Dates of Publication.

Part I.	pp.	1 — 30.	Plates	1 — 8.	(1850.
" II.	"	31 — 74	"	9 — 25	
" III.	"	75 — 88	"	26 — 30	(1853).
" IV.	"	89 — 148	"	31 — 42	
" V.	"	149 — 182	"	43 — 53	
" VI.	"	183 — 268	"	54 — 63	
" VII.	"	269 — 352.	"	64 — 67	(1861).
" VIII.	"	353 — 366.	"	67 — 77	(1862).

TRANSACTIONS

OF

THE ZOOLOGICAL SOCIETY

OF LONDON.

VOLUME IV.

LONDON:

PRINTED FOR THE SOCIETY:

SOLD AT THEIR HOUSE IN HANOVER-SQUARE;

AND BY MESSRS. LONGMAN, GREEN, LONGMANS, AND ROBERTS, PATERNOSTER-ROW,

AND M. J. ROTHSCHILD, PARIS AND LEIPZIG.

1862.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

CONTENTS.

TRANSACTIONS

OF

THE ZOOLOGICAL SOCIETY.

I. *On* Dinornis (Part IV.): *containing the Restoration of the Feet of that genus and of* Palapteryx, *with a Description of the Sternum in* Palapteryx *and* Aptornis. *By* Professor Owen, F.R.S., F.Z.S. &c.

Read February 26th, 1850.

In previous memoirs published in the Transactions of the Zoological Society, the remains of the wingless birds of New Zealand, consisting of the cranium and the bony beak[1], of the vertebræ 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

[1] Vol. iii. p. 345. [2] *Ib.* pp. 239, 253. [3] *Ib.* p. 316. [4] *Ib.* pp. 240, 319.

Williams[1], 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 of 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 of 1846, p. 327, as probably being 'a well-marked variety' of the *Dinornis giganteus*.

No specimens precisely corresponding with the characteristic femur, tibia and metatarse 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 metatarse of the entire foot figured in Plate I., but is accompanied by a well-marked articular rough depression for the ligamentous attachment of the rudimental 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 metatarse of *Palapteryx robustus*, fig. 1, in Pl. I., with the metatarse of *Dinornis giganteus*, vol. iii. pl. 27. fig. 1.

The subject of Pl. I., 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 vol. iii. p. 237. 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, and the progress of science will be proportionally retarded by hasty and erroneous ascription of names to such fossils by those who may have neither the leisure, the opportunity, or the skill for such comparisons.

The principal dimensions and general form of the tarso-metatarsal bone of the *Palapteryx robustus* are given in Pl. I. 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 in vol. iii. p. 243, and I may here premise that

[1] Vol. iii. p. 237.

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 metatarse 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 metatarse.

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 mesometatarse, 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 ectocondyloid surface: its lower part subsides before it reaches the foramen between the ecto- and meso-metatarse. The interval between the two interosseous foramina, which gives the breadth of the mesometatarse 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-metatarse. 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 mesometatarse, 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 mesometatarse 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 mesometatarse 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 metatarse 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 (II) 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. I.: 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 entometatarse (II). 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 (II. 1) of the second toe is distinguished from that of the third (middle) toe by the unsymmetrical 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. I. 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 developes 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 Emeu: 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.

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 enlightened 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. II., the other in Pl. III.

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 II. & III.

The metatarse 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, 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.

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. I. 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.

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

The tarso-metatarse 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. III. 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-metatarse, 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.

Description of the Femur and Tarso-metatarse of the Aptornis otidiformis.

In my Memoir on the *Dinornis* of 1843[1], I described and figured 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 *Dinornis* under the name of *Dinornis otidiformis*. In a subsequent Memoir[2] read before the Zoological Society in 1848, 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*[3]. I am now enabled further 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. III. figs. 3 & 4). This bone, which measures six inches three lines in length, has a straight, strong, subcylindrical shaft, with which the short and thick neck support-

[1] Zool. Trans. iii. Part iii. p. 235. pl. 25. figs. 5 & 6; pl. 26. figs. 5 & 6. [2] *Ib.* p. 347.

[3] By syncope for "Apterygiornis," from α *priv.*, πτέρυξ *wing*, ὄρνις *bird*.

ing 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-metatarse (Pl. III. 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-condyloid cavities at the proximal end of the bone (Pl. III. fig. 6) are deeper than in *Palapteryx* or *Dinornis*, are more equal in size, and are more widely separated by the intercondyloid tract and eminence: these modifications accord with those of the distal end of the tibia figured in vol. iii. pl. 25. fig. 6. The intercondyloid 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. III. 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, I. The anterior surface of the tarso-metatarse 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*, *Diomedæa* 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.

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 my Memoir of 1848[1].

It is to this genus that I refer the femur, tibia and tarso-metatarse about to be described, on account of their similar correspondence with the same 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. II. 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. II. 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 ectocnemial ridge: this is short, and descending obliquely inwards terminates or subsides upon the prominent fore part of the tibia about an inch below its upper angle. The procnemial ridge has an equally short origin, which is oblique and parallel with the ectocnemial ridge: it is broken in the specimen under description, but from the analogy of the *Brachypteryx* probably projects far forwards: where it subsides at the inner side of the tibia there is a tuberosity, from which a low ridge extends bounding internally the fore part of the tibia as far as the canal for the extensor tendon. The fibular ridge is well-marked; it begins on the outer side of the shaft one inch below the epicnemial ridge, extends nearly two inches down the shaft, and after a smooth tract of half an inch, reappears as a rough tract of an inch and a half in extent: a low narrow ridge is continued thence to the outer side of the fossa, lodging the extensor canal. The shaft of the tibia is compressed from before backwards, is smooth and rounded on the inner

[1] Zoological Transactions, p. 366.

side which is thicker than on the outer side. The hinder and under part of the distal articular surface is convex from behind forwards, slightly concave from side to side, increasing in breadth as it extends forwards, and bounded laterally by two prominent ridges: the division of this surface into condyles is limited to its fore part, where they project forwards, are of small size, and are divided by a very wide concave interspace, immediately above which is the bony canal for the extensor tendons. The distal end of the tibia is expanded chiefly at its inner side, towards which it seems to be slightly bent.

The tarso-metatarse (Pl. II. fig. 5) a little exceeds the femur in length: its proximal condyloid cavities are small and widely separated by a large intercondyloid prominence, and a non-articular tract behind extended upon a calcaneal process: the entocondyloid cavity is as usual the deepest. The calcaneal process is simple, imperforate, and subsides eight lines below its upper end upon the back part of the mesometatarse. The concavity on the inner side of the calcaneal process is bounded internally by a ridge continued from a tuberosity behind the entocondyloid cavity about two-thirds down the shaft, below which is the well-marked oval depression for the back-toe (i). A small foramen, indicating the interosseous space between the inner and middle metatarsals, opens into the upper part of the concavity below and at the inner side of the calcaneal process. On the outer side of that process, but at a lower level, is a similar remnant of the primitive space between the middle and external metatarsals: both these foramina unite as usual into a single median foramen at the fore part of the proximal end of the bone. A deep and wide concavity occupies the upper half of the fore part of the tarso-metatarse: it is gradually filled up by the advance forwards of the middle metatarsal element, which is placed as usual rather obliquely between the outer and inner elements. A slight groove between the distal portion of the middle metatarsal and the outer one, leads to the canal for the transmission of the adductor tendon of the fourth toe. The outer and inner trochleæ are nearly of equal extent, the outer one being a little longer or lower: the middle trochlea is the longest as well as largest: it does not advance so far forwards as in the *Aptornis*: each condyle is slightly grooved.

Remains of the Apteryx.

In the fluviatile deposits and in the cavern at the base of Tongariro, in the North Island of New Zealand, bones of the *Apteryx* have been discovered so associated with those of *Dinornis*, *Palapteryx*, *Aptornis* and *Notornis*, as to lead to the conclusion that they had been buried at the same period and were of equal antiquity. Most of these remains, of which a femur (fig. 6), and a tarso-metatarse (figs. 7 & 8) are figured in Pl. II., agree in size and other characters with the corresponding parts of the existing species (*Apteryx australis*): but amongst the specimens transmitted by Governor Grey from the cavern at Tongariro there is a femur, which agrees in size with that of the smaller species of *Apteryx* figured and described by my friend Mr. Gould under the name of *Apteryx Owenii*[1].

[1] Zool. Trans. vol. iii. p. 379. pl. 57.

The shaft of the femur of the *Apteryx* is characterized by the convexity of the fore part of the shaft in the direction of its axis, which is due, not only to a slight bending of the whole shaft forwards, but to an enlargement in that direction of the middle of the fore part of the shaft: the trochanter does not rise much above the neck and head of the bone: its anterior border, which is thick and rounded, is produced: the broad outer and back part of the condyle is impressed by coarse irregular grooves and pits. Two intermuscular ridges diverge from the middle of the back part of the bone to each condyle. The fore part of the outer condyle is slightly inclined inwards. There is no 'foramen pneumaticum.'

The tarso-metatarse (figs. 7 & 8) presents the general characters of that compound bone in the *Palapteryx*: but the intercondyloid tubercle is relatively higher, and the inner border of the entocondyloid fossa is more convex: the ectocalcaneal process is also better developed and more distinct from the mesocalcaneal one: the chief tendinous groove lies, however, between this and the entocalcaneal process. The back part of the mesometatarse projects and supports, as a buttress, the mesocalcaneal process: on each side of this are the interosseous foramina which converge as they extend forwards, but open separately into the anterior fossa below the proximal end of the bone. This fossa is relatively larger and deeper than in *Palapteryx* or *Dinornis*, but is not extended so far down the bone as in *Notornis*. The rough articular depression (1, fig. 7) for the syndosmosis of the hallux is well-marked. The meso-metatarse advancing forwards at its lower half, makes a median prominence at that part of the common shaft: the groove between it and the ectometatarse is well-marked, and just before its termination it shows a small perforation from before backwards: this is the most distinctive mark between the tarso-metatarse of the *Apteryx* and that of the *Palapteryx*. The inner condyle is the least produced, the middle one the most, and in a somewhat greater degree than in the *Palapteryx*. The trochlear groove deeply impresses the whole extent of the middle condyle: it is more feebly marked on the lateral condyles, except posteriorly where the lateral border of each is produced backwards.

When the general results of the restoration of extinct species and their relations to existing species of the different continents and islands of the globe are first received, they commonly suggest the idea that the races of animals have deteriorated in respect of size. The more striking phænomena first and most strongly impress the mind; which contrasts, for example, the great Cave-Bears of Europe with the actual Brown Bear; the Megatherioids of South America with the small existing Sloths; and the gigantic Glyptodons with the Armadillos. The huge *Diprotodon* and *Nototherium* afford a similar contrast with the Kangaroos of Australia; and the towering *Dinornis* and *Palapteryx* with the humble *Apteryx* of New Zealand. But the comparatively diminutive animals of South America, Australia and New Zealand that form the nearest allies of the gigantic extinct species respectively characteristic of such tracts of dry land, are yet specifically if not generically distinct from them, nor have such small species been more recently introduced.

In England, for example, our Moles, Water-voles, Hares, Weasels, Stoats, Badgers and Foxes are of the same species as those that existed when the Hippopotamus swam the rivers, the Hyæna, Bear and Lion lurked in the caves, and the Rhinoceros and Elephant trod the land. So likewise the remains of small Sloths and Armadillos are found associated with the Megatherium and Glyptodon in South America; and the fossil remains of species as diminutive as the present Kangaroos and Dasyures occur abundantly in Australia with those of herbivorous Marsupials as large as Tapirs and Rhinoceroses, and of carnivorous Marsupials as large as the Lion or Tiger. So likewise in New Zealand we find that the small *Apteryx* has co-existed with the great *Dinornis* and *Palapteryx*.

We have not a particle of evidence that any species of bird or beast that lived during the pliocene period has had its characters modified in any respect by the influence of time or of change of external influences. In proportion to its bulk is the difficulty of the contest which, as a living organized whole, the individual of such species has to maintain against the surrounding agencies that are ever tending to dissolve the vital bond, and subjugate the living matter to the ordinary chemical and physical forces. Any changes, therefore, in such external agencies as a species may have been originally adapted to exist in, will militate against that existence in a degree proportionate, perhaps in a geometrical ratio, to the bulk of the species. If a dry season be gradually prolonged, the large Mammal will suffer from the drought sooner than the small one: if such alteration of climate affect the quantity of vegetable food, the bulky Herbivore will first feel the effects of stinted nourishment: if new enemies are introduced, the large and conspicuous quadruped or bird will fall a prey, whilst the smaller species conceal themselves and escape. Smaller animals are usually, also, more prolific than larger ones.

The actual presence, therefore, of small species of animals in countries where larger species of the same natural families formerly existed, is not the consequence of any gradual diminution of the size of such species, but is the result of circumstances, which may be illustrated by the fable of the 'oak and the reed': the smaller and feebler animals have bent and accommodated themselves to changes which have destroyed the larger species. We find, nevertheless, that the same peculiar forms or families of animals exist and characterize particular portions of dry land, such *e. g.* as South America, Australia, and New Zealand, at the present day, as at a period long antecedent to Human history or existence; and although many species have perished, there has been no general sweeping away of the peculiar aboriginal land animals of those continents or islands. But just as the smaller Sloths and Armadillos still linger in South America, so the smaller Kangaroos, Wombats, Dasyures, and other Marsupials have continued to exist in Australia, and a few species of the comparatively diminutive wingless birds of the genera *Apteryx* and *Brachypteryx* still exist in the island where their peculiar families were once much more richly represented and by species on a far larger scale.

Sternum of Palapteryx *and* Aptornis.

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 breadth[2] 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 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 species[3] 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

[1] Zool. Trans. vol. ii. p. 278. pl. 51. fig. 4.

[2] *Ib.* vol. iii. p. 318. pl. 43. fig. 8.

[3] *Ib.* vol. iii. p. 316. pl. 43. figs. 1, 2 & 3.

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. 43, vol. iii.), 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. IV. figs. 1–4) of a smaller species of the great wingless birds of New Zealand confirms the general accuracy of the restoration attempted in my Memoir of 1846, 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 (*a*, *a*) 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 (*c*, *c*) 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 vol. iii. pl. 43, 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. IV. 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 skull[1], referred in my Memoir of 1848 to the genus *Notornis*, 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, equaling 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. IV. 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 natural family as the *Brachypteryx*, shows that the wings were still less developed than in that genus. 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.

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

DESCRIPTION OF THE PLATES.

PLATE I.

Restoration of the foot of *Palapteryx robustus*.

Fig. 1. Front view of the bones.
  I. Detached metatarse of the rudimental hallux.
  II. Distal trochlea of entometatarse, or that of the second toe: its three phalanges are numbered 1, 2, 3.
  III. Distal trochlea of mesometatarse, or that of the third toe: its four phalanges are numbered 1, 2, 3 and 4: a side view of the last is added in outline.
  IV. Distal trochlea of ectometatarse, or that of the fourth toe: its five phalanges are numbered 1, 2, 3, 4, 5.

Fig. 2. Outline of the proximal end of the compound tarso-metatarsal bone.
  3. Distal ends of the trochleæ of the three metatarsal elements, numbered as in fig. 1: below these are the proximal articulations of their respective proximal phalanges.
  4. A side view of the metatarse of the hallux, showing its characteristic twist.
  5. Back view of the metatarse of the hallux.
  6. Distal ends of the trochleæ of the three metatarsal elements of the compound bone of the Cassowary (*Casuarius indicus*): below these are the proximal articulations of their respective proximal phalanges.
  7. Outline of the bones of the foot, front view, of an Ostrich (*Struthio camelus*): the homologous phalanges with those of the *Palapteryx* are indicated by the same symbols.

All the figures are of the natural size.

PLATE II.

Restoration of the foot of *Palapteryx dromioides*.

Fig. 1. Front view of the bones. Only the distal ends of the coalesced metatarsals are figured. The bones of the toes are indicated by the same symbols as in Pl. I.
  2. A side view of the ungual phalanx of the third toe.
  3. Back view of the femur of *Notornis Mantelli*.
  4. Front view of the tibia of ditto.
  5. Back view of the tarso-metatarse of ditto.

Fig. 6. Side view of the femur of *Apteryx australis*.
7. Back view of tarso-metatarse of ditto.
8. Front view of ditto of ditto.

All the figures are of the natural size.

PLATE III.

Restoration of the foot of *Dinornis rheïdes*.

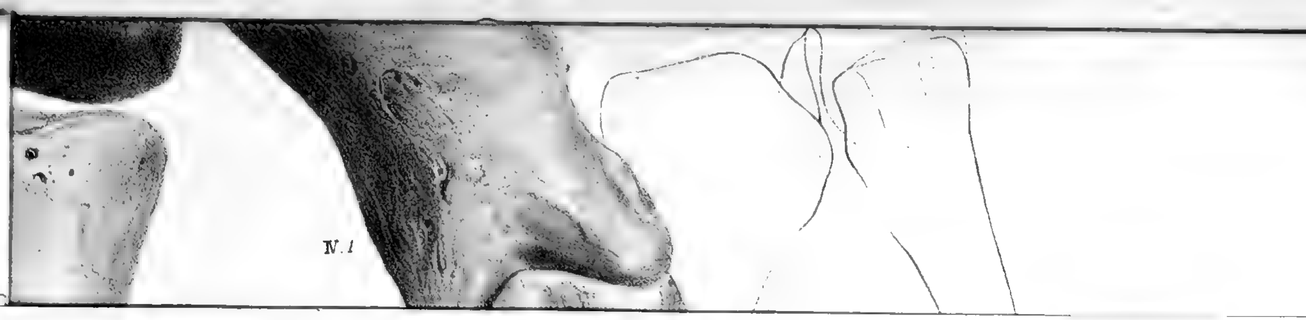
Fig. 1. Front view of the bones. Only the distal ends of the coalesced metatarsals are figured. The bones of the toes are indicated by the same symbols as in Plates I. and II.
2. A side view of the ungual phalanx of the middle toe.
3. Back view of the femur of *Aptornis otidiformis*.
4. Front view of distal end of ditto, with part of the medullary cavity and its compact walls exposed.
5. Back view of the tarso-metatarse of *Aptornis otìdiformis*.
6. Proximal end of ditto.
7. Side view of ditto.
8. Distal end of ditto.

All the figures are of the natural size.

PLATE IV.

Fig. 1. Outer or under view of the sternum of a species of *Palapteryx*.
2. Inner or upper view of ditto.
3. Lateral border of ditto.
4. Anterior border of ditto.
5. Outer view of the sternum of *Notornis Mantelli*.
6. Inner view of ditto.
7. Lateral border of ditto.
8. Anterior border of ditto.

All the figures are of the natural size.



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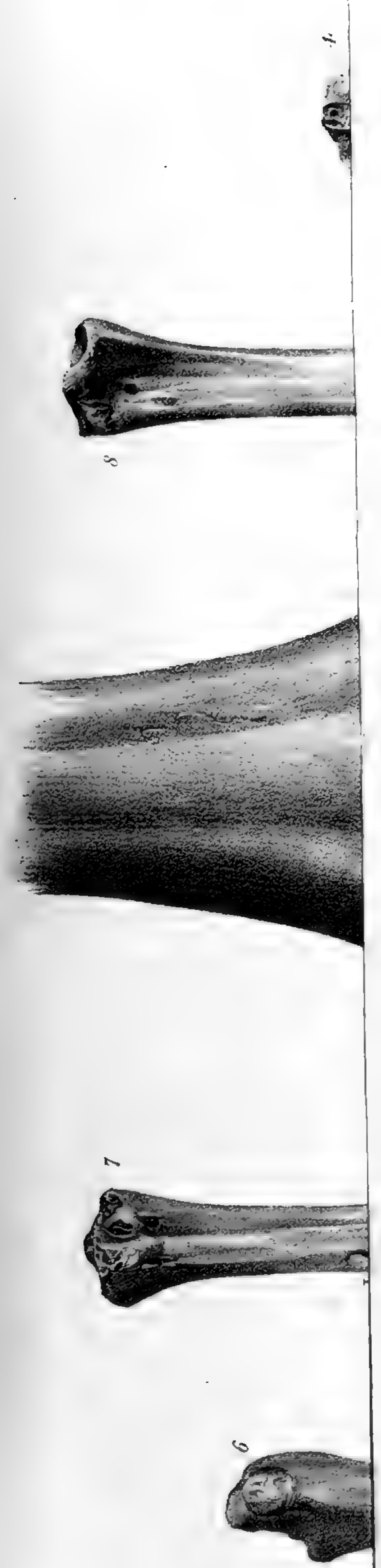
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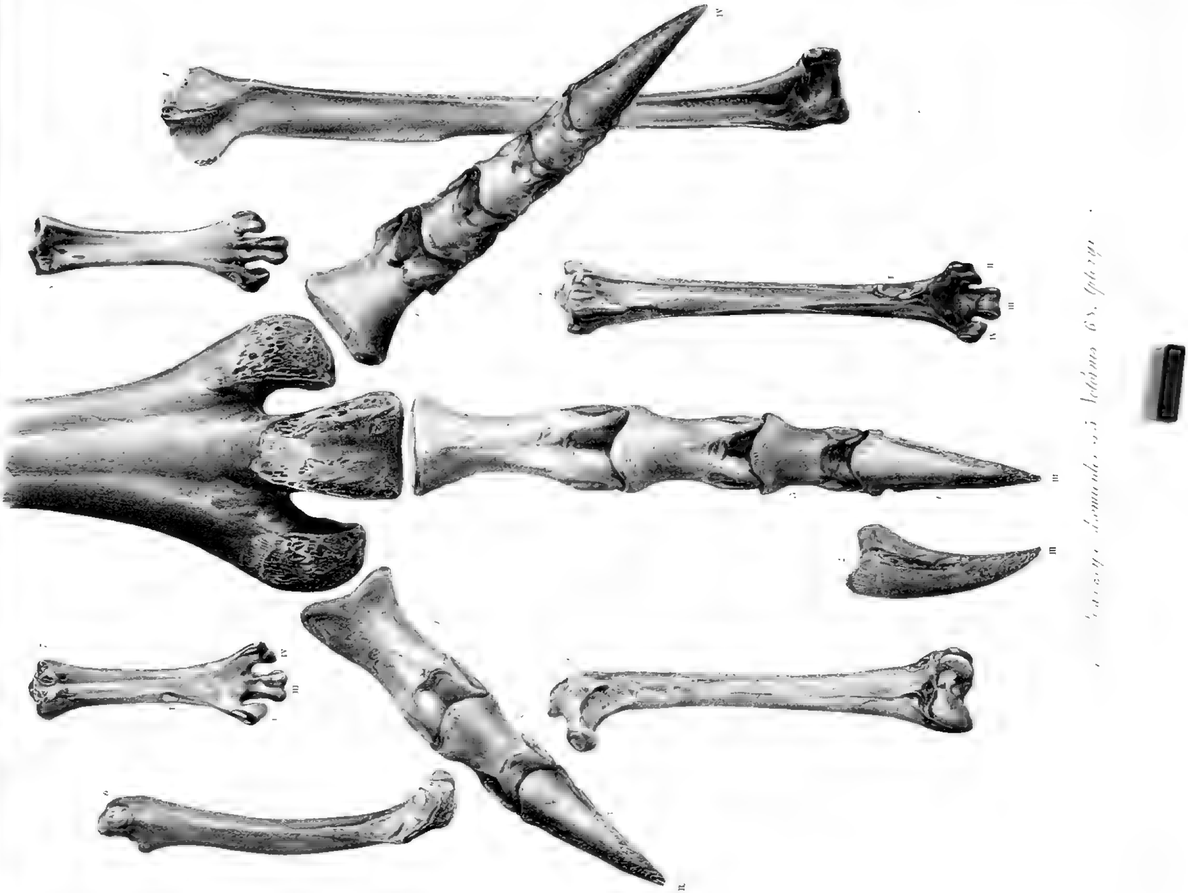

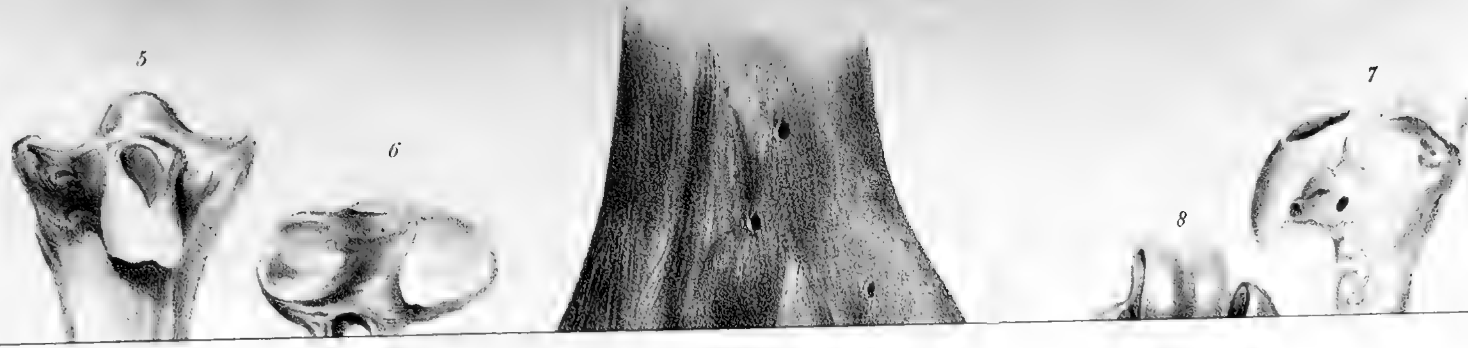
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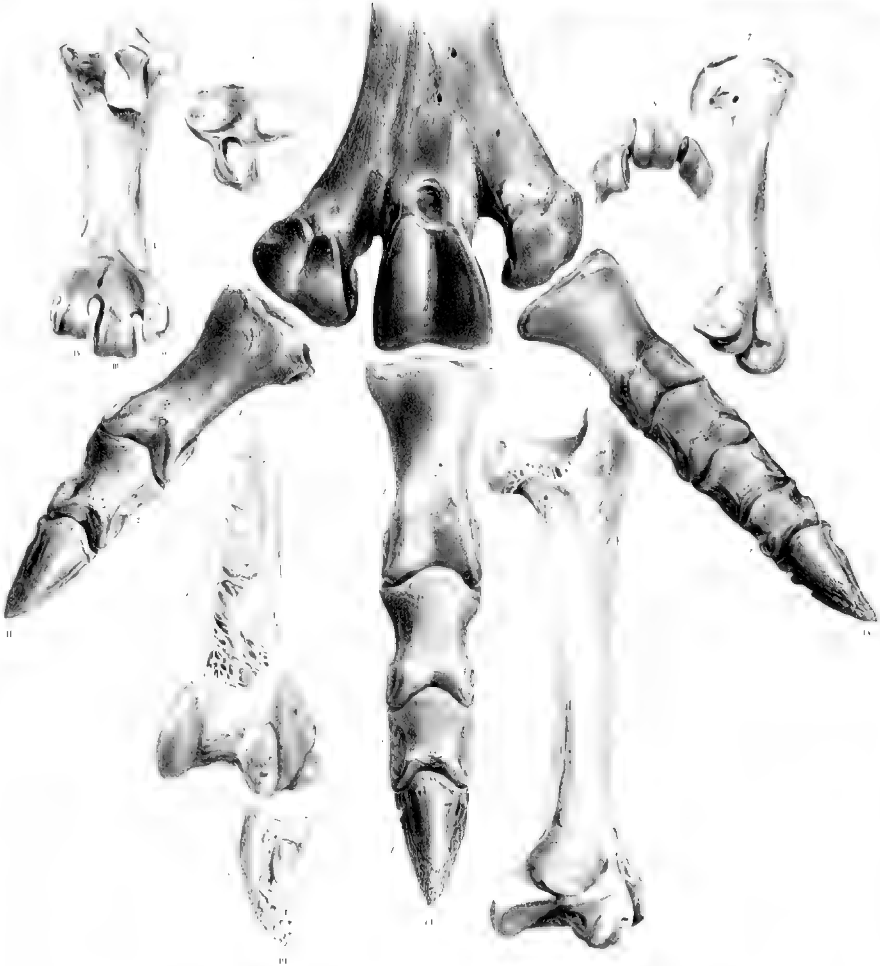


1 & 2 Dinornis struthoides 3-8 Æpyornis

J.Erxleben

1-4 Palapteryx 5_8 Notornis nat. size

II. *Contributions to the Knowledge of the Animal of* Nautilus Pompilius. *By* J. Van der Hoeven.

Read January 8, 1850.

THERE are hitherto but three original figures of the animal of *Nautilus Pompilius.* The first is that of Rumphius, in his 'Amboinsche Rariteitkamer' (No. xvii. at p. 62); the second that of Professor Owen in his accomplished 'Memoir on the Pearly Nautilus' (London, 1832, pl. 1); the third, drawn by M. Laurillard, was given by Professor Valenciennes in the 'Archives du Muséum d'Hist. Natur.,' ii. 1841, pl. 8.

The figure of Rumphius could only be deciphered after the discovery of a new specimen. As Professor Owen has observed, the animal is represented in that figure in an inverse position. Guided by that observation, it is possible to explain some parts in that enigmatical figure, but many obscurities still remain, and the whole gives the impression of a drawing made by recollection, and after the doubtful suggestions of a discomposed memory. This seems still more probable, because the text informs us (p. 61) that the figures to which the indications of the description allude, have been lost.

The animals represented by Professors Owen and Valenciennes were detached from the shells before they were presented to those distinguished cultivators of comparative anatomy and structural zoology. This circumstance explains some imperfections in the figures given by both. Professor Owen, for instance, gives an incorrect form to that production of the mantle which covers the convex part of the shell's circumvolution projecting in the aperture, or to the part which the author calls "the dorsal fold" (see his pl. 1 *b*); the superior free margin of the mantle is lower than it ought to be, as it conceals in the natural state a great part of the funnel and the inferior half of the eyes. In regard to the last circumstance, the drawing of Laurillard given in M. Valenciennes' paper is more correct; but in other particulars it is deficient, chiefly because the soft part of the integuments which forms the visceral sac was torn off and wholly wanting. It ought to be observed also, that those two figures represent the animal replaced in a shell of the same species indeed, but not its own.

I suppose then that it may be perhaps of some interest to publish some drawings I made, chiefly after two specimens, one of which was kindly presented to me in 1848 by Professor Reinwardt; the other I received lately from our settlements in the East, by the kind exertions of His Excellency Mr. T. C. Baud, formerly His Majesty the King of the Netherlands' Minister for the Colonial Department.

The first figure (1) represents the animal from the left side in its own shell, which has been opened with a file at such a height, that the whole last chamber was visible, together with a part of the three following compartments. The hood (a), composed according to Professor Owen by the conjunction in the mesial line of the two superior, excessively large digitations, covers with its projecting margin the superior surface of the pedunculated eye (b). The inferior half of the eye is concealed by the superior margin of the mantle, which covers also the greatest part of the digitations or lateral processes of the head (c, c). The extremity of the funnel (d) is visible and uncovered, the rest being contained in the anterior part of the mantle. There is no perforation or excision at this part of the mantle[1], but the margin of it is entire and slightly convex.

The mantle (f, f, f', i) has its anterior part of a more thick and fibrose texture and a yellowish colour; the posterior part (i) forms a thin and nearly transparent membranous sac, containing the different viscera. The free superior margin of the mantle ascends behind the hood (f') and forms the dorsal fold of Professor Owen's memoir; but at the side view only a small portion of this fold is visible. Beneath the posterior part of the hood, the mantle offers on each side a large aponeurotic flat piece (g), of a bluish white colour and a kidney-like shape, being convex at its anterior side and somewhat concave at the posterior border. This plate is the posterior insertion of a strong muscular mass—the great muscle of the shell—which goes from this attachment in an oblique course, converging with that of the opposite side, to its anterior termination at the cartilage of the head. From this oblong patch arises a narrow aponeurotic stripe, both at the superior and at the inferior extremity of it. The oblong plate may be considered as an expansion and development of this band, which, encircling the whole mantle, separates its posterior soft part or the visceral sac (i) from its free and thicker anterior part. The thin and membranous posterior part of the mantle is of a bluish white colour, but being imperfectly transparent, it seems to be dark at all places where it covers the bulky liver, whose colour is a dark red-brown, or chocolate-like purple. At the inferior part of the free portion of the mantle is a convexity (h), where lies a glandular laminated organ, secreting, as it seems, a covering to the eggs, and which projects at this place, being partly visible through the integuments. This glandular mass connected with the female generative system is situated behind the gills, at the inner surface of the mantle.

A more complete idea of the external form of the animal may be had by comparing the two following figures. Fig. 2 represents the animal taken out of the shell from a dorsal aspect. The circumference appears oblong, and of an irregular oval form. The whole is divided into two chief parts; the first (a) is the hood, exactly filling up the shell's aperture[2]; the second part (i) was concealed in the lower and posterior part of the terminating chamber of the shell. The dorsal fold (f') appears now wholly visible; it forms a thin lamellar production of the mantle, and ascends to the protuberant internal labium

[1] Professor Owen speaks of a large aperture through which the funnel passes. (Memoir on the Nautilus, p. 9.)

[2] It may be allowed to hazard here the opinion, that the two juxtaposed fossil shells, known by palæontographs as *Aptychus*, were two shelly supports of the hood of *Ammonites*, extinct Cephalopods not very different in structure from the *Nautilus*, and belonging, like that genus, to Prof. Owen's tetrabranchiate group.

or anfractus of the revoluted shell. Hence the upper surface of this fold is excavated, forming the exact counterpart of the shell's protuberance. Under that fold is a smaller plate of nearly the same form, but adherent to the posterior declivous surface of the hood, and only free at its circumference. This plate is of an aponeurotic texture and a white colour : at both sides it is united to the dorsal fold, and below it seems to have an intimate connection with the two side parts of the funnel, and indeed to be a continuation of those parts. The dorsal or superior part of the aponeurotic band, which forms, as we have said already, the continuation of the oblong side-plate (fig. 1 *g*), is here visible at *g*, *g*. Three small longitudinal bands or tendinous inscriptions (*h*, *h*, *h*) seem to give some firmness to the dorsal part of the abdominal portion of the mantle. Near the posterior end of this visceral sac, nearer however to the superior surface of it, is the beginning of the siphon (*j*) ; it seems nearly superfluous to say that this siphon is a tubular production of the visceral part of the mantle, protected by a calcareous covering, and penetrating by the central perforation of the several septa in all the following compartments of the shell.

At the inferior surface (fig. 3) a part of the funnel is visible in the middle of the digitations of the head. The inferior face of those digitations is of a white colour, contrasting with the brown and dark colour of the hood and of the superior surface of the digitations which are nearest to it. The free inferior and anterior margin of the mantle appears rounded and somewhat convex ; it conceals the basal part of the funnel and of the appendages of the head.

More instructive is an inferior view of the animal if the mantle has been removed or reflected backwards ; in this manner the branchial cavity is visible (fig. 4).

The two overlapping sides of the funnel form a striking particularity of the structure of the Nautilus. It is interesting that the embryo in the dibranchiate group, as we learn from Dr. Kölliker's observations[1], shows the funnel composed in the beginning of two lateral separate parts. The embryonic condition in the dibranchiate Cephalopods proves thus to be a persistent structure in the tetrabranchiate group.

Between the basal part of the second pair of gills the anal aperture is visible. This part has been misrepresented by Professor Valenciennes. It seems that a longitudinal fold connecting the integuments of the viscera with the two large shell-muscles was disrupted in his specimen, and that the author believed this to be the rectum. The oviduct in this supine position is situated at the left side, before the anus, and terminates with a transverse bilabiated and protuberant aperture or vulva. [Consequently, when the animal is in its natural position in the shell, the termination of the oviduct lies at the right side.]

There are three little slits on each side at the roots of the branchiæ. The first pair of those apertures is situated at the anterior surface of the first branchia, near the posterior margin of the large shell-muscle. Between the first and second branchiæ are the

[1] Entwickelungsgeschichte der Cephalopoden. Von Dr. A. Kölliker; Zurich, 1843, 4to, p. 41 &c.

two other slits, very near to each other, and at the outward side of them is a little depressed papilla, affixed to the posterior surface of the root of the first branchia. The first and the last slits are the exterior openings of two lateral blind sacs, containing the follicular appendages of the branchial arteries; the second slit communicates with the pericardium[1]. At the first slit I once found a calcareous reddish-white and friable concrement; I believed it to contain uric acid, but the chemical inquiry of my friend Professor Van der Boonchesch has not confirmed my supposition.

Behind the anus there are on each side two small and depressed caruncles, very similar to that mammillary eminence or papilla we have seen at the root of the first branchia. External to those caruncles and behind them is a series of small orifices, not unlike to the openings of the Meybomian follicles on the human eyelids. These are the emunctories of the glandular organ, for the secretion of the covering matter of the ova.

The head still requires some further description. In order to give a more correct idea of the mutual superposition of the numerous digitations and processes which exist in the Nautilus, instead of the eight or ten arms of the dibranchiate Cephalopods, I have represented them from the left side, in three comparative figures, so as they follow each other from the exterior surface of the head to the interior covering of the mandible (see figs. 5, 6 & 7).

In the first place (Pl. VIII. fig. 5), the mantle *f* being reflected, the hood (*a*), the different digitations (*c*, *c*), and the funnel (*d*), are visible. The large pedunculated and perforated eye (*b*) has two tentacles (ophthalmic tentacles, Owen), one before its anterior margin, the other behind, which are however not distinctly seen without reclining the surrounding parts, and bending the eye-peduncle[2]. Only a few tentacles are protruded from their sheaths, and partly visible. I never saw them protruded to such an extent as in M. Laurillard's figures. The number of these digitations seems not to be exactly the same in all specimens. Instead of nineteen digitations on each side, as in Professor Owen's specimen, I twice found only eighteen. M. Valenciennes found only seventeen in his specimen. That the hood is formed according to the ingenious supposition of Professor Owen, by two large digitations conjoined along the mesial line, has been mentioned above. The hood indeed contains two tentacles, and in this manner the whole number of exterior or digital tentacles varies from eighteen to twenty on each side.

[1] The three pairs of openings have been first observed by Professor Valenciennes. This point of the anatomy of the Nautilus has been chiefly elucidated by the observations of my friend Professor W. Vrolik (Tijdschrift voor de natuurkundige Wetenschappen, uitgegeven door de Eerste Klasse van het Koninklijk-Nederlandsche Instituut, ii. 1849, p. 312–315). Professor Owen describes in his memoir but one of those openings, and it is therefore questionable what opening he speaks of. It seems however to me to be the second, because Professor Owen describes the mammillary eminence which is nearest to this slit, and chiefly because the author observes that the orifice "conducts from the branchial cavity to the pericardium." (Memoir on the Nautilus, p. 27.)

[2] Under the eye is a part, first noticed by Valenciennes, a little hollow caruncle, with bilabiated aperture, which seems to be the true organ of smell (see fig. 8). It is only visible by bending the eye behind and above, and adheres to the root of its stalk.

The second layer of tentacular processes is brought into view by cutting off the hood and the external digitations. Fig. 6. Pl. VIII. gives a view of this dissection. In this figure *b* is the eye, *d* the funnel, as in the foregoing figure ; *c*, *c* are the cut parts of the tentacles contained in the digital processes. The layer now visible is formed by that set of tentacular sheaths which Professor Owen calls the *external* or superior labial processes (fig. 6, *k*, *k*). For a reason explained in the following part of my paper, I would be disposed to prefer the name of *external labial process* to that of *superior*. The membrane covering the mandibles and the muscular mass of the mouth, and terminating in the fringed lip encircling those parts, is to be seen at a little distance above this layer (at *m*), and shows numerous circular folds. Beneath this layer a small part of the third layer (*l*) is visible.

This third layer is brought into view by removing the second (see fig. 7). In this figure *k*, *k* are the cut parts of the tentacles of the external labial process, and *l* is the *internal* or inferior *labial process* of the left side. The folded membrane *m* is now almost wholly visible. The internal labial processus consists of a flattened stalk, which ascending expands in a compressed paddle, whose superior margin is straight and perforated for the exsertion of the tentacles. There is some likeness to a glove whose fingers are cut off. The description of Rumphius mentions all the digitations and processes as superimposed flaps, each in shape of a child's hand[1]. This comparison answers chiefly to the internal labial processes.

The number of tentacles in those two pair of labial processes is not exactly the same in different specimens, nor even in the same specimen at both sides. The description of Rumphius gives sixteen tentacles to the external labial processes, but does not mention their number in the internal processes. Professor Owen found twelve tentacles, Professor Valenciennes thirteen in each of those four processes. In the external processes Professor W. Vrolik observed twelve tentacles on each side, as was observed also by me. The internal processes seem to have in general a somewhat larger number ; Professor Vrolik observed in this layer fourteen on each side ; I found also fourteen at the left and sixteen at the right side. The external labial processes are united in the mesial line at the ventral side above the funnel by a membrane with numerous fine folds on the inside ; the internal approach here nearer to each other and are united in a similar manner ; the commissure presents on the inside, towards the dorsal surface, seventeen or eighteen eminent, compressed, longitudinal folds, like the parallel ridges in the olfactory cavity of Fishes. This part is, according to Professor Owen's opinion, the organ of smell ; but I believe that those folds are only rudimental digitations completing the circle of the internal labial processes, and similar to the more numerous and smaller folds of the external circle, or even to the fringed margin of the lip round the mandibles.

In respect to the observation of Valenciennes concerning the mandibles, it is perhaps not unnecessary to note that I saw them in different specimens always covered with a

[1] "Zijnde ieder lap gefatzoeneerd als een hand van een kind." (Amboinsche Rariteitkamer, p. 60.)

calcareous white matter, as has been observed in the first accurate description of the animal by my eminent friend Professor Owen.

The sexual difference of the Nautilus requires still further elucidation. Professor Owen's description was relative to a female, and also all the other specimens observed by subsequent authors, or preserved hitherto in the museums, seem to be of female specimens. Hence it seems to follow that males are rarer ; a similar circumstance of unequal number has been noted in many other animals of several classes. The recent observations of Kölliker and some other authors having elucidated the true nature of that abnormal animal form, not unlike to separated arms of Cephalopods, found in the shell of the (always female) *Argonauta,* and formerly described as a genus of worm under the name of *Hectocotyle* by Cuvier, would lead us to expect similar males of the Nautilus living like parasites with the female in her shell. There exists however not the least indication in the different memoirs of Owen, Valènciennes and Vrolik, that such parasites were present. I can say that in Nautilus the sexual difference is not so great, and that the male lives in a shell like the female. I was fortunate enough to observe one specimen of a male, which was kindly presented to me by my colleague at the Faculty of Sciences of the Leyden University, the Professor of Botany, W. H. de Vriese. The differences it showed in the conformation of the head may be ascribed either to sexual difference or to monstrosity. This must remain unsettled till another male can be observed ; but I incline to the first opinion, a similar aberration of structure not having been observed in any of the hitherto dissected females.

I have already described this male in a former paper[1], but I believe it will not be superfluous to give here the translation of the chief matter of my Dutch memoir on this specimen, together with some additional remarks and corrections.

At the inner surface of the circle of digitations, which were eighteen at each side, without the hood, there was a prolongation of the integuments rising up to another more internal circle. This prolongation unites at the ventral side by a free and thin margin to the connecting basal part of the digitations. At the inner surface of this connexion of the external digitations, there are many transverse dimples parallel to the transverse margin of this commissure : many little holes give a reticulated appearance to this part. The prolongation becomes thicker and expands on each side in a processus divided in eight digitations of different size, including each a tentacle, similar to those contained in the external digitations of the head, but smaller, as usual in other specimens. On account of their place, those processes seemed first to me to be analogous to the *superior labial processes* of Professor Owen's memoir, because they are situated at the dorsal side, and consequently I described them under that name in my former

[1] Tijdschrift voor de natuurkundige Wetenschappen, uitgegev. door de eerste Kl. v. h. Koninkl.-Nederl. Instit. i. 1848, p. 67–75. A short abstract of this description was communicated by me at the Oxford Meeting (1847) of the British Association, and is inserted in the Report of the Seventeenth Meeting of the British Association; London, 1848 ; Transactions of the Sections, p. 77.

publication; but as they are internal or nearer to the mandibles than the other pair of similar processes, I now believe them to be analogous to the inferior labial processes in the female, notwithstanding their superior position. The fold of the integuments connecting those processes at the central side to another in the mesial line divides in two plates; the exterior adhering to the commissure of the external digitations already described; the interior united to the covering of the mandibles. Between those two plates a pair of depressed cushion-like parts is placed, coming in contact to another in the middle, and nearly wholly adherent at their inferior surface to the inner plate. They have nearly 8 lines in length and $4\frac{1}{2}$ in breadth. Their free, superior and internal margin is divided by incisions in ten or eleven small tetragonal parts; the right part having eleven, the left ten of those digitations. The relative position seems to prove them to be analogous to the folds between the internal labial processes, which are considered as the olfactory apparatus by Professor Owen. I believe they afford an additional argument against this opinion, because they are doubtless only rudimental digitations.

Beneath those internal labial processes there is at each side outwards to them a fold in the inner surface of the external circle of digitations. At the right side a processus is exserted from this fold; it consists of the conjunction of the sheaths of four tentacles; three of those tentacles are placed on a common flat expansion; the fourth is contained in a separate slip, placed beneath the three other tentacles. At the left side, instead of this external labial processus, there was a great conoid body, the length of which was nearly $2\frac{1}{2}$ inches; this part was laterally compressed; at the basis its measure from the dorsal to the ventral side was found to be 1 inch 10 lines; from the right to the left side only 1 inch. This part was proved to me by dissecting it to be formed by the union of four unusually developed tentacular slips, one of which was shorter and more free, the three other chiefly composing the singular body. This part occupied a great space in the interior of the circle, which was formed by the external tentaculiferous digitations of the head, and perhaps its great development may have been the cause of the more imperfect condition of the other three labial processes.

I regret that this specimen was in a bad state of preservation; its abdominal sac being dilacerated and the viscera destroyed by maceration. Hence I am not able to give a description of the male organs of generation, but that the specimen was a male seems to me unquestionable. At the same place where in other specimens the vulva adheres to the ground of the branchial cavity, was a short conic part, evidently the penis, somewhat bent at the basis towards the ventral side, having an obtuse and perforated top. A very narrow canal was found to go from this aperture to the root of the penis, and to expand there in a pouch, of a firm parchment-like texture. This bladder contained a conglobate tube of a brown colour, having a little more than 1 line in diameter. The length of this tube could not be determined, because, by any attempt to unravel it, it broke into pieces. Microscopic investigation proved that this tube was formed by two membranes, the external transparent, the inner thicker, coloured, brittle, and offering circular stripes or fibres. In the interior of the tube there was a thread or band, coiled up in a spire with close circumvolutions, like the spiral fibre of the *tracheæ* of insects. This fibre was not of exactly equal broadness in its whole extent; its broadest parts had a diameter of nearly $\frac{1}{48}$th of a line. This fibre seemed composed of an external transparent membrane, including an internal part of a yellowish brown colour. Between the fibre and the tube containing it were observed several free microscopic parts; some greater, of a brown colour, oblong or navicular; some smaller, uncoloured, and still of different size. How different this conglobated tube, contained in the spermatic vesicle, may be from the *Needham-machines* or spermatophores of other Cephalopods, I still believe that we ought to consider it as a similar sperm-containing apparatus. It is highly desirable that a travelling naturalist should have the opportunity of observing the male Nautilus in a recent state.

Imperfect as they are, I trust those last observations to be still of some interest for comparative anatomy, as giving the first account of that which seems now to be the chief *desideratum* in our knowledge of the Nautilus, the disposition and structure of the male generative apparatus.

DESCRIPTION OF THE PLATES.

Figs. 1—8 belong to the female *Nautilus*; figs. 9—14 to the male specimen, which is described at the end of my memoir.

PLATE V.

Fig. 1. A female *Nautilus* in its shell, from the left side.

PLATE VI.

Fig. 2. The same specimen seen from above, and taken out of the shell.

Fig. 3. The same, from below.

The following letters indicate the same parts in those three figures: *a*, the hood; *b*, the eye; *c c*, the digitations; *d*, the funnel; *f f f' i*, the mantle; *i'*, its visceral part; *f'*, the dorsal fold of the mantle; *g*, the aponeurotic insertion of the shell-muscle.

In figs. 1 and 3, *h* indicates the place where the laminated gland is situated.

In fig. 2, *h h h* are three aponeurotic inscriptions on the visceral sac; *j* is the siphon.

PLATE VII.

Fig. 4. Branchial cavity and funnel of the same. *f*, funnel; *g*, mantle, reflected; *e e*, shell-muscles; *h h*, first pair; *h' h'*, second pair of branchiæ; *a*, anus;

b, vulva ; *c*, caruncle at the root of the first branchia ; *d*, two pair of similar papillæ at the bottom of the branchial cavity. 1, 2, 3, three pair of slits (at the left side of the figure the first is to be seen ; the two others are represented on the right side of the figure).

Fig. 10. Head of a male *Nautilus* seen from above ; the hood has been divided by a longitudinal section ; *g g* are the internal labial processes ; below them, at the right side, is placed and partly visible at *i*, the external labial processus. The place of it occupies at the left side a large conoid body, *a* ; *m m* is the fringed lip inclosing the mandibles.

Fig. 11. The conoid body of the foregoing figure, separately seen from the inner surface, together with the incumbent internal labial processus of the left side.

Fig. 12. Lateral view of the internal labial processus of the right side, with the mandibles and the surrounding lip.

Fig. 13. Penis. A, entire ; B, a longitudinal section of it.

Fig. 14. A portion of the circumvoluted spermatophore or tube contained in the bladder at the basis of the penis.

PLATE VIII.

Fig. 5. Side view of the head, the mantle *f* being reflected : *a*, hood ; *b*, eye ; *c c*, digitations ; *d d*, funnel.

Fig. 6. The same, after removing the digitations ; *c*, transverse sections of their tentacles ; *k*, external labial processes ; *l*, internal ditto ; *m*, membrane covering the mandibles.

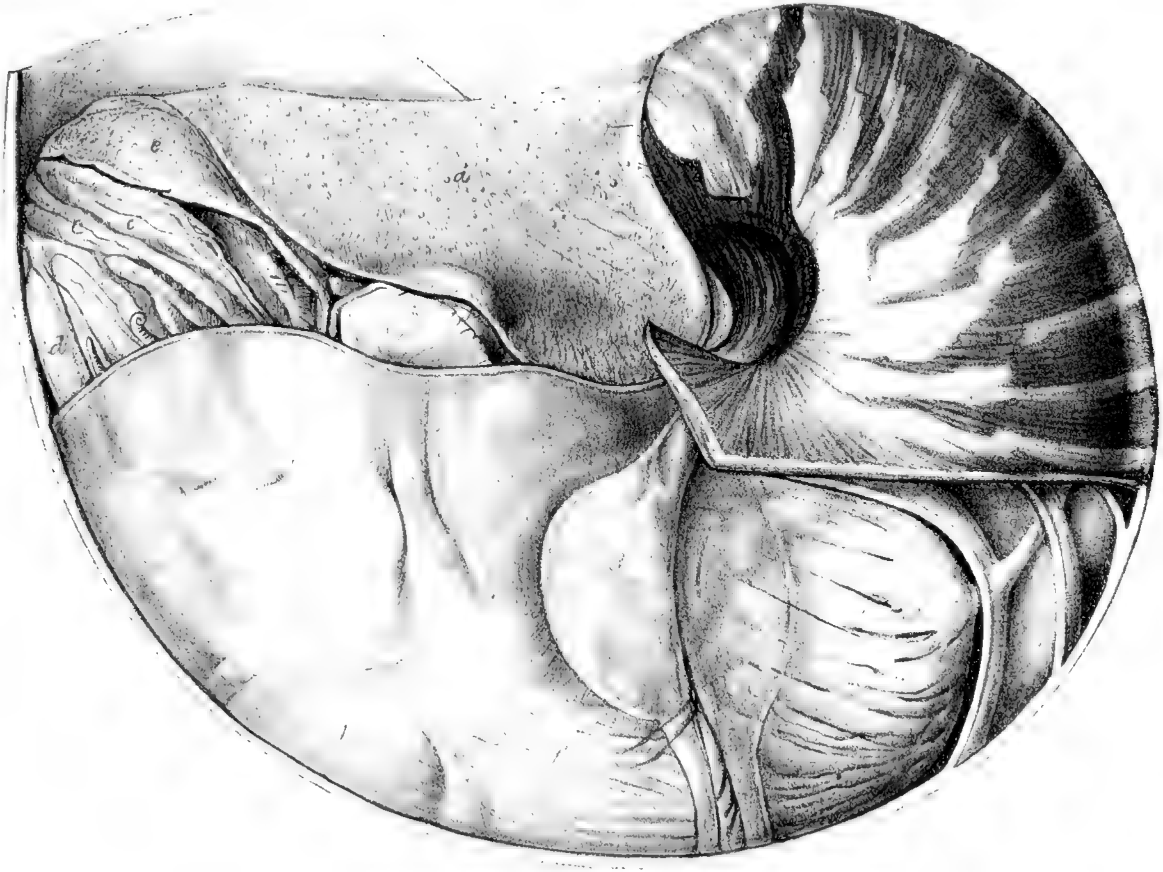
Fig. 7. The same, after removing the external labial processes, cut off at *k k*.

Fig. 8. Caruncle at the peduncle of the eye ; organ of smell, *a*.

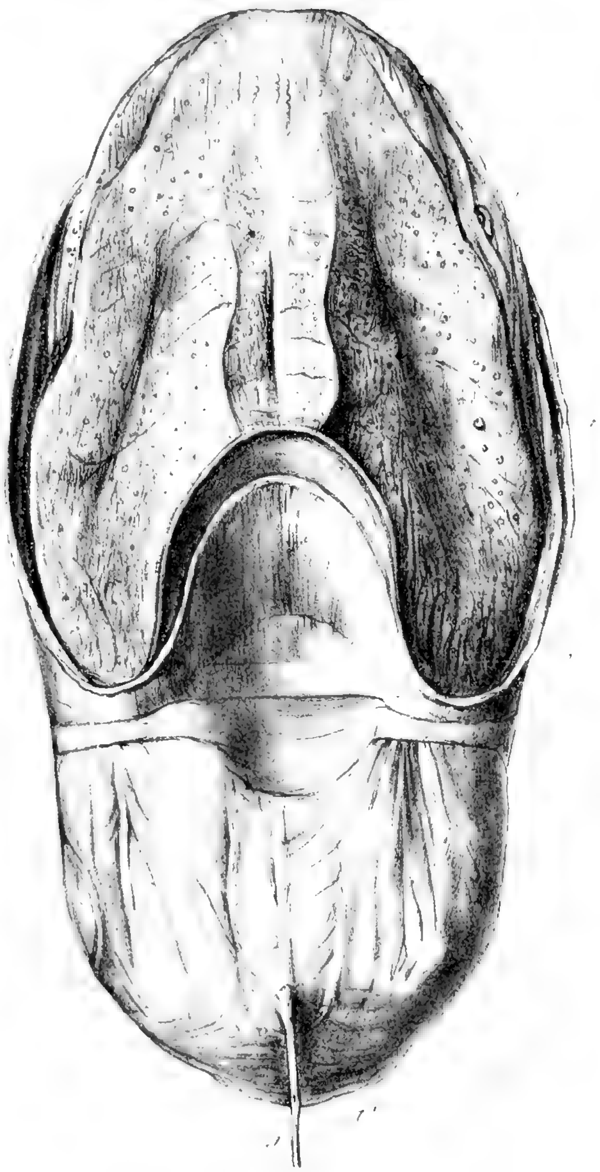
Fig. 9. View of the inferior surface of the muscular mass of the mouth, with the two cushion-like incised bodies, representing here the folds between the internal labial processes.

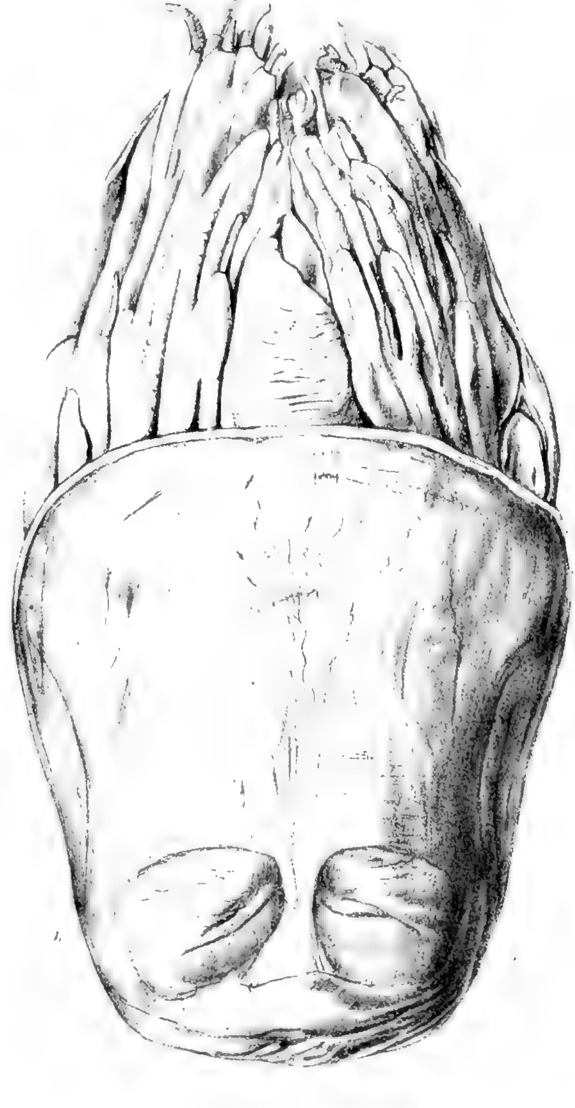
Leyden, 8 Dec. 1849.

Fig. 1

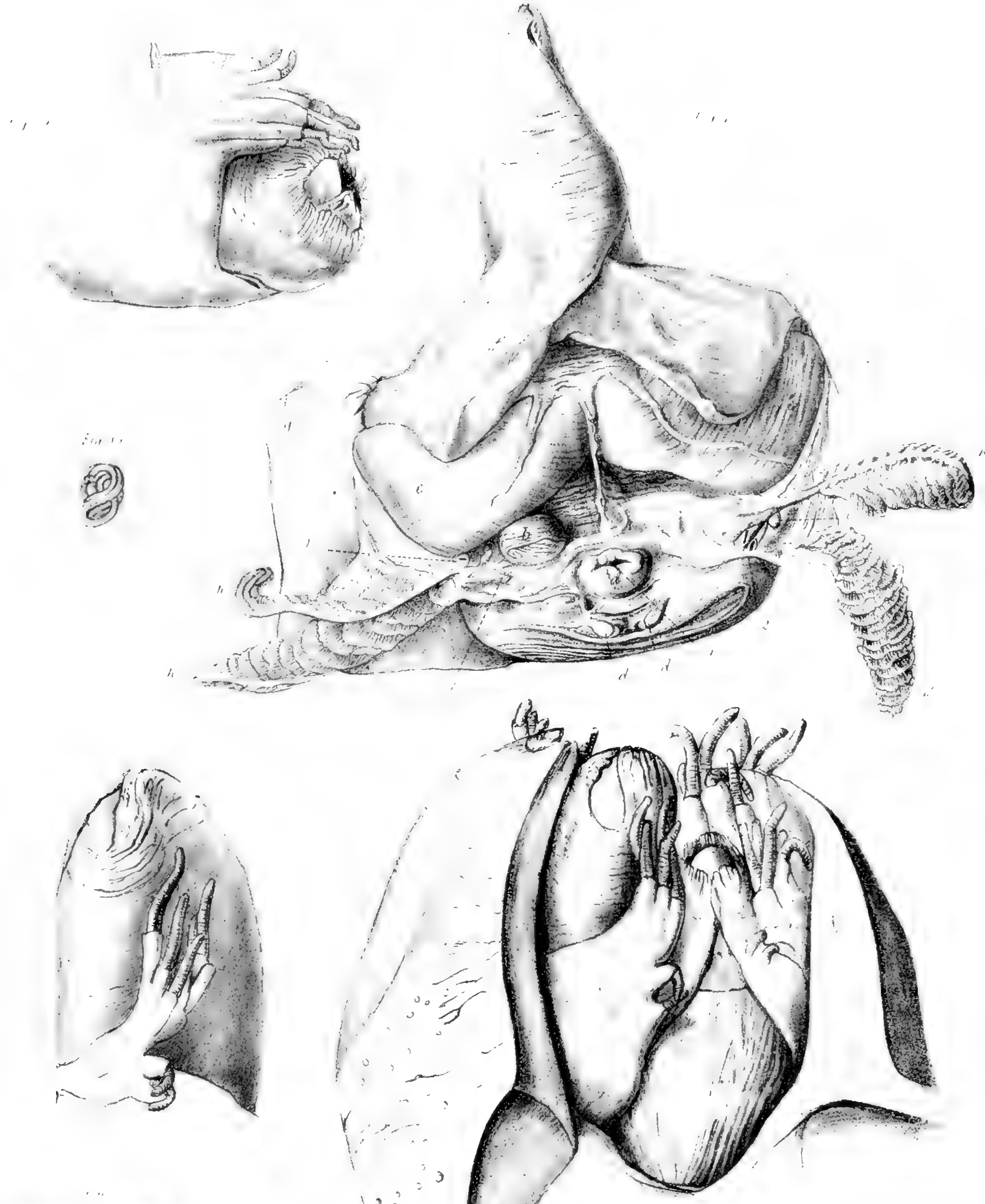


Nautilus pompilius





Nautilus pompilius.



Van der Hoeven del. W. Wing lith.

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Nautilus pompilius

III. *On the Anatomy of the Indian Rhinoceros* (Rh. unicornis, *L.*). *By* Professor Owen, *F.R.S.*, *F.Z.S.* *&c.*

Read Feb. 12, 1850.

Part I.

Introduction. External characters. Position of Viscera.

THE very rare opportunity of investigating the internal structure of the Rhinoceros, which the death of the fine male specimen of the Indian species, *Rhinoceros unicornis*, L., at the Menagerie of the Zoological Society, has afforded, enables me to submit to the Society the following details of its anatomy.

I may premise, as a requisite point of comparison with the dimensions and weight of some of the viscera, that the animal, which was full-grown and had lived in the menagerie fifteen years, measured thirteen feet and a half from the end of the muzzle to the root of the tail, and thirteen feet in its greatest circumference: its total weight was upwards of two tons[1].

The animal had begun to show a loss of appetite in July 1849, when it was supposed to be under the influence of the rut: the more decided symptoms of ailment first manifested themselves about a week before its death, when it was observed to make occasional efforts, as if to vomit, followed by the escape of a bloody and frothy mucus and fluid from the mouth and also from the nose. It died on the evening of the 19th of November 1849. Subjoined are the symptoms noted in the Head-Keeper's Minute-book[2].

After the removal of the integuments and some dissection of the muscles, the abdominal and thoracic viscera were exposed by the detachment of all the ribs of the left side; when it was found that the seventh rib had been fractured at the bend near the vertebral end: a kind of false joint had been formed between the broken portions. One

[1] Mr. Miller, the Superintendent, has transmitted to me a record which shows that the Rhinoceros, when received at the Gardens, 20th September 1834, weighed $1\frac{1}{2}$ ton: there was no means of weighing the entire animal after its death: but an approximation was made by weighing separately the limbs, the trunk, detached masses of flesh, the hide, &c., which allowed the total weight to be estimated at about 5000 lbs. avoirdupois.

[2] "1849, November 12th. Rhinoceros vomited slimy mucus.

14th.	ditto	ditto, with blood.		
15th.	ditto	ditto	ditto.	
16th.	ditto	ditto	ditto, and from the nostrils.	
17th.	ditto	ditto	ditto	ditto.
18th.	ditto	ditto	ditto	ditto.
19th.	ditto	ditto	ditto	ditto."

of these had wounded the left lung, and the inflammation, which had caused extensive adhesion of the back part of the lung to the pleura costalis, had also extended into the pulmonary substance, and along the bronchial tubes into the trachea. The surface of the part of the left lung near the wound was extensively emphysematous; and the inflamed bronchial tubes were loaded with bloody frothy serum and mucus. The supposed attempts at vomiting were doubtless efforts to disembarrass the windpipe of the successive accumulations of this fluid; and the death of the animal is to be ascribed to the injury and disease of the left lung consequent on the fracture.

The other morbid appearances were of minor moment: a portion of the right lung was the seat of Hydatids, of the genus *Echinococcus*. The parent cysts were of various sizes from the diameter of two inches to that of half an inch; two or three being successively included in one another. The uncinated vermicules floating freely in the fluid of the parent cysts were $\frac{1}{1000}$th of an inch in diameter, and in countless numbers. They will be more particularly described by Mr. Quekett in the Appendix to this paper; in which also will be given the particulars of the morbid state of the gastric follicles in the digesting portion of the stomach, as observed by the microscope: to this state may be attributed the failure of appetite which first drew attention to the declining health of this rare and valuable quadruped.

The calcareous matter which was discovered in the gastric follicles would probably have laid the basis of a gastric or intestinal calculus, if the animal had lived; but the apparently healthily digested condition of a considerable proportion of the contents of the stomach showed that the state of the secreting apparatus could only be remotely connected with the last fatal symptoms. The liver was less firm than usual; but this might be due to the rapidity with which the large pachyderms pass into a state of chemical decomposition after death. There is a striking difference in that respect in different mammalia; the Ruminants resist the decomposing forces longer than the Pachyderms, as I have experienced in dissecting the Giraffe and the Aurochs; and the resistance is more remarkable in some other orders. On dissecting the two-toed Sloth in moderately warm weather, I was surprised at the length of time in which it kept sweet. Martin, in his 'History of the British Colonies,' observes of the Sea Cow (*Manatus americanus*), "Its flesh is white and delicate, resembling veal in appearance and taste, and it will keep good several weeks, even in the hot climate of which it is a native, when other meat will not resist putrefaction for as many days." The Elephant and the Tapir which I have dissected at the Society's Gardens rapidly passed, like the Rhinoceros, into an offensive state of decomposition.

The bodies of the 5th, 6th and 7th dorsal vertebræ were anchylosed together along their under part, from which an exostosis of apparently old growth projected into the base of the mediastinum, forming there an obtuse rounded tumour of about two inches vertical thickness and twelve inches in circumference. The neural arches and spines of these vertebræ showed no fracture or disease, and as there had not been any symptom of paralysis, further damage to the skeleton for the purpose of examining the spinal marrow at that part was not deemed expedient.

Our able and active Secretary has reminded me, that at the time when the large male Elephant was exhibited along with the Rhinoceros in a contiguous paddock, the latter used to submit to be poked on the back by the Elephant, who could lift his head over the palings and press down with his tusks upon the thick hide of the Rhinoceros; and that the Rhinoceros has been observed to have been thus forced down until his belly touched the ground. Now although this procedure did not actually fracture the spines or neural arches so pressed upon, it most probably strained the ligaments beneath the bodies of the same vertebræ, and produced the ossific inflammation which led to the anchylosis and tumour discovered on dissection. One cannot, however, attribute to this old injury the immediate cause of the animal's rapidly fatal malady. It may have led to the fracture of the rib articulating to the anchylosed parts, through the suppression of that degree of elastic yielding, which the interspace of the vertebræ in their ordinarily moveable state would have afforded. The animal, in lying down, usually fell heavily on its side, and the rib had probably become fractured on one of these occasions by 'contre-coup.'

The external form and characters of the present specimen of Indian Rhinoceros agreed with the full and often-repeated descriptions which have been already published; especially with that excellent one by Daubenton in Buffon's 'Histoire Naturelle,' 4to, tom. xi. p. 198, and with the description, illustrated by two fine and accurate figures, by F. Cuvier in the 'Histoire Naturelle des Mammifères,' fol., fasc. xiii. 1820, p. 2. The only point which appears to have escaped these and other good observers, is the orifice behind each carpus and tarsus, which forms the termination of the duct of a pretty large subdermal glandular pouch.

In the male *Rhinoceros unicornis*, in a state of nature, the horn, when the animal has attained the length of nine feet eight inches, is, according to Mr. Hodgson, the learned and accomplished Resident at Nepal, five inches in height. In the Society's specimen, the horn, owing to the habit which the animal had acquired of rubbing and beating it against the woodwork of its den, had never been permitted to grow beyond eight inches in height; but its base measured nine inches in transverse breadth, eleven inches in antero-posterior extent, and twenty-six inches in circumference. It was distant

	Inches.
From the inner canthus of the eye	4
From the end of the upper lip	7
From the occipital ridge	22

In a female Rhinoceros of the same species which died in a travelling menagerie in January 1838[1], and was purchased by the Royal College of Surgeons, the horn was a mere

[1] This animal was found dead in its den after a night during which the thermometer had fallen 10° below

callous protuberance, scarcely an inch in height and only four inches across the base, although the animal was nine feet in length and the same in its greatest circumference. This difference indicates that the epidermal production in question varies in its proportions in the male and female, making a sexual distinction analogous to that which may be observed in the antlers of the Reindeer, the false antlers of the Giraffe, and in some other Ruminants in which horns are present in both sexes[1].

Since, as Daubenton well demonstrated, and as has been amply confirmed and elucidated by later observers, the horn of the Rhinoceros is an unvascular production, an agglutination of fibres like bristles, unsupported by any osseous core, the question early suggested itself to me, how the relative position of the epidermal conglomerate to the eye and the end of the muzzle was preserved during the progressive growth of the head, and I have carefully watched the progress of the horn in the male animal here described from its first reception into the Society's Menagerie. During the whole of the period of the animal's growth, the back part of the horn was that which alone exhibited natural decay; the fibres there being ragged and broken, while the new fibres were added at the sides and chiefly in front. Thus the horn kept pace, as to its relative position, with the progressive elongation of the jaws during the acquisition of the permanent teeth, by a process analogous to that by which the adductor muscle of the oyster maintains the same relative position to the hinge and outlet of the shell during the whole period of the shell's growth. This partial or local decay and renovation became less conspicuous after the Rhinoceros had attained its full size, and in the long and large horns of aged individuals the whole circumference presents the same smooth and polished surface: whence it may be concluded that when the skull, and especially the upper jaw of the Rhinoceros have attained their full size, the horn receives additional matter along the whole extent of the base, and increases more rapidly in length than in the immature animal.

The glandular orifices at the back part of each foot to which I have alluded, are situated about three inches above the callous sole in the fore-feet and about two and a half inches above the sole in the hind-feet: they are concealed from cursory observation in the middle of the transverse fold that runs parallel to the interspace between the carpus and metacarpus, and between the tarsus and metatarsus. The orifice is analogous to that which opens on the fore part of the foot between the digits in the Sheep and some other Ruminants. The gland itself (Pl. IX. fig. 1) in the Rhinoceros is of a compressed ovate figure, measuring one and a half inch in length and one inch in breadth. The thickness of the glandular parietes (*Ib.* fig. 2) varies from two to three lines. These parietes consist of a compact congeries of follicles, surrounded externally

the freezing point: it had previously exhibited no signs of disease, and had been carried about and exhibited upwards of a year.

[1] In the female *Rhinoceros Simus* the anterior horn is longer and more slender than in the male: in other two-horned species I am not at present aware of any sexual distinction in these weapons.

by a muscular and tendinous coat: the diameter of the excretory orifice (*Ib.* fig. 3) is about eight lines when fully expanded.

The anus is dilatable to a great extent, corresponding to the large masses in which the fæces are discharged; and the Rhinoceros presents, in the size of this aperture, the opposite extreme to the Giraffe and the Nilghau.

A deep groove formed by two thick and prominent parallel folds extends from below the anus along the median line of the perinæum, gradually widening, to the back part of the base of the preputial or pendulous part of the penis. In the ordinary retracted state of this organ, the distance from the anus to the preputial orifice is two feet ten inches: the length of the thick, wrinkled, tegumentary prepuce (Pl. IX. fig. 4), within which the long glans is commonly retracted and concealed, is about nine inches; its basal circumference measures one foot six inches; on each side of this part there is a hemispheroid warty prominence (*Ib. a*). When the animal stales, the glans is protruded downwards with a curve backwards (*Ib.* fig. 5), and the urine is ejected between the hind-legs in a succession of jerks. I never saw it issue in a continuous stream. Under sexual excitement the penis is much further protruded and drawn forwards in a straight line (*Ib.* fig. 6). The singular form of the glans will be subsequently described.

In the female Indian Rhinoceros, the vagina and the preputium clitoridis open on the external surface by two separate, narrow, vertically elongated orifices, each being, in the individual of nine feet long—the subject of the remarks on this sex in the present Memoir, about two inches in length: the vulva (*Ib.* fig. 7, *vu*) is immediately above the clitoris (*Ib.* fig. 8, *c*), *i.e.* nearer the anus. The extent of the perinæum between the anus and vulva was four and a half inches.

The nipples (*Ib.* fig. 8, *m*, *m*) were two in number and inguinal; they were situated fourteen inches in advance of the vulva, and two and a half inches apart from one another. They were subcompressed, obtusely rounded at the extremity, and about two inches in length: about a dozen lactiferous ducts opened upon the somewhat flattened summit of each nipple.

