MEMOIR

ON THE

GENUS APTORNIS,

WITH A

DESCRIPTION OF THE STERNUM OF

PALAPTERYX AND NOTORNIS,

AND A

RESTORATION OF THE FEET OF

DINORNIS AND PALAPTERYX.

Femur and Tarsometatarsus of Aptornis.

In the Memoir on the genus *Dinornis*, pp. 73, 83, I described and figured (Pl. XXV. & XXVI. fig. 5) a tibia obtained by the Very Rev. Archdeacon Williams from a fluviatile deposit in the North Island of New Zealand, and referred it provisionally to a species of that genus under the name of *Dinornis otidiformis*¹. In the subsequent Memoir on the genus *Notornis*, I determined the tarso-metatarsal bone which articulated with that tibia, and pointed out some characters of the tarso-metatarsal bone which indicated the generic distinction of the bird to which it belonged, from the *Dinornis*, and accordingly I proposed for it the name of *Aptornis* (p. 153). In the present Memoir I propose to give the details of the characteristics of the tarso-metatarsal bone of the *Aptornis otidiformis* (Pl. L. figs. 5–8), and to advance the knowledge of the characters of the bones of the leg of this genus and species by a description and figures of the femur (Pl. L. figs. 3 & 4).

The femur of the *Aptornis*, which measures six inches three lines in length, has a straight, strong, subcylindrical shaft, with which the short and thick neck supporting the head stands inwards at right angles. The head is impressed by a large pit for the

"ligamentum teres." The great trochanter rises above the level of the smooth upper surface continued to it from the head: there is a well-marked ridge which extends from the inner and back part of the shaft of the bone to the upper and back part of the inner condyle; in this character it resembles the femur of the Apteryx, as well as in its relative length to the tibia. The inner condyle reaches downwards nearly as far as the outer condyle. The fibular fossa, outside the outer condyle, is well-marked: above it is a deep and rough depression. The fore part of both condyles is more prominent than in the femora of Dinornis. There is no pneumatic foramen: the compact wall of the shaft of the femur is between one and two lines in thickness. As compared with the femur of the Bustard, that of the Aptornis is thicker in proportion to its length, and longer in proportion to the tibia; and the ridge extending in the Bustard’s femur from the middle of the back part of the shaft towards the outer condyle, is not present in that of the Aptornis.

The tarso-metatarsal of the Aptornis otidiformis (Pl. L, figs. 5–8) measures three inches ten lines in length; its proportions in comparison with the tibia and femur resembling those of the Apteryx. The ecto- and ento-condylloid cavities at the proximal end of the bone (fig. 6) are deeper than in Palapteryx or Dinornis, are more equal in size, and are more widely separated by the intercondylloid tract and eminence: these modifications accord with those of the distal end of the tibia figured in Pl. XXV, fig. 6. The intercondylloid eminence is obtuse and relatively higher than in Dinornis or Palapteryx. The calcaneal processes project further back and blend together in a smooth convex plate behind, converting the groove for the flexor tendons into a foramen which is remarkable for its width: its shape is shown in Pl. L, figs. 5 & 6. Figure 7 shows another character of the calcaneal prominence by which the Aptornis differs from the Dinornis and Palapteryx, viz. in the absence of the buttress-like support formed in those genera by the posteriorly projecting shaft of the mesometatarsal element. The back part of the shaft is even and almost flat, the surface being broken only by one or two narrow intermuscular or intertendinous ridges: just below the best-developed ridge near the inner side of the bone, is the large and well-marked surface for the attachment of the metatarsal bone of the hallux, 1. The anterior surface of the tarso-metatarsal is convex transversely, slightly concave lengthwise: the distal end of the bone is so equally expanded, that both the inner and outer sides show a nearly equal degree of concavity. A short groove on the outer third of the fore part of the bone leads to the canal which pierces the confluent parts of the outer and middle metatarsals, two lines above the space between the two condyles of those bones: this canal answers to that which in the Notornis, Didus, Diomedea and many other birds, transmits the tendon of the adductor muscle of the fourth toe (iv). The relative size and position of the condyles of the three coalesced metatarsals are shown in figs. 5 & 8. The middle one advances further in front of the others than in the Apteryx, Palapteryx and Dinornis: each condyle is impressed by a well-marked median groove.
Restoration of the Feet of Dinornis and Palapteryx.

