VIII. *On DINORNIS (Part XV.): containing a Description of the Skull, Femur, Tibia, Fibula, and Metatarsus of Aptornis defossor, Owen, from near Oamaru, Middle Island, New Zealand; with additional Observations on Aptornis otidiformis, on Notornis mantellii, and on Dinornis curtus. By Professor OWEN, F.R.S., F.Z.S., &c.*

Read March 10th, 1870.

[PLATES XL. to XLIV.]

§ 1.

THE Rev. RICHARD TAYLOR, M.A., to whose valuable cooperation in advancing the Natural History of New Zealand, the field of his devoted missionary labours, I have had occasions to testify¹, was so obliging as to submit to my inspection, on his recent return to England, a skull, femur, tibia, and fibula, which I recognized, with intense interest, to belong to that very rare and singular genus of extinct New-Zealand birds the *Aptornis*. Mr. Taylor favoured me with a copy of the following "entry" from his note-book relative to these bones:—"They were discovered in a cave of soft sand about fourteen miles from Oamaru, which was filled with birds' bones. The peculiarity of this skull is its massiveness, very small brain-receptacle, and width of bill: it appears to be allied to the *Notornis*, but of a much larger size."—July 1st, 1863.

It will be seen in the course of the following descriptions that these bones belong to that ornithic form first indicated by a tibia referred to a *Dinornis otidiformis*², but subsequently shown by metatarsal and cranial characters to represent a distinct genus, for which I proposed the name *Aptornis*³.

The generic characteristics of both skull- and leg-bones are closely repeated in the present specimens; but, as shown in the "Table of Admeasurements" (p. 378), they are larger than those parts of *Aptornis otidiformis*. This increase of size is also associated with some modifications of form and proportion. The original (smaller) specimens, on

¹ From the period, viz., of my Memoir on the first general collection of *Dinornis*-remains of November 1843. "The Rev. Mr. Taylor, of Wanganui, has a large collection of these bones, found in a river between that place and New Plymouth."—Trans. Zool. Soc. vol. iii. (November 1843), p. 271. This locality is in the North Island, where the smaller species of *Aptornis* was found. Mr. Taylor has recorded the results of long experience and observation in his work 'On New Zealand and its Inhabitants,' 8vo.

² Trans. Zool. Soc. vol. iii. p. 247, pls. 25 & 26. fig. 6.

³ In the Memoir (No. III.) read January 11th, 1848; ib. vol. iii. p. 347. In the 'Revue Zoologique' for October 1848, M. de Selys-Longchamps proposed the minor abbreviation "*Apterornis*" for some, then vaguely indicated, extinct birds of the Mascarene Islands.

which the genus was founded, are of a mature bird¹; and accordingly I propose to refer the bones under description to an *Aptornis defossor*.

§ 2. *Skull of Aptornis defossor.* (Plate XL. figs. 1-3, Plate XLI. figs. 1-4 & 6-8.)

The skull, as Mr. Taylor remarks, may be said to be massive, the cranial walls are thick, much of its osseous substance is compact, and there is the full amount of confluence of the bones of the head observed in birds. The beak is moderately down-bent, and terminated by a transverse subtrenchant margin, in both upper and lower jaws. The length of the part of the skull anterior to the orbit exceeds the rest by one-eighth; the fore-and-aft extent of the orbit is rather less than one-fifth that of the entire skull. The cranium, viewed either from above or below (Pl. XL. figs. 2 & 3), offers a subquadrate form. The breadth of the occiput at the paroccipitals (4, 4) equals that of the cranium at the postfrontals (12, 12), a character to which the skull in *Notornis* and *Dinornis* offers the nearest approach. The occipital region (Pl. XLI. fig. 1) extends below the foramen magnum (*o*) further than above it—a proportion unique in the class *Aves*.

Those most conversant with the osteological features of birds will best appreciate the singular and exceptional characters above defined. The external bony nostrils (Pl. XL. fig. 1, *n*) are large and triangular, or oval-elongate, with the upper, small end almost pointed. No groove or furrow is continued forward from them. The interorbital septum (ib. fig. 1, *o*) is entire; the temporal fossæ (*t*) are deep, though wide apart above (ib. fig. 2, 7); they are over-arched externally by an upper zygoma (ib. fig. 1, 8'-12), as in Crocodiles. The cerebral bosses are hardly raised above the level of the interorbital region (ib. fig. 2, 11).

The occipital tubercle (Pl. XLI. fig. 1, 1) is hemispheroid, 5 lines in transverse diameter, feebly impressed by a small pit at the middle of its upper half. The basioccipital advancing from the condyle about two lines, then curves downward, and, with the basisphenoid, forms a subquadrate almost vertical plate, inclined somewhat forward, below, with the lower angles produced and swollen to form a pair of oblong convex tuberosities (Pl. XL. fig. 3, *l'*, Pl. XLI. fig. 1, 5', 5').

The vertical surface of this descending part of the occiput is concave across, but less deeply than in *Aptornis otidiformis*², the lateral margins not being so produced backward, especially at their upper part. In both species they form angular lamelliform processes, each defending the inner side of the corresponding vagal fossa (ib. fig. 1, *v*). Three minute precondyloid foramina, in a vertical line, range on each side of the base of the condyle. The depth of the basioccipito-sphenoidal ("basilar") tract, from the under part of the condyle to the middle of its under surface, measures 1 inch 2 lines, to

¹ The ankylosis of the stylohyal in the original skull (Trans. Zool. Soc. vol. iii. pl. 52, figs. 3 & 6, 38) indicates it to have come from an old bird.

² Trans. Zool. Soc. vol. iii. pl. 52. fig. 4.

the end of the tuberosity 1 inch 4 lines; the breadth of the tract is 1 inch $\frac{1}{2}$ line: in the centre of the tract is a small venous foramen. The tuberosities bend forward and inward; each is indented by an oblique channel; and from each a ridge continuing the convergence is lost after 3 lines course upon the fore part of the basisphenoid. This curves upward and contracts to a median ridge slightly produced, as a compressed process, projecting about 2 lines forward freely below the base of the presphenoid (Pl. XL. fig. 3, 9). The occipital foramen (Pl. XLI. fig. 1, *o*) is vertically elongate, with a small process on each side, projecting inward and forward from the junction of the lower with the middle third, as in *Aptornis otidiformis*¹. The vertical diameter of the foramen is 7 lines, the transverse one $5\frac{1}{2}$ lines, the foramen being relatively smaller than in *Aptornis otidiformis*. As in that species, the occipital surface, as it rises from the foramen magnum, slopes forward to the superoccipital ridge (Pl. XL. fig. 2, 3).

From the under and inner base of the paroccipital an irregular ridge or bar of bone (Pl. XL. figs. 1 & 3, 4) passes downward and inward, forming the outer side of the vagal fossa, and bending forward into and abutting against the smooth deep channel outside the descending basicranial tract (1-5), where it terminates like an adherent process, with a rough tuberos ending. It was to the left of these productions (Trans. Zool. Soc. vol. iii. pl. 52. fig. 6, 4) of the paroccipital, which might be called "styloid processes," that the proximal element of the hyoid arch (stylohyal, ib. 38) was ankylosed in the skull of *Aptornis otidiformis*: this is significant of the arbitrariness of the ascription of the tympanic or quadrate bone to that arch. The hind part of the base of the alisphenoid is more produced and tuberos outside the end of the hyoid process of the paroccipital in *Aptornis defossor* than in *Apt. otidiformis*. Between this process and the expanded base of the alisphenoid there is a groove-like extension of the tympanic cavity.

The alisphenoid expansion is pneumatic; in advance of that swelling are two wide pneumatic openings; and two lines in advance of these is the foramen ovale.

The mastoid in mammals is characterized by its early ossification, the centre or centres appearing in the primordial or protocranial cartilage containing the acoustic vesicle. In this developmental relation Cuvier's "temporal" in birds agrees with the mammalian mastoid. Mr. Parker admits that the mastoids are already ossified at the "time that the parietals are small ovoid patches;" but he cannot apparently bring himself to state that his "squama temporis" in the chick is ossified in and from the protocranial cartilage, including the labyrinth. The "squama temporis" in the human embryo is ossified in a membranous basis, like the parietal; the base of the zygoma alone shows cartilage. The condition of the mammalian squamosal in Monotremes, in which it is almost reduced to its zygomatic part, shows well the homologous bone in birds. The mastoid, connate, as usual in birds, with the petrosal, here joins the alisphenoid, pushing inward, between the pneumatic vacuities and the canal for

¹ Trans. Zool. Soc. vol. iii. pl. 52. fig. 4, *o*.

the third division of the trigeminal nerve, to form the articulation for the double condyle of the tympanic. The cavity is oval, directed from behind, forward and outward; the postero-internal division is the largest and shallowest; the antero-external one is the deepest, and is hemispheroid. The articulation is close and deep, whereby, with a peculiar suspensory structure, the tympanic is retained on the right side of the present skull, where the surrounding parts of the cavity are entire. Between the articular cavities for the tympanic and the paroccipital are the large pneumatic vacuities; and behind them is a smooth, transversely extended deep fossa. This is partially bounded externally by the normal mastoid process, but is continued outward, contracting into the groove between the mastoid (Pl. XL. fig. 1, 8) and the mesomastoid (8') process. This process has contracted a filamentary bony union with the expanded base of the alisphenoid, the filament passing behind the neck of the tympanic, and helping to suspend and maintain it *in situ*. But the great characteristic of this part of the skull of *Aptornis* is the large size and advanced position of the premastoid process (ib. 8*). This diverges, like the two hinder ones, from the common diapophysial basis, developed in and from the primordial cranial cartilage, and retaining all the guiding homological characteristics of the Crocodile's mastoid. The process (8*), repeating the zygomatic development thereof, is three-sided; the fore and hind sides are broadest, and meet externally at a sharp ridge directed downward and forward, bisecting the temporal fossa, but leaving the hinder division widest. Near its lower end the premastoid contracts a bony union with the postfrontal (12) as in *Aptornis otidiformis*, but with a shorter, broader, and more compressed free termination beneath that union. The inner, narrow side of the premastoid process presents a rough surface for apparently ligamentous union with a process from the outer side of the tympanic.