The integument on the middle line of the abdomen, along which it was divided in the operation of skinning, presented a general thickness of three-fourths of an inch: where it was cut on the inner side of the extremities, it was about one-fourth of an inch in thickness. It was connected to the abdominal parietes by a loose cellular tissue, and by a closer subcutaneous tissue to most of the other parts of the body; but the parts to which the stiff and ponderous hide most firmly adhered were the spinous processes of the posterior lumbar and sacral vertebræ, and the anterior extremities of the iliac bones, at which places the corium was blended with the periosteum, and was remarkably thin. The hide adhered over the jugal bones to a kind of moveable fibro-cartilage; and its attachment along the median line of the fore part of the head was so firm as to require, especially beneath the horn, the use of a chisel in order to separate it from the skull.

But, besides its attachment to subcutaneous cellular tissue, fasciæ, elastic tissue, fibro-cartilages and periosteum, the hide is connected with parts which are destined for its motions and adjustment upon the body. So far from the *panniculus carnosus* being absent, it is developed in certain parts to an extraordinary thickness; and it became obvious, on contemplating these muscles, that one use of the permanent folds in the hide of this thick-skinned species of Rhinoceros, is to afford, like the processes of bones, a firmer insertion to the aponeuroses of the cutaneous muscles than a plane surface of integument could possibly have done. A sheet of *panniculus carnosus* situated on each side of the thoracic or scapular region sends its fascia into the interstice of the fold in front of the anterior extremities, the skin being bent upon itself, as it were, to grasp this fascia. Similar portions of *panniculus carnosus* send their aponeuroses into the posterior folds of the skin. But the most remarkable portions of the cutaneous muscular system are two, which arise, broad and thick, one on each side of the anterior part of the abdomen from the superficial fascia covering that part, and, passing backwards, terminate in aponeurotic sheets which are inserted into the fasciæ covering the patellæ and knee-joint. As the patellæ are higher than the abdomen, in the erect position of the animal, the preceding muscles would seem to be developed chiefly to afford additional support to the bulky abdomen, the weight of which is thus in part transferred immediately to the hinder extremities; and these the muscles in question must also tend to draw forwards during progressive motion.

The dense but highly elastic 'fascia superficialis', spread over the peripheral surface of the abdominal muscles upon their pubic and hypochondrial regions, increases in thickness as it passes over the abdominal rings, and invests the spermatic chord with a thick sheath, which becomes thinner where it expands upon the 'tunica vaginalis testis.' Each testis was situated out of the abdomen, but pretty close to the external abdominal ring, without, however, causing any protuberance in the thick integument: and there is no scrotum or outward indication of the essential glands of the male organs.

In the female the superficial fascia covering the external abdominal rings descended upon and surrounded the mammary glands; which occupy a corresponding position to that of the testes in the male[1]. On the internal or central surface of the mammary glands was situated a plexus of large veins: the arteries supplying them were a branch from the superficial femoral and branches of an artery answering to the cremasteric artery in the male, which passed with the 'ligamentum teres uteri' through each abdominal ring.

The sole of each foot was occupied by a thick cushion of elastic tissue, not adipose chiefly, as in Man, but of a whiter, gelatinous and ligamentous texture, resembling the morbid tissue called 'albuminous carcinoma.' The difference between the thick epidermal layer covering the sole, and that sheathing the fore part of each of the three

[1] This correspondence is accompanied by a similarity in the development and functions of the cremaster muscle in the two sexes of the Marsupial quadrupeds.

toes, is more marked than in the Horse: the hoofs proper, or homologues of the nails, are firmly attached to the periosteum of the ungual phalanges by fine vertical laminæ interlocking with corresponding vascular laminæ of the thickened periosteum.

Before entering on the subject of the visceral anatomy of the *Rhinoceros unicornis*, I may premise that some general details on this subject will be found in a paper by Dr. James Parsons in the Philosophical Transactions for 1743, on the occasion of the death of the Rhinoceros sent by the Chief of the Hon. E. I. Company from Patna to London in the year 1739: I possess an impression of a scarce print of the animal published in London in that year.

A second Rhinoceros of the same species, which was exhibited and died in London in 1800, was dissected by Honoratus Leigh Thomas, Esq., who has given an account of his observations on that occasion in a paper printed in the Philosophical Transactions for 1801. Mr. William Bell had previously contributed to the Philosophical Transactions for 1793, some interesting remarks on the anatomy of the Sumatran two-horned Rhinoceros, then for the first time described.

In the one-horned Indian specimens dissected by me, the peritoneal membrane was thick and much stronger than in the human subject: the cellular tissue connecting the external surface of this serous membrane to the adjacent structures is condensed into an aponeurotic firmness where it is attached to the serous coat, the free surface of which presents an opake, whitish appearance. In the female Rhinoceros I exposed the abdominal viscera by laying open the cavity along the middle line of the ventral surface, and turning aside the flaps of its yielding soft parietes. Not the least trace of epiploon was observable when the cavity of the abdomen was thus exposed; but the viscera which presented themselves were in immediate contact with the sustaining parietes. A single but enormous fold of the colon, not less than two feet in breadth, formed more than one half of the exposed surface of the abdominal viscera: it passed obliquely across the middle of the cavity, from the right hypochondriac to the left hypogastric or iliac region; immediately below this was a smaller fold of colon[1] running parallel with the preceding; below this was a second fold; and, occupying the right iliac region, a part of the smooth parietes of the cæcum appeared: a portion of the liver and the stomach were obscurely visible in the epigastric and hypochondriac regions, and below these were seen a few coils of the small intestine.

The colon was not displaced without considerable difficulty, owing to the weight of its contents, and the strength of the duplicatures of the peritoneum attaching it to the spine and contiguous parts. Behind and above the great oblique folds of colon lay a short, thin and corrugated epiploon, devoid of fat; and behind and below them were several coils of the small intestines: the spleen and kidneys were also brought into

[1] It is to these enormous folds of the colon that the great size of the abdomen is due, and not to the cæcum, which is not proportionally so large as in the Horse.

view, together with the large cæcum, appearing like a second stomach, occupying the right iliac and lumbar regions.

In the male Rhinoceros the thoracic and abdominal viscera were exposed by the successive detachment of the ribs of the left side, together with the soft walls of the same side of the thorax and abdomen. The diaphragm separating these two cavities extended from about the seventeenth dorsal vertebra obliquely downwards and forwards, curving, as it approached the ventral parietes, more rapidly towards them; its diameter following this course being four feet six inches. The length of the abdominal cavity was seven feet; its depth or antero-posterior diameter three feet six inches. The length of the thoracic cavity near the spine was three feet six inches; its depth at the most prominent part of the convex diaphragm was two feet; its size, contrasted in this view with that of the enormous abdomen, seemed disproportionately small.

The viscera of the abdomen which presented themselves, enumerated from the diaphragm backwards, were the free curved border and part of the upper convex surface of the left lobe of the liver, partly overlapping the stomach, of which about two-thirds of the greater or cardiac portion were visible. The lower free border of the spleen extended from below all the visible part of the great curvature of the stomach; and the thin, fatless, shrivelled epiploon was continued from beneath the spleen upon the upper part of the base of the great fold of the colon above mentioned. This enormous fold slipped forwards as soon as the supporting walls of the abdomen were removed, and exposed the large coils of the left descending portion of the colon continued from it, and below and ventrad of these were exposed some of the coils of the small intestine. A part of the left kidney protruding at the angle between the cardiac end of the stomach and the commencement of the descending colon, was covered by a duplicature of peritoneum extending from its ventral surface to the contiguous end of the spleen.

The dorsal border of the left lobe of the liver was attached by a similar duplicature, forming a strong 'ligamentum triangulare' to the contiguous part of the diaphragm. The length of the great fold of the colon taken in a straight line as it lay first exposed was six feet six inches: some idea of its capacity may be formed from the fact that the portion of the fold next the cæcum could easily contain a man, with ample room for him to turn about in it. But the dimensions of the alimentary canal and its several parts will be subsequently given.

Part II.

Digestive Organs. Abdominal Viscera.

The Mouth.—The substance of both the lower and upper lip was composed of cellular and subligamentous tissue permeated in all directions by muscular fibres, and resembling in section the 'corpus cavernosum penis' in the Horse: the skin covering this substance is very thin and vascular in the upper lip. These muscular fibres, which are homologous with the decussating fibres in the proboscis of the Elephant, presented the striated characteristic of the voluntary muscular fibre under the microscope.

The seventh pair of nerves, which was lost principally in the muscles and the above-described contractile tissue of the upper lip, was of large size.

In the male Rhinoceros the tongue measured two feet three inches from the epiglottis to the tip, and seven and a half inches across its broad anterior part: the depth or thickness of the tongue is four inches, at its root. In the female Rhinoceros the tongue measured nineteen inches in length from the epiglottis to the tip. This organ is broad and flat, slightly expanded at its anterior extremity, and becoming narrower and deeper as it extends backwards: there is a small protuberance on the upper surface opposite the posterior grinders, divided by a longitudinal depression: the large fossulate papillæ of the dorsum are principally collected in a group of ten to twelve on each of these risings: the epithelium is disposed on the anterior part of the tongue in a number of very fine close-set pointed papillæ, resembling short hairs: behind the papillæ the epithelium is condensed into a thick callous stratum, which gradually becomes thinner where it covers the posterior glandular part of the tongue. There are no retroverted cuticular processes, as in the Ruminants. There is a lytta beneath the anterior flattened part of the tongue.

A reticulate structure at the sides of the soft palate, having muciparous follicles in the interspaces of the meshes, and many subcompressed conical processes of various lengths, represents the tonsils (Pl. X. *t*, *t*, *t*): the arches of the palate, or 'isthmus faucium,' form on each side a thin sharp fold, which descends obliquely along the sides of the pharynx and terminates insensibly near the sides of the glottis. The soft palate consists of a stratum of muciparous follicles one-third of an inch thick, placed vertically between two layers of mucous membrane; their blind extremities being in contact with the whitish dense membrane lining the nasal or air-passage, their orifices terminating on the soft red and vascular membrane at the roof of the mouth. The constrictors of the pharynx formed at the anterior margin of that canal a thick rounded edge.

The pointed apex of the triangular epiglottis (*Ib. e*) curves forward above the base of the tongue, to which the epiglottis is attached by a pair of strong 'glosso-epiglottidei' muscles.

The alimentary canal.—The œsophagus extends pretty straight from the pharynx to the stomach, with an uniform diameter, in its passive or contracted state, of three inches: its total length was five feet. It extends about six inches into the abdomen after piercing the diaphragm, and terminates at the cardiac orifice about one foot five inches from the left extremity of the stomach. This organ (Pl. XI. figs. 1 & 2) presented the ordinary form of the simple stomach: it was moderately distended with food; with a large obtuse cardiac end, expanding to the cardiac orifice (fig. 2, *c*), opposite to which it presented the greatest circumference; thence contracting to near the pylorus (*ib. p*), on the cardiac side of which the stomach presented its smallest circumference; and then expanding into a blind end, of a hemispheric form, beyond the pylorus. The length of the stomach in a straight line was four feet; its diameter from the cardia to the opposite part of the great curvature was one foot ten inches. The small curvature between the cardia and pylorus was one foot nine inches. There was a glistening aponeurotic sheet (*ib. a*) upon the anterior and posterior surfaces of the contracted pyloric end of the stomach.

A sheet of white thick epithelium spreads from the cardia over the inner surface of the cardiac portion of the stomach, about one foot four inches along the lesser curvature, and along the greater curvature to the extent shown in figure 2, *e*. This epithelial layer is one line thick, smooth, or with very fine rugæ on its inner surface, and terminating by a well-defined border, near which it is perforated by numerous orifices of mucous follicles (*Ib.* fig. 4). The rest of the inner surface of the stomach presents the usual vascular structure, with the more minute orifices of the secerning follicles of the gastric juice. There is no crescentic fold or valve at the cardia, as in the Horse: nor is there any valvular protuberance on the gastric side of the pylorus, as in the Cow and most other Ruminants: the thickened rim of the pylorus was slightly produced into the duodenum.

In the female Rhinoceros the stomach presented the same simple elongated form as in the male, corresponding with the description of its external form given by Cuvier (after Vicq. d'Azyr?)[1]. Its total length in a straight line was thirty-two inches, and the distance from the cardia to the left extremity was fourteen inches. It was distended with a mass of coarsely divided hay mixed with oats. The whole of the cardiac extremity, excepting at one small spot, was lined with a smooth compact layer of thickened epithelium, like that in the male: it extended along the upper or smaller curvature of the stomach half-way between the cardia and the pylorus; its greatest extent from the left end of the stomach being twenty-two inches. The boundary-line between this and the glandular or mucous coat of the stomach was even, but as abrupt and well-marked as in the Horse. The epidermis was very easily detached, and in some places had separated spontaneously, as does the thick epithelial lining of a gizzard soon after death, and it is probable that such spontaneous separation of the cuticle in the Rhinoceros dissected by Mr. Thomas may have induced the belief that it was wanting in that animal[2]. The

[1] Leçons d'Anat. Comp. iii. (1805) p. 392.

[2] "The stomach upon its inside was in every part covered by a secreting surface; whereas in the Horse it is partly cuticular."—*Philos. Trans.* 1801, p. 147.

Indian species agrees, however, in the twofold nature of the lining membrane of the stomach, with the Sumatran two-horned Rhinoceros described by Mr. William Bell[1]. About the middle of the cuticular surface of the stomach of the female there was a small irregular patch of glandular membrane: this was proved to be an original formation, and not an appearance due to a partial separation of the cuticle, by detaching the surrounding cuticular lining and comparing the patch in question with the denuded surface. It is probably, however, but an individual variety, as it was not repeated in the male. The surface of the digestive membrane covering the pyloric moiety of the stomach was even, not broken by rugæ, and it presented the same peculiar smooth, almost polished, appearance which characterizes the peculiar glandular membrane lining the second cavity of the stomach of the Porpoise.

The cardia did not present the semi-spiral valve observable in the Horse. The globular pyloric extremity is suddenly bent upon the rest of the stomach, so as to appear partly separated from it by the entering fold. A thick circular lip projects from the pylorus into the duodenum. The outer layer of the muscular tunic, *a*, is one-fourth the thickness of the inner layer, *b*, and becomes thinner over the pyloric end of the stomach. The nervous or vasculo-cellular tunic, *c*, begins to increase in thickness near the termination of the thick epithelium, *d*, in relation to the increased vascular action required by the functions of the glandular layer, *e*: the relative thickness of this layer is shown in the section, figure 3, *e'*.

The contents of the duodenum were of a greenish black colour and almost fluid consistency: only very few small portions of the vegetable substances appeared in the tract of the small intestines, but the cæcum and colon were tensely distended with a magma of substances like those in the stomach, but of somewhat softer consistence, as if in a further stage of digestion.

	Female.	Male.
The length of the small intestines was . . .	50 feet.	65 feet.
The circumference of the duodenum	8 inches.	10 inches.
The circumference of jejunum	6 inches.	8 inches.
The circumference of ileum	7 inches.	9 inches.

The lining membrane of the duodenum, at the beginning of that gut, was puckered up into small irregular rugæ; the flattened triangular processes, as described and figured by Mr. Thomas, began to make their appearance about six inches from the pylorus (Pl. XII. fig. 1); in the jejunum three or four of the processes are often supported on a common base (*Ib.* fig. 2); as they approach the ileum they begin to lose breadth, and gain in length, until they assume the appearance, near the end of the ileum, of vermiform processes, like tags of worsted, from two-thirds of an inch to an inch in length (*Ib.* fig. 3). Peyer's glands appeared scattered here and there; a very conspicuous reticular patch was situated close to the end of the ileum.

[1] Philos. Trans. 1793. Cuvier does not describe the inner surface of stomach.

The small intestines have nearly the same disposition as in the Horse; they are suspended by a short mesentery, in which the anastomosing arteries form only one series of arches. The mucous membrane of the ileum projects in the form of a circular fold within the cæcum; but it seems inefficient as a valve for preventing regurgitation of at least fluid matters from the large intestines. The length of the cæcum (Pl. XIII. *cæ*) from this orifice to its blind extremity in the male Rhinoceros was three feet, and its greatest circumference was four and a half feet. In the female Rhinoceros the length of the cæcum was two feet; its circumference two feet six inches; these proportions to the colon and the rest of the intestinal canal being rather less than in the Horse. The anterior surface of the cæcum is traversed longitudinally by a fibrous band, four inches broad, upon which it is slightly sacculated: a second band appears, nearer the colon. Its lining membrane was puckered up into innumerable irregular small transverse rugæ, which appear, however, to be but temporary foldings of the mucous membrane, and are easily obliterated when this is stretched. The colon for the first four feet of its extent was puckered up upon three longitudinal bands into sacculi, each about five inches long: it was suddenly bent upon itself at this part, forming the long and large fold (*Ib.* co', co'), the two parts of the fold being very closely connected to each other; it there became dilated into the very wide portion which formed the most prominent object on laying open the abdomen; the beginning of this dilated portion is also closely adherent by its posterior surface to the opposite surface of the beginning of the cæcum. The circumference of this dilated part of the colon (which if permanent, and not due to accidental accumulation of alimentary matter, might be regarded as representing a second cæcum or reservoir,) is five feet: beyond this fold the colon becomes gradually narrower, its smallest circumference being twenty inches, where it passes into the rectum, which forms several short convolutions before its termination.

	Female.	Male.
The entire length of the colon was . . .	19 feet.	25 feet.
The entire length of the rectum	3 feet.	5 feet.

The total length of the intestinal canal, including the cæcum, was in the female seventy-three feet; in the male ninety-six feet, or eight times the length of the entire animal.

The circumference of the rectum was ten inches in the female, and sixteen inches in the male; but it widens towards the anus. The masses in which the fæces are discharged from the immense receptacles formed by the large intestine, are greater than in the Elephant, and are softer and more amorphous.

The longitudinal muscular fibres of the rectum were developed into such powerful fasciculi as to lead me to suspect some change of tissue; but on examining the fibre microscopically, it presented the same absence of aggregation of the ultimate fibres into striated bundles, as in the higher tract of the intestines. The contrast between these fibres in the rectum and those of the external sphincter was well-marked, the latter presenting the striated character of true voluntary muscles.

The herbivorous Mammalia differ from the carnivorous more in the character of their large intestines than of their small intestines. The less putrefactive nature of their food renders it susceptible of a longer retention in the body; and the receptacular and saccular character of the large intestines seems especially designed to retard the course of the alimentary substances. An observation made by the celebrated Surgeon Dupuytren, throws light upon the final purpose of this detention of the food of the Herbivora: he noticed in a patient who had an artificial anus near the end of the small intestines, that the vegetable parts of the food thence ejected were undigested. Dr. Beaumont also observed that the vegetable substances underwent much less change than the animal substances in the stomach of the man (Alexis) with the fistulous opening into the stomach. That organ in the artiodactyles (Peccari, Hippopotamus, and Ruminants) is rendered specially complex for overcoming the difficulty, and the cæcum and colon are comparatively small: but in the perissodactyles (Horse, Tapir, Rhinoceros) the more simple stomach is compensated by the increased capacity and complexity of the large intestines. The subdivided stomach in the Sloths is in some respects, as *e. g.* the glandular appendage, and vascular secerning surface of the paunch, more complex than that of Ruminants: and here accordingly we find the cæcum absent and the colon undefined. These facts should be kept in mind by the Physiologist when he draws from Comparative Anatomy in support of inferences as to the special function of the cæcum in completing the digestion of vegetable food. The Dormouse and other hybernating Rodents are far from being the sole exceptions to the presence of a proportionally large cæcum in the Herbivora: a large cæcum is rather the exception than the rule in the vegetable feeders. It is only found in those Herbivora, in which, through the necessity of a correlation with other circumstances than that of the nature of the food, the stomach retains the simple form and moderate size of that of the carnivorous or mixed feeding mammals. Comparative Anatomy significantly warns us against ascribing a special or exclusive importance to any particular dilatation of the alimentary canal. It plainly demonstrates that neither a complex stomach nor a large cæcum are essential to the digestion of vegetable food: but it teaches that a capacious and complex alimentary canal is essential for that purpose, at least in the Mammalia. Either a highly-developed and concentrated glandular apparatus must be added to the stomach, as in the Dormouse, Wombat and Beaver; or the stomach must be amplified, subdivided or sacculated, as in the Ruminants and herbivorous Marsupials; or both complexities must be combined, as in the Sloths, Dugongs and Manatees; or, if a simple condition of stomach is retained, it must be compensated by a large sacculated colon and cæcum.

Digestive glands.—The liver presented the dark colour noticed by Mr. Thomas in his dissection of the Rhinoceros. In the female specimen which I examined, its texture was as firm as in the Horse, and its weight was 21 lbs. avoirdupois. In the older and larger male its texture was softer and more grumous; and it weighed 44 lbs. avoirdupois. With respect to its form, I did not find an agreement either with the statement of Mr. Thomas[1] or the description in the second edition of the 'Leçons d'Anatomie Comparée,' iv. p. 464 (1836). In both specimens of Rhinoceros the liver was divided into fewer lobes than ordinary, taking the Mammalia generally, yet had a right lobe in addition to the principal bifid lobe and the left lobe, the two latter only being assigned to it by Cuvier. The form of the gland is flattened, as in the hoofed animals generally; its greatest thickness was not more than six inches in the male. Its longest or transverse diameter measured in the female twenty-seven inches, and the length or antero-posterior diameter of the middle lobe seventeen inches. Three great hepatic veins join the inferior cava just below the diaphragm. The strong serous tunic of the liver was beautifully marked by arborescent vessels of a white colour. The 'ligamentum rotundum' and corresponding fold of peritoneum entered as usual into the notch dividing the middle lobe, which might be compared to the cystic lobe in the quadrupeds which possess a gall-bladder. This appendage, however, as in Mr. Thomas's dissection[2], was wanting, as it is also in the other perissodactyle or odd-toed Pachyderms; *e. g.* the Hyrax, the Tapir, the Elephant, and the Horse. In these, as in the Rhinoceros, the absence of the gall-bladder seems to be dependent on the small size of the stomach as compared with the quantity of food taken, to the consequent frequency of feeding, and to the rapid and probably unintermitting transit of the gastric contents through the small intestines to the enormous cæcal and colonic receptacles where digestion and animalization are finally completed[3]. The great biliary duct is formed in the portal fissure by the union of six or seven branches from the lobes of the liver: its diameter is half an inch; it terminates in the duodenum six inches from the pylorus.

The *pancreas* resembles that of the Horse and Tapir: its principal duct (Pl. XIV. fig. 1, *h*) enters the intestine close to the biliary duct (*Ib. a*), communicating therewith in the oblique course between the tunics: the duct of the smaller portion of the pancreas (*Ib. h*) terminates about two inches from the large and protuberant common opening of the preceding ducts, but at the same distance from the pylorus.

The *spleen* is an elongated, subtrihedral, flattened body, lodged in the duplicatures of the short omentum. It weighed 5 lbs. in the male, and 3 lbs. in the female Rhinoceros: in the latter its length was two feet six inches; its greatest breadth one foot; its smallest breadth six inches: in the male it measured three feet six inches in length, one foot four inches in breadth: it resembles in structure that of the Horse.

Kidneys.—The weight of these two glands was about 8 lbs. in the female and 11 lbs. in the male Rhinoceros. In both they had the same situation in the abdomen as in the Horse. They were lobulated, and the extent of subdivision was intermediate between

[1] "It was divided into several lobes."—*Tom. cit.*

[2] See also Cuvier, *loc. cit.* iv. p. 549.

[3] See the excellent remarks by Mr. Youatt in his work on 'The Horse,' 8vo, 1831, p. 212. In the Hog the cæcum is comparatively small.

that which respectively characterizes the kidneys of the Ox and Bear; the average size of the component lobules being two inches[1]. In the female, the kidneys did not resemble each other in form. That on the left side was flattened and semi-ovate, ten inches long, six and a half inches broad, and two inches thick. The right kidney was subtriangular (Pl. XIV. fig. 2), presenting a flattened surface to the broadly expanded ribs on which it rested, and having on the opposite or anterior side two flattened surfaces meeting at an obtuse angle: this kidney was eight and a half inches long, seven and a half inches broad in the female. In the male the kidneys were more symmetrical: the right measured eleven inches in length and seven inches in breadth. The great vein, the artery, and the ureter had the usual relative position near the pelvis of the kidney; the vein being anterior, and the ureter descending behind the artery: this duct presented a diameter of half an inch.

The ureter (*Ib.* fig. 3, *u*) having penetrated the substance of the gland for the extent of an inch, divides into two branches (*Ib. p, p*) at right angles to the trunk: one branch ascends, the other descends, and both together form a long canal which may be called the 'pelvis' of the kidney. Into this canal the common trunks (*Ib. t*) of the radiating 'tubuli uriniferi,' from the several lobes, open without forming any valvular protuberance or 'mammilla.' There is the same facility, therefore, for injecting the 'tubuli' as in the Horse or Tapir.

A white injection of size and flake-white was thrown into the ureter, and forced into the tubuli uriniferi by pressing the injection onwards towards the kidney, and thus alternately emptying the ureter by the finger and thumb, and filling the ureter from the syringe: the tubuli uriniferi were injected as far as the superficies of the gland; and the injection was continued until a few specks of extravasation appeared; but not any portion of injection returned either by the artery or vein.

In the right kidney the tubuli uriniferi were filled, with similar success, and afterwards the emulgent artery was injected with red size injection; this returned by the vein, but did not penetrate any of the branches of the ureter. The tubuli uriniferi form loops at the periphery of the kidney, returning into the cortical substance.

The ureters, which preserve a diameter of about half an inch through their whole course, penetrate the urinary bladder, in the male (at *u*, *u*, Pl. XVI.), a little way above the fundus of the 'vesiculæ seminales,' where they are about six inches apart, but they converge in their oblique course through the thick muscular coat of the bladder. In the female they are more closely approximated at their terminations, which, in the young animal I dissected, were only half an inch apart, and about one line in diameter: their orifices were six inches from the commencement of the urethra. This short tube opened into the urogenital canal (Pl. XVIII. fig. 1, *u*) five inches from the vulva.

[1] The Rhinoceros examined by Mr. Thomas had not attained its third year, which led that gentleman to conjecture that the lobulated structure might be lost as the animal advanced in life (*loc. cit.* p. 148); but the persistence of this structure to the ninth year, in the female, and to the fifteenth year, in the male animal dissected by me, proves that to be a permanent condition of the renal organ in the Rhinoceros, as in some other Mammalia, which is a common fœtal peculiarity in Man.

Suprarenal glands.—These bodies, like the kidneys, differed from each other in form; they were elongated and nearly cylindrical. The right had one extremity bent at a right angle: its length in the female Rhinoceros was three and a half inches; its breadth across the bent extremity two inches: the left was simply elongated, three and a half inches long, one and a half broad and one inch thick. In section they presented an external greyish-yellow fibrous cortex, from one-fourth to one-third of an inch thick, enclosing a fleshy-coloured substance, in the middle of which there was a semilunar portion of the grey fibrous matter: there was no trace of a central cavity. Both suprarenal bodies adhered closely to the contiguous large veins.

The urinary bladder presented nothing remarkable except a very distinct pit or cicatrix, surrounded by a double concentric fold of membrane (Pl. XIV. fig. 4, *a*), where the duct of the allantois originally communicated with the cavity.

Part III.

Thoracic Viscera.

The thoracic viscera presented much the same relative position as in the Horse; the lungs becoming narrow and elongated at the contracted anterior part of the thorax: the distance between the pericardium and the diaphragm was relatively less than in the Horse.

The heart weighed 28 lbs. avoirdupois. The length of the undistended ventricular part was one foot one inch; the breadth of the ventricles was one foot three inches. The pericardium was of great strength. The heart presented the short, obtuse form which characterises it in the Elephant and Tapir.

The superior precaval vena cava receives the right or common vena azygos close to its termination at the upper part of the right auricle: two inches above this it receives the right vertebral vein, which is about half an inch in diameter; two inches above this it is formed by the junction of the left subclavian with the right subclavian vein. At the concavity of the great vein formed by this junction, which concavity crosses the fore part of the aortic arch, the bronchial veins and some small pericardial veins enter the superior cava. The upper part of the superior cava receives the two large jugular veins close together, so that a proper 'vena innominata' can scarcely be said to be formed. The left vena azygos, which is formed by the union of a few superior intercostal veins of the same side, terminates in the left subclavian vein, which receives separately the left vertebral vein from the neck. The right or principal azygos receives the intercostal veins of both sides as far forwards as its entry into the precaval vein; the Rhinoceros in this structure agreeing with the Horse.

The coronary vein receives only a small pericardial vein, which descends along the back of the left auricle, before it terminates with the inferior cava, at the base of the right auricle.

There was no trace of a valve at the orifices, either of the inferior cava or coronary vein; the latter easily admitted the end of the fore-finger. In the right ventricle, the tricuspid valve presented the following attachments:—its strong chordæ tendineæ were distributed to three obtuse and transversely oblong columnæ carneæ, one rising from the external or moveable wall, a second from the septum, and a third smaller one from the anterior interspace between the fixed and moveable wall: the tendons diverged from each column to the two contiguous moieties of the divisions of the tricuspid valve; a provision which ensures the simultaneous action and the outstretching of these three membranous processes. There were besides two smaller columns placed opposite to each other, one on the free and the other on the fixed wall of the ventricle; they were connected together by a single strong tendon passing across the ventricular cavity from the apex of one to that of the other.

The mitral and semilunar valves offered nothing unusual.

The aorta, after giving off two coronaries, each of which freely admitted the fore-finger, ascended and divided at the summit of its arch into the descending aorta and a smaller trunk supplying the head and anterior extremities. The vessels immediately derived from the ascending division were the two internal thoracics[1], the brachials, and the common trunk of the two carotids.

Each lung was divided into a small upper and a large lower lobe; the right lung gave off in addition a transversely elongated narrow azygos lobe. The superior lobe of each lung was characterized by numerous deep marginal notches, which gave it an appendiculated character. The lining membrane of the branches of the bronchiæ presented very strongly marked longitudinal rugæ; that of the trachea was similarly disposed. After reflecting the pleura from the surface of the lung, a thin extensible stratum of condensed cellular tissue continuous with the interlobular cellular tissue could alone be perceived. Between the pleuræ and the parietes of the chest was much elastic tissue.

The cartilaginous hoops of the trachea are stout and close-set; they meet posteriorly, but their extremities do not coalesce; their number was 31. The diameter of the windpipe is two inches and a half, being not greater than that of the Lion.

The larynx consists of the thyroid (Pl. XV. *th*), cricoid (*Ib. c*), and arytenoid (*Ib. a*) cartilages, of the epiglottis (*Ib. e*), and of a small sesamoid fibro-cartilage (*Ib.* fig. 1, *k*) developed in the commissure of the 'arytenoidei transversi' and 'obliqui,' here blended together; but there is no trace of the cartilages of Santorin or Wrisberg. The wings of the thyroid cartilage meet at a slightly obtuse angle, contrary to their usual disposition in the Hog tribe and Ruminants: there is no notch at the upper margin of the anterior median line; but there is a considerable triangular vacancy below, filled

[1] The intercostal spaces above or anterior to the heart, are numerous in proportion to the narrowness of the chest, which obliges the heart to be placed nearer the diaphragm; and the internal thoracics, which are of insignificant size in Man, are there largely developed in order to supply those intercostal spaces, which, from the position of the heart, cannot receive their arteries directly from the trunk of the aorta.

up by dense elastic and aponeurotic membrane, to which yielding walls of the larynx some of the fibres of the thyreo-arytenoidei muscles adhere. The arytenoid cartilages are relatively of large size; their base extends half-way across the aperture of the larynx, and from the anterior extremities of these produced bases, the upper (Pl. XV. fig. 1, *u*) and lower (*Ib. v*) 'chordæ vocales' extend forwards to the thyroid cartilage and base of the epiglottis. Only the anterior half, therefore, of the 'rima glottidis' is bounded by vibratile vocalizing material, and the ordinary feeble bleat of the Rhinoceros (like that of a calf) is what might be expected to be produced by such a structure.

On each side, between the upper and lower chordæ vocales there is the opening of a large sacculus laryngis, which communicates anteriorly with a crescentic fossa under the base of the epiglottis. A fold of membrane (Pls. X. & XV. *l*) extends on each side from a small fibro-cartilage (*f*), at the inner or under side of the base of the epiglottis, downwards, inwards, and forwards to the anterior termination of the chordæ vocales, *u* and *v*: these oblique folds form the inner or posterior walls of the anterior fossæ of the sacculi laryngis.

The anterior or superior labia (Pl. XV. fig. 2, *m*) of the glottis form two broad, thick, slightly everted folds of mucous membrane.

In the mass of muscles (Pl. XV. fig. 2, *o*, *o*) attached to and passing between the arytenoid cartilages, there are developed about twelve tendons which radiate to be inserted into the central sesamoid cartilage before mentioned.

The epiglottis (Pls. X. & XV. *e*, *e*) is of a triangular figure, with the pointed apex curved forwards, and having strong glosso-epiglottidei muscles attached to it.

The thyroid gland consisted of two elongate, subtriangular lobes extending from the sides of the larynx to the fourth tracheal ring; diminishing as they descend and united by a very thin and narrow strip continued between their inferior extremities, obliquely across the front of the trachea. The structure of this body is more distinctly lobular than is usually seen; a small compact yellow glandular body was attached to the thyroid at the point where the veins emerge.

Part IV.

Generative Organs.

Male organs.—The cremaster is a very powerful muscle, and consists of coarse carneous fasciculi in two flattened masses, one crossing the other obliquely as they escape with the spermatic chord beneath the arch of the abdominal ring. A cluster of lymphatic glands with much tough elastic cellular tissue fill up the rest of the ring. The cremaster at this part measures one inch and a half in breadth and half an inch in thickness.

The external inguinal position of the testis in close contact with the abdominal rings, has already been described. The tunica vaginalis communicated freely with the peritoneal cavity. Each testis presented an oval figure, seven inches in length, four inches and a half in breadth, and four inches in thickness. It is surrounded by a strong and thick 'tunica albuginea.' On making a section into the gland along the line of attachment of the epididymis, the 'corpus Highmorianum' was exposed, in the form of a moderately thick white band, continued from the end of the gland where the efferent vessels pass out to form the 'caput epididymidis,' along the whole longitudinal axis of the gland. From this almost ligamentous band or centre of the cellular framework of the gland, the septal layers diverge to all parts of the external tunic of the testicle, forming the compartments in which the lobes of aggregated 'tubuli seminiferi' are lodged. The branches of the spermatic artery, on penetrating the tunica albuginea, pass directly to the corpus Highmorianum, and their ramifications diverge thence, supported by the radiating septa, and form a rich network upon the inner or vascular layer of the capsule of the testis.

The vas deferens enters the inguinal canal surrounded by the vessels and especially by the plexiform veins of the spermatic chord, and on entering the abdomen is received in a peritoneal fold and is conducted to the side and then to the back part of the urinary bladder, passing between the bladder and the ureter: having got to the inner side of the termination of the ureter, the vasa deferentia (Pl. XVI. fig. 1, *vd*, *vd*) descend straight, slightly converging, to the middle of the back part of the prostate: they penetrate that gland, together with the ducts of the vesiculæ seminales, lying to the inner side of these; and, communicating with them, the common duct on each side finally terminates by a minute pore (Pl. XVII. fig. 4) upon the crucial verumontanum. The vasa deferentia are thickened to about thrice their ordinary diameter in the last three inches of their course; but their canal or area is not proportionally dilated; it is, on the contrary, rather contracted, by the thickness of the cellulo-glandular parietes to which the enlargement of the duct is due.

The vesicular glands or 'vesiculæ seminales' (Pl. XVI. fig. 1, *vs*, *vs*) present an elongate subcompressed pyriform shape, eight inches in length, and three inches and a half across the broadest part of the fundus. They have a lobulated exterior, and a structure very similar to that of the same bodies in Man.

The prostate (*Ib. pr*, *pr*) is much less compact than in Man and more resembles that of many Rodents, being composed of an aggregate of long slender cæcal tubes with glandular walls, converging to the ducts of the vesiculæ and vasa deferentia, and opening by numerous minute apertures on the verumontanum (Pl. XVII. fig. 4). The breadth of the prostate is six inches; its antero-posterior extent four inches: it does not quite surround the beginning of the urethra, but is closely applied to the back and sides of that canal.

The muscular or membranous part of the urethra, *m*, extends about three inches from the prostate before it joins the bulbous and cavernous portions, close to which are situated two large subcompressed oval Cowperian glands (*Ib.*, *c*, *c*). Each of these measures three inches and a half by two inches and a half. The structure of the corpus cavernosum resembles that of the Horse.

The great plexus of veins above the dorsum penis near its root, was enveloped in a mass of elastic tissue, like the 'dartos' of the human scrotum.

The fleshy part of the 'levatores penis' (Pl. XVII. *ll*) measures fourteen inches in length, five inches across their basal origin, and between one and two inches in thickness. Their oblique origin is extended over the space of one foot from the ento-pelvic part of the pubis down to the ischium. The tendinous part of the muscle commences where the pubic portion joins the ischial portion of the muscle at the inner and under border of the fleshy part: it is half an inch thick at its commencement, but expands as it extends along the muscle, the fleshy fasciculi of which are inserted into the tendon in an obliquely converging, or semi-penniform manner. As the tendon augments in breadth, it diminishes in thickness, converging towards its fellow, which it meets and joins two inches before the anterior termination of the fleshy portion. The two united flattened tendons beyond are gradually converted into a round chord of ligamentous substance an inch in diameter. This chord (*Ib. l'*) glides through a strong, slightly elastic aponeurotic sheath along the median groove of the dorsum penis; it is connected with the inner surface of the sheath by a highly elastic cellular tissue; the chord maintains its ropelike character along the basal third of the glans (*Ib. l''*), then subsides, expanding laterally, and is finally lost upon the firm capsule of the glans. There is no 'os penis.'

The nerves of the dorsum penis, the arteries, and trunks of two large plexuses of veins, pass beneath the bridge formed by the confluence of the tendinous and muscular parts of the 'levatores penis' and between the two suspensory ligaments of the penis. These ligaments are an inch in breadth, and one-third of an inch in thickness at their origin from the ischio-pubic arch a little in advance of the ligamentous attachments of the crura corporis cavernosi.

The total length of the undistended penis is three feet nine inches; the circumference of the prepuce is one foot five inches.

The external and constantly exposed firmer tegumentary part of the prepuce has been already described, and is figured in Pl. IX. fig. 4.

The substance of the large reflected preputial fold of softer integument (Pl. IX. fig. 5, and Pl. XVII. fig. 1, *pr*) is from half an inch to two-thirds of an inch in thickness, and consists of a moderately compact cellular corium, with a delicate epiderm, minutely rugose in the transverse direction, and perforate or punctate with the pores of the mucous follicles which are very regularly dispersed at intervals of about a quarter of an inch.

The glans penis (*Ib. ib. gl*) is a long and slender subcompressed cone with a truncate apex; it measured in its flaccid undistended state, one foot in length: the prepuce is reflected upon its base at the same transverse or circular line, and there is no frænum. The apex (Pl. IX. figs. 5 & 6, and Pl. XVII. figs. 1, 2 & 3, *a*) is not simple, but resembles a mushroom on a thick peduncle (fig. 3, *p*) projecting from an excavation (*Ib. e, e*) at the end of the glans with a thin wall or border, like a second prepuce; but this is of the same structure as the rest of the firm surface of the glans

On each side of the base of the glans, and rather towards its under part, there is a longitudinal thick oblong ridge or lobe (Pl. IX. figs. 5 & 6, and Pl. XVII. fig. 1, *r, r*), three inches and a half in length, and eight lines in basal thickness: the thick rounded free border of each lobe inclines downwards.

Mucous follicles similar to those on the under surface of the prepuce extend from the attachment of that fold along one half of the interspace of the lateral lobes. The depth of the preputial fold is least on the dorsal side of the glans. On each side of the base of the glans, near the dorsum, the follicles extend along a space of two inches from the root of the prepuce, but do not occur on the middle line. A narrow ridge commences in the median space of the 'dorsum glandis,' which increases in height as it advances forwards, and then subsides two inches from the border of the terminal or apical fossa. The projecting border of this fossa (Pl. XVII. figs. 2 & 3, *e, e*) describes a compressed oval, and is attached to the pedunculated appendage (*Ib. p, a*) by a process, like a frænum (*Ib.* fig. 3, *f, f*), continued upon the middle line of both the upper and under surfaces of the thick peduncle (*Ib. p*): the fossa between this peduncle and the free external border is not less than two inches in depth on each side; the upper or dorsal border of the fold is three times the breadth of the under one. The stem *p* of the terminal expanded discoid appendage *a* is subcompressed with an oval section, one inch in long diameter, where it supports the terminal disc two-thirds of an inch across. The disc *a* is ovate, one inch eight lines long by one inch across its broader inferior part, where it extends farthest from the supporting stem. The urethra (*Ib. u*) is perforated in the middle line of the terminal disc between its middle and upper third.

The lateral lobes (*Ib.* fig. 1, *r, r*) consist chiefly of erectile tissue; and all the parts of this singularly complex glans are much altered in size, and somewhat also in shape, during erection (see Pl. IX. figs. 4, 5 & 6).

Female Organs.—The ovaria are included within a large peritoneal sac (Pl. XVII. *o, p*) communicating with the general abdominal cavity by an opening which is three inches wide. They are compact, oblong, flattened bodies, with a smooth surface, as might be expected from the immature age of the animal. The left ovarium measured three inches and a half in length, by two inches and a half in breadth: the right was somewhat smaller. The external capsule of the ovarium is stout and unyielding, and the serous covering has the appearance of being strengthened by tendinous lines, one of which runs in a curved direction across the anterior part of the ovary, having other shorter lines diverging from it. The stroma ovarii is also dense. Three ovisacs or Graafian vesicles were dissected out of each ovarium: of these one was an inch in diameter, with very dense thick dark-coloured parietes; the rest had a diameter of two-thirds of an inch, with thinner coats. Their contents were examined with great care under the microscope, but the granular layer was evidently broken up by decomposition, and the ovulum was invisible. The animal had been dead a fortnight.

The Fallopian tubes or oviducts commence by wide orifices having a richly fimbriated margin (Pl. XVII. *f*, *f*); their diameter at the expanded end equals two-thirds of an inch, but gradually diminishes in size as the tube passes in a slightly tortuous course along the parietes of the ovarian capsule towards the uterus; just before they enter the cornu uteri their diameter does not exceed one-third of a line; they terminate in the extremity of the cornu upon a valvular protuberance about the size of a pea, which is divided into four or five processes (*Ib. p*). The inner surface of the oviduct is augmented by short irregular longitudinal folds or processes of the lining membrane. Each oviduct is fourteen inches in length.

The cornua uteri (*Ib. u'*, *u*) are each seventeen inches in length, and uniformly about an inch in diameter; their area is occupied by close-set longitudinal folds of the lining membrane, about a quarter of an inch in breadth, and having a wavy irregular free margin. There is no appearance of processes for the attachment of cotyledons. Where the cornua join the body of the uterus, the crenation or scalloping of the longitudinal folds becomes shorter and deeper. The length of the common uterus (*Ib. c u*) is about one and a half inch. The surface of its lining membrane is smooth, and presented, when first exposed, a leaden hue. The place of the 'os tincæ' is occupied by a complex and remarkable structure, which will be described as it was traced from the vagina towards the uterus.

A large transverse semilunar fold (*Ib. f*, *f*) projects from the upper and lateral parts of the vagina; the upper and broadest part of the fold is one inch; it gradually diminishes as it descends on each side, and the cresses are lost about four inches from the vaginal orifice, and about an inch and a half from the middle line of the lower surface. About an inch above this fold, or nearer the uterus, a second and smaller fold is formed, which also descends from the upper and lateral walls of the vagina, but passes across in an oblique direction. Then follow in quick succession a series of shorter, but equally broad semilunar folds (*Ib. f'*, *f'*), which become alternate in their relative position as they approach the uterus, so as to cause the vagina to assume a spiral course not very unlike the disposition of the intestine in the Shark. As these valvular folds also assume a thicker, softer, and more vascular texture as they approach the uterus, it is by no means easy to determine where the vagina ends or the uterus begins. Measuring from the thickest fold which most resembles an os tincæ, the common uterine cavity does not exceed two inches in length: and in this short extent, compared with the cornua, the Rhinoceros resembles the Elephant.

The form, size, and relative positions of the vulval and preputial orifices have been already described. The length of the common or urogenital canal (*Ib. v*, *ug*) was four inches; its diameter about three inches. On each side, and about one inch and a half from the external outlet, were situated the apertures of the Malpighian or mucous canals (*Ib. m, m*). The diameter of the orifice was about a line, but as the canals passed inwards in the parietes of the urogenital passage, they widened to the diameter of from two to three lines. At about three inches, distance from their outlet they branched off into two or three smaller divisions, from which a glairy mucus could be expressed, and these again subdivided and terminated in blind secerning cæca applied to the outside of the commencement of the vagina. The orifice by which the vagina (*v*) communicates with the uro-genital canal is small in proportion to the width of that canal, and its area is diminished by several short oblique longitudinal folds, whose free edges project into it: the whole of this contracted orifice may be regarded as a form of hymen, beyond which the vagina rapidly dilates in the wide canal represented at *v*, *v*, Pl. XVIII.

Part V.

Nervous System.

Of this part of the Anatomy of the Rhinoceros the opportunities for making observations were limited to the structure of the Brain and the Eye.

The brain of the full-grown male (Pl. XIX. XX. & XXI.) weighed, when deprived of its membranes, 1 lb. $14\frac{1}{2}$ oz. avoirdupois, its proportion to that of the entire body being as 1 to 164.

An upper view of the natural size is given in Pl. XIX. fig. 1, a side view in fig. 2, and a base view in Pl. XX.

The cerebral hemispheres present a subdepressed semioval form, broader behind, and narrower in front than in the Horse, and presenting fewer and larger convolutions. Their disposition resembles that in the larger hoofed mammalia generally; converging from behind forwards as far as the anterior third of the cerebrum, and thence diverging as they extend forwards, but in a minor degree than in the Horse or Ox.

In the view of the base of the brain (Pl. XX.), the large external crura *p*, and internal crura *q*, of the rhinencephalon or olfactory ganglia, 1, 1, are shown, together with the protuberance *r*, which lies between the two crura. The chiasma of the optic nerves is shown at 2, 2; the infundibular base of the hypophysis cerebri at *k*; the single mass representing the corpora candicantia at *l*; the crura cerebri at *i*, and the third pair of nerves at 3, 3. The obtuse apices of the 'protuberantiæ natiformes,' *o*, are less broad than in the Ox, and more resemble the shape of the same parts in the Horse.

The cerebellum shows the small lobes, called 'flocci,' at *h*; and the inferior convolutions at *g*. The olivary tracts make a very slight prominence at *d*; the pyramidal bodies are better defined, but are crossed by some superficial transverse fibres near the pores *f*: and the 'corpora trapezoidea,' *e*, are defined. The inferior 'vermiform process' of the cerebellum is more regular and better defined than the superior one: it is shown at *v*, fig. 4, Pl. XXII.

The relative longitudinal extent of the great commissure or 'corpus callosum' is shown at *s*, *s*, in the view of the vertical section of the brain of the female Rhinoceros given in Pl. XXII. fig. 1. A septum lucidum, *q*, of moderate extent, connects the under surface of the anterior half of the corpus callosum with the fornix: in the same section the optic thalami are seen at *o*; the 'plexus choroides' at *p*; and the mass of the quadrigeminal bodies at *k*. The arrangement of the grey and white matter in the lobes and lobules of the cerebellum, forming the 'arbor vitæ,' *a*, is also shown: this is less complex than in the Horse.

The lateral ventricle is laid open by the removal of its outer wall to show the size and shape of the great hippocampus at *n*, fig. 2, Pl. XXII.; and in the same figure are shown the 'plexus choroides' *p*, passing through the 'foramen Monroianum' *m*, beneath the crura of the fornix and the outer lamina of the septum lucidum, *q*. The left lateral ventricle is laid open from above to show the proportions of the 'corpus striatum' *f*, with the hippocampus *i*, and the intervening part of the fornix, covering the optic thalamus *h*, together with the 'plexus choroides' *p*. In Pl. XXI. the corpus callosum *s*, *s*, has been bisected and the hemispheres divaricated to show the forms and proportions of the bigeminal bodies; of which the posterior pair *b* are broader but shorter than the anterior ones *a*. The pineal gland is shown at *n*; the optic thalamus at *h*; the 'plexus choroides' at *p*; and the 'corpus striatum' at *f*.

The commencing decomposition of the inner substance of the brain prevented the better definition of some of the other parts of this organ.

The common anastomotic trunk of the basilar or vertebral arteries, after traversing the median line of the pons, gives off a pair of arteries at right angles, which cross the crura cerebri between the pons and the third pair of nerves: a second pair of transverse branches is sent off just anterior to the former, and receive the anastomosing longitudinal branches from the ento-carotids which complete the circle of Willis. From the ento-carotid parts of the circle, a branch is given off to the interspace between the middle and anterior lobes of the cerebrum, where it divides into three or four branches.

The eyeballs are of small comparative size; each measured in antero-posterior diameter one inch five lines, and in transverse diameter one inch three lines. Some dark-brown pigment lies under the conjunctiva for the extent of about a line from the circumference of the cornea: the same kind of pigment is also deposited upon the outside of the nictitating eyelid, and over a great part of the inner surface of the same part, covered of course by a reflection of the conjunctiva. The trunks of the venæ vorticosæ perforate the sclerotica half-way between the entry of the optic nerve and the edge of the cornea. I injected one of these veins with mercury, which immediately returned by vessels perforating the sclerotica near the optic nerve. The disposition of the venæ vorticosæ, with the flocculent but somewhat firm connecting tissue of their radiating branches, presented that structure which most nearly resembled the figures given by Mr. Thomas of the parts he describes as "processes having a muscular appearance, with the fibres running forwards in a radiated direction[1]." There are no fibres accompanying the radiated branches of the veins, showing the striated character of voluntary muscle under the microscope. Mr. Thomas found that "the ciliary processes were affixed to the crystalline lens;" but on removing the anterior part of the sclerotica, whilst the eye was suspended in spirit, both the vitreous humour and the lens rolled out; and the capsule of the lens showed no particular mark of the insertion or fixation of the ciliary processes; their impressions, in remains of pigmental matter, were perceptible on the anterior part of the canal of Petit. The transverse diameter of the lens was six lines, the antero-posterior diameter four lines. Mr. Thomas also states that "the pigment was confined to the inside of the choroid[2]." But in both Rhinoceroses dissected by me, I found on the outside of the chorion much loose cellular tissue, with dark pigment: this coloured flocculent tissue concealed at first the venæ vorticosæ, even when injected. The sclerotica is one line thick at the back part of the eyeball; and is thinnest near the middle of the ball, becoming thicker towards the cornea, which is two lines thick. The choroid adheres pretty strongly to the back part of the sclerotic, around the entry of the optic nerve, both by the entering vessels and by the tenacity of its outer flocculent coat, especially where the vessels penetrate the sclerotica. There is no tapetum lucidum. The lower eyelid has a special depressor muscle.

DESCRIPTION OF THE PLATES.

All the parts are of the natural size except when otherwise expressed.

PLATE IX.

Fig. 1. Metacarpal gland.
Fig. 2. Metatarsal gland, laid open.
Fig. 3. Excretory orifice of the gland.
Fig. 4. External prepuce during the ordinary retracted state of penis (one-sixth natural size).
Fig. 5. Penis as protruded when this retromingent quadruped stales (one-sixth natural size).
Fig. 6. Glans penis, or the portion uncovered by the prepuce, when the organ is in a state of erection (one-sixth natural size).
Fig. 7. External parts of generation in the female (two-thirds natural size).
Fig. 8. The two teats.

PLATE X.

Fig. 1. Right tonsil, epiglottis, and back part of larynx.

[1] Philosophical Transactions, 1801, p. 150. pl. 10. figs. 1, 2, 3. [2] Ib. p. 150.

Fig. 2. Inner surface of left side of the larynx laid open; a part of the accessory fold of membrane *l*, and of the lower 'vocal chord' *v*, of the right side are preserved and turned forwards: *f*, accessory fibro-cartilage; *u*, upper 'vocal chord'; *th*, thyroid cartilage; *cr*, cricoid cartilage; *tr*, first tracheal ring; *e*, epiglottis.

PLATE XI.

Fig. 1. Outer surface of the stomach, with the serous tunic partially reflected to show the two decussating muscular layers (one-eighth natural size).

Fig. 2. Inner surface of the stomach (one-eighth natural size).

Fig. 3. Section of the coats of the stomach at the junction of the epithelial with the gastro-mucous linings.

Fig. 4. A portion of the inner surface of the stomach, showing the follicular structure at the termination of the cardiac epithelium.

PLATE XII.

Fig. 1. Portion of the inner surface of the beginning of the jejunum.

Fig. 2. Portion of the inner surface at the end of the jejunum.

Fig. 3. Portion of the inner surface near the end of the ileum.

PLATE XIII.

The cæcum, colon, and beginning of the rectum (one-tenth natural size).

PLATE XIV.

Fig. 1. The inner surface of the duodenum, showing the terminal orifices of the biliary and pancreatic ducts.

Fig. 2. The inner surface of the fundus vesicæ, showing the allantoic or urachal cicatrix.

Fig. 3. Outside view of the right kidney (one-third natural size).

Fig. 4. View of a portion of the pelvis of the kidney, with the beginning of the ureter.

PLATE XV.

Fig. 1. Back view of the larynx, showing, *th*, thyroid cartilage; *c*, cricoid cartilage; *a a*, arytenoid cartilages; *e*, epiglottis; *d*, *crico-arytenoidei* muscles, the

left reflected; *o*, the right *arytenoideus*, reflected; *e*, *thyro-cricoideus*; *c*, articular tubercle, with a synovial surface for the joint with the base of the arytenoid cartilage.

Fig. 2. Back view of the larynx, showing in addition to the foregoing,—*k*, the commissural cartilage of the *arytenoidei* muscles *o o*; *g*, the right *thyro-arytenoideus*; *m*, the superior labia of the glottis; *n*, the upper 'chorda vocalis'; *v*, the lower 'chorda vocalis' bounding the entry of the laryngeal sac; *f*, the fibro-cartilage giving attachment to the epiglottideal fold of membrane *l*, which bounds the upper part of the suprachordal sacculus.

PLATE XVI.

The urinary bladder, vasa deferentia, vesicular, prostatic, and Cowperian glands (one-fifth natural size). The letters are explained in the text.

PLATE XVII.

Fig. 1. Muscles of the penis: *c*, crura penis; *pr*, reflected prepuce; *gl gl*, glans penis; *r*, lateral lobes of glans; *a*, terminal appendage of glans; *l l*, carneous mass of *levatores penis*; *l'* beginning, and *l''* insertion of the common tendon of the *levatores*, which runs along the 'dorsum penis'; *t t*, retractores penis.

Fig. 2. Front view of terminal fossa, and appendage of the glans penis: *u*, the orifice of the urethra.

Fig. 3. Oblique view of the same parts, showing, *e e*, the borders of the fossa; *p*, the peduncle of *a*, the discoid appendage; *f f*, its upper and lower fræna; *u*, urethral orifice.

Fig. 4. Part of the 'cervix vesicæ' showing the common orifices, into which bristles are inserted, of the vasa deferentia and vesicular glands, upon the crucial verumontanum; and the smaller excretory pores of the prostatic lobes.

PLATE XVIII.

The female organs of generation (one-fifth natural size): *op*, ovarian capsules; *f*, fimbriæ of oviduct; *p*, valvular papilla on which the oviduct terminates in the uterus; *u' u*, cornua uteri, the left laid open; a probe is passed through the coats of the right cornu to show the place of confluence of the cornua with the 'corpus uteri'; *f f'*, valvular folds of 'cervix uteri' and 'fundus vaginæ'; (the complex glans penis has, probably, relation to this structure;) *v v*, vagina; *u*, the urethra, beyond the hymeneal constriction dividing the vagina from the uro-genital canal; *m m*, Malpighian canals, the left laid open—bristles are inserted into both; *vu*, vulva and clitoris.

PLATE XIX.

Brain of the male Rhinoceros.

PLATE XX

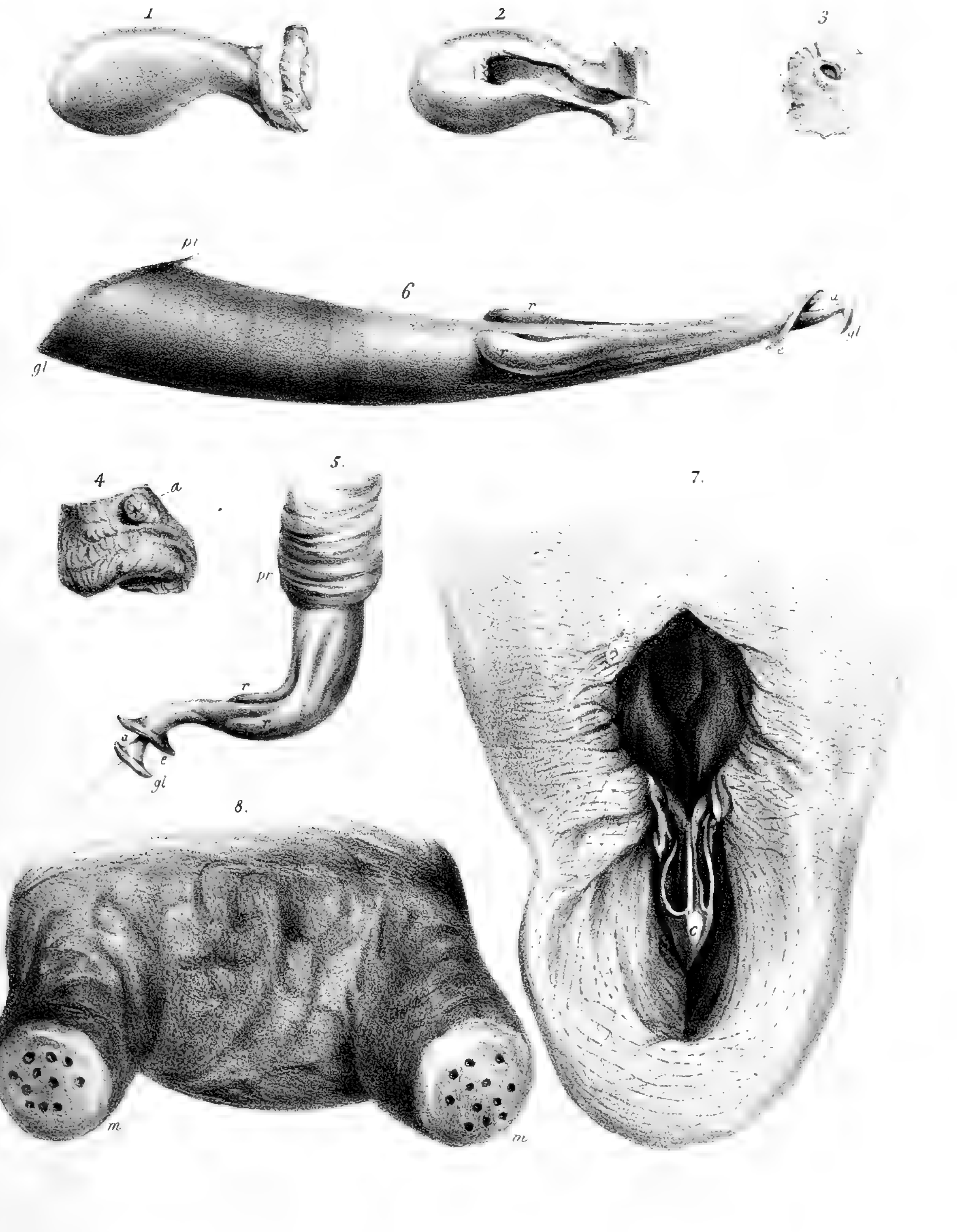
Base of the brain of the male Rhinoceros.

PLATE XXI.

Dissection of the brain of the male Rhinoceros.

PLATE XXII.

Dissections of the brain of the female Rhinoceros. The letters are explained in the text.



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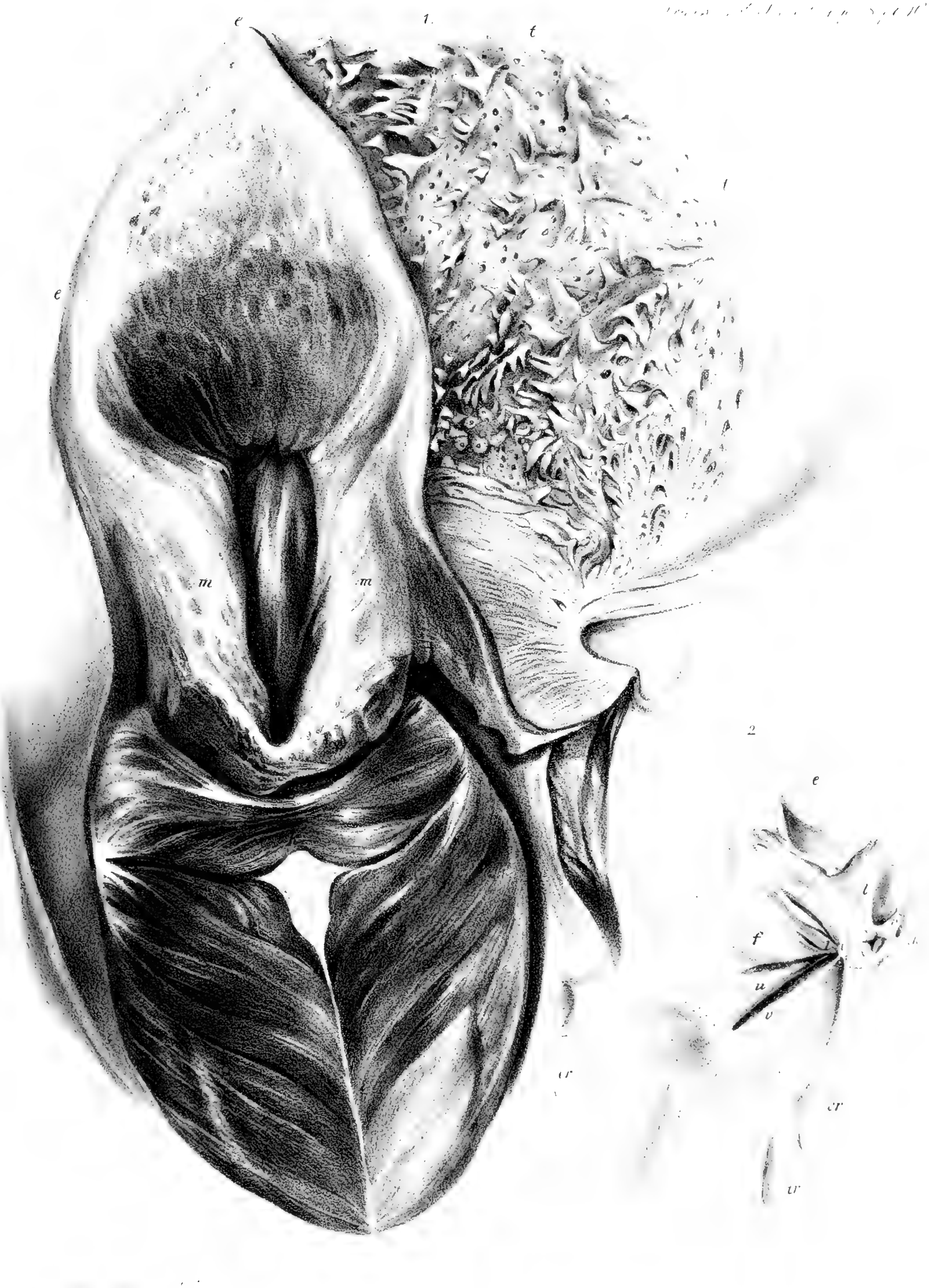

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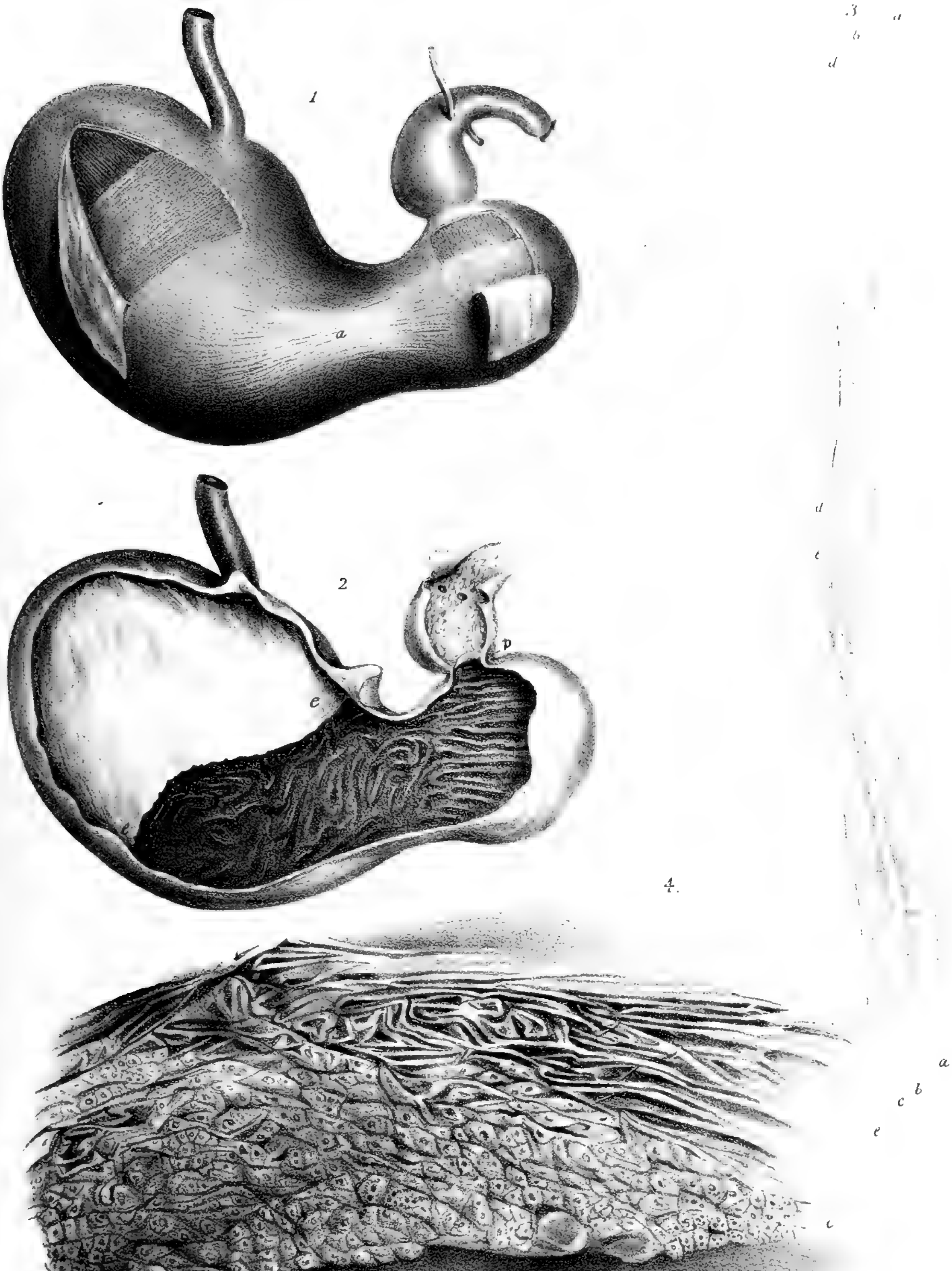

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Rhinoceros Indicus.

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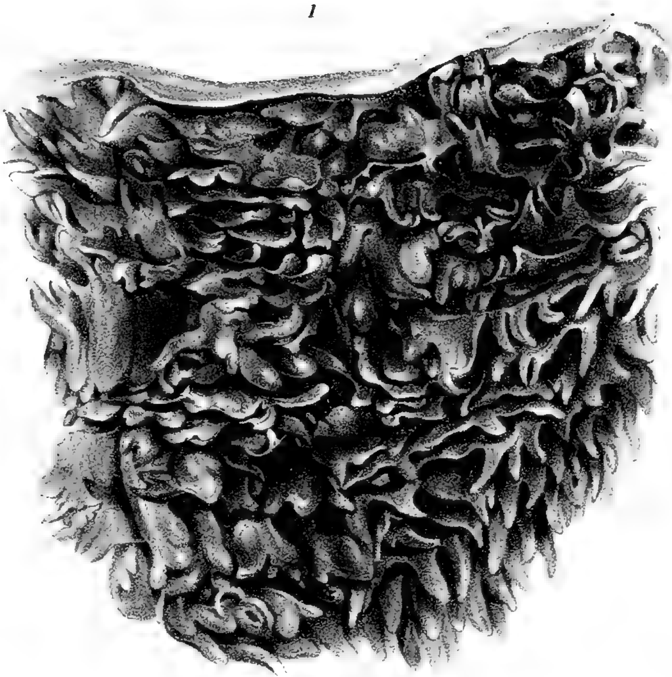

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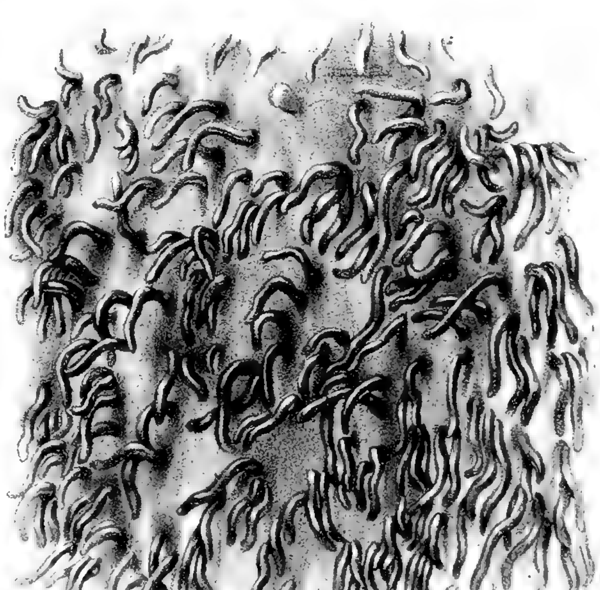

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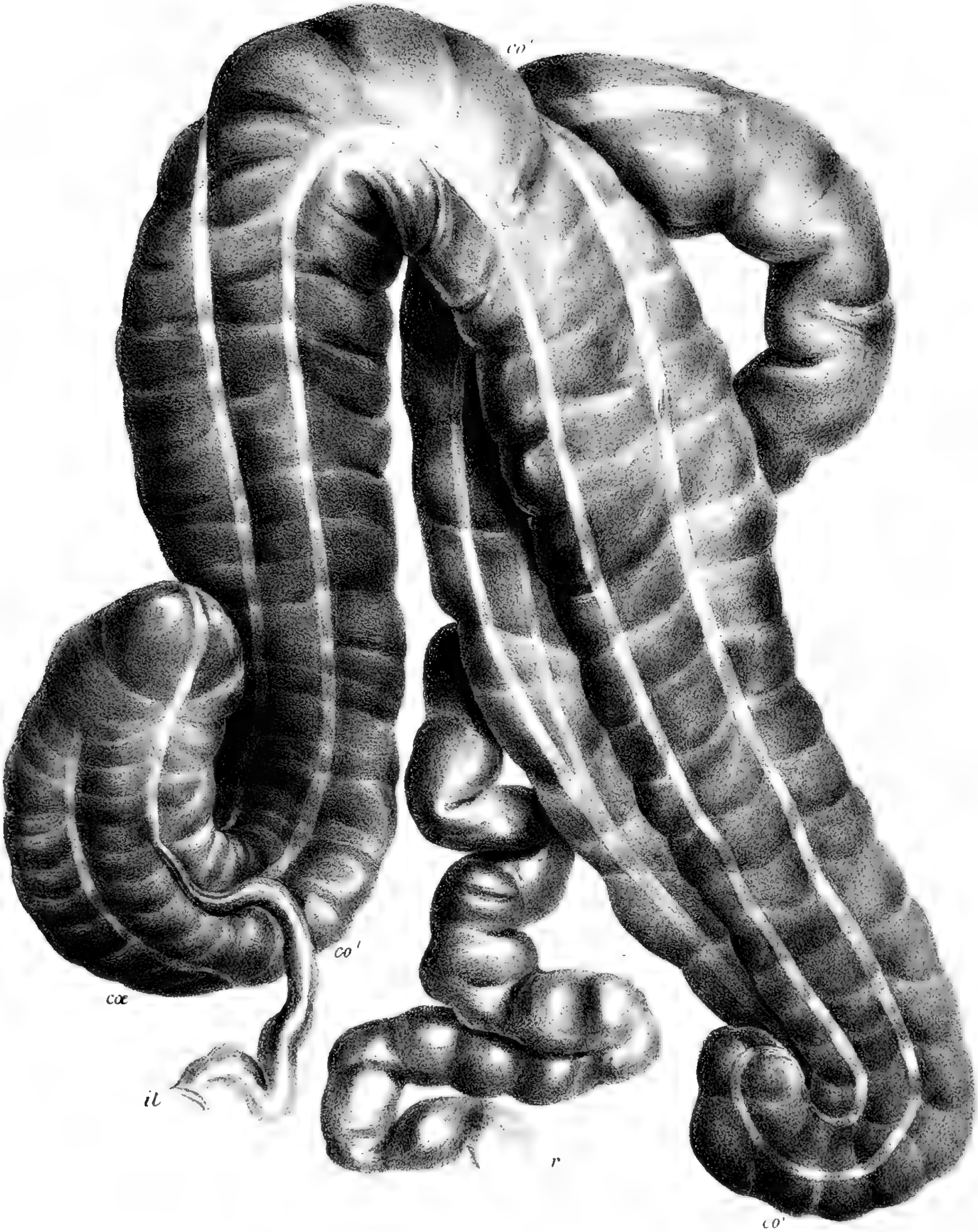

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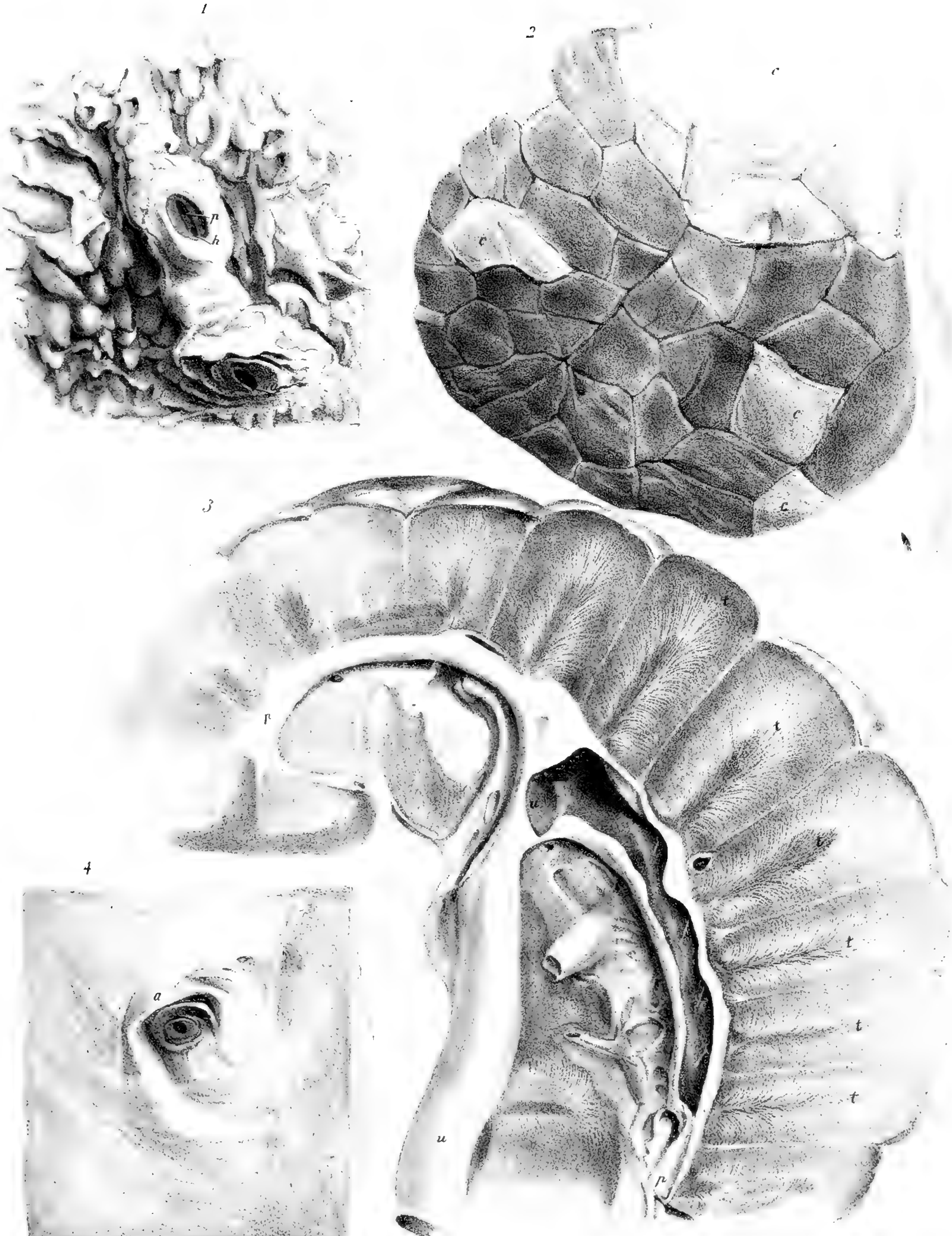
Rhinoceros Indicus.