In the previous memoirs of the present Work, the remains of the wingless birds of New Zealand, consisting of the cranium and the bony beak\(^1\), of the vertebrae and pelvis\(^2\), of the sternum\(^3\), and the principal bones of the leg\(^4\), have been determined, described, and referred for the most part to different species of Dinornis and Palapteryx; the rest belonging to the genera Aptornis and Notornis, the species of which, though they would be called large in comparison with the majority of the actual class of birds, dwindle into insignificance by the side of their stupendous contemporaries.

There chiefly remained to complete our knowledge of the osteology of these apparently extinct forms of the feathered class, the complete restoration of the feet: and when the number of different bones which compose this part of the skeleton of the bird is called to mind, the slight though definite modifications of form that distinguish them, and the chances against the discovery of such comparatively small bones, it will not be matter of surprise that the foot should have been the last of the segments of the limbs to be so reconstructed.

With each successive collection of the remains of the great terrestrial birds of New Zealand, since the arrival, in 1843, of that first transmitted by the Very Rev. William Williams\(^5\), more or fewer toe-bones have, nevertheless, been associated; and, as their numbers increased, their determination became facilitated. Already in the partial restoration of the Dinornis giganteus in pl. 30 of my memoir in the 3rd Volume of the Zoological Transactions, in 1843, I had ventured to sketch the probable proportions and disposition of the phalanges in each of the three anterior toes, guided by the analogy of the Apteryx, in building up that part on the basis of the few specimens of phalanges that then suggested the probability of such analogy being correct.

Each successive acquisition of additional phalanges has tended to support my original supposition of the general resemblance of the foot of the Dinornis to that of the Apteryx: and the rich acquisition of remains from Waikawaite in the Middle Island, transmitted, in 1849, by the late Col. Wakefield, has enabled me to recompose the entire skeleton of the foot of three species of Dinornis and Palapteryx, the largest appertaining to that great bird which I had indicated in my memoir in the 3rd Volume of the Zoological Transactions, in 1846, p. 327, as probably being 'a well-marked variety' of the Dinornis giganteus.

No specimens precisely corresponding with the characteristic femur, tibia and metatarsal of the Dinornis giganteus have, as yet, been transmitted from the Middle Island: the homologous bones of similar size from Waikawaite present more robust proportions; and this difference is not only well-marked in the metatarsal of the entire foot figured in Plate XLIX, but is accompanied by a well-marked articular rough depression for the

\(^1\) pp. 116, 118.  \(^2\) pp. 91, 97, 121.  \(^3\) pp. 124, 190.  \(^4\) pp. 78-90, 127-137.  \(^5\) Trans. Zool. Soc. vol. iii. p. 237.
ligamentous attachment of the rudimentary metatarsal of the back-toe (hallux), and also by that characteristic bone of the genus *Palapteryx* (fig. 1, i).

The general differences in the proportions of thickness to length will be appreciated by comparing the metatarsal of *Palapteryx robustus*, fig. 1, in Pl. XLIX., with the metatarsal of *Dinornis giganteus*, Pl. XXVII. fig. 1.

The subject of Pl. XLIX., which was obtained, like most of the bones transmitted by Col. Wakefield, from the recent vegetable deposits at the mouth of the Waikawaite, is in a much better state of preservation than the bones obtained from the more ancient beds of the actual rivers in the North Island, described by the Very Rev. Archdeacon Williams, in the letter quoted at p. 75. The relative age of the present North and Middle Islands of New Zealand, the question of their original union and of the period of their separation—in short, all the geological and geographical deductions from the evidence of their organized fossils—depend for their true solution upon a rigorous comparison and exact determination of those fossils.

