to two from Benham dated 4 and 18 January 1932), in the National Museum files, Oliver gives further details on his methods of taking leg bone measurements "In the measurement of femora of moas...I take the measurement along the

axis of the neck, that is the greatest measurement that can be taken at the proximal end of the bone. I have been able to take this measurement in mounted specimens by means of a craniometer...I am recording both the transverse and antero-posterior measurements of all the leg bones." Benham (1934:91) followed Oliver and used the LPMD system ("Length/ Proximal Breadth/Middle Breadth/Distal Breadth") adding "Girth at Middle" (referred to below as "G"). He comments on these measurements by saying "The breadth at the proximal end of femur is taken along the axis of the head, as Owen measured it. The dimensions of all the bones were taken between two vertical uprights. Hutton does not mention how he took his measurements; in earlier days, at any rate, he seems to have used a tape, and given his figures in inches. The girth is liable to vary with the personal equation, i.e. with the precise point at which it is measured". Benham used "percentage of breadth to length" for the proportional dimensions of leg bones as did Oliver.

Oliver's Figures on Tag Labels

In his 1941 monograph on moas, Archey used the LPMDG system of Oliver and Benham but introduced on page 13 a new way of presenting these figures and the percentage of width to length figures. This consisted of placing the figures in two lines with the upper line giving the measured dimensions and the second line giving the widths as percentages of the length. For example the figures for one of the tibiae of the holotype skeleton of Eury-apteryx tane Oliver (AM. 3) as given in Archey's table H (under the name E. exilis) would be presented as follows (in mm):

L	P	M	D	G
337	98	28	56	74
	29.1	8.4	16.6	21.9

It is important to know just what Archey meant in his presentation because Oliver used a similar but different method of presenting measurements on the back of the brown, "Dominion Museum", tie-on tag lebels used throughout the National Museum moa collection. He did not use the LPMD heading and did not take the measurement G.

An example of Oliver's different presentation would be the left tibia from Nuhaka, Hawke's Bay, identified by Oliver as Anomalopteryx didiformis (Owen), from an incomplete skeleton collected by A. Hamilton in 1913 (NMNZ S. 209). On the back of the tag label are the following figures in Oliver's hand:

350	99	31	60
	59	21	58
			51

The top line is LPMD with P, M and D all being Oliver's "greatest widths"; P is taken more or less diagonally to the transverse plane of the bone, while M and D are both "transverse" measurements. In the second line P is "transverse", M is the "antero-posterior" measurement (the least "width"; i.e. depth) and D is the "antero-posterior" depth of the inner (and larger) condyle. D in the third line is the "antero-posterior" measurement of the outer (and smaller) condyle. This three-line method of presenting measurements

can be found on a great many of the bones examined by Oliver in the National Museum.

Sometimes Oliver added a fourth line to this presentation to give the percentage of width to length. Thus the right tibia of the holotype skeleton of Pachyornis septentrionlis (shown in fig. 1.1) shows Oliver's figures on the back of the tag label at their most complicated. Ignoring an alteration, and expressing the measurements in millimetres rather than in centimeters as they are written, the label has the following figures in Oliver's hand:

320	85	28	48
	52	19	48
			43
	26.4	8.7	14.3

The first three lines are as explained for the Nuhaka tibia while the fourth line gives percentages of width to length for the top line (figures surprisingly inaccurate!).

Archey's and Scarlett's Methods of measuring Moa Bones

Archey (1941:13) states that his "measurement have all been made between uprights and, to measure width, the bones have been placed at right angles to the direction of the measuring slide". His fig. 1 (ibid. 14) shows the distal end of a moa leg bone with its width being measured between the uprights of the measuring "apparatus".