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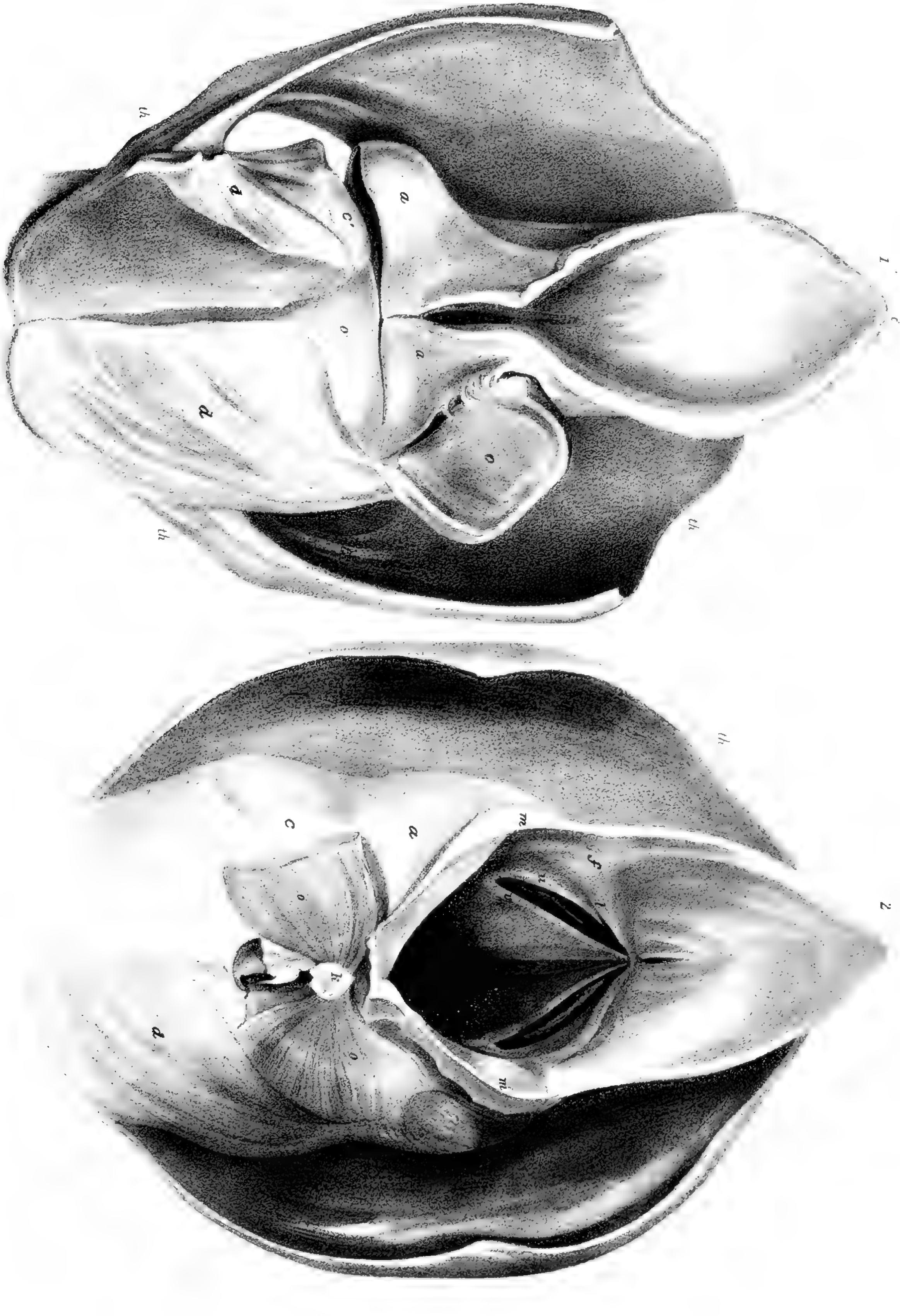
Rhinoceros Indicus.

Trans. Zool. Soc. Vol. 4. p. 58. pl. 15



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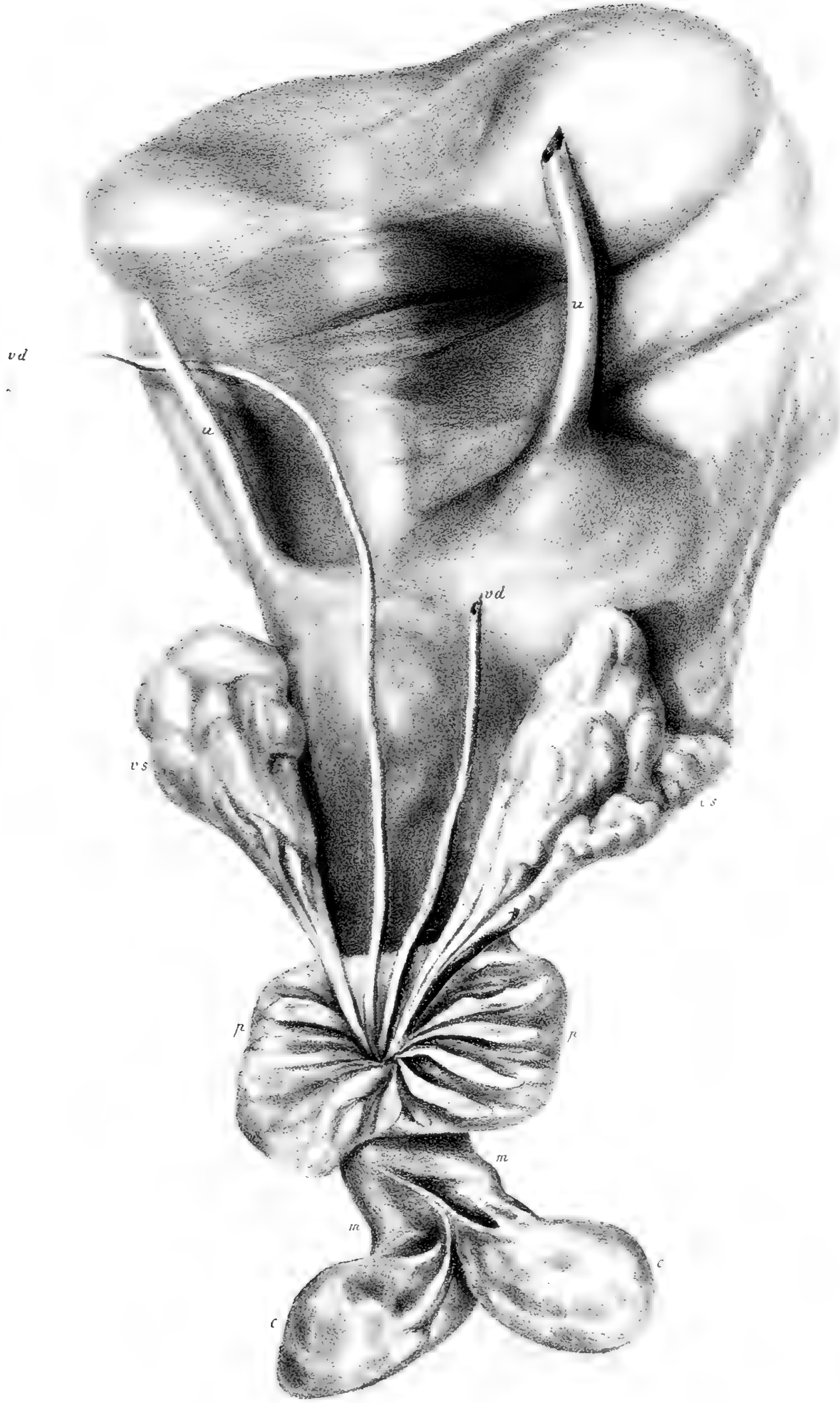

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Rhinoceros Indicus

Vol. I p. 58. pl. 17

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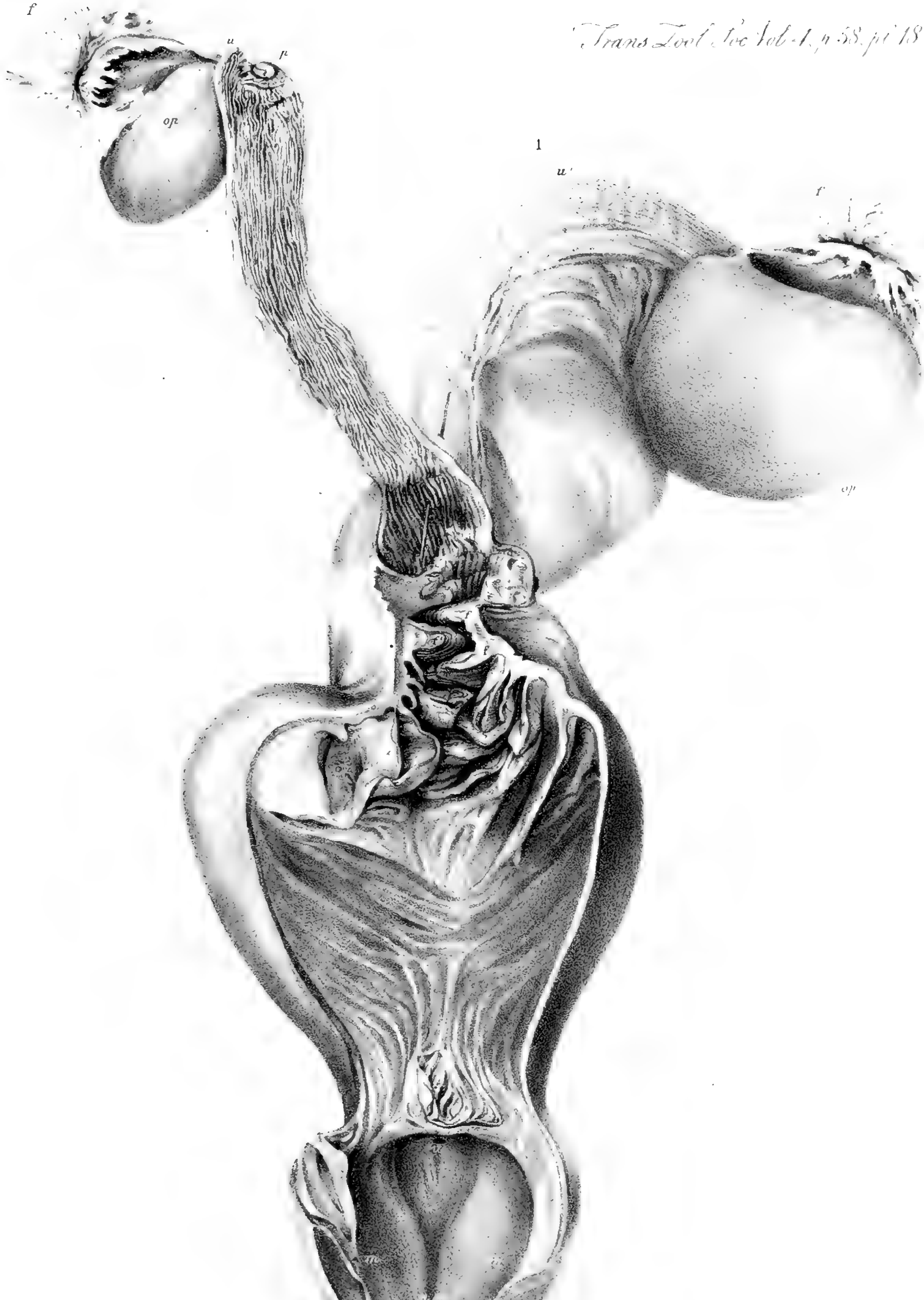
Rhinoceros Indicus.



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Rhinoceros Indicus.

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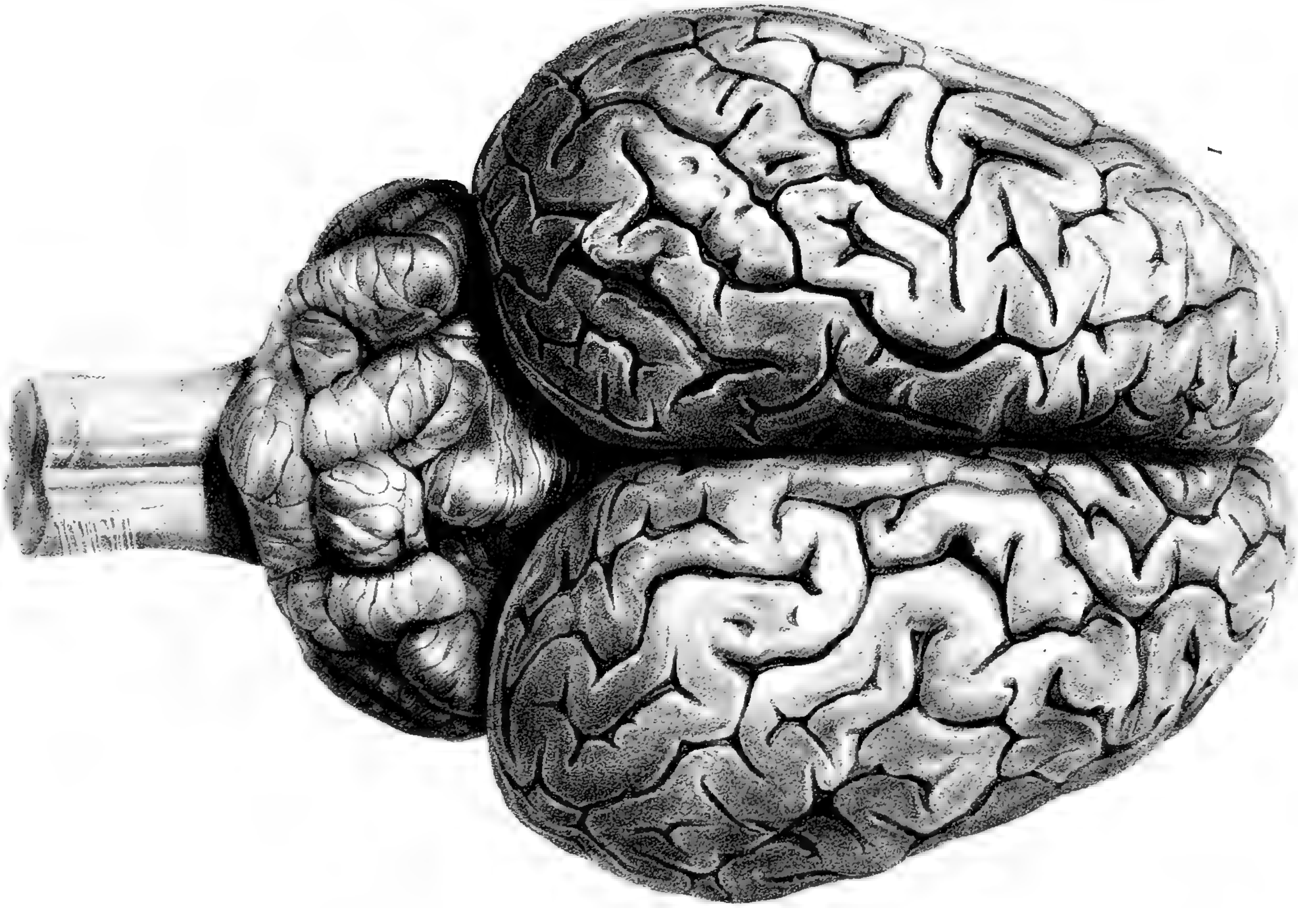

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Rhinoceros Indicus.

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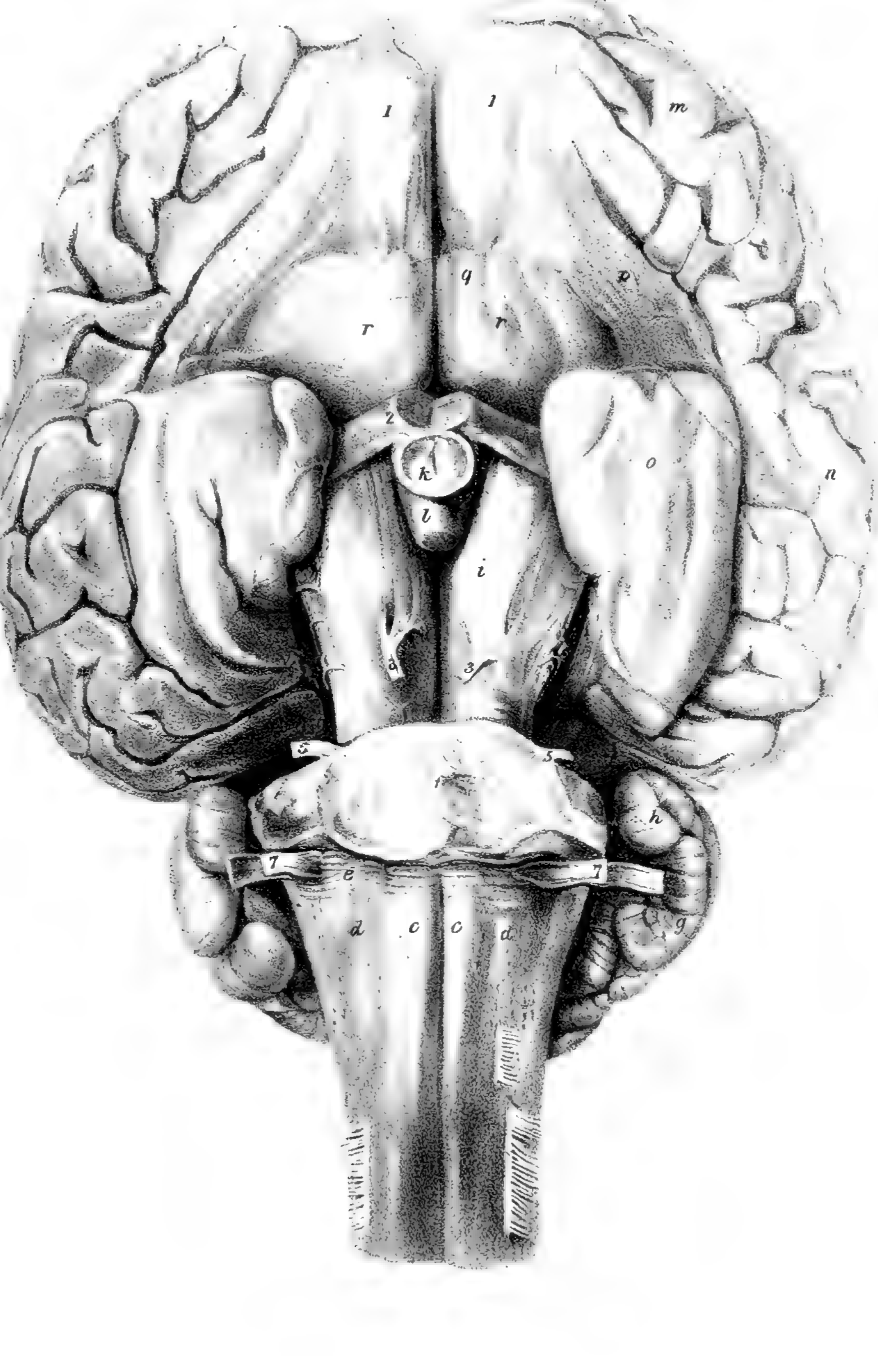

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Rhinoceros Indicus.

…ana Zool. Soc. Vol. 4. p. 58. pl. 21

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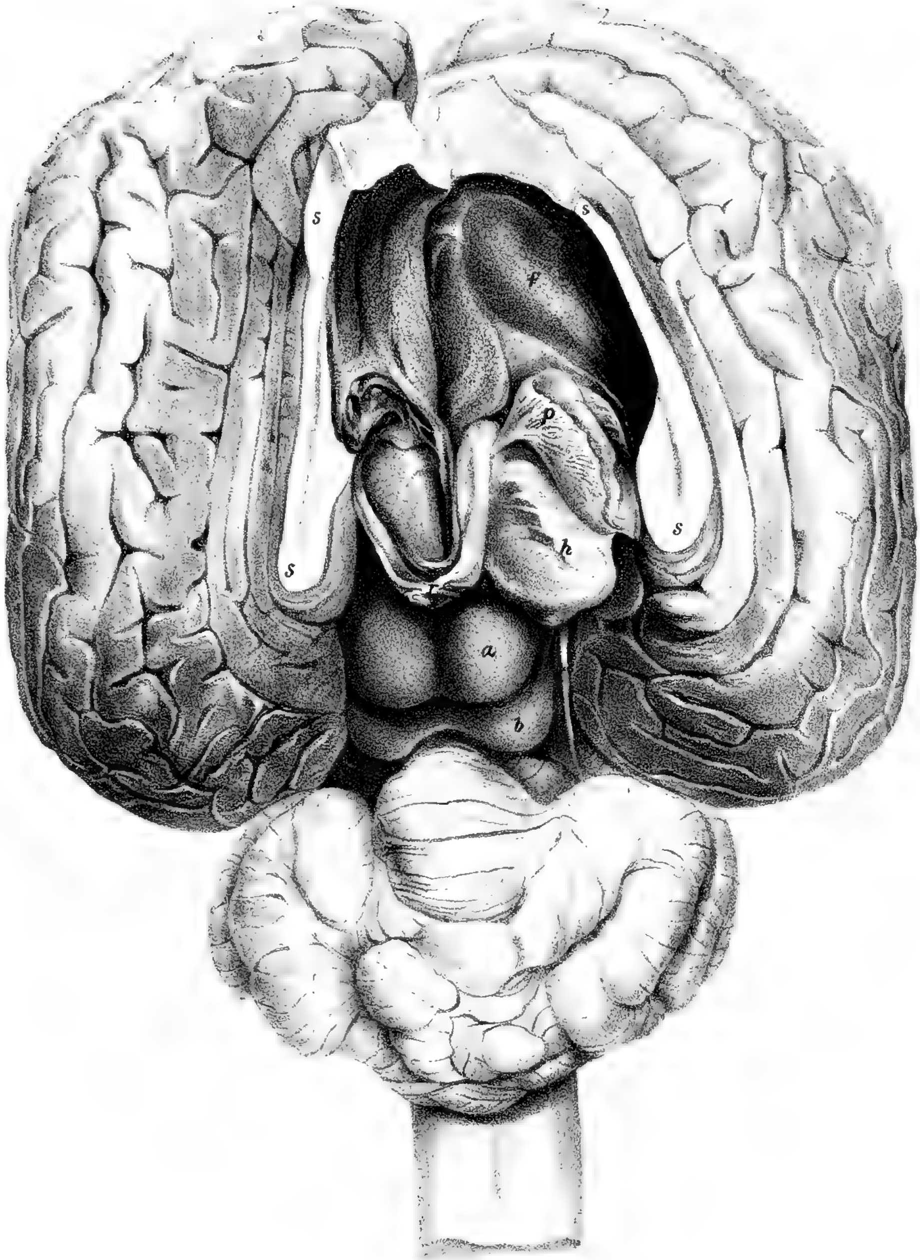

From Nat. on Stone by J. Erxleben

Day & Son Lith.

Rhinoceros Indicus.

Trans Zool: Soc Vol 4. p 58, pl. 22

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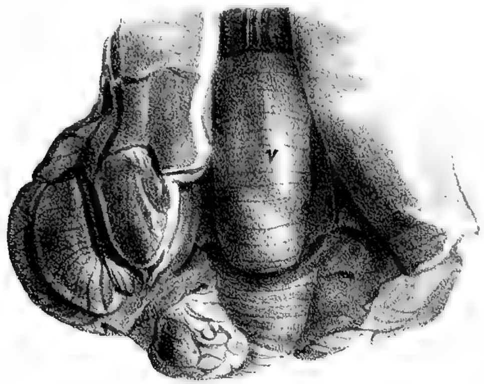

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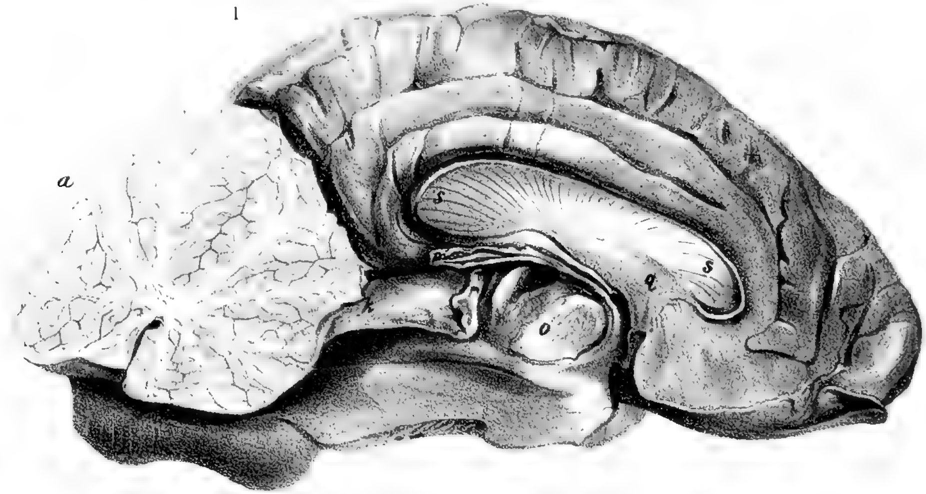

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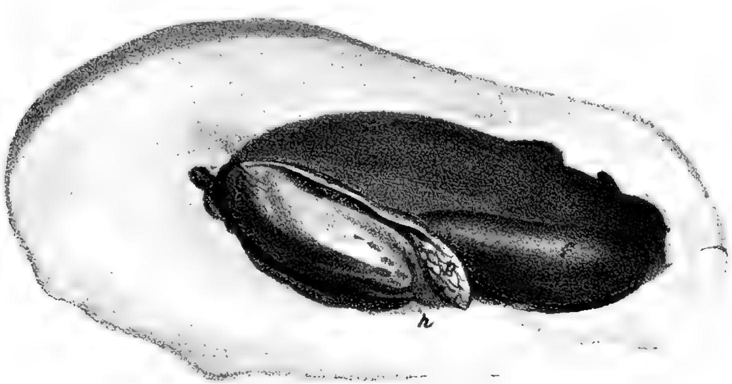

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From Nat. on Stone by J Erxleben.

Day & Son, Lith^rs to The Queen

Rhinoceros Indicus

IV. *On* DINORNIS (Part V.) : *containing a Description of the Skull and Beak of a large species of* Dinornis, *of the Cranium of an immature specimen of* Dinornis giganteus (?), *and of Crania of species of* PALAPTERYX. *By* Professor OWEN, *F.R.S., F.Z.S. &c.*

Read November 12, 1850.

IN a former memoir on the cranial organization of the wingless birds of New Zealand[1], I pointed out four distinct generic types of that part of the skeleton:—one referable to an existing genus of Parrot (*Nestor*), peculiar to New Zealand; a second to a bird most nearly allied to the Purple Coots, but of a distinct genus (*Notornis*), represented by a species about the size of a goose: the other two types belonged to much larger birds; one, from its nearer approach to the *Apteryx* and *Emeu*, I referred to the genus *Palapteryx*; the other, which was different in the structure of the back part of the cranium and in the greater extent of the ossified portion of the bill, I referred to *Dinornis* proper.

I have now the pleasure to submit to the notice of the Society a still larger and more complete skull than any previously described, which in the greater extent of its ossified and deflected upper mandible approaches the *Dinornis* and deviates from the *Palapteryx*, but in the structure of the back and under part of the cranium more resembles the type referred to *Palapteryx*. In regard to its size, as compared with that cranium described and figured in vol. iii. pl. 38, and referred to the *Dinornis struthioïdes*, the present cranium would, at least, merit reference by its size to the species called *ingens*, the second in point of stature of those that have hitherto been found in the North Island of New Zealand.

The circumstances under which this at present unique specimen came into my hands are as follows:—

In March 1850 I was favoured by a letter from His Excellency Sir George Grey, Governor-in-Chief of New Zealand, dated Auckland, November 29th, 1849, informing me that he had been "able to procure a number of bones of birds, which were found in a cave in the district which lies between the River Waikate and Mount Tongariro:" and intimating his liberal intention of transmitting them to me. They arrived soon after: and in this collection, which included remains of various species of *Dinornis* and *Palapteryx*, and the cranium of a *Notornis*, I had the extreme pleasure to find, with several smaller crania, the remarkably fine specimen, with the bone of the upper mandible, which forms the subject of Pl. XXIII. of the present memoir. The following are some of the dimensions of this cranium:—

[1] Trans. Zool. Soc. vol. iii. p. 345.

	Pal. ingens (?).		Struthio.	
	inches.	lines.	inches.	lines.
Breadth of the cranium across the mastoids (8, 8)	3	8	3	0
Length of the cranium to the anterior border of the coalesced frontals (11)	4	2	3	2
Breadth across the postorbital angles	4	8	3	1
Breadth across the temporal fossæ	2	8	2	1
Vertical diameter from supraoccipital ridge to basisphenoid	1	11	1	9
Transverse diameter of occipital foramen	0	8	0	$6\frac{1}{2}$
Breadth across the paroccipitals (4, 4)	......		1	9
Total length of skull, in a straight line	8	0 (?)	7	0
Total length of premaxillary	4	0 (?)	3	10
Breadth of the middle of the upper beak	2	0	1	8
From the anterior border of the intercommunicating aperture between the nostrils to the end of the premaxillary	2	4	0	10
From the fore-part of the bony palatal opening of the nostrils to the end of the premaxillary	2	3	0	10
Length of the olfactory fossæ in the frontal bone	1	3		
Breadth of the same fossæ	2	0		

The occipital region of this cranium corresponds very closely with that of the cranium referred to *Dinornis struthioïdes*, in vol. iii. p. 308. pl. 38. of the 'Zoological Transactions,' and with that subsequently conjectured to show the characters of *Palapteryx geranoïdes* (?) in the same volume, p. 361, pl. 52, repeating the distinctive characters there pointed out, by which the large wingless birds of New Zealand differ from the Ostrich, Emeu, Cassowary, and Rhea of the existing class.

The pedunculate occipital condyle (Pl. XXIII. fig. 1, 1), the descending basioccipital, the square basisphenoidal platform with its two posterior tuberous angles (*ib.* fig. 2, 1″), the extremely broad, low superoccipital region (*ib.* fig. 1, 3), with its inclination from below upwards and forwards, and its subdivision into four depressions, are all well-marked characters in the present skull. The border of the vertical occipital foramen is rounded off, not sharply defined or grooved, as in the crania above-cited. The outer superoccipital depression is separated from the temporal fossa by a smooth non-muscular tract above the mastoid, of four lines in breadth, as in the cranium figured in vol. iii. pl. 38. The temporal fossæ are separated from each other by a similar tract upon the parietals (Pl. XXIII. fig. 1, 7) of one inch eight lines in breadth: this tract is almost flat: two very shallow channels, four lines broad, diverge from the flat parietal surface along the upper part of the skull close to the anterior border of the temporal fossæ and terminate at the upper part of the much-developed and deflected postfrontal (*ib.* 12). Between these shallow impressions the frontal region is slightly convex, but it becomes a little concave at its anterior half, the middle of the fore-part of which is impressed by a sharply-defined shallow channel for the reception of the cranial and of the median branch of the coalesced premaxillaries. The large tympanic fossa, overarched by the mastoid (*ib.* fig. 2, 8), shows the single oblong deep cavity for the upper condyle of the tympanic bone, with the pneumatic, jugular, and auditory foramina, and the adjacent trigeminal one (*ib.* *tr*). An arterial canal is continued upwards from the posterior aperture of the carotid canal, and grooves or notches the lower border of the paroccipital. The antero-posterior extent of the temporal fossa (*ib.* fig. 2, 7, *tr*, 12) is one inch eight lines, indicating, with the depth of the same fossa, the great strength of the temporal muscles of this bird. The median part of the roof of the orbit is slightly convex towards that cavity : the lateral part becomes concave by the remarkable downward production of the postfrontal. But, perhaps, the most extraordinary features are the olfactory depressions on the under surface of the frontals, the dimensions of which have already been given. The great extent of these depressions has been dwelt on in previous memoirs as peculiarly characterizing the great wingless birds of New Zealand, and it becomes remarkably striking in the present large cranium. The olfactory foramen opens into the upper part of the posterior third of these cavities, and the grooves which radiate from each foramen indicate the dispersion of the branches of the nerve after its emergence from the cranium. One cannot avoid the inference that the living bird must have been remarkable for its acuteness of smell. The deep circular 'sella turcica' has not increased in the same ratio : there is a special depression at its back part above that which receives the orifices of the entocarotid canals.

The upper and median branch of the premaxillary (*ib.* fig. 1, 22′) slightly expands at its flattened cranial end, but that part is broken away which would have filled the depression on the frontal (*ib.* 22″). Allowing for it according to the proportions of the cranium with the entire lower jaw restored at pl. 54. vol. iii., the length of this skull would be about eight inches. But the skull is much shorter in proportion to its breadth than in the existing large Struthious birds, or than in the *Palapteryx* described and figured, vol. iii. p. 361, pl. 54. As the median branch of the premaxillary advances forwards, it decreases in breadth and increases in thickness ; its outer margins become rounded, and it sends down from the median line of its inferior surface a ridge (*ib.* fig. 2, *n*), which divides the external nostrils anteriorly, and which rapidly expanding, as it descends, becomes continued into the broad palatal plate of the premaxillary. The back part of the base of the septum presents a triangular depression, on each side of the base of which is a canal, which conducted vessels or nerves into the substance of the bone: the middle line of the upper surface of the median branch of the premaxillary is impressed by a groove leading, also, to a canal which enters the substance of the bone. Where this branch is confluent with the body of the premaxillary, it slightly expands towards its anterior end, and a deep and narrow groove divides it on each side from the body of the bone. This is formed by a strong osseous mass curved downwards, with sharp lateral margins, and richly perforated by vascular and nervous foramina. There is a slight median ridge along the fore-part of the broad, moderately concave, palatal surface (*ib.* fig. 3) : and there is a broad shallow channel along each side of the same surface, with numerous large foramina opening into it. The outer border of this groove is sharply defined. Only the anterior border of the naso-palatine foramen is here preserved ; a canal is continued forwards from it into the substance of the bone. The apex of the massive, broad, deflected premaxillary seems to have been rather obtuse.

The chief difference which the skull under consideration presents as compared with that figured in pl. 54, vol. iii., is the greater relative extent of the osseous body of the premaxillary, and of its downward curvature, in which it resembles in the same degree the skull presumed to be of the *Dinornis* figured in pl. 52, vol. iii.

From the remarkable modifications of the back part of the cranial portion of that skull, its generic distinction from the large skull under consideration is evident; and if we refer the present large cranium to the genus *Dinornis*, distinguished as it is by its superior extent and curvature of the bony beak from the skull referred to *Palapteryx*, then the still more remarkable skull figured in pl. 52 might possibly belong to the genus *Aptornis*, of which the equally remarkable bones of the legs have been described and figured in a preceding Memoir[1]. It seems, however, to be too large for those small metatarsi.

The skull of, perhaps, a larger species than the subject of the previous description, is indicated by the hinder half of the cranium (Pl. XXIV. figs. 1, 2 & 3), which, by the persistency of the sutures, the absence of the superoccipital and temporal ridges, and the smooth exterior of the bones, has belonged to a young individual of, it may be, the *Dinornis giganteus*. The occipital condyle (*ib.* fig. 2, 1) is larger than in the older skull; the elements of the occipital bone have coalesced: but the lambdoidal suture dividing the superoccipital (3) from the parietals (7), the sagittal suture (*s*), and that dividing the parietals (7) from the mastoids (8), and both these from the alisphenoids, remain. Not any of these sutures are dentated; they are more properly 'harmoniæ': the sagittal is the most irregular or wavy. The particular form of the cranial bones of the *Dinornis* is indicated by these sutures.

The superoccipital (3), as in the skull last described, deviates most, by its great breadth and small height, from that in other birds: the middle and major part of its anterior margin is slightly convex, or subangular forwards, the outer parts notched for the reception of the posterior external angles of the parietals: yet, notwithstanding the little elevation of the superoccipitals, it reaches the level of the upper surface of the cranium, owing to the flatness of the parietals: it slopes forwards at once from the upper border of the foramen magnum. The broad paroccipitals (4) spread outwards and backwards, and nearly attain the level of the upper surface of the cranium.

Each parietal terminates behind in an obtuse angle, which penetrates a corresponding emargination in the superoccipital near its outer angle; and it sends a rounded projection from its anterior border, near its outer angle, which enters a corresponding emargination between the frontal and postfrontal. The outer part of the parietal bends down, forms the bottom of the temporal fossa, and meets the alisphenoid near the lower part of that fossa at a straight longitudinal suture. The tumid mastoid (8) forms the outer and posterior angle of the upper surface of the skull, as in the Crocodile, and is wedged between the parietal, superoccipital, alisphenoid, and tympanic bones,

[1] Zool. Trans. vol. iv. p. 11. pl. 3. figs. 5–8.

for which latter bone it affords the major part of the glenoid cavity. The apophysary part (8′) of the mastoid descends vertically from its outer side for more than half an inch, external and posterior to the tympanic; the inner side of the base of the process is perforated by the pneumatic foramen supplying air to the cancelli of the cranial walls. In consequence of the non-obliteration of the sutures in the young bird, to which this interesting cranial fragment has belonged, the right mastoid had become detached, exposing the great breadth of its suture with the parietal and alisphenoid; and the pneumatic foramen is exposed. The whole extent of the paroccipital process is preserved on this side. The loss of the frontals and orbitosphenoids from the fragment of skull in question shows the thickness of the cranial walls at the coronal suture (*ib.* fig. 3, *r*), and exposes the cranial cavity, which is here divided into epencephalic, mesencephalic, and prosencephalic chambers. The epencephalic division is entire, is excavated below for the medulla oblongata, and above for the cerebellum, and is perforated behind by the foramen magnum (*fm*). The mesencephalic division (*o*) consists of two small, well-defined, hemispheric pits for the optic lobes, in front of the lower part of the epencephalic chamber. The portion of the prosencephalic division (*p*) above and external to the depressions for the optic lobes is excavated in the alisphenoids and parietals: the thick cancellous walls form a striking contrast to the general character of the cranial parietes in birds. The deep subspherical sella turcica (*t*) sinks down between the mesencephalic pits.

As compared with the cranium of other birds, and particularly with those of the Ostrich and Emeu, the *Dinornis* and *Palapteryx* are remarkable for the forward production and lateral expansion of the upper cranial walls. In the Ostrich, a vertical line dropped from the point of union of the sagittal with the coronal sutures, would fall into the interspace between the basioccipital and basisphenoid: in the Emeu the same line falls behind the sella turcica; but in the *Dinornis*, the same line falls in advance of the sella turcica. In taking the greatest vertical diameter of the cranium of the Ostrich, the points of the compass touch the middle of the frontal region, and the interspace between the pterapophyses[1] of the sphenoid: the dimension is two inches five lines. In the *Dinornis* and *Palapteryx*, the lower point of the compass in this measurement touches the narrow presphenoidal prolongation of the sphenoid, and the dimension does not exceed two inches. As a result of this anterior production of the frontal, it overhangs in a peculiar degree the coalesced prefrontals which are excavated to form the wide chambers of the olfactory capsules, and the upper walls of which chambers coalesce with the overarching part of the frontal.

The cranium, Pl. XXIV. fig. 6, exhibits in a remarkably perfect degree the three transverse processes (4, 8, 12) of the three principal vertebræ of the skull, together with the basisphenoidal platform and the pterapophyses (′) of the sphenoid.

[1] I use this word instead of 'pterygoid processes,' as the latter term has been employed in Anthropotomy to designate the independent bones which, in birds, articulate with the pterapophyses.

This appears to be of the same species as the more mutilated cranium figured in vol. iii. pl. 55. figs. 4 & 5.

The paroccipitals (4) are less expanded relatively than in the *Pal. ingens*, and are almost straight vertical plates.

The apophysary part of the mastoid (8) is also vertical, straight, and compressed from behind forwards with the outer border a little advanced.

Between this and the postfrontal intervenes a wide and deep temporal fossa, much exceeding in its proportional size that of the *Palapteryx* figured in pl. 54. fig. 1.

The postfrontal (12) is long, three-sided, and curves outwards, downwards and backwards as low down as the mastoid.

The pterapophyses (5′) are shorter than in the Ostrich or Emeu, and are depressed. The base of the alisphenoid swells out a little above them.

The cranium, Pl. XXIV. fig. 5, is somewhat smaller than that of the *Palapteryx* figured in vol. iii. pl. 54; it more nearly corresponds in size with that figured in vol. iii. pl. 55. fig. 3, but it differs in the greater elevation of the frontal region, which is more marked than in any skull of *Dinornis* or *Palapteryx* I have yet seen. This skull is of a mature bird: all the cranial sutures are obliterated; and we learn from the specimen of the young *Dinornis*, Pl. XXIV. fig. 2, that, as in the Ostrich, this obliteration did not take place in these wingless birds until they had nearly arrived at their full size.

The interorbital part of the skull is relatively narrower than in the *Palapteryx* (vol. iii. pl. 54): the temporal fossæ are relatively narrower than in the skull, Pl. XXIV. fig. 6.

The occipital condyle is more sessile than in the larger species, and the occipital foramen is less vertical, the plane sloping from above downwards and a little forwards. The mastoid is shorter and more pointed, and the pneumatic hole is reduced to a very small foramen behind its base.

The interorbital septum is entire and thick; a slender compressed process (Pl. XXIV. fig. 5, 14) is sent down from it just behind the large olfactory fossa. The cranial end of the premaxillary, which is bifid as in the Ostrich, has coalesced with the frontal; but they remain distinct from the subjacent prefrontals, which have as usual coalesced together to form the cavities for the olfactory capsules. The septum between these cavities is entire.

The skull, of which a vertical section is figured in Pl. XXIV. fig. 4, appears to belong to the same species as that figured in vol. iii. pl. 55. fig. 5, and differs from those figured in Pl. XXIV. figs. 5 & 6 in the minor development of the mastoid and postfrontal processes. The olfactory chambers (18) are deep, and the diameter of the single orifice penetrating the upper and back part of the roof of each division of that cavity, indicates the large size of the olfactory nerve. The outer and inner tables of the cranium are seen to be divided by a diploë of air-cells about one and a half line thick; but the extent of the diploë varies much when seen in transverse section.

The epencephalic chamber (*a*, *v*, *c*) is remarkable for its size, rising to the highest level of the prosencephalic one (p), and sinking much below it; the mesencephalic fossa (o) is comparatively small.

The transverse section across the broadest part of the cranium shows that the prosencephalic cavity is far from being of corresponding breadth: a considerable extent of diploë intervenes between that chamber and the base of the postfrontal processes. The outer and inner tables unite without diploë above the highest part of the upper longitudinal elevations of the cerebrum. The inner circumference of the olfactory orifices is partially grooved.

In order to gain some idea of the size of the bird to which the largest cranium belongs, I have compared the diameter of its foramen magnum with that of a lower cervical vertebra and of a middle dorsal vertebra, both referable by their size to the *Dinornis giganteus*, the same comparisons having previously been made in the skeleton of the Ostrich.

	Dinornis. Lines.	*Ostrich.* Lines.
Transverse diameter of the foramen magnum	9	6½
Transverse diameter of middle of spinal canal, lower cervical vertebra .	6½	5
Transverse diameter of middle of spinal canal, dorsal vertebra	7	4½

From the above admeasurements and comparison we might be led to conclude that the skull of the *Dinornis* yielding that of the foramen magnum belonged to a larger species than the vertebræ; but the size of these vertebræ forbids the supposition; for they are larger in proportion to the size of the skull compared, than in the Ostrich. The canal for the spinal chord is, in fact, singularly small in proportion to the bulk of the entire vertebra in *Dinornis* as compared with that in the Ostrich or other birds, and forms, as I have pointed out in a former Memoir, one of the peculiarities of the large wingless birds of New Zealand. The cervical vertebra, for example, with a spinal canal six and a half lines wide, has a body of four inches in length; whilst that of the Ostrich with a spinal canal five lines in diameter has a body only two and a quarter inches in length; and the dorsal vertebra presents similar relations.

Lower jaw.—An almost entire lower jaw of a *Dinornis* or *Palapteryx*, of rather smaller size than the one of which a large portion is figured in vol. iii. pl. 54. figs. 6, 7, closely accords with that portion as far as they can be compared: the symphysial end of the jaw is rounded and short, and impressed below by two parallel longitudinal grooves, *sg*. Each ramus is slightly bent in a sigmoid flexure, concave below at the anterior half, convex at the posterior one. The alveolar border is pierced by vascular grooves and foramina at its anterior part, and obliquely levelled off to an edge behind. There is on coronoid process, and no vacuity in the ramus of the jaw, but only a deep longitudinal groove half an inch long, between the originally distinct 'angular' and 'surangular' pieces, which groove is completely closed up on the inner side by the splenial piece: in this respect the present lower jaw differs from that portion of a very large one ascribed to the *Dinornis* in my former Memoir, vol. iii. pl. 53. figs. 1 & 2.

The principal articular cavity is the large and deep one that occupies the major part of the expansion at the articular end of the ramus: the second surface for the tympanic is a very narrow strip along the outer border of the expansion, which slightly overhangs that part of the ramus. The angle of the jaw is obtuse. From the proportions of this lower jaw it appears that the ramus, as restored in vol. iii. fig. 1. pl. 54, is about half an inch too long, and the whole beak of the *Palapteryx* thus figured must be shortened to that extent.

Humerus.—As the number of importations of the remains of the large wingless birds of New Zealand has progressively increased, the argument deduced from the absence of any bones of the anterior extremity in the first large collection transmitted by the Very Rev. Wm. Williams, has been gaining cumulative force, in proof of the extremely insignificant size of those bones. But, in the collection of remains last transmitted to me by Governor Grey, I found a fragment of a long bone, which I believe to be the proximal half of the humerus. It is three inches and a quarter in length, with an enlarged oblong-ovate, convex articular end; the shaft, at first three-sided, takes an oval transverse section as it recedes, diminishing from the head, and shows a slight ridge on one side, and a rough surface on the opposite for the attachment of small antagonizing muscles. The only other bone in the *Dinornis* with which it is comparable is the fibula; but, in the present specimen, the head is too convex, and has not the lateral concave articular surface which this fibula shows for the tibia. This small humerus may belong to a large species of *Dinornis* or *Palapteryx*; but to whatever sized species it did belong, it is as devoid of those muscular crests and tuberosities indicative of powers of flight, as the humerus of the *Apteryx* is.

A cranium of the *Notornis* in the collection transmitted by Governor Grey exhibits the frontal portion which was deficient in the specimen described in vol. iii. p. 366, in which that genus and its affinities were defined.

The postfrontal processes equally divide the upper region of the skull from the superoccipital ridge to the naso-premaxillary groove: that region is moderately convex: the superorbital ridge is of about the same extent as the temporal ridge; it is somewhat irregular, is grooved posteriorly, and terminates anteriorly in very short antorbital processes directed forwards. The coalesced frontals terminate anteriorly in a moderately thick straight transverse border of nine lines' extent, overhanging the flat smooth platform formed by the coalesced prefrontals: from the outer border of this platform, a bony plate descends and blends with the interorbital septum, half-way down, leaving an interval between the septum and the upper part of the plate, through which the olfactory nerves were continued. The posterior turbinals were attached to the fore-part of these descending plates. The interorbital septum is perforated anterior to the common outlet of the optic nerves, is deeply grooved at its upper part by the olfactory nerves, and is formed below by the presphenoidal prolongation.

In all other respects in which a comparison can be instituted with the less complete cranium of the *Notornis* described in my previous Memoir, the present specimen agrees with it: the part conjecturally restored in my former figure[1] is shown by the present specimen to be correct as to extent.

The number of skulls of full-grown large terrestrial birds of New Zealand that have now been described, clearly indicate at least four species, independently of the one with the remarkable occiput, referred to *Dinornis* proper in my former Memoir, and also of that on which the genus *Notornis* was founded. The rich development of the wingless family of birds, not in individual magnitude only, but in the number of species, thus progressively receives additional illustration. Owing, however, to the remains of these great birds reaching England for the most part in a detached or disconnected state,—few portions of the skeleton of one and the same bird having yet been discovered in juxtaposition, or so transmitted to this country, and not any specimen, so far as I can learn, having been found with the head,—the skull can only be restored to the other parts of the skeleton of species already described, conjecturally; and much remains to be done before such conjectures can acquire a degree of certainty. That, however, which is mainly necessary to be done, is to record with accuracy and depict with fidelity the several materials for the reconstruction of these apparently extinct species of large wingless birds as they from time to time reach this country: and the desired result will without doubt in time be gained.

[1] Zool. Trans. vol. iii. pl. 56.

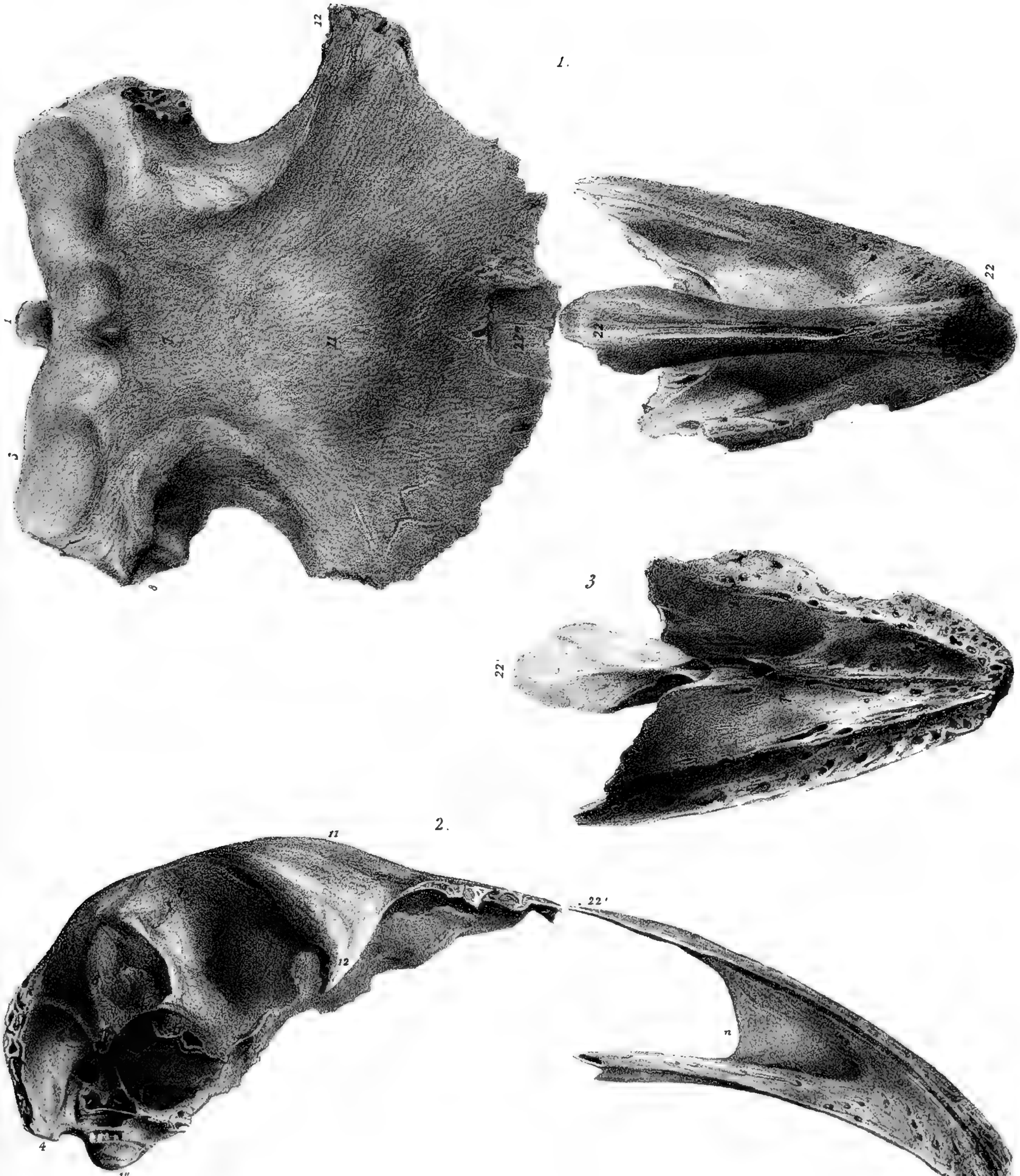
DESCRIPTION OF THE PLATES.

PLATE XXIII.

Fig. 1. Upper view of the cranium of a large species of *Dinornis* (?).
Fig. 2. Side view of ditto.
Fig. 3. Under view of the premaxillary bone of the same cranium.

PLATE XXIV.

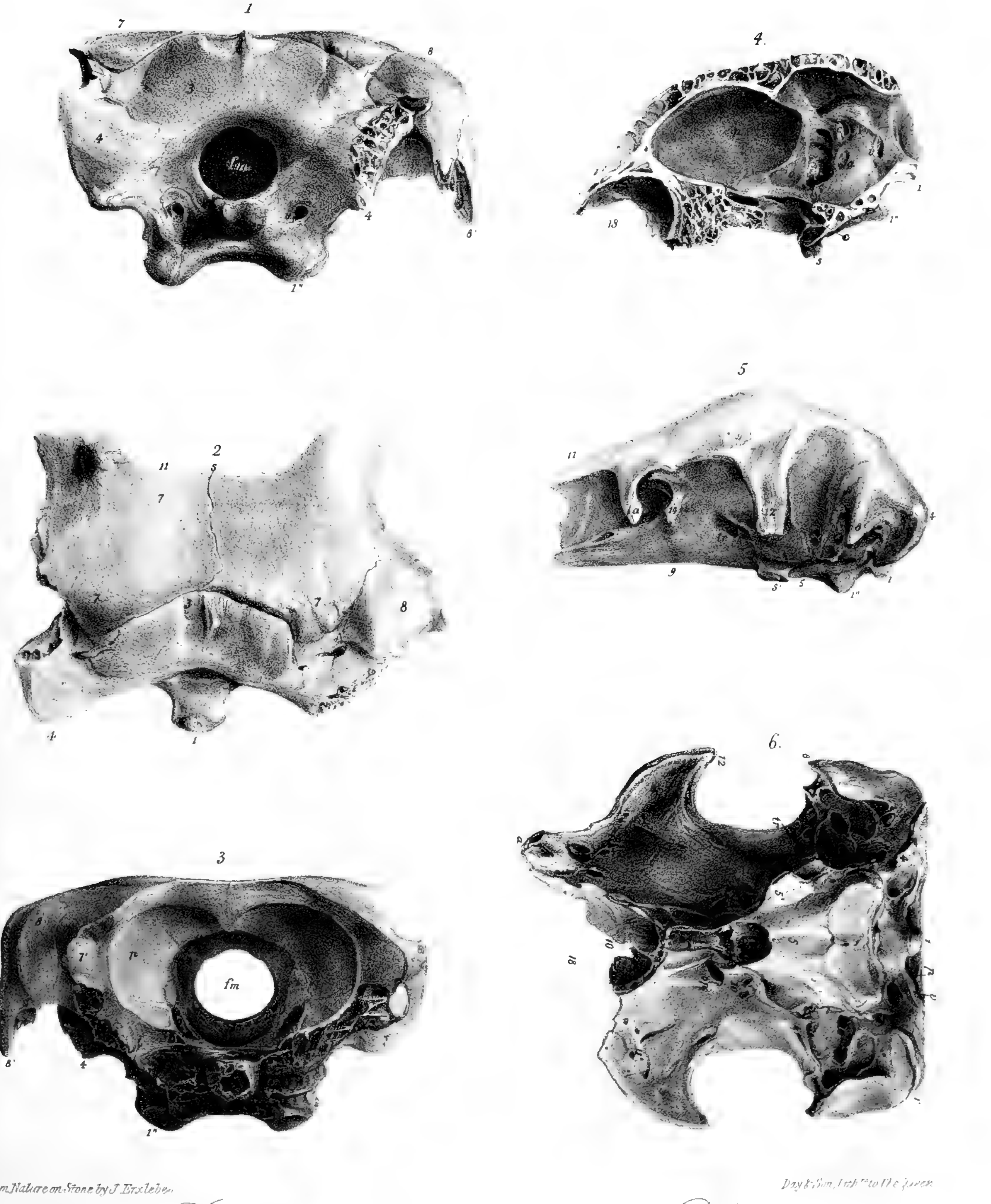
Fig. 1. Back view of the mutilated cranium of the young of the *Dinornis giganteus* (?).
Fig. 2. Upper view of ditto.
Fig. 3. Front view of ditto, from which the frontal bones have been separated at the coronal suture.
Fig. 4. Moiety of a vertically and longitudinally bisected cranium of a *Palapteryx* (?).
a, Internal auditory foramina.
v, Foramen for the nervus vagus and a vein.
tr, Foramen for the third division of the trigeminal nerve.
c, Cerebellar fossa.
All these letters are in the epencephalic compartment of the cranium.
o, Mesencephalic compartment lodging the optic lobes: and below these the third ventricle and its hypophysis.
p, The prosencephalic compartment.
18, Olfactory chamber.
Fig. 5. Side view of the cranium of a *Palapteryx* (?).
Fig. 6. Base view of the cranium of another species of *Palapteryx*.
The letters and figures are explained in the text.



Fr. a Nat. on Stone by J. Erxleben

Day & Son Lithrs to The Queen

Dinornis ingens?



From Nature on Stone by J. Erxleben

Day & Son, Lith^rs to the Queen

1_2. *Dinornis giganteus (pullus)?* 4_6. *Palapteryx.*

V. *Notice of the Discovery by* Mr. WALTER MANTELL *in the Middle Island of New Zealand, of a Living Specimen of the* NOTORNIS, *a Bird of the* Rail *Family, allied to* Brachypteryx, *and hitherto unknown to Naturalists except in a Fossil State. By* GIDEON ALGERNON MANTELL, *Esq., LL.D., F.R.S. etc.*

Read November 12, 1850.

AMONGST the fossil bones of birds collected by my eldest son in the North Island of New Zealand, which I had the honour of placing before the Zoological Society in 1848, in illustration of Professor Owen's description of the crania and mandibles of *Dinornis*, *Palapteryx*, &c., there were the skull, beaks, humerus, sternum, and other parts of the skeleton of a large bird of the Rail family, which from their peculiar characters were referred by that eminent anatomist to a distinct genus of *Rallidæ* allied to the *Brachypteryx*, under the name of *Notornis*[1]; a prevision, the correctness of which is confirmed by the recent specimen that forms the subject of the present communication.

Towards the close of last year I received from Mr. Walter Mantell another extensive and highly interesting collection of fossils, minerals, and rock specimens, obtained during his journey along the eastern coast of the Middle Island, from Banks' Peninsula to the south of Otago, in the capacity of Government Commissioner for the settlement of native claims. This series comprised also a fine suite of birds' bones from Waingongoro, the locality whence the former collection was chiefly obtained, and among them were relics of the *Notornis*, and crania and mandibles of *Palapteryx*.

The results of my son's observations on the geological phænomena presented by the eastern coast of the Middle Island are embodied in a paper read before the Geological Society in February last, and published in vol. v. of the 'Quarterly Journal.' It will suffice for my present purpose to mention that they confirm in every essential particular the account given of the position and age of the ornithic ossiferous deposits, in my first memoir on this subject[2].

The only fact that relates to the present notice is the nature of the bone-bed at Waikonaiti, whence Mr. Percy Earl, Dr. Mackellar, and other naturalists procured the first relics of the gigantic birds, sent by those gentlemen to England, and which are figured and described in the 'Zoological Transactions.'

This so-called tertiary deposit is situated in a little bay south of Island Point, near the embouchure of the river Waikonaiti, and is only visible at low-water, when bones more or less perfect are occasionally observable projecting from the water-worn surface

[1] Zoological Transactions, vol. iii. p. 366.

[2] Geological Journal, vol. iv.

of the bog. This deposit is about 3 feet in depth and not more than 100 yards in length; the extent inland is concealed by vegetation and a covering of superficial detritus, and is supposed to be very inconsiderable. This bed rests upon a blue tertiary clay that emerges here and there along that part of the coast, and which abounds in shells and corals, of species existing in the adjacent sea.

This bone deposit was evidently a morass or swamp, on which the New Zealand flax (*Phormium tenax*) once grew luxuriantly. Bones of the larger species of Moa have from time to time been obtained from this spot by the natives and European visitors; and, as in the menaccanite sand beds at Waingongoro, they are associated with bones of one species of dog and two species of seal: my son also collected crania and other remains of a species of *Apteryx* (probably *Ap. Australis*), Albatros, Penguin, and of some smaller birds whose characters and relations have not yet been ascertained: no bones of the *Notornis* were observed in this locality.

It was from this ancient morass that my son obtained the entire series of bones composing the pair of feet of the same individual *Dinornis robustus*, standing erect, the one about a yard in advance of the other, as if the unfortunate bird had sunk in the slough, and unable to extricate itself had perished on the spot. The upper or proximal ends of the tarso-metatarsals were alone visible above the sod on the retiring of the tide; these were carefully dug round, and the phalanges exposed in their natural order and connection: the bones were numbered as they were extracted from the soil, and thus the normal elements of the locomotive organs of one of the colossal struthious bipeds of New Zealand were for the first time determined[1].

It was in the course of last year, on the occasion of my son's second visit to the south of the Middle Island, that he had the good fortune to secure the recent *Notornis* which I have now the pleasure of submitting to this Society, having previously placed it in the hands of the eminent ornithologist Mr. Gould to figure and describe, as a tribute of respect for his indefatigable labours in this department of Natural History.

This bird was taken by some sealers who were pursuing their avocations in Dusky Bay. Perceiving the trail of a large and unknown bird on the snow with which the ground was then covered, they followed the foot-prints till they obtained a sight of the *Notornis*, which their dogs instantly pursued, and after a long chase caught alive in the gully of a sound behind Resolution Island. It ran with great speed, and upon being captured uttered loud screams, and fought and struggled violently; it was kept alive three or four days on board the schooner and then killed, and the body roasted and ate by the crew, each partaking of the dainty, which was declared to be delicious. The beak and legs were of a bright red colour. My son secured the skin, together with very fine specimens of the Kakapo or Ground Parrot (*Strigops*), a pair of Huïas (*Neomorpha*),

[1] The principal dimensions of these bones are given in the Quarterly Journal of the Geological Society, vol. vi. p. 338; and figures with descriptions in 'The Pictorial Atlas of Organic Remains,' just published.

and two species of Kiwi-kiwi, namely *Apteryx Australis* and *Ap. Oweni*; the latter very rare bird is now added to the collection of the British Museum.

Mr. Walter Mantell states, that, according to the native traditions, a large Rail was contemporary with the Moa, and formed a principal article of food among their ancestors. It was known to the North Islanders by the name of "*Moho*," and to the South Islanders by that of "*Takahé*;" but the bird was considered by both natives and Europeans to have been long since exterminated by the wild cats and dogs, not an individual having been seen or heard of since the arrival of the English colonists. That intelligent observer, the Rev. Richard Taylor, who has so long resided in the islands, had never heard of a bird of this kind having been seen. In his 'Leaf from the Natural History of New Zealand[1],' under the head of "*Moho*," is the following note: "RAIL, colour black, said to be a wingless bird as large as a fowl, having a long bill and red beaks and legs; it is nearly exterminated by the cat: its cry was 'keo, keo.'" The inaccuracy and vagueness of this description prove it to be from native report and not from actual observation. To the natives of the pahs or villages on the homeward route, and at Wellington, the bird was a perfect novelty and excited much interest. I may add, that upon comparing the head of the bird with the fossil cranium and mandibles, and the figures and descriptions in the 'Zoological Transactions' (pl. 56), my son was at once convinced of their identity; and so delighted was he by the discovery of a living example of one of the supposed extinct contemporaries of the Moa, that he immediately wrote to me, and mentioned that the skull and beaks were alike in the recent and fossil specimens, and that the abbreviated and feeble development of the wings, both in their bones and plumage, were in perfect accordance with the indications afforded by the fossil humerus and sternum found by him at Waingongoro, and now in the British Museum, as pointed out by Professor Owen in the memoir above referred to.

It may not be irrelevant to add, that in the course of Mr. Walter Mantell's journey from Banks' Peninsula along the coast to Otago, he learnt from the natives that they believed there still existed in that country the only indigenous terrestrial quadruped, except a species of rat, which there are any reasonable grounds for concluding New Zealand ever possessed. While encamping at Arowenua in the district of Timaru, the Maoris assured him that about ten miles inland there was a quadruped which they called Káurĕke, and that it was formerly abundant, and often kept by their ancestors in a domestic state as a pet animal. It was described as about two feet in length, with coarse grisly hair; and must have more nearly resembled the Otter or Badger than the Beaver or the Ornithorhynchus, which the first accounts seemed to suggest as the probable type. The offer of a liberal reward induced some of the Maoris to start for the interior of the country where the Káurĕke was supposed to be located, but they returned without having obtained the slightest trace of the existence of such an animal;

[1] Published at Wellington, 1848.

my son, however, expresses his belief in the native accounts, and that if the creature no longer exists, its extermination is of very recent date.

In concluding this brief narrative of the discovery of a living example of a genus of birds once contemporary with the colossal Moa, and hitherto only known by its fossil remains, I beg to remark, that this highly interesting fact tends to confirm the conclusions expressed in my communications to the Geological Society, namely, that the *Dinornis*, *Palapteryx*, and related forms, were coeval with some of the existing species of birds peculiar to New Zealand, and that their final extinction took place at no very distant period, and long after the advent of the aboriginal maoris. As my son at the date of his last letter was about to depart on another exploration of the bone deposits of the North Island, I indulge the hope that he will ere long have the gratification of transmitting or bringing to England additional materials for the elucidation of the extinct and recent faunas of New Zealand.

With much pleasure I resign to Mr. Gould the description of the ornithological characters and relations of this, in every sense, *rara avis*, from the Isles of the Antipodes.

VI. *Remarks on* Notornis Mantellii. *By* J. Gould, *F.R.S.*

Read November 12, 1850.

Dr. MANTELL having kindly placed his son's valuable acquisition in my hands for the purpose of characterizing it in the Proceedings of the Society, and of afterwards figuring and describing it in the appendix to my work on the 'Birds of Australia,' I beg leave to commence the pleasing task he has assigned to me.

The amount of interest which attaches to the present remarkable bird is perhaps greater than that which pertains to any other with which I am acquainted, inasmuch as it is one of the few remaining species of those singular forms which inhabited that supposed remnant of a former continent—New Zealand, and which have been so ably and so learnedly described, from their semi-fossilized remains, by Professor Owen; who, as well as the scientific world in general, cannot fail to be highly gratified by the discovery of a recent example of a form previously known to us solely from a few osteological fragments, and which, but for this fortunate discovery, would in all probability, like the Dodo, have shortly become all but traditional. While we congratulate ourselves upon the preservation of the skin, we must all deeply regret the loss of the bones, any one of which would have been in the highest degree valuable for the sake of comparison with the numerous remains which have been sent home from New Zealand.

Upon a cursory view of this bird it might be mistaken for a gigantic kind of *Porphyrio*, but on an examination of its structure it will be found to be generically distinct. It is allied to *Porphyrio* in the form of its bill and in its general colouring, and to *Tribonyx* in the structure of its feet, while in the feebleness of its wings and the structure of its tail it differs from both.

From personal observation of the habits of *Tribonyx* and *Porphyrio*, I may venture to affirm that the habits and œconomy of the present bird more closely resemble those of the former than those of the latter; that it is doubtless of a recluse and extremely shy disposition; that being deprived, by the feeble structure of its wing, of the power of flight, it is compelled to depend upon its swiftness of foot for the means of evading its natural enemies; and that, as is the case with *Tribonyx*, a person may be in its vicinity for weeks without ever catching a glimpse of it.

From the thickness of its plumage and the great length of its back-feathers, we may infer that it affects low and humid situations, marshes, the banks of rivers, and the coverts of dripping ferns, so abundant in its native country: like *Porphyrio*, it doubtless enjoys the power of swimming, but would seem, from the structure of its legs, to be more terrestrial in its habits than the members of that genus.