The basisphenoid is pierced anteriorly by the outlets of the Eustachian canals, continued into each other by converging channels, underlapped by the process (Pl. XL. fig. 3, *m*), which is compressed and slightly produced downward. Above the Eustachian channels the basisphenoid contracts, and is produced into the presphenoid, first sending off on each side a small, horizontally compressed ridge or plate representing a "pterygophysis," but without an articular surface. If it is joined at all to the pterygoid, it must be only by ligament.

Each orbito-sphenoid shows three small foramina in a transverse line, representing the "prelacerate fissure," behind the large optic foramen. The optic foramina are barely two lines apart anteriorly. Beneath them the connate orbito-presphenoid is impressed by a smooth, oblong cavity, and is continued forward, confluent with the prefrontal, as an entire but thin "interorbital septum," expanding anteriorly to form the back part of the olfactory chamber. The rhinal platform (Pl. XL. fig. 3) is subcompressed vertically.

The olfactory chambers do not extend backward beyond the "platform;" they are subspherical, half an inch in diameter, divided by a thin but complete septum, and perforated each by a single olfactory foramen a little external to their hind walls.

They are wholly anterior to the cerebral cavity. Their condition in *Aptornis otidiformis* (Trans. Zool. Soc. vol. iii. pl. 52. fig. 5, 18) is closely repeated in *Apt. defossor*.

The cranial cavity, exposed in the present specimen by an opening on the left side (which may have been made to extract the brain), shows a slight falcial ridge; and about half an inch outside this, runs a less marked parallel ridge, indicative of a longitudinal sulcus on the surface of the cerebral hemisphere. The under parts of the anterior cerebral lobes were divided from each other by a short ridge continued forward from above the common intracranial beginning of the optic foramina. A well-marked curved "tentorial" ridge marks the boundary between the prosencephalic and the combined mes- and ep-encephalic divisions of the cranial cavity. The "sella" is small and moderately deep. There is a well-defined, oblong, rough depression for the "Harderian gland" at the back part of the orbit.

The nasal bones (Pl. XL. figs. 1 & 2, 15) seem to touch each other at their postero-internal angles, whence they diverge, and are distinct from each other in the rest of their course. They coalesce with the frontal; but the fronto-nasal suture seems traceable, forming a strong curve convex backward, touching the transverse parallel of the middle of the superorbital ridge, and thence curving forward to the antorbital process, where a portion of the suture is persistent: it is possible that this curved line may indicate the limit of a frontal expanse of the nasal. At one inch and a quarter from the hindmost part of the nasal, that bone bifurcates into its maxillary (*b*) and premaxillary (*a*) branches.

The maxillary branch (Pl. XL. fig. 1, *b*) is a long, straight, narrow, subdepressed rod, a little wider midway, and coalescing with the nasal process of the maxillary (ib. 21) too closely for any trace of the original distinction.

Although the nasal branch of the premaxillary (22') has coalesced with the nasals, the line of original distinction is traceable, and shows the premaxillary branch of each nasal (ib. fig. 1, *a*) to have become soon overlapped by the premaxillary, and to have extended forward from the bifurcation of the nasal nearly two inches, each slightly inclining toward its fellow, underlapping and strengthening that part of the bony arch of the upper mandible.

The palatine plate of the maxillary (Pl. XL. fig. 3, 21') underlaps that of the premaxillary (22'), filling the interval between it and the dentary part of the premaxillary. The line of suture is apparent; it is transverse and convex forward, nearly in the same relative position to the prepalatine vacuity as in *Dinornis*¹. This vacuity is continued backward between the maxillaries (ib. 21'), and then between the palatines (ib. 20), and is continuous with the palato-nares (ib. *e*, *e*).

The palatines (20), at their upper and mesial beginnings, extend backward, parallel to each other, for an inch or more on each side of the vomer and the fore end of the presphenoid. Their contiguous sides in this extent are nearly straight, with an interval of

¹ See *Dinornis ingens*, Trans. Zool. Soc. vol. vii. pl. 15. fig. 3, 22'', 21.

from one to two lines. From this type connexion or origin each arches obliquely upward and outward, in a degree increasing from behind forward, where opens the base of a semiconical cavity so formed, the thin lamellar wall of which is continued down into the posterior one of the palatal nostril. The cavity above this opening is divided by a horizontal portion into two *culs-de-sac*. From the walls of this cavity two plates are continued, one median, the other lateral. The median one projecting, where the palato-narial cavity begins to expand, from the common posterior plate or body of the palatine, descends vertically and abruptly, for 5 lines, gradually losing depth and gaining breadth at the level of the roof of the mouth, where it extends forward on each side the midpalatal vacuity for about one inch, coalescing with the maxillary, but leaving a trace of the original separation; the median side of the median plate is convex; the outwardly curved free border is somewhat thickened; the outer concave side of the plate and the oblique longitudinal channel between the median and lateral descending plates of the palatine have a rather rough surface. The outer or lateral lamella, continued from the outer wall of the palato-narial *cul-de-sac*, extends downward and outward in a less degree than does the median plate, and without thickening of the free border, but expanding horizontally, as it advances, to coalesce with the base of the malar process of the maxillary. The interlamellar channel, with a general breadth of 4 lines, gradually deepens as it retrogrades, until the inner plate suddenly ceases; the outer plate then contracts, becomes horizontal, and converges to unite with that of the opposite palatine behind the palato-nares. The inner wall of the palato-narial *cul-de-sac* is continued forward, contracting to a styliform process, which is, indeed, the fore end of the articular origin of the complex cranial pleurapophysis—such origin extending backward, as above described, from its own to the succeeding centrum, as the head of a rib is apt to do.

At the opposite end the palatine, as above described, bifurcates to effect two junctions with its hæmapophysis, the maxillary—one with its outer or dentary border, the other with its inner or palatal productions.

The short maxillary (21) presents or radiates, as usual in birds, its premaxillary, palatine, nasal, and malar productions. Posteriorly, between its palatine, nasal, and malar rays, it expands into a sort of rudimental “antrum” consisting of two low, shallow, pneumatic fossæ divided by a horizontal shelf, concave backward; and from the lower division goes a small oblique communication with the fore part of the hypopalatine channel, just showing where the maxillary contributes to and continues the fore part of that channel. The small foramen answers to the commonly larger (palato-maxillary) vacuity at this part of the roof of the mouth. The nasal process of the maxillary preserves part of its posterior margin free; the rest is intimately blended with the long maxillary style of the nasal (fig. 1, *b*) above described. The anterior transversely expanded part of the maxillary is intimately blended with and contracts above to be wedged between the maxillary and palatal parts of the premaxillary. These are the true or type beginnings, or basis, of that “hæmal spine.” They speedily coalesce as

they extend forward into a horizontal plate half an inch broad (fig. 3, 22''); it is slightly concave, with an irregular surface below, more concave and smooth above; it has a thickish, smooth median margin, and a rough outer one rapidly rising as it advances to be continued into the nasal branch of the premaxillary.

The anterior part or "body" of the bone (Pl. XL. figs. 1 & 2, 22) is 2 inches 9 lines in length, 1 inch 3 lines in breadth at the base, whence the branches radiate, thence tapering to an anterior, depressed, slightly rounded terminal trenchant edge half an inch broad. The upper surface for about an inch from this end is smooth; each lateral margin is rough, and gains in thickness as it recedes, forming a convex, non-canalicate dentary border, 2 inches 5 lines long, about $1\frac{1}{2}$ line thick, continued, contracting, for about 6 lines, upon that of the maxillary. The rough surface gradually extends upon the outer side of the premaxillary to a breadth of $3\frac{1}{2}$ lines, where it is arrested by a very shallow smooth impression, above which open six or eight conspicuous nervo-vascular foramina in an irregular longitudinal series. Here the sides of the premaxillary are more rapidly continued into the upper surface; the arch or transverse convexity not being a regular curve.

The palatal surface of the premaxillary (ib. fig. 3, 22') is concave lengthwise, but more so across, especially midway between the fore and hind end of such surface. It is divided lengthwise into three tracts—one median, becoming concave and smooth at its posterior half, and two lateral, similarly concave, but irregular of surface. They deepen forward into narrow grooves, from which nervo-vascular canals pass into the substance of the bone; and the grooves grow more shallow as they extend to the almost trenchant termination of the upper beak. The fore part of the common midpalatal vacuity is half an inch in advance of the fore part of the outer bony nostril; and the ridge from the upper mid tract of the premaxillary part of the roof of the mouth extends half an inch in advance of the palatal vacuity before it rises to the upper plate of the premaxillary. The vacuity of the premaxillary, which is an anterior extension of the common nasal cavity, becomes divided only along the anterior half of the outwardly seeming solid part of the premaxillary. From the apices of the long conical cavities, so separated and extended toward the fore end of the upper beak, one or two canals are continued outward, forming by their termination the anterior of the conspicuous nervo-vascular canals above noted. The nasal branch (22'), 2 inches 8 lines in length, gradually loses breadth as it recedes, viz. from 11 lines to 7 lines between the bifurcating part of the nasals, then more rapidly to its cranial termination, which is nevertheless broadly rounded, where it overlies the smooth and free prefrontal, coalescing by its periphery with the frontals and nasals. The premaxillary processes of the latter underlap the premaxillary, the margins of which appear thickened by bending down to the nasal coalescence; the under surface of the internarial part of the premaxillary is reticulate. This part of the long arch of the base of the beak is strengthened by the pair of longitudinal ridges due to the produced premaxillary processes of the nasals.