The principal dimensions and general form of the tarso-metatarsal bone of the *Palapteryx robustus* are given in Pl. XLIX. fig. 1, where the anterior surface is represented of the natural size; other dimensions are recorded in the text. The compound nature of this bone in birds generally is described at p. 78, and I may here premise that I have applied to the principal elements the names of 'entometatarse' (ii), 'mesometatarse' (iii), and 'ectometatarse' (iv) respectively, for the convenience of description.

The shaft in *Palapteryx robustus* is subtriedral in its upper two-thirds, subcompressed from before backwards in its lower third, of equal breadth in its middle fourth, and thence expands to both extremities, but more to the inner than the outer side, and in a greater degree at the lower end; so that the inner margin is more concave than the outer one. This difference is not so great in the *Dinornis giganteus*, in which, also, the shaft continues gradually to diminish in breadth towards its lower third.

The proximal articular surface of the metatarsal of the *Palapteryx robustus* is divided, as usual, into two concavities, that for the inner condyle of the tibia being the largest and deepest: it is of a triangular form bounded internally by a well-defined edge which extends in a nearly straight line from the anterior internal angle to the posterior angle of the concavity: the anterior external angle is formed by the prominent fore part of the intercondyloid protuberance. The more shallow concavity for the outer condyle is subcircular, its outer boundary being convex and most raised at its middle part; posteriorly the border subsides and the concavity passes into a convexity at that part. The non-articular surface of the proximal end is chiefly behind the concavities and extends upon the upper part of the calcaneal processes: these are, as usual, three in number, the internal and middle ones being most prominent: they are obtusely rounded, and separated by the deep and wide groove for the flexor tendons of the toes: the longitudinal extent of the inner process (the entocalcaneal one, fig. 2, c e) measures one
inch and a half: its obtuse and thick upper end commences behind and half an inch below the posterior border of the entocondyloid cavity: the process gradually contracts to a point at its lower end, which overhangs the smooth groove continued obliquely downwards and outwards to the foramen formed by the persistent remnant of the interosseous space between the inner (II) and middle (III) metatarsal elements of the compound metatarsal.

The mesocalcaneal process (fig. 2, c m) is the largest of the three: it is broad and rounded about, slightly grooved down its posterior surface, and supported by the rough posteriorly projecting buttress-like part of the mesometatarsal, of which it seems to form the obtuse summit.

The ectocalcaneal process is the smallest: it is separated by a shallow open groove from the mesocalcaneal process: it begins to project half an inch below the posterior convexity of the entocondyloid surface: its lower part subsides before it reaches the foramen between the ecto- and meso-metatarsal. The interval between the two interosseous foramina, which gives the breadth of the mesometatarsal at that point, is greater in the Palapteryx robustus than in the Dinornis giganteus, notwithstanding the greater length of the bone in the latter species.

The anterior intercondyloid protuberance sends a short obtuse ridge downwards and slightly outwards upon the fore part of the upper end of the tarso-metatarsal. A large low rough protuberance projects forwards and outwards below the antero-internal angle of the entocondyloid surface; between this protuberance and the opposite angle the anterior surface is gently concave from side to side: the fossa between the proximal ends of the ento- and ecto-metatarsals commences two inches below the intercondyloid eminence: it is a vertical elongated ellipse, bounded behind by the mesometatarsal, and below by the rough depression and protuberance, for the insertion of the Tibialis anticus. Below this protuberance a broad and very shallow depression extends to near the middle of the shaft, where it is filled up by the advance of the mesometatarsal towards the anterior surface of the bone, where it forms a longitudinal prominence, which increases in breadth as it approaches the condyle of the same element: a shallow and longitudinal groove extends on each side of this median eminence to the interspaces between the middle and the lateral condyles. There is no perforation in either of the grooves leading to these interspaces.

