Transactions of the Zoological Society of London.

[London] :Published for the Zoological Society of London by Academic Press
http://www.biodiversitylibrary.org/bibliography/45493

v. 7 1869/72: http://www.biodiversitylibrary.org/item/91122
Page(s): Page 513, Page 514, Page 515, Page 516, Page 517, Page 518, Page 519, Page 520, Page 521, Page 522, Page 523, Page 524, Page 525, Page 526, Text, Text, Text, Text, Text, Text

Contributed by: Natural History Museum, London
Sponsored by: Natural History Museum Library, London

This page intentionally left blank.

XV. *On the Dodo* (Part II.).—*Notes on the Articulated Skeleton of the Dodo* (Didus ineptus, *Linn.*) *in the British Museum.* *By* Professor Owen, *F.R.S.*, *F.Z.S.*, *&c.*

Read April 18th, 1871.

[Plates LXIV. to LXVI.]

Since the former communication, of January 9th, 1866, to the Society[1], in which were figured the bones of the Dodo then at my command, and, in pl. 15. fig. 1, as laid down skeleton-wise within the outline of the British Museum oil-painting of the Dodo, natural size, I have been favoured with other specimens of the osteology of that extinct bird. These, chiefly due to further transmissions by Mr. George Clarke, C.M.Z.S., from the Mauritius, justified the undertaking an articulation of the skeleton, which has accordingly been carried out ably and artistically by Mr. E. Gerard, jun.; and the specimen is now exhibited in the Ornithological Gallery of the British Museum (Pls. LXIV. and LXV.). It is not, indeed, entirely complete, there still being wanting the bones of the hand and of the tail. But one important character of the pelvis has been rectified by the acquisition of the os pubis[2], which yields an additional mark of affinity of *Didus* to *Pezophaps*[3] and the existing pigeons.

Pezophaps and *Didus* (the Solitaire and the Dodo) agree in the extent and kind of anchylosis in the dorsal region of the spine. It affects, in both, the three vertebræ preceding the last free, rib-bearing dorsal. In both species the neural spines have run together into a bony ridge, with a straight, thickened upper free border. In both the confluence of the neural arches is only interrupted by the conjugational foramina (pl. 17. figs. 1 & 5, *ff*, O.; pl. 15. fig. 51, N.), which are similar in size and shape.

My series of these coalesced vertebræ included two varieties:—one showing a feeble beginning of the hypapophysis at the fore part of the last vertebra (pl. 17. fig. 5, O.); the other a better-developed, though small, hypapophysis, but so extended as to reach, and coalesce at its extremity with, that of the antecedent vertebra, leaving a vacuity corresponding with the wider one between the first and second of the coalesced hypapophyses. In *Pezophaps* the specimen (pl. 15. fig. 51, N.) resembles the variety (pl. 17. fig. 5, O.) of *Didus*, save in the absence of any indication of hypapophysis on the third

[1] Trans. Zool. Soc. vol. vi. p. 49.

[2] I mistook that rib-like bone for one of the dorsal ribs in my former Memoir; the body of the restored rib (pl. 16. fig. 2) and the detached portion of the rib (figs. 9, 9*a*) are portions of the "pubic bones."

[3] Professor A. and Mr. E. Newton, "On the Osteology of the Solitaire, &c.," Phil. Trans. 1869, pls. 17 & 18, figs. 66, 68–70. Future references to this interesting and instructive Memoir will be made under the letter N.; those to my own Memoir, of 1866, on *Didus* by the letter O.

vertebra. And in the instructive example of the three partially anchylosed vertebræ of a young *Pezophaps* (pl. 16. fig. 60, N.) the third vertebra shows no hypapophysis[1]. In this specimen anchylosis is seen to have begun at the neural arch and spine, chiefly between the first and second vertebræ, and co-ossification of the centrums is more advanced between the first and second than between the second and third of these vertebræ.

The inference that these anchylosed vertebræ included the penultimate, antepenultimate, and the next dorsal vertebra in advance, and that only one free dorsal vertebra intervened between the coalesced mass and the sacrum, was confirmed by the specimens of *Pezophaps* (N., p. 332), as it has been by additional vertebræ of *Didus*; and the correspondence of both the extinct Mascarene species with the *Columbidæ* in this vertebral character must now be held to be well established.

One would be glad to receive the evidence of the vertebral formula which the entire skeleton of one and the same individual of *Didus* or *Pezophaps* would afford; but the discovery of such with the bones in requisite contiguity is hardly to be hoped for. The concurrence, therefore, of Messrs. A. & E. Newton, as to the number of moveable thoracic or dorsal ribs[2], with the estimate similarly formed from comparison of detached vertebræ of *Didus*[3], is welcome.

To both the Mauritian and Rodriguez extinct Ground-Doves may be referred eight pairs of dorsal ribs. For the similarity of size and proportions of some of these ribs, and of the confluent epipleural appendage, figures 5 & 7, pl. 16 (O.), may be compared with figures 63 & 64, pl. 16 (N.).

The first material discrepancy between *Didus* and *Pezophaps*, or between the descriptions of their respective osteologies here quoted, is in the number of sternal ribs.

To Messrs. Newton there appear to be only four pairs in *Pezophaps*, the last articulating with the sixth dorsal rib[4]. It is to be regretted that the mutilated lateral border of the best-preserved sternum of *Pezophaps*, one of six received by the Messrs. Newton, does not allow a certain conclusion to be arrived at as to the number of articular surfaces on the costal border.

Messrs. Newton do not entertain so much doubt on this point as I do; they write:—"A more remarkable difference is presented by the costal border in this" [their best-preserved] "specimen, which shows articular surfaces for four sternal ribs only, instead of five, which is the normal number in *Didus*; and, so far as can be determined from the broken state of the remaining specimens, there is nothing to induce the belief that they possessed more than four such surfaces"[5].

If any one will compare fig. 2, pl. 18, O., with fig. 74, pl. 18, N., he may be allowed to doubt whether the fracture following the fourth articular surface on the costal border of the least-mutilated sternum of *Pezophaps* may not have removed a fifth

[1] In other respects the last of the three anchylosed dorsal vertebræ in *Pezophaps* does "bear a great general resemblance to the same bone in *Didus*."

[2] N., p. 332. [3] O., p. 53. [4] N., p. 334. [5] N., p. 338.

narrow ridge like that (fig. 2, pl. 18, O., *c* 5) to which the fifth sternal rib articulates in *Didus*. Admitting, however, that "too much importance must not be placed on this character"[1], and cognizant of instances, like that cited by Messrs. Newton, of *five* articular surfaces on one side, and *four* on the other, yet I am unwilling to suppose that the last (in *Didus*, "sixth") sternal rib, which terminates below in a point and joins the antecedent sternal rib before attaining the sternum, had not its homologue in *Pezophaps*. I quite concur, however, with the observant and conscientious authors of the Monograph on the Solitaire that its affinity to the Dodo "is nowhere better shown than on a comparison of the sterna of the two forms"[2].