The tympanic¹ (Pl. XL. fig. 1, 28, Pl. XLI. figs. 2, 3, 4) has its mastoid end expanded and divided into two convex condyles (figs. 2 & 4, *k*), corresponding in form and relative size to the cavities for their reception above mentioned. The inner, larger, oblong condyle is more convex lengthwise than transversely; the outer, smaller condyle is subhemispheric; they are connected by a narrow tract, forming the upper part of a pneumatic foramen which divides the condyles from each other posteriorly. The stem of the condyles, subcompressed, from 3 lines to 4 lines in length, quickly expands as it descends, sending off anteriorly a broad, thin, compressed, triangular, obtusely pointed orbital plate (ib. *e*), and downward and backward outswelling in every direction, but chiefly antero-posteriorly, to form an unusually large lower end (*i*), the anterior half of which affords the single articular surface (Pl. XLI. fig. 3, *i*) for the mandible. On the outside of the base of the articular stem is the process with the flat articular surface (fig. 4, *f*) for the premastoid; on the outside of the mandibular articular expansion is the articular cavity (ib. *h*) for the squamosal. The orbital plate is widely excavated internally; and the lower border of the cavity sends off the small hemispherical articular tubercle (fig. 2, *g*) for the pterygoid. Thus there are not fewer than five articular facets on this singularly modified homologue of the element or "process of the tem-

¹ In regard to the homology indicated by this name, I have no better reason for breaking a silence which an accuser might call obstinate, save the following, which I give for what it is worth. Prof. Huxley states (Proc. Roy. Soc. Nov. 18, 1858), with the emphasis of italics, and a repetition of negatives, implying sense of the insecurity of his ground, "that the tympanic of the mammal does *not* articulate with the lower jaw, nor with the pterygoid, nor with the jugal or quadrato-jugal;" and so trite a statement of a commonly known fact would have remained unnoticed by me if it had not been quoted, in a former volume of the 'Transactions of the Zoological Society,' with commendation, as if it were a novel contribution to the elements for determining the homology of that bone in other vertebrates. Mr. Parker puts this statement, which he rightly characterizes as "very true," in the van of his arguments for opining "that the quadratum of birds is the homologue of the mammalian incus" (Trans. Zool. Soc. iv. p. 316).

But the "incus" "of the mammal does *not* articulate with the lower jaw, nor with the pterygoid, nor with the jugal, or quadrato-jugal." What is more, also, and what Mr. Parker's guide was careful to be silent upon, is this, viz. that the incus of the mammal does *not* articulate with the mastoid, or with the squamosal, nor does it support the membrana tympani or any part thereof. No doubt the tympanic of the mammal is reduced in divers degrees in that class; but it always retains those relations with the mastoid and squamosal, and performs that function in reference to the ear organ, which characterize it under all its subordinate and accessory developments in Birds, Chelonians, Crocodiles, and other air-breathing vertebrates. The averment that "Professor Owen, once wrong, goes far astray" (Parker, *ibid.* p. 304), does not affect the facts nor the legitimate deductions from them which guide to a recognition of the homology of the tympanic, the mastoid, and the squamosal—at least by one bent "on *ascertaining*, instead of pleasantly *supposing*, the true nature of an anatomical element" (Parker, *ib.* p. 271). The case is this: the negative argument tells as strongly against the incus or other member in the chain of ossicles or gristles connecting the membrana fenestræ vestibuli with the membrana tympani, as it does against the tympanic, whilst the positive evidence is exclusively in favour of the tympanic.

One use of homology or "namesakeism" is to rid anatomy of different names for the same thing. Why do not those who believe the "quadratum" to be the "incus" or the "malleus" call it one or the other in the bird and hæmatocrya, or else call the mammalian otosteal of their choice "quadratum"?

poral bone" reduced, in human anatomy, mainly to the support of the tympanic membrane. The feebly marked groove and ridge on the hind concavity of the tympanic intimates the degree in which the function in relation to the organ of hearing is exercised in the ornithic modification of the air-breathing vertebrate tympanic bone. The vertical length of the present tympanic is 1 inch $2\frac{1}{2}$ lines; the long diameter of the distal articular-surface is 1 inch; it is slightly convex, but by a downward production of the middle of the outer border is there made concave transversely at the outer half.

The mandible of *Aptornis* presents in profile (Pl. XL. fig. 1, 29-32) a series of graceful curves. By the downward production of the angle (30) and the elevation of the articular surface (29), it is curved for a short way with the concavity below, then becomes concave above for a longer extent, and finally is again bent with the concavity downward. The extent of the symphysis (Pl. XLI. figs. 6, 7, 32) is 2 inches, following the curve, rather more than one-fourth the length of the mandible; its upper surface (ib. fig. 6, 32) is longitudinally convex, transversely concave, deepening, as it widens, backward. The hinder half of this concavity is smooth; the fore half shows two parallel longitudinal nervo-vascular tracts, with canals leading forward and opening upon the outside of the symphysis near the end; this has a horizontal, subtrenchant, slightly convex border. The dentary margins are rather sharp as they extend backward for an inch and a half, then begin to thicken into a convex border, $1\frac{1}{2}$ line across, which border again contracts before it is lost in the thick hinder half of the ramus. The outside of the trenchant margin of the symphysis is indented by a delicate line. An oblique groove, beginning about the middle of the outside of the ramus, indicates the junction of the dentary (Pl. XL. fig. 1, 32*) with the angular element (30), which is further denoted by a ridge continued backward from the groove. A fissure on the upper border of the ramus, half an inch in front of the articular surface (Pl. XLI. fig. 6), sinks into the substance of the bone as it advances, and opens by a shorter fissure upon the inner surface of the ramus nearly two inches from the angle. The tract between the two fissures probably included the hind end of the splenial. Save at these indications all the elements of the mandible are fused into one bone of a strong, compact osseous tissue, as in a few other strong-billed birds¹. The articular surface is single (Pl. XLI. fig. 6, 29) with the moderate convexities and concavity of its undulated surface answering to those on the tympanic. The fore-and-aft diameter of this surface of the mandible is 7 lines, the transverse diameter is $7\frac{1}{2}$ lines. I never saw a mandibular condyle of an oviparous Vertebrate in which so large a proportion was convex. Behind the articular surface there is a very small and not deep fossa; internal thereto the bone extends obliquely upward and inward into an irregular conical process, attached by ligament to the posterior non-articular part of the mandibular end of the tympanic. The outside of the ramus, below the articular surface, is strengthened by a tuberos ridge, between which and the angle is a broad oblique channel. There is no "coronoid" elevation; the ramus rather loses than gains

¹ *Ramphastos, Buceros, Psittacidae, Balæniceps.*

vertical extent from the symphysis, where it is $6\frac{1}{2}$ lines, to the articular end; but the thickness of the rami, with the outer angular ridge and the curvatures, indicate adaptations for strength in relation to powerful applications of the beak. And this accords with the massive character of the cranium, the extraordinary lever afforded by the transfer of the attachments of the recti capitis laterales¹ to the large basilar tuberosities carried down to so exceptional an extent below the bony junction of the head with the neck.

The skull of *Aptornis* offers many and well-marked differences compared with that of *Dinornis*. The occipital condyle is larger, more hemispheroid, more prominent; the foramen magnum is narrower in proportion to its vertical extent (comp. fig. 2. pls. 10, 12, 15, with fig. 1. Pl. XII.); the paroccipitals are more outwardly and less backwardly extended, the breadth there across exceeding that at the mastoids or at the postfrontals; in this particular *Aptornis* resembles *Apteryx*² and *Notornis*. But the angle or protuberance (Pl. XLI. fig. 1, *t*) for the insertion of the portion of the "longus colli posticus" called "biventer capitis"³ is more developed than in any bird⁴. The linear depression, indicative of the "coronal suture," is more marked than in *Dinornis*.

The mastoid process is smaller, but the premastoid much larger; and it adds by its bony union with the postfrontal another to the few exceptions (*Tetraonidæ*, *Crax*, *Lophophorus*, and some *Psittacidæ*) in which the Crocodilian character is repeated in the class of Birds.

The "rhinal chambers"⁵ are much smaller, absolutely and relatively, than in *Dinornis*⁶, and receive the olfactory nerves each by a single foramen instead of by several foramina.

The basilar tract descends much lower before developing the tuberosities for the "recti capitis laterales;" and these tuberosities are larger, indicative of the great strength of those muscles and of the other "recti" inserted into the marginal ridges and broad, deep, rough intervening surface of this extraordinary development. The basisphenoid contracts to a triangular process beneath the converging Eustachian channels, not present in *Dinornis*, and the surface in advance of the basilar tuberosities is more vertical and compressed in *Aptornis*. The pterapophyses are rudimental and devoid of articular surface. The mastoidal articular cavity for the tympanic is divided or double, instead of being single as in *Dinornis*⁷; the upper condyle of the tympanic is correspondingly modified. The tympanic has a premastoid process and articulation, not present in *Dinornis*; the squamosal articular cavity is not pedunculate; the surface for the mandible is single, not double as in *Dinornis* and most birds.

¹ See Trans. Zool. Soc. vol. iii. pl. 35, *b*, *c*.

² Ib. vol. ii. pl. 53. fig. 5.

³ Ib. vol. iii. pls. 32 & 33, *o***.

⁴ This has no relation whatever with the superior or any other of the semicircular canals; it answers to the thickened part of the superoccipital ridge marked *ep* in *Balaeniceps* (Trans. Zool. Soc. vol. iv. pl. 65. fig. 3).

⁵ Trans. Zool. Soc. vol. iii. pl. 52. fig. 5, *is*.

⁶ Ib. vol. v. fig. 1, *n*.

⁷ Ib. ib. fig. 1, *u*.

The beak is more elongate, more decurved, more depressed terminally; the outer wall of the premaxillary extends so far back, before the divergence of the maxillary and nasal branches, as to hide from view the prenasal septum and convert the cavity on each side into a fossa. This septum is exposed in *Dinornis*¹; and a shallow depression on each side represents the cul-de-sac of *Aptornis*.

The nasal branch of the premaxillary coalesces with the frontals and nasals. The maxillary branch of the nasal is longer, and directed more forward, leaving a larger antorbital vacuity (Pl. XL. fig. 1, v) in *Aptornis*. In *Dinornis*, as in *Apteryx*, the maxillary branch of the nasal descends anterior to and in connexion with the lacrymal², leaving no antorbital vacuity distinct from the external nostril. The mandible, besides the difference in shape and articulation, has the angle deflected.