The back part of the upper two-thirds of the shaft of the mesometatarsal forms a buttress-like prominence extending from the mesocalcaneal process down to the lower third of the common shaft; the upper third of this process is very rugged; the rest is comparatively smooth: the borders of the back part of the common shaft are roughened for the attachment of the strong fascia that bound down the tendons traversing that aspect of the shaft: the rough tract on the inner side terminates in the rough oval depression for the attachment of the rudimental metatarsal of the hallux: from the lower border of this depression to the division between the inner and middle condyle measures
two inches eight lines; the relative position of the depression being the same as in the Apteryx.

The distal trochlear or condyloid extremities of the three coalesced metatarsals terminate at different distances from the proximal ends of the bones, the outer one being the shortest—not the inner one, as in the Apteryx; and the middle one, as in most birds, being the longest and the most prominent one anteriorly. The inner trochlea (11) presents a depression on its inner surface and another on its under surface, from which a shallow channel is continued a little way backwards upon the back part of the condyle and forwards upon the broad anterior convex articular surface: this surface slopes obliquely from the outer to the inner margin of the trochlea: the inner part of the hinder surface of the trochlea is the most produced: the outer surface of the condyle presents a wide and deep depression.

The articular surface of the middle trochlea is narrowest at its posterior commencement, gradually expands to its lower and fore part, and contracts, but in a less degree, to its anterior boundary: it describes three-fourths of a circle, and is grooved along its middle, the groove widening towards the posterior part of the bone. The outer portion of the posterior boundary projects from the level of the short stem of the condyle: the anterior boundary rises very gradually but somewhat obliquely from the level of the stem: the sides of the condyle are widely and deeply excavated for the lateral ligaments.

The outer trochlea (iv) has a deep and rough depression on its narrow outer side, and a wider depression on the side next the middle condyle; but it is not impressed on its under surface. The articular surface slopes from the inner to the outer side; it is moderately convex, with a faint median channel at its under part. The fore part of the stem of this condyle presents a transverse groove between two transverse ridges. The outer and hinder border of the trochlea is produced backwards. The rudimental metatarsal of the hallux is figured of its natural size at fig. 1, and in figs 4 and 5, Pl. XLIX: it is of a rhomboidal form, is subcompressed, with its lower end enlarged and convex for articulation with the proximal phalanx of the hallux. The opposite end of the bone is obliquely truncate and roughened for the attachment of the ligaments which connected it with the similarly rough articular depression on the entometaatarsal (11). The outer and anterior surface is slightly convex; the inner and posterior surface is concave lengthwise: the bone is slightly twisted upon itself, this character being best shown by the direction of the inner and longer border of the bone. It is longer in proportion to its breadth than in the Apteryx, and it doubtless supported, as in that genus, a small proximal phalanx terminated by an ungual one: the convex articular surface is impressed by a shallow longitudinal groove, indicative of a trochlear articulation with the phalanx.

The phalanges of the three anterior toes are present in the same progressively increasing number in the Palapteryx as in birds generally. The proximal phalanx (11, 1) of the second toe is distinguished from that of the third (middle) toe by the unsym-
metrical form of the proximal articulation, and from that of the fourth (outer) toe by its greater length in proportion to its thickness. The form of the proximal articular surface is given in fig. 3, at II. 1: the outer half of the surface is most extended from before backwards, and its posterior rounded angle is produced, and divided by a groove from the corresponding part of the inner part of the joint. The under surface of the phalanx presents a rough tuberosity near each of these angles, and the inner surface of the inner angle is impressed with a pit for the insertion of the lateral ligament: the under surface of the middle of the phalanx is flattened: the section of the bone at that part would give almost a semicircle with the angles rounded off; but the inner side of the upper convex part of the phalanx is rather more extended and sloping than the outer one. The distal articulation is a convex trochlea describing rather more than a semicircle in the vertical direction, and divided by a wide and deep median channel: the inner moiety of the trochlea is rather the most produced: on each side of the distal end of the phalanx there is a depression for the lateral ligament; it is deepest on the outer side.