I have carefully compared the bill of this example with that figured by Professor

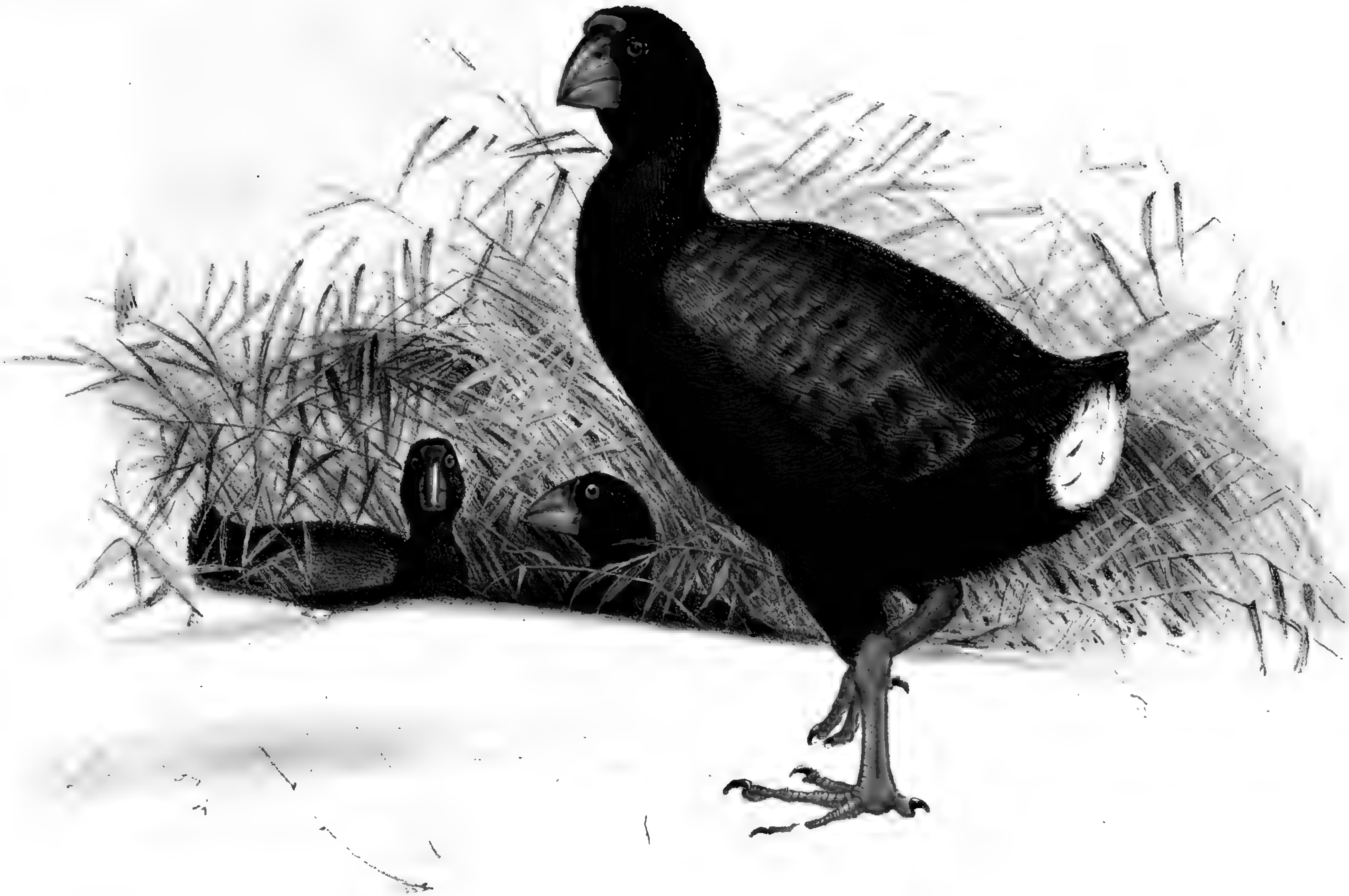
Owen under the name of *Notornis Mantellii*, and have little doubt that they are referable to one and the same species; and as we are now in possession of materials whence to obtain complete generic characters, I hasten to give the following details, in addition to those supplied by Professor Owen:—

Bill somewhat shorter than the head; greatly compressed on the sides, both mandibles being much deeper than broad; tomia sharp, curving downwards, inclining inwards and slightly serrated; culmen elevated, much arched and rising on the forehead to a line with the posterior angle of the eye: *nostrils* round, and placed in a depression near the base of the bill; *wings* very short, rounded, and slightly concave; primaries soft and yielding; the first short; third, fourth, fifth, sixth and seventh equal and the longest; tail-feathers soft, yielding, and loose in texture; *tarsi* powerful, longer than the toes, almost cylindrical; very broad anteriorly; defended in front and on either side posteriorly by broad and distinct scutellæ; the spaces between the scutellæ reticulated; anterior toes large and strong, armed with powerful hooked nails, and strongly scutellated on their upper surface; hind-toe short, strong, placed somewhat high on the tarsus, and armed with a blunt hooked nail.

Head, neck, breast, upper part of the abdomen and flanks purplish blue; back, rump, upper tail-coverts, lesser wing-coverts and tertiaries dark olive-green, tipped with verditer-green; at the nape of the neck a band of rich blue separating the purplish blue of the neck from the green of the body; wings rich deep blue, the greater coverts tipped with verditer-green, forming crescentic bands when the wing is expanded; tail dark green; lower part of the abdomen, vent and thighs dull bluish black; under tail-coverts white; bill and feet red.

Total length of the body, 26 inches; bill, from the gape to the tip, $2\frac{1}{8}$; from the tip to the posterior edge of the plate on the forehead, 3; wing, $8\frac{1}{2}$; tail, $3\frac{1}{2}$; tarsi, $3\frac{1}{2}$; middle toe, 3; nail, $\frac{7}{8}$; hind-toe, $\frac{7}{8}$; nail, $\frac{3}{4}$.

I cannot conclude these remarks without bearing testimony to the very great importance of the results which have attended the researches of Mr. Walter Mantell in the various departments of science to which he has turned the attention of his cultivated, intelligent and inquiring mind, nor without expressing a hope that he may yet be enabled to obtain some particulars as to the history of this and the other remarkable birds of the country in which he is resident.



Notornis Mantelli.

VII. *Osteological Contributions to the Natural History of the Chimpanzees* (Troglodytes) *and Orangs* (Pithecus). No. IV. *Description of the Cranium of an Adult Male Gorilla from the River Danger, West Coast of Africa, indicative of a variety of the Great Chimpanzee* (Troglodytes Gorilla), *with Remarks on the Capacity of the Cranium and other characters shown by sections of the Skull, in the Orangs* (Pithecus), *Chimpanzees* (Troglodytes), *and in different varieties of the Human Race. By* Professor Owen, *F.R.S., F.Z.S., &c.*

Read November 11, 1851.

THE cranium of a Gorilla (*Troglodytes Gorilla*, Pls. XXVI. to XXVIII.) from a new locality on the Western Tropical Coast of Africa—the river Danger—about 200 miles distant from the Gaboon, is larger than the largest crania hitherto received by me from the Gaboon, and differs remarkably in the proportions of some of its parts, not only of those that relate to muscular attachments, but of parts exempt from the modifying influences of such.

The bony palate (20, 21, 22), for example, is longer, narrower and deeper, as may be seen by comparing Pl. XXVI. with Pl. LXIII. vol. iii.; the basioccipital (1) is longer and narrower; the vaginal process of the tympanic (*v*) is much more strongly developed, the whole under wall of the auditory canal (*v*, *au*, and 28) being, as it were, pinched up and produced downwards, the margin becoming acute as it extends mesiad and terminating in front of the stylohyal fossa (38); the entoglenoid process (*g*) is smaller and shorter, not extending one line below the eustachian process (*e*) of the petrosal (16).

When the upper surface of the cranium of the Gorilla from the river Danger (Pl. XXVII.) is compared with the same part of that from the Gaboon, we see not only a much greater development of the lambdoidal (*s*, *l*) and sagittal (*s* 7, 11) intermuscular crests, which are enormous in the variety figured in Pls. XXVII. and XXVIII. (3, 11), but the superorbital ridge (11′, 11′, Pl. XXVII.) is much more produced both upwards and forwards from the plane of the forehead, as may be seen by comparing Pl. XXVIII. with Pl. LXI. vol. iii., the side view of an equally adult male's skull of the *Troglodytes Gorilla* from the Gaboon. In comparing the skulls of the two varieties in a direct front view, the malar bones are larger, the lacrymal bones smaller, and the lacrymal fossæ and canals much more expanded, than in the Gaboon variety. The nasal aperture is also wider and has more sharply defined lateral borders in that from the river Danger: but the upper jaw below the nostril is not more developed, and in proportion to the rest of the skull is shorter and narrower than in the variety from the Gaboon. The suborbital foramina (Pl. XXVII. 21) are two on one side and three on the other in the skull under description, in which, as in the Gaboon variety, there is neither superorbital foramen nor groove.

It would at first seem probable that the greater development of the lambdoidal and sagittal cristæ, to which the greater extent of the cranial part of the skull depends, in the specimen from the river Danger, might be due to the greater age of the individual, and the longer continuance of the stimulus of the action of the muscles concerned in the support of the head, and in the movements of the anteriorly produced and preponderating jaws. But the condition of the grinding surface of the teeth (Pl. XXVI.), and more especially that of the sutures (Pl. XXVII. 8, 27 and 11, 15 and 22), negative the idea of the skull of the Gorilla from the river Danger having belonged to an older animal than those skulls of the Gorilla from the Gaboon with which it has been compared. In fact, in no other skull of the adult *Troglodytes Gorilla* that has hitherto been described, is the course and extent of so many sutures more clearly traceable than in the present specimen.

The whole circumference of the partially coalesced nasal bone (Pl. XXVII. 15) is shown by a suture which is as wavy or dentated as most of those in the Human cranium. The two nasal bones are quite blended together at their upper or interorbital halves, which form the usual well-marked ridge-like prominence characteristic of the species. Above this ridge the bone expands and again contracts as it ascends, and terminates in a point within three lines of the summit of the superorbital ridge. The remnant of the straight suture which divided the lower halves of the nasals is confined to the anterior surface of those bones. The strong and dense plate of bone (Pl. XXVIII. 15) sent back to join the interorbital part of the frontal (*ib.* 11) comes off from the middle line of the upper two-thirds of the nasals, is of a triangular form, and increases in breadth to its lower border, which measures one inch three lines in extent.

The suture of the upper expanded part of the premaxillary (Pl. XXVII. 22′), which is wedged between the nasal (15) and maxillary (21), and forms the upper and lateral boundary of the nostril, is very distinctly marked, and is continued down to within an inch of the alveolar border between the canine and outer incisor: the premaxillary suture on the inner surface of the nostril (Pl. XXVIII. 22″) is continued into the outer one about nine lines below the nasal bone, and so insulates the upper end of the premaxillary. This variety does not exist in the skulls of the Gaboon Gorillas which I have compared, and may be accidental to the individual from the river Danger. The extent of the premaxillary in some young specimens of the *Troglodytes Gorilla* plainly demonstrates the homology of the separated portion of the premaxillary in the present adult, and saves the invention of a name for a bone, which otherwise might be deemed to deserve such sign of a new and superadded part.

The squamosal (Pl. XXVII. 27) unites with the frontal (11) by a dentated suture more than an inch long, separating the alisphenoid from the parietal to the same extent. The suture between the squamosal and alisphenoid is also dentated; that between the squamosal (27) and parietal (7) is even and is slightly concave upwards instead of being convex as in Man; that between the mastoid (8) and parietal (7) is convex upwards and is continued backwards upon the lambdoidal crista, where it bends down to define the mastoid from the superoccipital. The coronal suture (27, 11) becomes obliterated at the base of the fronto-parietal crest (11, 7, *s*) at the junction of its middle and anterior thirds, thus indicating the proportion of that crest which is formed by the coalesced frontal bones.

The remarkable skull above-described and compared belongs to the 'Philosophical Institution of Bristol,' and I am indebted to the liberality of the Council of that Institution not only for the opportunity of describing it, but likewise for the permission to make such a section of the skull as would best display the relative proportions of the cranium and face.

Permission to make a similar section of the skull of an adult male Orang (*Simia Satyrus*) in the Museum of the Zoological Society having been granted with a like enlightened desire for the advancement of knowledge, by the Council of that body, I next proceed to lay before the Society the results of the comparisons of these sections with each other and with similar sections of the skulls of different races of the Human species.

In the comparison of the Human skeleton with that of other mammalia, especially those of the quadrumanous order, the most striking and characteristic differences are presented by the skull, and depend chiefly upon the different proportions between the cranium and the face, *i. e.* between the part lodging the brain and that forming the cavities for the eyes, the nose and the mouth.

These differences have been indicated in a readily appreciable manner by the angle which a line drawn from the most prominent part of the forehead to that of the upper jaw forms with a second line extended from the lower border of the external auditory canal to the lower border of the bony nostril (Pl. XXVIII. C . . . . C)[1]. But this angle, called by Camper the facial angle, fails, as Cuvier[2], Mr. Lawrence[3] and others have well remarked, to indicate precisely the relative size of the brain-case to the jaws: it is affected of course by whatever may occasion a prominence of the outer wall of the glabella or frontal part of the skull, and this may be occasioned either by the production of a strong superorbital ridge, or by the interposition of large sinuses between the two tables of that part of the skull, or by both circumstances.

The difference between the Orang (*Pithecus*, Pl. XXIX.) and Chimpanzee (*Troglodytes*, Pl. XXVIII.) in the development of the superorbital ridge (11′) affects materially the facial angle, whether taken after the Camperian, the palato-facial[4] (B - - - - B), or the

[1] Camper, as defined by Cuvier, Leçons d'Anat. Comp. tom. ii. (Ed. 1799), p. 5. [2] *Ibid.* p. 9.

[3] Lectures on Man, 8vo, 1819, p. 171.

[4] In this method, proposed by Dr. Barclay, the horizontal line is drawn parallel with the under surface of the bony palate. But the plane of the palate varies much in the mammalian series in its relation to the base of the cranium.

basi-facial[1] (O—O) method, without a corresponding difference really existing between the proportions of the cranium to the face in the two species. The only true mode of demonstrating these relative proportions is by a vertical section through the median line of the skull. This section demonstrates not only the true proportion of the brain-chamber to the rest of the skull, but many other differences of structure, not otherwise appreciable, between the lowest races of Man (Pl. XXX.) and the highest species of Ape (Pls. XXVIII. and XXIX.).

In the Negro and Papuan (Pl. XXX.) the area of the cavity of the nose, as exposed by this section, including therein the sphenoidal and other sinuses, communicating with the nasal passages, equals about one-fourth of the area of the cavity of the cranium. In the Gorilla (Pl. XXVIII.) it is very nearly one-half: it is somewhat less in the Orang (Pl. XXIX.), owing chiefly to the smaller extent of the interorbital sinuses. The cranial cavity is lower in proportion to its length and breadth in the Gorilla than in the Orang: the vertical line from the lower border of the occipital condyle to the parietal vault above, measures—

	In.	Lines.
In the Papuan Negro	5	7
In the Gorilla	3	7
In the Orang	3	10

The most anterior part of the cranial chamber is formed by the narrow, deep and well-defined rhinencephalic fossa (*rh*) in the Gorilla (Pl. XXVIII.), but in the Papuan (Pl. XXX.) the prosencephalic compartment is continued two-thirds of an inch in advance of the rhinencephalic fossa (*rh*), and it expands into a much higher and wider arch above it. The rhinencephalic fossa is so slightly depressed and so ill-defined in Man that it has failed to be recognized under any distinctive name in Human Anatomy, although the parts which it contains, as *e. g.* the 'cribriform plate,' the 'crista galli' and the 'foramen cæcum,' have been duly noted. The distinct definition of this primary division of the cranial chamber in the Gorilla forms one of the well-marked differences between it and Man. Its antero-posterior diameter is less by one-third than in Man, and the median ridge called 'crista galli' is rudimental or absent. Another equally strong distinction is seen in the relation of the plane of the cribriform floor of the rhinencephalic fossa with the plane of the upper surface of the basioccipital (1) and basisphenoid (5). In Man the latter (5), terminating above in the postclinoid process, forms an angle of 95° with the cribriform plate (*rh*); in the Gorilla they are nearly on the same parallel.

There being no posterior clinoid process, nor any depression marking a 'sella turcica' in the bisected cranium of the Gorilla, here described, the floor of the cavity of the cranium extends from the foramen magnum straight forwards and a little upwards to

[1] In this method the horizontal line is drawn from the lower border of the foramen magnum to that of the fore part of the premaxillary bone.

the optic platform (*o*), beyond which the presphenoidal part of the floor (9′) describes a slight convexity upwards before it sinks into the deep and narrow rhinencephalic fossa (*rh*).

The lower boundary dividing the anterior from the middle lobes of the cerebrum, formed by the orbitosphenoids or 'lesser alæ,' which in Man, after overarching the 'foramen lacerum anterius,' is continued outwards as a ridge upon the inner surface of the frontal, has no existence in the Gorilla, and the fossa for the 'natiform protuberances' (*n*, Pl. XXVIII.) of the cerebral hemispheres is much less deep; so that the division of the prosencephalic compartment into the fossa for the anterior, and that for the middle, lobes of the cerebrum is so feebly indicated in the Gorilla, that we may safely aver it would not have been recognizable without the indications afforded by the better-developed boundaries in the Human subject. By the light of the same comparison we are able to recognize, reciprocally, through the better-defined rhinencephalic compartment in the Gorilla and Orang, the true nature of that almost effaced primary natural division of the cranial cavity in our own species.

In the Gorilla the boundary of the epencephalic chamber is more complete and definite than in Man, the tentorial ridge being continued from the petrosal (16, Pl. XXVIII.) outwards and backwards to the superoccipital (2). The epencephalic compartment of the cranium, which, in Man, is bounded behind by the impression of the lateral sinus in the higher races,—which impression is feebly, if at all, marked in Papuan skulls,—is relatively larger and especially deeper in all the races than in the Gorilla; and this greater depth, with the more central position of the foramen magnum at the base of the skull, is associated with a production of the walls of the epencephalic compartment downwards in an infundibular form to the foramen magnum, and with a remarkable difference in the aspect of the plane of the basioccipital and basisphenoid in the Human cranium.

The posterior boundary of the epencephalic compartment is only half an inch above the foramen magnum in the Gorilla, whilst in the Papuan it is one inch two thirds, and in the European nearly two inches; and this difference depends not only on the greater vertical extent of the cerebellum, but on the above-mentioned characteristic position of the foramen magnum which relates to the erect posture and gait of the Human species.

By no method, indeed, is the strongly marked distinction afforded by the foramen magnum between Man and the highest Quadrumana so clearly demonstrated as by the vertical bisection of the skull here described. In the first place, as to the size of the foramen, it is, relatively to the capacity of the cranium, much larger in the Gorilla than in Man. Taking the antero-posterior diameter crossed by the section, we find this to be precisely the same in the skulls of the Gorilla and the Papuan compared. The difference in the aspect of the plane of the foramen (D - . - . - D) is, perhaps, best shown by comparing such plane with that of the bony palate (B - - - - B).

If a line drawn along the floor of the nostrils be intersected by one drawn parallel with the lower surface of the basioccipital and basisphenoid, an angle of 45° is intercepted in the Human cranium; whilst in the Gorilla, the lower plane of the basioccipital (1) and basisphenoid (5) and the plane of the floor of the nostrils (20, 21) are parallel.

In the Gorilla the precondyloid canal is relatively smaller than in Man, and, in the present skull, behind the foramen there is on each side a well-marked pit, which is not present in the variety of the Gorilla from the Gaboon, hitherto observed by me.

The extent of the basisphenoid (5) is much greater in the Gorilla than in the Papuan; and, as it is wholly excavated, inflated as it were, by large sphenoidal sinuses (5), these differ from those in Man in having a stronger, more complete and better-defined bony floor: the communication with the middle meatus of the olfactory cavity in the Gorilla is by a perforation at the lower part of the anterior wall of the sinus, instead of by a wider and less regular vacuity in the floor of the sinus, as in Man (Pl. XXX.).

In the variety of Gorilla here described, the sinus in the presphenoid (body of the anterior sphenoid, Pl. XXVIII. 9) is distinct from that in the basisphenoid. Absorption and expansive growth have not obliterated the primitive distinction between these bodies of the two middle cranial vertebræ. The two sinuses (5) and (9) communicate with each other at the middle line, just above their common opening into the nasal meatus.

The suture between the basioccipital (1) and basisphenoid (5) still remains in the adult Gorilla, but all trace of it is obliterated in the Papuan skull compared.

The absence of any depression for a sella turcica, as well as of postclinoid processes, is very remarkable in the present variety of the Gorilla[1].

The internal meatus (Pl. XXVIII. *m*) is smaller in the Gorilla than in Man, as is also the foramen jugulare below the petrosal.

The intracranial part of the petrosal (16) is shorter but broader, its upper surface is more level, and more horizontal in position.

The long axis of the foramen ovale is in the antero-posterior direction, and is not transverse as in Man.

The interorbital sinuses (*f*) in the Gorilla are divided from each other in the median plane by a septum of extremely dense bone formed by the backward production of the frontal and of the coalesced median margins of the nasals, forming a plate (15, 11) answering to the 'crista' of Soemmerring, but much larger, thicker, and of denser texture. It is of a triangular form, widening as it descends to an extent of one inch three lines. The posterior margin of the nasal plate is firmly united by a wavy suture to the equally dense interorbital part of the frontal: a small part of the inferior border, near the posterior angle of the nasal plate, unites with the 'lamina perpendicularis æthmoidei' (14).

The relative position of the nasal and orbital cavities is different in the Papuan and

[1] The postclinoid processes exist in the skulls of the variety of the Gorilla from the Gaboon which I have examined, but these variable processes offer no character of consequence.

Gorilla. The upper boundary of the nasal cavity, formed by the cribriform plate of the æthmoid and the nasal bones, is on a level with the middle of the orbit in the Papuan, but with the floor of the orbit in the Gorilla. The extent, therefore, of solid interorbital median wall is much greater in the Gorilla, and forms a striking differential feature with Man, as seen in the vertical section (Pls. XXVIII. and XXX.).

Sinuses extend from the middle meatus upwards on each side this septum into the interorbital space, as high as the base of the middle fourth of the superorbital ridge (*f*), where they answer to the 'frontal sinuses' of Man; but, owing to the peculiar development of that ridge in the Gorilla, they occupy no part that can properly be called forehead in that animal. The superorbital ridge itself is chiefly composed of solid bone with a small extent of minute cancellous structure in the middle of the substance.

The inner or vitreous table of the calvarium is better defined, where it is defined, in the Gorilla than in Man, as is shown in the section (Pl. XXVIII.) for about an inch above the foramen magnum, at the base of the lambdoidal crest, and along the posterior half of the base of the sagittal crest; elsewhere it blends with the outer table to form a dense compact roof of bone. The whole of the enormous sagittal crest (11, 3) is formed of bony substance almost as compact. The basal half of the lambdoidal crest (3, *l*), exposed by the section, is cancellous at its middle; and the boundary line between this and the sagittal crest is well marked by the long venous canal continued downwards from the foramen parietale (3).

It is scarcely necessary to say that the parietal and lambdoidal cristæ, which in the Gorilla surpass in height those of all the Carnivora, do not exist, even rudimentally, in any of the races of Mankind. The crucial ridge in Man is developed from a lower part of the superoccipital than is the lambdoidal ridge of the Anthropoid apes.

If we next proceed to compare the nasal chamber itself in the skulls of the Gorilla and Papuan, we have first to notice the greater proportional length of that cavity in the Gorilla, especially in the extent of its bony floor (20–22), but the turbinal plates have not a corresponding antero-posterior extent. The premaxillary is relatively longer and larger, and the part below the nostril, divided by the section at 22, Pl. XXVIII., slopes more forwards than in the Papuan. The answerable part (22, Pl. XXX.), though confluent with the maxillary in Man, is well defined by the incisive canal: this is divided at its nasal end in the Gorilla, as in some Papuan and other Human skulls, by the junction of a process of the premaxillary with the fore part of the nasal spine of the maxillary (21).

The remains of the premaxillary suture, which are obvious in the Gorilla for half an inch upon the under surface of the palate, may be traced for an inch upwards and backwards along the lateral wall of the incisive canal into the nasal cavity, where it is lost, but appears again at the upper and lateral part near the nostril (Pl. XXVIII. 22″), where the upper extremity of the premaxillary remains, as a distinct ossicle, detached from the coalesced part of the bone, in the present variety from the river Danger. The vomer (13) appears to be less completely ossified in the Gorilla than in Man.

The inferior turbinal (19) is a large thin rhomboidal plate, slightly convex towards the median line, terminating in a straight margin below, and by a long oblique margin in front, which joins a reflected thin plate of the maxillary, bounding the fore part of the lacrymal fossa, an inch behind the external nostril.

The middle turbinal (18) resembles in its simple shape the lower one, but is smaller; the still smaller upper plate is bent, but not convoluted. The 'lamina perpendicularis æthmoidei' (14) is of much less extent than in Man.

The cranium of the adult Orang (*Pithecus Satyrus*) when bisected (Pl. XXIX. fig. 1), as in the foregoing specimens, presents a close general resemblance to that of the Gorilla, and the same wide differences in the proportions of the cranial and olfactory cavities from that of the Papuan.

The brain-chamber is shorter, but higher, than in the Gorilla, and though there is but two lines' breadth difference in favour of the Orang in the latter diameter, it appears to be proportionally greater on account of the less antero-posterior extent of the chamber, which in the Gorilla is 5 inches 2 lines, whilst in the Orang it is only 4 inches 3 lines.

	In.	Lines.
The greatest vertical diameter (in front of the foramen magnum) in the Orang is	3	5
Ditto in the Gorilla	3	3
Ditto in the Papuan	5	0
Ditto in the European	5	6

The rhinencephalic compartment (Pl. XXIX. *rh*) is somewhat narrower, and is as deep in the Orang as in the Gorilla: the 'crista galli' is equally rudimental. The division of the prosencephalic compartment, for the anterior and middle lobes of the cerebrum, is as ill defined.

The tentorial ridge is not continued backwards beyond the petrosal, as in the Gorilla. The basisphenoid has coalesced with the basioccipital, and is of less extent.

The sphenoidal sinus is almost wholly formed by the presphenoid, and it is divided by a longitudinal horizontal, instead of by a vertically transverse septum, as in the Gorilla. The lower border of the basi-occipito-sphenoidal floor of the cranium has the same parallelism with the bony palate or floor of the nostrils as in the Gorilla. The plane of the occipital foramen forms a somewhat less open angle with the straight basi-occipito-sphenoidal line than in the Gorilla, and to that extent departs further from Man. The interorbital sinuses (*f*) do not ascend to within half an inch of the upper level of the orbits (11′), and there is consequently no proper frontal sinus: a cancellous structure occupies the usual place of this, below which, part of the interorbital septum formed by the hinder crista of the nasal bone and the frontal presents, as in the Gorilla, a very compact dense structure. The small venous canal continued from the foramen cæcum traverses the base of this septum to terminate at the lower end of the short nasal bone. The lamina perpendicularis æthmoidei presents a quadrate form 8 lines in diameter.

The floor of the nasal cavity is shorter, thicker, and a larger proportion of it is contributed by the premaxillary (22) in the Orang than in the Gorilla. The part of the premaxillary divided by the section is absolutely longer, larger, and more nearly parallel with the palato-nasal plate of the maxillary (21) than in the Gorilla. The nasal end of the incisive canal is divided by the process extending from the premaxillary to the maxillary; but this is the only part of the premaxillary which has not coalesced with the maxillary; every other trace of the original suture has disappeared, even that on the palate.

There is no production of the nasal below the crista sent backwards to form the dense interorbital septum, and no production of the feebly marked superorbital boundary, forwards and upwards, to form a crest, as in the Gorilla. The turbinal plates are less developed than in the Gorilla; the lower one is shorter than the one above; and there is not any plate answering to the small superior turbinal in the Gorilla and in Man.

Both lambdoidal and sagittal cristæ are much less developed than in the Gorilla.

In comparing together the vertical sections of the Papuan and European skulls, the relative proportion of the cranial and nasal chambers is seen to differ in a slight degree; the nasal chamber is nearly of the same size in both,—a little longer at its floor in the Papuan; but the cranial cavity is greater in the European, as is shown by the table of the mean capacity of the cranium in the different races of Man and in the Chimpanzee and Orang, p. 99. Although no part of the calvarium is raised into crests, yet the whole calvarium is thicker in the Papuan, as it is in most African Negroes, than it is in the European. But there is another character in which the Papuan more nearly resembles the Orang, which I was not prepared to find, viz. the total absence of frontal sinuses. The front wall of the cranium is thickened by a superorbital ridge, and by protuberances that appear externally to be due to the usual sinuses; but in the vertical section the interval between the two tables was here seen to be occupied by a fine cancellous structure.

As this might possibly have been a mere individual variety, I had a section made of another male Papuan skull from Tasmania, both vertically and horizontally, through one of the protuberances, and found the same absence of any sinus.

In a third cranium of an Australian, which showed external indications of the sinuses, I made a horizontal section through the protuberances, about 3 lines above the brim of the orbit, and the same close cancellous structure was exposed without any air-cavity. If anatomists who may possess other crania of the Australian and Tasmanian Papuans would repeat the investigation, a sufficient number of instances might be collected to establish the rule, and show the absence of frontal sinuses to be characteristic of those Papuan Æthiopians[1]. In the African Negros whose skulls I have examined by section, the frontal sinuses are developed.

It may be worthy of inquiry and observation whether the voice of the Australian Papuans is more harsh and guttural, and has less of that clear resonance in ordinary conversation, which we may observe in most Europeans, in whom it depends upon the greater extent of the cavities for vibratory air, which communicate with the nasal passages. The frontal sinuses are late in their development and subject to much variety in the European races: too much stress must not, therefore, be laid upon their absence in the Papuan aborigines of Australia, if even that absence should prove to be constant. Another well-marked difference between the Papuan and European, by which the former more nearly resembles the anthropoid Apes, is the larger premaxillary part of the upper jaw, and its more obliquely prominent position, as shown by the section at 22, Pl. XXX.

In the skull of a young Orang Utan with the deciduous teeth (Pl. XXIX. fig. 2), the antero-posterior diameter of which is 5 inches 6 lines, that of the cranial cavity is 3 inches 11 lines, the vertical diameter of the same cavity being 2 inches 10 lines. In this skull the nasal cavity equals little more than one-fourth that of the cranium, presenting almost the same proportions as in the adult Man. The brain-chamber also swells out in front of the rhinencephalic fossa (*rh*), showing a certain change of position of this fossa in the progress of growth. The basisphenoid is as yet occupied only by cancellous structure, the sinuses not being developed.

But the relative capacities of the cranial and olfactory chambers are not absolutely indicative of degrees of proximity to Man in the Mammalian class, or in the Quadrumanous order. Some of the smaller species of the South American Monkeys, as, for example, the *Callithrix Pithecia*, resemble the immature Orang in the predominating capacity of the cranial chamber. This is due to a retention, with the diminutive size of the whole body, of some other immature characters. The brain is relatively larger in proportion to the body than in the Chimpanzee and Orang, but it has a much less proportional amount of grey cerebral matter; the surface of the hemispheres being as little convoluted in the full-grown Marmoset as in the half-developed fœtus of a larger and higher species of Quadrumane.

In the higher mammalian classes the brain rapidly acquires a certain bulk by an accelerated rate of growth. In all the Quadrumana, and doubtless in a much larger proportion of the Mammalian class, the brain, at that early stage of development, bears the same large proportion to the bulk of the embryo in all the species, notwithstanding the great

[1] Since the above was in type, I have had the opportunity of examining, through the kindness of Dr. Acland, Lee's Reader of Anatomy in the University of Oxford, the cranium of an Australian Papuan in the Museum which owes so much to his zealous and judicious superintendence. Although the place of the frontal sinuses was indicated, as in some of the previously examined specimens, by outward prominences, the sinuses had not been developed.

difference of size which may distinguish such species when arrived at maturity. The subsequent differences in the relative size of the brain depend upon the specific stature ultimately to be attained; for, the destined degree of cerebral development in a large species having once been obtained, as it is very rapidly in regard to the size of the hemispheres, the growth of the trunk, limbs and jaws afterwards proceeds without corresponding growth of the brain.

These considerations must be allowed their due weight in comparing the relative size of the brain or brain-case of small and great species of the same Order of warm-blooded animals, otherwise the same mistake may be made as to the relative perfection, or standing in the group, of the smaller species with comparatively large brains, as has been made with regard to the degree of relationship of the Chimpanzee and Orang to Mankind, when judged of by the proportion of the brain and brain-case in small and immature individuals of those large and formidable species of Ape.

The great characteristic in Man arises from the great relative size of the brain and capacity of the cranium being associated with a stature which surpasses that of the largest of the Quadrumana. Dr. Wyman, the accomplished Professor of Anatomy in the Medical College at Boston, U.S., in a recent Memoir descriptive of two additional crania of the *Troglodytes Gorilla*, in the 'American Journal of Science and Arts,' 2nd Series, vol. ix., cites the following Table of the capacity of the cranium, from the careful admeasurements taken by the late lamented and talented Dr. S. G. Morton of Philadelphia.

Races.	No. of Skulls measured.	Largest capacity.	Smallest capacity.	Mean.
Teutonic Race of CAUCASIANS.		Cubic inches.	Cubic inches.	Cubic inches.
Germans	18	114	70	90
English	5	105	91	96
Anglo-Americans	7	97	82	90
MALAY GROUP.				
Malayan Family	20	97	68	86
Polynesian Family	3	84	82	83
AMERICAN GROUP.				
Toltecan Family.				
Peruvians	155	101	58	75
Mexicans	22	92	67	79
Barbarous Tribes	161	104	70	84
ÆTHIOPIAN GROUP.				
African Family	62	99	65	83
Hottentots	3	83	68	75
Australians	8	83	63	75

Dr. Wyman gives the following results of similar admeasurements taken of the skulls of the Gorilla and Chimpanzee; to which I have added some from personal observation.

Cranial capacity of adult *Troglodytes Gorilla.*

		Cubic inches.
I.	Male from Dr. Perkins	34·5
II.	Male from Dr. Savage	28·3
III.	Female from Dr. Savage	25·0
IV.	Male from River Danger	32·6
V.	Male from the Gaboon	30·3

Cranial capacity of adult *Troglodytes niger.*

		Cubic inches.
I.	Male	27·6
II.	Female	26·0
III.	Female	24·0
IV.	Female	22·0

Cranial capacity of young *Troglodytes niger.*

		Cubic inches.
I.	First dentition complete	20

Cranial capacity of adult *Pithecus Satyrus.*

		Cubic inches.
I.	Male	26
II.	Female	24

Cranial capacity of young *Pithecus Satyrus.*

		Cubic inches.
I.	First dentition complete	19·6

From the above admeasurements it appears that the Hottentots and Papuans of Australia have the smallest cranial capacity amongst the Human races; but that the largest capacity yet observed in the adult male Gorilla is less than one-half the mean capacity in those Æthiopian races.

The Chimpanzee, *Troglodytes niger*, with its inferior size, has also a lower capacity of cranium than the Gorilla has; and the Orang has a smaller capacity of cranium than in either of the two species of Chimpanzee.

DESCRIPTIONS OF THE PLATES.

(All the figures are of the natural size.)

PLATE XXVI.

Base of the cranium of the *Troglodytes Gorilla* from the River Danger.

PLATE XXVII.

Summit of the same cranium.

PLATE XXVIII.

Inside view of the same cranium, vertically and longitudinally bisected.

PLATE XXIX.

Inside views of similarly bisected skulls of—fig. 1. an adult, and fig. 2. an immature male, *Pithecus Satyrus*, from Borneo.

PLATE XXX.

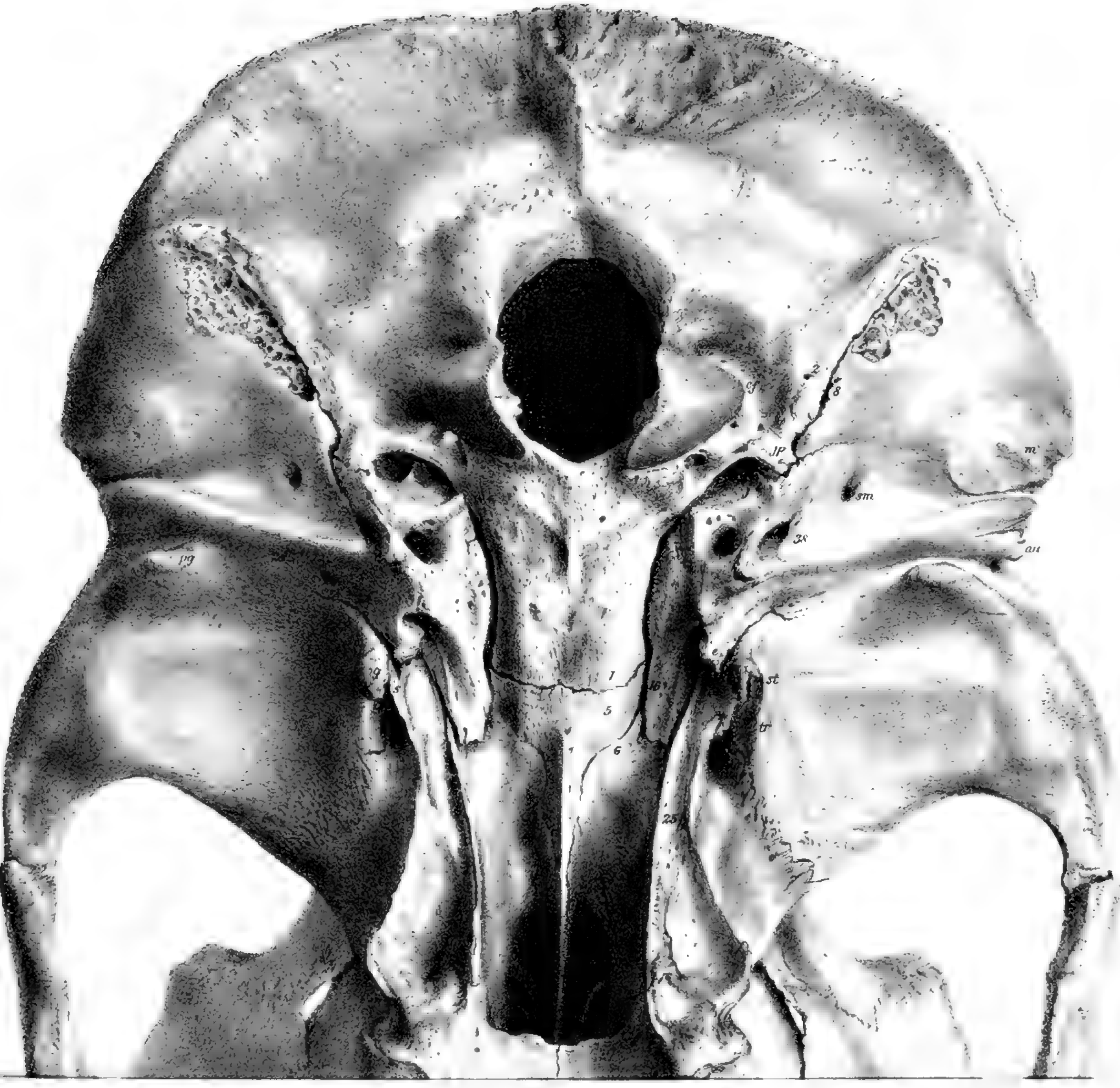
Fig. 1. Inside view of a similarly bisected skull of a male Australian Papuan.
2. Horizontal section through the superorbital ridge of the skull of a male Tasmanian Papuan.

(The same figures, letters and lines indicate the same parts in each Plate.)

1. Basioccipital.
2. Exoccipital.
jp. Jugular process.
j. Jugular foramen.
cf. Condyloid fossa.
5. Basisphenoid.
6. Alisphenoid.
n. Fossa for 'natiform protuberance.'
7. Parietal.
8. Mastoid.
m. Mastoid process.

9. Presphenoidal sinus.
9'. Cranial surface of presphenoid.
11. Frontal.
11'. Superorbital ridge.
16. Petrosal.
e. Eustachian process.
28. Tympanic.
au. External auditory foramen or meatus.
m. Internal auditory foramen.
v. Vaginal process.
38. Stylohyal fossa.
c. Carotid canal.
pg. Post-glenoid process.
g. Entoglenoid process.
s. Styliform process.
st. Styloid or spinous foramen.
tr. Foramen ovale.
15. Nasal.
rh. Rhinencephalic fossa.
20. Palatal.
21. Maxillary.
22. Premaxillary.
22'. Facial part of premaxillary joining the nasal.
22''. Suture between this part and the rest of the premaxillary.
25. Pterygoid fossa.
26. Malar.
26'. Zygomatic process of malar.
27. Squamosal.
27'. Zygomatic process of squamosal.
73. Lacrymal.

C . . . . C. The line intersecting the facial line according to the method of Cuvier.
B - - - - B. The line intersecting the facial line to form the palato-facial angle.
O—O. The line intersecting the facial line to form the basifacial angle, as proposed by the author (p. 92).
D . - . - . - D. The line crossing the plane of the foramen magnum and intersecting the basal line, as proposed by Daubenton.



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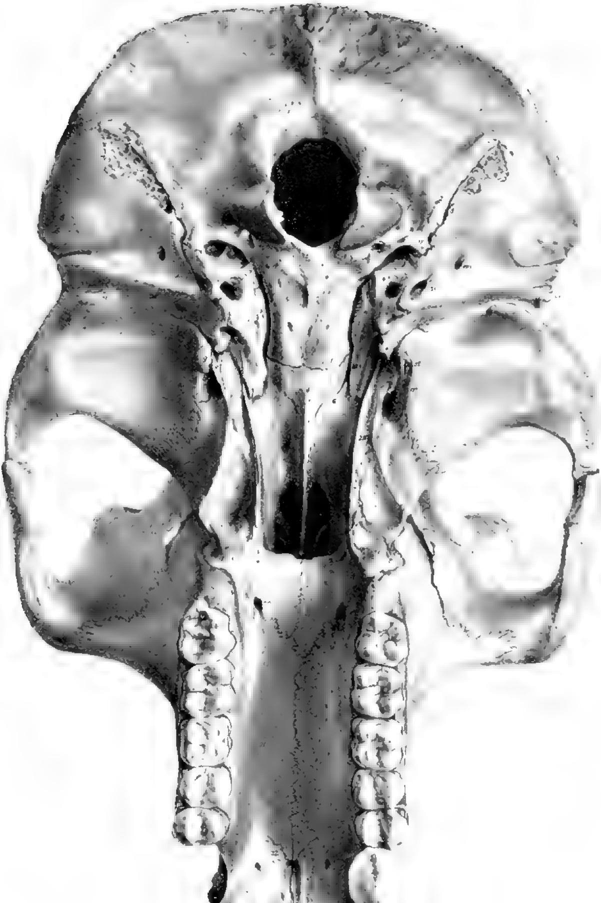

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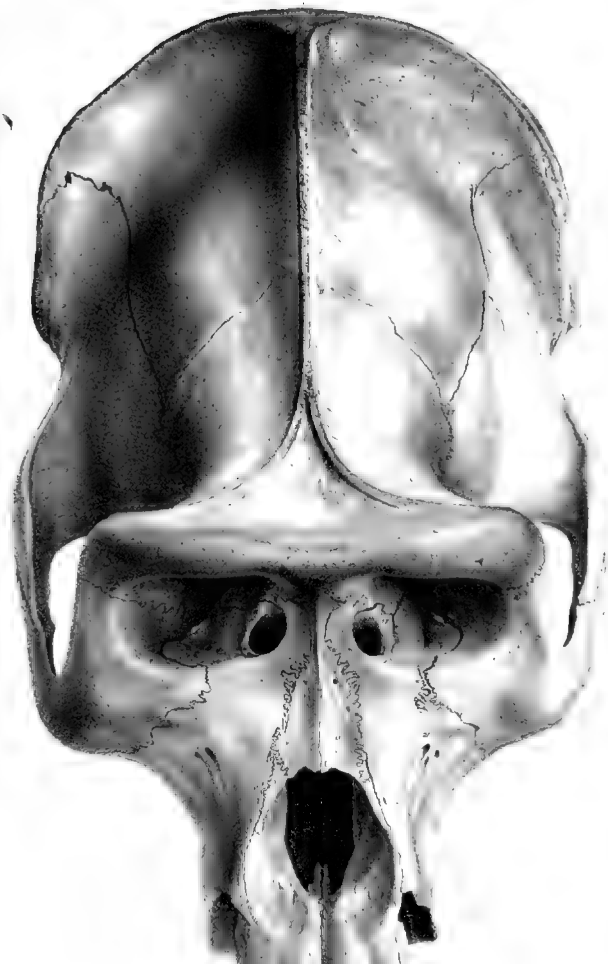

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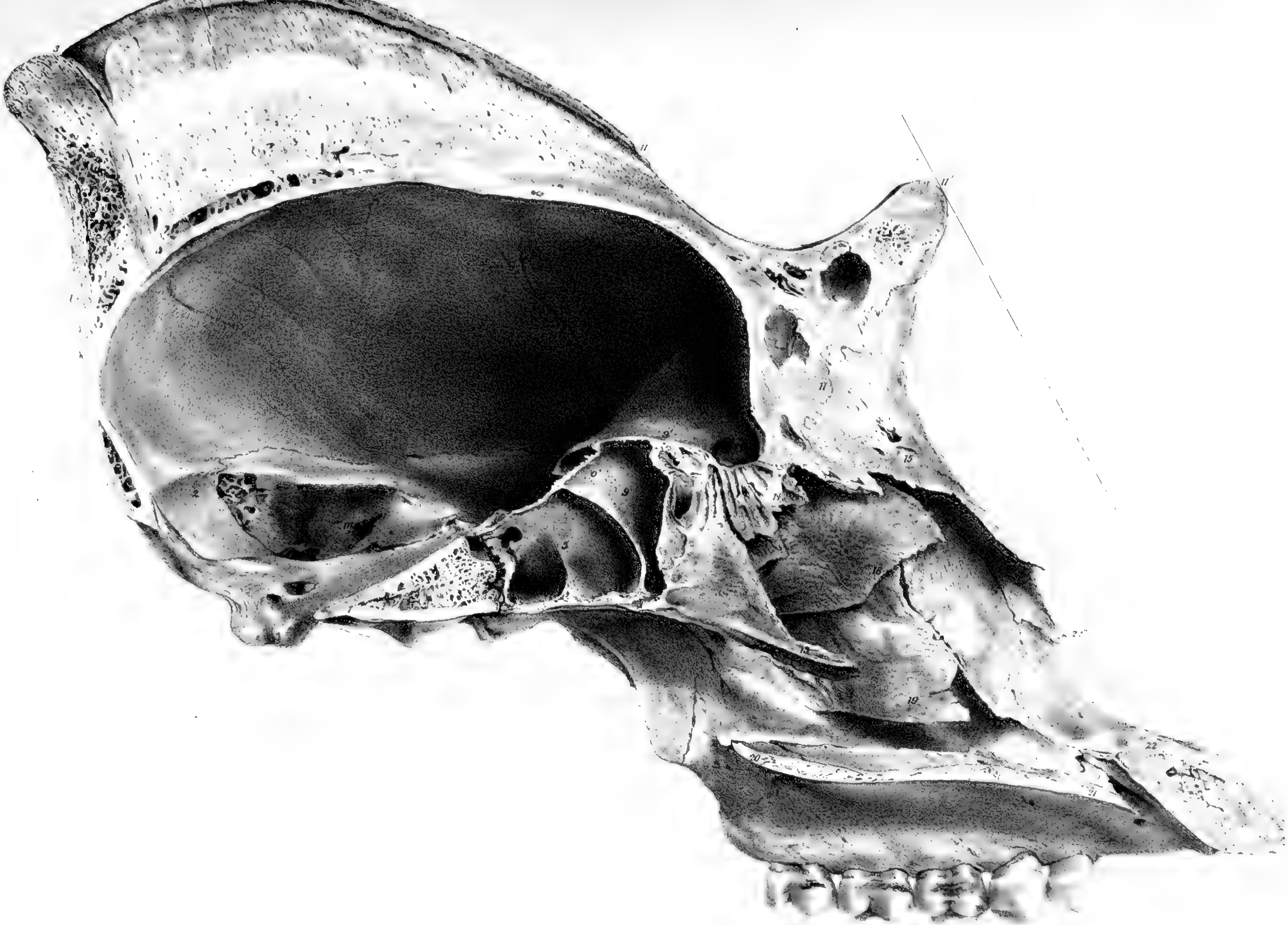

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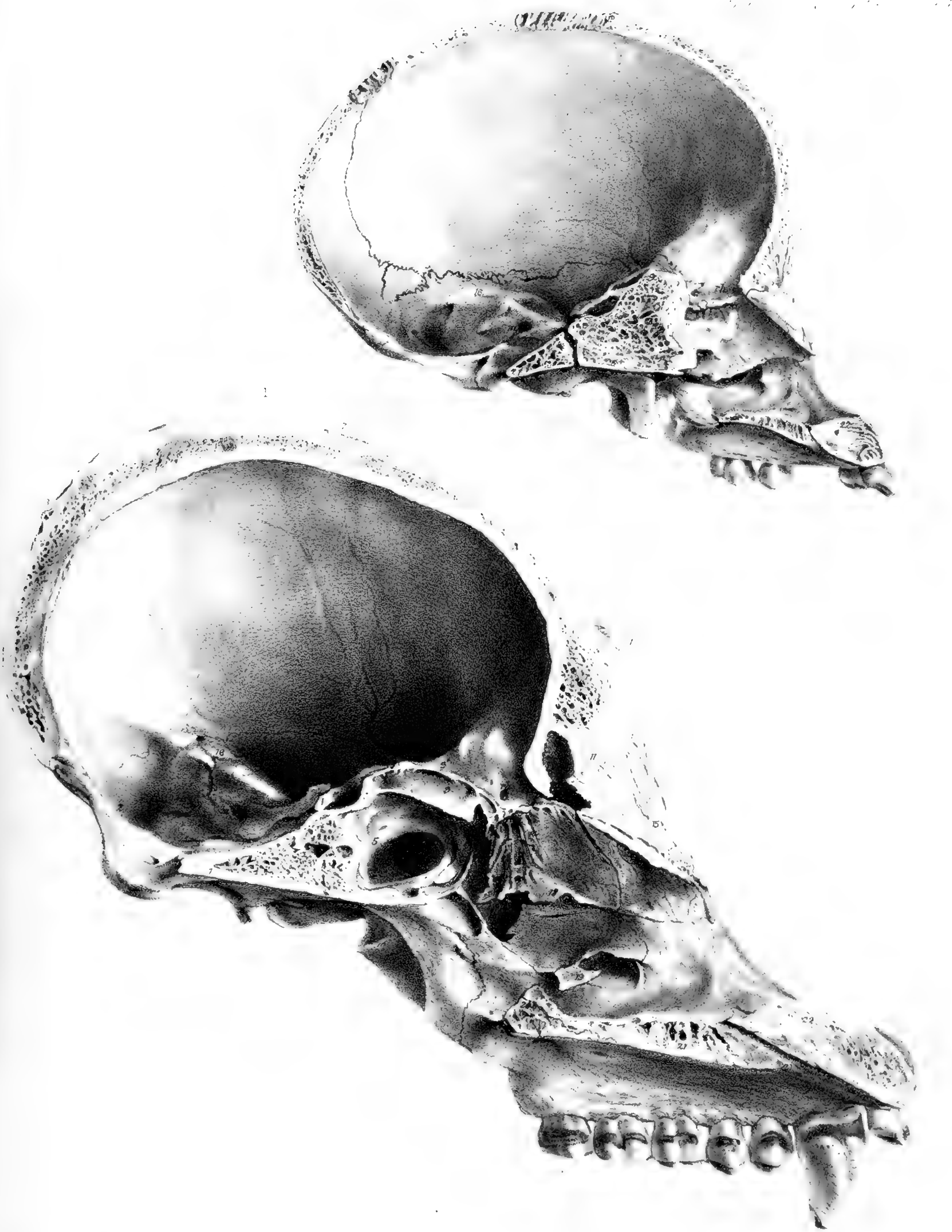

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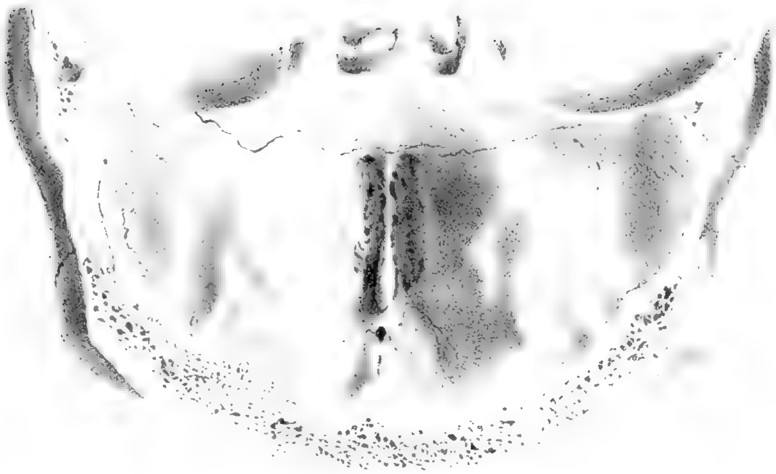
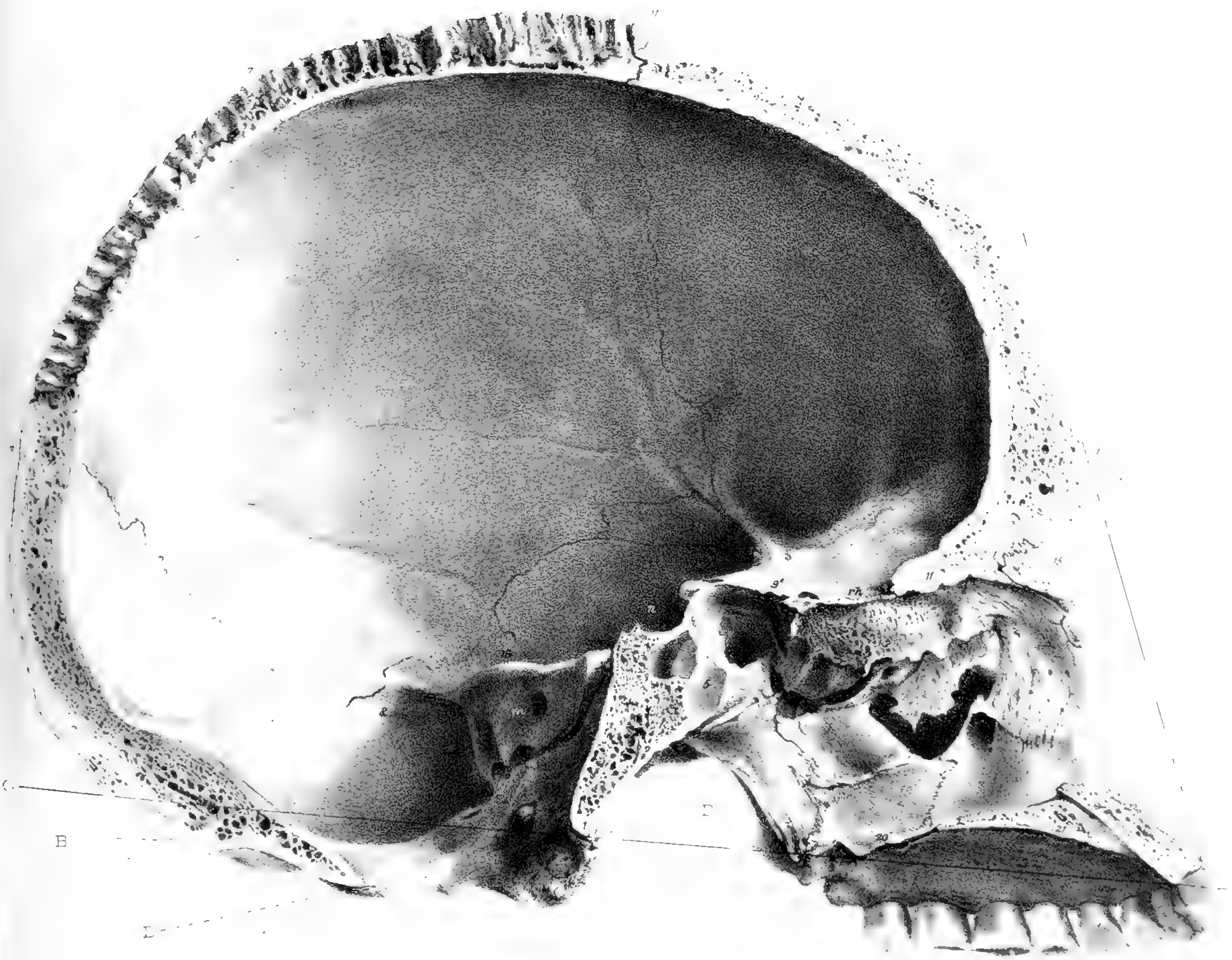
PITHECUS SATYRUS, 1 mas 2. pullus





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VIII. *Osteological Contributions to the Natural History of the Chimpanzees* (Troglodytes) *and Orangs* (Pithecus).—No. V. *Comparison of the Lower Jaw and Vertebral Column of the* Troglodytes Gorilla, Troglodytes niger, Pithecus Satyrus, *and different varieties of the Human Race.* *By* Professor Owen, *F.R.S., F.Z.S. &c.*

Read September 9, 1851.

In the communication I had the honour to make to the Zoological Society in 1848[1], on the subject of the Gorilla, the results of the comparison of its cranium and dentition with those parts in other Anthropoid Apes, and in different varieties of the Human race, were recorded ; I now submit the results of the like comparisons carried out in the rest of the skeleton.

The Mandible or Lower Jaw.—Plates XXXI. & XXXII.

The lower jaw (mandibula) of the *Troglodytes Gorilla* is one bone in the adult by confluence of the two halves at the symphysis, as in all Quadrumana. Each half or ramus (Pl. XXXI. fig. 1) shows the usual horizontal and vertical portions ; the former gradually augmenting in depth as it approaches the latter, where the breadth of the bone suddenly increases. The rami diverge from each other, according to lines touching the sockets of the canines and the outer side of the condyles, at an angle of 35°. The length of the jaw, in a straight line from the back part of the condyle to the fore part of the symphysis, is 7 inches 4 lines. From the outer side of one condyle to that of the other, 5 inches 5 lines. The vertical extent of the rising ramus from the summit of the coronoid process is 4 inches 6 lines ; the antero-posterior diameter of the same ramus is 2 inches 9 lines. The extent of the alveolar series, from the last molar to the canine inclusive, is 3 inches 8 lines ; this part of the series is longitudinal, almost straight, with a very slight bend inwards, and is parallel with the same part on the opposite side. The incisive alveoli are at right angles to the above, and unite them together across the fore part of the jaw. The number of the alveoli corresponds of course with that of the teeth described in a former Memoir[2]. The socket of the canine is the largest and deepest depression : those of the molars and anterior premolar are nearly equal : that of the posterior premolar is much smaller ; and those of the incisors the smallest of all.

The symphysis curves from the incisive alveoli downwards and backwards with a gentle convexity to the lower border of the jaw. Its exterior surface is smooth and convex ; rather more prominent near the middle of its lower part, but devoid of vertical or transverse ridges or tuberosities. There are slight depressions opposite the interspaces

[1] Transactions of the Zoological Society, tom. iii. p. 381. [2] Vol. iii. p. 395.

of the sockets of the incisive and canine teeth; the outer walls of these sockets are a little prominent, chiefly so in the canines, and also where the anterior root of the first premolar is implanted. A thin ridge of bone extends along the outer side of the openings of the molar sockets, beneath which there is a shallow longitudinal channel which insensibly passes below into the flat surface of the bone, which becomes convex towards the lower border.

A little behind and below the prominent part of the first premolar alveolus, and a little nearer the lower than the upper border of the bone, is the 'foramen mentale': I have seen it double on the right side, the smaller division being in advance of the chief opening: two or three much smaller foramina open behind this.

There is a low tuberous rising near the lower border of the bone, below the beginning of the fore and outer part of the ascending ramus. This ramus commences from a platform of bone which extends outwards beyond the alveolus of the last molar; a strong ridge, continued from the back part of that alveolus, inclines, as it rises, towards the outer ridge which it joins, after it has bounded the fore part of the crotaphite depression.

The lower border of the horizontal passes into the hinder border of the vertical ramus by a pretty regular convex curve, without a projecting angle: the outer part of this curve forms a low, rather sharp ridge: the inner part presents four or five tuberosities bounding intermediate concavities (Plate XXXII. fig. 2). The outer surface of the rising ramus is nearly flat: there is a feeble middle rising and a shallow depression anterior to this. The anterior border rises nearly vertically and straight for two-thirds of its extent, then curves gently backwards to the summit of the coronoid process. This summit is pointed and is divided from the condyle by a deep and pretty regular concavity, formed by the upper border of the ascending ramus, which terminates near the outer side of the condyle.

The condyle is convex, subovate, with its long axis transverse, and its larger end inwards: the fore part of its articular surface terminates by a well-defined line or ridge; the back part curves downwards to a lower level, and is insensibly lost on the neck of the condyle: there is a rough protuberance below the outer end of the condyle; and a more extensive rough surface below the inner end, which overhangs the rising ramus. The smooth, broad, convex rising which bounds the lower part of the crotaphite fossa terminates at the fore and inner part of the condyle.

The inner side of the symphysis presents at its lower fourth part a rough, oval, shallow depression traversed by a slight median vertical ridge, which terminates in the rough, transverse, broader ridge bounding the depression below. The inner surface of the horizontal ramus is smooth; a sudden but slight sinking marks the beginning of the inner surface of the ascending ramus. This surface is divided by the ridge leading to the condyle into an upper and lower part: the upper and smaller depression receives the insertion of the crotaphite muscle; the lower one is pierced by the dental canal, from which hole a canal is continued downwards and forwards. The hole is in the middle of the ascending ramus.

Compared with the mandible of the Human species, even of the lowest variety, the Australian, *e.g.* (Pl. XXXI. figs. 2 & 3), the first and chief distinction is the absence of the chin, a feature which is as well marked in the black as in the white races of the Human kind. The entire jaw is much shorter in proportion to the intercondyloid space, in Man; for the distance between the condyles is as great in most adult male jaws as in the Gorilla, and in some it is greater; whilst the ordinary length of the lower jaw, in a straight line from the back part of the condyle to the fore part of the symphysis, is from $4\frac{1}{2}$ to 5 inches. The angle of the jaw is usually more rounded off in the Australians, as is shown in fig. 2, than in Europeans; but is always less rounded and better marked than in the Gorilla. The parabolic or elliptic curve of the alveolar arch (fig. 3), the progressively diminishing size of the sockets from the molars to the incisors, and the thin sharp wall between each alveolus, are also well-marked characteristics of the human jaw in this comparison.

Of the generally developed vertical ridge or 'tuber maxillare' at the lower and fore part of the symphysis in the human jaw, there is no trace in the Gorilla; and the tubercles, sometimes developed in a transverse pair, or three in number, at the back surface of the symphysis, are equally wanting in the Gorilla. The outer surface of the jaw, beneath the outer and anterior origin of the ascending ramus, is more protuberant in Man. As to the 'external oblique ridge' attributed by some Anthropotomists as a normal character to the Human lower jaw, the very frequent absence of any such ridge in Man renders the like absence in the jaw of the Gorilla of little moment in this comparison.

The foramen mentale, which is below the first premolar in the Gorilla, is usually below the second premolar in Man, as it is also in the Chimpanzee and Orang. The inner and anterior ridge of the ascending ramus converges more regularly or directly as it ascends to the outer one in Man, and has not the angular deflection which it shows in the Gorilla. The ridge which extends from that angle to the condyle in the Gorilla, above the foramen dentale, is more feebly marked, or is wanting, in Man. The horizontal ramus gradually and slightly diminishes in vertical extent as it approaches the ascending ramus: the contrary is the case in the Gorilla. The thickest and most prominent part of the condyle is nearest the middle of that joint in Man. The point of the coronoid is on the same vertical line with the fore part of the base of the ascending ramus: in the Gorilla it is bent more backwards. The interval between the coronoid and condyloid processes is relatively wider and more shallow in man.

The inner wall of the molar alveoli overhangs the subjacent part of the jaw more abruptly in Man than in the Gorilla: the frequent development of the (internal oblique) ridge extending from behind the socket of the last molar forwards and downwards to beneath the first molar, or a little further, is a characteristic of the human jaw as compared with that of the Gorilla and other Anthropoid Apes. There is only a slightly roughened longitudinal tract beneath the inner wall of the alveoli of the last two molars in the Gorilla. The foramen or entry of the dental canal is relatively larger in the white varieties of Man than in the Gorilla, and the inner boundary of that foramen is more produced. The crotaphite fossa is less depressed and less marked in Man.

The condyle is more compressed from before backwards in Man, and its articular surface is better defined. The outer surface of the angle of the jaw in the Gorilla has neither the tuberosity nor the vascular groove present in some human jaws.

In comparison with the lower jaw of the Chimpanzee (*Troglodytes niger*)[1], that of the Gorilla is chiefly distinguished by the superior height and expanse of its ascending rami. The rounded part of the angle is less extensive in the Chimpanzee ; that angle is consequently better marked ; and both in this respect, and in the minor vertical extent of the horizontal ramus beneath the last molar tooth, the Chimpanzee approaches nearer the Human subject : but both differences seem to be due to its inferior strength as compared with the Gorilla, and are not particularly characteristic of Man. The symphysis is accordingly relatively deeper in the Chimpanzee ; and though sloping backwards as it descends, it is more angular at its lower part than in the Gorilla. The mental foramen, besides being situated below the socket of the second premolar, is nearer the lower border of the ramus than in the Gorilla, and in so far differs more from Man.

The antero-internal ridge of the ascending ramus is more behind, and more distant from, the antero-external ridge than in Man ; but it rises, without the angular bend shown in the Gorilla, and the crotaphite depression is relatively smaller and is less well-defined than in the Gorilla. The smooth, rounded ridge, continued from the middle of the antero-internal ridge to the condyle, is well marked in the old male Chimpanzee. The breadth of the symphysis is almost equal to that in the Gorilla, as is shown in Pl. XXXII. fig. 3, and is consequently relatively greater, compared with the length of the jaw, than in the Gorilla, the Chimpanzee in this important character departing further from the Human type.

The entry of the dental canal is nearer the antero-internal ridge, and is relatively lower, in the Chimpanzee than in the Gorilla, which, in the more central position of that foramen, more nearly approaches Man. At the lower and back part of the symphysis there is a fossa, bounded below by a transverse crescentic ridge, or backward continuation of the under surface of the centrum.

The coronoid process agrees with that in the Gorilla in its shape and the backward curve of its apex. The condyle resembles in shape that of the Gorilla, but the articular surface does not extend so far downwards behind, and is better defined there. In two lower jaws of adult specimens of Chimpanzee, the uppermost of the ridges on the inner and back part of the rising ramus is the most developed, as is shown in fig. 5. The form of the posterior margin of that ramus is shown in Man (Pl. XXXI. fig. 4), in the Gorilla (Pl. XXXII. fig. 2), and in the Chimpanzee (*ib.* fig. 5).

[1] Trans. Zool. Soc. vol. iii. Pl. LVIII.

In the lower jaw of the adult male Orang-utan (*Pithecus Satyrus*, var. *Wurmbii*)[1] the first difference is the lower and more obtuse coronoid process; next, the more full elliptical form of the condyle, due to its greater antero-posterior breadth; then the stronger development and lower origin of the antero-external ridge of the ascending ramus, and the greater breadth of the channel dividing it from the antero-internal ridge: this ridge rises straight to join the external one at the fore part of the coronoid process. Behind it the crotaphite depression is deeper but narrower than in the Gorilla. The external crotaphite depression is also better marked.

The dental foramen, by its relatively higher position than in the Chimpanzee, corresponds closer with that in Man. Behind and below it one or two 'mylohyoid' grooves extend in the direction of the canal. The mental foramen is nearer the lower border of the jaw than in the Gorilla; it is below the second premolar tooth.

The symphysis is broader, flatter, and less sloping at its upper half; below this it is convex and receding, as in the Gorilla. There is a slight prominence at its under part, on each side of which a rough tract extends outwards for nearly two inches. A fossa, bounded below by a rough tract or ridge, characterizes the lower and back part of the symphysis. A narrow linear ridge extends from behind the last alveolus forwards and downwards—a feeble trace of the internal oblique ridge in Man. Five or six rough ridges on the inner side and back part of the ascending ramus, with intervening depressions, indicate the attachment of the pterygoid, as in the Gorilla. The angle of the jaw is better marked in the Orang. The alveolar part of the jaw is shorter in proportion to the rami in the Orang. The same characteristic distinction from Man is shown, as in the Gorilla and Chimpanzee, by the straightness and parallelism of the molar series.

In the lower jaw of a female *Pithecus Satyrus*, the anterior and posterior borders of the ascending ramus are nearly straight and parallel.

Hyoid Arch.

This arch, in the Gorilla, offers some well-marked peculiarities and distinctions from that in Man. The basihyal is relatively much larger: it is more deeply excavated behind, with the aperture directed towards the glottis: the opposite convexity is raised. The outer surface of the thin osseous walls is smooth, save at its lower and lateral part, which shows marks of muscular insertions. There was no trace of lesser cornu or ceratohyal: the thyrohyal or greater cornu is long and nearly straight, diminishing in thickness as it approaches the thyroid. The stylohyal is relatively shorter than in Man, and does not become anchylosed to the base of the skull in the adult Gorilla.

Vertebræ of the Trunk.

The vertebral column of the trunk in the Gorilla differs from that of Man in showing but one gentle curve, with the concavity forwards, from the sacrum to the cervical

[1] Trans. Zool. Soc. vol. i. Pl. LIII.

series, which series is straight when extended. It differs also in the more uniform transverse diameter of the bodies of the dorsal and lumbar vertebræ, the latter not expanding in the same degree, as they approach the sacrum, as they do in the Human subject. These general differences in the relative position and proportions of the 'true' vertebræ are repeated, and are rather more strongly marked in the Chimpanzee and Orang.

The comparison is instituted, throughout, with the Australian variety of the Human species—a variety, of which the entire skeleton, and the separate bones, have not hitherto been described and figured.

The cervical vertebræ of the Gorilla are the same in number as in the class Mammalia generally, viz. 7. The number of dorsal vertebræ, or those bearing moveable ribs, is 13; that of the lumbar vertebræ 4; that of the sacral vertebræ 5: the total number of true or moveable trunk-vertebræ being the same as in Man, only the ribs which answerto the transverse processes of the first lumbar in Man retain their distinctness with a greater length, whilst those which form the transverse processes of the last lumbar vertebra become modified, by age, like the same elements of the sacral vertebræ.

Cervical Vertebræ (Pl. XXXIII.).—Of the true vertebræ the cervical series departs most from the Human type in the extraordinary length of the spines of the last five vertebræ (Pl. XXXIII. fig. 1, 3, 4, 5, 6, 7); that of the fourth cervical (4) being not less than $3\frac{1}{2}$ inches; those of the third and fifth are nearly of the same length, but are thicker, and have a slight curvature in opposite directions, diverging in a slight degree away from the fourth; the spines of the sixth and seventh cervicals gradually decrease in length and increase in thickness: the spine of the dentata (2) is trihedral, the surfaces being divided by produced sharp ridges. The canal for the vertebral artery decreases in diameter from the sixth (*ib.* fig. 6, *v*) forward to the atlas.

The atlas (Pl. XXXIII. fig. 2) has a less transverse and a greater fore-and-aft diameter than that of Man (*ib.* fig. 8), with a wider neural canal (*n*), especially between the condyles (*z*), which are smaller than in Man. An obtuse process is developed backwards from the part (*hy*) representing the body, which is broader than in Man; the perforation of the transverse process (*v*, fig. 3) is smaller, and that process is narrower, especially vertically, and is slightly recurved: the groove behind the upper articular processes is deeper and narrower. The neural spine is represented by a tubercle, which is more developed in the older male skeleton of the Gorilla in the Paris Museum.

The axis or dentata (fig. 4 & fig. 1, 2) differs chiefly in the greater size of the neural canal, and in the greater length and less breadth of the neural spine. This, however, dilates at its extremity into a three-sided cone, with the broadest side downwards. The zygapophyses are smaller, the transverse processes[1] are more directly perforated by the arterial foramina, and the diapophyses are more produced, and more remote from the posterior zygapophyses. The body is more quadrate behind.

[1] This term is applied to the whole of the compound part marked *d, p,* and *pl,* in fig. 1, 3; *d* being the diapophysis, *p* the parapophysis, and *pl* the pleurapophysis.

The bodies of the succeeding cervical vertebræ are longer in proportion to their breadth; the basis of the neurapophysis ascends to embrace the hinder half of the antecedent vertebra, as in Man. The difference observable in the dentata in regard to the length of the spinous process is manifested in excess in the third cervical vertebra; the neural canal also exceeds that of Man in diameter; the zygapophyses are smaller than in Man; the arterial canal (*v*) is transversely elliptic, not circular; the transverse process is longer, more slender and more simple, the pleurapophysial (*p*) not projecting distinctly from the diapophysial (*d*) part; the diapophysis is more remote from the zygapophysis; the neurapophyses are much thicker and stronger; the long neural spine (3) becomes subcompressed and slightly dilated at its extremity, which is not bifurcate.

The same general differences, and especially the very striking one in the length of the neural spine, are manifested in the fourth cervical vertebra (Pl. XXXIII. fig. 5), but the pleurapophysial part (*pl*) of the transverse process is now distinctly developed as a triangular depressed plate produced forwards and a little downwards; the lower part of the centrum is proportionally less than in Man, and the smaller size of the zygapophysis is the more remarkable in contrast with the larger proportions of almost all the rest of the vertebræ. In the fifth cervical vertebra the centrum (*c*) is smaller, but the zygapophyses equal in size those of the corresponding vertebra in Man (fig. 12); the pleurapophysial part of the transverse process (*pl*) is less developed than it is in the fourth, but is more prominent than in Man: the arterial canal (*v*) is wider, the anterior and posterior zygapophyses are more nearly upon the same plane, and the neural arch (*n*) has a greater anteroposterior extent; the superior thickness of the neurapophysis above these processes is very striking. In the sixth cervical (fig. 1, 6, & fig. 6) the arterial canal of the transverse process (*v*) increases in a greater degree than in Man (fig. 11); the pleurapophysial part (*pl*) of that process is more suddenly increased in length and breadth, and it diverges more from the diapophysis (*d*) than in Man; the zygapophyses (*z'*, fig. 1) are larger; the neural spine (*n s*) is still very long and very strong, but is shorter than in the antecedent vertebra (fig. 5). The elongated spines of the last five cervical vertebræ are a little expanded at their end [and this character is more marked in the skeleton of the old male in the Paris Museum].