It is instructive to find in the cranial organization of *Aptornis* these evidences of family distinction from *Dinornis* repeated in the second species of the genus, although the fact was more plainly and decisively shown by the leg-bones in the Memoir (Part III.) of 1848³.

In the downward production of the basilar platform *Aptornis* differs from *Notornis* more than it does from *Dinornis*; it differs from *Notornis* and all Coots (*Rallidæ*) in the development of the premastoid process and its junction with the postfrontal; from the same group it differs in the adze-like form of the bill, which is commonly in Coots, as in *Notornis*, not only pointed but straight; *Aptornis* further differs in the entire, imperforate structure of the mandibular ramus, and more especially in the absence of the outer narrow second synovial articular surface for the tympanic. When to these well-marked differences we add the form and proportions of the metatarsus of *Aptornis*⁴, the ornithologist might be pardoned for pausing before referring the present remarkable genus to the *Rallidæ*.

In *Aptornis*, e. g., the metatarsus is but three-fifths the length of the femur; but it is quite as broad as that bone at the middle of the shaft, and both articular ends expand to corresponding proportional dimensions.

The two upper articular surfaces of the metatarsus are very nearly on the same level, the inner one being rather the higher; and the intermediate eminence is broad and high. The calcaneal process is abruptly prominent, and is perforated, the outer and inner crests having coossified around the flexor tendons; such structure has not been seen in any Coot. The outer and inner calcaneal crests are distinct in *Rallidæ*—the outer one being most produced, but subsiding more gradually to the level of the shaft of the metatarsus than in *Aptornis*.

Yet the following correspondences of cranial structure show, unequivocally, a closer

¹ Trans. Zool. Soc. vol. vii. pl. 10. fig. 1, s.

² Ib. vol. v. pl. 55. fig. 1, 15"; vol. ii. pl. 54. In this specimen the suture between the nasal process and the lacrymal was obliterated, and both were referred to the lacrymal (ib. 286).

³ Trans. Zool. Soc. vol. iii. p. 346.

⁴ Ib. vol. iv. pl. 3. figs. 5, 6, 7, 8.

affinity of *Aptornis* to *Notornis* than to *Dinornis*. The basilar (basioccipito-sphenoidal) platform is pentagonal, the anterior angle projecting below the base of the rostral production¹; the Eustachian canals have a corresponding adjustment. The pterapophyses are obsolete in both *Aptornis* and *Notornis*. The articular cavities for the tympanic are two in each mastoid, similarly divided by a pneumatic slit. *Notornis* has muscular productions from the outside of the mastoid, answering to the mastoid process—the midmastoid and premastoid ones; but the two latter are mere ridges, or, if the premastoid be produced, it ends freely in a point, as in smaller Coots². The nasal branch of the premaxillary coalesces with the nasals and frontals in *Aptornis* and *Notornis*. The maxillary branch of the nasal is similarly directed, leaving an antorbital vacuity, with a long oval nostril, almost pointed at the upper, smaller end. The ossification of the fore part of the premaxillary hides from view the prenasal septum. In the mandible the angle is deflected in *Ocydromus*, *Porphyrio*, and *Notornis* as in *Aptornis*. The variation of palatal structure might be a bar to an approximation of *Aptornis* to *Notornis* and smaller Coots, were it not such in other families, united by sounder ties of organic character, as to show its low taxonomic value.

From another point of view the peculiarities of the skull in *Aptornis* may be considered in relation to the food of the bird and the work to which its long adze-like beak was put.

I infer this work to have involved frequent strong and deep thrusts into the ground, and that the quest was for animal, not vegetable matters. I have heard casually and vaguely of the great number, size, and unusual colour of the earthworms of New Zealand; and it is probable that a rich field here remains to be explored by the helminthologist.

The strange appearance of the parasitic cryptogam, *Sphæria*, sp., when it has achieved its growth at the cost of the caterpillar infested, has made us familiar with the burrowing habits of at least two species of New-Zealand Nocturnal Lepidoptera (*Cheiragria virescens* and *Cheir. rubroviridens*) at the larval stage of their existence. Such larvæ and earthworms were probably the food of *Aptornis*.

The cranial part of the skull may be regarded as the base or handle in which the digging adze was set; its expansion, radiating from the occipital condyle as a centre (Pl. XLI. fig. 1, 1), speaks decisively, by its superficial accentuation, to the size and power of the muscles therein implanted: the special development of the leverage-tract below the centre of motion relates to adequate fixation of the muscular powers that were to strike down the adze into the soil.

The muscles working the beak as part of the head are better developed in the ground-piercing *Apteryx* than in most birds, as will be estimated by the myotomist who may

¹ Trans. Zool. Soc. vol. iii. pl. 56. fig. 11.

² In a *Porphyrio smaragnotus* I have seen the tendon of each crotaphyte muscle ossified, and extending from a part of the temporal fossa answering to the "midmastoid" as far as its insertion into the mandibular ramus.

compare therewith the muscles in a fowl answering to those called *rectus capitis anticus major* (Zool. Trans. vol. iii. p. 285, pl. 35, *b*), *rectus cap. ant. minor* (ib. p. 286, pl. 35, *c*), *rectus cap. lateralis* (ib. pls. 32 & 35, *d*), *biventer capitis* (ib. p. 284, pl. 33, *o***), *complexus* (ib. pls. 32 & 34, *y*), and *trachelo-mastoideus* (ib. pl. 34. fig. 1, *x*). The developments of cranial bone for the insertions of the corresponding muscles in *Aptornis* indicate a fourfold increase of force and size, and bespeak corresponding power with which the beak was driven through the surface and the soil displaced. For this application it was requisite that the lower jaw should be held firmly in contact with the upper one, that both might penetrate as one instrument with a common sharp-edged extremity; hence the evidence of unusual extensions from the main cranial diapophyses of the bony processes giving origins to the muscles working the cranial rib, *i. e.* drawing up the mandible and holding it in close contact with the maxilla, as in that action of the corresponding muscles of the strong man who in a determined and vigorous effort sets his teeth.

Underlying all these exaggerations of apophysial outstandings, we nevertheless discern a "porphyrian platform"—so much more essential resemblance to the cranial characteristics of the Coots, especially the larger kinds, whose craniology is illustrated in plate 56 of the third volume of the Transactions of the Society, as to conclude *Aptornis* to have been (if one may not speak of it as present in the living creation) a gigantic modified "Ralline." The down-bending of the mandible, it is true, is not seen in *Notornis* or *Porphyrio*; but in the "Poule rouge au bec de Bécasse" of the Mascarene Islands (for a knowledge of which we are indebted to Von Frauenfeld's publication of the coloured drawing, from the life, preserved in the library of the Emperor Francis I.) one sees a curve of beak like that of *Aptornis*. The mandible of this probably extinct Mauritian bird, which has been obtained, with bones of the Dodo, from the famous "Mare aux Songes," shows also, in the figures given by M. Alphonse Milne-Edwards¹, the deflected angle answering to 30 in *Porphyrio* (fig. 1. pl. 56, Trans. Zool. Soc. vol. iii.) and *Notornis* (ib. fig. 7), also the small "prearticular foramen" (ib. ib. figs. 1 & 7, 10). The larger vacuity (ib. ib. *u*) is almost reduced to the state of obsolescence which characterizes the more consolidated and more powerful mandible of *Aptornis* (comp. fig. 4 with the mandible in fig. 1, Pl. XL.). The extent of symphysis, with its canaliculate upper surface, is interestingly similar in *Aphanapteryx* (Pl. XLI. fig. 5) and *Aptornis* (ib. fig. 6); and I concur in the conclusions to which M. A. Milne-Edwards has been led as to the "analogies of *Aphanapteryx* with the Rails"². In speculating on the

¹ "Researches into the Zoological Affinities of *Aphanapteryx*," in *Ibis* for July 1869.

² *Ibis*, 1869, p. 267. By a curious coincidence, at a later period of the year (1848) in which I proposed a diminutive of "*Apterygiornis*" for the large extinct Coot of New Zealand, the accomplished Belgian ornithologist, M. de Selys-Longchamps, was moved to propound a minor diminutive of the same term for some loosely indicated Mascarene birds, one of which we now know to have been an extinct Coot of the Mauritius. Without entering into the question of the degree of synonymy of *Aptornis* and *Apterornis*, the priority of proposition of the first will, I apprehend, secure it for the main subject of my present Memoir.

origin of the much larger extinct(?) brevipennate Rallines of New Zealand, it may be remembered that our own Coots and Waterhens are poor fliers compared with most water-birds.

§ 3. *Pelvis of Aptornis otidiformis.* (Plate XLII. figs. 1-3; Plate XLIII. figs. 1-4.)

My materials for the description of this instructive part of the skeleton are derived from the smaller species (*Apt. didiformis*), and were obtained from Wanganui, North Island of New Zealand.

Referring for the definition of the bone called "sacrum" to my 'Anatomy of Vertebrates,' "Aves," vol. ii. p. 29, I find it most convenient to adhere to the character of "confluence of vertebræ in connexion with the pelvic arch." In the 'Archetype &c. of the Vertebrate Skeleton' are discussed the characters by which the homologies of the twenty "sacral vertebræ" of the Ostrich *e. g.* with the lumbar and caudal vertebræ of Reptiles and Mammals may be determined; therefore I need not be misunderstood if, to make plain, or easily comprehensible, the characteristics of the pelvis of the extinct ground-birds of New Zealand, I continue to speak of such confluent series of vertebræ as "sacrum."

In *Aptornis* the sacrum includes nineteen vertebræ (Pl. XLII. fig. 2, s 1-19). The under surface of the confluent centrams shows well-defined modifications: it is pinched into a median ridge in the first three; the ridge is then, as it were, scooped off, leaving a smooth concave surface or mid channel along the next six centrams, beginning and ending in a point (fig. 2, *c c'*). From the hind point (*c'*) a broadish obtuse ridge runs along the next seven centrams, which gradually lose breadth. The seventeenth centrum suddenly expands; and those of the eighteenth and nineteenth have the form of broad depressed plates moderately concave across; the lateral confluent productions of the vertebræ being defined by two pairs of small vertical canals.