The second phalanx of the second toe (II. 2) has its expanded proximal articular surface divided by a submedian vertical ridge into two concavities, the inner one being broader in proportion to its vertical extent than the outer one, which shows reverse proportions: the section of the middle of the shaft is subtriedral with rounded angles; the outer and inner sides converging more to the upper surface than in II. 1, and the inner surface sloping rather more than the outer one: this character distinguishes the phalanx in question from the corresponding one in the other toes (III. 2 or IV. 2). The under surface is flattened, the upper one slightly concave lengthwise. The distal trochlea, divided by the vertical wide groove, is more contracted above than in II. 1. The pits for the lateral ligaments are large and well-marked; that on the outer side is the deepest and has a tuberosity beneath it.

The third or ungual phalanx (II. 3) is three inches in length; it is figured somewhat foreshortened, being viewed as it is naturally bent in Pl. XLIX. It is a subtriedral long cone, bent slightly downwards. The proximal articular surface is shield-shaped with the base downwards; it is nearly equally divided by the vertical ridge which fits into the groove of II. 2: the under surface of the base of the phalanx presents a broad rough surface for the insertion of the flexor perforans tendon; the rest of the under surface is smooth and nearly flat transversely, slightly curved lengthwise. The lateral surfaces converge to an upper smooth convexity, which near the base of the phalanx shows the line of insertion of the expanded extensor tendon. The inner surface is most sloping and most extensive: the upper surface is smooth and convex; each side is impressed by a deep vascular groove extending half way towards the apex of the phalanx. The apex of the claw is pierced by many large vascular canals, for the issue of the vessels supplying the secreting organ of the powerful claw.

The length of the toe II, as given by the three phalanges, is seven inches and a half. The length of the proximal phalanx of the middle toe (III. 1) is four inches and a half;
the form of its proximal articular surface is shown at fig. 3, III. 1. A rough, somewhat prominent tract, of a triangular shape, extends from the lower angles of the proximal surface forwards upon the lateral and under surface of the shaft, over more than one-third of its extent; and they bound a shallow channel which impresses the middle of the under surface of that part of the bone. The section of the middle of the shaft of this phalanx yields a full transverse ellipse, a little flattened at the under part. The upper surface of the phalanx is almost straight lengthwise: there is a slight depression above the upper border of the distal trochlea. This trochlea is more equally divided, and by a less deep median groove, into the two articular convexities, than in the phalanx II. 1: there is a depression at the middle of the under border of the surface, and a deep and large ligamentous depression on each side of the distal trochlea. The second phalanx, III. 2, differs from II. 2, not only by its greater size, but by its more symmetrical form, and by the straight line in which the upper surface extends from the posterior to the anterior trochlea. The inner of the two divisions of the proximal trochlea is rather the largest, but the inequality is less than in II. 2. The distal trochlea is almost symmetrical; the under surface is more deeply notched than in II. 2: the outer of the two impressions for the lateral ligament is the deepest.

The third phalanx, III. 3, has almost a square contour, with three of the sides slightly concave, and the fourth formed by the proximal articular surface slightly produced at the middle: the section of the middle of this phalanx would be nearly a semicircle, the under surface being flat transversely: the pits for the lateral ligaments, near the distal end of the bone, are large and well-marked: the median depression of the distal trochlea is shallower than in II. 2. The proximal surface of the ungual phalanx is consequently marked by a much more feeble median vertical prominence, and it is broader and of a more symmetrical form than that of the ungual phalanx of the inner toe (II. 3); it is very little longer than that phalanx, and in other respects closely resembles it.