The deeper and more approximate coracoid grooves in the sternum of *Pezophaps* relate to the greater size, thickness, and breadth, especially of the sternal half and articular end of the coracoid in that extinct genus. In additional specimens of the sternum of *Didus*, the antero-median depression of the inner surface is more marked than in the subject of fig. 2, pl. 18 (O.); but in none has it perforated the bone as in fig. 74, pl. 18 (N.). Considering the peculiarity of the configuration of sternum in the Solitaire and Dodo—unlike that of any other bird known to me, as to Messrs. Newton—the degree of affinity of the two forms appears to be closer than would admit of real or intelligible generic distinction. The Solitaire is a longer-legged, more active, variety of Ground-Dove, in which the abortion of unused wings had not extended to the degree manifested by the larger, heavier, and more sluggish form.

In the articulated skeleton of the Dodo (Pls. LXIV. and LXV.) I assign twelve vertebræ to the cervical series, as in the restoration in pl. 15 of my original Memoir; and this is the estimate of the number of the cervical vertebræ in *Pezophaps* to which Messrs. Newton are led after careful comparison and analysis of the "hundred and sixty-one vertebræ" of that extinct bird in their collection[3].

In the unlikely contingency of the disinterment of the bones of any individual Dodo or Solitaire which may have lain so undisturbed as to demonstrate the precise number of vertebræ intervening between the skull and pelvis, the accuracy of our respective inductions as to the vertebral formula may be put beyond question. But should it prove that there have been one or two cervicals more or less than have been assigned to *Didus* and to *Pezophaps*, the responsibility as to the former bird will rest with the author of the Memoir of 1866, and not with the artist, as to whose figure of the skeleton of *Didunculus*, in pl. 15 of that Memoir, I must observe that there are plainly twelve cervicals given, neither more nor less, succeeded by seven dorsals, of which the three confluent ones are the fourth, fifth, and sixth, as in *Didus* and *Pezophaps*. The remark hazarded by Messrs. Newton in reference to my old, painstaking, and accurate artistic fellow-labourer Erxleben, "that the skeleton of *Didunculus* in the same plate appears to be represented as possessing fourteen cervical and seven dorsal vertebræ, being altogether two *more* than we are able to count in the very specimen, now in the

[1] N., p. 338. [2] N., p. 338. [3] N., p. 332.

Museum of the Royal College of Surgeons, which served as the subject of his pencil" (*op. cit.*, N., note, p. 332), seems to have been sent to press without due consideration.

With respect to the pelvis of *Didus*, Mr. Erxleben drew no more of the pubic bones than the specimens at that time warranted. It was at my suggestion that this portion of bone, originally detached, was brought into contact with the ischium at two points, as it is in *Didunculus*. The more perfect specimens of the long and slender pelvic hæmapophysis, since obtained and recognized, seem to show that the second junction does not take place, but that the pubis extends freely backward, with a graceful downward curve, and for an extent corresponding with the characters of the same bone in *Pezophaps*. (Compare Pls. LXIV. and LXV. of the present Memoir with fig. 70, pl. 18, N., and the restoration in dotted outlines in fig. 179, pl. 24, N.) Nevertheless a pelvis with the whole extent and entire lower border of the ischium seems still to be a desideratum in the collections of the bones of both *Didus* and *Pezophaps* which have as yet reached England. The better-preserved sacral elements of the pelvis permitted sixteen vertebræ to be counted in that extensive anchylosed mass of bone-segments. Messrs. Newton state that one specimen of pelvis of *Pezophaps*, complete in its posterior half, "has eighteen coalesced sacral vertebræ." It is to be regretted that this specimen is not figured; the subjects, at least, of figs. 66, 68, 69, & 70, in their paper, are plainly mutilated behind. The two "perfect examples" [of sacrum?] "of *Didus ineptus* show only sixteen (vertebræ), which is probably the normal number in that species." *Op. cit.* N., p. 334.

The essential characters of the pelvis show a close correspondence in *Didus* and *Pezophaps*. "The articular surface of the centrum of the last dorsal" [first 'sacral' by the character of confluence] "is in *Pezophaps* almost exactly as in *Didus*"[1]. Other pelvic correspondences are seen in the general shape and disposition of the ilia, which, however, are not developed behind in *Pezophaps* so as to give the flatness and breadth to the posterior half of the pelvis which seem to specifically characterize the Dodo. The position of the skeleton in Pl. LXV. has been selected to exemplify this peculiarity. Other particulars, especially the more essential ones, such as the length, curvature, and movable articulation of the ribs of the first sacral vertebra[2]—the confluence, shortness, and straightness of the pleurapophyses of the next three sacrals—the suppression of the rib-elements in the three succeeding vertebræ, and their reappearance in the eighth and sometimes in the ninth sacral as strong abutments against the ilia above and

[1] N., p. 334.

[2] In this, as in my former paper, I adhere to the usual characters of the sacrum afforded by coalescence. Messrs. Newton are influenced by its extent—and where it leaves the ribs free, reckon such vertebræ as "dorsal." Accordingly my "first sacral" is their "last dorsal." Anchylosis, like most of the characters of the classes of vertebræ in anthropotomy, is an artificial one, and might justify the ascription to the *Columbacei* or "*Gemitores*" of four sacrums, viz, "caudal," "pelvic," "lumbar," and "dorsal;" for the vertebræ answering to the lumbar and anterior caudals in Mammals and Reptiles are massed with the interacetabular or proper pelvic vertebræ into one extensive and complex bone.

behind the acetabula—and the indications of "prerenal," "midrenal," and "postrenal" depressions—are all correspondences with the pelvis in *Didunculus* and *Goura*, which *Pezophaps* shows in common with *Didus*.

The chief difference between *Didus* and *Pezophaps* in cranial structure is the degree in which the cancellous tissue is developed between the outer and inner "tables," the minor quantity of that tissue in *Pezophaps* leaving a flatness of the frontals above the orbits contrasting with the convexity of that part of the cranium in *Didus*. I suspect that when the part of the skull of the Solitaire may be found, supplying what is wanting in the specimens figured in figs. 149, 150, pl. 22 (N.), there will be a depression or concavity in the profile contour between the fore part of the frontals and the naso-premaxillaries, which will suggest the presence of a "frontal protuberance" differing only in degree from that so called in *Didus*. Indeed Messrs. Newton recognize the fact that "the frontals rise abruptly as in *Didus*"[1], the precise extent of the "rise" being yet to be determined in *Pezophaps*. A section of the cranium of a Solitaire, like that of the Dodo, in fig. 1, pl. 23 (O.), would, if it had been made and figured in N., have afforded ready means of judging of the degree and value of the difference in cranial structure of the two extinct Columbaceans. The orbital chambers are relatively, not absolutely, larger in the Solitaire. Taking the distance between the anterior and posterior orbital process in fig. 149, pl. 22 (N.), I find it three lines less than the same admeasurement in the skull of the Dodo in pl. 15 (O.).