The pleurapophyses of the first and second sacral vertebræ retain their moveable joints. The cup for the head of the rib (Pl. XLII. fig. 1, *pl, pl*) is oval, with the small end upward, rather deep, well defined, and supported on an eminence at the upper part of the centrum, nearer the fore end in the first than in the second sacral. The surface for the "tubercle" is small, flat, cut obliquely at the fore part of the end of the diapophysis, which expands above to contract bony union with its successor and with the overlying ilium (62). The unossified space left between the first and second sacral diapophyses constitutes the foremost of the "interdiapophysial holes" (Pl. XLII. fig. 2, *i d'*). The third pleurapophysis (ib. *pl*) is short, straight, expanded, and confluent at both ends, broadest at that which underlies and is soldered to the ilium, beyond which it does not extend. The fourth is still shorter, and abuts as a parapophysis against the distal end of the third, with an extensive bony union above with the diapophysis of its own vertebra. The fifth, sixth, and seventh parapophyses lose length, gain breadth, and abut, with complete confluence, against the ilium a few lines from its

lower margin; the seventh blends with a smooth ridge-like thickening of the lower border of the acetabulum as it passes to be continued into the origin of the ischium (63).

There then follow three sacrals without "parapophyses;" a side view of these, defined by the double intervertebral foramina, is given from a fragment of a second pelvis at fig. 3, Pl. XLIII. In the eleventh sacral the lower process is suddenly resumed, passing obliquely outward and backward, straight to its confluent abutment against the postacetabular wall of the ilium; from this a continuous plate of bone curves inward and backward, with the lower margin bending forward to receive the expanded ends of the shortening parapophyses of the twelfth, thirteenth, and fourteenth, as well as of the eleventh, sacrals. The lower processes of the succeeding vertebræ are more or less broken away. The curved and bent lamelliform process of the ilium divides the interacetabular renal fossa from the ilio-ischial fossa behind. This (Pl. XLII. fig. 2, *r*) is remarkable for its size, depth, and smooth surface, so far as it is preserved.

Fracture of the fore part of the right ilium exposes the neural spine of the first sacral (fig. 2, *ns*). It is directed upward and forward, is 1 inch 5 lines in height, 7 lines from before backward, where it becomes free; and it terminates in a slightly expanded truncate border, which has contracted no ankylosis with the over-arching confluent iliac bones. The anterior articular surface of the first sacral (Pl. XLII. fig. 3, *c*) is, as usual, concave transversely, convex vertically, but almost bilobed in form from a shallow emargination below and the down-sinking of the neural canal above; its breadth is 11 lines, its mid vertical diameter but $3\frac{1}{4}$ lines. The neural canal is circular, $2\frac{1}{2}$ lines in diameter. The prezygapophyses (ib. *z z*) look upward, inward, and rather forward; they are each 6 lines in diameter; together, an inch across their outer margins. The fore part of the base of the spine is impressed with a rough laterally ridged surface for the interneural ligament. The beginning of the inferior ridge represents a short "hypapophysis" in the front view (Pl. XLII. fig. 3, *h*). The vertical extent of the fore part of the first sacral is 2 inches 3 lines; from the lower ridge to the upper part of the coalesced ilia is 2 inches 6 lines. The extreme breadth of the fore part of the pelvis, which is that of the first sacral across its diapophysis, is 1 inch 11 lines. The neural canal of the sacrum expands, as usual, as it extends backward, chiefly transversely (Pl. XLIII. fig. 4, *n*), then contracts to the diameter shown at *n*, fig. 1, Pl. XLII.

The ilia (Pl. XLII. fig. 1, 62), anterior to the acetabulum, ascend from their outer margins and converge rapidly to contact and partial confluence with the bases or mid parts of the sacral spines, above which they coalesce and form a ridge, the contour of which describes a moderate convex curve from before backward. The ridge, which is about 4 lines across anteriorly, narrows as it recedes. The outer surface of the preacetabular part of each ilium is uniformly concave, and the concavity is continued, contracting, above the acetabulum (*a*). The "gluteal ridges" (Pl. XLII. fig. 1, *g*), which divide the concave tract (62) from the expanded convex or undulated tracts of the ilia, called "pelvic disk" (*rr*), rise as they recede and diverge, terminating rather abruptly

2 inches 3 lines from their origin; they recommence, to be continued with partial thickening to the hind end of the coalesced ilium and ischium, dividing its horizontal from its vertical surface.

The "pelvic disk" is deeply impressed along the middle of its anterior half, the channel or groove contrasting with the iliac ridge in advance. The bottom of the channel is entire, slightly widening as it recedes and descends, when the depressed spineless upper surface of the neural arches of the last three sacral vertebræ come into view at *n*, fig. 1, Pl. XLII., between the hind parts of the ilia. The sloping sides of the interiliac groove are pierced each by three interneural foramina. The fore part of each side of the pelvic disk is convex transversely; but this changes to a concavity as it recedes.

Of the ischial and pubic elements the broken origins are preserved at 63, 64, Pl. XLII. fig. 1, Pl. XLIII. fig. 2. That of the pubis has a long diameter of 5 lines, where it extends from below the acetabulum. Where the ischium becomes free, half an inch below the postacetabular facet, it is 4 lines by $2\frac{1}{2}$ lines in thickness.

This facet (*ib. b*) is a more continuous part of the general acetabular cavity than usual. Including it therein, the long diameter (from before backward) measures 1 inch 5 lines; the vertical diameter of the acetabulum proper is barely 1 inch; the acetabular vacuity (*ib. a*) has a diameter of half an inch; its margin projects, as usual, into the prerenal or interacetabular fossa. The vertical diameter of the postacetabular facet is $6\frac{1}{2}$ lines. Between the margin of the acetabulum and the free part of the ischium (63) is a well-defined (antischial) fossa (Pl. XLIII. fig. 1, *e*). The ischial foramen is subcircular, 8 to 9 lines in diameters. On the right side a distal part of the ischium, coalescent with the ilium, is preserved, descending vertically at right angles with the area of the "disk," and effecting, by an inwardly extended plate (Pl. XLII. fig. 2, *v*) underlying part of the postrenal fossa, a bony union with the depressed terminal sacral vertebræ (*ib. 19*). The degree of coalescence of the sacrum and iliac bones is such as to reduce the ilio-neural canals to small separate spaces (Pl. XLIII. fig. 4, *i d*), into which the interdiapophysial foramina (fig. 2, *i d*) open.

The pelvis of *Aptornis* differs from that of *Dinornis*¹ in its greater length relatively to the breadth, in its less sudden and minor expansion behind the acetabula, in the inferiorly carinate anterior centrums, in the more sudden expansion of the hindmost centrums, in the more convex contour and sharper upper ridge of the coalesced preacetabular plates of the ilia, in the deeper and narrower channel dividing the postacetabular parts of the same bones, in the relatively narrower interval between the postacetabular parts of the ilium and ischium, and in the relatively smaller ischial foramen². The rather sudden down-sinking of the preacetabular iliac ridge into the superacetabular iliac channel is also very significant of the distinction of ordinal groups between *Aptornis* and *Dinornis*.

¹ Compare Pl. XLII. figs. 1 & 2, and Pl. XLIII. figs. 1-4, with pls. 19, 20, 20 A, of vol. iii. Trans. Zool. Soc.

² Compare Pl. XLIII. fig. 1, with pl. 20. (*tom. cit.*) figs. 1 & 2.

Aptornis agrees with *Apteryx* in the proportional extent of the antacetabular part of the ilium¹, but offers the same differences, and some of them exaggerated, which have been noted in the pelvis of *Dinornis*. In the general proportions, as in size of pelvis, the correspondence between *Aptornis* and *Cnemiornis*² is closer than between either of them and *Dinornis*; but there are differences of at least generic value.

The anterior sacral centrums are relatively broader and less deep in *Aptornis*; there is no increase of breadth or expansion in the seventh or contiguous antacetabular ones, as in *Cnemiornis*; the narrowing is continuous, though quicker, after the seventh, in *Aptornis*, as far as the sixteenth, when the sudden expansion takes place. In *Cnemiornis* there is no indication of such expansion of terminal sacral centrums; they continue narrow and ridged below from the twelfth to the seventeenth. The breadth of the anterior sacral vertebra across the costal pits of the centrum in *Cnemiornis* is 7 lines, in *Aptornis* it is 13 lines; but the height of this vertebra must have been the same, or nearly so, in both. There are surfaces for the articulation of a third pair of free sacral ribs in *Cnemiornis*; but these do not exist in *Aptornis*. The concavity of the preacetabular part of the ilium in *Cnemiornis* is bounded above by a curved ridge, leaving a flatter tract between it and the summit of the bone; but there is no trace of this division of the bone in *Aptornis*. The posterior, horizontal iliac tract is divided by a median convex ridge in *Cnemiornis*, but by a deep median furrow in *Aptornis*. In that genus there is no trace of the superacetabular pneumatic fossa as in *Cnemiornis*, in which the acetabulum is relatively larger, its vacuity wider, its distinction from the posterior flat facet greater. The antischial depression of *Aptornis* is not repeated in *Cnemiornis*. In this genus there is no indication of the smooth, large, deep, hemispherical postrenal fossa on the under surface of the ilium which characterizes *Aptornis*; neither is there an iliac lamella bounding behind the interacetabular renal fossa.

In both genera there are indications of similarity of the pelvis to that in *Rallidæ*; there is the length of the antacetabular part and its steeply inclined roof-like iliac plates, the great reduction of the iliac fossæ through the non-extension, or slight extension, of the ilia beyond the sacral diapophyses; but this affinity is more marked in *Aptornis*, as by the development of the postrenal ischial lamellæ (Pl. XLII. fig. 2, *v*) and the small and round ischiatic foramen.