The proximal phalanx of the outer toe (IV. 1) is characterized by its unsymmetrical proximal surface and its great breadth in proportion to its length. The proximal articular surface is less expanded in proportion to the shaft than in II. 1. The median concavity of that surface is smaller in proportion to its peripheral convexity: the inner moiety of the surface has a much greater vertical extent than the outer one, its lower angle being produced downwards and backwards, as shown in fig. 3: a deep notch divides it from the corresponding part of the outer surface; a broad rough tract extends forwards from the lower half of the outer surface along half the extent of the shaft: the similar rough tract from the lower angle of the inner part of the proximal articulation is narrower and of less extent. The smooth under surface of the shaft is slightly concave; the upper surface is slightly concave lengthwise, convex transversely. The distal trochlea is divided by a deeper median vertical groove than in III. 1, and the inner convexity is broader, whilst the outer one is the most prominent: the inferior boundary of the distal trochlea is sharply defined and almost straight, not notched in the middle as
in III. 1 and II. 1. The second phalanx (iv. 2) is almost as broad as it is long. The inner concavity of its proximal trochlea is the broadest: the upper surface extends straight from the proximal to the distal trochlea, and it is less convex from side to side than in III. 2. The under surface is nearly flat, and presents a ridge near to and nearly parallel with the lower margin of the proximal trochlea. The large and deep pits for the lateral ligaments occupy nearly the whole of the lateral surfaces of the phalanx. The distal trochlea is proportionally broader in comparison with its vertical extent than in III. 2 or II. 2; it is less contracted above than in III. 3, and is also more deeply impressed by the median channel: the inner division is the broadest.

The third phalanx (iv. 3) viewed from above is broader than it is long; but the production backwards of the inferior border of the proximal articulation makes its extreme length rather greater than its breadth: the section through the middle of this phalanx would be nearly quadrate, the upper surface being broader and flatter than in any of the previously described phalanges. The under surface develops a ridge along the outer half of the inferior border of the proximal articulation: the inner concavity of that articulation is the broadest. The ligament-pits occupy the whole lateral surface. The distal articulation is much broader than it is deep, and the median channel is wide and shallow; the inner convexity is the broadest.

The fourth phalanx (iv. 4), besides its smaller size, is shorter above in proportion to its breadth than the preceding (iv. 3): the proximal surface is divided by a less prominent ridge, and the distal one is still more feebly impressed by the median channel.

The ungual phalanx (iv. 5) consequently may be distinguished from that of the other toes by the almost uniform concavity in the vertical direction of its articular surface. It is the smallest of the three; the outer surface is more extensive and is flatter than the inner one. In its lateral grooves and general downward curvature it agrees with the ungual phalanges of the toes III and II.

The ungual phalanges are of great strength: the base of the cone bears the same proportion to its length as in the phalanx which terminates the strongest of the two toes of the Ostrich (III. 4, fig. 7); and it exceeds that in the ungual phalanges of the Rhea and Emu: notwithstanding which, the claw phalanges of the Palapteryx show a degree of downward curvature greater than in the Ostrich or Rhea, and such as is rarely seen except in claw-bones of more slender proportions.

The breadth of the base, or articular surface of the ungual phalanx of the middle toe in the Palapteryx robustus is one inch four lines, the length of the phalanx being three inches: the same admeasurements in the ungual phalanx of the inner toe, II, give one inch three lines, and three inches, and in that of the outer toe, IV, one inch one line, and two inches four lines. These proportions, with the downward curvature of the claw-bones, indicate that the powerful claws with which they were sheathed must have been put to uses requiring great force, analogous to those for which the similarly proportioned claw-bones of the Apteryx are adapted. In this small species the power of
scratching up the soil is exercised to such a degree that it excavates a burrow for its safe habitation: in the larger allied extinct species the rasorial actions would doubtless be restricted to the acquisition of food: and the ascertained structure of the foot thus accords with and bears out the conclusions deduced from the structure of the bones of the neck and head.  