In Bones for the New Zealand Archaeologist, Scarlett (1972:2) explains his methods of measuring bird bones as follows: "All bird limb bones should be given four measurements. Length, width at proximal (top) and distal (bottom) ends, and width of the shaft. These are expressed as L., P., M., D. M. is taken by some workers at the exact centre (Middle) of the shaft. Others, myself included, measure at the narrowest point. This usually differs little from the width obtained at the centre and facilitates comparison with broken bones, where the exact length is unknown, and is much quicker. It does not matter which method is used, provided that one states where the measurement is taken. ...In the field, an approximate length for larger bones, such as those of Moa or Aptornis can be obtained with a steel tape. Much greater accuracy can be obtained with a measuring device consisting of a base with rule, a fixed upright and a sliding bar and upright (see illustration). This is useful for measuring adzes, as well as bones". The illustration referred to shows a moa bone being measured on a sliding scale between uprights as described. The apparatus Scarlett uses is the same one used by Dr. (later Sir Gilbert) Archey in his work on moas at the Auckland Museum.

To test Oliver's method of taking measurements against Scarlett's, the writer asked Scarlett to remeasure two moa leg bones on Archey's sliding scale with the following results:

MNNZ S. 209, left tibia Anomalopteryx didiformis, Nuhaka

	L	P	M	D
Oliver	350	99	31	60
Scarlett	350	97	29	60

NMNZ S. 78, left femur Pachyornis mappini from Eketahuna, Wairarapa, coll. John Golder, 11 May 1894.

Oliver	211	79	33	92
Scarlett	212	78	34	90

The main difference would appear to be in M which Oliver took across the "middle of the shaft" and Ron Scarlett takes across the "narrowest point". The P and D discrepancies in the femur are probably due to abrasion since Oliver measured the bone.

When these bones were being remeasured, Scarlett commented on shrinkage and warping in moa bones as follows (in litt. 16 February 1962): "bones can shrink a few mm. Aptornis bones and moa bones that I have measured soon after they came out of Pyramid Valley, and re-measured a few years later, after they had well dried, did shrink longitudinally a little, not very much...something like 3-4 mm for some of the Dinornis tibia, but less for Aptornis. Transversely the shrinkage was negligible. Most bones don't warp in drying unless there is too much heat. Have had warped bones occasionally from Caves and swamps where pressure seems to be the cause".

Summary of W. R. B. Oliver's Measurement Method

When recording dimensions of moa leg bones Oliver used the following measurements:

L - total length between uprights;
P - greatest width at proximal end (e.g. along axis of neck in femur);
M - greatest width at middle of shaft, and
D - greatest width at distal end.

When writing measurement on tag labels in the National Museum collections, Oliver recorded LPMD in one ling adding on a second line a transverse width at P, a least "width" (i.e. depth) at M, and a greatest depth at D. In a third line he gave the depth of the lesser condyle at D (i.e. not the least depth possible at D, which would be through the intercondylar groove). The percentages of widths to length for the top line measurements, if given, appeared as a fourth line.

SUMMARY

The holotype of Pachyornis septentrionalis (synonymized by Cracraft (1976) with P. mappini), is an incomplete skeleton from Te Pohue, Hawke's Bay. Oliver figures the pelvis and leg bones of this type. The holotype of P. australis (syn.with P. elephantopus), is a skull and 20 vertebrae from the Salisbury Tableland, Nelson. Only Oliver's figures of the skull of this species are from the type. The holotype of Dinornis gazella (syn. with D. struthoides),

is a pelvis figured by Oliver from Te Aute, Hawke's Bay. The holotype of D. hercules (syn. with D. novaezealandiae), is a tibia from Coonoor, Wairarapa, figured by Oliver but since broken and relabelled. These four species were described by Oliver in 1949 and the type material, except for the P. australis vertebrae, are in the National Museum. The holotype of P. murihiku Oliver, 1949 (syn. with P. elephantopus) is a skeleton from Bluff in the Southland Museum, and that of Euryapteryx tane Oliver, 1949 (syn. with E. curtus) is a skeleton from Doubtless Bay, North Auckland, in the Auckland Museum. Oliver's figures of both these species are from their type skeletons. The holotype of E. kuranui Oliver, 1930 (syn. with E. geranoides) is a skeleton from Castlepoint, Wairarapa, in the Canterbury Museum. The type skull was figured by Oliver in 1949. No paratypes were designated by Oliver for any of his species.

Oliver's LPMD headings for moa leg bone measurements in 1949 refer to length between uprights, greatest width at proximal end, transverse width at middle of shaft, and greatest width at distal end.

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