§ 4. Notice of a mutilated Pelvis of *Notornis*.

I have long entertained hopes of receiving, through the friendly cooperation of some collector of natural-history objects in New Zealand, materials for a monograph on the osteology of *Notornis*³; but, so far as I know, only a very few skins of that still lingering species of Ground-Coot have hitherto reached Europe.

¹ Compare Pl. XLII. fig. 1, *sz*, with Trans. Zool. Soc. vol. ii. pl. 54.

² Compare the figures in the present Memoir with figures 5, 6, 7, pl. 64. Trans. Zool. Soc. vol. v.

³ *Notornis* is affirmed to be living in considerable numbers in some districts on the west coast of the Middle Island (Mackay in 'Ibis,' 1867, p. 144).

I no longer delay, therefore, to communicate a description of a very mutilated portion of pelvis received from the sand-beds at the embouchure of the Wanganui river, North Island of New Zealand, in the same brittle but unpetrified state as the parts on which the genus *Notornis* was originally founded¹, under the impression of its being extinct, as in the North Island of New Zealand it actually is.

I am led to refer the specimen about to be described to that genus by reason of the relation of its size to that of the skull described and figured in the under-cited Memoir, and also to the size of the femur and tibia described and figured in a subsequent Memoir².

This portion of pelvis includes thirteen confluent sacral vertebræ, the rest being broken off from the hind end of the series.

The first sacral offers the usual articular surfaces on the prezygapophyses (Pl. XLII. fig. 6, z) and on the fore part of the centrum, the transverse concavity of the latter (ib. c) being deep, the vertical convexity slight. A circular costal pit (ib. fig. 6, pl) impresses each side of the centrum and each diapophysis. A large pneumatic foramen opens at the base of each diapophysis. The neural spine, moderately compressed and high, is confluent at top with the iliacs: the vertical length of the vertebra is 1 inch 5 lines; the transverse diameter across the diapophyses is 1 inch. The sides of the centrum converge below to a tract from $1\frac{1}{2}$ line to 2 lines in breadth (Pl. XLII. fig. 5, c). The second sacral has no free rib; its transverse process, directed outwards, contracts an extensive anchylosis with the ilium; the centrum, expanding backward, has a broader convex under surface. That of the third sacral continues the expansion with a broad, smooth, convex under surface; the lamelliform transverse processes incline forward to their terminal coalescence. The more expanded fourth sacral centrum has a broad, flat under surface, on a level with which the thick, short parapophyses pass directly outward. Those of the fifth and sixth sacrals have a like position, size, and direction. The breadth of the flat lower surface is here half an inch. The four succeeding vertebræ are "interacetabular," have no parapophyses; the inferiorly flattened centruns gradually lose breadth, and are defined by the nerve-canals in pairs, as usual, opening obliquely backward, and progressively decreasing in size from the seventh to the eleventh (Pl. XLIII. fig. 9, c, 7-11). In this and the succeeding centruns the parapophysis reappears, but is broken away in each of the remaining sacrals.

As much of the iliacs remain as have coalesced with the neural arches of the thirteen sacrals here preserved. They meet and form an obtuse continuous smooth ridge above the first five sacrals, from which ridge the bones slope, like the sides of a steep roof, to their lower, fractured margin. The longitudinal contour above (ib. fig. 9) is slightly convex, then rather abruptly sinks to the lower level of the expanded neural arches of the seven or eight hinder vertebræ, describing a concavity, which again becomes convex

¹ On *DINORNIS* (Part III.): Trans. Zool. Soc. vol. iii., "Cranial characters of the genus *Notornis*," p. 366, pl. 56.

² Trans. Zool. Soc. vol. iv. p. 12, pl. 2. figs. 3 & 4.

in a slight degree. Here the upper surface is almost flat, with a feeble mid linear rising; where this rises to the anterior convexity there is a linear slit on each side, leading to the "ileo-neural" vacuities.

Fragmentary as is this portion of pelvis, it permits of the deduction of some characters which support the reference of it to the porphyrian genus *Notornis*. The antacetabular portion included, as I am led to infer, at least half the total length of the pelvis. In this respect it resembles *Apteryx*¹; but the superior contour of the coalesced iliacs in that bird is convex. The undulated contour of the same part of *Notornis* rather exaggerates that in *Aptornis* (Pl. XLII. fig. 1), and still more so what is more feebly shown in *Tribonyx* and some other Rallines, viz. *Gallinula nesiotis*, Scl., *Porphyrio*, sp., and *Ocydromus*, sp. But in none of these is the undulation so strong as in *Notornis*. In *Gallinula nesiotis* I observe the same slit-shaped outlets of the ilio-neural canals on each side the descending mid ridge of the coalesced ilia.

The character of the under surface of the antacetabular centrums in *Notornis* (Pl. XLII. fig. 5) agrees with that in species of *Gallinula* and *Porphyrio*. The ridge-like shape of the same part in *Aptornis* and *Cnemiornis* finds a partial resemblance in the first and, sometimes, second sacral centrums of species of *Fulica*. Only the first sacral supports, as in *Notornis*, moveable ribs in *Gallinula nesiotis* and *Porphyrio caelestis*; but in some species of *Fulica* both first and second sacrals have moveable ribs, as in *Aptornis* and *Cnemiornis*. In the vertebræ which I have called "interacetabular," though they are partly in advance of the internal openings of those articular cavities, *Notornis* resembles *Aptornis* and many existing Rallides, in the absence of transverse processes; the neurapophyses rise, from above the double nerve-holes, as vertical walls slightly expanding to be lost in the flat iliac roof of that part of the pelvis. In *Cnemiornis* oblique ridges extend from the neurapophyses of those vertebræ, strengthening, as buttresses, the support of the superincumbent bony roof².

§ 5. *Femur, Tibia, and Fibula of Aptornis defossor.*

Femur.—The difference in the size of this bone, as compared with the femur of *Aptornis otidiformis*, is given in the "Table of Admeasurements" (p. 378), and may be seen by comparing fig. 5. Pl. XLIII. with those cited below³. The differences which the femur of *Aptornis* presents, as compared with that of *Dinornis*⁴, are repeated, and in some respects exaggerated, in *Apt. defossor*: the straight subcylindrical character of the proportionally longer and more slender shaft in *Aptornis* is better marked in the present species. That of *Apt. didiformis*, viewed in profile, as in the figure of the femur of the larger species given in Pl. XLIII., shows a slight bend, convex forward; this is due to a minor diminution of fore-and-aft diameter in the lower part of the shaft, and to a relatively greater fore-and-aft diameter of the outer condyle in *Apt. defossor*. The

¹ Trans. Zool. Soc. vol. ii. pl. 54.

² Ib. vol. v. pl. 64. fig. 6.

³ Ib. vol. iv. pl. 3. fig. 3; vol. v. pl. 63. fig. 3.

⁴ Ib. vol. iv. p. 10.

"well-marked ridge," extending down the back part of the shaft, and inclining to terminate in the border of the inner condyle¹, is repeated in the present species. In *Dinornis* the corresponding ridge is more median or even tends toward the outer side of the back surface of the femoral shaft, and ends abruptly in a tuberosity, usually one of a pair, at the lower third of the shaft, from the innermost of which extends the ridge to the inner condyle. This condyle in *Dinornis* does not reach so low as the outer one; and the terminal distal line is oblique, indicative of the greater angle at which that end diverges from the hip-joint to rest on the tibia of the robust-bodied bird. In *Apt. defossor*, as in *Apt. didiformis*, the inner condyle more nearly equals in vertical extent the outer one, yet in a somewhat minor degree in the larger species. In both, the fore part of the two condyles is less prominent, and the rotular groove less deep, than in the femur of *Dinornis*². The head of the femur is more truncate or depressed in *Aptornis*, through the relatively larger size of the ligamentous pit, than in *Dinornis*. The lower part of the head is more produced downward in *Aptornis*; and a short ridge from the under and back part of the head (*Apt. otidiformis*), or of the neck near that border of the head (*Apt. defossor*) (Pl. XLIII. fig. 6), extends downward and rather backward for 6 or 8 lines. Of this ridge there is no trace in *Dinornis*. A broader parallel ridge or rising extends about the same distance from along the back part of the supracervical articular surface: this extension from the head of the femur is more convex from before backward in *Aptornis* than in *Dinornis*. Of the pneumatic fossa, which in some species or individuals of *Dinornis* breaks the surface below the back part of the supracervical surface, there is no trace in either species of *Aptornis*.

For the characters of the femur of *Aptornis* as compared with that of *Cnemidornis*, reference may be made to Trans. Zool. Soc. vol. v. p. 400, pl. 65. They are as well marked in *Apt. defossor* as in *Apt. otidiformis*.

Tibia.—The importance of such distinctive characters as "the tibial half of the proximal articulation is broader from behind forwards than transversely," "the anterior ridge at the proximal end ['procnemial ridge'] is nearer the middle of the bone," "the more rounded or less angular inner side of the shaft," "the proportionally greater antero-posterior thickness of the shaft," "the deeper posterior notch between the distal condyles," "the more compressed and more backwardly produced inner condyle," could not be fully estimated in the solitary tibia of the smaller species first described³. In the absence of a femur or of a tarso-metatarsal bone to match this tibia, I could only venture to affirm that "it unequivocally established a fourth species of cursorial bird" in the series of tibiæ first received from New Zealand. The subsequent acquisition of the femur, the "tarso-metatarsal"⁴, and the skull of the *Dinornis otidiformis* of 1843 impresses one instructively with the value of such seemingly insignificant modifications

¹ Trans. Zool. Soc. vol. iv. p. 10.

² In my fourth Memoir, Trans. Zool. Soc. vol. iv. p. 11, nine lines from top, for "more" read "less".

³ Trans. Zool. Soc. vol. iii. p. 247, pls. 25 & 26. fig. 5.

⁴ Ib. vol. iv. pl. 3.

of the chief leg-bone, and the need of close scrutiny and comparison of every character thereof in solitary fossil specimens.

