

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 unguis 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-metatarsus, 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.

so constant and well-marked, that the Comparative Osteologist, who had had the opportunity of comparing them, would afterwards readily distinguish the genera *Struthio*, *Rhea*, *Casuarius* and *Dromaius*, by the sternum alone. That bone in the *Apteryx* is still more characteristic of the genus, and it is to this particular modification of the keel-less sternum that the sternum of one or both genera of the gigantic wingless birds of New Zealand makes the nearest approach. This is exemplified in the attempted restoration of the sternum of a large species¹ referred to *Dinornis* prior to the reception of the evidence afforded by the cranium and beak of two genera of large wingless birds in New Zealand. That sternum may, however, belong to the *Palapteryx robustus*: it was obtained, it will be remembered, from the same deposit at Waikawaite in the Middle Island, from which the most abundant and instructive evidences of that species have been had. The restoration was unavoidably imperfect, as regards especially the form and extent of the anterior or costal angles (*a*, Pl. XXXV.), but was sufficiently established to illustrate the nearer resemblance of the sternum in form to that of the *Apteryx* than to that of any of the larger existing Struthious birds.

A much more perfect specimen of the sternum (Pl. XLVIII. figs. 1–4) of a smaller species of the great wingless birds of New Zealand confirms the general accuracy of the restoration attempted in the Memoir on the *Palapteryx* (p. 124), and affords additional illustration of a near affinity to the *Apteryx*. For this reason I refer the sternum in question to the genus *Palapteryx*. Like that of the *Apteryx*, this sternum is remarkable for its shortness in comparison with its breadth, and for the breadth and depth of the two posterior notches. The chief difference is presented by the anterior border, which extends in almost a straight line from one costal angle to the other. These angles are produced into short, broad, subcompressed processes, rounded and thick at their free and expanded ends, and slightly twisted upon their neck, or point of attachment. Only three articular surfaces for sternal ribs are indicated (fig. 3), the intervening fossæ being very shallow; and the whole extent of the costal border is shorter than in the *Apteryx*, and resembles in this respect that in the Gallinæ, Pigeons, and Penguins. The coracoid fossæ are small and unusually shallow; there is a large depression on each side of the fore part of the concave surface of the sternum nearly opposite the coracoid fossæ, the bottom of which is cribriform; numerous small foramina having apparently conducted air from the anterior thoracic cells into the sternum. That bone in the *Apteryx* shows no trace of such depressions. The bone, which is cellular at the thicker parts of the periphery, is very thin and compact at the middle of the body of the sternum.

The posterior border is marked by two deep and wide angular emarginations leaving a broad middle process with two very long and narrow diverging lateral ones; but the extremities of all these processes have been broken away. The chief specific distinction of the sternum in question, which is that of a mature bird, from the sternum figured in

¹ Vide *supra* p. 124. Pl. XXXV. figs. 1, 2 & 3.

Pl. XXXV., is its smaller size, and the angular form of the posterior notch, which was rounded at the bottom in the larger sternum, as in the *Apteryx*.

A distinct form of sternum, although evidently appertaining to a bird which was deprived of the power of flight, is that which is represented in Pl. XLVIII. figs. 5–8. The specimen is part of the collection obtained by Mr. W. Mantell at Waingongoro, and which was sold by Dr. Mantell to the British Museum; where, for the facilities afforded for describing and figuring the specimen, I feel indebted to the kindness and urbanity of the learned Keeper of the Department, Charles König, K.H., and of his able Assistant Mr. Waterhouse.

Its proportions would justify its reference to a bird of the size of that to which the skull¹, referred in the Memoir on *Notornis*, p. 151, to that genus, has belonged; and although its shape, so far as I at present know, is unique in the class of Birds, I conceive it to be a modification of that type which characterises the Rail and Coot tribe (*Rallidæ*). The grounds for this opinion will, perhaps, be best illustrated if I premise a description of the sternum of that existing species of the family in New Zealand, which, being incapable of flight from the shortness of its wings, I have referred to a genus called *Brachypteryx*.