In like manner I discern no essential or generic difference of character in upper or lower mandibles of *Pezophaps* and *Didus*, only such modifications of shape and proportion as may differentiate such closely allied species. With the longer proportional metatarsals of the Solitaire goes a more slender and lighter-constructed beak (fig. 179, pl. 24, N.). The authors, however, note a "remarkable variation in the size of the upper mandible in different individuals, to the extent of very nearly one half the linear dimensions between the largest and smallest specimens, of which the collection contains thirteen in all."[2] Is there an intermediate gradational series? May this difference of length of beak concur with that pointed out by Strickland in the length of leg?

Better specimens of the mandible of *Pezophaps* than had reached Messrs. Newton at the date of publication of their interesting and instructive memoir seem to be needed to solve these questions, and are indispensable for profitable comparison with that part in *Didus*. The portions of the mandibular rami described and figured in N., however, serve to show an agreement with the maxilla in the more slender and less powerful proportions. It is interesting to note that the differences in size and proportion are less in the proximal than the distal elements of the mandible.

No tympanic bone of *Didus* has yet reached me; so that I am unable to give figures of it separately, in order to compare with those of the Solitaire, figs. 163–168 in pl. 22 (N.).

[1] N., p. 347.

[2] N., p. 347.

The atrophy of wings had not proceeded so far in the extinct Ground-Dove of Rodriguez as in the larger species of the Mauritius. The constituents of the scapular arch—scapula (pl. 19, figs. 97–99, N.) and coracoid (ib. figs. 76–79)—are absolutely larger, or are relatively thicker or broader (pl. 19, figs. 132, 133) in *Pezophaps* than in *Didus*; and the same difference of proportion prevails in the humerus, radius, and ulna. The expansion of the distal end of the scapula in *Pezophaps* makes the general curve of the upper and anterior border slightly concave; in *Didus*, beyond the proximal concavity of the curve of that border, it runs straight to near the distal end, towards which it curves, convexly, as in *Pezophaps*. The absence of any example of confluence of scapula and coracoid in the rich series of specimens possessed by Messrs. Newton of these bones (thirty-six of scapula, twenty-seven of coracoid) in the bird of Rodriguez, indicates a more habitual and powerful use of the appendage of the arch than was exercised by *Didus*.

The bones of the manus of the latter bird are still unknown; the desire to obtain such is increased since the discovery that the metacarpns of *Pezophaps* has, on the radial border, a large subspherical knob resembling a tumour, and compared by its describers to a callus-like mass of diseased bone. Its repetition, however, in all the perfect specimens, its association with a similar outgrowth from the radial border of the distal end of the radius in the larger examples of that bone, supposed by Messrs. Newton to be of the male Solitaire, and the notice of the same structure in the living bird by Leguat[1], show it to be normal in *Pezophaps*, though, when fully developed, perhaps sexual. Such tumefaction of the metacarpus has not been noticed in any of the accounts or figures of the living Dodo, and it may well be one of the marks of distinction between the Solitaire and Dodo. I should not be disposed, however, to assign to the metacarpal knob a higher than specific value.

In *Didus* and *Pezophaps* the metatarsal bone presents, besides difference of proportions illustrated in a paper by Strickland[2] and in the joint work of Strickland and Melville[3], differences of structure, which I fix at a like value. As the characters afforded by the articular extremities of the metatarsal of *Pezophaps* are obscured, more or less, by the stalagmitic incrustation of the bones figured in pl. 15 of 'Dodo and its Kindred,' I believe that the subjects of Pl. LXVI. of the present paper may not be deemed superflous or be unacceptable.

The metatarsus of *Pezophaps* is represented by bones of different dimensions, but may be said to be, as Strickland recognized them to be, "large" and "small," the variations in these two categories ranging within narrow limits. The two nearly perfect specimens, a right and left, presented by Professor Newton to the British Museum, are of

[1] "The bone of their wing grows greater towards the extremity, and forms a little round mass under the feathers, as big as a musket ball." Quoted by Messrs. Newton at p. 350 of their memoir.

[2] Trans. Zool. Soc. vol. iv. p. 187, pl. 55.

[3] 'Dodo and its Kindred,' 4to, 1848, pls. 11 & 15.

the large size, and would be referred by Strickland to his *Pezophaps solitaria*. I have also had under observation three metatarsi (of the right side) of the small size, by which Strickland characterized his *Pezophaps minor*[1]. The following description is from the larger metatarsi (Pl. LXVI. figs. 1–4, fig. 13). The entocondylar cavity (*a*) is deeper and wider from before backward than the ectocondylar one (*b*); it has the same transverse diameter. The intercondylar tuberosity (*c*) rises to the height of $4\frac{1}{2}$ lines from a base 7 lines in breadth, and terminates obtusely; the fore-and-aft extent of the base occupies rather more than half that of the proximal articular surface, of which a flat triangular tract (fig. 13, *d*), 6 lines in breadth posteriorly, intervenes between the back parts of the ento- and ecto-condylar cavities; and from it is continued a tract, of a breadth of 1 or 2 lines, along the back part of the ectocondylar fossa. The obtuse low summit of the ectometatarsal ridge marks the outer termination of the rising

[1] Trans. Zool. Soc. vol. iv. p. 191. One of these specimens is alluded to by the Messrs. Newton as follows:—"In addition to these *eighteen* specimens, we are informed that in 1860 or 1861 a tibia, the shaft of a tarso-metatarsal, and some fragments of the shaft of a femur, all of which belonged to the Solitaire, were sent to Professor Owen by M. Bouton of the Museum at Mauritius; but the fate of these specimens is unknown to us." They are referred to in the following letter:—

"8 Great Ormond Street, Queen Square, W.C.,
"18th December, 1860.

"Dear Sir,—By the last 'Overland' from Mauritius I received from the Curator of the Museum of Port Louis the two fragments of bones, which he suspects to be those of the Dodo, and he is anxious to have your opinion in the matter. Under these circumstances I have taken the liberty of sending them to you just as they came to me on Saturday last. The Curator writes me: 'Je les ai trouvés dans la Collection du Muséum déposés à côté d'ossements fossiles de Tortues recueillies dans un dépôt Calcaire aux Quatre Cocos, à Flacq, à une petite distance de la mer. No. 1 me paraît se rapprocher à la figure 1, planche xv. de Strickland, et dans ce cas serait un fragment du tibia droit du Solitaire; No. 2 se rapproche de la figure 2*a* de la planche xv. de Strickland. Ce serait dans ce cas le métatarse droit auquel il manquerait une portion de l'articulation inférieure et la totalité de l'articulation supérieure .... s'ils sont ce que je les crois être, je vous prie de me les renvoyer ensuite quand ils seront examinés.'

"As my friend mentions the district of Flacq, I know that several fossil remains have been found there; and some years ago when I was in the island, I and other friends made an examination of the locality in order to find some remains of the Dodo, at the request of Mr. Strickland, who was them preparing his excellent work on the Dodo, &c.

"If, therefore, you will do me the favour to give me your opinion on the fragments I now take the liberty of sending you, such an opinion from so high an authority will set the matter at rest.

"I remain, dear Sir,
"Very truly yours,
(Signed) "James Morris."