**Bones of the Foot of Palapteryx dromioides.**

Amongst the toe-bones of smaller dimensions, which from time to time were transmitted to me, I soon found homologous ones presenting different proportions; and, finally, by means of the rich accession of specimens due to the obliging exertions of Col. Wakefield, I have been enabled to recompose the entire feet of two species characterized by those different proportions of the phalanges. One of these feet is represented in **Pl. L.**, the other in **Pl. LI.**

As the coalesced metatarsals might be expected to manifest the same general proportions as the toes they sustained, I have referred the more slender phalanges to the *Palapteryx dromioides*, and the more robust ones to the *Dinornis rheides*, the articular condyles of the metatarsi of these species bearing the closest correspondence with the joints of the proximal phalanges to which they have been respectively adjusted in the specimens represented of the natural size in Plates **L.** & **LI.**

The metatarsal of the *Palapteryx dromioides* shows the articular depression for the small back-toe: but the bones of this toe have not yet reached me. The proximal phalanx of the inner or second toe, **Pl. LI.**, ii. 1, has the contour of the proximal articulation cordiform, the apex being superior, the notched base below: it is more concave than in the *Palapteryx robustus*, and the inner and lower angle is as much produced as the outer one. A well-marked rough surface extends from each of these angles forwards upon the under and outer surfaces of the bone. The vertical channel dividing the distal trochlea is deeper than in the *Palapteryx robustus*, especially at its upper part: the more gradual slope from the upper to the inner side of the bone, as contrasted with the more vertical outer side, is better marked than in the *Palapteryx robustus*. The inner depression at the distal end for the lateral ligament is deeper than the outer one. The second phalanx is characterized by the deep lateral cavities and the prominent median vertical ridge forming the proximal articulation, which is also more nearly symmetrical than in the *Palapteryx robustus*; the inner division is, nevertheless, the broadest. The distal articular surface extends further back upon both the upper and under surfaces of the bone. The ungual phalanx (ii. 3) shows the same unsymmetrical character, produced by the more sloping inner side and the more vertical outer side, as the proximal phalanx (ii. 1) does: the inner side terminates below in a ridge; the outer one is rounded off into the under surface: this is protuberant near the lateral vascular grooves, which are well-marked. The length and slenderness of the ungual phalanx contrast better with the proportions of the same bone in *Palapteryx robustus*, than do those of the preceding phalanges.

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1 pp. 107, 180.
The proximal phalanx of the middle toe (III. 1) shows well the characters of length and slenderness: its proximal articulation differs from that in the Palapteryx ingens by the absence of any median vertical ridge: it is a single shallow concavity, a little deepened towards the upper part: each angle between the under and lateral surfaces, at the proximal expanded end of the bone, supports a rough triangular prominent surface: the distal trochlea repeats the same character of the deep median cleft as in the phalanx II. 1, but the divisions are more symmetrical: the articular surfaces extend further upon the upper and under surfaces of the bone than in the Pal. robustus. The second phalanx (III. 2) has its proximal articulation divided and adjusted by the development of the median prominence to the deeply cleft trochlea of the preceding phalanx: its distal trochlea repeats the deep-cleft character. In the third phalanx (III. 3) the distal trochlea is much less deeply cleft: and the articular surface of the ungual phalanx is correspondingly simplified. This claw-bone (III. 4) repeats the long and slender proportions of that of the second toe: the lower border of each lateral groove is notched, which gives a character something like that shown in the corresponding phalanx of the Ostrich (III. 4, Pl. XLIX, fig. 7).

The proximal phalanx of the outer toe (IV. 1) is shorter and broader in proportion to III. 1 and II. 1 than in the Palapteryx robustus: its proximal articulation is more extended transversely, is less notched below and less concave: the inner half has the greater vertical extent, its lower angle being produced downwards: the shaft is depressed and slopes away towards the outer side: the distal trochlea is less deeply cleft than in III. 1 or II. 1.