The somewhat more perfect tibia of *Aptornis defossor* (Pl. XLI. fig. 9, and Pl. XLIII. fig. 8) than that of *Apt. otidiformis* (pl. 25. fig. 5, of Trans. Zool. Soc. vol. iii.) yields other differences between *Aptornis* and *Dinornis*, in this bone, than are noted in the first Memoir (ib. p. 247). The bony canal for the tendon of the "tibialis anticus" and "extensor longus digitorum pedis"¹, is nearer the middle of the anterior surface. The ridge forming the inner wall of the groove thereto leading is longer and sharper, the bony bridge (Pl. XLI. fig. 9, *f'*) is broader, the fibular ridge (*h*) is more prominent and more lateral. In most of these characters may be discerned a significant resemblance to the tibia of *Notornis*². In the median position and breadth of the "extensor tendon bridge" (*f*), in the development of the inner wall of the groove, in the outer position and prominence of the fibular ridge, similar affinities are indicated in the tibia of *Cnemiornis*; but the exaggerated development of ectocnemial and procnemial ridges in that genus only comes out the stronger in the comparison with *Aptornis* (Pl. XLI. fig. 9, and Pl. XLIII. fig. 8, *p, e*). As in *Apt. otidiformis*³, the tendinal canal is less strictly median in *Apt. defossor*, and the fore part of the inner distal condyle is more produced and more compressed, than in *Cnemiornis*.

The fibula of *Aptornis defossor* (Pl. XLI. figs. 10, 10 *a*) is 6 inches in length, has the usual subcompressed head, with the convex elongate articular surface for the groove of the outer femoral condyle; the proximal end is slightly hollowed on the inner side, in a minor degree convex on the outer side; the shaft, gradually tapering as usual to a pointed end, which seems to have contracted a second junction with the tibia, shows also the two rough surfaces for tendinous attachments, but less strongly marked than in *Cnemiornis*.

§ 6. Femur of *Notornis*.

The acquisition of a second, somewhat more perfect specimen of the femur of *Notornis*, from Waingongoro, in the North Island of New Zealand, induces me to repeat and develop a description of the bone with special reference to the illustration of the Ralline affinities of *Aptornis*. The femur of *Notornis* (pl. 2. fig. 3, Trans. Zool. Soc. vol. iv.), in the proportions of length to thickness of shaft, in the degree of curvature, and of torsion on the axis, resembles that in smaller existing Rails and Coots more closely than does the femur in *Aptornis* or *Cnemiornis*.

The head shows the same free and sharp downward production of its lower margin, the same proportion and position of the depression for the round ligament as in *Aptornis*, the same form and degree of extension of the articular surface upon the neck, the same transverse convexity of that surface. The great trochanter rises higher than this surface, but is relatively less elevated than in *Aptornis*; it is relatively as broad;

¹ Trans. Zool. Soc. vol. iii. pl. 35, s. 9.

² Ib. vol. iv. p. 12, pl. 2. fig. 4.

³ Ib. vol. v. p. 402.

the anterior border is rather more sharply produced, and is brought more to the front surface of the bone. A linear ridge is continued therefrom down three-fourths of the shaft, inclining toward its inner side. A tuberosity projects below the base of the trochanter at the outer side of the bone, from which goes a linear ridge along the back part of the shaft, toward the outer side; a second linear ridge, commencing lower down, runs along the back of the shaft towards the inner side as far as the popliteal space; between these ridges, near halfway down the bone, opens the canal of the medullary artery. The distal end is less expanded than in *Aptornis* or *Cnemiornis*. The rotular channel, though wide, is relatively deeper and narrower than in *Aptornis*, and the inner border is more produced. A small tuberosity projects external to the upper end of the outer border: this may be individual. The popliteal space shows no definite fossa, and its surface is irregular. The fibular articular groove is deeper, with a better-defined and produced outer border. As in the thigh-bone of the *Rallidæ* generally, there is no pneumatic foramen.

§ 7. *Metatarsus of Aptornis defossor.*

In general form and proportions this bone resembles that in *Aptornis otidiformis*: the superiority of size is shown in the "Table of Admeasurements," and in figs. 1 & 6, Pl. XLIV. As compared with *Dinornis* (ib. figs. 7-10), the metatarsal of *Aptornis defossor* shows the same greater depth and nearer equality of size of the two condylar cavities (Pl. XLIV. fig. 4), with the broader and loftier intercondylar tract, as in *Apt. otidiformis*¹, the same superior prominence and perforation of the calcaneal process (ib. *c, c'*), the same flattening of the back part of the shaft through the non-projection there of the upper half of the mid metatarsal element, also the presence of the canal (ib. *t*) for the tendon of the "adductor digiti externi." The inner (entotibial) condylar cavity is on a rather higher level than the outer (ectotibial) one, is rather deeper, rather less from before backward. The cavity at the upper part of the front surface of the metatarsal shaft is relatively less deep than in *Aptornis otidiformis*; it is not continued so low down upon the shaft; but the anterior outlets of the interosseous canals open separately at its bottom, and the ridge at the inner border for the insertion of the corresponding part of the tendon of the "tibialis anticus" is strongly marked and defined. In *Dinornis* the interosseous canals converge from behind forward to a common orifice (*o*, fig. 7) at the bottom of the shallow upper and anterior depression. In one specimen of metatarsus of *Aptornis defossor* the groove (*t*, fig. 1) for the tendon of the "adductor digiti externi" deepens as it approaches the interspace between the middle and outer digital trochleæ, and perforates the bone above that interspace; in another it deeply grooves the interspace, but is not crossed by the bony bridge at the fore part of the interspace. A similar variety is shown by one of three specimens of metatarsus in *Apt. otidiformis*. Where the bridge exists, the tendinal canal opens in the interval or chink

¹ Trans. Zool. Soc. vol. iv. p. 11.

between the two trochleæ; but there is commonly another canal, continued from the "adductor groove," which traverses the bone backward and opens into the lower concavity of the posterior surface of the metatarsal above the interval between the outer (IV) and middle (III) trochleæ, as at fig. 2, *h*, Pl. XLIV., and in vol. iv. pl. 3. fig. 5, *Apt. otidiformis*. Now, this orifice is not present in one of three metatarsi of *Apt. otidiformis*, nor in one of the two metatarsi of *Apt. defossor*. Neither the vertical nor the fore-and-aft canal is present in *Dinornis*: I have once seen the latter canal, as an exception, in *Apteryx*.

At the back part of the shaft *Aptornis defossor* shows a perforate calcaneal process (Pl. XLIV. figs. 2, 3, *c*), relatively longer vertically than in *Apt. otidiformis*: the ridge on the inner side of each side-wall (fig. 4), indicating the portions of the canal traversed respectively by the tibialis posticus (*e'*) and the "flexor longus digitorum" (*e*), is better marked, and the bony canal is less contracted posteriorly, than in *Apt. otidiformis*. The postinternal longitudinal crest is shorter and more produced in *Apt. defossor*; the fossa internal to its upper part, for the origin of the "flexor brevis hallucis," is well defined, as is the surface below the crest for the attachment of the metatarsal of the hallux (fig. 2, *i*). The longer surface at the outer and back part of the metatarsal for the insertion of part of the strong gastrocnemial sheath-like tendon is strongly marked. Every thing bespeaks the force with which this massive metatarsal was worked in *Aptornis*. The proportions and disposition of the distal trochleæ in *Apt. otidiformis* (fig. 5) are closely repeated in the larger species (fig. 1, *a*); the inner one (fig. 2, *II*) does not terminate at a higher level than the outer one (ib. *IV*); the cleft between the outer and middle trochleæ is deeper and anteriorly wider than the inner cleft, in both species of *Aptornis*. The outer trochlea in *Dinornis* (fig. 8, *IV*) is shorter than the inner one (ib. *II*).

To exemplify the generic, or family, or ordinal distinction between *Aptornis* and *Dinornis*, I take the present opportunity to figure the metatarsus of the species coming nearest to *Aptornis* in size¹, viz. *D. curtus* (Pl. XLIV. figs. 7-10), first indicated by the mutilated bone described and figured in Zool. Trans. vol. iii. p. 325, pl. 48. fig. 6.

The metatarsus of *Aptornis defossor*, above described, formed part of the extensive series of remains brought by Mr. Walter Mantell from Ruamoā, Middle Island of New Zealand, and purchased by the British Museum in 1856 (Trans. Zool. Soc. vol. iv. pp. 149, 156). Deeming, then, that it might prove to belong to a larger variety of the *Aptornis otidiformis* of the North Island, I concluded to wait for further evidence, which the bones brought from the same neighbourhood (Oamaru) by Mr. Taylor have now given. The tibia (Pl. XLI. fig. 9) fits this metatarsus (Pl. XLIV. fig. 1) as well as the tibia of *Apt. otidiformis* (Zool. Trans. vol. iii. pl. 25. fig. 5) fits the metatarsus figured in *op. cit.* vol. iv. pl. 3. fig. 5.

¹ Unless the small bone (Pl. XLIV. fig. 7) should indicate an established breed of that inferior size, meriting a distinctive name, and should not belong to a female or somewhat dwarfed individual of *D. curtus*.

On comparing the metatarsus of *Aptornis* with that of *Notornis*, *Ocydromus*, or *Tribonyx*, the bone¹ would seem, at first sight, to drive the extinct genus far away from the Ralline waders: the occiput of *Aptornis* hardly presents more marked differences from that in any known recent Ralline's skull.

I discern, however, a certain harmony in the departures from type thus presented by the two extreme parts of the skeleton of *Aptornis*—an associated relation to the needs and habits of this most strange brevipennate bird. On the functional hypothesis of the large and long adze-like bill of *Aptornis*, as being designed and used for the purpose of feeding its great body with earthworms and burrowing grubs, the delving-instrument may have needed another one to clear off the broken-up surface and to help in the unearthing quest. What, then, we may ask, would be the modifications superinduced, say, upon the Ralline type, if indeed such type-characters be not predicable of a wider range of the "precocious birds"?