"*Professor Owen, &c. &c.*"

The fragment of the tibia marked No. 1, included the distal articular end and part of the shaft of that bone; No. 2 was rightly recognized by M. Bouton. Both portions belonged to the *Pezophaps minor*, Str. So named, they were returned to the Museum at Port Louis, Mauritius. The first and sole evidence of Messrs. Newton's interest in these fragments reached me with their memoir. Any previous inquiry would have, at once and most readily, received the reply given in the present note. No portion of femur, and no entire tibia, were sent to me.

between the anterior and posterior parts of the so divided ectocondylar surface (fig. 13, *b*, *k*). A difference of colour and of texture indicates that the articular cartilage was not continued upon the flat triangular intercondylar facet (ib. *d*). The extreme transverse extent of the proximal articular surface is 1 inch 6 lines; the extreme fore-and-aft extent of that surface is 9 lines. In *Pezophaps minor* (ib. fig. 12) these dimensions give 1 inch 3 lines and $7\frac{1}{2}$ lines respectively.

The side of the entocondylar division of the proximal end is traversed by three longitudinal ridges. The anterior, beginning by a slight rise of the articular border, extends along the inner (tibial) side of the entometatarsal about one third of the way down; it is the "entometatarsal ridge" (fig. 4, *e*, *e*). The second ridge begins at the highest part of the entocondylar border, and subsides after a downward course of two thirds of an inch; it is the "entocondylar" ridge (*f*). The third ridge begins at the back part of the entocondylar border, makes a curve as it descends toward the inner side of the entometatarsal, but descends before attaining that side, and is continued downward two thirds of the length of that metatarsal as the "entogastrocnemial" ridge (fig. 4, *g*). The second short ridge (*f*), in some specimens, joins the third to form the entogastrocnemial ridge. The fore part of the entocondylar expansion shows two or three oblong tuberosities, in the same transverse line, the outermost of which (fig. 3, *h*) extends down as a short ridge and forms part of the inner boundary of the "anterior interosseous depression (*i*).

This, which is due to the retrogression of the head of the mesometatarsal (III), is bounded above by the part of the confluent epiphysis developing the intercondylar tuberosity (*c*); its sides are formed by the more advanced proximal ends of the ento- (II) and ecto- (IV) metatarsals, the latter bone defining that side of the fossa by a ridge or ridge-like angle continued into the "ectometatarsal ridge" (*k*), which descends inclining to the outer side of the lower part of the ectometatarsal (IV). Into the antinterosseal depression (*i*) open the two fore-and-aft canals between the upper ends of the metatarsals, that (*l*) between the ento- and meso-metatarsal being the largest; it is vertically elliptical, $3\frac{1}{2}$ lines by $2\frac{1}{2}$ lines in diameter. The canal between the meso- and ectometatarsals opens into the fossa by a vertical slit (fig. 3, *m*), two lines long and two thirds of a line wide. Below the larger foramen is a rough surface (*n*) for the insertion of the "tibialis anticus;" it does not project. The interosseous depression (*i*) gradually shallows and contracts as it descends, or as the middle metatarsal advances into line with the outer and inner ones, the boundaries being defined by low narrow antinterosseal ridges, which, midway down the shaft, diverge as they descend, the outer one (fig 3, *o*) terminating in the groove leading to the lower interosseal canal (*p*) between the meso- (III) and ecto- (IV) metatarsals. The anterior orifice of this canal (fig. 3, *p*) is vertically oblong, about $1\frac{1}{3}$ of a line in width; the posterior orifice (fig. 2, *p'*) is minute and circular. The bar or bridge of bone (ib. *q*), from the neck of the ectotrochlea (IV) to that of the mesotrochlea (III), converts the remaining interspace behind

into a vertical "adductor" canal, leading from the anterior orifice of the lower interosseal canal (*p*) to the interval between the ecto- and meso-trochleæ. The tendon of the "adductor digiti externi" traverses this canal, to be inserted into the inner side of the base of the proximal phalanx of the outer toe.

The calcaneal process (*r*, *s*) is developed from the back part of the head of the mesometatarsal (III) and the part of the proximal epiphysis confluent therewith; it is divided into ento- (*r*) and ecto- (*s*) calcaneal portions, by the tendinal canal (*t*) completed by peripheral ossification between those portions; this uniting plate of bone is impressed externally by an open shallow tendinal groove (*u*). The outer part of the ectocalcaneal process is impressed by a narrower and deeper tendinal groove. The posterior rough and flattened surface of the entocalcaneal process is elongate and contracted below; in *Pezophaps minor* (fig. 6, *r*), where alone I have seen it entire, it is 10 lines long by $3\frac{1}{2}$ lines in extreme width. The ectocalcaneal process (ib. *s*) shows a similar surface, 7 lines in length and 2 lines in breadth, in *Pez. minor*. A deep and wide elongate channel (fig. 4, *v*) intervenes between the entogastrocnemial ridge (*g*) and the calcaneal process (*r*), with its sustaining buttress formed by the back part of the mesometatarsal; into the upper part of this concavity opens the canal (*l*) between the ento- and meso-metatarsals. The smaller interosseous canal (*m*), between the meso- and ecto-metatarsals, opens into the shallower depression (fig. 1, *w*) external to the calcaneal prominence. This depression is bounded externally by the ectogastrocnemial ridge (*x*), which describes a slight curve, convex backward, as it descends to terminate on the ectotrochlear ridge (fig. 2, *z*). From the back part of the mesometarsal (fig. 2, *r'*), which projects in a subtriangular form, a narrow (postinterosseal) ridge (ib. *y*) is continued, which descends for some way outside of and parallel with the one continued down from *r'*; but at the beginning of the trochlear expanse it bends outward, and terminates in the tuberosity, or thicker ridge[1] (*z*), at the outer and hinder part of the ectotrochlea (IV). The entogastrocnemial ridge[2] (*g*) terminates at the upper border of the "hallucial surface" (I). The mid ridge or hind angle of the mesometatarsal (III) runs down along the outer side of the hallucial surface, almost subsiding, but seeming to be continued by a strong oblique ridge (fig. 2, *α*), lost upon the back part of the neck of the entotrochlea (II). A tendinal groove (fig. 2, B) extends from the upper and outer part of the oblique ridge to or near to the interspace between the ento- and meso-trochleæ.

The posttrochlear depression (fig. 2, *γ*), bounded by the oblique ridges (*α* & *z*), and

[1] This is mutilated in the specimen figured in Trans. Zool. Soc. vol. iv. pl. 55. fig. 6.

[2] The insertions of "the strong ligamentous aponeurosis" formed by the confluence of the tendons of the *gastrocnemius internus* and *gastrocnemius externus* (Trans. Zool. Soc. vol. iii. p. 294) are represented in pl. 32. fig. 2, R, and in fig. 1; also in pl. 35. R***, of that volume, in *Apteryx australis*. The ridges termed "gastrocnemial" mark the lines of insertion of this strong aponeurotic sheath for the tendons of the deeper-seated muscles, chiefly flexors of the toes.

by the backwardly produced ento- (II) and ecto- (IV) trochleæ, is shallow, but well defined.