The atlas of the great Orang (*Pithecus Wurmbii*, Pl. XXXIII. figs. 13, 14) departs in the same way from the Human type, but in a greater degree than that of the Gorilla; the transverse diameter being still less in proportion to the fore-and-aft diameter, and the transverse processes (*d*) being less developed: the neural arch (*n*) is more bowed and slender. The vertebral artery, after perforating the transverse process, slightly grooves the neural arch. The transverse extent of the bony bar (hypapophysis, *hy*) which holds the place of the centrum, in proportion to the antero-posterior extent of the whole vertebra, is greater than in Man: the flattened posterior articular processes (fig. 14, *z'*) are subelliptic or reniform, not subcircular as in Man, and the vertebral foramina (*v*) are absolutely as well as relatively less. There is no trace of spine in the adult male in the Museum of the Royal College of Surgeons; but a tubercular rudiment is developed in the atlas of the older male skeleton in the Paris Museum.

In the dentata of the Orang, the short transverse process resembles that of the Gorilla in being perforated, and it is not bifurcate: the neural spine is pointed in the College skeleton, but is slightly expanded at the end in the Paris skeleton. The posterior articular surface of the centrum is convex transversely, slightly concave vertically. The odontoid (true centrum of the atlas) is longer, in proportion to its thickness, than in Man; the anterior articular surfaces are narrower, the lower surface of the centrum is flatter, the spine is longer and more pointed, and the perforation in the transverse process relatively smaller than in Man. The transverse convexity of the posterior surface of the centrum is greater, and the vertical concavity less than in Man.

The third cervical vertebra, in the Orang as in the Gorilla, is chiefly distinguished from the corresponding Human vertebra by the length and slenderness of its simple spinous process. The transverse process has a short oblique pleurapophysial plate. In the fourth cervical vertebra the angles of the oblique lamelliform transverse process begin to be produced. In the fifth cervical the diapophysial and pleurapophysial portions project distinctly from each transverse process. In the sixth the pleurapophysis, or rudimental rib completing the perforated transverse process, has not coalesced with the parapophysis; and it has either not been ossified, or is lost in the adult skeleton examined. In the seventh cervical vertebra the transverse process is represented, as in the Gorilla, by the diapophysis only, which is not perforated.

The spinous processes of the last five cervical vertebræ markedly differ, like those of the Gorilla, by their great length, from the corresponding parts in Man; but they are proportionally less developed than in the Gorilla.

In the atlas of the Chimpanzee (*Troglodytes niger*), there is a short process from the back part of the hypapophysis (*hy*): the vertebral artery, after traversing the transverse process, also perforates the neural arch, but this may be an individual variety: the costal part of the left transverse process has not been ossified: that process is represented by a short parapophysis and a long diapophysis, the vertebral foramen being, nevertheless, complete. A small ridge represents the neural spine. In comparison with the Orang, the breadth of the atlas exceeds its antero-posterior diameter chiefly by the length of the diapophysial part of the transverse process: it thus, as in the Gorilla, more nearly resembles that of Man in its general shape. It likewise resembles it more in the minor breadth and greater length of the part representing the body, in the larger and more definite surface on the upper part for the articulation with the odontoid process, and in the greater breadth and more produced margins of the hinder articular processes. In all these approximations it agrees with the atlas of the Gorilla.

In the dentata of the Chimpanzee the transverse processes are short and terminate simply and obtusely: the neural spine is trifid, having an anterior ridge and two terminal tuberosities directed outwards and a little backwards. The body is deeper behind in proportion to its breadth than in the Orang, and the vertical concavity equals the transverse convexity of that articular surface: the neural canal is less contracted above: the anterior zygapophyses are larger and better defined. In all these respects the Chimpanzee, like the Gorilla, approaches nearer to Man than the Orang does.

In the third cervical vertebra of the Chimpanzee the fore part of the bases of the neurapophyses are produced forwards beyond the centrum and complete the transverse concavity for the reception of the backwardly-produced body of the axis. This surface is deeper in proportion to its breadth than in the Orang, and in this respect approaches nearer to that of Man. The vertebral arterial foramina are larger, the neural canal wider, and the anterior zygapophyses better defined, than in the Orang. The body of the vertebra is longer in proportion to its breadth than in the Orang, and the vertical concavity of the hinder surface is deeper. The costal portion of the transverse process is compressed and slightly produced downwards, forming an obtuse angle distinct from the more acute diapophysis which is prolonged outwards and backwards. The neural spine is subtrihedral, slender, obtusely pointed, and its base is coextensive with the neural canal.

The fourth cervical vertebra of the Chimpanzee, in the greater depth and minor breadth of the body, and in the larger relative size of the neural canal and of the vertebral arterial foramina, repeats the same differences from that of the Orang, and the same resemblances to that in Man, as the foregoing vertebra does. The neurapophyses still form the sides of the anterior concavity of the body. The costal ridge is equally distinct; the diapophysis is longer and the neural spine is a little longer than in the preceding vertebra.

The same differences, as compared with the fifth cervical in the Orang, are repeated in this vertebra of the Chimpanzee. The costal portion of the transverse process is more produced. The neural spine is both longer and stronger. The diapophyses are somewhat less.

The sixth cervical differs from the foregoing in a slight increase of breadth and prominence of the pleurapophysis, and in a diminution of the diapophysis: the centrum is more expanded posteriorly: the neural spine is longer and thicker than in the Orang, but is proportionally less developed than in the Gorilla.

In the seventh cervical vertebra the costal portions of the transverse process are reduced to an osseous filament, which completes the lower boundary of the vertebral arterial canal. The diapophysis is much longer and thicker than in the sixth. The transverse extent of the centrum continues to increase, as also the antero-posterior breadth of the neurapophyses. The neural spine increases in breadth and slightly in length.

In the atlas of the male Australian (Pl. XXXIII. figs. 8 & 9) there is a tubercle from the fore part of the hypapophysis (*hy*) representing the body, and a rough surface on the back part of the neural arch (*n*) in place of a spine. The body is longer and deeper in proportion to its breadth than in the Gorilla, Chimpanzee, or Orang. The surface for the odontoid process, or true body of the atlas, is more nearly circular and better defined. The vertebral artery, after perforating the transverse process, grooves the neural arch behind the produced angles of the upper zygapophysis (fig. 8, *z*). The cavity for the occipital condyle is relatively larger, deeper, with the margins more produced. The parapophysial boundary (*p*) of the vertebral arterial foramen (*v*) is thicker than the diapophysial one (*d*); they are equal in the Gorilla: the arterial foramina are relatively larger and the lower zygapophyses (fig. 9, *z'*) are relatively much larger than in the Gorilla.

These differences chiefly relate to the more secure articulation and support of the vertically-sustained head, and to the larger size of the cerebral organ, in part nourished by the vertebral arteries, in the Human species. The development of the zygapophyses gives a greater antero-posterior extent to those parts of the atlas, and the transverse processes are thicker in proportion to their length.

In the Australian the anterior surface of the body of the dentata (fig. 10) is less flattened than in the Gorilla (fig. 4) or Chimpanzee, the middle line being produced almost into a ridge; its hinder border is more rounded. The transverse process (*pl*) is thicker and more obtuse in proportion to its length: both the anterior and posterior zygapophyses are relatively larger: the neural canal is relatively wider transversely: the neural spine is much less developed: in fact, what is usually described as the bifurcated spine of the axis seems rather to be the upper slightly-produced extremities of the not completely coalesced neurapophyses of that vertebra in Man. Lines drawn parallel with the transverse plane of the anterior zygapophyses would meet at a right angle in the Chimpanzee, but at a more open angle in Man, especially in the White races.

In the third cervical vertebra (fig. 7, 3), the upper angle of the base of each neurapophysis is produced forwards beyond the centrum, and assists in forming, but in a less proportion than in the Gorilla or Chimpanzee, the transverse concavity for the produced body of the axis. The centrum is larger in proportion to the rest of the vertebra than in the Chimpanzee, save in its length. The pleurapophysial part (*pl*) of the transverse process forms a distinct obtuse angle from the diapophysial part, which is shorter, thicker and more obtuse than in the Chimpanzee. The same difference is here repeated in the greater relative size of the zygapophyses, particularly the anterior ones. The transverse diameter of the neural canal is relatively greater. The neural spine (*n s*) is very much shorter than in the Gorilla: it is, however, simple, not bifurcate, as usually in Europeans.

In the fourth cervical vertebra (*ib.* 4) the sides of the upper concavity of the body are still formed by the neurapophyses, which are less produced than in the preceding vertebræ, or than in the corresponding vertebræ of the Gorilla. The diapophyses are shorter than in the Chimpanzee; the neural spine is considerably shorter than in the Gorilla. The zygapophyses are relatively larger. The pleurapophysial and diapophysial parts of the transverse process are nearly equally developed, and are bent upwards on the sides of the groove which impresses the upper part of the transverse process. The pleurapophysial boundary for the canal for the vertebral artery is here much thinner than the diapophysial one. The short neural spine is simple.

In the fifth cervical vertebra (fig. 7, 5, and fig. 12) the upper concavity of the body (*c*) is less deep than in the Gorilla or Chimpanzee; its length is absolutely less; but it is greater in breadth and depth. The costal portion (*pl*) is now more developed than the diapophysial (*d*) and parapophysial (*p*) portions of the transverse process, and forms a short broad plate with the angles bent upwards. The zygapophyses are relatively larger than in the Gorilla and Chimpanzee: the antero-posterior extent of the neural arch (*n*) is less than in the Gorilla; its upper margin is sharper than in the Chimpanzee: the neural spine (*n s*) is much shorter than in the Gorilla, and is bifurcate. In a female Australian it is simple.

In the sixth cervical vertebra (fig. 7, 6, and fig. 11) the Human characteristics are shown in the greater relative increase in the transverse diameter of the centrum (*c*), with the minor degree of the upper concavity and lower transverse convexity (*c*) of the centrum. The pleurapophysial part (*pl*) of the transverse process is more produced outwards in proportion to the diapophysial part (*d*) than in the preceding cervicals, and it is much less developed than in the Gorilla (fig. 1, 6, and fig. 6, *pl*). The arterial canal (*v*) is less than in the Gorilla (fig. 6, *v*). The zygapophyses continue to present their characteristic superiority of size; and the neural spine (*n s*), although here of greater length than in the fifth cervical, is vastly inferior in this respect to that in the Gorilla, Orang, or Chimpanzee. The upper border of the neural arch is sharper than in the Gorilla or Chimpanzee.

In the seventh cervical vertebra (fig. 7, 7) the increase of breadth in the centrum, the increase of the vertical extent of the neural arch, and in the length and thickness of the neural spine, is greater in this vertebra, as compared with the sixth cervical, than in the Gorilla or Chimpanzee. The costal part of the transverse process, completing the arterial foramen, is thicker than in the Chimpanzee: the diapophysis (*d*) is shorter, but much thicker.

In the skeleton of a Boschisman, as in that of the female Australian in the Museum of the Royal College of Surgeons, the spines of the five lower cervical vertebræ are simple.

In both the Human subject and the great Anthropoid Apes, the aspect of the articular surfaces of the zygapophyses are, in the upper pair, upwards and backwards, and the reverse in the lower ones. The metapophysial tuberosities (fig. 7, *m*) are better marked in the last three cervical vertebræ of the Australian than in the Gorilla.

The differences between the cervical vertebræ of the Australian and the Gorilla, which are prominently exemplified in the figures of Pl. XXXIII., especially in the contrast of the fifth cervical vertebra of the Gorilla (fig. 5) with that of Man (fig. 12), and of the sixth cervical vertebra (fig. 6) with fig. 11, gradually decrease as we pass from the first dorsal vertebra to the lower or succeeding ones.

Dorsal Vertebræ (Pl. XXXIV.).—The dorsal vertebræ (fig. 1), besides their increase of number—the thirteenth, however, answering to the first lumbar in Man, with the pleurapophyses retained as free elements—differ in the greater length of the spines of the first five vertebræ, which progressively decrease to the length they present in the Human subject, but with greater thickness, and in the last three with greater vertical extent. The bodies of the middle dorsal vertebræ are shorter in proportion to their breadth; the diapophyses are thicker, stand more directly outwards (fig. 3, *d*), and the costal surfaces are more concave and oblong; the metapophysis which projects distinctly in the eleventh vertebra in Man (Pl. XXXIV. fig. 2, 11, *m*), does not so project until the twelfth in the Gorilla (*ib.* fig. 1, 12, *m*).

In the first dorsal vertebra the centrum is larger from before backwards, and the spine is twice the length of that in Man and is less inclined downwards. The zygapophyses are larger than in Man; the costal surface is more produced on the side of the body: but the chief difference is in the position and direction of the diapophysis, which in the Gorilla projects directly outwards below the level of the upper zygapophysis; the fore part of the base of the neurapophysis is less deeply grooved in the Gorilla.

The same general differences may be noticed in the four succeeding dorsal vertebræ; the spine, however, becomes shorter and the centrum larger than in the first vertebra; the neural arch rises more abruptly beyond the upper zygapophysis. In the sixth dorsal vertebra the neural spine is reduced to the same length as is the corresponding spine in Man; the centrum is larger, the neural canal of the same size, the posterior costal pits are longer, the diapophyses still stand out more transversely. The neural spine is less obliquely bent backwards, and is thicker vertically, though not longer; the upper zygapophyses are more produced; the diapophyses are broader and somewhat shorter.

The tenth dorsal vertebra of the Gorilla (Pl. XXXIV. figs. 3, 5, & 7) is contrasted in corresponding views with that of Man (*ib.* figs. 4, 6, & 8). The under surface of the body (*c*) is somewhat smaller in the Gorilla, and the surfaces (*pl*) for the ribs are better marked: a slight difference in the aspect of the zygapophyses allows more of their articular surface to be seen in fig. 3, at *z′*; the greater difference in the direction of the diapophyses (*d*) is also well shown. The somewhat thicker diapophyses (*d*) and summit of the spine (*n s*) are shown in fig. 5, as compared with fig. 6; and the more prominent upper zygapophyses (*z*, *z*) in Man are exemplified in both figs. 6 & 8.

In the eleventh dorsal vertebra the neural spine is more expanded at its extremity than in Man.

In the twelfth there are distinct and well-developed metapophyses (fig. 1, 12, *m*) projecting from the upper part of the diapophyses behind the upper zygapophyses. This vertebra corresponds in this character with the eleventh of the Human subject. The neural spine is broader vertically and thicker, especially superiorly. There is but one costal surface on each side of the base of the neurapophysis. The diapophyses (*d*) are reduced in size, the metapophyses equalling them.

In the last dorsal vertebra of the Gorilla (fig. 1, 13), which answers to the first lumbar in Man (Pl. XXXV. fig. 2, 1), the chief difference is the articular surface (p) for the free rib-element. The metapophysis is well developed in this vertebra.

The increase in the size of the centrum, as the dorsal vertebræ descend in the Gorilla, is more in the antero-posterior than in the transverse diameter; and in the size of the spine it is more in the vertical diameter than in length.

The dorsal vertebræ of the Chimpanzee accord very closely, except in size, with those of the Gorilla, and manifest the same general distinctions from those of Man.

In the first dorsal the bases of the neurapophyses, instead of being produced upwards, have those angles as it were truncated, to form the articulation with the heads of the first pair of ribs. The breadth of the centrum is augmented, and also, in a more especial degree, that of the diapophysis, which is excavated below for articulation with the tubercle of the rib. The neural spine is increased in vertical extent, and is as long as that of the last cervical; it is consequently longer than in Man.

In the second dorsal the centrum is larger than in the first; the upper zygapophyses are more approximated and distinct from the diapophyses, which thereby appear to be longer: the neural spine is somewhat longer than in the first dorsal.

The third differs from the second dorsal in its narrower upper neural emargination, in the somewhat shorter diapophyses and longer neural spine.

In the ninth dorsal the centrum presents a marked increase of size: the spine is thicker transversely and more expanded at its end.

In the tenth dorsal there is an increase in the size of the body and of the neural spine; and the inferior costal surface is replaced by a non-articular tubercle: that surface is retained and well marked in the corresponding vertebra of the Gorilla (Pl. XXXIV. fig. 1, 10, p').

In the twelfth dorsal the metapophysis projects distinctly upwards from the diapophysis.

In certain characters the thirteenth dorsal resembles the last or twelfth dorsal of Man: for instance, in the distinct and well-developed metapophyses, which are thicker and longer in the Chimpanzee; also in the narrower and longer lower part of the neural arch, concomitant with the change of position of the lower zygapophyses. The diapophysis still shows, in the Chimpanzee, an articular surface for the tubercle of the thirteenth rib. The neural spine is longer and larger than in Man, especially in its vertical extent.

Although the Orang more resembles Man than does either the Gorilla or Chimpanzee in the number of dorsal vertebræ, or those characterized by moveable ribs, yet the individual vertebræ do not offer so close a similarity to the corresponding Human ones as they do in the Chimpanzee. The spines of the first and second dorsals are equally characterized by their superior length. The spine of the third dorsal has an upper and lower prominence: the succeeding spines gradually diminish in length, but increase in breadth and vertical extent to the penultimate lumbar.

In the dorsal series of a half-grown Orang (*Pithecus Wurmbii*) I have noticed that the metapophysis begins to project from the anterior angle of the diapophysis in the seventh vertebra, progressively increases in size in succeeding vertebræ, and rises in position close to the upper zygapophysis in the last dorsal. In the adult male skeleton in the College of Surgeons, the metapophysis appears as a tubercle, near the base of the upper zygapophysis of the twelfth dorsal: it is equally distinct on the first lumbar, but subsides to a slight eminence on the succeeding lumbar vertebræ. The anapophysis is only distinguishable from the diapophysis upon the first lumbar vertebra, where it serves to illustrate the true relation of the diapophysis of that vertebra to those of the antecedent dorsals and the succeeding lumbars.

In comparing the last dorsal vertebra with that of Man, one may notice the smaller size of the body and the shorter neural spine of the Orang; and that the neural arch of the Orang is entire below, not notched.

In the Negro and Australian skeletons the body of the first dorsal vertebra (Pl. XXXIV. fig. 2, 1) is relatively larger than in the Chimpanzee, particularly anteriorly: it is less convex below; it is larger in proportion to the neural arch and its appendages than in the Gorilla. The transverse processes are thicker and are more inclined backwards and upwards: the spinous process is thicker and relatively much shorter, and more inclined downwards.

In the second dorsal vertebra (*ib.* 2) the centrum is increased in vertical and antero-posterior extent: the upper zygapophyses are nearer to each other and are more produced than in the first dorsal, whereby the upper notch of the neural arch becomes deeper and narrower. The diapophyses are longer and thinner. The neural spine is also thinner, and the lower zygapophyses are smaller. This vertebra differs from its homologue in the Gorilla and Chimpanzee in the more backward direction of the diapophyses and the more outward aspect of their articular surface. The upper emargination of the neural arch is less deep: the neural spine is absolutely shorter and smaller. The body is relatively larger than in the Gorilla, and is absolutely larger than in the Chimpanzee, and the pedicles of the neural arch are longer in conformity with the wider neural canal.

The third dorsal vertebra (*ib.* 3) differs from the second in a slight diminution in the transverse and increase in the antero-posterior extent of the centrum: the diapophysis and neural spine are somewhat thicker: the upper neural emargination is narrower. It differs from that of the Gorilla and Chimpanzee in the minor length of the neural spine, the greater relative breadth of the centrum, the greater length of the pedicles and concomitant expanse of the neural canal. The accessory tubercle is less distinctly developed upon the diapophysis than it is in the Chimpanzee.

In the fourth dorsal vertebra (*ib.* 4) the same general differences, in comparison with the Gorilla and Chimpanzee, are repeated, with a greater development of the diapophysis backwards and an increased size of the accessory tubercle.

In the seventh dorsal vertebra (*ib.* 7) the progressive increase in the size of the centrum is greater, and the upper and lower costal surfaces are less equal and less approximated than in the Chimpanzee.

The neural spines of the eighth and the preceding dorsal vertebræ are shorter than in the Gorilla and also than in the Chimpanzee; they are thicker transversely and less extended in the axis of the spine, especially at their extremities, which are tuberous, not truncate as in the Chimpanzee.

In the ninth dorsal vertebra (*ib.* 9) the centrum is relatively larger, and the accessory tubercle above the diapophysis is more produced.

The tenth dorsal vertebra (*ib.* 10, & figs. 4, 6 & 8) chiefly differs from the preceding in the absence of the lower costal surface on each side, as at *pl*, fig. 4, in which it agrees with the tenth dorsal of the Chimpanzee and differs from that in the Gorilla.

In the eleventh dorsal vertebra the metapophysial tubercle (*m*) which was slightly indicated in the preceding vertebra becomes more distinct. The centrum continues to increase in size.

In the twelfth dorsal vertebra (fig. 2, 12) the centrum continues to enlarge, and the neural spine to gain in vertical extent. The metapophyses are well developed: the anapophyses (*a*) may be recognized distinctly: the diapophyses are reduced to smooth tubercles without an articular facet. The neural arch of this vertebra contracts in breadth below, concomitantly with the modified shape and direction of the lower zygapophyses (*z*′), which are elongated and incline more obliquely outward than in the preceding vertebra. This modification does not characterize the corresponding vertebra in the Gorilla or Chimpanzee. The upper emargination of the neural arch is wider in the twelfth dorsal, which is distinguishable from the eleventh not only by this character, but by the distinctness and greater length of the metapophyses, and by the greater length and minor breadth of the part of the neural arch supporting the lower zygapophyses.

Lumbar Vertebræ (Pl. XXXV.).—These in the Gorilla and Chimpanzee are four in number, by reason of the retention of distinct or free pleurapophyses in the vertebra answering to the first lumbar in Man: they are, also, in some adults of both Gorilla and Chimpanzee, further reduced by the modification of the vertebra answering to the last lumbar in Man, by which it assumes the characters of a sacral vertebra.

In the full-grown but not old male Gorilla in the Museum of the Royal College of Surgeons, the four lumbar vertebræ are distinct. They are figured in Pl. XXXV. fig. 1, and have longer bodies in proportion to their breadth than in Man; their spines slope more downwards, are more expanded at their extremities, and in all but the last are subbifid, in the Gorilla. The metapophyses (*m*) continue more distinct and prominent.

When naturally articulated together, they form a straight line, without any tendency to convexity forwards as in Man; and the whole series of true vertebræ in the Gorilla form but one curvature which is slightly concave forwards, especially in the dorsal region.

In the first lumbar vertebra (Pl. XXXV. fig. 1, 1) the metapophysis (*m*) is still large and distinct; the upper zygapophysis becomes more convex and oblique in position; the diapophysis is suddenly elongated, as compared with that of the corresponding Human vertebra; the chief difference is seen in the smaller size of the neural canal, and in the greater length, terminal expanse and downward slope of the neural spine. The same difference obtains in the second lumbar vertebra; the diapophyses are broader and more depressed in the Gorilla; the upper zygapophyses are more convex in part, not wholly concave as in Man; a fossa divides them from the metapophyses; the centrum is as broad as in Man, but is deeper and longer; the neural spine extends more obliquely downwards, and its expanded apex is bifid (fig. 4, *n s*). In the last lumbar vertebra (fig. 1, 4) the difference is very striking in the minor expanse of the centrum in the Gorilla, especially below, in the much smaller and more depressed form of the neural canal, in the shorter and broader diapophysis, the more distinct metapophysis, in the convex anterior and more approximated posterior zygapophysis, and in the greater length of the centrum.

[The tendency to a sacral modification of the transverse processes of the last lumbar vertebra is more constant and more marked in the Gorilla than in Man: this, at least, is the result of an examination of four adult skeletons, two male and two female, which have now reached Europe. In the adult, but not aged male skeleton, in the Museum of the Royal College of Surgeons, the right transverse process is the broadest and thickest, but both touch and were syndesmotically attached to the iliac bones. Yet it is plain, that the proper sacrum commences by the succeeding vertebræ; the homology of the fourth lumbar of the Gorilla with the fifth lumbar of Man is unmistakeable. In the skeleton of the older male Gorilla in the Paris Museum the sacral modification of the last lumbar vertebra is complete; the transverse processes are not only articulated to the ilia, but are so expanded as to join and coalesce with the similarly modified parts of the first sacral vertebra. The less expanded transverse processes of the penultimate lumbar are joined by ligament to the ilia. The spine of this vertebra is distinct: that of the last lumbar has coalesced with the beginning of the strong ridge formed by the confluent spines of the proper sacral vertebra: and, as the first two of the coccygeal vertebræ have coalesced with each other and with the last sacral vertebra, the sacrum of this old male Gorilla, as characterized by coalescence, includes not less than eight vertebræ. In the skeleton of the adult female Gorilla in the Paris Museum the transverse processes of the last lumbar vertebra are short, broad and deep, and are joined by ligament to the iliac bones; but have not coalesced with the sacrum, which consists, as normally, of five vertebræ.]

The chief differences between the normal lumbar vertebræ of the Gorilla and Man are exemplified in the views of the second lumbar vertebra of the great Ape (Pl. XXXV. figs. 3 & 4), and of its homologue the third lumbar vertebra of an adult male Negro (*ib.* fig. 5). They are, in the Gorilla, the greater length of the centrum; the greater inclination downwards and less inclination backwards of the diapophysis (*d*); the more upward production of the upper zygapophysis (*z*), giving greater distinctness to the metapophysis (*m*); the rhomboidal form and downward inclination of the neural spine, the base of which extends further down upon the lower zygapophysis (*z'*); whereas this process is more distinct and prominent, and has its articular surface more everted in Man (fig. 5, *z*).

The contracted calibre of the neural canal in the lumbar vertebræ of the Gorilla, as exemplified in fig. 4, is an interesting and important difference in its relation to the minor development of the lower limbs in that great Anthropoid Ape. The superior capacity of that canal in the corresponding Human vertebra (fig. 5) relates to the enlargement of the myelonal centre of the supply of nervous influence to the characteristically developed and modified lower limbs of Man, in relation to his privileged upright posture. This difference demands or occasions a greater length in the crura or bases of the neural arch in the Human lumbar vertebræ.

The first lumbar vertebra of the Chimpanzee (Pl. XXXV. fig 6) which, as in the Gorilla, answers to the second lumbar vertebra in the Orang and Man, differs from both in the superior relative length and size of the neural spine (*n s*). The metapophyses (*m*) project from the hinder and outer part of the upper zygapophyses, from which they are separated by a narrow groove. There is a feeble rudiment of anapophysis from the lower part of the long and depressed diapophysis (*d*).

In the second lumbar vertebra the metapophyses still continue to be separated by a groove from the anterior zygapophyses. The neural spine is more expanded at its broad flattened termination. The centrum is somewhat augmented in size.

In the third lumbar vertebra the diapophysis is shorter and thicker, and the anapophysial tubercle larger and more distinct at its lower part. There is a slight increase in the size of the centrum. The neural canal, which, in the first lumbar vertebra, is relatively narrower than in Man, becomes gradually more contracted as it approaches the sacrum.

The fourth lumbar, in the adult Chimpanzee examined by me, has had its diapophysial elements modified for articulation with the iliac bones, and functionally forms the beginning of the sacral series (Pl. XXXVI. fig. 3, *l*.)

In proceeding with the examination of the vertebral column in the Ethiopian and Australian varieties of the Human race, in reference to the present comparison, we see that the lumbar vertebræ, five in number (Pl. XXXV. fig. 2), are so arranged, when in their easy and natural co-articulation, as to form a slight curve, with the convexity forwards; and owing to the less length of the bodies, these five vertebræ do not exceed by more than half a vertebra the length of the four lumbar vertebræ in the Gorilla. Compared with the dorsal vertebræ of the same Australian skeleton, the first lumbar vertebra (*ib.* fig. 2, 1) has its centrum much increased in size, and the neural spine in extent. The metapophysial tubercles (*m*) are also enlarged, but do not project so freely, by reason of the extension of the articular surfaces of the upper zygapophyses upon the inner sides of their base. The diapophyses are much increased in length. The anapophysial tubercles are still distinct. The lower half of the neural arch is more contracted than in the last dorsal, and the lower zygapophyses are turned directly outwards. This outward direction is much less in the Gorilla and Chimpanzee.

The second lumbar vertebra (*ib.* fig. 2, 2) chiefly differs from the first by a slight increase in the size of the centrum and in the length of the diapophysis. The upper zygapophyses are larger and look more directly inwards. Both metapophysial and anapophysial tubercles are distinct. This vertebra differs from its homologue, the first lumbar vertebra, of the Gorilla, in the greater size of the neural arch, and in the greater size of the zygapophyses as compared with the diapophyses; from that of the Chimpanzee it differs also in the greater relative size of the centrum. The anapophysial tubercles are better developed in the Human vertebra, and are situated at the upper, and not at the hinder part of the base of the diapophysis. The downward production of the lower zygapophyses, occasioning the deep inferior emargination of the neural arch, is also a characteristic distinction of the Human lumbar vertebræ.

In the third lumbar vertebra (*ib.* fig. 2, 3, and fig. 5), both metapophysial (*m*) and anapophysial tubercles continue distinct. The lower margin of the neural spine projects between two oblique ridges which diverge from the sides of that spine upon the lower zygapophyses (z'): this character adds a marked distinction from the corresponding bone in the Gorilla and Chimpanzee to the other differences pointed out in the preceding lumbar vertebræ.

The fourth lumbar vertebra (*ib.* fig. 2, 4) shows, like the corresponding vertebra in the Gorilla and Chimpanzee, a decrease in the length of the diapophysis, but it likewise shows a marked diminution in the vertical extent of the neural arch, occasioned principally by a diminished length and increased breadth of the lower zygapophyses. The anapophysial tubercles are distinctly developed. The body of the vertebra, though much broader, is not longer than that of its homologue, the third lumbar, in the Chimpanzee, and it is shorter than the corresponding vertebra in the Gorilla.

The fifth lumbar vertebra (*ib.* fig. 2, 5) is characterized not only by its superior size, especially breadth, but by the great transverse expansion of the lower part of the neural arch concomitant with the superior development and outward extension of the lower zygapophyses. The diapophyses and neural spine are shortened: the anapophyses appear like a part of the upper border of the base of the diapophysis pinched up and produced downwards. The metapophysial tubercles are separated by a groove from the anterior zygapophyses.

Sacral Vertebræ (Pl. XXXVI.).—As we recede from the thoracic or central region of the vertebral column, the deviations from the Human type become greater and the specific peculiarities of the Ape more marked. Even the differences of race begin to be more clearly indicated in the structure of the vertebræ when we come to the sacrum, which has induced me to contrast that bone in a European (fig. 7) with the sacrum of an Australian (fig. 5) of the same age and sex.

In the Gorilla the sacrum (Pl. XXXVI. figs. 1 & 2) departs in a great and instructive degree from the Human type: it consists normally of five anchylosed vertebræ, but they are longer and narrower than in Man, and present a minor degree of forward curvature. The neural foramina (*n*) are much smaller, and the neural spines (fig. 2, *n s*) are more developed: they coalesce to form a single strong bony ridge, extended over and gradually subsiding on the last sacral vertebra, the neural arch of which is entire. The articular surface of the body of the first sacral vertebra (fig. 2) is one-third smaller than in Man (figs. 6 & 8); the zygapophyses (*z*) are smaller, but the metapophyses (*m*) are present and well developed. The iliac articular surface extends to the upper half of the third vertebra, is narrower than in Man, but owing to the greater length of the first and second vertebræ, it is longer. The posterior outlets of the nervous canals are very small, and the whole neural canal is much more contracted.

In the sacrum of the Orang (*Pithecus Wurmbii*), which consists of five vertebræ, the confluent spines form a lower ridge with projections corresponding to the three upper vertebræ, of which the third prominence is the thickest, and there it ceases: the sacro-iliac symphysis is restricted to the first and second vertebræ and a small part of the third. The neural arch is unclosed in the last two vertebræ. The entire sacrum is relatively shorter, and broader above than in the Gorilla.

In the Chimpanzee (Pl. XXXVI. figs. 3 & 4) the sacrum more resembles in its general form and proportions that of the Gorilla; it also consists of five vertebræ. The neural arch (*n*) is complete in each, and the spinous process is developed from all but the last, the four posterior spines being confluent. The metapophyses are developed from the four anterior sacrals: the three anterior ones join the iliac bones.

The sacrum of the male Australian, figured in Pl. XXXVI. figs. 5 & 6, consists, as in the Human species generally, of five anchylosed vertebræ. They differ from the sacral vertebræ of the Gorilla and Chimpanzee by their greater breadth and by their anterior concavity both lengthwise and transversely. The nervous foramina are relatively much larger: the spinous processes are shorter and thicker. The two anterior sacrals and a small part of the third form the sacro-iliac joint. The neural arch of the last two sacral vertebræ is complete.

The characteristic peculiarities of the first sacral vertebra in Man, *e. g.* the greater relative capacity of the neural canal (*n*), the larger size, especially in the antero-posterior direction, of the articular surface of the centrum (*c*); the greater length of the coalesced pleurapophyses (*pl*); and the less length of the neural spine, are shown in figs. 8 and 6, as contrasted with figs. 2 & 4.

In both the Gorilla and Chimpanzee the diapophyses of the last sacral vertebra (figs. 1 & 3, *s* 5, *d*) terminate in an obtuse angle divided by a notch from the side of the body of the vertebra, down which they are continued lower in the Chimpanzee than in the Gorilla. In Man they subside gradually upon the sides of the last sacral vertebræ.

In the Anthropoid Apes, as in Man, the tail is reduced to three more or less stunted vertebræ, which being usually anchylosed together in the Human adult form the bone called "coccyx." This is shorter and broader at its base in Man (fig. 7, *c* 1, *c* 2) than in the Gorilla or Chimpanzee (fig. 3, *c* 1, *c* 2). In some rare instances the first caudal vertebra is anchylosed to the last sacral vertebra and modified like it, as in fig. 7, when the coccyx, *c* 2, is reduced to two vertebræ.

As the question of the degree of variety to which the portion of the skeleton described and compared in the foregoing pages may be subject in the Human species, is one of much interest in the actual state of organic philosophy, the following results of comparisons of a skeleton of a male Esquimaux, of a male Dyak (Borneo), and of a well-formed European (Frenchman) may not be unacceptable; at least as a guide in future comparisons extended over a greater number of individuals.

Vertebræ of an adult male Esquimaux compared with those of an adult male Australian.

The atlas differs from that of the male Australian in the larger relative size of the zygapophyses.

The axis. This is larger, has larger zygapophyses, and the under part of the centrum less compressed, than in the Australian. The notch between the lower zygapophysis and diapophysis is less deep in the Australian than in the Esquimaux. In both the neural spine is broad transversely, with its angles bent back.

The third cervical vertebra. The lower zygapophyses are larger, the diapophyses thicker and more produced, and the canal for the vertebral artery wider, than in the Australian.

The fourth cervical vertebra. The vertical diameter of the centrum is much greater than in the Australian.

The first dorsal vertebra. It differs chiefly in its longer and stronger proportions from that of the Australian.

The second to the sixth dorsal vertebræ. The parapophysis (or articular surface for the head of the rib) increases in size and distinctness from the fourth to the sixth. These vertebræ differ chiefly from those of the Australian by the relatively greater size of the centrum and the stronger processes.

The seventh to the tenth dorsal vertebræ. They differ chiefly in their relatively larger centrum from those of the Australian.

The eleventh dorsal vertebra. It has a single surface for the head of the rib on each side, which has ascended from the body upon the neurapophysis. The diapophysis is very short and obtuse: a metapophysis of greater length extends from its upper and back part towards the zygapophysis. There is a short anapophysis.

The twelfth dorsal vertebra. The costal surface has now wholly passed upon the extremity of the short and thick diapophysis: the metapophysis and anapophysis are distinct from this. As compared with the twelfth dorsal of the Australian, besides a considerable inferiority of size in that variety, the costal surface is on the side of the neurapophysis, and has not ascended upon the tubercle which represents the diapophysis.

The first lumbar vertebra. The anapophysis and metapophysis have subsided to tubercles, and the diapophysis is elongated by the extension of ossification into the fibro-cartilaginous basis of the pleurapophysis. In the Australian the metapophysis is relatively longer, the diapophysis smaller, and the tubercles on the back of the posterior zygapophyses are less developed.

The third lumbar vertebra. The upper part of the neural arch has been, probably after fracture, moveably articulated with its piers or bases. The anapophyses are well developed.

The fourth lumbar vertebra. That of the Australian differs in its much shorter diapophyses.

The fifth lumbar vertebra. The shortened and much thickened diapophyses present an articular surface for the produced angles of the sacrum.

The sacrum. It is larger and broader in proportion to its length than in the Australian; it is also more concave anteriorly. The neural arch is left open and incomplete in all the vertebræ, whilst in the Australian the neural arch of each of the three anterior sacral vertebræ is completed and supports a spine.

Vertebræ of a male Dyak (Borneo) compared with those of a male Australian.

The atlas. Compared with that of the Australian, the zygapophyses are smaller, the diapophyses are larger, and the sub-bifurcate neural spine is better developed. The canals for the vertebral arteries are larger, and they perforate the neural arch as well as the transverse process. The neural arch is likewise perforated by the first spinal nerve. The characters of age are manifested by the irregular ossification extending from the periphery of the odontoid articular surface.

The axis. The diapophyses here are smaller, the bifid spine longer, and the transverse processes more widely perforated and more produced, than in the Australian.

The third cervical vertebra. This, also, repeats the differences of the smaller zygapophyses, the larger articular canals, and the more produced divisions of the bifid spine.

The fifth cervical vertebra. The same differences are repeated in both these vertebræ as compared with those of the Australian.

The sixth cervical vertebra. The body is proportionally larger and the costal part of the transverse process more produced than in the Australian. As an individual peculiarity, the neural arch and spine are slightly distorted towards the right side, and the vertebral arterial canal of the same side is contracted and divided by a transverse bony bar.

The seventh cervical vertebra. Both transverse processes are perforated. All the foregoing vertebræ to the axis inclusive show characters of age by irregular ossifications extending into the anterior vertebral ligament.

The first dorsal vertebra. The inequality of size in the zygapophyses is here less. The diapophyses are longer and stand more outwards, and the centrum is larger than in the Australian.

The sixth dorsal vertebra. In each of the preceding the diapophyses are less bent upwards than in the Australian.

The metapophyses are distinctly developed from the upper part of the base of the diapophyses of the eleventh vertebra.

The twelfth dorsal vertebra. It is larger than in the Australian, has the neural spine more extended in the direction of the axis of the body, has a larger costal surface, and shows the anapophysis more distinct from the rudimental diapophysis.

The first lumbar vertebra. In this the metapophyses, anapophyses and diapophyses are more produced and distinct than in the Australian. Although the vertebra is larger than in the Australian, the zygapophyses continue to be absolutely as well as relatively less.

The second lumbar vertebra. Although the anterior zygapophyses in their change of position have ascended to the base of the metapophyses, both these and the anapophyses continue to be distinct from the progressively increasing diapophyses.

The third lumbar vertebra. Here both metapophyses and anapophyses have subsided to tubercles. The zygapophyses equal those in the Australian, and the diapophyses are of the same length, but the body and neural spine of the vertebra are much larger.

The fourth lumbar vertebra. This is individually remarkable for the ossific growths which have extended from the under part of its centrum into the ligamentous sheaths underlapping the contiguous vertebra before and behind: the last lumbar vertebra shows in a minor degree the same characteristics of age.

The sacrum is relatively broader, especially across the third vertebra, and is less concave than in the Australian. The neural arch is completed over the first four vertebræ.

Vertebræ of an adult male Frenchman, compared with the foregoing varieties.

The atlas is larger, particularly in the transverse diameter, than that of the Esquimaux or the Australian. As compared with the latter, the zygapophyses and arterial foramina are proportionally larger. The diapophyses are broader and less obliquely twisted.

The axis. With the same superiority of size, it differs from that of the Esquimaux in the more backward inclination of the transverse processes and in the deeper notch between these and the posterior zygapophyses. The spine is not so broad, but is higher.

The third cervical vertebra. In this, the character of the deeper notch between the zygapophysis and diapophysis is repeated. The spine is longer and more slender.

The fourth cervical vertebra. The notch between the diapophysis and zygapophysis is wider than in the Esquimaux and deeper than in the Australian. The spine is longer, and, as in the preceding vertebræ, is unsymmetrically bifurcate.

The seventh cervical vertebra. This shows a marked superiority of size over that of the Esquimaux, and still more so over that of the Australian. The diapophyses are thicker and more produced: both, but especially the right, are perforated by smaller foramina than those of the preceding cervical vertebræ. Besides the increase of size, this vertebra differs from the preceding in the minor depth of the anterior articular surface of the centrum, in the increase of that part transversely, and the absence of any prominent plate from the costal part of the transverse process which now forms simply the lower boundary of the arterial foramen; in the greater length, breadth and thickness of the diapophysial part of the same process; and in the greater length and thickness of the spine, which terminates in ar obtuse enlargement notched behind but not bifurcate. The posterior zygapophyses are also relatively larger.

The first dorsal vertebra. The diapophyses are longer, and less inclined upwards than in the Esquimaux or Australian, and the aspect of the costal surface upon them is more directly downwards. In the Australian it looks more outwards than in the Esquimaux. The ridge along the lower part of the same process, here strongly developed, is feebly marked in the Esquimaux and is not present in the Australian. The produced parts of the border of the anterior articular surface of the centrum formed by the neurapophyses are more restricted to the upper and outer parts than in the preceding vertebræ.

The second to the tenth dorsal vertebræ inclusive. In each of these the aspect of the costal surface of the diapophysis is more directly downwards than in either the Esquimaux or Australian.

The eleventh dorsal vertebra. This vertebra is characterized, as in the Esquimaux and Australian, by the development of well-marked metapophyses from the upper and fore part of the diapophyses, which are shorter and less thick than in the foregoing vertebræ. The surface for the head of the rib has passed upon the side of the neural arch. This differs from the preceding vertebra in the distinct development of the metapophyses, in the diminished size of the diapophyses, which now cease to show the well-defined articular surface, and in the diminished length with increased thickness of the spine.

The twelfth dorsal vertebra. This differs from that of the Esquimaux in the articular surface for the rib being still confined to the side of the base of the neurapophysis and not transferred to the diapophysis, which is short and obtusely pointed. The neural spine has a less antero-posterior extent, and a more expanded summit. This vertebra differs from the eleventh dorsal in the superaddition of small but distinct anapophyses, in the increase of the metapophyses and diminution of the diapophyses. The posterior zygapophyses are smaller, and have convex, instead of flat or slightly concave, surfaces; and those surfaces are turned more obliquely outwards. The hinder half of the neural arch is narrower.

The first lumbar vertebra. This differs from that of the Esquimaux in having the metapophysial tubercles larger and the anapophysial ones smaller: the diapophyses are shorter, but broader: the neural canal is wider in proportion to the size of the centrum. As compared with that of the Australian, besides the general superiority of size, the difference is chiefly marked in the much longer and larger diapophysis of the Frenchman's vertebra. As compared with the last dorsal vertebra, besides the usual difference of absence of the costal articular surface, may be noted the diminution of the metapophysis and its approximation to the anterior zygapophysis, which has now a concave surface directed obliquely upwards and inwards. The two tubercles, which terminate the posterior ridge of the neural spine below in the tenth, eleventh and twelfth dorsal vertebræ, are here further apart and advanced upon the back part of the posterior zygapophyses.

The second lumbar vertebra. The transverse processes of this vertebra are relatively longer than in the Australian, and the spine is higher in proportion to its antero-posterior extent. The tubercles behind the posterior zygapophyses are more distinctly developed. The anapophyses have subsided to mere ridges.

The third lumbar vertebra. That of the Esquimaux differs from it chiefly in the retention of the anapophyses. The zygapophyses are less wide apart in the Esquimaux. The distance between the zygapophyses in each pair is the same in the Australian as in the European, although the vertebra itself is smaller in the Australian.

The fourth lumbar vertebra. The zygapophyses are relatively larger than in the Esquimaux, and the whole neural arch with its processes are larger in proportion to the centrum than in the Australian; the spine more particularly is longer. This vertebra differs from the foregoing in the reappearance of the anapophysis upon the back part of the base of the diapophysis. Three ridges radiate from it; one to the diapophysis, another to the anterior zygapophysis, a third to the side of the neural arch.

The fifth lumbar vertebra. The posterior zygapophyses are larger and wider apart than in the Esquimaux, and are larger but not wider apart than in the Australian: the spine is longer than in either of those varieties: the diapophyses are much thicker than in the Australian. The fifth differs from the fourth lumbar vertebra chiefly in the shortening and thickening of the diapophyses, at the back part of which the anapophyses are reduced to tubercles. The metapophyses now appear as simple thickenings upon the upper border of the anterior zygapophyses. The posterior zygapophyses are larger; their articular surface is concave, and looks more directly downwards. The neural spine is reduced, particularly in antero-posterior extent.

The sacrum (Pl. XXXVI. fig. 7) consists of six anchylosed vertebræ, the supplemental one, *c.* 1, being at the caudal extremity of the bone, and answering to the first caudal vertebra in the normal type of skeleton. The first vertebra of the coccyx in the present instance has nevertheless the usual size and shape of the first vertebra of the ordinary coccyx. The sacrum is consequently longer in proportion to its breadth than in the Esquimaux, and, like the sacrum of most male Europeans, it is larger in all dimensions, with a deeper anterior concavity, than in the Negro or Australian. The so-called transverse processes of the first sacral vertebra slope more downward from the anterior articular surface of the centrum than in the Esquimaux, the direction being more like that in the Australian. The anterior zygapophyses also resemble those of the Australian in being larger and more sessile than in the Esquimaux, and the tuberosity which extends outward and forward from their base is much less produced than in the Esquimaux. The articular surface for the ileum terminates on the same transverse line with the third sacral foramen, as in the Australian. In the Esquimaux it extends very little beyond the second sacral foramen. In the present sacrum the neural arch is completed over four vertebræ and supports a spine: in the last two sacral vertebræ the neurapophysis coalesces with its homotype of the contiguous vertebra, but not with its fellow in the same vertebra.

All the differences above noted, after a scrupulously detailed comparison of the bones of the different varieties of the human race, are much less in degree and very inferior in importance to the majority of distinctions established in the present comparison between the skeleton of the lowest varieties of Man, and that of the highest of the Ape tribe[1].

DESCRIPTION OF THE PLATES.

(All the figures are of the natural size.)

PLATE XXXI.

Mandibula or Lower Jaw.

Fig. 1. Side view of the lower jaw of an adult male Gorilla (*Troglodytes Gorilla*).
Fig. 2. Side view of the lower jaw of an adult male Australian.
Fig. 3. Upper view of the lower jaw and teeth of ditto.
Fig. 4. Back view of the ascending ramus of the lower jaw of ditto.

PLATE XXXII.

Fig. 1. Upper view of the lower jaw and teeth of the Gorilla.
Fig. 2. Back view of the ascending ramus of the lower jaw of ditto.

[1] The paragraphs in brackets were added in 1853 to the original Memoir, and communicated, with an exhibition of the illustrations of that Memoir, to the Academy of Sciences, Institute of France, September 1853. (See the 'Comptes Rendus,' Sept. 5th, p. 388.) The memoir on the *Troglodytes Tschego* and *Gorilla gina*, by my late esteemed friend Prof. Duvernoy, was read to the Academy on the 30th May, 1853, and has been published in the 'Archives du Muséum d'Hist. Nat.' tom. viii. 1855. It was the last of a long series of valuable contributions to his favourite science.

Fig. 3. Upper view of the lower jaw and teeth of an adult male Chimpanzee (*Troglodytes niger*).

Fig. 4. The grinding surface of the molar series of the right side of the jaw with the crown of the canine of an old male Chimpanzee.

Fig. 5. Back view of the ascending ramus of the lower jaw of the Chimpanzee.

In all the figures *c* signifies the canine; *p* 3 & *p* 4 the premolars, indicative of their homology with the third and fourth of the typical series, as shown in the hog; *m* 1, *m* 2 and *m* 3, the first, second and third true molars.

PLATE XXXIII.

Cervical Vertebræ.

Fig. 1. The cervical vertebræ of the Gorilla (*Troglodytes Gorilla*), (a part only of the seventh is indicated in outline).

Fig. 2. Upper view of the atlas of the Gorilla.

Fig. 3. Under view of the atlas of ditto.

Fig. 4. Under view of the dentata of ditto.

Fig. 5. Under view of the fourth cervical vertebra of ditto.

Fig. 6. Upper view of the sixth cervical vertebra of ditto.

Fig. 7. The cervical vertebræ of an adult male Negro.

Fig. 8. Upper view of the atlas of ditto.

Fig. 9. Under view of the atlas of ditto.

Fig. 10. Under view of the dentata of ditto.

Fig. 11. Upper view of the sixth cervical vertebra.

Fig. 12. Under view of the fifth cervical vertebra.

Fig. 13. Upper view of the atlas of the Orang (*Pithecus Satyrus*).

Fig. 14. Under view of the same atlas.

PLATE XXXIV.

Dorsal Vertebræ.

Fig. 1. The thirteen dorsal vertebræ of the Gorilla.

Fig. 2. The twelve dorsal vertebræ of a Negro.

Fig. 3. Lower view of the tenth dorsal vertebra of the Gorilla.

Fig. 4. Lower view of the tenth dorsal vertebra of a Negro.

Fig. 5. Hinder view of the tenth dorsal vertebra of the Gorilla.

Fig. 6. Hinder view of the tenth dorsal vertebra of a Negro.

Fig. 7. Front view of the tenth dorsal vertebra of a Gorilla.

Fig. 8. Front view of the tenth dorsal vertebra of a Negro.

PLATE XXXV.

Lumbar Vertebræ.

Fig. 1. The four lumbar vertebræ of the Gorilla.
Fig. 2. The five lumbar vertebræ of a Negro.
Fig. 3. Side view of the second lumbar vertebra of the Gorilla.
Fig. 4. Upper view of the second lumbar vertebra of ditto.
Fig. 5. Side and upper views of the third lumbar vertebra of a Negro.
Fig. 6. Upper view of the first lumbar vertebra of the Chimpanzee (*Troglodytes niger*).

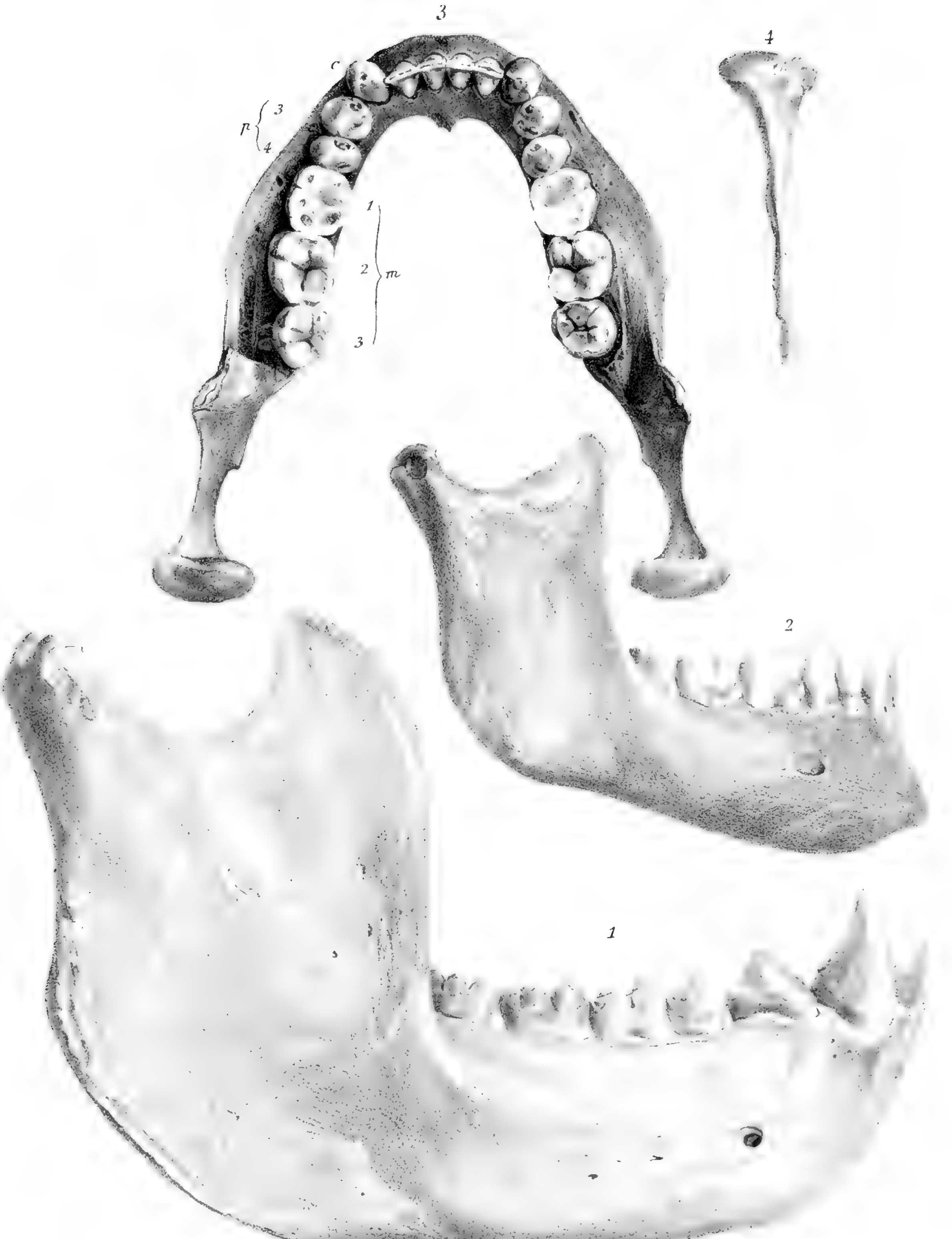
PLATE XXXVI.

The Sacrum.

Fig. 1. The sacrum of the Gorilla.
Fig. 2. Upper view of the same sacrum.
Fig. 3. The sacrum and coccyx of the Chimpanzee.
Fig. 4. Upper view of the same sacrum.
Fig. 5. The sacrum of an adult male Australian.
Fig. 6. Upper view of the same sacrum.
Fig. 7. The sacrum and coccyx of a Frenchman.
Fig. 8. Upper view of the same sacrum.

The initial letters of the vertebral elements and processes are the same for each figure, and are explained in the text.

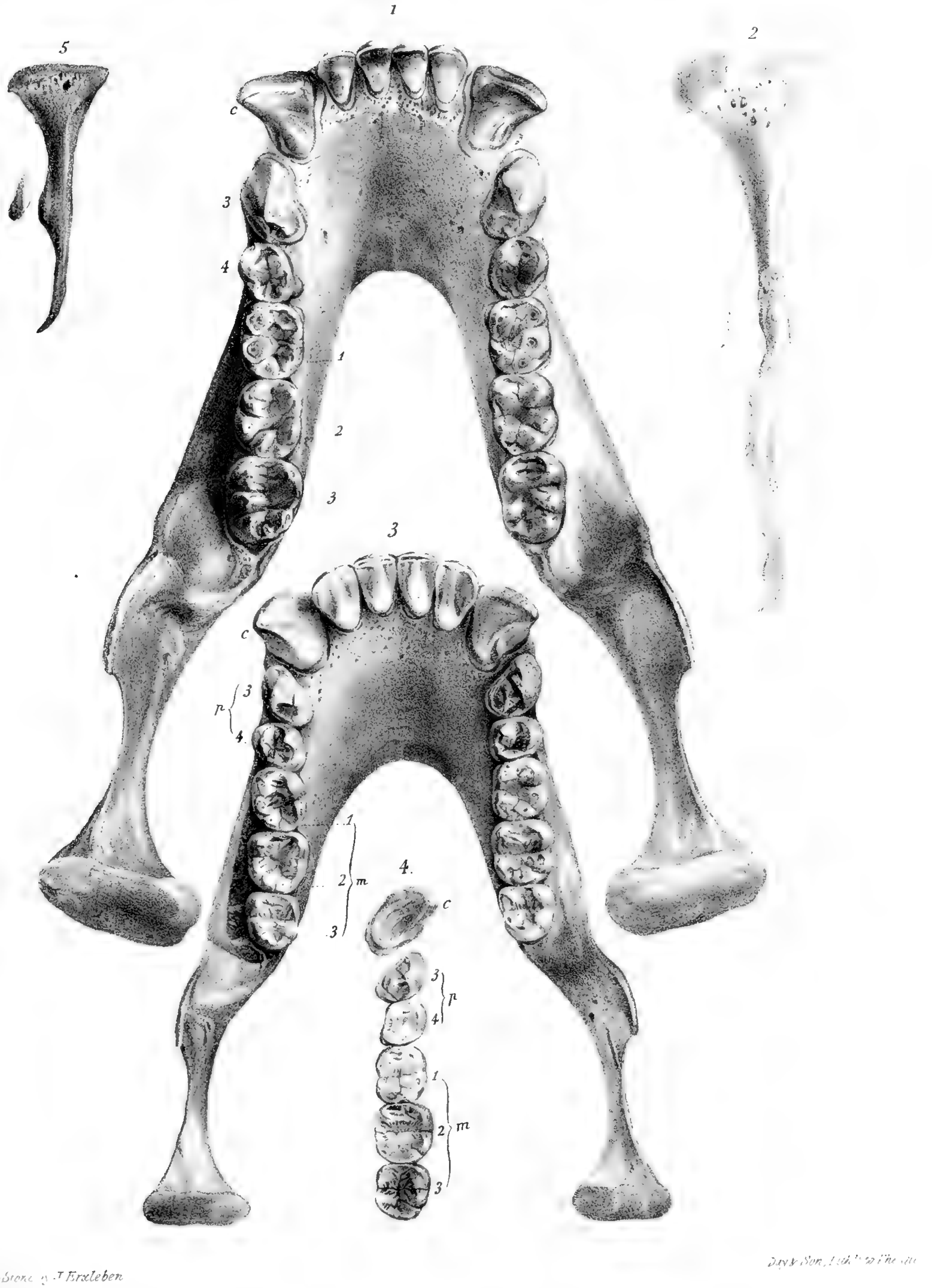
Maxilla Inferior.



From Nature on Stone by J. Erxleben

Troglodytes Gorilla 2. 3. 4 Homo.

Maxilla Inferior.



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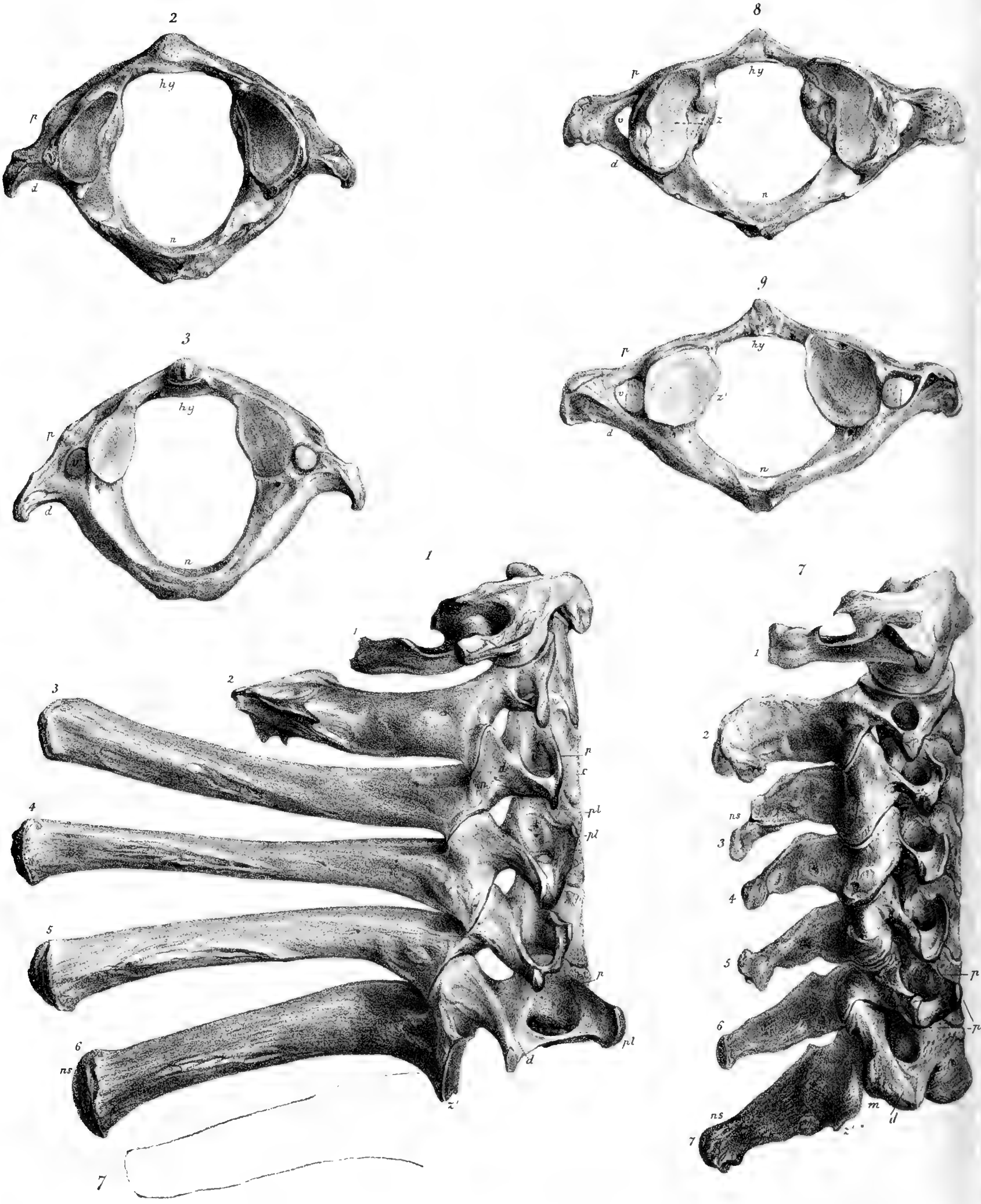
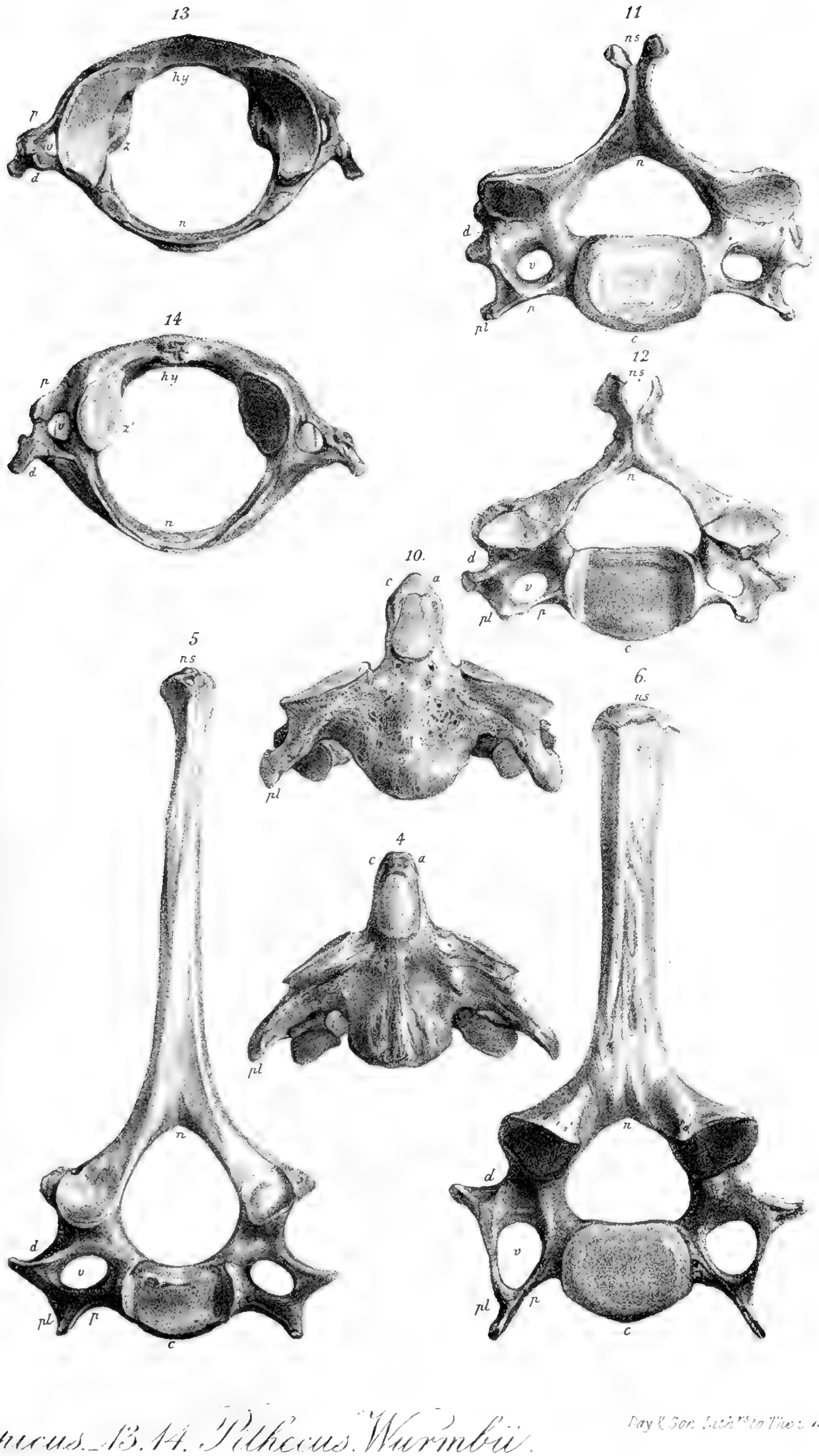
Day & Son, Lith. to the Queen

1.2. Troglodytes Gorilla. 3.5. Troglodytes niger.



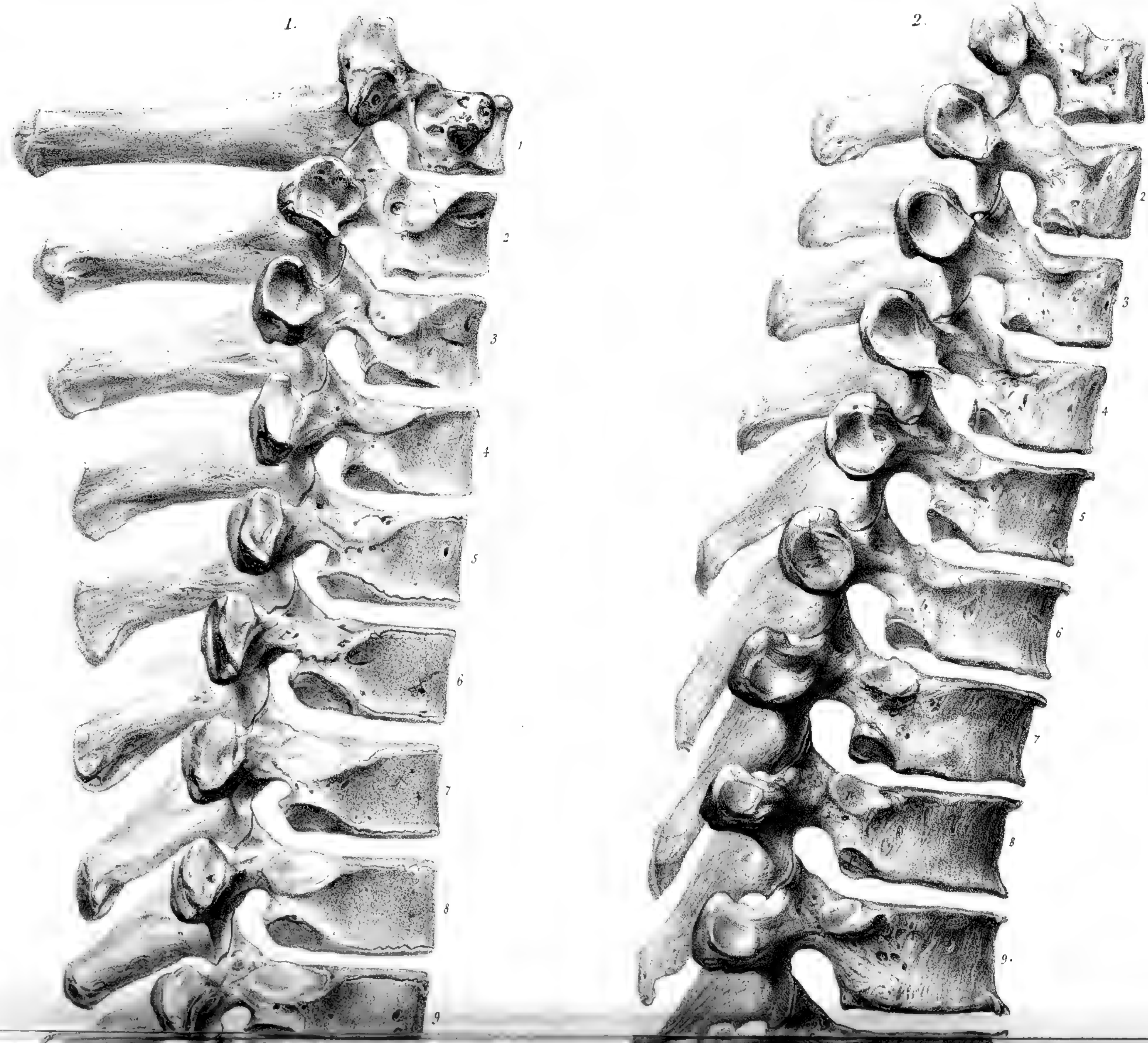
1.6. Troglodytes Gorilla _ 7.12 Homo, var.

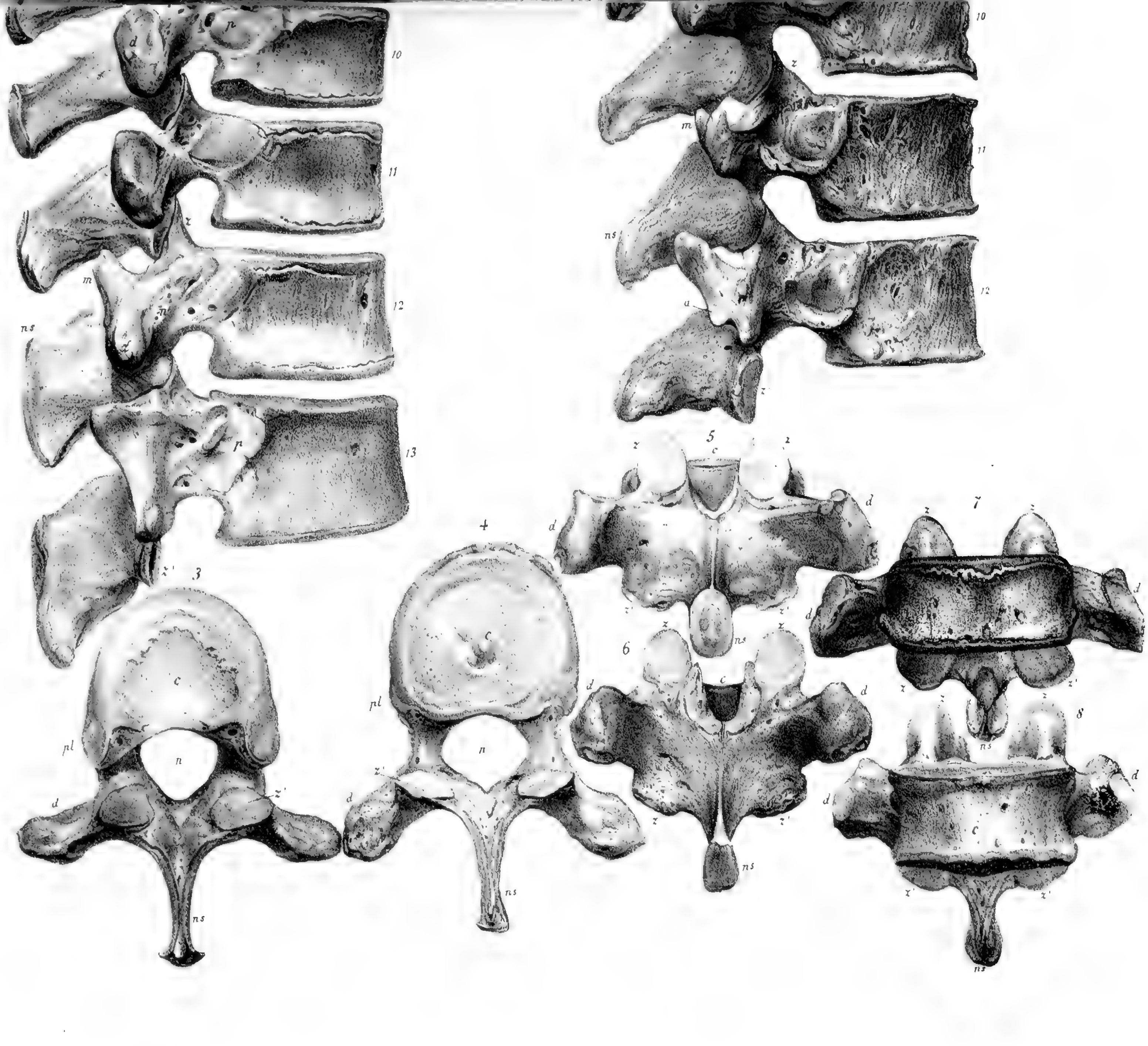


Æthiopicus. 13. 14. Pithecus Wurmbii.