In the first place, the foot, if it is to be used, with due vigour, in scratching up and scraping away soil, must be brought near to the bending powers; their force must not be wasted upon long tendons traversing a stilt-like metatarsus before they can be inserted into the toes. The shortness of that segment in proportion to the tibia is accordingly notable in scratchers (*Rasores*, *Gallinæ*) as compared with waders (*Grallæ*).

The metatarsus is less remarkable for its length in most *Rallidæ* than in waders generally; but that of *Aptornis* is reduced to shorter proportions than have been seen in any known grallatorial or, even, rasorial bird. In some of the Grouse-tribe the metatarsus may be reduced to one-half the length of the tibia; but in *Aptornis* it is less than half. In strength or robustness it loses nothing in this comparison with *Gallinæ*, rather gains; the transverse diameter of the middle (narrowest part) of the shaft of the metatarsus in *Aptornis* is equal to, or exceeds, that of either the tibia or the femur.

For the strength of a "double joint," equality of the two condyles, and of their cups, may be a condition, as well as prominence and depth of interlocking; and both ecto- and entotibial cups on the proximal articular surface of the metatarsus in *Aptornis* are almost on the same level: the outer one (ectotibial) is rather the lowest; and this may be deemed significant of its porphyrian affinity, seeing that the level of this surface is conspicuously lower, in Coots, than that of the inner (ento-tibial) cup; and this cup, though higher, is deeper than the outer one, as in *Rallidæ* generally. The intervening rise of the proximal surface, however, which, as it passes into the joint between the condyles of the tibia, is called "intercondylar," instead of being low, as in *Rallidæ*, is raised considerably; but this is in more direct relation with the strengthening of the ankle-joint than is the equality or level of the two cups and balls.

The perforate condition of the strongly produced calcaneal process seems, with the shortness and thickness of the metatarsus, to speak for the rasorial affinities of the bird to which it belongs. But there are no longitudinal grooves upon either the back or

¹ Trans. Zool. Soc. vol. iv. pl. 3. figs. 5-8; and Pl. XLIV. figs. 1-6, of the present Memoir.

the sides of the perforate calcaneal process in *Aptornis*. If the ento- and ectocalcaneal plates of *Notornis*¹ or of *Porphyrio* were united by coossification of their free borders, the condition of the calcaneal process in *Aptornis* would be produced. One can see the advantage of a complete bony pulley for the traversing tendon of the flexors of the toes²; and this was a strong one in *Aptornis*, with a pulley to match. The base of the perforated process equals half the transverse diameter of the proximal end of the metatarsus, outstanding a little to the outer side of the middle of the hind part of that surface, slightly deflected at the end. The inner wall has a longer base of origin than the outer one. There is a feeble indication of the parts of the canal respectively traversed by the "perforans" and "perforatus" tendons, but no outside grooves; and the difference from the gallinaceous metatarsus is shown by the non-continuation of the entocalcaneal plate with the postinternal crest on the shaft of the bone, giving attachment to one of the divisions of the sheath-forming insertional tendon of the "gastrocnemius externus"³.

The beginning of the postinternal crest is separated from the entocalcaneal process by a canal about $1\frac{1}{2}$ line wide, into which opens the antero-posterior (interosseous) canal between the inner and middle metatarsal elements. The surface on the inner side of the postinternal crest for the origin of the "flexor brevis pollicis" is extensive and well marked, according with the size of the digit indicated by the hallucial articular surface (Pl. XLIV. fig. 5, 1). The anterior surface of the metatarsus is impressed, near the tibial articulation, with a deep fossa, into which open the two "interosseous" tubular canals; beneath these are surfaces for the origins of the "extensor pollicis brevis" and "adductor digiti externi;" and the inner side of the fossa is produced into a short ridge, into which the tendon of the "tibialis anticus"⁴ is in part inserted. Midway down the fore part of the shaft begins the groove for the "adductor digiti externi," the tendon of which glides through the canal above the interval between the middle and outer trochlear condyles, which canal is present in the *Notornis* and Coots, though by no means peculiar to them. It is one of the well-marked distinctions between the metatarsus of *Aptornis* and of *Apteryx*, this latter bird agreeing with *Dinornis* in the absence of the intertrochlear canal.

The surface below the postinternal crest indicates a strong and large back toe (hallux, Trans. Zool. Soc. vol. iv. pl. 3. fig. 5, 1); but *Notornis* and the Coots have this in common with the *Rasores*. The trochleæ of the digits II & IV descend almost to the same level; IV is, perhaps, rather the lowest; in *Notornis* and the Coots it is more decidedly so. The mid condyle is more advanced and more produced in *Aptornis*, as is usual in *Grallæ* and *Gallinæ*, and as it is, indeed, in *Apteryx* and *Dinornis*. The interval between the toes

¹ Trans. Zool. Soc. vol. iv. pl. 2. fig. 3.

² Trans. Zool. Soc. vol. iii. "Myology of *Apteryx*," pls. 22, 25, 1, 3, 4, 5, 6.

³ *Op. cit.* vol. iii. pl. 35, R***.

⁴ *Ib. ib.* 8.

III & IV in *Aptornis* is wider and deeper than that between III & II. The grooved or trochlear character of each condyle is well marked.

On the whole, the inference seems legitimate that we have in the metatarsus of *Aptornis* a bone extremely modified for "rasorial" functions upon a porphyrian or "ralline" type.

Table of Admeasurements.

	<i>Aptornis defossor.</i>		<i>Aptornis otidiformis.</i>	
	in.	lines.	in.	lines.
<i>Skull.</i>				
Length	7	2	6	2
Breadth (across paroccipitals)	3	3	2	9
Breadth (across postfrontals)	3	2	2	10
Breadth (across temporal fossæ)	2	3	1	1
Breadth of base of upper mandible at fore part of orbit	1	6	1	3
Breadth of middle of upper mandible	1	4	1	1
Breadth of fore end of upper mandible	0	7	0	6
Length of cranium to coalesced premaxillary	2	6	2	2
Length of premaxillary	5	0	4	3
From the fore part of external nostril to the end of the premaxillary	2	9	2	3
From the superoccipital ridge to the lower border of the fore basilar tuberosities	2	6	2	1
<i>Femur.</i>				
Length	7	6	6	2
Breadth of proximal end, in the axis of the neck	2	2	1	9
Breadth of distal end, across the condyles	2	2	1	9
Circumference of middle of shaft	2	9	2	3
<i>Tibia.</i>				
Length	10	3	8	9
Breadth of proximal end	2	3	1	9
Breadth of distal end	1	10	1	3
Circumference of middle of shaft	2	6	1	11
<i>Metatarsus.</i>				
Length	4	4	3	10
Breadth (transverse) of proximal end	1	8	1	5
Breadth (transverse) of distal end	1	9	1	6
Breadth (transverse) of middle of shaft	0	11	0	8
Breadth from fore part of proximal end to back part of calcaneal process	1	6	1	4

DESCRIPTION OF THE PLATES.

PLATE XL.

Aptornis defossor.

- Fig. 1. Side view of skull.
- Fig. 2. Top view of skull.
- Fig. 3. Base view of skull (without mandible).
- Fig. 4. Side view of mandible of *Aphanapteryx* (ex A. Milne-Edwards, 'Ibis,' July 1869).

PLATE XLI.

Aptornis defossor.

- Fig. 1. Back view of cranium.
- Fig. 2. Inner side view of tympanic bone.
- Fig. 3. Mandibular articular surface of tympanic bone.
- Fig. 4. Outer side view of tympanic bone.
- Fig. 4 *a*. Hind view of palatines.
- Fig. 5. Upper view of mandible of *Aphanapteryx* (ex 'Ibis,' &c.).
- Fig. 6. Upper view of mandible.
- Fig. 7. Under view of mandible.
- Fig. 8. Hind surface of ramus of mandible.
- Fig. 9. Front view of tibia.
- Fig. 10. Side view of fibula.
- Fig. 10 *a*. Upper end of fibula.
- Fig. 12. Hind view of palatine bones.

PLATE XLII.

Aptornis otidiformis.

- Fig. 1. Pelvis, from above, or dorsal aspect.
- Fig. 2. Pelvis, from below, or ventral aspect.
- Fig. 3. Pelvis, from before, or front view of first sacral vertebra and iliac bones.

Cnemiornis calcitrans.

- Fig. 4. Front view of mutilated first sacral vertebra and iliac bones.

Notornis mantellii.

- Fig. 5. Fore part of sacrum and iliac bones, from below.
- Fig. 6. Front view of first sacral vertebra and iliac bones.

PLATE XLIII.

Aptornis otidiformis.

- Fig. 1. Side view of pelvis.
Fig. 2. Side view of neural spine of first sacral vertebra.
Fig. 3. Side view of middle sacral vertebræ.
Fig. 4. Section of fourth sacral vertebra and confluent parts of iliac bones.

Aptornis defossor.

- Fig. 5. Outside view of right femur.
Fig. 6. Back view of proximal end of right femur.
Fig. 7. Distal articular surface of right femur.
Fig. 8. Proximal articular surface of tibia.

Notornis mantellii.

- Fig. 9. Side view of anterior portion of pelvis.

PLATE XLIV.

Aptornis defossor.

- Fig. 1. Metatarsus, front view.
Fig. 2. Metatarsus, back view.
Fig. 3. Metatarsus, outer side view.
Fig. 4. Proximal end of metatarsus.
Fig. 1 *a*. Distal end of metatarsus.

Aptornis otidiformis.

- Fig. 5. Distal end of metatarsus.
Fig. 6. Metatarsus, front view.

Dinornis curtus.

- Fig. 7. Metatarsus, small var. : front view.
Fig. 8. Metatarsus, normal size : front view.
Fig. 9. Metatarsus, id. : proximal end.
Fig. 10. Metatarsus, id. : distal end.

All the figures are of the natural size. The letters and numerals of reference are explained in the text.

From nat. on stone by J. Exleben.

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1. 5. APTORNIS DEFOSSOR. 6. APTORNIS OTIDIFORMIS, 7. 10. DINORNIS CURTUS.