The entotrochlea (II) is convex anteriorly, canaliculate behind, and chiefly through the production of its inner and hinder part. The ectotrochlea (IV) is less concave, almost flat, transversely, behind, its outer and hinder border being less produced and more rounded off. The depression (*i**) on the outer side of the ectotrochlea is rather deeper and better defined than that on the inner side of the entotrochlea (fig. 4, II). The outer trochlea does not extend so low down as the inner one; and the interspace between it and the mid trochlea reaches higher up, especially behind, so that the outer part of the neck of the mid trochlea (fig. 2, III) is the longest. The mid groove of that trochlea runs from the fore to the hind part, and is deepest anteriorly (fig. 3, III).

As compared with *Didus*, the entocondylar cavity (*a*) is deeper, and the margin better defined, in *Pezophaps* (figs. 12, 13). The intercondylar tubercle is higher and less obtuse in *Pezophaps*. The hind border of the entocondylar expansion extends further in *Pezophaps* than in *Didus* before passing to the inner side of the entocalcaneal process (ib. *r*). The upper border of the entocalcaneal process is thinner in *Pezophaps*. The calcaneal canal (*t*) is smaller. The tendinal groove (fig. 1, *u*) is shallower. The ectocalcaneal process (*s*) is narrower: the groove on the outer side of that process is also narrower, and is defined by a ridge not developed in *Didus*. The short ridge or process below the posterior margin of the entocondylar cavity in *Didus* (fig. 10, *j*) is more developed; it is feebly indicated in *Pezophaps*, and is continued into the ento-gastrocnemial ridge (fig. 4, *g*), which is not the case in *Didus*. *Didus* has not the entometatarsal ridge (fig. 4, *e*) anterior to the entogastrocnemial ridge (ib. *g*), but only the latter, which is strongly marked and more internal in position (fig. 16, *g*).

The postinternal depression (fig. 2, *v*) receiving the larger of the two upper inter-osseal canals (*l*) is narrower, and in *Pezophaps minor* deeper, than in *Didus*, owing to the more posterior position, in *Pezophaps*, of the entogastrocnemial ridge (*g*) defining that depression internally. The antero-superior interosseal depression (*i*) is deeper in *Pezophaps* than in *Didus*; but the insertional surface for the *tibialis anticus* (fig. 14, *n*) is better-defined in *Didus*. The anterior ectometatarsal ridge (fig. 1, *k*) is more strongly marked in *Pezophaps* than in *Didus*.

The groove leading to the lower interosseal canal is more strongly marked in *Didus* (fig. 15, *p*) than in *Pezophaps* (fig. 3, *p*), and indicates a more powerful "adductor muscle," the tendon of which emerges at the interspace between the neck of the middle and outer trochleæ, in its course to be inserted into the outer toe.

The middle trochlea (III), as compared with the outer (IV) and inner (II) trochleæ, is larger in *Pezophaps* (fig. 3) than in *Didus* (fig. 15); its relative position to the outer and inner trochleæ, and the consequent curve which they describe transversely, I find, in the specimens before me, to be the same in both extinct genera.

In order to facilitate future comparisons and the following of the above descriptions,

I subjoin the names of the parts and their symbols in Pl. LXVI. which appeared to me to call for special notice in this part of the osteology of *Didus* and *Pezophaps*.

Parts of Metatarsus.

	marked		marked
Entocondylar cavity	*a*	Adductor bridge	*q*
Ectocondylar cavity	*b*	Entocalcaneal process	*r*
Intercondylar process	*c*	Ectocalcaneal process	*s*
Intercondylar triangular tract	*d*	Calcaneal canal	*t*
Entometatarsal ridge	*e*	Calcaneal groove	*u*
Entocondylar ridge	*f*	Postinternal depression	*v*
Entogastrocnemial ridge	*g*	Postexternal depression	*w*
Entocondylar tuberosity	*h*	Ectogastrocnemial ridge	*x*
Antinterosseal depression	*i*	Postinterosseal ridge	*y*
Ectometatarsal ridge	*k*	Ectotrochlear ridge	*z*
Entinterosseal canal	*l*	Hallucial surface	I
Ectinterosseal canal	*m*	Entotrochlear ridge	*a*
Facet for "tibialis-anticus" tendon	*n*	Intertrochlear groove	β or B
Antinterosseal ridges	*o*	Posttrochlear depression	γ
Lower interosseal or "adductor" canal, anterior orifice	*p*	Ectotrochlear depression	*i**
		Entotrochlea	II
Lower interosseal or "adductor" canal, posterior orifice	*p'*	Mesotrochlea	III
		Ectotrochlea	IV

The "hallucial facet" is not higher above the entocondyle in *Pezophaps* than it is in *Didus*; the greater length of the metatarsus is due to elongation of the shaft between that surface and the subsidence of the calcaneal process.

The shorter and stronger metatarsus of *Didus* indicates more powerful actions of the foot, in reference to the greater weight of body to support—perhaps, also, to more habitual and powerful applications in scratching up the soil.

The longer and more slender metatarsus of *Pezophaps* relates, as Strickland justly observes[1], to the lighter weight and more active movements of that bird, which seems to have preserved its existence to a later period (1735) than the Dodo.

In a Memoir on the *Apteryx*, read August 14th, 1838, and printed in the second volume of the 'Zoological Transactions' (p. 257), the composition of the metatarsus is described as follows:—"The upper articular surface is formed by a single broad piece. The original separation of the bone below into three pieces is plainly indicated by two deep grooves on the anterior and posterior part of the proximal extremity; the intermediate portion of bone is very narrow anteriorly, but broad and prominent on the opposite side" (p. 293). This prominence was indicated in subsequent Memoirs as the

[1] Annals and Magazine of Nat. Hist. 2nd ser. vol. iii. 138.

"calcaneal process;" but it does not form the whole upper end or head of the middle piece or metatarsal element.

In my Memoir on *Dinornis*, part 1 (1843[1]), I entered, with a view to determine the composition and processes of the metatarsal bone, into an analysis of its development, and showed, in an immature Ostrich[2], that the head of the middle of the three normal metatarsals, which middle bone may be reckoned as that of the third digit, if the rudimental metatarsus of the back toe be viewed as the innermost or first metatarsal, projects posteriorly beyond those of the other two (second and fourth), and developes the chief and commonly sole "calcaneal process." I also showed that the mid metatarsal, in its descent toward the toes, changes its relative position to the others, coming gradually forward and developing its condyle in advance of, or in a plane somewhat anterior to, the condyles of the second (inner) and fourth (outermost) metatarsals.

Messrs. Newton, in reference to the "calcaneal process," or the "inner or longest" one in *Pezophaps*, state, "This process is now regarded[3] as the head of the third (anchylosed) metatarsal," and quote Gegenbaur as their authority. I must, however, enter my dissent from that view. The process, as its name implies, is only a part of the head of the third or mid metatarsal. The portion of the head in advance of the origin of the process is wedged between the heads of the second and fourth metatarsals, and in a greater degree in *Dinornis* (*tom. cit.* pl. 28. figs. 4 & 7) than in *Struthio* (ib. fig. 2).