The sternum of the *Brachypteryx* is almost as remarkable for its narrowness as in the *Apteryx* for its breadth. The anterior border has a deep rounded median emargination, between the projecting borders of which, and the more produced costal angles, the wide coracoid grooves are placed. The costal border occupies one-fifth of the lateral margin of the sternum and presents articulations for five sternal ribs: the narrow posterior border has a deep and moderately wide median emargination and two lateral, very narrow and very deep ones, like fissures, equalling one-third of the entire length of the sternum, the outer border of each fissure being a long slender filiform process. Two ridges commencing on the outer surface of the sternum behind the coracoid grooves, converge to support the fore part of a shallow keel which subsides before it reaches the posterior border of the sternum. The outer surface of the bone is slightly concave between the keel and the costal margins of the bone. The upper or concave surface of the sternum presents two pneumatic depressions behind the coracoid grooves.

The sternum of the *Notornis* (Pl. XLVIII. figs. 5 & 6) resembles that of the *Brachypteryx* in its elongated and narrow proportions, and in the rudiment of a keel which commences by two ridges converging from the inner ends of the coracoid grooves: but the lateral styliform appendages, and consequently the lateral fissures of the posterior part of the bone, are wholly wanting, and the intermediate part of the body of the bone is narrower, and gradually contracts to what seems to have been an obtusely pointed extremity: but this is broken in the specimen. The keel does not project so far from the surface of the bone as in the *Brachypteryx*. The coracoid grooves are more shallow, and the whole sternum, although its general form and proportions are indicative of a bird of the same

¹ Zool. Trans. iii. p. 366. pl. 56. fig. 7.

natural family as the *Brachypteryx*, shows that the wings were still less developed than in that genus¹. The costal border exhibits articulations for five sternal ribs (fig. 7) on each side, as in the *Brachypteryx*; the anterior border shows a wide and shallow concavity, not the deep narrow median notch. There are no pneumatic fossæ on the upper surface. The anterior buttresses of the keel divide the fore part of the anterior surface of the sternum into three parts, as shown in fig. 8, where the coracoid grooves are represented near the fractured anterior or costal angles of the bone.

Bones of the Leg of Notornis.

The genus *Notornis*, of the family of the *Rallidæ*, and most nearly allied to the *Porphyrio*, was established on a skull described and figured in the Memoir on that genus, pp. 151, 172, Pl. XLVII.

To the same genus I refer the femur, tibia and tarso-metatars about to be described, on account of their similar correspondence with the homologous bones in *Porphyrio*, and their proportional agreement in size with the skull of the *Notornis*.

The specimens were obtained from the North Island of New Zealand, and were transmitted by the Rev. William Cotton, M.A. The femur (Pl. LI. fig. 3) is moderately long and slightly bent with the convexity forwards, as in the *Brachypteryx*. A small head supported on a short and thick neck is impressed on its upper part by a large fossa for the 'ligamentum teres': the apex of the three-sided trochanter is bent upwards and forwards: the broad irregular convex outer surface of the trochanter extends between a concavity at the inner and fore part of the trochanter and a smaller concavity at the back part of the upper surface of the shaft. A narrow intermuscular ridge extends down the middle of the back part of the shaft to the shallow popliteal space, above the inner condyle, as in the *Brachypteryx*: the shaft is nearly cylindrical. The rotular intercondyloid surface is wide and slightly inclined inwards. The fibular notch behind the outer condyle, and the rough fossa above it, closely accord with those of the *Brachypteryx*.

The tibia (Pl. LI. fig. 4) measures seven inches ten lines in length, and like the femur is more slender in proportion to its length than in the *Aptornis*: the proximal articular surface is almost confined to the entocondyloid division, which is very slightly concave in adaptation to the almost flattened broad inferior surface of the inner condyle of the femur: the intercondyloid tuberosity is low. The epicnemial ridge rises much above it, and equals in extent the breadth of the articular surface of the tibia: it forms an angle at the fore part of the middle of the proximal end of the tibia and extends thence obliquely outwards and backwards, where it terminates by meeting at a right angle the ecto-

¹ Since the memoir in which this passage occurs was printed, the *Notornis* has been discovered alive in the Middle Island of New Zealand, and an entire skin transmitted thence by Mr. Walter Mantell, which was described and exhibited by Mr. Gould at the Meeting of the Zoological Society, November 12, 1850. The wings are too short to serve the purposes of flight, and the feathers show that downy or decomposed character common to those land birds that cannot fly.