The second (IV. 2), the third (IV. 3) and the fourth (IV. 4) phalanges repeat the characters of their homologues in the Palapteryx robustus, in regard to their shortness and breadth, and the flattening of their upper surface: the under border of the proximal joint of one phalanx underlaps the trochlea of the preceding phalanx, and the distal joint of the fourth phalanx is divided by the median groove to which a median ridge on the proximal joint of the last phalanx is adapted.

The extent of the articular surfaces of all the joints of the toes of the Palapteryx dromioides shows a corresponding freedom and extent of motion of those toes.

**Bones of the Foot of Dinornis rheïdes.**

The bones of the foot restored and figured in Pl. L, fig. 1, accord by their proportions with the tarso-metatarsal of the Dinornis rheïdes, the distal trochleæ of which are quite adapted to the proximal joints of the proximal phalanges.

The tarso-metatarsal of the Dinornis rheïdes differs from that of the Palapteryx robustus, by the absence of any rudiment of the ectocalcaneal process; by the greater elevation of the entocalcaneal process and its equality of size with the mesocalcaneal process; and by the presence of a tubercle at the middle of the inner border of the inner concavity for the tibia. There is no trace of a depression for the articulation of the back-toe.
The phalanges differ from those of the *Palapteryx dromioides*, not only by their thicker proportions, as shown in **Pl. L.**, fig. 1, but by the less deep divisions of the trochlear surfaces. In the short cuboidal phalanges, 3 and 4, of the outer toe (iv), the distal trochlea presents an almost uniform convexity: and the ungual phalanx of this toe is distinguished from that of the other toes by the uniform concavity of its proximal surface. The greater strength of the toes of the *Dinornis casuarinus* accords with the superior thickness of the tarso-metatarsae, compared with that bone in the *Palapteryx dromioides*; and a corresponding difference in the habits of the two birds may be inferred from these differences in the structure of the feet.

**Sternum of Palapteryx and Notornis.**

The most simple form of sternum in the class of *Birds* is that which is presented by the terrestrial species deprived of the power of flight, in which, however, the size and especially the breadth of the bone surpass those of the sternum of any of the terrestrial mammals, and relate to the peculiar mode of respiration in the class of Birds. The mechanical part of this function is effected by alternately bringing the sternum nearer to the back and pushing it farther from it; these movements of elevation and depression being performed chiefly upon the synovial joints between the sternal and vertebral ribs; by these movements the large air-cells interposed between the concave surface of the sternum and the lungs, which lungs are fixed in intercostal cavities at the back of the thorax, are alternately expanded and contracted, receiving the air in expansion from the orifices on the sternal aspect of the lungs, and expelling it on contraction through the same apertures back into the lungs; or, if, as is commonly the case, other air-cells be developed beyond the sternum, into those extrasternal cells. The suprasternal or thoracic air-cells being those which are most essential to this mode of respiration, are constantly developed in Birds, and are present in the *Apteryx*¹, where no other extra-pulmonary air-cells exist; in which bird accordingly we find the sternum of greater relative breadth² than in any Mammalian animal, notwithstanding the wings are reduced to mere rudiments; the primary and essential relations of the sternum being to the ornithic mode of respiration above described. The other modifications of the sternum in Birds relate to the functions and actions of the anterior extremities. The great extent, however, of its diversity of shape and proportion has not, as yet, been fully or satisfactorily explained on the principle of final causes; but they are characteristic, to a certain degree, of natural groups, and are useful as accessory guides to the natural arrangement and affinities of the class.

The relation of particular forms of sternum to particular genera of Birds is illustrated by those which characterize the different genera of the Struthious family, in which the secondary modifications are superinduced upon a common family type of the bone exemplified by its resemblance to a buckler and the total absence of the keel. They are

¹ Zool. Trans. vol. ii. p. 278. pl. 51. fig. 4. ² *Ib.* vol. iii. p. 318. pl. 43. fig. 8.