In a subsequent Memoir (July 14, 1846) the upper and hinder outstanding process of the middle element of the compound bone is termed "calcaneal"[4], in reference to its functional analogy to the calcaneal fulcrum in Mammals, not to indicate homology, as Professor Gegenbaur appears to have believed. The metatarsal element to which any tarsal homology might be applicable is expressly limited to the one affording articular cavities to the tibial trochleæ, and "which seems to represent a proximal epiphysis"[5].

To the three principal elements of the shaft the following names and symbols were applied[6]:—"'entometatarse' (II), 'mesometatarse' (III), 'ectometatarse' (IV)"—the numerals referring to the toes in the type or pentadactyle foot, which the three metatarsus elements respectively bore.

The "calcaneal process" is not the "head" of the mesometatarse (III), but, as the

[1] Trans. Zool. Soc. vol. iii. p. 240.

[2] Ib. pl. 28. figs. 1 & 2.

[3] "*Cf.* Gegenbaur, Arch. für Anat. und Physiol. 1863, pp. 450–472; Untersuchungen zur vergleichenden Anatomie der Wirbelthiere (4to, Leipzig, 1864), pp. 93–108, pl. 6."

[4] "The posterior surface of the calcaneal process is broad, triangular, vertically grooved, and perforated at its base" (*loc. cit.* p. 52).

[5] Trans. Zool. Soc. vol. iii. p. 243 (1843); and see ib. vol. iv. pl. 45. fig. 2 (metatarsus of immature *Dinornis crassus*).

[6] Ib. vol. iv. p. 3 (1850).

name rightly implies, is a process from the upper and back part of that element, conjoined with a corresponding projection from the part of the common epiphysis covering the mesometatarsal.

DESCRIPTION OF THE PLATES.

PLATE LXIV.

Side view of the skeleton of the Dodo (*Didus ineptus*, Linn.), articulated and displayed in the Ornithological Gallery of the British Museum.

PLATE LXV.

Oblique back view of the same skeleton.

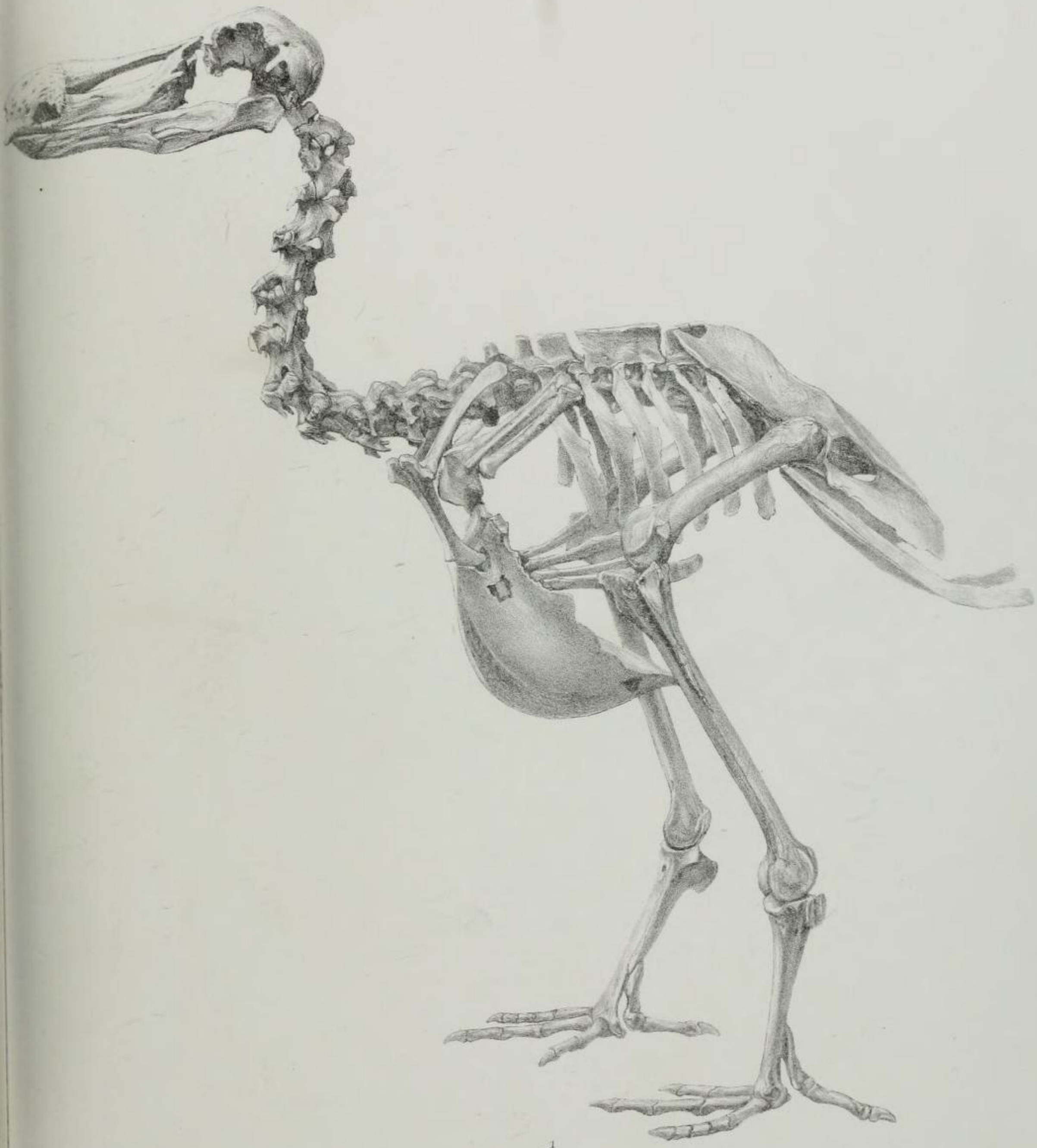
Both these Plates are taken from photographs, corrected, as to perspective and better indication of details, from the subject. The lithographs are reduced to $\frac{1}{3}$ the natural size.

PLATE LXVI.

Metatarsals of Pezophaps *and* Didus.

Fig. 1. Outer side view (*Pezophaps solitaria*, Str.).
Fig. 2. Back view (*Pezophaps solitaria*, Str.).
Fig. 3. Front view (*Pezophaps solitaria*, Str.).
Fig. 4. Inner side view (*Pezophaps solitaria*, Str.).
Fig. 5. Outer side view (*Pezophaps minor*, Str.).
Fig. 6. Back view (*Pezophaps minor*, Str.).
Fig. 7. Front view (*Pezophaps minor*, Str.).
Fig. 8. Outer side view of proximal end (*Didus ineptus*, Linn.).
Fig. 9. Outer side view of distal end (*Didus ineptus*, Linn.).
Fig. 10. Back view of proximal end (*Didus ineptus*, Linn.).
Fig. 11. Back view of distal end (*Didus ineptus*, Linn.).
Fig. 12. Proximal articular surfaces (*Pezophaps minor*, Str.).
Fig. 13. Proximal articular surfaces (*Pezophaps solitaria*, Str.).
Fig. 14. Front view of proximal end (*Didus ineptus*, Linn.).
Fig. 15. Front view of distal end (*Didus ineptus*, Linn.).
Fig. 16. Inner side view of proximal end (*Didus ineptus*, Linn.).
Fig. 17. Inner side view of distal end (*Didus ineptus*, Linn.).