Day & Son Lith^rs to The ...

Vertebræ dorsales.

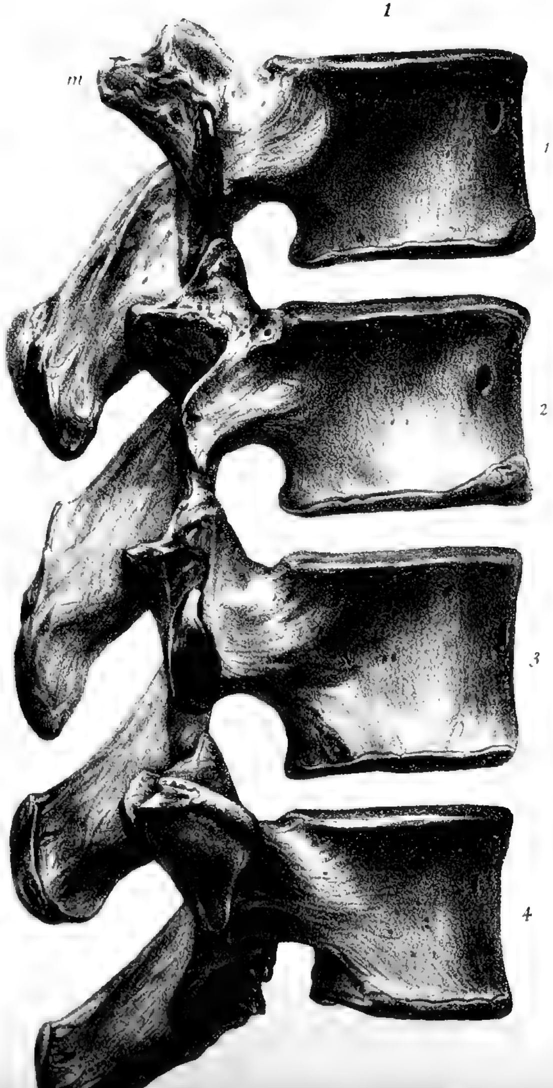




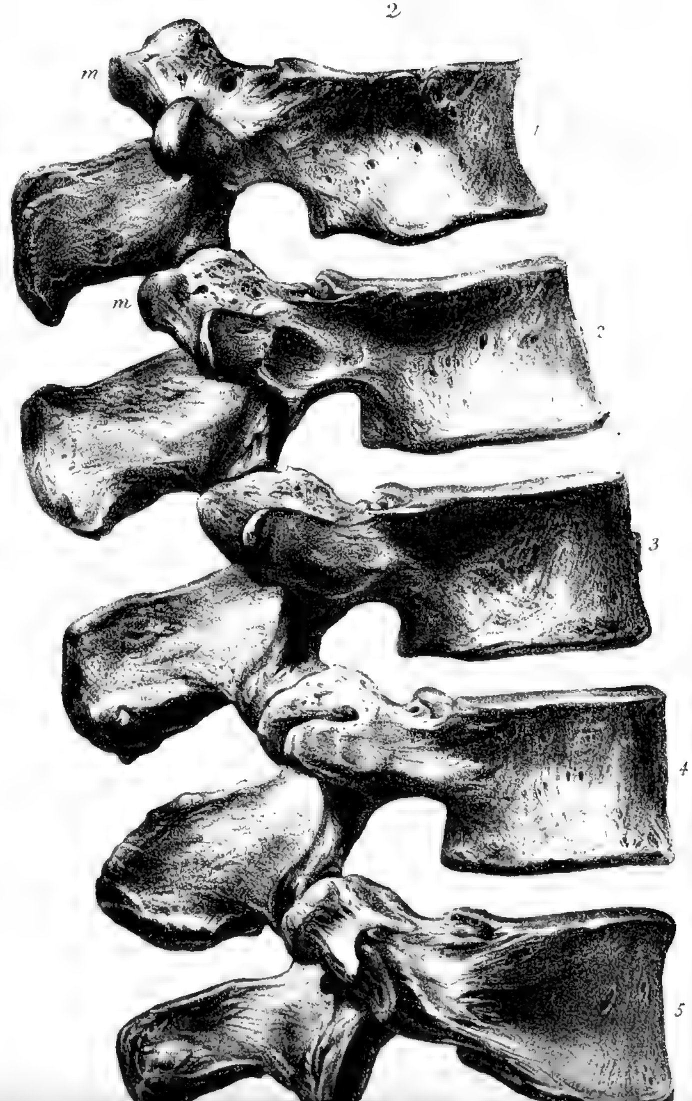
1. 3. 5. 7. *Troglodytes Gorilla*. 2. 4. 6. 8. *Homo var. Æthiopicus*

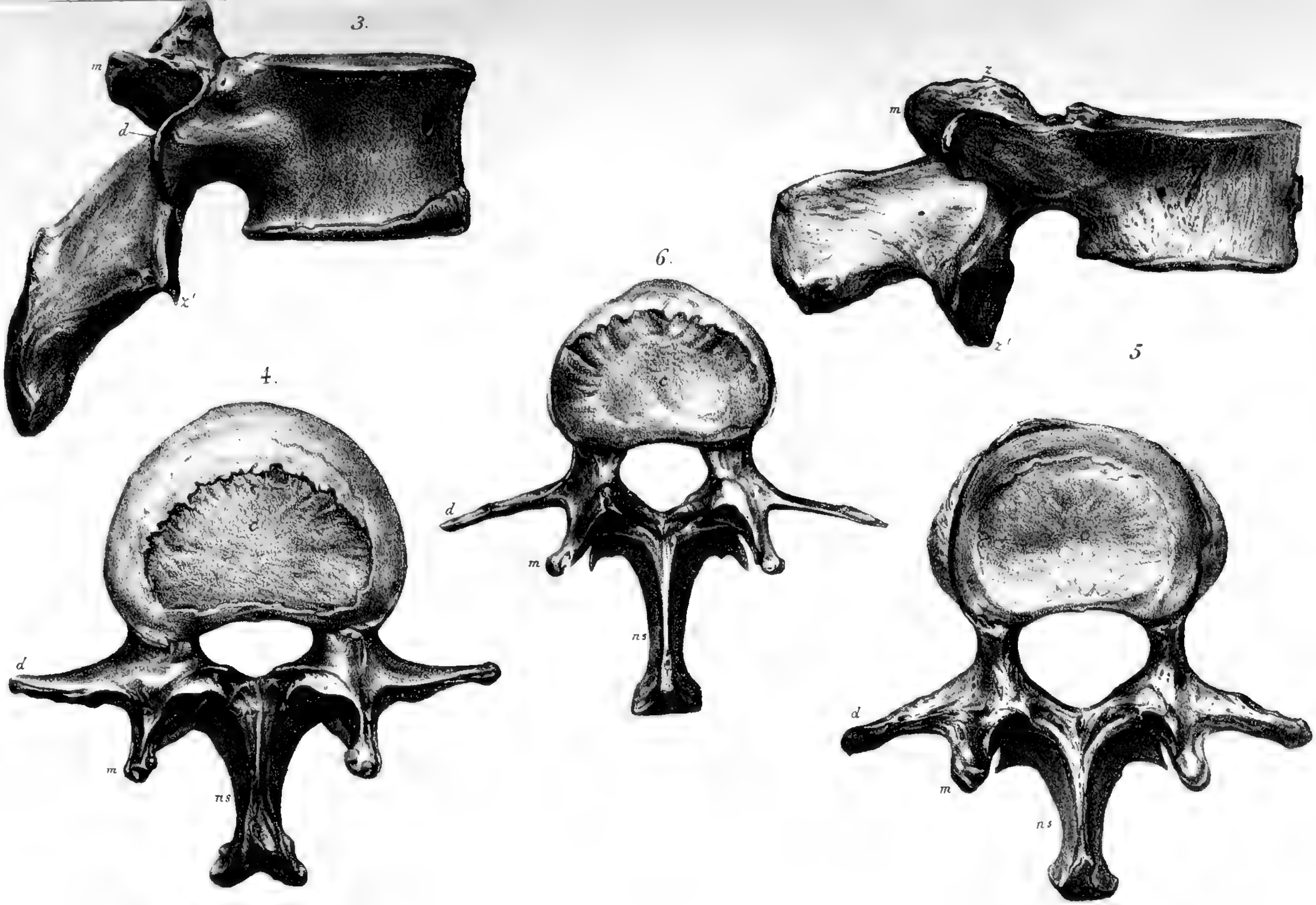
Vertebræ lumbales.

1



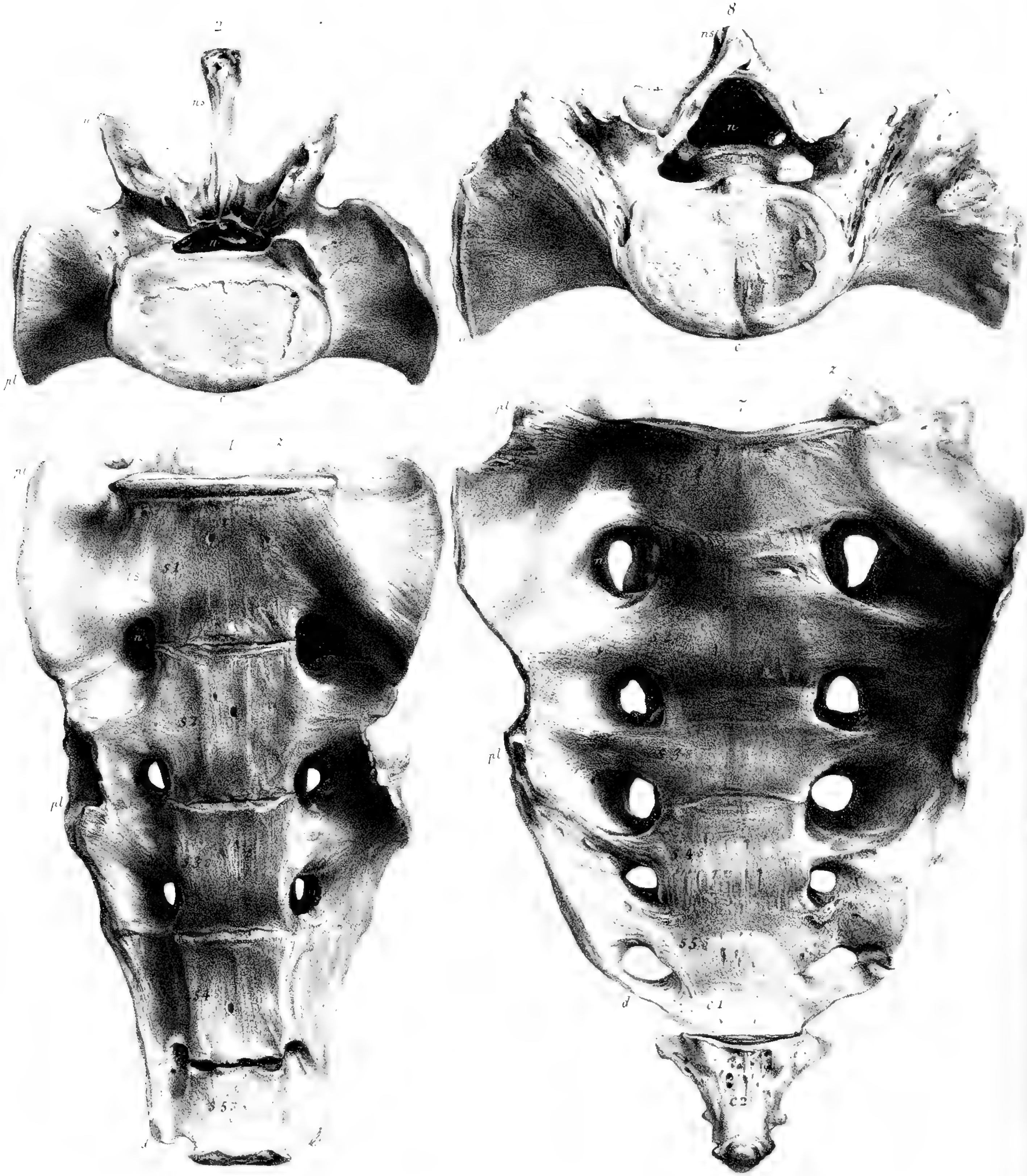
2





1.3.4._ Troglodytes Gorilla 2.5 Homo var. Æthiops.

6. Troglodytes niger.



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1. 2. Troglodytes Gorilla: 3. 4. Trog

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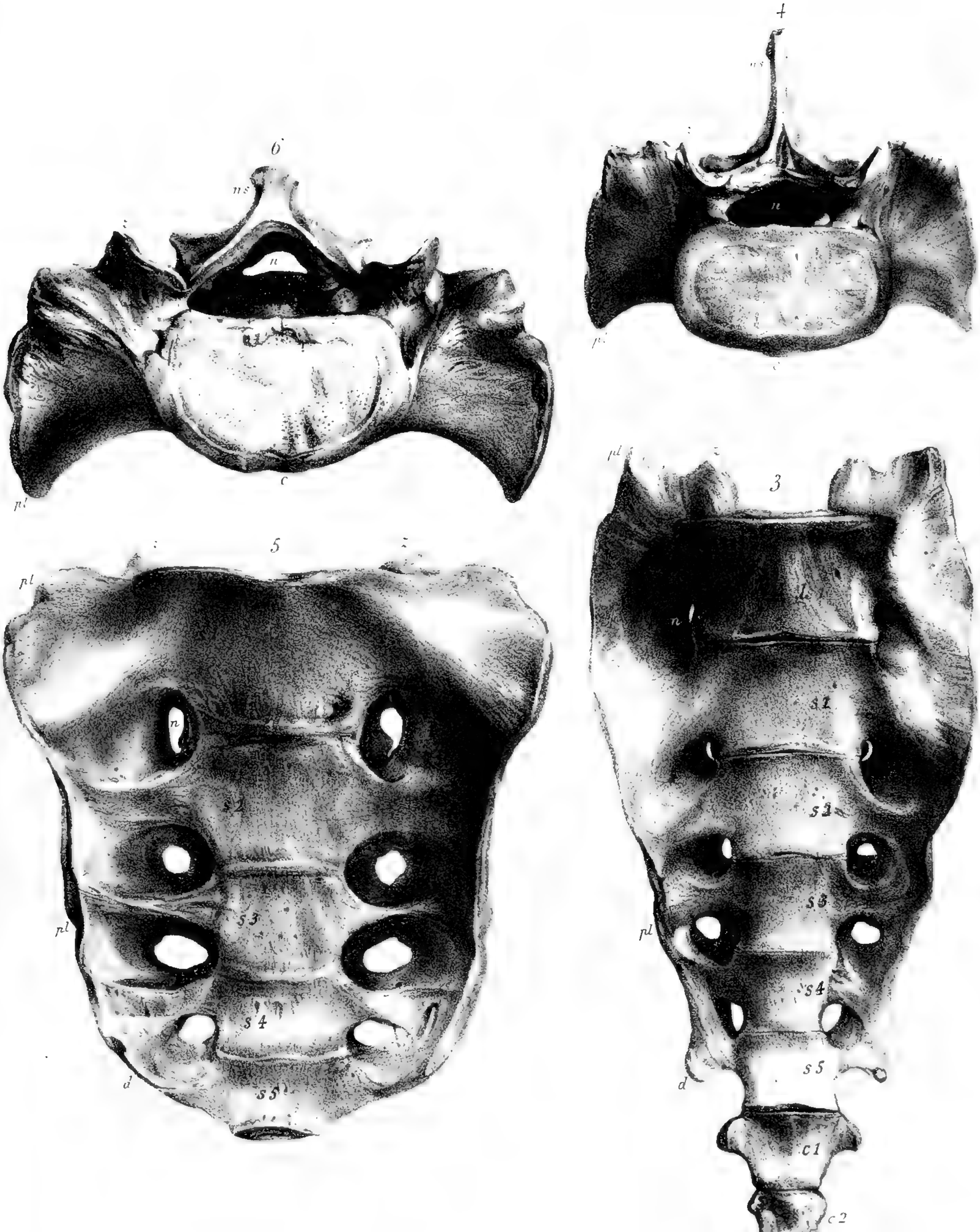

Day & Son Lithrs to the Queen

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IX. *On the Anatomy of the Great Anteater* (Myrmecophaga jubata, *Linn.*).

By Professor Owen, *F.R.S., F.Z.S. &c.*

Read July 25, 1854.

THE energetic administration of the Zoological Society of London, besides adding to the means of instruction and instructive recreation for the millions who reside in or visit the metropolis, is not less operative in advancing the purely scientific aims of the Fellows of the Society.

Already the 'Transactions' and other publications of the Society contain the records of the organization of many rare animals, unknown, at least anatomically, before their exhibition in the Menagerie in the Regent's Park; and in addition to former Monographs, including those on the Giraffe, Phacochere, Walrus, and Rhinoceros, I have now the good fortune to be able to communicate the commencement of one on the Great Anteater of South America.

The subject of the present description was a full-grown female animal which was received at the Gardens in the Regent's Park, September 29, 1853, and there died, July 6, 1854. Contemporary notices of the peculiarities of its external form, modes of motion, particularly of its large, vertically fan-shaped, long-fringed tail, when the animal, coiled up for repose, covered itself with that portable blanket, preclude the necessity of premising much on these subjects; for information on which I may refer more particularly to the 'Literary Gazette,' No. 1916, for October 8, 1853, to Mr. Broderip's most interesting Paper in the No. of 'Fraser's Magazine' for February 1844, and to the excellent articles in the 'Household Words,' and the periodical entitled 'Excelsior.'

The weight of the entire animal at the time of its death was 62 lbs. avoirdupois. [Since communicating an account of the anatomy of this animal to the Scientific Meeting of the Zoological Society, July 25, 1854, a male Anteater of the same species (*Myrmecophaga jubata*), not quite fully grown, has also been examined by me, and the present memoir combines the results of both dissections.]

External Peculiarities and Dermal Muscles.

The following remarks on some external peculiarities, as observed in the recent animal, seemed to be worthy of recording.

The length of the naked sole of the fore foot, from the base of the middle claw to the back part of the carpal pad, is five inches. The distal half of the ungual phalanx of the first toe, or 'pollex,' projects from the common cutaneous sheath of the toes; it supports a slender curved claw one inch three lines long by three lines in greatest breadth. The end of the second phalanx, with the ungual phalanx of the second toe, 'index,' projects freely: the length of the exposed part of the claw is three inches, its basal diameter six lines: this claw is curved, with its inner border and convex extremity trenchant; it can be bent so as to touch the carpal pad, but cannot be extended so as to bring the end of the claw in the line of the digit; its movements are limited to one plane. The ungual phalanx of the third digit, 'medius,' is free: the length of the claw following the convex curvature is four inches, its greatest basal breadth nine lines; its basal circumference two inches six lines; its under surface is flat, bounded by trenchant borders; its extremity is more pointed than that of the index; it can be bent so as to touch the carpal pad, but forms an obtuse angle downwards with the digit in a state of greatest extension. The second and ungual phalanges of the fourth digit are free; they are compressed, and terminate in a straight compressed pointed claw six lines in length; the joint of the last phalanx permits a slight extent of flexion and extension, and of free movement from side to side. A semilunar notch on the outside of the base of the liberated portion of the fourth digit indicates the extremity of the abortive fifth digit. This, with the metacarpal and proximal phalanx of the fourth, supports a convex callous pad at the outer and under part of the sole, two inches by one inch and a half in extent. The corium of this digital pad is developed into a number of large, low, obtuse papillæ, perforated or notched at the apex and covered by larger and more complex papillæ of the thickened cuticle. The carpal pad is smaller, of a kidney shape, one inch five lines in breadth. The part of the foot which receives the superincumbent weight in ordinary progression is the digital pad, and the outer side of the free portion of the compressed fourth digit.

The length of the sole of the hind-foot is five inches. The naked part begins about one inch in advance of the prominence of the calcaneum: the breadth of the sole at the base of the digits is two inches six lines, and there is a callosity at the inner margin one and a half inch behind the innermost digit, upon which the supplementary tarsal ossicle rests. Each of the five digits has the second as well as the ungual phalanges liberated, and each supports a curved, obtuse claw, about one inch in length, but somewhat longer on the middle digit and shorter on the outer digit. The three middle digits project the furthest, and their claws terminate at the same line: the outermost or fifth digit ends a little short of these, and the innermost digit is still shorter.

The integument of the Great Anteater has something of a pachydermal character; and although there is not any extensively diffused *panniculus carnosus*, there are some well-developed dermal muscles having attachments to parts of the endo-skeleton.

The corium between the rami of the lower jaw is one line in thickness, and increases as the skin approaches the sternum to a thickness of three lines, which is its average thickness over the back and sides of the trunk; it becomes rather thinner where it covers the abdomen, and upon the limbs.

The skin is connected to the subjacent muscles, by a thin layer of tough elastic cellular substance, along the under part of the neck; but, near the sternum, and over the fore part of the sternum, the lobules of an immense salivary gland, resembling fat-lobules at first sight, were found interposed. Pressure upon this glandular mass (Pl. XXXVII. fig. 1, *a*, *a'*)—the size, shape, and disposition of which will afterward be noticed,—was followed by the escape of thick tenacious mucoid saliva from the mouth, where it was poured out of two apertures, situated one a little behind the other, and both within six lines of the anterior border of the lower lip. After squeezing out much of the muco-salivary fluid, which presented a nearly clear opaline appearance when collected in a moderate quantity, an injection of size and vermilion was thrown into both orifices, whereupon the course of the long ducts became indicated by their tumefaction, especially at the base of the neck, where they dilated into reservoirs (*ib. c, c*), before communicating, as at *b*, immediately with the glands. The body of the hyoid, the epihyals, and the bases of the ceratohyals formed a bilobed prominence (*ib. l, l*) just anterior to the chief mass of the great salivary gland, and twenty-two inches behind the opening of the mouth.

The ordinary course of dissection was then proceeded with. Before carrying the incision along the abdominal integuments, the nipples were searched for: only one pair was found. Each nipple is subcompressed, subquadrate, about half an inch in length, with from ten to twelve lacteal orifices; it is situated four inches behind the axilla, nearly opposite the lower border of the pectoralis major. The mammæ may be said to be post-pectoral in position. The common cloacal aperture is situated beneath the root of the tail, on a prominence of soft integument, in shape like the letter T with the cross slightly bent, and the stem directed forwards, and forming the fissure where the urogenital canal opens. The tumid sides of this fissure, representing the labia majora, have their hinder ends overlapped by the crescentic fold, bounding the anus behind, the horns of which fold are bent forward and terminate outside the labia: the soft vascular lining of the vulva is continued by a short narrow median strip directly into that of the rectum.

On reflecting the skin from the under part of the head, the attention was first directed to a feeble development of a panniculus carnosus in the form of thin transverse fasciculi (*ib. e, e*) about half an inch in breadth, and occurring at intervals of from two to three inches, where they underlie the rami of the slender elongated under-jaw, and of the breadth of an inch and a half where they lie below the base of the cranium; these muscular strips (*dermogulares*) have their attachments exclusively in the integument, and aid in accommodating its movements to the alternating expansion and contraction of the great gular dilatation (Pl. XXXIX. fig. 3, *p, q*) near the base of the tongue. The transverse fasciculi are crossed by a longitudinal strip of cutaneous muscle (*dermolabialis posticus*, Pl. XXXVII. fig. 1, *f*) on each side of the under part of the head and neck; the strip emerges from beneath the fore part of the great subpectoral gland, *a*, is here very thin, and about six lines in breadth; it diminishes in breadth and increases in thickness as it extends forwards, assuming near the mouth the character of a muscle independent of the skin (Pl. XXXIX. fig. 1, *t*); where, passing beneath the tendon of the *retractor anguli oris, ib. f*, it is inserted into, or blends with, the fibres of an accessory portion of the *orbicularis oris* (*ib. r*). A shorter longitudinal muscular strip (*dermolabialis anticus*, Pl. XXXVII. fig. 1, *f''*) arises from the integument below the fore part of the preceding muscle, becomes free as it advances (Pl. XXXIX. fig. 1, *s*), and is inserted into the proper *orbicularis oris* (*ib. q*).

Between the integument of the abdomen and the abdominal 'panniculus,' there is a layer of tough elastic cellular tissue like a fascia. On reflecting this, a broad layer of muscular fibres (*dermo-abdominalis*) is exposed, which covers the proper abdominal muscles. The flattened and slightly separated fasciculi of this dermal muscle arise from the fascia covering the anterior and inferior part of the sternum and contiguous sternal ribs; also from a median raphé of the subcutaneous fascia, attached to the linea alba, and extending two-thirds of the way towards the pubis. The anterior two-thirds of the above muscular sheet are joined by a broad layer of similar flattened fasciculi coming off from a fascia covering the side of the thorax, and the muscle so formed passes obliquely downwards and outwards, converging to form a thick fleshy band, about two inches broad, which is continued along the inner and upper part of the thigh, and becomes slightly twisted prior to its attachment to the aponeurosis covering the knee-joint. The posterior portion of the dermo-abdominalis consists of thinner and more scattered flattened fasciculi which pass outwards and downwards, and, as they diverge from the median line, are lost in the subcutaneous fascia covering the tendinous expansion of the *obliquus externus abdominis*. Between the dermo-abdominalis and the proper abdominal muscles there is a moderately thick layer of elastic cellular tissue.

Reserving the details of the muscular system in general for a subsequent communication, I proceed next to the visceral anatomy of the Great Anteater.

Thoracic and Abdominal Cavities, and general disposition of their Viscera.

On opening the abdomen, the liver is seen arching across the upper part of the abdominal cavity from the right to the left hypochondrium. The suspensory ligament enters a cleft to the left of the median plane, near the left end of the middle or cystic division, but not extending to within two inches of the anterior border of that division. To the right of the ligament is a wide subcircular notch, through which the fundus of the gall-bladder projects. Below the cystic lobe appears a prominent portion of the stomach, opposite the right side of the ensiform cartilage. The right lobe of the liver occupies the right hypochondrium, and between it and the stomach is seen a short convolution of the duodenum with the head of the pancreas. The spleen, a long and narrow organ, appears below the left half of the liver, between it and the stomach, and then bends downward and to the right, overlapping the middle constriction of the stomach. A short epiploon, without fat, extends from the spleen over the left division of the stomach which is seen projecting below the spleen. The epiploon is reflected back to a line a little behind the greater curvature of the stomach. The convolutions of the alimentary canal occupy the rest of the exposed part of the abdominal cavity. A thin layer of fat was interposed between the peritoneum and the soft walls of the abdomen.

One common duplicature of peritoneum, continued from the middle of the back part of the abdomen, and eighteen inches in extent where it is broadest, at the junction of the ileum with the colon, supports the whole intestinal canal, as in most reptiles,—mesentery, mesocolon and mesorectum being one and the same fold: the shorter diameter of this fold is from eight to ten inches. The mesenteric part is puckered to support the convolutions of the small intestines. A mesenteric gland of a dark colour is continued along the base-line of these plicæ for the extent of sixteen inches, beginning at the duodenal end of the pancreas and ending with the ileum. Parallel with this, on what may be regarded as the base-line of the mesocolon, are a number of detached glands of the same dark colour, and flattened, like the long mesenteric gland, but of a subcircular form, and from three lines to twelve lines in diameter. The mesenteric artery forms one series of arches, with their convexity at from six to twelve lines distance from the gut. The mesocolic vessels form also one series of arches, which are close to the gut.

The duodenum, arching round the head of the pancreas, is suspended on the beginning of the mesentery, where it is from two to three inches broad; and it is continued into the jejunum without being tied by a contraction of the mesentery to the back of the abdomen, as in most Mammalia. The right lobe of the liver is suspended to the dome of the diaphragm by a right coronary ligament, and a duplicature of peritoneum connects the extremity of that hepatic lobe to the upper part of the right kidney. There is also a left coronary ligament: a fold of peritoneum two inches broad connects the left lobe of the liver with the stomach at the fore part of the cardia; and a more posterior fold connects the left lobe of the liver to the left suprarenal body and left kidney. The peritoneum passes over the under surface (sternal aspect) of the kidneys, and over the same part of the right suprarenal body: it affords a more entire covering to the left suprarenal body. The peritoneal folds called 'broad ligaments' begin to be reflected from the front of the lower ends of the kidneys, converging to sustain the ovaria and enclose the ovarian ligaments, fallopian tubes, uterus, and ureters. The urinary bladder was empty and corrugated: the urachal fold, reflected from the middle of its fore part to near the fundus, expands as it extends to the lower part of the linea alba, terminating above at the obliterated umbilicus which is situated six inches above the symphysis pubis. A flat glandular body about the size of an almond was situated in the urachal fold: it might be the debris of part of an umbilical sac. Two narrow ureteral folds of peritoneum diverge from the back part of the urinary bladder to the broad ligaments.

The length of the female from the muzzle to the vent was four feet seven inches; the length of the head was fourteen inches; that of the tail thirty-three inches. The total length of the intestinal canal was thirty-four feet; the small intestines measuring thirty feet in length. The ileum dilates rapidly into the colon, which commences without any cæcal projection. The greatest circumference of the duodenum is two and a half inches:

the calibre of the intestinal canal gradually contracts to a circumference of one inch nine lines at the part which would be called jejunum in Man, and it recovers a circumference of three inches near the end of the ileum. The colon, within three inches of the ileum, has a circumference of nine and a half inches; and has decreased to a circumference of six inches, where it forms the rectum, about nine inches from the anus.

The inner surface of the duodenum and jejunum is smooth, offering no villi to the naked eye. A few irregular very narrow longitudinal folds of the lining membrane, not parallel to, but following one another, begin to appear in the ileum: these are succeeded by a longer longitudinal fold, or two, which are soon followed by one extending continuously through the ileum, along the side of the gut opposite the attachment of the mesentery: this fold is from two to three lines in breadth, is narrowest where the canal has been most distended, but is not obliterated by the utmost dilatation of the gut: it is a permanent single longitudinal production of the vascular lining membrane, and forms the chief characteristic of the lower half of the small intestines in the *Myrmecophaga jubata.* In this part of the canal there are patches of glandulæ agminatæ from one to two inches long, and with intervals of about one foot.

The transition of the ileum into the colon is effected by a rapid increase of diameter, viz. from one inch to two and a half inches; by a slight thickening of the muscular coat; by the appearance of a few transverse ridges or very low folds of the mucous membrane at the beginning of the colon, and not extending round the circumference of the gut: but the boundary of the ileum is not defined by any ileo-colic valve nor by any appreciable alteration in the vascularity or other structure of the mucous membrane in the two divisions of the intestinal canal.

The inner surface of the colon is smooth, finely reticulate, with a few very narrow transverse folds, from one inch to half an inch apart, subsiding for the most part before reaching the attached line of the gut; these folds are not obliterated when the canal is fully distended; they commence about eighteen inches from the ileum, gradually become shorter and narrower, and disappear about a foot from the rectum.

The longitudinal folds of the rectum extend to the margin of the anus, where a little dark pigment is developed under the epithelium. The soft epithelial-covered integument extends from the fore part of the anus to the vulva, which is distant about half an inch. The longitudinal muscular fasciculi of the rectum and rectal end of the cloaca are strongly marked, and are from one line to one line and a half in breadth.

In the thorax, a mediastinum, increasing in breadth from two to three inches as it passes backward from the aortic arch, completely divides that cavity into a right and left compartment; the heart and pericardium projecting equally into both. A peculiar subcompartment of the right pleural cavity is formed by a duplicature of pleura extending from the right division of the mediastinum and from the lower part of the pericardium around the inferior cava, into which compartment the lobulus azygos from the right lung projects.

The structure of the thoracic and abdominal viscera will form the subject of a succeeding part of the present memoir.

Salivary Glands.

The glandular mass representing the submaxillary salivary glands in Man (Pl. XXXVII. fig. 1, *a*, *a'*), is a bilobed body, sixteen inches in length, two inches in greatest thickness at the posterior part which forms the isthmus or junction of the two lobes or glands. From this confluent base they diverge, extending outwards and forwards, and form, each, a flattened triangular mass, from four to five inches in breadth and two inches thick posteriorly, and becoming thinner towards the outer and anterior border, where the apex is prolonged into a slender process. The isthmus, or base of the combined glands, overlies the anterior half of the thorax; the base of each lateral lobe is notched by the prominence of the shoulder-joint (*s*, *s*), round which its outer border extends; the contracting anterior prolongations of the gland pass forwards along the sides of the neck, external to the sterno-maxillares (*w*, *w*), and terminate a little in advance of the angle of the jaw, at *a'*.

The two packets of ducts (*ib*. *b*, *b*, figs. 1 & 2), which indicate the essential doubleness of the gland, emerge from the inner and posterior part of the lateral lobes, five or six inches in a straight line from the posterior border of the isthmus, and nine or ten inches from the anterior attenuated extremity of the gland. After a short course, the ducts dilate and form a small reservoir, *ib*. *e*, on each side; they are here so closely covered and connected by elastic cellular tissue as to seem a single reservoir; they maintain however their distinctness, and continue, contracted, from each dilatation, as three closely united attenuated ducts, which at length unite into one long and slender duct. The dilated portion is surrounded by a compressor muscle (*constrictor salivaris*, *ib*. fig. 3, *k*).

The gland is conglomerate, the primary lobes being for the most part oblong, subcompressed, from about three to nine lines in diameter. The closely united ducts (*d*, *d*), after quitting the reservoir, are continued forwards covered by the extraordinarily extended *mylohyoideus* (*g*, *h*, *i*, *j*), and, after their union, the common duct terminates, as above described, at the symphysis of the lower jaw (Pl. XXXIX. fig. 3, *d*).

The parotid gland (*ib*. fig. 1, *x*) is small in proportion to the animal: it is situated in front and below the root of the ear, is of a triangular form, two inches four lines in length, one inch two lines in breadth, with the duct continued from the outer side of the anterior apex of the gland, which apex terminates at the posterior end of the origin of the masseter muscle. The duct (*ib*. *y*) extends forwards along the outside of the masseter near its origin, passes along the buccinator near its upper border and beneath the tendons of three of the retractors of the mouth, then dips under the orbicularis oris (*q*, *q*), and terminates near the opening of the mouth. The length of the duct is eleven inches, its diameter scarcely half a line. This is perhaps the longest duct, in proportion to the size of the gland, in the animal kingdom. The depressor auris (*w*),

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which arises from the angle of the jaw, perforates the parotid gland. A chain of lymphatic glands is continued backward from beneath the parotid on the side of the neck.

The representative of the sublingual gland forms a thin layer, divided for the most part into narrow elongated lobes or groups of follicles (Pl. XXXIX. fig. 2, *fa*), attached to and spread over the inferior buccal membrane for an extent of twelve inches: the greatest breadth of this layer is two and a half inches, and is opposite the angle of the jaw.

There is a small elongated labial gland (*ib.* fig. 2, *z*), lying upon the fore part of the buccinator, near its lower border, and sending its secretion into the side of the fore part of the mouth; apparently to lubricate that contracted aperture during the frequent and rapid protrusive and retractile movements of the tongue. The buccal glands form a very extensive but extremely thin stratum of muco-glandular follicles, closely attached to the thin membrane of the mouth; they are chiefly developed at the lower and lateral parts, and along the middle of the upper surface of that part of the mouth which is prolonged backward, below the similarly prolonged nasal canal, beyond the bony palate. These glands terminate by innumerable very minute orifices upon the smooth inner surface of the buccal membrane, which they serve to lubricate. They are continuous with the better-marked series of follicles extending along the sides of the under surface of the mouth, beneath the lower jaw, which represent the 'sublinguales.' But the glands that pour out the abundant viscid secretion which lubricates the tongue and is mainly subservient to its peculiar prehensile function in the Great Anteater, are those conjoined or interblended pair that answer to the submaxillary salivary glands in other animals; which glands are most modified and developed, for a like function, in other species of *Myrmecophaga*, in the Armadillos (*Dasypus*), and in the Echidna.

In the little scansorial *Myrmecophaga didactyla*, the homologues of the submaxillary glands (Pl. XL. fig. 3, *c*, *c*) are subcervical and blended together, as in the larger species; and a slender process (*d*) is continued from them to the labial gland, *a*. The duct (*e*) commences by three tubes continued on each side from the main body of the gland; and these tubes dilate into a small reservoir, provided with a compressor muscle, before the long and slender single duct is continued, covered by the mylohyoideus, to the symphysis of the jaw. The parotid gland is of very small relative size; and this striking difference in the proportions of the two chief salivary glands indicates the difference in their functions and in the quality of their respective secretions. The labial glands (*a*) are relatively larger in the *Myrmecophaga didactyla* than in the *Myrmecophaga jubata*; and there is a superadded aggregate of mucous follicles (*b*) behind the eyeball, in the shallow orbit of the smaller species, the secretion of which enters near the angle of the mouth.

In the Armadillos (*Dasypus*), the submaxillary glands are subcervical in position, and, though large, are relatively less than in the true Anteaters (*Myrmecophaga*); they are also disunited, but come into contact at their lower extremities. Figure 1 of Pl. XL. represents these glands, *in situ*, of the natural size, in the specimen of the *Dasypus sexcinctus* described by me in the Proceedings of the Zoological Society for July 1832,

p. 130. The salivary bladder (*e*) is relatively larger than in the Great Anteater, and is a simple pyriform sacculus receiving the secretion of the great gland by three or four short ducts, entering obliquely at its fundus: the apex of the bladder is continued into the long and slender duct which terminates in the mouth just behind the symphysis mandibulæ. Figure 2 of Pl. XL. shows a further dissection of the right submaxillary salivary gland and bladder in another species of Armadillo (*Dasypus Peba*[1]). The saliva which these reservoirs contain is very tenacious, the serous part being probably absorbed during its detention. Thus prepared and accumulated, it is expelled at the extremity of the mouth, in order to lubricate the tongue, which is thus, as in the Anteaters, made subservient to the catching of insects[2].

In the Spiny Anteater of Australia (*Echidna*), the homologues of the submaxillaries are as largely developed as in the hairy Anteaters of America, and are subpectoral and subcervical in position; but they are not blended together. The primary lobes are fewer and larger than in the *Myrmecophagæ*, and the secretion is carried from each gland by a single relatively very wide duct. When the duct has reached the interspace of the lower jaw, it dilates and then divides into eight or ten undulating branches, which subdivide and ultimately terminate by numerous orifices upon the membranous floor of the mouth. This unique modification of a salivary apparatus is figured and described in my Article *Monotremata* of the 'Cyclopædia of Anatomy and Physiology,' 8vo, vol. iii. 1847, p. 388, fig. 188.

Muscles of the Mandibular and Hyoid arches, and of the Tongue.

Mylohyoideus.—The muscle answering to the mylohyoideus is of unusual extent, and is divisible into different portions: the first of these is a thin layer of transverse fibres (Pl. XXXVII. fig. 1, *g*), extending from the symphysis menti about five inches backwards: the fibres pass from the under and outer side of one mandibular ramus to the opposite ramus, and are attached along the middle line of their central surface to the long and thin tendon of the geniohyoideus: the posterior transverse fibres overlap the anterior termination of the second division (*h*) of the mylohyoideus. The transverse fibres of this division arise externally, or laterally, from the inner side of each mandibular ramus, and are attached mesially and centrally to a continuation of the tendon of the geniohyoideus, which may be seen shining through the fibres of the mylo-

[1] Proceedings of the Zoological Society, 1832, p. 130.

[2] The preparations exemplifying the above interesting modifications of the salivary apparatus are preserved in the Physiological Series of the Museum of the Royal College of Surgeons, Nos. 772 L and M, and are described in the first volume of my Catalogue of that Series, p. 228, 4to, 1831. Prof. Rapp, in his excellent work, 'Über die Edentaten,' 4to, 1843, has given a figure of this structure, in the *Dasypus peba*, and refers to a description of it in an Inaugural Thesis by Winker, "Dissertatio sistens observationes anatomicas de Tatu novemcincto. Præs. Rapp. Tubingen, 1824." This Thesis I have never seen, nor, as yet, been able to obtain: I became aware of its existence only through the reference in the work above quoted.

hyoideus, and which looks like a raphé of the muscle. This portion, which represents the normal mylohyoideus (*h*), extends backward as far as the ascending ramus of the jaw. A third portion (*ib. i*, and Pl. XXXIX. fig. 1, *i*) arises fleshy from the inner side of the ascending ramus of the jaw, whence its fasciculi radiate towards the middle line, in a somewhat twisted course, the anterior ones passing beneath the second or normal part of the mylohyoideus. The fourth portion, *j*, at its anterior part arises from the angle of the jaw, then from the base of the cranium, and afterward from a strong fascia extended thence backwards, between the postcranial prolongations of the nose and mouth (Pl. XXXIX. fig. 2, *j*); the posterior and longest fasciculi come off more outwardly and radiate to spread over and blend with the gular fasciculi of the sternoglossi, passing outward and downward, and then bending inward to envelope that part of the hyoid apparatus. All the fibres of the fourth portion terminate in a median raphé, which is less marked than in the anterior portion. The fibres of the posterior division of the mylohyoideus, especially those which are attached superiorly to the under surface of the posteriorly prolonged nasal canal, form a kind of muscular sheath for the basal part of the muscles of the tongue (*ib.* fig. 1, *j*).

Constrictor salivaris.—This is a flat subquadrate muscle (Pl. XXXVII. fig. 3, *k*), which arises fleshy from the inner border of the base of the ceratohyal, *m*, passes downward and forward beneath the *ceratohyoideus*, *n*, expands on emerging, bends over the salivary reservoir (figs. 1 & 2, *c*), and is inserted into the tendon marked * in fig. 2: it also blends with the back part of the *mylohyoideus*. The *constrictor salivaris* is crossed by the ectocarotid (fig. 3, *o*), and by the large lingual nerve, *u*, which, winding round the ceratohyal, *m*, curves over the ectocarotid and the constrictor, passing forward beneath it and the ceratohyoideus muscle, to accompany the sternoglossi to the base of the tongue.

Ceratohyoideus.—This muscle (Pl. XXXVII. figs. 2 & 3, *n*) arises from the ceratohyal, *m*, about an inch from its upper end, whence its origin is continued for an extent of one inch and a half: its fibres converge and form a fasciculus six lines in breadth, which is inserted into the commissural tendon (*, fig. 2), and is connected with a strip, *x*, from the sternomaxillaris muscle. The ceratohyal (Pl. XXXIX. fig. 2, *m*), after giving attachment to the foregoing two muscles and to the anterior constrictor of the pharynx, extends freely forward in front of the scalenus, and mesiad of the sternomastoid muscle, its extremity being attached to the *stylohyoideus* muscle, *v*.

Stylohyoideus.—In most mammals, the hyoid arch, by the length of the ossified part of the stylohyal and the extent of the ossification of the ceratohyal, is almost restricted to hinge- or swing-movements forward and backward upon the proximal joints of the stylohyals as a fixed point; so that the basihyal with its immediate appendages—usually the tongue—cannot be very far protruded or retracted. In the *Myrmecophaga jubata* the usual place of the stylohyal bone is occupied by a long and slender muscle, the *stylohyoideus* (Pl. XXXIX. fig. 2, *v*), which arises from the petromastoid, and after a course of five inches is inserted into the ceratohyal, here the first bone of the hyoid arch. Supposing the *stylohyoideus* to contract one-third of its length, it would protract the hyoid arch to the same extent: in which act it combines with the *geniohyoideus*. The retraction of the hyoid arch is provided for by the *sternothyroidei* (Pl. XXXVIII. fig. 1, *p*) and their apparent continuations the *thyrohyoidei*. There is no direct sterno-hyoid muscle: the homologue of this seems to be the sternal portion of the *sterno-glossus* (*ib. g*).

Geniohyoideus.—This muscle arises by a single tendon from the symphysis of the jaw. It is one line in breadth, flat, runs back beneath the raphé of the anterior mylohyoideus; slightly expands beneath the raphé of the middle mylohyoideus, then again contracts and again expands, and at about ten inches from its origin becomes diffused into fleshy fibres, which gradually acquire a breadth of six lines, continue back in close connexion with the *mylohyoideus* to the commissural tendon (*, fig. 2) and there expand, the lateral borders being attached thereto. Here a mid-line of separation appears, and the muscle bifurcates into two flat fasciculi (Pl. XXXVII. figs. 1 & 2, *l*, *l*) each six lines broad, which are inserted into the angles of the basihyal.

The *Sternothyroidei* (Pl. XXXVIII. fig. 2, *p*, *p*) come off from the inner and lateral parts of the sixth, seventh and eighth sternal bones, and from the seventh and eighth sternal ribs near their articulations therewith. The interthoracic extent of these muscles is six inches. At about two inches from the origin is the point of a tendinous angular intersection (*), somewhat more marked than in the *sternoglossus*; the angle is turned forward on the opposite side of the muscle. These intersections vary somewhat in the two muscles, the left *sternothyroideus* presenting two within the chest, the right one three. Behind the manubrium the left muscle sends off a small fasciculus of fibres to the right one, and the right reciprocally to the left. Where the decussation takes place there is a tendinous intersection at the fore part, which does not extend to the back part of the muscle. In advance of the interchange of fasciculi the sternothyroidei diverge, increase in thickness, and decrease in breadth just before they emerge from the chest; beyond which cavity they are fleshy throughout their extent (*ib.* fig. 1, *p*, *p*), and are inserted into the lower and fore part of the thyroid cartilage (*ib. q*).

Cricothyroidei.—These muscles (Pl. XXXVIII. fig. 1, *r*, *r*) cover the whole of the cricoid cartilage, beneath and external to the *sternothyroidei*, and are inserted into the lower and lateral borders and productions of the thyroid cartilage.

The *Thyrohyoidei* (Pl. XXXVIII. fig. 2, *s*, *s*) arise from the lateral and anterior parts of the thyroid cartilage, above the preceding, and are inserted into the median two-thirds of the thyrohyal or posterior horn of the hyoid.

The *Intercornualis* (Pl. XXXIX. fig. 2, *q*) is a straightened mass of fibres passing obliquely from the thyrohyal forwards and inwards to the epihyal.

A ligament connects the mesial end of the ceratohyal with the anterior and outer end of the thyrohyal. A shorter and thicker ligament ties the posterior and outer end of the thyrohyal to the thyroid cartilage.

Sternoglossus.—This remarkable muscle arises fleshy from the lateral border of the dilated xiphoid and last sternal bone, and from its junction with the last two true ribs. The origin (Pl. XXXVIII. fig. 2, *e*) is at first triangular, but soon assumes a flattened shape, six lines broad by two lines thick, the muscle gradually diminishing in breadth, as it extends forwards, without losing thickness. Linear tendinous intersections (*ib. f, f*) mark the part of the muscle within the chest; the first occurs about two inches and a half from the origin, and is bent with the angle turned forward; the second, about two inches in advance, crosses the muscle obliquely; the third, at about the same interval, sends a slight angle forward; the fourth is an angular intersection, with the point turned backward on one side and forward on the other side of the muscle. From this point the sternoglossus passes forward, emerging from beneath the manubrium sterni as a simple fleshy muscle (Pl. XXXVIII. figs. 1 & 2, *g*), five lines broad and from two to three lines thick. Opposite the hyoid it is perforated by a lingual artery: between four and five inches in advance it is perforated by the lingual nerve (*ib.* fig. 1, *u, u*); and here it begins to give off, or its inferior stratum is resolved into, flattened fasciculi of fibres which decussate or combine with those of the opposite muscle, *h, h*. About six inches in advance of the basihyal these fasciculi spread over a dilated membranous portion of the buccal cavity, at the lower part of which the base of the tongue is situated: and here they converge and blend with corresponding flattened fasciculi, *o'*, *o'*, sent off from the lower part of the *genioglossi*, as these pass backward to the base of the tongue. The main continuation of the sternoglossus, which is concealed by the subgular fasciculi, forms a rounded slender muscle (*i, i*, fig. 2), which raises the buccal membrane so as to form the back part of the frænum linguæ, and penetrates, or forms, the back part of the base of the tongue, and a great proportion of its substance.

Genioglossus.—This muscle (Pl. XXXVIII. *m, n, o*) has a complex origin, by a middle portion, from the short symphysis mandibulæ, *m*, and by a flattened penniform series of fibres, from the lower border of the mandibular rami for the extent of four inches behind the symphysis, *n, n*. The symphysial origin is round and slender, and belongs more directly to the proper tongue-muscle: the ramal origins seem to be the more special fixed point of the subgular fasciculi. The fibres of the ramal origin, *n, n*, pass obliquely backward and inward, converging to a middle raphé, to which the symphysial origin closely adheres. The two origins of the muscle are blended into one for about three inches beyond the point of attachment, in which extent the muscle forms a moderately thick depressed mass along the middle of the under part of the mouth. It then begins to expand, and to detach from its under surface those subgular fasciculi, *o'*, *o'*, which diverge and unite with the corresponding dismemberments, *h, h*, of the sternoglossi. The main part of the *genioglossus* enters, as a single muscle (*ib.* fig. 2, *o*), the fore part of the base of the tongue, carrying into the floor of the mouth a fold of buccal membrane forming the fore part of the frænum linguæ. Between the genio- and sterno-glossi, the fifth pair of nerves (Pl. XXXIX. fig. 2, *o*), which have arched almost transversely beneath the lower part of the gular pouch, converge to penetrate the tongue at the base of the frænum.

Epihyoglossi.—Beneath the insertions of the geniohyoidei (Pl. XXXVIII. fig. 1, *l*, *l*), a pair of more slender muscles (*ib. k*, *k*) come off from the median ends of the epihyals. These muscles, after a brief course, expand into a thin layer, resolve themselves into separate fasciculi, and combine an inch in advance of their origin to form a layer about eight lines in breadth below the middle line of the postlingual part of the mouth; which layer (*k*) slightly diminishes in size as it approaches the commissure of the sterno-glossi (*h*), and, with them, penetrates the back part of the frænum linguæ. The antero-posterior diameter of the base of the tongue, where it rises freely from the buccal membrane (Pl. XXXVIII. fig. 2, *o*, *p*, *i*), is three and a half inches. The convergence of the *sterno-* and *genio-glossi*, with the connecting frænal fold, forms a triangle, from the apex of which the tongue, *b*, assumes its vermiform shape, gradually diminishing from a breadth of eight lines to the obtuse apex which is one line in breadth, the length of this free part of the tongue being eighteen inches.

The tongue is covered by a smooth shining epithelium, which begins to present a softer, more vascular or mucous character fourteen inches from the apex; but the only papillæ anywhere present are two fossulate ones, 'papillæ vallatæ' (Pl. XXXIX. fig. 3, *f*), forming a pair, two lines apart, situated on the dorsum of the tongue about two inches in advance of the termination of the frænum. A linear groove, commencing two inches from the base of the tongue, extends along the dorsum to within four inches of the apex.

The muscular substance of the free part of the tongue is formed by the lingual portions of the *sternoglossi*, by the *genioglossus*, and by the proper 'linguales' muscles.

The buccal membrane (Pl. XXXIX. fig. 3, *p*, *q*) is smooth, perforated at its lateral and inferior parts, and also superiorly beyond the bony palate, by innumerable very minute orifices, from a quarter of a line to one line apart, by which the secretion of the thin glandular stratum before described enters the mouth.

Four inches in advance of the angle of the jaw, near the lower border of the ramus, a longitudinal ridge or low fold of the buccal membrane begins to rise, increasing in depth and assuming a callous hardness as it extends forwards and upwards: this ridge (Pl. XXXIX. fig. 3, *r*) is about two lines in breadth, and bends down so as to leave a groove between it and the lower membrane of the mouth. It is possible that the Termites may be crushed by the action of the tongue against these two callous ridges, which seem to occupy the place of teeth on each side the mouth.

The cavity of the mouth quickly expands as it passes backward and acquires its greatest breadth opposite the base of the skull and of the tongue (*ib.* fig. 3, *p*, *q*), having there a diameter of from four to five inches. The thin membrane, over which the diverging fasciculi of the sternoglossi and hyoglossi spread, is capable of considerable dilatation, and may serve, therefore, as a temporary receptacle for the Termites, where they may be blended with the more alkaline and solvent salivary secretion of the parotids after being pounded by the tongue against the callous ridges, before they are finally swallowed: the singular backward extension of the fauces and nasal passages appears to relate in part to the presence and function of this receptacle.

The buccal cavity gradually contracts beyond the receptacle to the hyoid bone, immediately in advance of which, nineteen inches from the aperture of the mouth, are situated the tonsils (Pl. XXXVIII. fig. 2, *t*, *t*; Pl. XXXIX. fig. 3, *t*), each tonsil being an oval patch of a thin layer of muco-glandular substance with a finely reticulate surface, measuring one inch by nine lines. Behind the tonsils, and between them and the basihyals, a pouch of the gular membrane (*ib.* *s*) descends between the epihyals; it is one inch and a half in depth, by one inch in width.

One inch behind the prehyoid pouch, the extremity of the epiglottis, *v* (bisected in fig. 2, Pl. XXXVIII.), is seen projecting into the cavity of the mouth; it is broad and trilobed, the middle lobe subquadrate and curved downwards and backwards. A *hyo-epiglottideus* muscle extends from the back of the basihyal to the fore part of the base of the epiglottis: some fibres from this muscle appear to spread upon the prehyoid pouch.

The thyroid cartilage (Pl. XXXVIII. fig. 1, *q*) is ossified. The cricoid (*ib.* fig. 2, *y*) is cartilaginous. The arytenoids (*ib.* fig. 2, *w*, *w*) are low obtuse cartilages.

The *chordæ vocales* (Pl. XXXIX. fig. 3, *x*, *x*) extend from the middle of the lower and front part of the thyroid forwards to the arytenoid cartilages, *w*, the fold containing them expanding as they advance. There is a shallow fossa beneath this fold and a deeper one above it, or between it and the folds continuing from the epiglottis, *v*, to the arytenoids. There is a small fibrocartilage supporting an obtuse prominence from near the hinder end of the epiglottidean fold. The posterior interspace of the first tracheal cartilage is half an inch wide, but at the third ring the posterior extremities come into contact.

The posterior margin of the soft palate terminates by a low angular projection like the rudiment of a uvula (*ib.* *u*) opposite the base of the epiglottis. From the sides of this uvula the membrane arches backward, and gradually subsides upon the beginning of the œsophagus.

The whole length of the nasal passage (Pl. XXXIX. fig. 3, *c*, *e*) is twenty-two inches. The first inch is surrounded by the cartilaginous part of the nose: the next thirteen inches is enclosed by bone: the last eight inches of the canal has musculo-membranous walls, and is an enormously-developed homologue of the 'palatum molle' in Man.

Constrictores pharyngis.—The canal of the posterior nares is continued far back beyond the base of the skull (*ib.* fig. 3, *e*, *e*), and the homologues of the 'constrictor pharyngis' act upon this canal before they embrace the proper pharynx. They consist of several distinct muscles. The most anterior one (*ceratopharyngeus*, Pl. XXXIX. fig. 2, *f*) comes off from an extent of more than an inch of the middle part of the ceratohyal, *m*. It is a thin broad layer, the fasciculi of which diverge to spread upon the sides of the postcranial continuation of the nasal passage interlacing with the constrictor fibres which spread over the back part of that passage. The second muscle (*epipharyngeus, ib. g*) has a thicker origin, of ten lines in extent, from the back part of the inner end of the ceratohyal, and from the joint between this and the epihyal. The fasciculi diverge and spread over the sides of the posterior part of the soft nasal canal, partly overlapping the preceding muscle anteriorly, and being themselves slightly overlapped by the next portion behind. The third constrictor (*hyopharyngeus, ib. h*) has an origin three lines in extent from the thyrohyal and contiguous part of the basihyal: the fibres diverge upon the sides of the end of the nasal canal and the beginning of the pharynx; the anterior fibres overlapping and then blending with the posterior fibres of the preceding muscle. The fourth constrictor (*thyropharyngeus, ib. i*) comes off from the outer margin of the thyroid cartilage, having an origin of nine lines in extent. The fibres pass transversely round the pharynx, partially overlapping the preceding muscle, and slightly expanding at the back of the pharynx. The posterior continuation of this portion, which might be regarded as a fifth muscle (*cricopharyngeus, ib. i'*) arises from the posterior and outer prolongation of the cricoid, behind the three upper rings of the trachea.

Retractor pharyngis (Pl. XXXIX. fig. 2, *k, k*).—A slender longitudinal muscle, arising from a fascia connected with the origin of the scalenus, runs along the outer side of a long slender gland, and then passes forwards to the outer side of the cricopharyngeus, where it bends backwards, slightly expands, and appears to blend with the contiguous fibres of the crico- and thyro-pharyngei. The breadth of the free part of this retractor pharyngis is from one to two lines.

In the dissection of the neck of the Great Anteater, three pairs of long and slender muscles are met with, which relate to the movements of the head.

Sternocervicalis.—This muscle arises from the upper and outer angle of the manubrium sterni, close to the inner (mesial) side of the *sternomaxillaris*, by a thin tendon four lines broad, which soon becomes fleshy, and the slender muscle (Pls. XXXVII. fig. 2, and XXXIX. *y*) gradually contracts to be inserted into the side of the middle cervical vertebra.

The *Sternomastoideus* (*ib. z*) arises from the outer angle of the manubrium sterni, by a tendon two lines broad, which gradually expands, is flattened, and at one inch nine lines from its origin becomes a fleshy flat muscle six lines broad; this gradually increases in thickness to a rounded form, then contracts, and forms a tendon at about eleven inches from its origin, which contracts to its insertion into the paroccipital representative of the mastoid protuberance.

Sternomaxillaris.—This muscle arises from the inner side, near the upper and outer angle, of the manubrium sterni, and manubrial fascia, centrad of the clavicular fascia, and of the origins of *sternomastoideus* and *sternocervicalis* (Pl. XXXVIII. fig. 1, *w, w*); its origin is by a flat, very short tendon, five lines broad: an aponeurosis passes from one tendon to that of the fellow muscle. The fleshy part forms a long slender band six lines in breadth, which passes forward, and about four inches from its origin sends off a slender fleshy strip (Pl. XXXVII. fig. 2, *x*) to the ceratohyoideus, *n*, and the central tendon, *. It then advances as a slender round fleshy muscle, which degenerates into a subcompressed tendon about half an inch in length, opposite the *compressor salivaris*. Resuming its fleshy structure, it forms an anterior subcompressed belly, ten inches in length and from four to five lines in diameter (Pl. XXXIX. fig. 1, *w*). This gradually contracts and terminates in a slender tendon three inches long, which expands to be inserted into the outer and under part of the maxillary ramus, six inches in advance of the angle of the jaw.

To the action of the pair of muscles, so inserted, is mainly due that characteristic movement of the head of the Great Anteater when it composes itself to sleep, and draws its head downward and backward between the fore-limbs, in contact with the chest. The mouth is small, and susceptible of so slight an opening as not to require for that action so remarkable a modification of what appears to be a dismemberment of the homologue of the sternocleidomastoideus muscle.

The proper muscles of the jaws consist of the *temporalis*, the *masseter*, and the *pterygoidei*.

The *temporalis* (Pl. XXXIX. fig. 2, *a*) arises from a low ridge extending from the stunted zygomatic process of the squamosal upwards and slightly forwards,—the boundary rather of a large and ill-defined orbit than of a temporal fossa, which is in no wise marked off from the orbit: some fibres are derived from the temporal fascia; but the muscle is not above an inch in breadth, and its greatest length does not exceed an inch and a half; it is inserted into the external ridge, an inch in advance of the condyle, which feebly represents a coronoid process.

The *masseter* (Pl. XXXIX. figs. 1 & 2, *b*) has an extent of origin of three inches three lines from the malar process of the maxillary, from the short and free malar, and from a very strong fascia continued thence over the temporal muscle to the zygomatic process of the squamosal. The maxillary origin has the appearance of a distinct tendon, *b′*, expanding into an aponeurosis, which spreads over nearly the upper half of the outside of the muscle. The carneous fibres from the maxillary tendon pass vertically downward: the more posterior fibres proceed more obliquely downward and backward as they approach the angle of the jaw, into which the most posterior ones are inserted. The extent of the insertion from this point forward is four inches two lines. The action of this muscle is to close the mouth and protract the mandible.

The *pterygoideus internus* arises, chiefly fleshy, from a longitudinal channel on the under part of the pterygoid bone, which is bounded mesially by a low ridge, to which a short aponeurotic origin of the muscle is attached: the muscle gains in thickness and depth as it passes forward and outward to be inserted into the concavity on the inner side of the ascending articular part of the jaw.

The external *pterygoideus*—a narrower and smaller muscle—is not clearly distinct from the foregoing; it arises fleshy from the outer part of the tuberosity of the pterygoid bone, and the fibres pass more directly forward to their insertion, where they blend with those of the preceding muscle: this external part of the pterygoideus is more directly a retractor of the jaw: the other fibres would antagonize the masseteric ones in rotatory horizontal movements of the jaw.

Muscles of the Nose, Ear, and Lips.

The back part of the upper maxillary bone, which slopes downward and a little outward, to form the malar process, affords an aponeurotic origin to four muscles of the nose and lips. The *levator nasi* (Pl. XXXIX. fig. 1, *c*) is the superior of these; it becomes distinct an inch in advance of the common origin, its fleshy fibres converging to a small tendon two inches nine lines from that origin: the tendon, which is four inches in length, is inserted into the upper part of the nose, which it raises.

The *retractor anguli oris* (*ib. d*) is the second muscle: it comes off from the lower and outer part of the preceding, about an inch in advance of their common origin, and is aponeurotic on its upper border for two and a half inches. The aponeurosis, which forms the tendon of insertion, begins at the lower border of the muscle near where the first aponeurosis terminates. The whole length of the fleshy part of this muscle is four inches nine lines: its greatest breadth, where distinct, is three lines: the length of the slender tendon is two inches; it passes over the *orbicularis oris*, *q*, to be inserted into the angle of the mouth.

The *retractor alæ nasi* (*ib. e*) is the third muscle: it is sent off below and from the inner side of the preceding; has a fleshy belly three inches four lines in length, and a very slender tendon four inches three lines in length, which passes over the *orbicularis oris*, to be inserted into the skin of the back part of the nostril.

The *retractor labii inferioris* (*ib. f*) is the fourth muscle: it forms the lower and outer part of the common origin, covers that of the preceding muscle, has a fleshy portion five inches six lines in length, and a tendinous one two inches four lines in length. This tendon seems to penetrate the orbicularis oris, to the fibres of which it gives attachment both along its upper and lower borders. It is inserted into the lip below the angle of the small mouth.

The *retractor labii superioris* (*ib. m*) forms a fifth muscle, which has a more distinct origin from the malar process of the maxillary, than the preceding four, for the extent of one inch. Its fleshy part is three inches three lines in length; its very slender tendon is five inches in length, and is inserted into the upper lip, and to the lower part of the nostril, of both of which parts it is a retractor. Near its insertion it is connected with muscular fibres descending from the skin of the nose to the circular lip, where they are connected with the cutaneous muscles affecting that part.

The *orbicularis oris* (*ib. q*) arises from the outer side near the fore part of the long maxillary: it is a thin muscular layer, eight lines in breadth, inserted into the tendon of the retractor anguli oris, and partly continuous with a thicker layer of the same sphincter which passes round, beneath the mouth, closely connected with the skin of the lip, to the same tendon of the opposite side. A small oblique tendon is developed near where the fibres of the longitudinal muscle (*dermolabialis anticus*, *s*) blend with and are lost in the *orbicularis oris*.

The *accessorius ad orbicularem oris* (*ib. r*) arises from the maxillary behind the muscle it assists, and contracts as it descends and blends its fibres with the true orbicularis: it receives the insertion of the *dermolabialis posticus*.

The *buccinator* (*ib. u*) is of unusual longitudinal extent, and consists of a thin layer of flattened fasciculi of vertical fibres arising from an aponeurosis attached to the toothless border of the upper jaw, and inserted at the outside of the similar border of the lower jaw.

A small mass of labial glands, two inches in longitudinal extent and from two to three lines in breadth, rests upon the under and fore part of the buccinator and dips under the *orbicularis oris*.

The *levator auriculæ* (*ib. v, v'*) has an extent of origin from the epicranial fascia of nearly four inches. The most anterior fasciculus, *v*, comes off behind the eye and is a protractor: the posterior fasciculus, *v'*, arises from the occiput and is a retractor: these with the intermediate fasciculi acting in succession would rotate the ear. Beneath the posterior fasciculus is a deeper-seated retractor of the ear inserted into the inferior and outer part of the auricular cartilage.

The *depressor auriculæ* (*ib. w*) is a roundish, slender muscle, which arises from the angle of the jaw, penetrates the parotid gland, and is inserted into the lower part of the cartilage of the ear.

Cuvier and Duvernoy long ago pointed out that the protraction and retraction of the tongue of the Anteaters and Echidna were not due to any peculiar conformation of the hyoid bone and muscles, but to another mechanism answering the same end. Those distinguished anatomists seem, however, not to have noticed to what an extent the base of the tongue is removed from the basihyal, nor to have recognized the share which the genioglossus takes in the formation of the tongue itself. "The hyoid in the *Myrmecophagæ* (the species is not noted) is placed very far back, and as a consequence, the base of the tongue is placed equally far back, although it is not, so to speak, attached to the hyoid bone. It seems to be composed exclusively of the sternoglossi and of an annular muscle[1]."

The gular fasciculi of the genioglossus are recognized as 'geniobuccales,' and are described as "diverging upon the sides of the base of the tongue, beyond which they

[1] "L'os hyoïde étoit placé très en arrière; il en résulte que la base de la langue est également très en arrière, quoique celle-ci ne tienne pas, pour ainsi dire, à l'os hyoïde."—"Elle ne semble composée que des *sternoglosses* et d'un muscle *annulaire*."—Leçons d'Anatomie Comparée, tom. iii. 1799, p. 265.

form a tendinous sheath enveloping the sternoglossi, with which they are continued to the sternum[1]:" in this description will be recognized what I have described as gular fasciculi, or dismemberments of the sternoglossi and genioglossi respectively. For the absence of any styloglossi, Duvernoy accounts by the remark, "that the base of the tongue is much further back than the stylohyal[2]." But this is not the case in the Great Anteater.

In the posthumous edition of Cuvier's 'Leçons d'Anatomie Comparée,' t. iv. 1836, p. 558, Prof. Duvernoy intimates, that the brief notice respecting the anatomy of the tongue in the Anteaters, inserted in the first edition, was an extract from a Memoir on that subject, which he read to the 'Société de la Faculté de Médecine de Paris' in 1804, and which was afterwards inserted entire in the 'Mémoires de la Société d'Histoire Naturelle de Strasbourg,' tom. i. 1830.

On referring to the latter volume, I find that the interesting remarks of the venerable anatomist were based upon dissections of the *Myrmecophaga tamandua*, Cuv., the *Myrmecophaga didactyla*, and the *Echidna Hystrix*: the Great Anteater (*Myrmecophaga jubata*) seems not to have come under the scalpel of either Cuvier or Duvernoy. Whatever discrepancy, therefore, may be found between the descriptions in the present Memoir and those in the 'Strasbourg Transactions,' may be set down, either to a different interpretation of the structures observed, or to the specific modifications of the *Myrmecophaga jubata*. I have not, at least, had the opportunity of testing by actual dissection the degree of concordance between the *Myrmecophaga tamandua* and the large species which would seem to have been now anatomized for the first time.

DESCRIPTION OF THE PLATES.

PLATE XXXVII.

Salivary and Lingual Structures.

Fig. 1. Superficial view of the submaxillary salivary glands, and muscles of the tongue and jaw, beneath the head and neck: half the natural size.

Fig. 2. Further dissection of the submaxillary gland and duct, and contiguous muscles: half the natural size.

Fig. 3. Muscles of the salivary reservoir and contiguous muscles: natural size.

[*The following letters indicate the same parts in each figure.*]

a, a. Main body of the confluent submaxillary (here subcervical and subpectoral) salivary glands: *a'*, their slender anterior continuation.

b, b. Ducts, prior to their dilatation.

c. Dilated portion of the ducts, or salivary reservoir, surrounded by a muscle.

[1] *Ibid.* p. 264.

[2] "... que la base de la langue est plus en arrière que l'os styloïde."

d. Long and slender portion of the ducts leading to the mouth, covered by the mylohyoideus muscle.
e, e. Submandibular transverse fasciculi of panniculus carnosus (Dermogulares).
f. Dermolabialis posticus.
f'. Dermolabialis anticus.
g. Anterior } portions of the Mylohyoideus.
h. Middle } portions of the Mylohyoideus.
i. Twisted or radiated } portions of the Mylohyoideus.
j. Posterior } portions of the Mylohyoideus.
k. (fig. 3, *c.* fig. 1) Constrictor salivaris.
l. Geniohyoideus.
m. Ceratohyal.
n. Ceratohyoideus.
o. Carotid artery.
p. Sternothyroidei.
q. Thyroid cartilage.
r. Cricoid cartilage.
s. Prominence of shoulder-joint.
t. Trachea.
u. Lingual nerve.
v. Stylohyoideus.
w. Sternomaxillaris. *, (fig. 1) its middle tendon. *w''*, its tendon of insertion.
x. (fig. 2) Its strip to the tendon *.
y. Sternocervicalis.
z. Sternomastoideus.

PLATE XXXVIII.

Muscles of the Tongue.

Fig. 1. Inferior superficial view of muscles of the tongue: half the natural size.
a. Mouth.
b. Tongue.
c. Rami of lower jaw.
d. Ducts of submaxillary gland.
e. Origin (fig. 2) } of the Sternoglossus.
f. Tendinous intersections (*ib.*) } of the Sternoglossus.
g. Extrathoracic part } of the Sternoglossus.
h. Gular fasciculi } of the Sternoglossus.
i. Proper lingual part (fig. 2) } of the Sternoglossus.
k. Epihyoglossi.

l. Geniohyoidei (insertions of).
m. Symphysial origin ⎫
n. Ramal origin ⎬ of the Genioglossus.
o. Lingual or proper part ⎪
o′. Gular fasciculi ⎭
p. Sternothyroidei.
q. Thyroid cartilage.
r. Cricothyroidei.
s. Thyrohyoidei.
t. Thyrohyoidei antici, seu minores.
u. Lingual nerve.
v. Lingual artery.
w. Sternomaxillaris.
y. Sternocervicalis.
z. Sternomastoideus.

Fig. 2. Proper muscles of the tongue: half the natural size.
a. Mouth.
b. Tongue.
c. Rami of the lower jaw.
d. Termination of the duct of submaxillary gland.
e. Origin ⎫
f. Tendinous intersections ⎪
g. Extrathoracic part ⎬ of the Sternoglossus.
h. Gular fasciculi (fig. 1) ⎪
i. Proper lingual part, or continuation, ⎭
k. ⎫
l. ⎭ fig. 1.
m. Symphysial origin ⎫
n, n. Ramal origin ⎬ of the Genioglossus.
o. Proper lingual part ⎪
o′. Gular fasciculi (fig. 1) ⎭
p. Frænal fold of the gular membrane at the base of the tongue.
q. Membrane of the mouth forming the gular dilatation.
r. Roof of the mouth.
s. Subgular or prehyoid pouch.
t. Tonsils.
u. Uvula.
v. Divided epiglottis.
w. Arytenoid cartilage.
x. Chordæ vocales.
y. Cricoid.
z. Trachea.

PLATE XXXIX.

Fig. 1. The parotid salivary gland and duct, and the superficial muscles of the jaws, tongue, mouth, nose, and ear.

a. Fascia covering the temporalis muscle.
b. Masseter; *b'*, its maxillary origin.
c. Levator nasi.
d. Retractor anguli oris.
e. Retractor alæ nasi.
f. Retractor labii inferioris.
m. Retractor labii superioris.
q. Orbicularis oris.
r. Orbicularis accessorius.
s. Dermolabialis anticus.
t. Dermolabialis posticus.
u. Buccinator.
v. Levator auriculæ, anterior (protractor) portion; *v'*, occipital (retractor) portion.
w. Depressor auriculæ.
x. Parotid gland.
y, *y*. Its duct.
z. Labial gland.

[*The other letters signify the same parts as in the previous plates.*]

Fig. 2. Muscles of the head, tongue, and neck.

a. Temporalis.
b. Masseter; *b'*, its maxillary origin.
d. Duct of submaxillary gland.
e. Soft part of nasal canal behind the skull.
fa. Fauces or dilated part of mouth behind the skull.
f. Ceratopharyngeus.
g. Epipharyngeus.
h. Hyopharyngeus.
i. Thyropharyngeus.
i'. Cricopharyngeus.
j. Posterior part of mylohyoideus.
k. Retractor pharyngis.
l. Insertion of geniohyoideus.
m. Ceratohyal.
n. Ramal origin of genioglossus.
o. Gular fasciculi of ditto, blending with those of ·
p. Sternoglossus.
q. Intercornualis.

r. Cricothyroideus.
s. Thyrohyoideus.
tr. Trapezius.
t. Atlanto-acromialis.
u. Atlantoscapularis.
u'. Axioscapularis.
v. Stylohyoideus.
w. Sternomaxillaris.
x. Parotid gland.
y. Sternocervicalis.
z. Sternomastoideus.