All the figures are of the natural size.



$\frac{1}{3}$

On Stone by J. Erxleben.

Printed by M. & N. Hanhart.

DIDUS INEPTUS

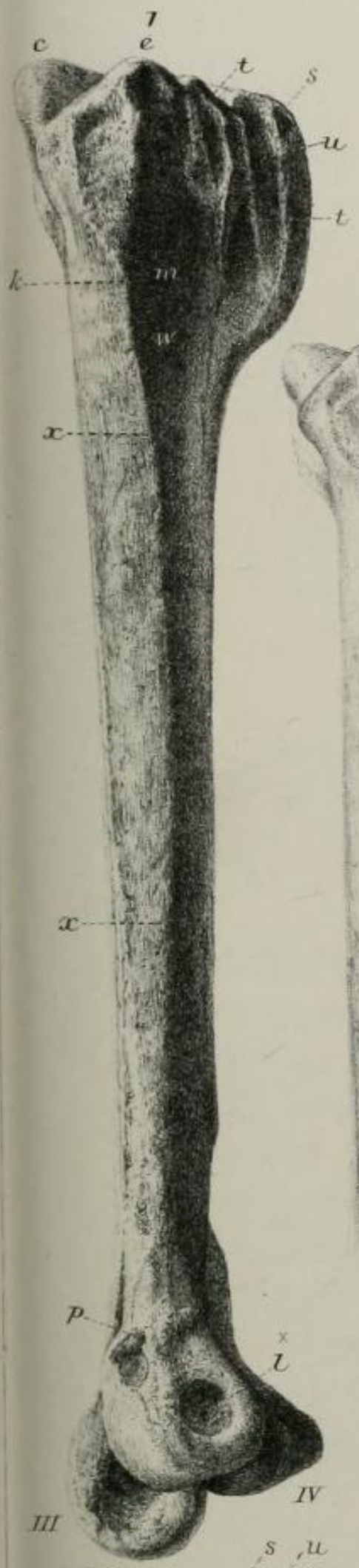
$\frac{1}{3}$

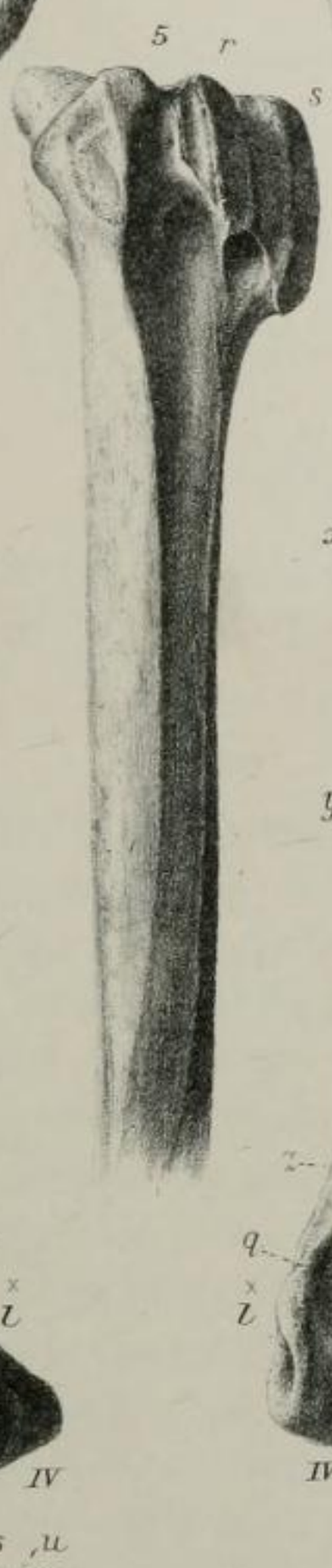
On Stone by J. Erxleben.

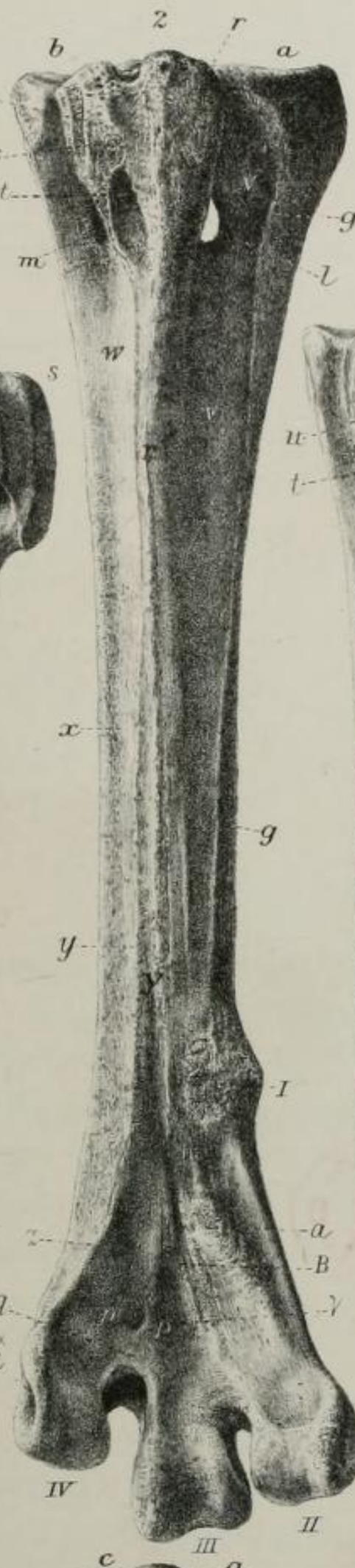
Printed by M. & N. Hanhart.

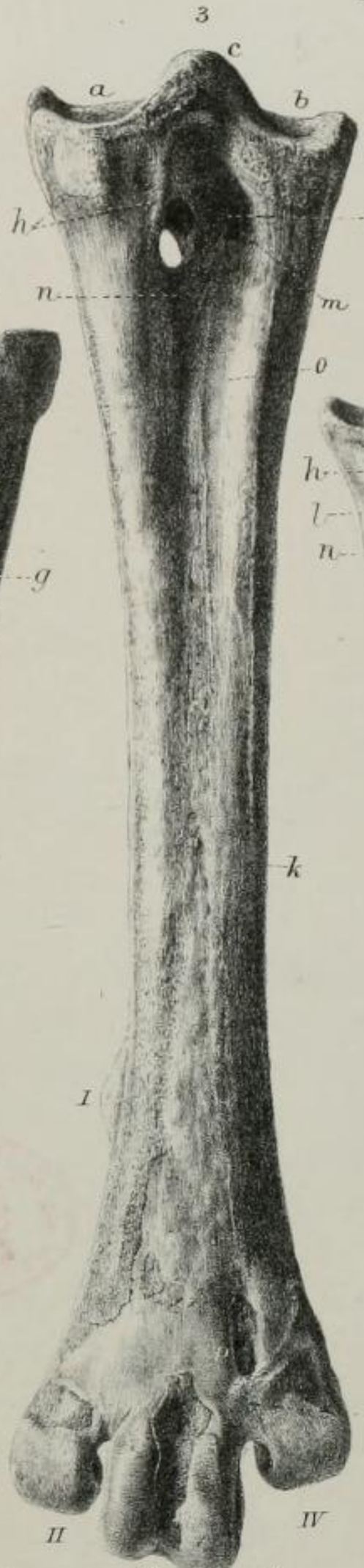
DIDUS INEPTUS.

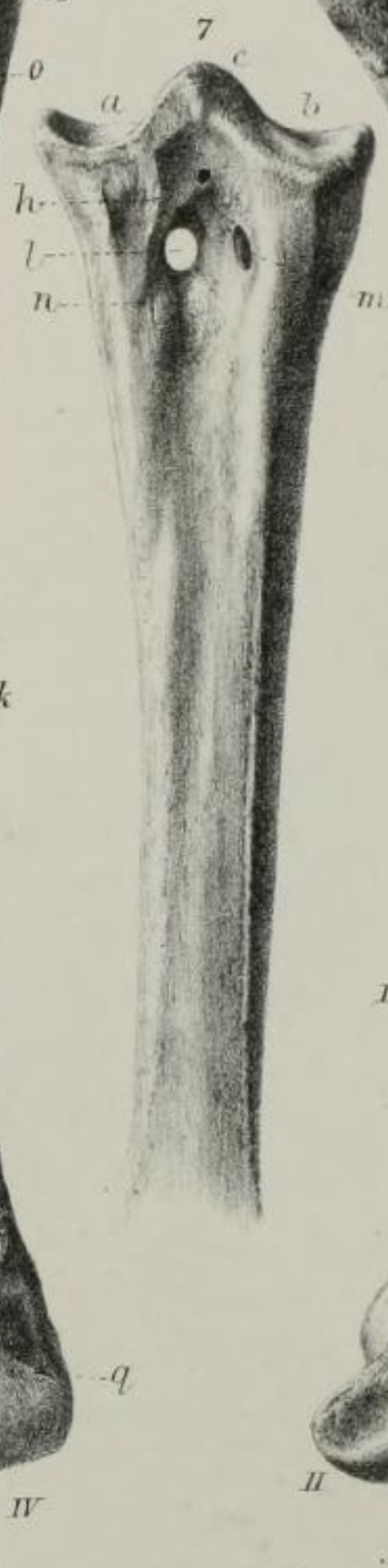
Trans Zool Soc Vol 7 Pl 66

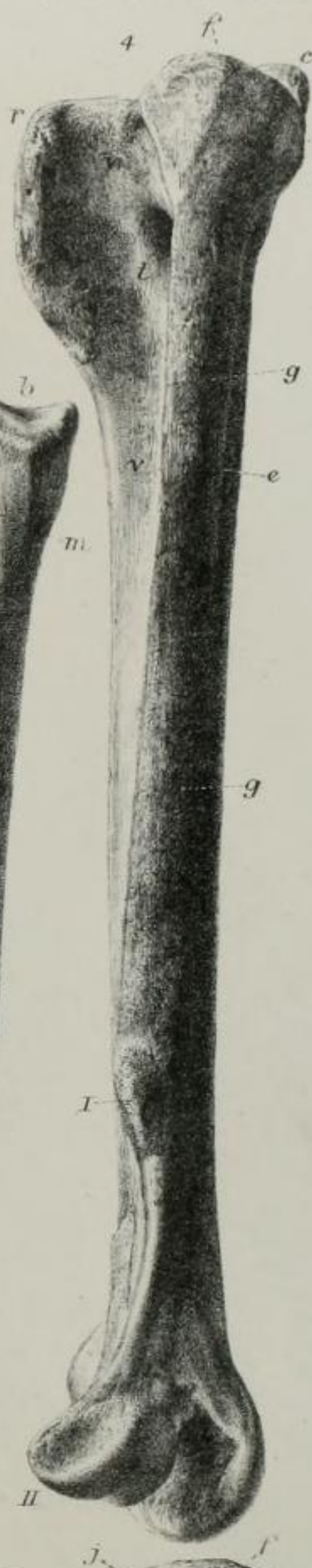


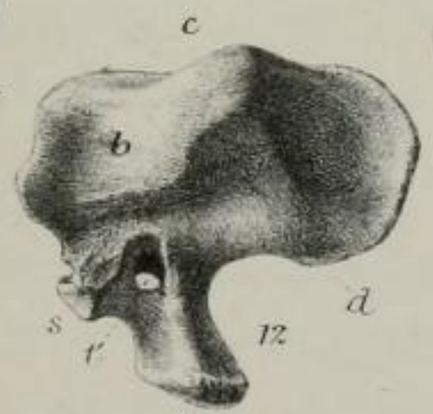


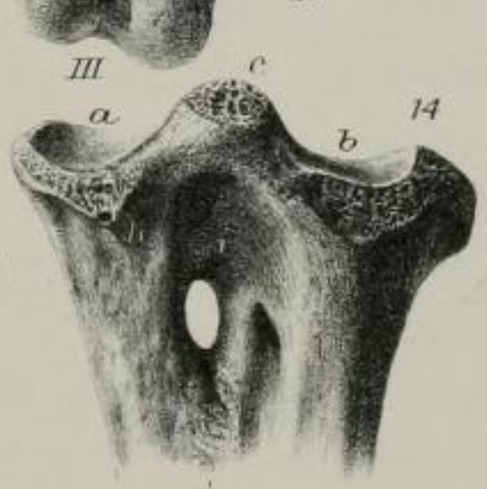


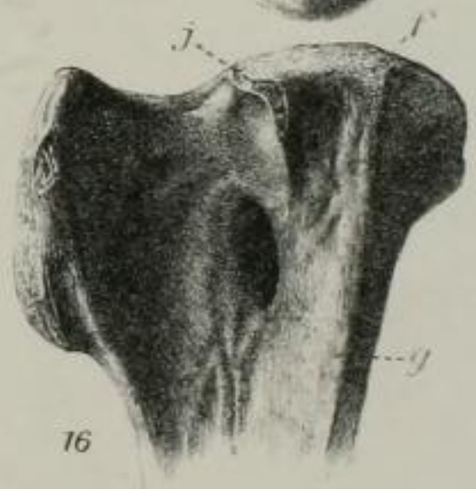












G.H.Ford.

Mintern Bro.s imp

1–4 Pezophaps solitaria. 5–6–7–12 Pezophaps minor. 8–11–14–17 Didus ineptus.