Fig. 3. The oral and nasal canals, pharynx, larynx, and beginning of the œsophagus and trachea, vertically and longitudinally divided.

a. Opening of the mouth.
b. Tongue.
c. Style passed through the external nostril into the cranial part of the nasal canal *c–c.*
e–e. Postcranial part of the nasal canal.
i, i. Sternoglossi.
a, p. Prelingual part of the mouth: the faucial fasciculi of the genioglossus are seen through the thin membrane of the dilated part of the mouth.
q, s. Postlingual part of the mouth.
s. Prehyoid pouch.
t. Tonsil.
u. Uvular part of soft palate.
v. Epiglottis.
w. Arytenoid cartilage.
x. Chorda vocalis.
y. Cricoid cartilage.
z. Trachea.

PLATE XL.

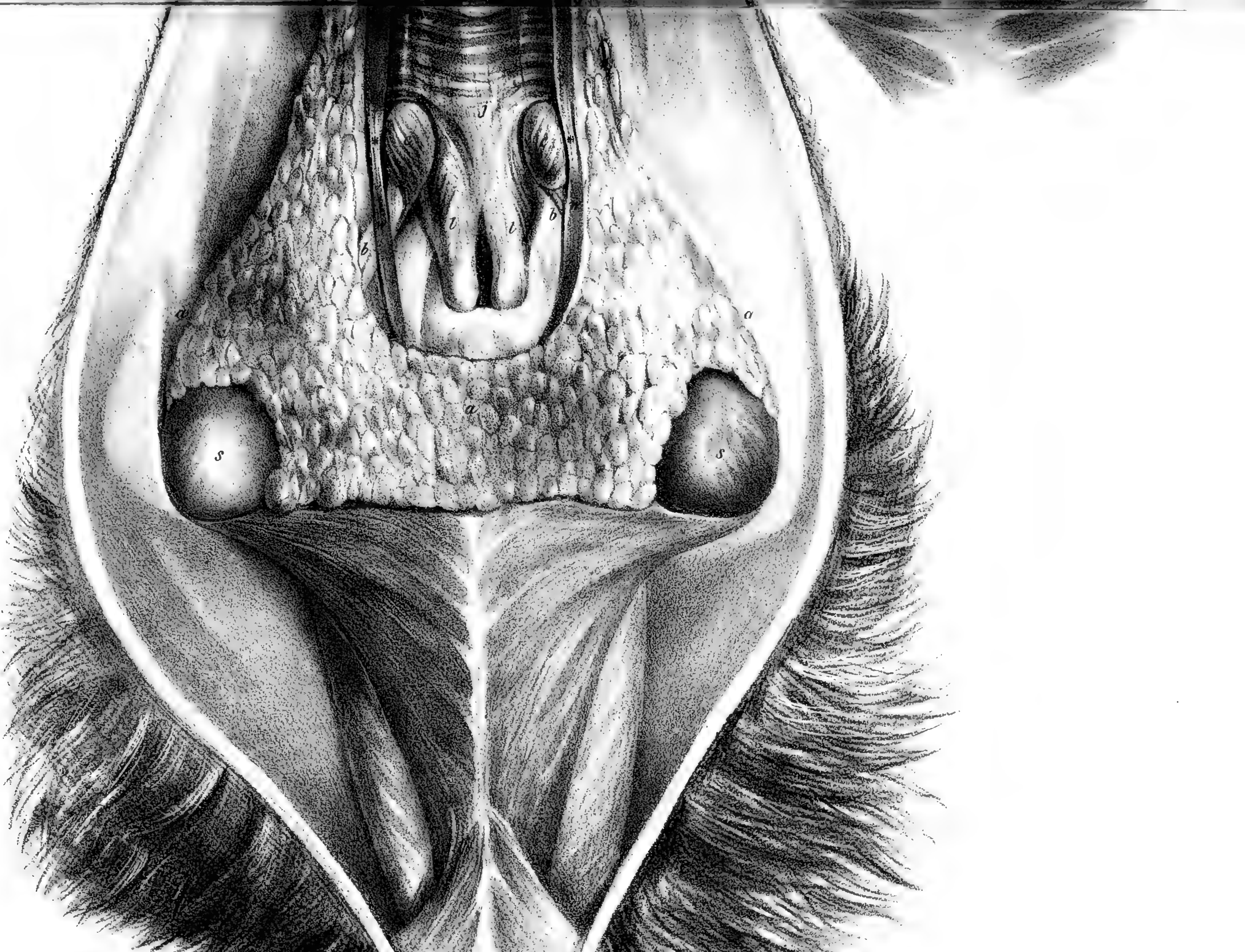
Fig. 1. Head and fore part of body of the Weasel-headed Armadillo (*Dasypus sexcinctus*), dissected to show the submaxillary glands and reservoir.

Fig. 2. Lower jaw, larynx, submaxillary gland and reservoir of the *Dasypus Peba.*

Fig. 3. Salivary structures of the Small Anteater (*Myrmecophaga didactyla*). All the figures are of the natural size: the letters indicate the same parts in each.

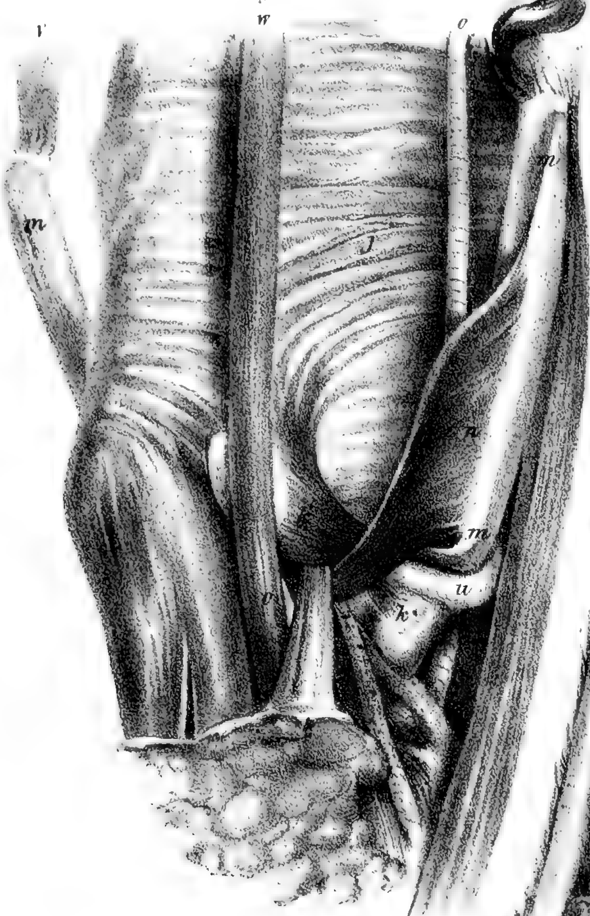
a. Labial gland.
b. Postorbital gland.
c. Submaxillary (subcervical) gland.
d. (fig. 1) Slender anterior prolongation of ditto.

d. (fig. 3) Ducts leading from submaxillary gland into
e. Salivary bladder or reservoir.
f. Duct continued from ditto.
g. Dermal muscular fasciculi, adapted to compress the salivary reservoirs.
h. Sternomaxillares.
i. Mylohyoidei.
k. Hyoglossi.
l. Lingual nerve.
m. Larynx.
n. Trachea.
o. Thyroid gland.
p. Pectorales muscles.
q. Parotid.



E. ...rier del. – J. Erxleben lith.

Day & Son, Lith^rs to the Queen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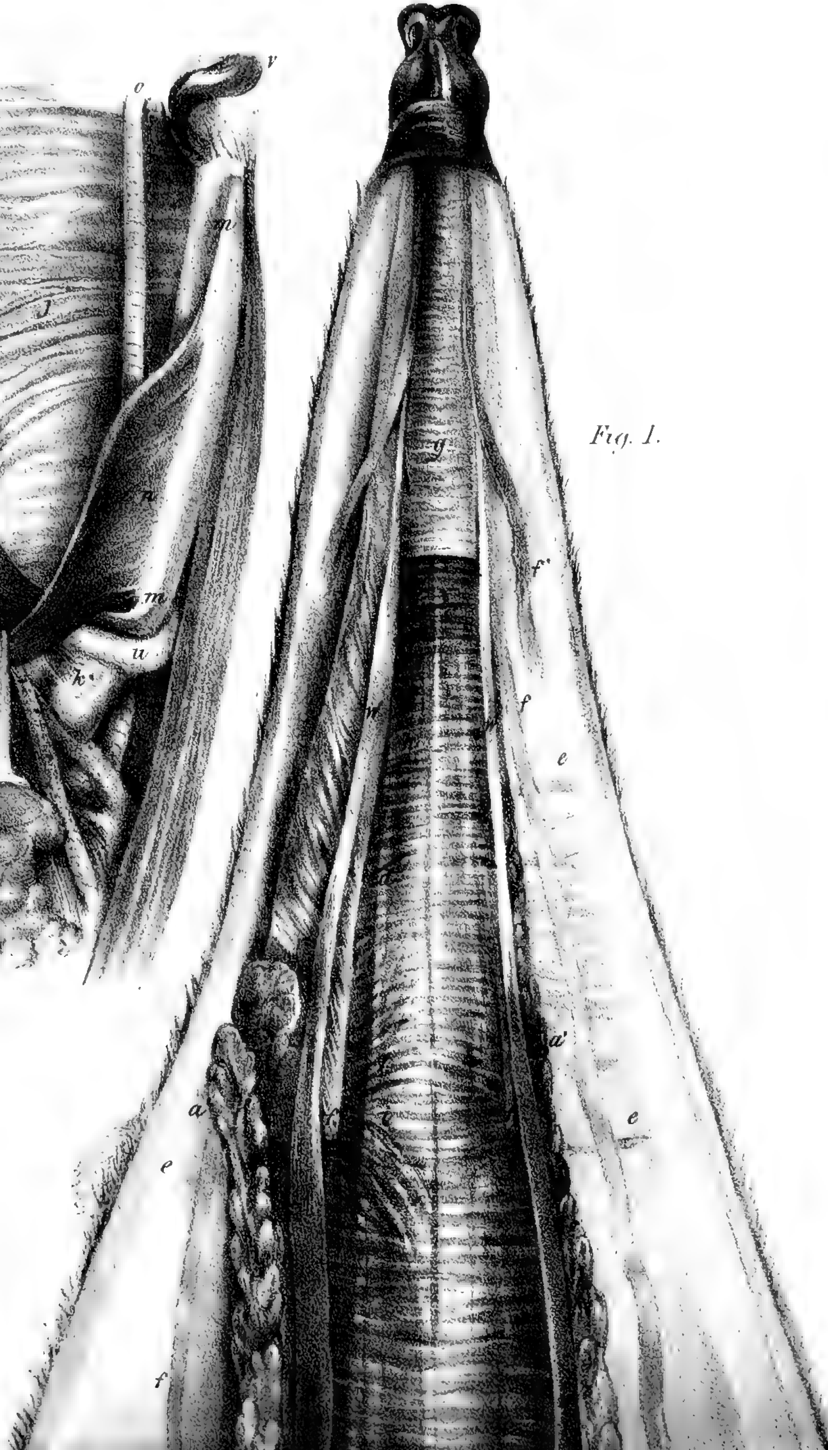
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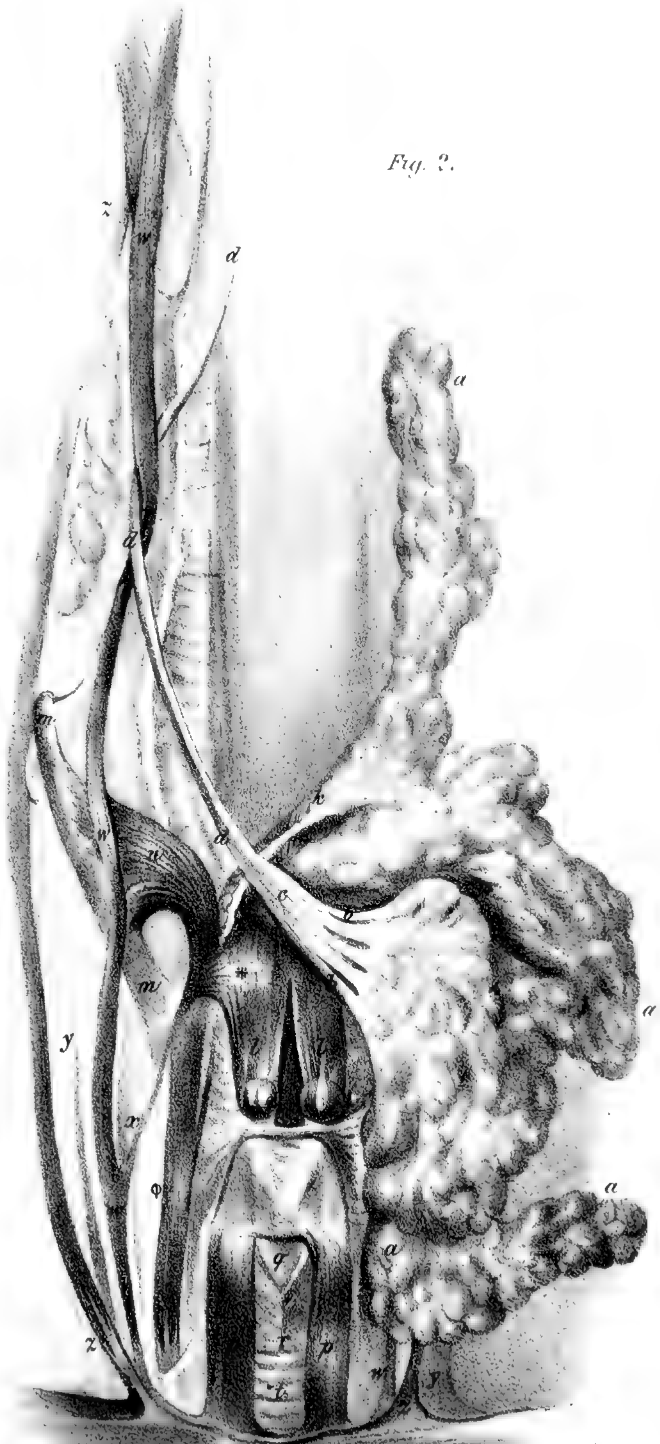
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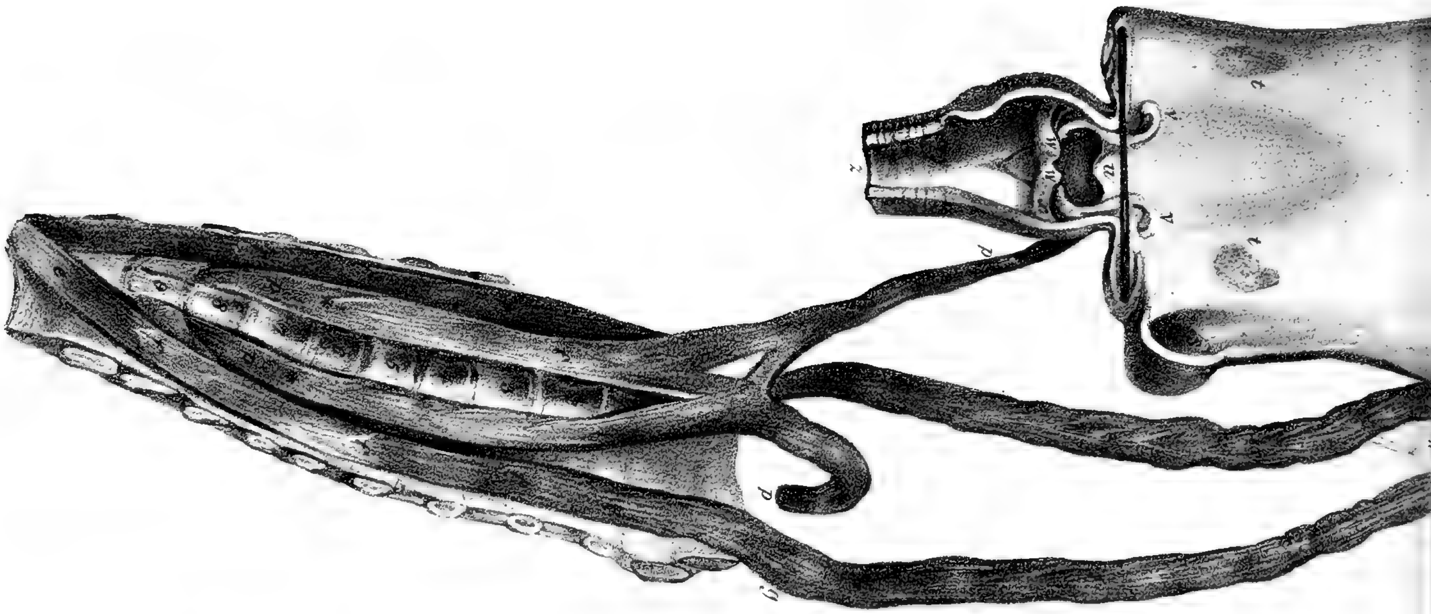
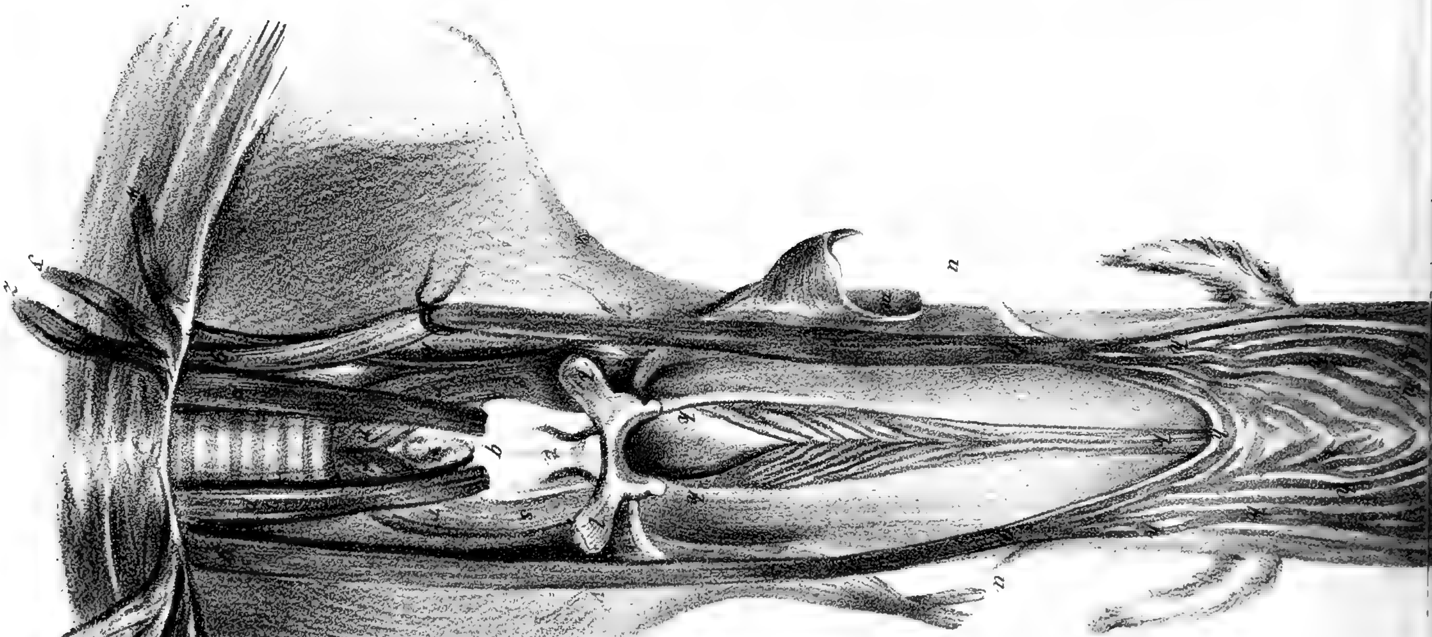




E V Carter, del _ J Erxleben, lith

Fig. 2.

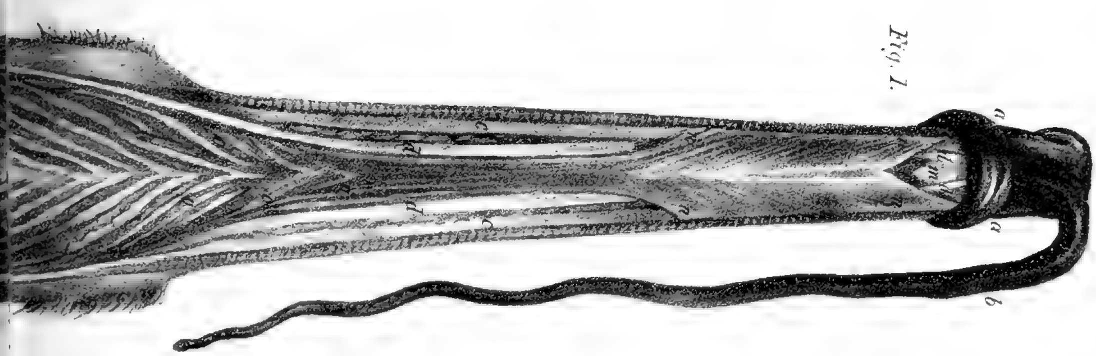
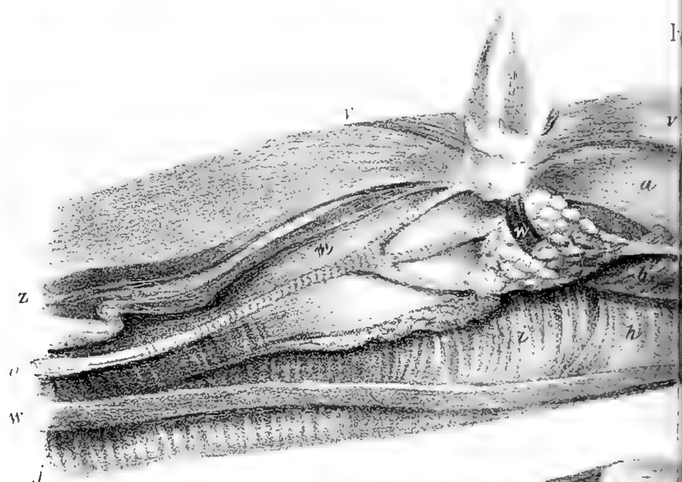
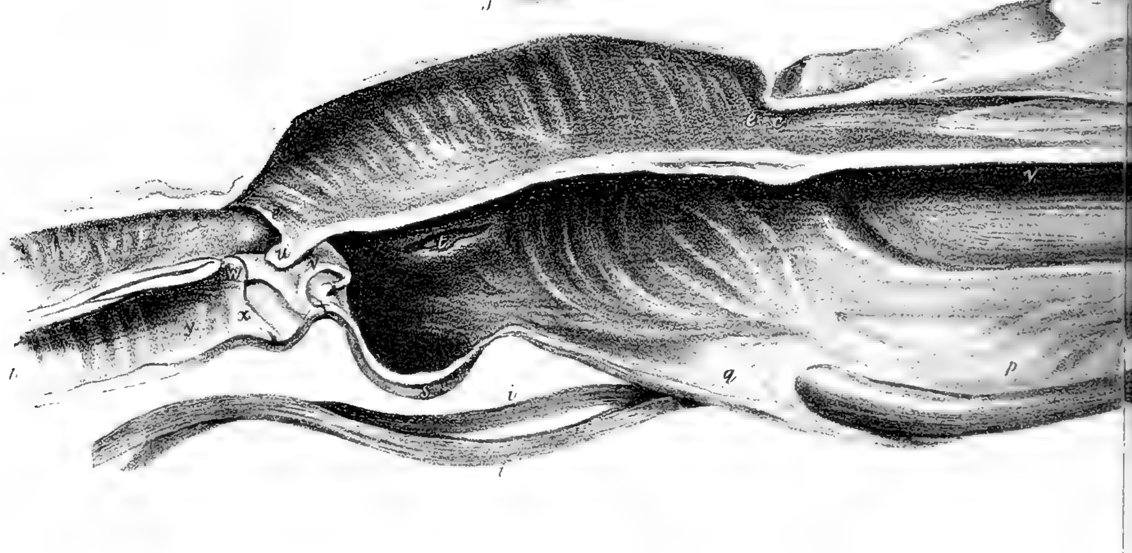


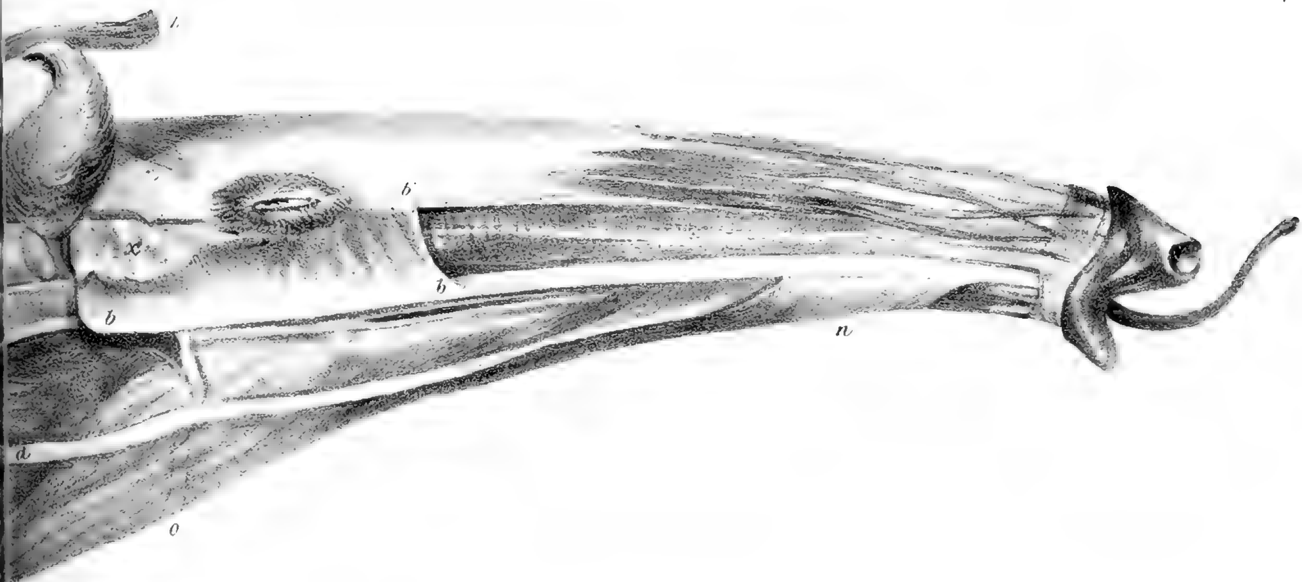
Fig. 1.

Day & Son, Lith^{rs} to the Queen.

Fig. 2.







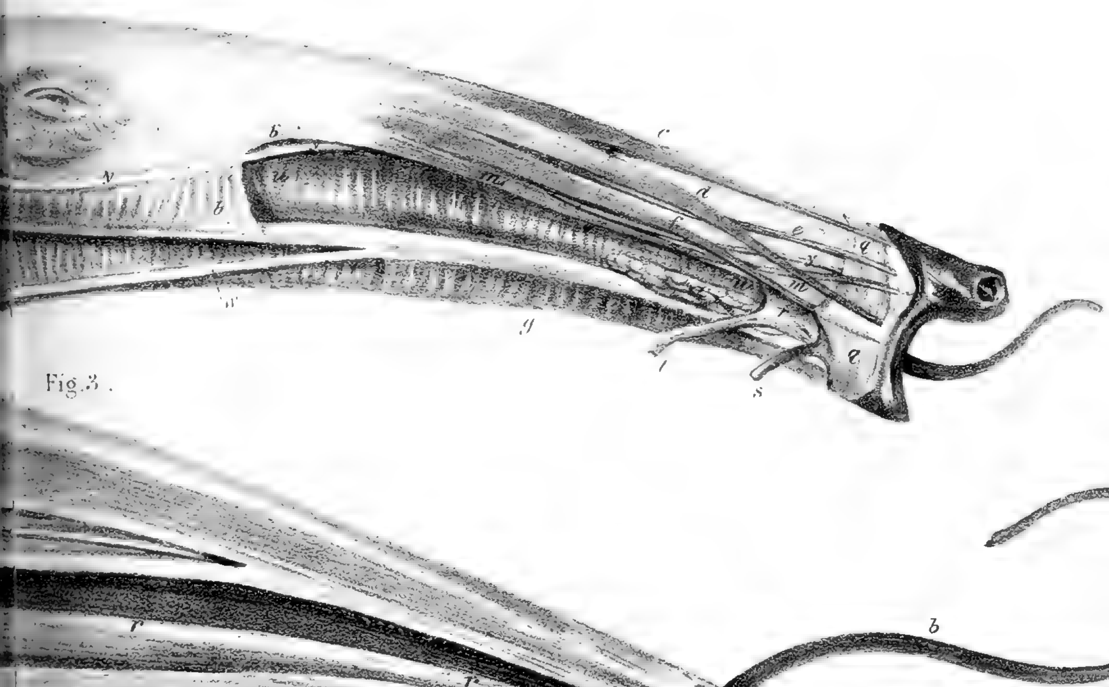
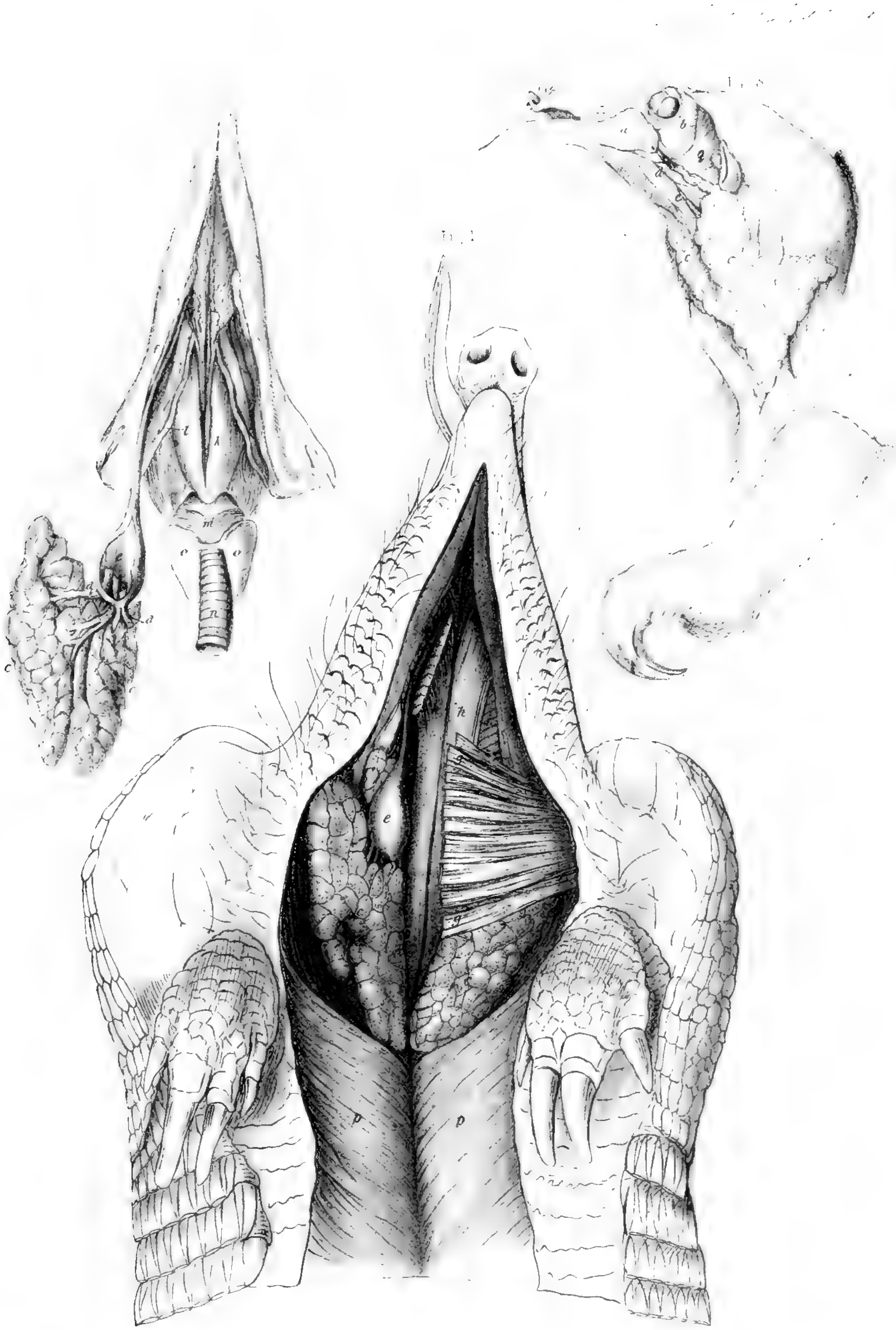


Fig.3.



SALIVARY GLANDS

1 & 2 Armadillo. — 3. Ant-eater

X. *On* Dinornis (Part VI.) : *containing a Description of the Bones of the Leg of* Dinornis (Palapteryx) struthioides *and of* Dinornis gracilis, *Owen.*

By Professor Owen, *F.R.S., V.P.Z.S., &c.*

Read November 14, 1854.

In my memoir of 1843[1], I described two femora of birds from tertiary deposits in New Zealand, agreeing in size with that bone in the Ostrich, and referred them to a species called *Dinornis struthioides*; one of these specimens however consisted only of the shaft; the other and more perfect specimen, figured in pl. 21. fig. 3, was mutilated at both its extremities. I have since received, through the kindness of the Rev. Mr. Colenso, M.A.[2], and the Rev. William Cotton, M.A., three entire specimens of femora, ranging between 11 and 12 inches in length, and the shaft of a fourth femur of the *Din. struthioides*, confirming very satisfactorily that species, and completing our knowledge of the anatomical characters of the bone.

The head (Pl. XLI. fig. 2) is rather more than a hemisphere, more prominent than in the Ostrich, and with a smaller proportion cut off, as it were, from the upper and outer part, and roughened for the attachment of the strong ‘ligamentum rotundum.’ From the upper part of the base of the head, an almost flat, slightly concave, surface ascends, expanding, as it rises, to the broad semicircular ridge which crowns the great trochanter. In the Ostrich that process does not rise above the level of the head of the bone. In the *Din. struthioides* the upper trochanterian platform is broader proportionally than in the *Din. casuarinus*[3]. The anterior surface of the trochanter is also extensive through the continuation outwards of the great process: it is slightly concave, sculptured by muscular impressions with intervening ridges, and by a defined oval rough tract between the head and the base of the trochanter. The outer convex expanded surface of the trochanter is more strongly marked by the insertions of powerful tendons, surrounding an irregular smooth tract near the centre of the surface. The back part of the upper end of the femur in two of the specimens presents two or three small holes leading into the superficial cancelli, by which it is possible a little air may have been admitted to these cavities; but this is a very feeble representation of the wide orifice and canal at the same part of the Ostrich's femur which conducts directly to the large air-cavity in the body of that bone.

[1] Zool. Trans. vol. iii. pp. 247, 249, pl. 21. fig. 3.

[2] The specimen contributed by this gentleman is cited in the table of admeasurements, Zool. Trans. vol. iii. p. 329.

[3] *Ibid.* pl. 46. fig. 2.

The shaft of the entire femur of the *Din. struthioides* repeats the characters described and figured in the memoir above cited. The fore part of the external condyle begins to rise from the level of the shaft, about one-third from the distal end of the bone, and bends outwards, forwards and downwards, increasing in breadth and convexity, and forming the outer boundary of the characteristic broad rotular surface. The convex fore part of the inner condyle forming the inner boundary of that surface is shorter, and rises more abruptly. The deep oval fossa, above the vertical broad groove for the fibula, behind the outer condyle, is well-marked. The orifice of the medullary artery is at the middle of the back part of the shaft of the femur in two of the specimens.

With regard to the metatarsus of the *Dinornis struthioides*, the same satisfactory confirmation of the species has been received, as in the case of the femur, by the addition of three specimens repeating the characters of the original bone described at p. 240, and figured in pl. 27. fig. 2. of my memoir of 1843. One of these specimens, kindly sent to me by J. R. Gowen, Esq., F.G.S., Sec. H.S., was discovered in the tertiary deposits at Waikawaite, Middle Island of New Zealand, and has the two extremities more entire than in the original specimen figured. The middle of the distal trochlea is impressed by a shallow groove running its whole length, and becoming more shallow as it approaches the contracted back part of the trochlea, which terminates abruptly, projecting beyond the level of the back part of the distal end of the bone.

A second of the additional specimens of the metatarsus of the *Din. struthioides* was obtained by the Rev. Wm. Cotton, M.A., at Tarawaite, in the North Island of New Zealand: a third specimen (Pl. XLI. fig. 4) was discovered by Governor Sir George Grey, C.B., in a cave in the district which lies between the river Waikate and Mount Tongariro, in the North Island.

From the same cave Sir George Grey likewise obtained and very liberally transmitted to me, with a most valuable collection of other bones of *Dinornis* and *Palapteryx*, an entire tibia (Pl. XLII. fig. 2) agreeing with the portion of shaft, which, from the dimensions given in vol. iii. p. 329, I was induced to refer to the *Dinornis struthioides*, differing in its size and proportions from all the tibiæ previously described and referred to other species, but presenting similar relations of size to the femur and metatarsus of the *Din. struthioides*, which the previously described tibiæ have presented to the other bones of the leg of the respective species to which those tibiæ have been referred.

I conclude, therefore, that in the tibia transmitted with the metatarsus of the *Din. struthioides* by Sir George Grey, I possess the bone, which I have been so long desirous to obtain in order to complete the leg of the *Din. struthioides*. Like the metatarsus above-cited, it is from the left side, and they appear to have belonged to the same individual bird.

	in.	lin.
The length of this bone is	22	0
The breadth of the proximal extremity . .	5	6
The breadth of the distal extremity	3	2
The circumference of the middle of the shaft .	5	0
The fibular ridge extends down	10	0

This ridge begins, as in the tibiæ of other species of *Dinornis*, below the expanded end of the tibia near the middle of its back part, inclining to its outer side.

In its slender proportions, and the relative positions of the procnemial (*p*) and ectocnemial (*e*) ridges, the tibia of the *Dinornis struthioides* agrees with that of the *D. dromioides.*

Description of the Bones of the Leg of the Dinornis gracilis.

The advantage of additional specimens, as confirming, by the repetition of the same characters, a species previously defined, is still greater in respect of the ground which they afford for the discrimination of a distinct but nearly allied species. Notwithstanding the well-marked differences observable between the femur of the *Dinornis struthioides* (Pl. XLI. fig. 2) and the *Dinornis gracilis* (*ibid.* fig. 1), I might have deemed them due to differences of sex or individuals, had I not had evidence of the fixity of the specific characters of the *Dinornis struthioides* by the successive arrivals of additional specimens of its bones. Attending the hoped-for confirmation from such arrivals, it appeared to be most prudent to refrain from announcing a new species of the rapidly increasing family of the great wingless birds of New Zealand until further evidence might be obtained by corresponding differences in the tibiæ and metatarsi of the two species.

Having had the good fortune at length to receive, through the kind contributions of the Rev. Richard Taylor, M.A., of Wanganui, and of W. E. Cormack, Esq., these additional illustrations of the *Din. gracilis,* I no longer delay communicating descriptions and figures of them to the learned Society, in whose Transactions my former Memoirs have appeared and have been so liberally illustrated.

Femur.

The bone (Pl. XLI. fig. 1) was obtained at the Bay of Opito, East Coast of the North Island, from beneath a sandy deposit, about three feet below the surface, by Mr. Cormack.

The following are the chief dimensions of this bone:—

	in.	lin.
Length	11	0
Breadth of proximal end in the axis of the neck .	3	8
Breadth transverse of distal end	4	0
Circumference of middle of shaft	4	8

A small portion of the upper ridge of the great trochanter has been broken off: when entire, the femur of the *Din. gracilis* presents the average length of that of the *Din. struthioides*; but it is more slender in proportion, the head is smaller, and is supported by a better marked constriction or neck, especially at its under part. The upper platform of the trochanter is narrower, the anterior border of the trochanter not being extended so far forwards and outwards. The angle between the upper and fore surfaces of the trochanter is a right one, and they meet at a sharp ridge. The rough oval surface between the head of the femur and the base of the trochanter is smaller than that of the *Din. struthioides*. The outer irregular surface of the trochanter is of much less breadth in the *Din. gracilis*. The muscular impressions at the sides of the shaft meet and form a longitudinal ridge along the back part of the middle third of the shaft: they are separated by a tract of half an inch in the *Dinornis struthioides*, and terminate below in two tuberosities. The corresponding ridge formed by the meeting of the vasti muscles along the fore part of the shaft is shorter in *Din. gracilis* than in *Din. struthioides*.

The most marked distinction, however, is presented by the distal extremity of the bone, which is not only relatively less expanded in the *Din. gracilis*, but the rotular groove is narrower, and is bounded laterally by condyloid eminences of more nearly equal length; the external one not rising so high up, nor describing the sigmoid curve in descending, as in the *Din. struthioides*. The rotular groove in the *Din. gracilis* is impressed by a transversely oval rough depression, at its upper part, with sharp lateral borders, which depression does not appear in any of the femora of the *Din. struthioides*. The popliteal space is triangular and better defined in the *Din. gracilis*; the fibular groove is shorter and less angular, and the rough deep pit above it is smaller. The tibial surface on the inner condyle is relatively smaller.

Tibia.

The same character is repeated on the proximal end of this bone, where the surface applied to the inner condyle is absolutely smaller than in the *Din. struthioides*, although the entire bone, as shown in the subjoined admeasurements, is longer in the *Din. gracilis*: it is also, as the name of the species implies, more slender in proportion to its length.

This bone (Pl. XLII. fig. 1) was obtained from beneath a sandy deposit, about two feet below the surface, at a locality between Wanganui and Turakina, North Island of New Zealand, by the Rev. Mr. Taylor.

	D. gracilis. in.	lin.
The entire length of the bone is	23	6
The transverse breadth of its proximal end . .	5	0
The transverse breadth of its distal end	2	10
The circumference of the middle of the shaft . .	4	6
The fibular ridge extends down the shaft . . .	9	6

But this ridge commences nearly three inches below the back part of the proximal end of the bone, nearer the outer side than in the *D. struthioides*: it is interrupted by an oblique smooth tract at the point indicated in the admeasurement, where the medullary artery penetrates the bone; it then reappears about an inch and a half below the interruption, and soon gradually subsides. This second lower part of a fibular ridge is better marked than in the *Din. struthioides*. The relative size and position of the procnemial, *p*, and ectocnemial, *e*, ridges are much the same as in the tibia of the *Din. struthioides* and *Din. dromioides*.

Metatarsus (Pl. XLI. fig. 3).

The difference between the *Din. struthioides* and the *Din. gracilis* is more obvious at first glance in a comparison of their metatarsi than in that of the above-described bones; especially to an eye accustomed to the comparison of the metatarsi of the different species. The superior length and slenderness of that bone in the *Din. gracilis* would at once prevent its being confounded with the metatarsus of the *Din. struthioides*.

The following are the chief dimensions of the bone in question: those of the extremities being approximative by reason of their worn margins:—

	D. gracilis. in.	lin.
Length of the tarso-metatarsus	13	0
Circumference at the middle of the shaft	4	3
Transverse breadth of proximal end	3	4
Transverse breadth of the distal end	4	3
Breadth of the middle of the shaft	1	7
Thickness or antero-posterior diameter of ditto	1	2

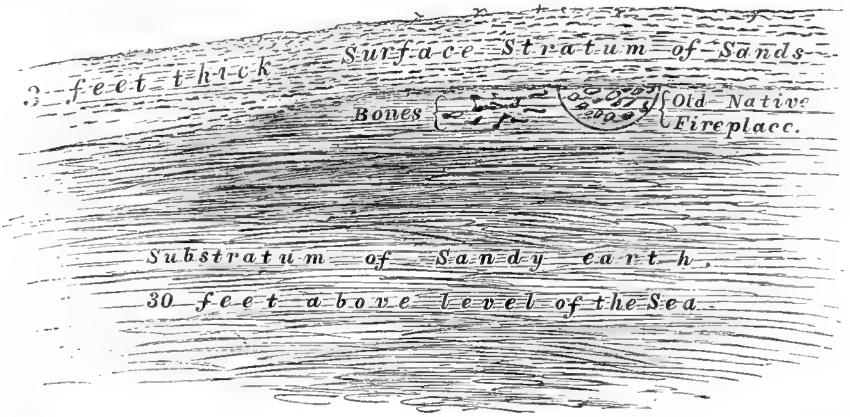
The depressed surface for the back toe is better marked than in the *Din. struthioides*.

Subjoined is the "Note on the locality" affording the femur of the *Dinornis gracilis*, kindly contributed by W. E. Cormack, Esq.; with a sketch of the section of the strata, of which a woodcut is here given.

"The bone "(Pl. XLI. fig. 1)" of the *Dinornis* now presented to Professor Owen was found in the north part of the North Island of New Zealand, in the month of January 1849. Its *locality* was in a small bay called 'Opito,' at the east extremity of the projecting land between Mercury Bay and Wangapoua, on the east coast, in about the latitude of 36° 40′ S., and fifty miles east from Auckland. The bay is about a mile in length, northerly and southerly, by about half a mile in depth, with high bluff heads or rocky cliffs projecting at each extremity; the semicircular sandy beach inside forming the bay. An irregular strip of low land lies inside of the beach, in some parts fertile, in other parts consisting of downs, and is overlooked in the rear by round hills of from 100 to 300 feet in height. The hills are composed of yellow-white and red burnt earth; very barren, producing stunted fern, and a solitary bush or scrubby tree here and there.

Towards the north end of the bay a small brook discharges itself, from a swamp at the foot of the hills in the rear: and at the mouth of the brook a short range of downs runs along the beach to the southward, presenting a line of earthy cliffs, wasting away and forming the shore as they fall down by the washing of the sea at the foot. These cliffs are about from twenty-five to thirty feet in height, and nearly perpendicular. The upper stratum of the cliffs is formed of sand, and is about three feet in thickness, producing the usual arenaceous shrubs, grasses, &c. Underneath, the line of demarcation being very distinct, is a thick stratum or bed of sandy earth, sand predominating: out of this substratum, about fifty or sixty yards south of the mouth of the brook, the *Moa's* bones were exposed, projecting, in consequence of a late falling away of that part of the cliff in which they were imbedded: they lay a foot or more beneath the upper surface of the substratum. At the same spot there was a '*kapura maori*,' or *native cooking fireplace*, dug into the surface of the substratum, and full of stones that had been once heated (to convey the heat to the food laid upon them),—and left, just as similar cooking-places are left at the present day by the natives;—about two feet from which lay the bones. Close to the fireplace, and similarly imbedded, were bones of smaller birds, and of fishes similar to those found at present in the sea adjacent; all, including those of the *Moa*, having been evidently the remains of the food cooked here at a former period and eaten, as my native attendant remarked, by the then native inhabitants. A part of a leg bone, about two feet in length, apparently belonging to the same leg as this femur[1],—the bone having been broken near the middle (probably in order to be placed more conveniently over the fireplace), was also found close to the femur.

"The antiquity of these remains can only be arrived at by inference. How long it is since the superficial stratum of sand now exhibited at the top of the cliffs overlooking



the sea, was formed by water and winds, is a matter of induction for the geologist. The sea is now undoing, and claiming the privilege of, former lacustrine or marine

[1] It accords with the size of the tibia of the *Dinornis gracilis*.—R. O.

deposits. It would not be difficult to compute, with some shadow of approximation, the time required for the inroad of the ocean into strata of the nature of those described, supposing them to have extended from the summit of the cliffs to the ocean half a mile distant, along a line between the two heads or extremities of the bay: but that period would be conjectural only; for there are rocks, islets, and islands succeeding each other—mile beyond mile,—extending into the surrounding ocean, all of which are, by marine inroad, vestiges only of former rock-formations. Man and the *Moa*, however, were coeval at man's cooking fireplace upon this substratum.

"The mother ocean is altering, in some places very rapidly, the configuration of the coast of New Zealand. It is consuming some parts, and forming others by deposits; and again removing former deposits. In a general view, many parts of the east coast of the North Island are being disintegrated, not to reappear above water for many ages; while on the west coast, downs are not only being formed, stretching into the sea, but superimposing themselves—inland—in some places.

"These shiftings of the outline of the earth's crust are not limited to the sea-coast: for in the interior are many partial and violent settlings of the earth, evidently from earthquakes; submerging, in some instances many feet under the surface of fresh-water lakes, land with the natives' houses, fences, &c. upon it. This has happened in regard to the lake situated some miles from the east bank of the River Waipa, and south-eastwardly from the ruins of the famous sacked Pa (town) called 'Matakitaki.'

"W. E. Cormack,
6, Percy Street, 22nd October, 1850."

"*To Professor Owen,*
Royal College of Surgeons, London."

DESCRIPTION OF THE PLATES.

PLATE XLI.

Fig. 1. Front view of the femur of the *Dinornis gracilis*.
Fig. 2. Front view of the femur of the *Dinornis struthioides*.
Fig. 3. Front view of the metatarsus of the *Dinornis gracilis*.
Fig. 4. Front view of the metatarsus of the *Dinornis struthioides*.

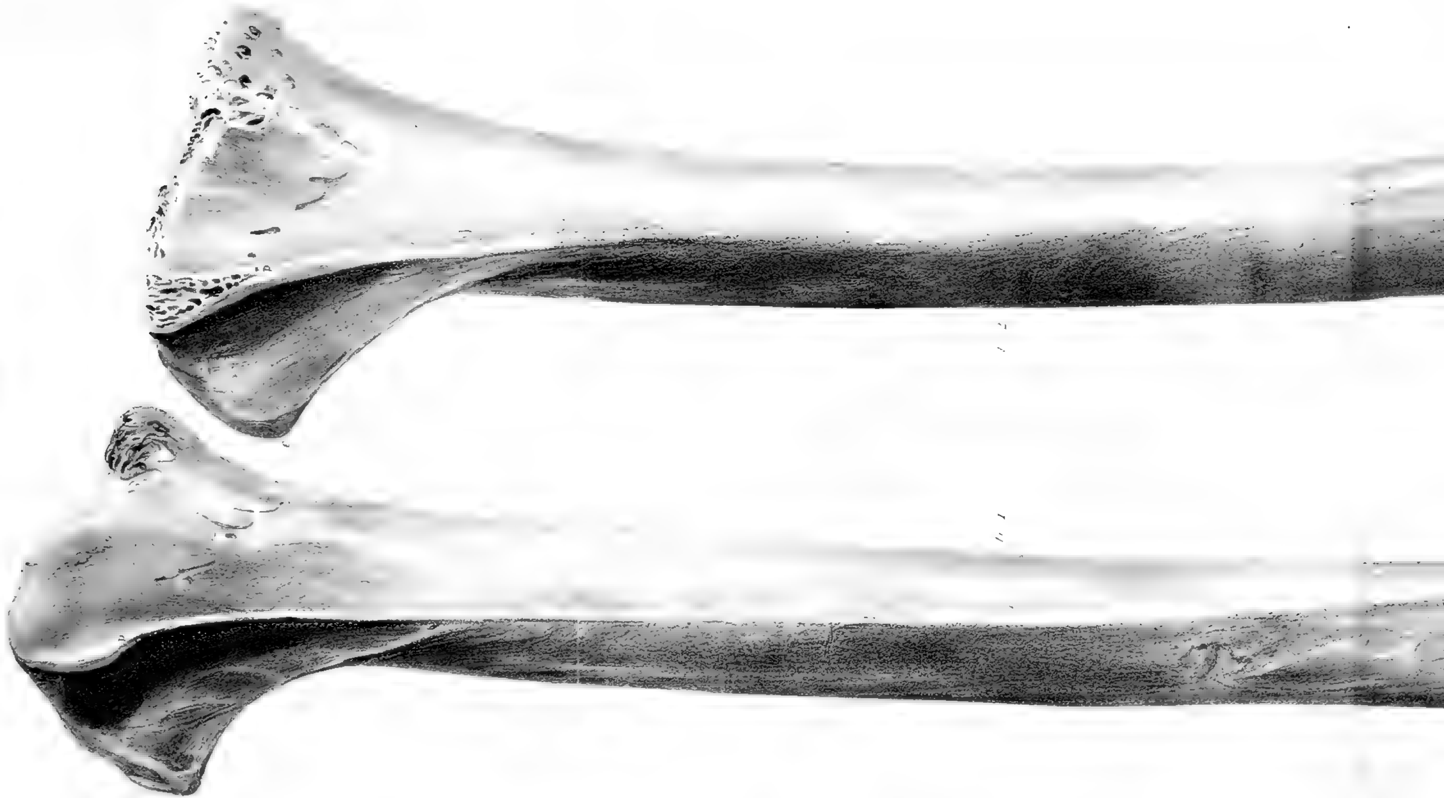
PLATE XLII.

Fig. 1. Front view of the tibia of the *Dinornis gracilis*.
Fig. 2. Front view of the tibia of the *Dinornis struthioides*.
p. Procnemial ridge. *e.* Ectocnemial ridge.
All the figures are of the natural size.

Fig. 1.

Fig. 2.

Figs. 1 & 3. Dinornis gracilis._Figs. 2 & 4. Dinornis struthioides.



Trans. Zool. Soc. Vol.

Fig. 1. Dinornis gracilis. Fig. 2. Dinornis struthioides.

XI *On* Dinornis (Part VII.) : *containing a Description of the Bones of the Leg and Foot of* Dinornis elephantopus, *Owen.* *By* Professor Owen, *F.R.S., V.P.Z.S., &c.*

Read April 8, 1856.

Mr. Walter Mantell having, on his recent return from New Zealand, provisionally deposited his very extensive collection of remains of Dinornithic and other Birds in the British Museum, I have gladly acceded to the wishes of that successful and enterprising collector, and of my friend the able Keeper of the Geological Department of the Museum, to devote the leisure at my command to the examination of this interesting and valuable collection[1].

I had advanced as far as the determination of the bones of the leg, and their classification according to their species, when the distinctive characters of one series of these bones irresistibly brought a conviction that they belonged to a species of *Dinornis* that had not previously come under my notice,—a species which, for the massive strength of the limbs, and the general proportions of breadth or bulk to height of body, must have been the most extraordinary of all the previously restored wingless birds of New Zealand, and unmatched, probably, by any known recent or extinct member of the class of Birds.

On a former occasion, I was so much struck by the form and proportions of the metatarsal bone referred to the species called *Dinornis crassus*, and described in the Memoir read to the Zoological Society, June 23, 1846, and figured in pl. 48, figs. 4 & 5, vol. iii. of the 'Zoological Transactions,' that I alluded to it as "representing the pachydermal type and proportions in the feathered class[2];" and the bone unquestionably indicated, at that period, "the strongest and most robust of birds." But by the side of the metatarsus of the species which I have now to describe, and for which I propose the name of *elephantopus*, the metatarsus of *Dinornis crassus* shrinks to moderate if not slender dimensions. But the peculiarities of the elephant-footed Dinornis stand out still more conspicuously when the bones of its lower limbs are contrasted with those of *Dinornis giganteus*.

I propose, in the present Memoir, to combine with the account of the leg- and foot-bones of *Dinornis elephantopus*, that of the bones of the lower limb of *Dinornis crassus* which had not previously been described, and to bring out their characteristics by comparison with the bones of other species, especially those of *Dinornis robustus*.

[1] Since the communication of the present Memoir, this collection has been purchased by the Trustees of the British Museum, and the entire skeleton of *Dinornis elephantopus* has been recomposed and articulated, and is now exhibited in the Gallery of Fossil Remains.

[2] *Ib.* p. 325.

Femur of Dinornis elephantopus.

Commencing with the femur, I shall premise the following Table of admeasurements of that bone in the three above-named species of *Dinornis*.

Dimensions of the Femur in

	D. robustus.		*D. elephantopus.*		*D. crassus.*	
	in.	lines.	in.	lines.	in.	lines.
Length	14	2	13	0	11	10
Transverse breadth of proximal end	6	0	5	10	4	5
Fore-and-aft breadth of ditto	5	0	4	5	3	9
Transverse breadth of distal end	6	0	5	11	4	7
Fore-and-aft breadth of ditto	4	3	3	9	3	5
Circumference (least) of shaft	7	10	7	9	6	0

The above comparative dimensions bring out the characteristic proportions of the femur of *Dinornis elephantopus* (Pl. XLIII. fig. 1), as shown by its greater thickness and strength. Compared with the femur of *Din. robustus*, this character is remarkably exemplified in the articular extremities (Pl. XLIII. figs. 2 & 3). Had these parts alone of *Din. elephantopus* been preserved and submitted to me, I should have scarcely ventured upon a conclusion as to their specific distinction from *D. giganteus*, or its representative on the Middle Island, *D. robustus*, the correspondence of configuration being so close and the difference of size so slight.

The articular surface is continued from the head upon the upper part of the neck (Pl. XLIII. fig. 2), expanding as it approaches the great trochanter, along the summit of which it is terminated by a ridge. In both species the surface for attachment of the ligamentum teres is formed, as it were, by a portion of the inner and back part of the hemispheric head, having been cut off obliquely with a slight excavation. The corresponding ligamentous surface in the head of the femur of *Din. crassus* is relatively smaller, less depressed and less defined. The upper and fore part of the trochanter is less produced relatively to the breadth of the supra-trochanterian articular surface in *Dinornis elephantopus*. In this species the subcircular rough surface for the attachment of the *iliacus internus* muscle (fig. 1, *i*) is relatively nearer to the head of the bone than in *Dinornis robustus*: the rugged and thick fore part of the great trochanter descends lower upon the shaft; indeed the shortness of the entire bone seems to depend chiefly on the shaft being relatively shorter in *Din. elephantopus* than in *D. giganteus* or *robustus*. The intermuscular ridge continued from the trochanterian one down the fore part of the shaft bifurcates sooner in *Din. elephantopus*. The depression behind the trochanterian ridge is less deep in *Din. elephantopus*.

The oblique rotular channel is relatively as wide and deep as in *Din. robustus*, but the inner boundary formed by the fore part of the inner condyle is shorter in *Din. elephantopus*. At the back part of the shaft of the femur the medullo-arterial foramen is relatively nearer the proximal end of the bone: the two tuberosities below this are closer together: the two sides (fig. 3, *s* & *t*) of the fibular groove (fig. 3, *r*) are at a more open angle, and the groove is less deep in *Dinornis elephantopus*, the outer side, *t*, being less produced, as compared with *Din. robustus*. The antero-posterior breadth of the outer and inner condyles is equal in *Din. elephantopus*, as it is in *Din. robustus*; but in *Din. crassus* that dimension of the outer condyle exceeds the same dimension in the inner one, and the fibular groove is more open or shallow than in *Din. elephantopus*.

The generic modifications of the femur are, however, very closely preserved in each species, being strictly of the type ascribed to the genus *Dinornis* in my original Memoir in the 'Zoological Transactions,' vol. iii. p. 247.

Tibia of Dinornis elephantopus.

Dimensions of the Tibia in

	D. robustus.			*D. elephantopus.*			*D. crassus.*		
	feet.	in.	lines.	feet.	in.	lines.	feet.	in.	lines.
Length	2	8	3	2 1	0 9	0 6[1]	1 1	7 6	6[1] 6
Transverse breadth of proximal end	0	7	6	0 0	7 7	5[1] 0	0	6	2
Fore-and-aft breadth of ditto	0	4	9	0 0	4 4	6[1] 3	0	3	6
Least circumference of shaft	0	6	9	0	6	5	0	4	10
Transverse breadth of distal end	0	4	4	0 0	4 4	2 0	0	3	3

The characters of the upper end of the tibia of *Dinornis elephantopus* (Pl. XLIII. fig. 5) closely accord with those of the *Din. robustus*, and the difference of size, as exemplified in the foregoing Table, is so slight, that, had this extremity only of the bone reached me, I should most probably have referred it to *Din. robustus*. The almost flat articular surface for the inner condyle of the femur is somewhat less in its shorter diameter: the epicnemial ridge, *k*, is less extended transversely: the ectocnemial ridge, *e*, curves more strongly outward: but there are individual varieties in all these characters in the tibiæ before me. All, however, differ in the earlier subsidence of the ridge continued downward from the procnemial plate, *p*, which ridge is continued in *Dinornis robustus* uninterruptedly to that above the inner division of the distal trochlea. The space between the ecto- and pro-cnemial plates in *Dinornis crassus* is relatively greater than in either of the above larger species: the ridge continued from the procnemial plate is interrupted as in *Din. elephantopus*. The concave fore part of the tibia between the ectocnemial, *e*, and procnemial, *p*, ridges is impressed by irregular vascular grooves. The fibular ridge is interrupted by a smooth tract, in or near which

[1] The extremes of size in a series of several bones are here given.

is the orifice of the canal for the obliquely descending medullary artery, in all the species of *Dinornis*. The upper division of the ridge is shorter in *Dinornis elephantopus* than in *Din. robustus*, and relatively shorter than in *Din. crassus*. The surface between the fibular ridge and the inner border of the shaft, at the back part, is concave transversely in *Din. elephantopus*, not merely flat as in *Din. robustus* and *Din. crassus;* and, as it descends, it continues longer a flat surface before it changes gradually to a convex one. The oblong rough insertional surface above the inner condyle is relatively shorter and better defined in *Din. elephantopus* than in *Din. robustus*. On the characteristic fore part of the lower end of the tibia, that bone in *Din. elephantopus* repeats all the modifications ascribed to the genus *Dinornis* in my Memoir on the *Gastornis*, or large fossil bird from the Paris eocene[1].

The tendinal canal inclines obliquely inward, parallel with the inner border of the expanding end, near which it is placed (Pl. XLIII. fig. 4, *f*) : the bony bridge spans across it from a flattened tubercle developed from the lower part of the outer pier. The outlet of the canal is as wide as in *Din. robustus*; its aspect is obliquely forward and downward. External to the tubercle is an oblique rough depression, relatively narrower and better defined than in *Dinornis robustus*. The inner condyle, *a*, is relatively narrower and more produced forward than in *Din. robustus*, resembling more the proportions of that part in *Din. crassus*. The general form and oblique direction of the wide distal trochlear articulation of the tibia are closely repeated in all the species; the concavity being rather more sharply defined behind in *Din. elephantopus* than in *Din. robustus*. The depression on the entocondyloid surface is less deep in *Din. elephantopus* than in the *Din. robustus*.

The above specific differences, as well as all that I have noticed in the tibiæ of other species of *Dinornis*, are so inferior in degree to those which I have found in closely allied genera, and even in different species of the same genus, of other large land- and wading-birds, as *e. g.* in species of *Ciconia*, and in the existing Struthious genera, as to leave a strong impression on my mind of the generic affinity of the species of wingless birds of New Zealand which I have referred to *Dinornis* and *Palapteryx*, and which species have been divided, with a more liberal imposition of terms, by Dr. Reichenbach, into the nominal genera *Anomalopteryx*, *Movia*, *Emeus*, *Syornis*, &c.; no other facts or characters being assigned for that multiplication of generic names than those which are to be found in the pages or plates of the Memoirs in the Zoological Transactions.

Fibula of Dinornis elephantopus.

The fibula of *Dinornis elephantopus* remains, as in other *Dinornithes*, and as in the existing Struthious genera, permanently distinct from the tibia. As a general rule in Birds, the fibula soon becomes anchylosed to the tibia. In the species now defined, it is a straight styliform bone, 14 inches 6 lines in length (Pl. XLIII. fig. 6). The head is

[1] Quarterly Journal of the Geological Society, 1856, vol. xii. p. 210. pl. 3. fig. 2.

subcompressed and produced, as if slightly bent, backward. The upper articular surface is convex from before backward, almost flat transversely. The head of the bone is flattened on the inner side; almost flat, but a little convex, on the outer side: the fore-and-aft dimension of this end of the bone is 2 inches 9 lines; the transverse diameter is 1 inch 3 lines. Below the head the bone assumes a trihedral form with the sides convex, gradually tapering and blending into a shape, elliptic in transverse section, and ending in a point about 9 inches above the ankle-joint. The outer surface of the shaft of the fibula is impressed by two oblong rough surfaces for the insertion of muscles, the upper one 2 inches 9 lines in length. The inner part, which is ridge-like, dividing the fore from the back surface of the bone, presents a rough surface, *r*, *r'*, with a median interruption, for the ligamentous attachment of the bone to the fibular ridge of the tibia.

Metatarsus of Dinornis elephantopus.

Comparative dimensions of the Metatarse of

	D.giganteus[1].		*D.robustus*[2].		*D.elephantopus*[3].		*D.crassus*.	
	in.	lines.	in.	lines.	in.	lines.	in.	lines.
Length	18	6	15	9	9	3	8	8
Transverse breadth of proximal end	4	3	4	6	4	5	3	3
Ditto ditto distal end	5	4	5	3	5	4	3	9
Least ditto of shaft	2	3	2	0	2	5	1	9
Fore-and-aft breadth of proximal end	3	2	3	2	2	10	2	5
Circumference of ditto	12	0	12	9	12	0	9	3
Least circumference of shaft	6	3	5	3	6	6	4	6
Breadth of middle trochlea	1	10	2	3	2	2	1	8
Length, following the curve	5	9	5	4	5	3	4	0

I had, hitherto, regarded the metatarse of *Dinornis crassus*, described and figured in the 'Zoological Transactions,' vol. iii. pl. 48. figs. 4 & 5, as presenting the most extraordinary form and proportions of all the restored species of huge wingless birds of New Zealand; but it is strikingly surpassed in robustness and in great relative breadth and thickness by the same bone of the present species (Pl. XLIV. fig. 1), which chiefly on that account I have proposed to name *elephantopus*. Only in the great Maccaws and Penguins do the proportions of the metatarsus resemble those in this most robust-legged of birds; but the Parrot-tribe present those peculiar modifications of the distal trochleæ, with the strong articulation for the back toe, which relate to the Scansorial modifications of the bird's foot; and the Penguins associate with their broad and short metatarsus a characteristic retention of much of the primitive separation of the three constituent bones. In *Dinornis elephantopus* these elements have become as completely coalesced as in any other species, and the general characters of both proximal and distal ends accord with those in previously described species. On a more special

[1] Trans. Zool. Soc. vol. iii. pl. 27. fig. 1. [2] *Ib.* vol. iv. pl. 1. [3] *Ib.* vol. iv. pl. 46.

comparison of the metatarse of *Dinornis elephantopus* with that of its nearest congener the *Dinornis crassus*, the following differences present themselves. The entocondyloid depression (fig. 2, *e*) is deeper, its fore-and-aft diameter is greater, and its transverse diameter less, than in the ectocondyloid one, *c*; but the breadth of the entocondyloid depression is relatively greater and its depth somewhat less in *Dinornis elephantopus* than in *Dinornis crassus*.

The transverse convexity dividing the two condyloid depressions is relatively broader in *Dinornis elephantopus*; and the rough surface external to the anterior intercondyloid prominence is more strongly marked.

The two calcaneal ridges present an equal prominence in *Dinornis elephantopus*: the ectocalcaneal one, *c e*, is the most prominent in *Dinornis crassus*.

The anterior surface of the metatarsus differs chiefly in the proportions indicated in the "Table of admeasurements," p. 153, from that in *Dinornis crassus*: like most of the metatarsi of that species, one or more vascular foramina occur above the subcircular rough surface of insertion of the *flexor pedis*, which occupies the lower part of the shallow depression on the upper and fore part of the shaft.

Along the lower half of the shaft the median longitudinal and progressively widening prominence, due to the middle of the coalesced metatarsal bones, is rather more marked than in *Dinornis crassus*.

The inner side of the shaft is marked at its upper half by the oblique rough tract indicative of the insertion of the powerful aponeurosis of the gastrocnemic muscles. At the back surface the upper part of the mesometatarse is relatively less prominent than in *Dinornis crassus*.

The two vascular foramina occupy corresponding relative positions. All other notable differences are those of size and proportion.

From the metatarsus of *Dinornis robustus* that of the *Dinornis elephantopus* differs, most strikingly, in its proportions of length to breadth, being little more than half the length, but of nearly equal breadth; the distal trochleæ, however, being relatively less expanded than in *Dinornis robustus*.

The anterior vascular perforation is less than in *Dinornis robustus*: the insertional roughness for the *tibialis anticus* below the foramen is of equal size. The upper half of the fore part of the metatarsus is longitudinally channeled in *Din. robustus*, not in *Din. elephantopus*. The corresponding part of the back part of the shaft is much more prominent in *Dinornis robustus*. The characteristics of the metatarsus of *Dinornis elephantopus* are more strongly manifested in the comparison with that of *Dinornis giganteus*[1], of which bone it has only half the length, other dimensions being equal or even greater in *Din. elephantopus*.

Of the depression,—which is very faint in *Dinornis robustus*,—for the ligamentous

[1] Trans. Zool. Soc. vol. iii. pl. 27. fig. 1.

attachment of the rudimental back toe, there is no trace in the metatarse of *Dinornis elephantopus.*

The form of the articular pulleys for the three toes is shown in Pl. XLIV. fig. 3.

Toe-phalanges of Dinornis elephantopus.

The bones of the foot I shall compare with those of *Dinornis robustus*[1], to which they make the nearest approach in size.

Equalling, or nearly equalling, the phalanges of that bird in breadth and thickness, they differ chiefly in shortness, but in a less degree than the metatarsi differ.

These proportional characters of the species are best given and easiest appreciated in the plates (compare the above-cited Plate I. with Pl. XLIV.). A few minor differences, however, may be noticed: the outer portion of the proximal end of the first phalanx of the inner toe, I, II., is broader in proportion to its fore-and-aft diameter in *Dinornis elephantopus.* The inner portion of the proximal end of the first phalanx of the outer toe, I, IV., presents the like difference: the general form of that articular surface, fig. 3, II. & IV., is less triangular and more oval in both the specified phalanges of *Dinornis elephantopus*; the under side being indented as usual in the proximal phalanges of the inner and outer toes.

The modifications in the other phalanges, besides those of size and proportion, are not greater or other than might be expected in different species of the same genus.

Of the very remarkable species of *Dinornis* based upon the powerfully developed limbs, the bones of which are described in the foregoing pages, Mr. Mantell's collection includes five right and eight left femora, three right and four left tibiæ, nine right and fourteen left fibulæ, three right and eight left metatarsi; together with a considerable collection of toe-bones, from which, probably, other entire feet might be reconstructed in addition to the one of the left foot here exhibited, figured in Plate XLIV.[2]

There are also two femora and two metatarsi of an immature bird, apparently, by their proportions, from one individual of *Dinornis elephantopus*, Pl. XLV. fig. 1; to which may also belong the proximal end of a tibia, wanting the articular epiphysis.

The femora, as in other birds, retain the two articular ends, which are simply rougher than in the adult, having been covered by a thicker cartilage; but are not developed upon distinct osseous pieces, as in land mammals.

The proximal epiphysis is wanting in both the immature metatarsi, the left of which is figured in Pl. XLV. fig. 1, so that they exhibit the separate expanded ends of the three constituent bones, as shown in fig. 1, *a*; which bones terminate in the three prominent trochleæ below. The length of the femur of this young bird is 11 inches, that of the metatarse $7\frac{1}{2}$ inches. They already present the characteristic robustness of the adult bird.

[1] See Trans. Zool. Soc. vol. iv. pl. 1.

[2] The bones of the entire right foot of apparently the same individual bird have been determined and restored since the above was written.

The first evidence of the *Dinornis crassus* reached me from a turbary deposit at Waikawaite, in the Middle Island; it formed part of the collection there made by Mr. Earl. I have never received any evidence of this species of *Dinornis* from the North Island.

In like manner the bones of the much larger bird, which I have called *Palapteryx robustus* and *Dinornis robustus*, and which I was formerly inclined to regard as not only specifically but generically distinct from *Dinornis giganteus*, appear to be peculiar to the Middle Island; or at least have not, hitherto, been found in any locality of the North Island.

The richer series of illustrations of both *Dinornis robustus* and *Din. crassus* in the collection of Mr. Walter Mantell are from localities in the Middle Island; and the abundant illustrations of *Dinornis elephantopus* are exclusively from one locality in that island: they were obtained at Ruamoa, three miles south of Oamaru Point, or that called the "First Rocky Head" in the New Admiralty Map. This fact might give rise to the idea that the original range or locality of *Dinornis elephantopus* had been a restricted one; unless, at the period when the species flourished, the geographical extent of the Middle Island of New Zealand was widely different from what it now is. Yet Mr. W. Mantell has obtained strong, if not unequivocal, evidence that *Dinornis elephantopus* and *Din. crassus* existed contemporaneously with Maori natives in that island. The bones described in the foregoing pages are in a recent and most perfect condition. They retain the usual proportion of animal matter, and have undergone no mineral change.

They were discovered under circumstances closely resembling those described in a previous Memoir, Zool. Trans. vol. iv. p. 146, under which the femur of *Dinornis gracilis* was found in the North Island, by Mr. Cormack. Remains of native ovens, with the baking stones, were not far from the chief collection of bones of *Dinornis elephantopus*, discovered by Mr. W. Mantell, in the Middle Island. Both were covered by drifted sand from three to seven feet in thickness. Some of the bones have been scorched by fire.

From the sum of our present information respecting the localities of the several species of *Dinornithidæ*, we may infer that most, if not all, of the species of the North Island were distinct from those of the South Island.

To birds that could neither fly, nor, probably, swim well or far, the channel called Cook's Straits would prove an effectual bar to any migration from one island to another. With each successive addition of materials for the history of this most remarkable family of birds, I feel, nevertheless, impressed with the conviction of how little comparatively we still know respecting them, and how much more is likely, through the enlightened cooperation of active, resolute and accomplished explorers, such as Mr. Walter Mantell, to be, hereafter, contributed towards a complete history of the New Zealand wingless birds.

DESCRIPTION OF THE PLATES.

PLATE XLIII.

(All the figures are of the natural size.)

Fig. 1. Front view of the left femur of *Dinornis elephantopus.*
Fig. 2. Upper view of the head of the same bone.
Fig. 3. Under view of the condyles of the same bone.
Fig. 4. Front view of the left tibia of *Dinornis elephantopus.*
Fig. 5. Upper articular end of the same bone.
k. epicnemial ridge; *p.* procnemial plate; *e.* ectocnemial process; *a.* inner condyle; *b.* outer condyle; *f.* tendinal groove and bridge.
Fig. 6. Left fibula of *Dinornis elephantopus*: the side which is applied to the tibia is shown.

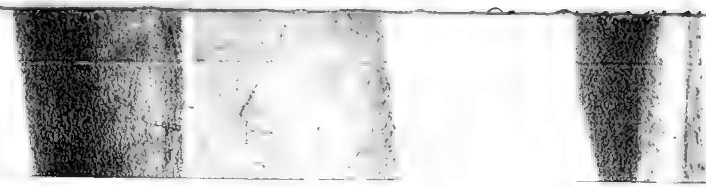
PLATE XLIV.

(All the figures are of the natural size.)

Fig. 1. The bones of the left foot of *Dinornis elephantopus*: II., III. & IV. indicate the distal trochleæ of the metatarsus; II. 1, 2, 3, the three phalanges of the inner toe; III. 1, 2, 3 & 4, the four phalanges of the middle toe; IV. 1, 2, 3, 4 & 5, the five phalanges of the outer toe.
Fig. 2. The proximal articular surface of the metatarsus: *e.* the internal, *c.* the external, articular cavity; *e c.* the ectocalcaneal, *m c.* the mesocalcaneal, process.
Fig. 3. The distal trochleæ of the metatarsus: II. that of the inner toe; III. that of the middle toe; IV. that of the outer toe.
Fig. 4. The proximal articular surfaces of the proximal phalanges of the three toes.
Fig. 5. Side view of the ungual phalanx of the middle toe.

PLATE XLV.

Fig. 1. Front view of the left metatarsus of an immature *Dinornis elephantopus*: *a.* its proximal end uncovered by the tarsal epiphysis.
Fig. 2. Back view of the left metatarsus of an immature *Dinornis crassus.*



Dinornis elephantopus.

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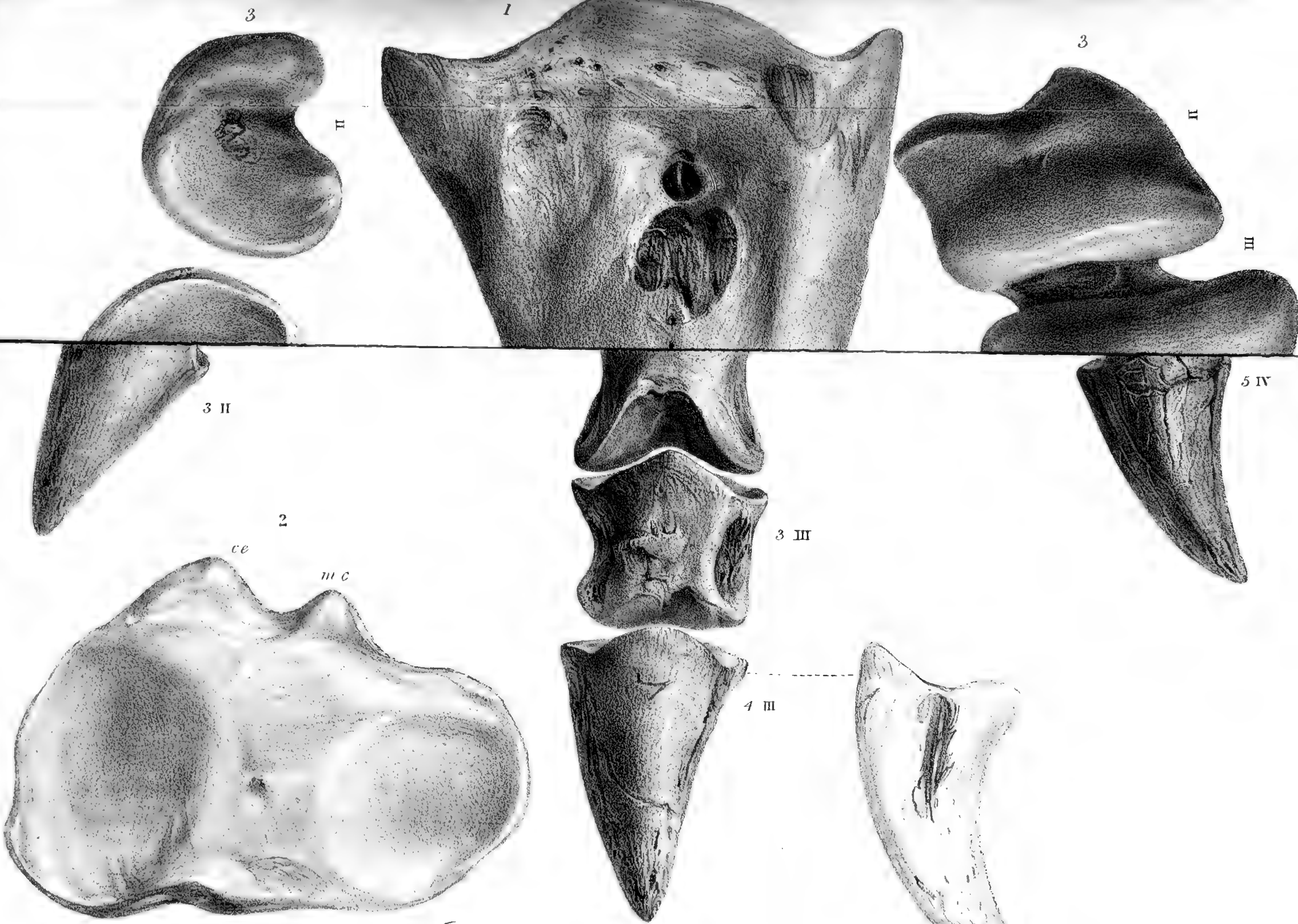

Dinornis elephantopus.

Dinornis elephantopus

Fig. 2.

Fig 1

a

From Nature on Stone by J. Erxleben

Fig. 1. Dinornis elephantopus, jun. – 2. Dinornis crassus, jun.

XII. *On* Dinornis (Part VIII.) : *containing a Description of the Skeleton of the* Dinornis elephantopus, *Owen*. *By* Professor Owen, *F.R.S.*, *V.P.Z.S.*, *&c.*

Read April 8, 1856.

In attempting the reconstruction of the entire skeleton of the *Dinornis elephantopus*, after the structure of the leg and foot had yielded the grounds for determining the species, my first step was the classification of the vertebræ.

Of these bones several hundreds had been collected by Mr. Commissioner Mantell at the spot where the bones of the leg had been found (*ante*, p. 156).

Upon comparison, the several vertebræ of obviously the same individual or species of *Dinornis*, presented good distinctive characters; and many series, of greater or less extent, were formed in the progress of the work; such series belonging, respectively, to the same individual skeleton of a different species of *Dinornis*.

Not to dwell needlessly on the different steps of this work of arrangement, in which I was efficiently aided by Mr. Flower, the experienced Articulator, I may proceed to state, that, after classifying the pelvises according to their size and probable species, one of these, which in general size and in the proportions of acetabulum accorded with the femur of *Dinornis elephantopus*, was found to present a well-marked anterior articular surface both on the centrum and on the fore part of the peculiarly long and strong square-shaped spine; the articular surface on the spine being unusually rugged.

Among the vertebræ previously classed as the 'last dorsal,' was found the one that had articulated with the above pelvis; and that dorsal vertebra terminated a series of seven dorsals, progressively decreasing as they advanced forwards, and indubitably belonging to the same individual bird.

The last dorsal vertebra of the *Dinornis* is characterized by a pair of tuberous processes (hypapophyses) from the under part of the centrum, close to the hind border: in the present skeleton of the *Dinornis elephantopus*, they are an inch apart: this vertebra is also characterized by the height of its spine, which is subquadrate; slightly expanded above; smooth at the sides, but rough at the fore and back parts. The height of this spine is four inches. There is a rudimentary tubercle at the middle of the under surface of the centrum near the anterior border. The articular surface at that end is concave transversely, convex vertically. The parapophysis is a large surface with slightly raised borders near the fore part of the centrum. The diapophysis is short and thick: at its under part is the pneumatic orifice. The proximal end of the rib is strongly bifurcated to articulate with the two processes; it supported an appendage, but does not join the sternum. The above-described vertebra is the seventh dorsal, or the last free vertebra that supports moveable ribs (Pl. XLVI. D 7).

The sixth dorsal (*ib.* D 6) is narrower and with a spine somewhat shorter than the seventh. The posterior hypapophyses are nearer together: the anterior one is more developed: the spine, besides being shorter, is more compressed; but the diapophysis is longer, and the base of the neural arch is of greater fore-and-aft extent. The rib is stronger and longer; it supported an appendage, but is equally free from junction with the sternum. At the under part of the base of the diapophysis is the large pneumatic opening.

The fifth dorsal (*ib.* D 5) presents a corresponding decrease in transverse and vertical diameter, without any loss of fore-and-aft extent. The posterior hypapophyses have coalesced into a single process: the anterior hypapophysis is a strong ridge, with the fore part a little in advance of the anterior articular surface of the centrum. The shorter and more compressed spine has a somewhat greater fore-and-aft breadth than in the sixth vertebra: its height is not quite three inches.

In the fourth vertebra (*ib.* D 4) the anterior and posterior hypapophyses have coalesced into a single ridge, with a tuberosity on each side of its fore part; the ridge appearing to be a downward continuation or termination of the sides of the compressed centrum. The diapophysis is thicker but shorter than in the foregoing vertebræ: the spine, though shorter and somewhat thinner, has a greater fore-and-aft diameter; it is truncate a-top, like the rest.

The ribs of this and the succeeding vertebra, the fifth, are the largest; they each support a lamelliform appendage articulated to a well-marked surface at the back part, below the middle of the rib. The appendage is three inches in length and one in breadth; ascending obliquely and overlapping the succeeding rib. The sternal portion of the rib of the fourth dorsal joins the sternum.

The third dorsal vertebra (*ib.* D 3) much resembles the fourth; but with a slight diminution of size and a somewhat lower position of the parapophysis: this is associated with a rather longer and more bent-down neck of the rib. The sternal part of this rib joins the sternum.

In the second dorsal vertebra (*ib.* D 2) the inferior ridge is divided by a notch into an anterior and posterior hypapophysis; but the diminished size of the vertebra, the lower parapophysis, with a smaller articular surface for the rib, and shorter diapophysis, distinguish it from a fifth dorsal. The spine is somewhat shorter, and inclines more forward than that of the third dorsal.

In the first dorsal (*ib.* D 1), the hypapophysis is a ridge projecting from rather more than the anterior half of the centrum: the parapophysis has a smaller cup for the head of the rib than in the second dorsal: the diapophysis is proportionately diminished in size: the neural spine is smaller in every dimension, and slopes more forward. There is a small pneumatic foramen below and in front of the diapophysis. The rib, about four inches in length, terminates in a point, and has no sternal portion, nor any appendage.

Besides the seven pairs of ribs from the seven dorsals, there are two pairs from the anterior sacrals, progressively diminishing in size, and the last terminating freely in a point. The first of these sacral ribs was moveably articulated to the first sacral vertebra: the second is anchylosed to the second sacral vertebra.

Thus the *Dinornis elephantopus* had nine pairs of long, conspicuous ribs: the first floating; the second to the fourth pairs inclusive composed of pleurapophysis and hæmapophysis, the latter articulating with the expanded hæmal spine or sternum. The next three pairs had hæmapophyses, or 'sternal ribs' which did not reach the sternum: the eighth and ninth pairs, simple and pointed like the first pair, belong to the first two of the vertebræ that have coalesced to form the long sacrum.

Of the cervical vertebræ there are fifteen, each having its individual character, and with trochlear articular surfaces so clearly or definitely sculptured on the ends of the centrum as to permit of no mistake in the co-adaptation of the vertebræ, successively, from the last or fifteenth, *ib.* C 15, up to the atlas, *ib.* C 1. The size of the articular cup on the fore part of the atlas determined the cranium belonging to the present skeleton of *Dinornis elephantopus.*

In the last cervical, *ib.* C 15, the hypapophysis is a ridge from the front half of the centrum; which centrum is longer, but of less fore-and-aft extent than that of the first dorsal. The short rib is anchylosed to both parapophysis and diapophysis; it is an inch and a half in length, pointed and directed backwards. The spine is smaller in all its dimensions than in the first dorsal.

In the fourteenth cervical, *ib.* C 14, the hypapophysis is a thick sub-bilobed ridge from near the fore part of the centrum, but is extended transversely, not from before backwards. The rib is merely a bar uniting the ends of the two transverse processes: the spine is rather more than an inch long, nearly an inch broad, half an inch from before backwards, and bifurcated, with the two divisions on the same transverse line.

The thirteenth cervical, *ib.* C 13, has a pair of anterior hypapophyses with their tuberous ends approaching and almost meeting each other, so as to complete a hæmal canal. The median cleft of the short spine almost divides it into two processes. The canal circumscribed by the met-, di- and pleur-apophyses, on each side of the vertebra, is large enough to admit the fore-finger. The centrum appears to be larger than in the succeeding vertebræ, because it does not lose in fore-and-aft extent while decreasing in other dimensions.

In the twelfth cervical, *ib.* C 12, the anterior hypapophyses are wider apart: the transverse pair of spines are also more apart, and are shorter than in the thirteenth vertebra.

In the eleventh cervical, *ib.* C 11, the hypapophyses are shorter and wider apart: the neural spine is now a pair of tuberosities.

The under surface of the tenth cervical, *ib.* C 10, is widely grooved, with the hypapophysial tubercles deepening the fore part of the sides of the groove. Slightly converging ridges from the upper part of the posterior zygapophyses represent the neural spine.

These ridges converge as they advance upon the neural arch, in the ninth, eighth, seventh, sixth, and fifth cervicals, in which a low tuberosity on the fore part of each ridge represents the divided neural spine. The under surface of the centrum becomes flatter in the above vertebræ: the hypapophyses are represented by a tubercle on the lower part of each parapophysis.

In the fourth cervical, *ib.* C 4, the pair of tubercles representing the neural spine are longer: in the third cervical they are closer together: in the second they have coalesced to form a single spine, with a deep fossa at its back part: in the atlas, *ib.* 1, the neural spine is obsolete.

The hypapophysis in the third cervical is a single median ridge, as it is also in the axis, or second vertebra: in the atlas it is absent. The hind surface of the body of the atlas is convex, a little hollowed above to receive the odontoid process: the lateral 'vertebral' canals are defined each by a slender vertical bar of bone. The under surface is produced into a pair of short tubercles at its hind margin and at its front margin; and they project respectively backwards and forwards, not downwards as hypapophyses. The deep anterior cup, which receives the single occipital condyle, is notched at the middle of its upper part. The neural arch expands beyond the breadth of the centrum, and developes only the posterior pair of zygapophyses.

The pelvis of the *Dinornis elephantopus* (Pl. XLVI. S 63, 64) is one foot nine inches in length, contrasting extraordinarily with the size of the skull.

Six of the anterior sacral vertebræ have parapophyses with the ribs confluent with them, save in the first: beyond the second vertebra the ribs simply abut against the ilium, with which they are confluent.

The ischium, 63, and pubis, 64, which coalesce with the ilium to form the acetabulum, do not again unite with each other: the notch at the under and fore part of the ischium opens into the long interspace between the two posteriorly extended bones. This part of the pubis, 64, is straight and styliform, 8½ inches in length; slightly expanded, to a breadth of 14 lines, near the end; flattened externally, convex internally, so as to offer a subtrihedral transverse section. The ischium, 63, with an upper and lower notch, having smooth and thick rounded borders, near the acetabulum, expands gradually, and is flattened, into a plate of about three inches of vertical depth, with a truncate termination.

Nine caudal vertebræ, of a transversely subquadrate form, with a contracted neural canal, surmounted by a low transversely extended arch supporting a pair of tubercles, represent the basis of the short tail of the Dinornis.

The last of these vertebræ is as small and simple as in other large birds devoid of the power of flight; showing nothing of that characteristic modification of the terminal coalesced coccygeals in birds of flight, for the support of the rectrices, or steering quill-feathers of the tail.

The cranium is six inches eight lines in length; three inches nine lines across the broadest part, behind the orbits. The post-orbital process is broad, compressed, and descends nearly to the zygomatic arch. The upper mandible is slightly deflected, conical, obtusely pointed, with the external nostrils terminating at the distance of about an inch from the apex of the premaxillary. The upper part of the median nasal process of this bone, together with the nasals, has been broken away. The minor characters of the cranium and of the lower mandible accord generically with those of the *Dinornis*, described in the present volume of the 'Transactions of the Zoological Society,' pp. 60–65. The chief peculiarity of the skull in the present species is its small size, as contrasted with the pelvis and hind limbs.

The characters of the bones of the leg and foot of the *Dinornis elephantopus* have been described in a preceding memoir, and need not here be repeated.

The keel-less sternum, in its shortness, breadth, and subquadrate form; in the two wide and deep posterior notches; in the unusually small and shallow coracoid fossæ; and in the reduction of the articular pits on the costal borders to three on each side, closely conforms to the type of that instructive bone, in the *Palapteryx* (*Dinornis*), described in the fourth volume of the 'Transactions of the Zoological Society,' pp. 194, 195.

I have refrained from entering into closer descriptive details of the skeleton of the *Dinornis elephantopus*, because only the plates can convey an adequate idea of its extraordinary proportions to those who have not seen the original itself.

The specimen, as now articulated, stands in the first compartment of the Palæontological Gallery of the British Museum. The articulated hind-limbs of the *Dinornis* (*robustus*) are placed on each side, as in Pl. XLVII., to illustrate the characteristic proportions of the two extinct species.

The drawings from which the plates have been engraved were taken from two successful photographic views, corrected, as to the relative size of the parts, from the skeleton itself: I am much indebted for the care and skill which Mr. Erxleben has bestowed on this complex subject.

The bones which have served for the reconstruction of the skeleton of the *Dinornis elephantopus* were selected from the large collection obtained by Mr. Commissioner Mantell, in the Middle Island of New Zealand, at the locality (Ruamoa, Middle Island of New Zealand) and under the circumstances described in the preceding memoir.

DESCRIPTION OF THE PLATES.

PLATE XLVI.

Side view of the skeleton of the *Dinornis elephantopus*; with a scale of English feet and inches, showing the degree of reduction of the figure, and the natural height of the skeleton, in the ordinary attitude of the bird, viz. five feet six inches.

PLATE XLVII.

Fig. 1. Front view of the same skeleton.
Fig. 2. Front view of the right leg and foot of the *Dinornis robustus*.
Fig. 3. Front view of the left leg and foot of the *Dinornis robustus*.


III


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XIII. *Osteological Contributions to the Natural History of the Chimpanzees* (Troglodytes) *and Orangs* (Pithecus).—No. VI. *Characters of the Skull of the Male* Pithecus Morio, *with Remarks on the Varieties of the Male* Pithecus Satyrus. *By* Professor Owen, *F.R.S., F.Z.S. &c.*

Read December 9, 1856.

At the Meeting of the Zoological Society for scientific business, held on the evening of October 25, 1836, I communicated a description of the skull of an adult Orang-utan, which, on account of its small size, but more especially from the proportions of the teeth, I was led to regard as appertaining to a species distinct from either of the varieties of the then known larger species of Orang-utan (*Pithecus Satyrus*), indicated by the names *Pithecus Wurmbii* and *Pithecus Abelii.*

For the smaller species of Orang—with canine teeth relatively less in proportion to the incisors than in the female of the *Pith. Satyrus*, with the molar teeth relatively larger in proportion to the size of the skull, whilst the superior incisors were nearly as large, and the inferior incisors quite as large, as those of the males of the great *Pith. Satyrus*,—I proposed the name of *Pithecus Morio.*

No record of the sex of the individual from which the skull in question had been derived was obtainable. My own belief was that it belonged to a female Orang; and in a letter on the subject, printed in the 'Revue Zoologique,' 1839, p. 38, in reply to a paper by M. Dumortier[1], I particularly compared the skull on which the *Pithecus Morio* had been founded with the skull of the adult female of the *Pith. Satyrus* (var. *Wurmbii*), and showed that the canine teeth of the *Pith. Morio* were relatively smaller, the molars relatively larger, the cranium being absolutely less, with the occiput rounded and convex instead of being flattened, and with the temporal ridges wider apart.

Various have been the subsequent comments of naturalists on the new species, and the evidence on which it was proposed. Mr. Blyth, in his "Remarks on the different species of Orang-utan[2]," states that he "inclines to infer that Mr. Owen's specimen is the skull of a male animal, chiefly from the greater depth of the alveoli" (p. 3), as compared with the skull of a known aged female *Pith. Morio* which died at Calcutta, and the skin and skull of which are preserved in the Museum of the Asiatic Society. Mr. Blyth gives figures of a side- and of a front-view of the skull of the above old female *Pith. Morio* (*op. cit.* pls. 7 & 8). The comparison of these figures with mine, published in the 2nd volume of the Zoological Society's Transactions, confirmed me in

[1] "Notice sur les Modifications du Crâne de l'Ourang-outang," Bulletins de l'Académie Royale de Bruxelles tom. v. 1838.

[2] Journal of the Asiatic Society of Bengal. I quote from a private copy, without date, of the Memoir.

the belief that the Plates 33 and 34 in that volume were of the skull of a female Orang. The small development of the canine teeth, corresponding with that in the skull of ascertained sex, figured by Mr. Blyth, outweighed the difference in the depth of the alveoli of the lower incisors and canines, which I knew to be a variable character in the same sex of the larger species of Orang.

But prior to the publication of Mr. Blyth's paper, the original indication of the second, smaller, and more Anthropoid species of Orang-utan in Borneo had attracted the notice of other able naturalists; some either tacitly ignored the specific distinction, adding the name *Pithecus Morio* to the synonyms of *Pith. Satyrus*, or formally combated my conclusion, as *e. g.* M. Dumortier, in a paper containing many excellent observations on the phases of dentition in the great Orang[1]. Other observers, as *e. g.* Sir James Brooke[2] and Mr. Blyth[3], adopted the species, and gave confirmatory evidence of the constancy of its distinctive characters from the larger Orangs (*Pith. Wurmbii*, *Pith. Abelii*, or *Pith. Satyrus*). Nevertheless, excepting a brief notice by Mr. Blyth of "a nearly grown living male of what he considered to be *Pithecus Morio*, which had no 'cheek callosities,' and had not developed its hindmost molares" (p. 5), I still remained in ignorance of the sex of the first-described specimen of my small species, and felt an increasing desire for the means of comparing the skull and dentition of a known adult male *Pith. Morio* with those characters in the adult male *Pith. Satyrus*. This interesting additional evidence has at length been afforded me by the enterprising explorer of the less-known parts of Borneo, Mr. A. R. Wallace, who has recorded the chief results of his observations on the Orangs in their native wilds in two interesting papers "On the Orang-utan or Mias of Borneo," dated Sarawak, Dec. 1855, and printed in the 'Annals and Magazine of Natural History,' 1856, p. 471.

Mr. Wallace's conclusions are based on the comparison of seventeen freshly-killed Orangs, all but one shot by himself, and of two skeletons and two skulls of Orangs, "the sex and external characters of which were ascertained from those who killed them" (*loc. cit.* p. 472).

Of this most important series for the settlement of the mooted questions of variety or specific distinction of the Orangs, sixteen were fully adult, nine being males, and seven females; and "all obtained in a very limited tract of country, watered by the same small river, and of very uniform physical features," in Borneo (p. 472).

Passing over, for the present, Mr. Wallace's judicious remarks on the characters of the larger Orangs (*Mias Pappan* or *Chappan*[4] and *Mias Rambi* of the Dyaks), I have the satisfaction to quote, with respect to the smaller kind of Orang (*Mias Kassar* or *Kassa* of

[1] *Op. cit.* and Comptes Rendus de l'Acad. des Sciences, 17th December, 1838.

[2] Proceedings of the Zool. Soc. 1841, p. 55.

[3] Journal of the Asiatic Society of Calcutta.

[4] Mr. Blyth, in his "Further remarks on the different species of Orang-utan," seems not to have been aware that these native terms were synonymous, for he writes—"One of them (a small but full-grown female) is marked by himself *M. Pappan*; and another is sent by the new name *M. Chapin*," &c.

the Dyaks), that, having obtained two adult males and five adult females, Mr. Wallace regards them as a distinct species, and refers them to my *Pithecus Morio*. The females "so exactly correspond with Prof. Owen's figure, that there is no doubt of their belonging to the same species, the adult male of which will," Mr. Wallace believes, "now be made known for the first time" (p. 474).

The skins of the two small males and of the females were sent, in spirits, together with the skulls, in order to serve for the determination "of the characters of the two species of Bornean Orang, *Simia Satyrus* and *S. Morio*" (p. 475).

The skins and skulls of an adult male and an adult female of the *Pith. Morio* have been secured for the British Museum. The skulls of the other adult male and female *Pith. Morio* are now, through the kindness of Mr. W. Stevens, to whom Mr. Wallace consigned his collections, exhibited, together with the skulls of an adult male and adult female of the *Pith. Satyrus*, to the present Meeting of the Zoological Society (December 9th, 1856).

Mr. Wallace briefly records the height of the two male Morios shot by him, which were respectively 3 feet $8\frac{1}{2}$ inches and 3 feet $9\frac{1}{2}$ inches from the heel to the crown of the head, 6 feet 6 inches between the extremities of the outstretched arms, and about 2 feet 6 inches in the girth of the body; they showed no trace of the cheek-excrescences; the canine teeth "were quite as large as in most specimens of the larger animal, and of exactly the same form" (p. 474).

This was the character I was most desirous of knowing, and the testimony to it, which we owe to Mr. Wallace, sets at rest the question of the sex of the individual, on the skull of which the species *Pith. Morio* was founded twenty years ago.

I proceed now to the comparison of the skull of the adult male *Morio* (Plates XLIX. & L.) with one of the male *Satyrus*, of corresponding age, as indicated by the grinding surface of the molar teeth.

By this indication both skulls have belonged to mature, but not to very aged, animals; the inner enamelled cusps of the first molar (*m* 1), lower jaw, have impressed corresponding cavities on the inner side of the crown of the first molar above; and reciprocally, the two more produced outer cusps of that tooth have made impressions on the outer half of the grinding surface of the first molar (*m* 1) below. In the *Satyrus* the like impressions may be seen, of less size, on *m* 2 below, and the incisors have been more worn; but the crowns of the canines are almost entire, and the peculiar minutely wrinkled surface of the newly formed grinders of the Orangs is still retained on the last molars, as in the male *Morio*.

The canines in the male *Morio* presenting, like the incisors and molars, an equality of size with those of the great male *Pith. Satyrus*, the small size of the skull and lower jaw supporting them is more remarkable than in the female skull.

This difference is particularly marked in a comparison of the span of the zygomatic arches; in the breadth of the cranium as compared with its length; in the greater expanse and flatness of the occiput occasioned by the more strongly developed lambdoidal crest in the *Pith. Satyrus*; and in the smaller relative as well as absolute size of the ascending ramus of the lower jaw and of the condyles in *Pith. Morio.* The incisors of the *Morio*, especially the large mid-pair above, are of equal size with those of the *Satyrus.* The molar series in one of the male skulls (that in the British Museum) occupy a longer tract in both upper and lower jaws than in the female *Morio* figured in my previous Memoir[1].

In the lower jaw the dental series is uninterrupted in the skulls of both species of Orang, the long and large crown of the upper canine diverging a little outwards as it descends, and terminating outside the interspace between the crowns of the lower canine and first premolar.

In the skulls under comparison, the premolar and molar teeth are absolutely larger in the smaller species of Orang.

	Pith. Morio.		*Pith. Satyrus.*	
	in.	lines.	in.	lines.
Extent of the molar series, above . . .	2	4	2	1½
,, ,, ,, ,, below . . .	2	8	2	6

The bony palate is narrower and deeper in proportion to its length in the *Pith. Morio.* The correspondence in the configuration and structure of the teeth in the two species is very close.

The differences between the skulls of the two Orangs, *P. Satyrus* and *P. Morio*, besides those of size and proportion, which are noted in the "Table of Dimensions," are chiefly as follows:—

Concomitant upon the permanent retention of the characteristics of immaturity by the adult male of the smaller species, to which 'arrest of development,' *i. e.* of development in the Orang-direction, its more Human-like characters, are due, is the less produced temporal ridge, and its separation from the one on the opposite side by a smooth convex tract of cranium, 1 inch 10 lines in width at the narrowest part. To the same 'arrest' are due the more feeble and less outwardly arched zygomatic processes; the lower and shorter lambdoidal ridges, which are separated by the breadth of the posterior part of the space dividing the temporal ridges, and a consequently more uniformly convex occiput. The orbits are proportionally larger, and in one skull are more sharply defined. The shorter and narrower pterygoid plates in the *Pith. Morio* relate to its proportionally smaller mandible. The bony apertures, both external and internal, of the nasal or respiratory passage are smaller in the *Morio* than in the *Satyrus*; but the occipital foramen (*f. magnum*) in the skulls compared is relatively larger than in the *Pith. Satyrus.*

The two skulls of the male *Morio* transmitted by Mr. Wallace present some notable varieties, of which the most remarkable is that exhibited by the size and extent of the molar teeth, especially those of the upper jaw. In the individual, however (no. 1), in

[1] Trans. Zool. Soc. vol. ii. pl. 34.

which, as shown in the Table of Admeasurements (p. 178), these teeth are so much smaller,—the normal series of five not exceeding in fore-and-aft extent that of the last four of the same series in the other skull,—the smallness of the normal series has been compensated by the superaddition of a fourth molar on each side of the upper jaw, which makes the series of equal extent with that of the other skull. This supernumerary tooth is smaller than the last; it had not emerged from its formative cavity on the left side, nor attained the level of the grinding surface on the right side. There is no trace of a corresponding supernumerary tooth of the lower jaw of the same individual, in which the extent of the normal series of five grinders equals that of the six teeth above. The extent of the grinding surface of the molar series in the other male *Morio* (no. 2) exceeds that in the above-described, owing to the larger size of the crowns of the teeth, which are of the usual kind and number.

In one of the skulls of the female *Pithecus Morio*, transmitted by Mr. Wallace, the left series of molars in the lower jaw shows a supernumerary or fourth true molar; it is rather more than half the size of the contiguous *m* 3, which is not less than the *m* 3 of the right side, where there is no trace of the sixth tooth or its socket. That tooth on the left side has its crown in a proper position for use, and the fore and outer angle has been worn by the action of the last molar, *m* 3, above. There is no trace of the supernumerary tooth on either side of the upper jaw. The length of the molar series here is 1 inch $11\frac{1}{2}$ lines; of the right side, lower jaw, 2 inches 3 lines; of the left side, lower jaw, 2 inches 6 lines.

I first noticed the variety of the supernumerary molar tooth in a skeleton of an adult male Orang (*P. Satyrus*) in the collection of Baron Van der Capella (formerly Governor of Batavia) at Utrecht[1], in the year 1838. In an adult of the large Bornean Orang, which Mr. Blyth believed to be a female, in the Calcutta Museum, but which from the size of the canines I deem to be a male, he records a similar anomaly, in "a fourth true molar, above and below, though on the left side only; that of the upper jaw being of small size and round form, its crown scarcely exceeding that of an upper false molar of *Macacus rhesus*; in the lower jaw the accessory fourth true molar is very little smaller than the normal molars; its crown is directed obliquely inwards, so that as a functional tooth it must have been almost useless; but the outer or upper margin of its crown is a little worn by attrition, as is also the outer cusp of the small accessory molar above[2]."

In consequence of the superior size of the upper incisors and canines in the male *Morio*, no. 1, there is no vacant space between the outer incisor and canine in that skull, and the series of teeth is as continuous in both jaws as it is in the Human subject (Pls. XXXI. & XLVIII.): the points of the long canines are so directed as to overlap, when the mouth is shut, the intervals of those teeth, which are widened into

[1] Odontography, p. 442.

[2] Blyth, "Further remarks on the different species of Orang," *loc. cit.* p. 3.

'diastemata' in other adult male skulls of *Pithecus*, at least in the upper jaw. In the skull of the male *Morio*, no. 2, with the supernumerary molars, the diastema is between 2 and 3 lines wide between the upper canine and the outer incisor on each side. The dental series of the lower jaw is as continuous as in the other male *Morio's* skull.

In the adult males of the *Pith. Satyrus* the intervals between the upper incisors and canines are seldom under 3 lines in extent, and are constant in all the skulls I have examined. I have only observed in one skull corresponding interspaces in the lower jaw: the left canine is separated by a space of a line in breadth from the first premolar, and by one of the same breadth from the outer incisor: the right canine is separated from the outer incisor by an interval of between 3 and 4 lines; but this is evidently due to an abnormal shape and backward twist of the canine on that side. In the upper jaw of the same skull, the right canine has a diastema on each side, that behind being $2\frac{1}{2}$ lines, that in front $1\frac{1}{2}$ line in extent; the left canine is, as usual, in contact with the premolar, but is separated from the outer incisor by an interval of $4\frac{1}{2}$ lines.

There is the same range of variety in the size of the premolar and molar teeth of the *Pith. Satyrus* as of the *Pith. Morio*: the average fore-and-aft extent of the grinding series is, in the upper jaw 2 inches 2 lines, in the lower jaw 2 inches 6 lines; the increase, here, being mainly due to the greater size especially in fore-and-aft extent of the last molar. In the great Bornean male Orang's skull, in the Hunterian Museum of the Royal College of Surgeons (Osteol. Catal. no. 5051), figured in the Zoological Transactions, vol. ii. pl. 32, the upper molar series is 2 inches $4\frac{1}{2}$ lines in extent: in the male's skull, locality unknown, figured in *op. cit.* vol. i. pl. 54, the same series has only 1 inch 9 lines in extent: in the skull of the adult male Sumatran Orang's skull, the skeleton of which is preserved in the Hunterian Museum (*tom. cit.* plates 49, 50 & 56, figs. 4 & 8, Ost. Catal. no. 5050), the extent of the molar series is just 2 inches.

Besides the two skulls, nos. 5050 & 5051, of adult male Orangs of the larger species (*Pithecus Satyrus*) in the Museum of the Royal College of Surgeons, and the skull of the adult male Orang in the possession of the late Mr. Cross of the Surrey Gardens, of which three skulls I published figures and descriptions in 1835 and 1836; I have since described the skull of the adult male, no. 5054, Mus. Coll. Chir., of which a figure of a longitudinal section is given in Trans. Zool. Soc. vol. iv. pl. 29; and the skull of the adult female, no. 5056, Mus. Coll. Chir.[1] I have also examined and compared the skulls of the adult Orangs in the Museum of the Garden of Plants at Paris, and in several museums, public and private, in Holland, together with the skulls, thirteen in number, of the adult male great Bornean Orangs, now in the British Museum.

The results of these comparisons, and of due consideration given to the figures and descriptions by other authors, more especially Temminck, Dumortier, Solomon Mueller, and Blyth, have confirmed me in the opinion expressed in my first Memoir of 1835, in

[1] "Descriptive Catalogue of the Osteological Series contained in the Museum of the Royal College of Surgeons of England," 4to. vol. ii. 1853, pp. 761, 762.

regard to the great Orang or *Pithecus Satyrus*, viz. that the observed and recorded differences "are not sufficient to afford grounds for specific distinction[1]."

The following are notes on the adult Orangs made in 1838, in the Continental Museums.

"*Museum of the University of Leyden. Adult Orangs.*—The skulls of the females all exhibit the relatively smaller canines and corresponding feeble development of the occipital and parietal crests which M. Temminck has described; but they differ in these respects and in relative size; and these differences, as is evident from the condition of the teeth, are not differences of age. I observed one of those crania in which the canine teeth were not more developed than in my *S. Morio*; it was marked '*Simia Satyrus*, female:' the strong ridges at the outside of the lambdoidal suture soon subsided, and were not continued into each other to form a single occipital crest, as described by M. Dumortier in both the male and female of the large Orang (*Simia Wurmbii*) at the fourth epoch, or when just arrived at maturity: there was no sagittal crest. The front incisors were as large as in the great male Pongo, but the longitudinal extent of the molar series of the upper jaw was only 2 inches 3 lines; that of my *Morio* being 2 inches 2 lines; so that the difference here is unimportant. The length of the molar series in the lower jaw was 2 inches 6 lines: length of the skull 8 inches, greatest breadth 5 inches. The grinding surface of the molars showed the animal to be fully adult. This skull presented the characteristics of the *S. Wurmbii* in the contracted interorbital space: there were numerous (three) suborbital foramina, and some vascular perforations in the thick outer border of the orbit. The nasal bone is totally interrupted by the junction of the nasal processes of the maxillary bones of the opposite sides with each other; the lower part of the nasal bone is triangular.

"In a second example of a female, having the canines and the molars of the same size as in *S. Morio*, all the sutures were obliterated, and the frontal and lambdoidal ridges were stronger than in the *Morio*.

"In the skull of a female, immature, all the permanent incisors and bicuspides, and the first and second molares, are in place: the points of the permanent canines are just appearing, having pierced the alveolus: the last molars are still in the formative cavity, but the crowns are complete. This would seem to show that the canines are later in appearing than in the Human subject. The intermaxillary suture has begun to be obliterated at its lower extremity, between the sockets of the canines and incisors; it continues open upon the face. The sutures of the head, with the exception of a small part of the lambdoidal, remain unobliterated. The temporal joins the frontal bone on both sides.

"In the skull of a male I observed the zygomatic process of the malar bone existing as a separate piece: the wise-tooth, *m* 3, was mal-placed, its grinding surface abutting against the adjoining molar: either the revolving motion had been carried too far, or the mal-position had been original.

[1] Trans. Zool. Soc. vol. i. p. 378.

"*M. Klingenberg's Museum.*—In the skull of an adolescent male *S. Satyrus*, all the permanent molars were in place, and the large canines had nearly got into place: there was a well-marked diastema between the canines and premolars in the lower jaw, as well as the diastema always present between the canines and incisors of the upper jaw: here the maxillo-premaxillary suture had become nearly obliterated; a small proportion of its upper part, and that within the nasal cavity, alone remaining open. The parietals do not join the frontals on either side.

"*Adult female.*—The lambdoidal, sagittal, and premaxillary sutures were obliterated: the canines were small, and these, with the incisors, had been well worn: there was scarcely any diastema or vacant space between the canines and bicuspides of the lower jaw; but a well-marked interspace between the canines and incisors in the upper jaw. The nasal bone was not compressed in this skull, as in one of the preceding.

"*Baron V. der Capella's Collection.*—Here I saw a singular variety in the skull of an adult *S. Wurmbii*, viz. six molar teeth instead of five on each side of the lower jaw. In the skeleton of the adult Sumatran Orang, at the College of Surgeons, there is the reverse variety of dentition, only four molars, two true and two false, being developed on each side of each jaw. It was this which partly led Dr. Harwood to imagine it to be a distinct species from the young *Simia Satyrus*.

"*Museum Senkenbergianum, at Frankfort.*—Here I saw the cranium of an adult Orang, sex unknown, most probably female, smaller than my *S. Morio*, the total length being 7 inches 3 lines: the canines were nearly as feebly developed, the length of the enamelled crown being 7 lines; the length of the molar series, upper jaw, was 2 inches 1 line; but the middle incisors were as large as in the *Morio*, the breadth of the crown being $6\frac{1}{2}$ lines: the principal difference in this cranium arose from the great development of the supra-orbitary ridge, which gave it the character of the skull of the Chimpanzee, from which, however, it differed in other essential points."

The chief variety in the skulls of the adult males of the large species of Orang is in the temporal ridges, depending on the development of the temporal muscles: in some (Pl. L. fig. 1) the ridges meet and form a 'parietal crest,' rising above the median line of the vertex; in others (Pl. L. fig. 3) they do not meet, but form two low lines or ridges, at varying distance from each other in different skulls.

Of the thirteen skulls of large male Bornean Orangs in the British Museum, seven have the parietal crest, and six have the two separate temporal ridges. Both series of skulls are fully adult, and show nearly the same differences of age, so far as such differences are indicated by the degree of abrasion of the teeth. The presence or absence of the parietal ridge clearly does not depend upon the age of the adult. In certain individuals only it depends upon age: the temporal ridges do not meet in any of the great male Orangs until the permanent canine teeth have come into place; but in many individuals those ridges remain separate throughout life, or until a very advanced age. The sixth stage, described by M. Dumortier[1], is characteristic of the adults of certain indi-

[1] *Op. cit.* p. 7.

viduals of the great Orangs (*Pith. Satyrus*) before they attain old age ('l'âge vieux'): it is not the absolute characteristic of any age of the species.

In the skull no. 3 B, Brit. Mus., the parietal crest is 3 lines high: the first true molar shows the small cavities on the grinding surface formed by the more prominent pair of cusps of the opposite tooth, upon the inner half of the upper, and on the outer half of the lower tooth. These cavities have hardly begun to be formed on the second molar; and the grinding surface of the third molar shows its primitive minutely wrinkled surface. In this skull about half an inch of the stylohyal is ossified and anchylosed to the vaginal ridge, forming the so-called 'styloid process' of the temporal bone.

The skull no. 1080, which by the state of the teeth is about the same age as the preceding, has also a parietal crest 3 lines in height, but it is thicker than in no. 3 B: the styloid processes are 3 lines in length.

In the skulls nos. 1085 and 1088, the cavities in the second true molars are rather better marked, but the crown of the third molar is wrinkled; the crowns of the canines are obliquely worn, the upper ones by attrition against the first lower premolars; but they retain their full length: the incisors have had half the crown abraded. The sagittal crest is similar to the foregoing: there are no styloid processes. The nasal bone is shorter in 1085.

In an adult male of the large Orang, in Mr. Stevens's charge, no. 2, with less-worn incisors and canines, the parietal ridge is 4 lines high. The nasal bone does not rise above the level of the malo-frontal suture; it is bisected by the maxillaries meeting at the median line, as in the skull in the Leyden Museum, above noticed[1].

In the skull in the British Museum, no. 3 A, with the canines and incisors much more worn down than in the foregoing skull, and with deep cavities in both the first and second molars, and also in the third molar of the lower jaw, the temporal ridge is less elevated, but is thicker: there is a styloid process on the right side, 5 lines in length.

In the skull no. 1079, all the molars, as also the premolars, show deep cavities through long attrition, and the crowns of the upper canines are much worn away: the temporal ridge is low and thick, not higher than in the skull no. 3 A. The styloid processes are 5 lines in length.

The skull no. 3 C (Pl. L. fig. 1) is of an aged individual: the inner halves of the upper molars (*ib.* fig. 2) are worn half-way down. The parietal crest is moderately thick, and 4 lines high.

In this series of crested skulls there are modifications of general size and proportions, of extent of the molar series, of the shape of the nasal bone, of the size and shape of the orbits, of the degree of prominence of the superorbital ridge, and of the pre-

[1] I have seen the skull of an Orang (*Pith. Satyrus*) in which the nasal bone was reduced to its lower border—a small piece wedged into the upper part of the bony nostril; and another skull of an Orang without any trace of nasal bone, the place of which was supplied by the united nasal processes of the maxillaries.

maxillaries, with concomitant varieties of profile contour,—offering forms and characters of cranium intermediate between the two extremes of the crested adult male skulls figured in the Zoological Transactions, vol. i. pl. 54, and vol. ii. pl. 32.

I next proceed to notice some characters in the series of six adult male skulls of the large Bornean Orang, which have no parietal crest.

In the youngest of this series, no. 1100, the temporal ridges are 14 lines apart, yet half the crowns of the incisors are worn away; but the crowns of the canines are nearly entire, and the molars are not more abraded than in the crested skull, no. 3 B. The lambdoidal ridges are interrupted by the breadth of the space between the temporal ridges.

In the skull no. 1101 (Pl. L. fig. 3), those ridges are 10 lines apart, and are more directly continued behind into the lambdoidal ridges: the inner halves of the upper molars (fig. 4) and the outer halves of the lower molars are worn into smooth cavities. There are styloid processes 3 lines in length.

In no. 1086, with the molars as much worn as in the preceding skull, the temporal ridges are 12 lines apart: there is a low smooth longitudinal rising, not to be called a ridge, in the midspace between the ridges. The styloid processes are 3 lines in length. The lower molars of this skull are figured in Plate L. fig. 5.

In no. 1087, the temporal ridges are 10 lines apart, with a low narrow median longitudinal rising; the molars are as much worn as in no. 1101, except that the last, owing to their unusually small size, have escaped their due share of abrasion. One half of the crowns of the canines are worn down: the lambdoidal ridge is strongly developed, and the occiput proportionally broad.

In no. 1131, the grinders are so much worn that the roots protrude from the sockets, yet the temporal ridges are 6 lines apart.

A still greater degree of abrasion is shown by the molars of no. 15, the inner halves of the upper ones being ground down to the roots, which project from the sockets: the temporal ridges are 3 lines apart.

The kind and degree of variety in the above series of non-crested skulls are the same as in the crested series. My interpretation of the difference of development of the temporal muscles, as indicated by the separation or confluence of the temporal ridges in these great Orangs, is as follows:—those muscles are closely related, in regard to their development beyond a certain size, to the magnitude and use of the canine teeth. The great proportional size of these teeth is a characteristic of the male sex; their chief use has probably, therefore, a sexual relation. Like the horns of the Bull or the antlers of the Deer, they are the weapons by which the males contend for the possession of the female.

Orangs may be born with original differences of disposition, some being more courageous, more combative than others. This proneness to fight and conquer is the probable concomitant of a superior general robustness of frame, of greater nervous energy and consequent activity. Those males which are so endowed will acquire, by the more frequent and energetic exercise of their biting muscles in such conflicts, a greater development of these muscles; just as the blacksmith or boxer gains a greater bulk and firmer fibre in the muscles of the arms; and, as this development of the brachial muscles is indicated by stronger ridges on the humerus, so the corresponding development of the biting and fighting muscles in the combative Orangs is accompanied by the confluence of the temporal ridges and their development into an intermuscular crest along the top of the calvarium.

Males of a more peaceful and sluggish disposition have not the stimulus for the extra-development of the temporal muscles, the upper borders of which accordingly remain at a greater or less distance from each other, and the temporal ridges are more or less apart.

No physiologist would interpret such modifications in the development of a particular pair of muscles as a specific distinction. The question, with me, in 1836, was, whether intermuscular crests or ridges, with other observed varieties, in the skulls of the large Orangs of Borneo and Sumatra, were constant in particular breeds, or were indicative of local varieties. The number of skulls, however, of ascertained Bornean origin has, for some time past, satisfied me that there were no ascertained craniological characters differentiating the great Bornean Orang from the great Sumatran one. The valuable and acceptable evidence lately adduced by Mr. Wallace[1], proves that the single-crested and double-crested, or non-crested, skulls of the great males are not respectively the indications of races inhabiting any particular localities in Borneo, but occur in individuals resembling each other in stature, in kind and colour of hair, and in cheek-protuberances: such individuals have been shot in the same limited tract of country.

The skull of the crested variety of the male great Orang (*Pithecus Satyrus*) is figured by Mr. Blyth, as the *Mias Pappan*, in plates 1 and 2 of his "Remarks on the different Species of Orang-utan." The skull of the non-crested or double-ridged variety of the male great Orang is figured, as the *Mias Rambi*, in plates 5 and 6 of the same memoir. Plates 3 and 4 are stated to be of an aged female of the *Mias Rambi*, from Borneo. This specimen is referred to, at p. 1 of Mr. Blyth's memoir, as "an aged female skull marked 'from Borneo' in this Society's Museum," and again at p. 8, as "an aged female skull of a *Mias Rambi* from Borneo." I have looked closely through every part of Mr. Blyth's "Remarks," in the hope of finding some direct evidence of the sex of this specimen. It would seem that the sole record received with the specimen related to its locality. The size of the canines, in the plates of Mr. Blyth's memoir, satisfies me that the specimen was of the male sex. The degree of abrasion of these teeth, of the incisors, and of the outer portions of the inferior molars, indicates it not to have been very old. It exemplifies the single-ridged variety of cranium, of the adult male *Pithecus Satyrus*.

[1] *Loc. cit.* p. 472.

The size of the skull of that specimen, from Borneo, which Mr. Nicholls says was given him, "if he remembers right, as that of a male *Pappan*, full-grown, but not aged," and which skull Mr. Blyth states to be fully equal or even to exceed in size that of the foregoing single-ridged skull, proves it to be, in my opinion, also of the male sex, in which it illustrates the variety without the median crest, the temporal ridges "being an inch apart where most approximated" (p. 8). Mr. Blyth founds his belief that the specimen presented by Mr. Nicholls was a female, on modifications of the pelvis; but I doubt whether the long and flat ossa innominata of the great Bornean Apes are safe guides for determining sexual characters. The skeleton from Sumatra, in the Mus. Coll. Chir., No. 5050[1], to which he refers, p. 10, is that of an adolescent male animal. I have not yet received any good evidence, or proof, that the canines are developed to the degree presented in that skeleton, in any female individual of the large species of Orang.

Mr. Blyth has recorded a very remarkable and interesting variety presented by an "adolescent female resembling *Pithecus Morio* in size, but having a much shorter fore-arm and more anthropoid conformation of skull," of which he gives a sketch of the side and front view in his plates 9 and 10.

On this subject I would remark, that, in a genus characterized by so unusual a length of upper limbs as *Pithecus*, or the Orang-kind, we ought not to be surprised to find, as an individual variety, an arrest of development of those limbs; the abnormality, as it regards the genus, being a nearer approach to the general type.

Much more evidence than a single specimen is required to establish our confidence in the existence of a propagating variety of shorter-armed Orang,—still more research to prove it to be a species. The cranium, indeed, shows (in pl. 10 of Mr. Blyth's memoir) a shorter and more receding chin; but this part of the lower jaw is subject to variation in other Orangs.

When we review the varieties, already recorded, in the large Orang (*Pithecus Satyrus*) of Borneo and Sumatra, especially in regard to the presence or absence of the nail and its phalanx in the hallux; the occasional supernumerary molar tooth; the length of arm; the intermuscular ridges and crests of the skull; the shape of the orbits; the size and other conditions of the nasal bones; the fore-and-aft extent of the molar series, and the profile contour of the skull; we derive additional proof *that the* Simia Satyrus *of Linnæus is subject to a greater amount of variety in a state of nature, than has hitherto been observed in any other Quadrumanous species.* As to the primitive originality of the *Pithecus Morio* in Borneo, I by no means entertain a decided opinion. Had the whole dental series been proportionally smaller, as it is in the *Troglodytes niger*, in comparison with the *Trogl. Gorilla*, there might have been more reason for concluding as to the distinction of the species. For I have observed, that in the shorter or dwarf varieties of the human species, the teeth do not diminish in size in the ratio of the general stature.

[1] See the description of the skeleton in my Catalogue of the 'Osteology' in that Museum, vol. ii. p. 759.

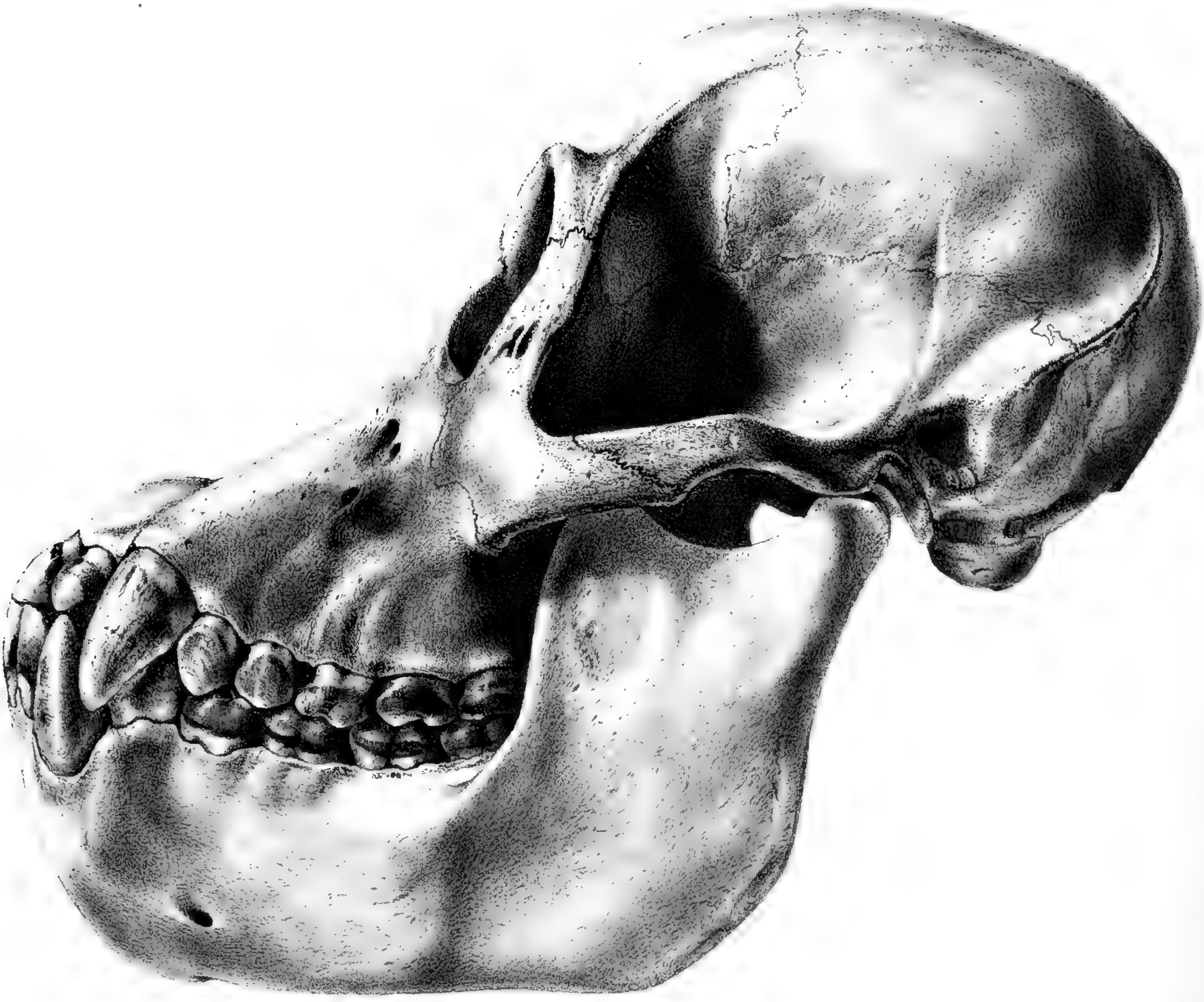

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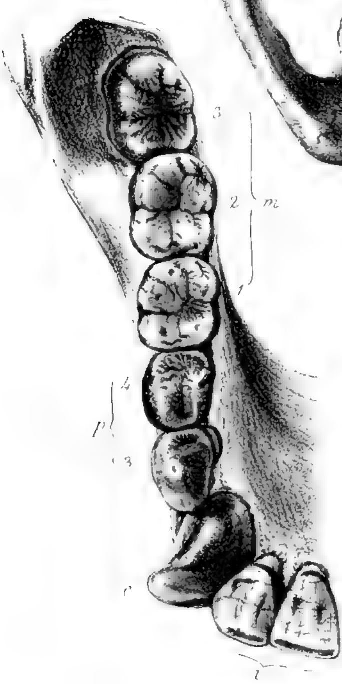
Fig. 1

Fig. 2



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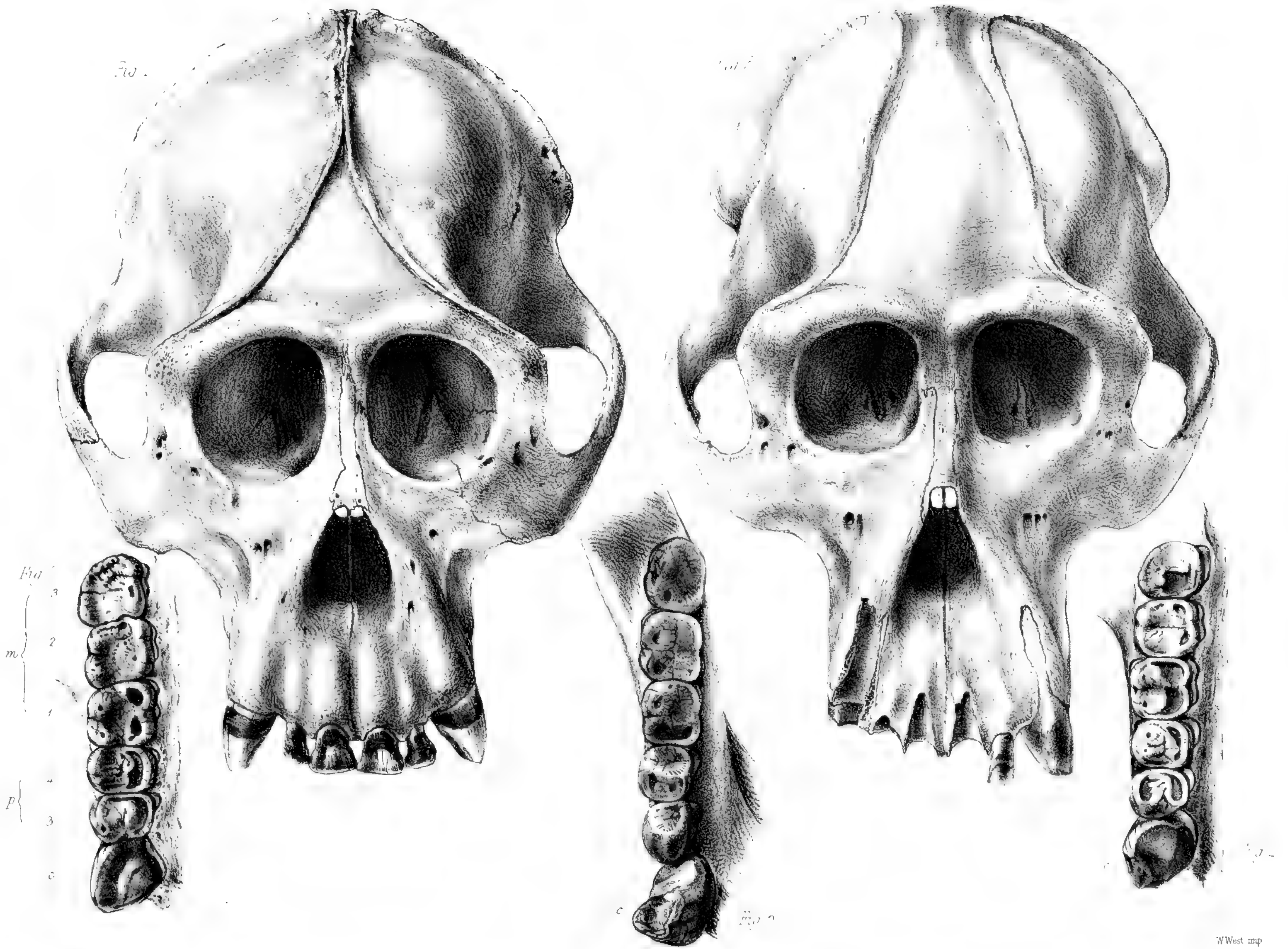

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Figs. 1.2 Pithecus Satyrus var Pappan. Figs 3, 4 5 Pithecus Satyrus var Rambi

The *Pithecus Morio* may, therefore, *quoad* its origin, be an old-established, and now permanent, dwarfed variety of the *Pith. Satyrus.* I apprehend that few naturalists, now-a-days, in describing and proposing a name for what they call "a new *species*," use that term to signify what was meant by it twenty or thirty years ago, that is, an originally distinct creation, maintaining its primitive distinction by obstructive generative peculiarities. The proposer of the new species now intends to state no more than he actually knows; as for example, that the differences on which he founds the specific character are constant, in individuals of both sexes, so far as observation has reached; and that they are not due to domestication or to artificially superinduced external circumstances, or to any outward influence within his cognizance; that the species is wild, or is such as it appears by nature. It becomes, therefore, a matter of convenience, if not of necessity, to indicate the species by a distinct name, in the imparting of zoological knowledge.

The justification of such a procedure depends on the kind and degree of evidence, and I believe that I have at length been enabled to record such evidence, in regard to the *Pithecus Morio*, in the 'Transactions of the Zoological Society.'

DESCRIPTION OF THE PLATES.

PLATE XLVIII.

Side view of the skull of an adult male *Pithecus Morio*: nat. size.

PLATE XLIX.

Fig. 1. Base view of the same skull: nat. size.
Fig. 2. Grinding surface of the lower teeth, right side: nat. size.

PLATE L.

Fig. 1. Top view of the skull of an adult male *Pithecus Satyrus*, var. *Pappan*: half nat. size.
Fig. 2. Grinding surface of upper molars and canine, left side: nat. size.
Fig. 3. Top view of the skull of an aged male *Pithecus Satyrus* (the variety called *Mias Rambi* by Blyth), with separated temporal ridges: half nat. size.
Fig. 4. Grinding surface of upper molars and canine, left side: nat. size.
Fig. 5. Grinding surface of lower molars and canine, right side: nat. size.

Table of Admeasurements.

	P. Morio. Mas. No. 1. in. lin.	*P. Morio.* Mas. No. 2. in. lin.	*P. Morio.* Fem. in. lin.	*P. Satyrus.* Fem. in. lin.	*P. Satyrus.* Mas. Crested. in. lin.	*P. Satyrus.* Mas. No crest in. lin.
Length of the skull from the vertex to the base of the occipital condyle	3 10	3 10	3 6	3 7	4 2	3 10
Length of the skull from the posterior plane of the occiput to the margin of the incisors	8 3	8 3	7 6	8 0	9 3	8 6
Length of the skull from the posterior plane of the occiput to the fronto-nasal suture	4 11	4 9	4 6	4 6	5 0	4 10
Length of the skull from the fronto-nasal suture to the margin of the incisors	3 9	4 0	3 8	3 7	4 6	3 11
Length of the skull from the anterior margin of the occipital foramen to that of the premaxillaries	5 7½	5 8	5 0	5 6	6 2	5 10
Breadth, between the outsides of the zygomata	5 2	5 3	4 10	5 9	6 6	6 0
Breadth, between the post-auditory ridges	4 6	4 9	4 6	5 8	5 6	5 3
Breadth, behind the orbits	2 7	2 6	2 5	2 6	2 6	2 9
Breadth, between the outsides of the orbits	3 10½	3 10	3 8	4 3	4 2½	4 3
Transverse diameter of orbital cavity	1 4½	1 5	1 4	1 6	1 6	1 5
Vertical diameter of orbital cavity	1 8½	1 7	1 6	1 7	1 7	1 8
Vertical diameter of nasal aperture	1 3	1 2½	1 1½	1 3	1 7	1 4½
Transverse diameter of nasal aperture	0 10½	0 9	0 9	1 0	1 2	1 0
Interspace between suborbital foramina	1 9	1 7	1 6	1 9	2 1	1 11
Distance between the inferior margin of the nasal bone and that of the premaxillary	2 2	2 6	2 1	2 0	2 9	2 3
Distance from the anterior margin of the occipital foramen to the posterior margin of the bony palate	2 10	2 6	2 5	2 5	3 0	2 8
Length of the bony palate along the median suture	2 10	3 2½	2 9	3 0	3 3	3 3
Length from the anterior margin of the premaxillaries to that of the prepalatal foramen	0 9	0 11	0 9	0 11	1 2	0 11
Breadth of the crown of the first incisor, upper jaw	0 6¼	0 7	0 6	0 6	0 7	0 6½
Breadth of the four incisors, *in situ*, upper jaw	1 6	1 7½	1 6	1 5	1 6	1 6
Fore and aft extent of the grinding surface of the molar series, upper jaw[1]	1 11½[2]	2 3½	1 11½	1 11	2 2	2 0
Length of the enamelled crown of the canine tooth, upper jaw	1 0	1 1	0 7	0 7	1 0	1 0
Breadth, greatest, of the enamelled crown of the canine tooth, upper jaw	0 7	0 7½	0 6	0 6	0 8	0 7½
Length of the lower jaw, from the condyle to alveolar margin of incisors	5 7	5 13	5 3	6 0	6 9	6 2
Height of ascending ramus of lower jaw	3 5½	3 6	3 3	4 0	4 4	3 10
Greatest breadth of lower jaw (between outsides of condyles)	4 6	4 9	4 3	4 10	5 5	5 0
Interspace between mental foramina	1 7½	1 8	1 10	2 0	2 1	1 10
Fore-and-aft extent of grinding surface of the molar series[1], lower jaw	2 4	2 8	2 2	2 3	2 6	2 6
Least interspace between temporal ridges	1 4	1 10	1 10	0 7	....	1 3

[1] The bicuspids or premolars are included in this series.

[2] Exclusive of the small supernumerary back-tooth; including that, the length of the molar series is the same as in Nos. 2, 2″, 2‴.

XIV. *On the Anatomy of the Great Anteater* (Myrmecophaga jubata, *Linn.*).—Part II.

By Professor Owen, *F.R.S., F.Z.S. &c.*

Read February 10, 1857.

In my former communication on the Anatomy of the Great Anteater [1], the position of the stomach and its relations to adjoining viscera were briefly pointed out. In the present paper I propose to describe the form and structure of this very remarkable organ in the *Myrmecophaga jubata.*

Moderately distended (Pl. LI.), the stomach presents a subglobular form, of about 8 inches diameter, with a smaller subglobular appendage as it seems, of about 3 inches diameter (*g*, *g*,), intervening between the main cavity (*c*, *c*) and the intestine (*m*).

The œsophagus (*a*) terminates near the middle of the upper surface of the main portion, of which about 4 inches extend to the left of the cardia, to form what Haller called the 'saccus cæcus.' The general configuration of the stomach, as seen from the anterior surface, is shown in Plate LI.

On the middle of both the anterior and posterior surfaces of the stomach is a sheet of tendon (*d*), of an irregular triangular form, 6 inches in longest diameter, which is in the direction of the length of the stomach, and in which the tendon extends from the large to the small division of the organ, expanding upon both divisions, but acquiring upon the latter its greatest thickness and whitest colour.

Upon bisecting the stomach lengthwise, as in Plate LII., the part described as the main cavity (*c*, *c*) is seen to correspond with the cardiac division, and the appendage (*h*, *i*) to correspond with the pyloric division of the stomach, in Rodentia: but they are much more distinct in structure and functions in the *Myrmecophaga jubata* than in any other mammal with a stomach similarly divided externally. The cardiac cavity has a vascular secreting surface, the lining membrane being disposed in very numerous small wavy rugæ: at the parts where the parietes have yielded most to the distending force, the rugæ are nearly effaced: other larger and more permanent folds are confined to the vicinity of the communication (*f*) with the pyloric cavity, and converge towards the aperture (Pl. LIII. fig. 1, *e*).

The cardiac orifice in the inverted stomach (Pl. LIII. fig. 1, *b*) presents the form of a narrow, slightly bent crescentic slit. It is situated about 3½ inches from the similarly shaped aperture (*f*) of communication between the cardiac and the pyloric cavities:

[1] Trans. Zool. Soc. vol. iv. p. 117.

but the margin of this latter aperture is indented, as it were, by the ends of the converging folds of the lining membrane, about ten in number (*e*, *e*), which are continued into the pyloric cavity. The length of the cardiac slit (*b*) is 1 inch, that of the intercommunicating aperture (*f*) is 1 inch 3 lines.

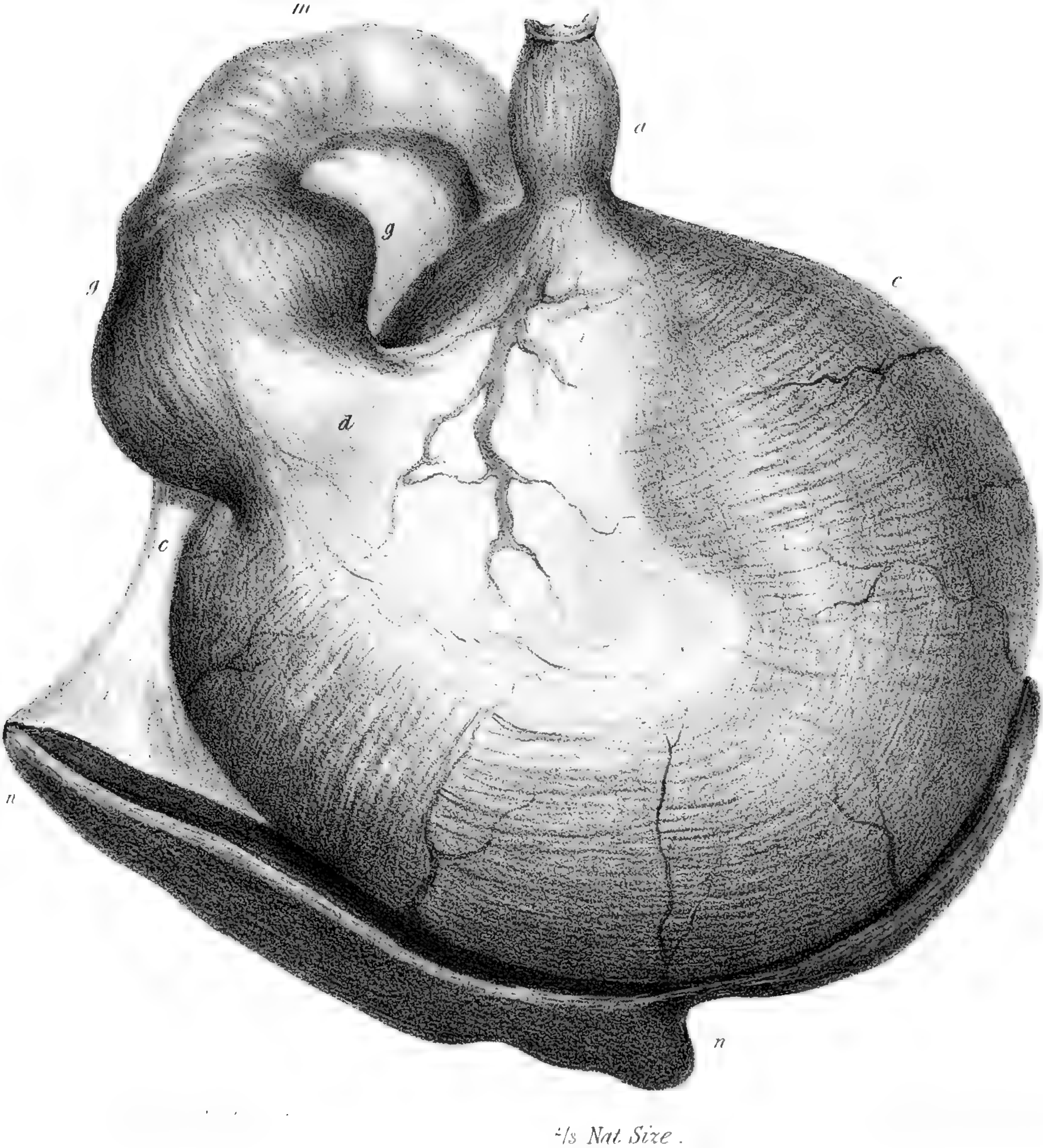
The pyloric division of the Great Anteater's stomach is remarkable for the thickness of its muscular tunic and the density of its epithelial lining, which convert it into a veritable gizzard.

The muscular coat (Pl. LII. fig. 2, *h*, *h*) varies from one inch to half an inch in thickness; at the middle of the cavity it is separated from the lining membrane by an unusual accumulation of the elastic submucous cellular tissue (*i*), which is most abundant in the upper wall of the cavity. A very small proportion only of food can enter at one time into this cavity (*k*), to be subjected to the triturating force of its parietes, operating, with the aid of swallowed particles of sand, in the comminution of the unmasticated or imperfectly masticated Termites.

The area of the pyloric cavity, as exposed by a vertical longitudinal section, as in fig. 1, Plate LII., appears a mere linear, slightly sinuous, tract, with a dilatation near the pylorus (*l*), due to a kind of valvular protuberance of the upper wall projecting towards that aperture. But, when the pyloric cavity is bisected transversely, as in fig. 2, its area then presents a crescentic figure, owing to the protuberance formed by the thicker muscular tunic and the more abundant submucous elastic tissue (*i*) in the upper parietes. The lower longitudinal plicæ (*k*), which commenced on the cardiac side of the intercommunicating aperture, give a longitudinally ridged character to the inner surface of the cavity.

This character is changed near the pylorus, for a reticular rugosity: the pylorus, when viewed from the duodenal side, as in Plate LIII. fig. 2, presents a crescentic form, with the horns of the crescent directed upwards. The lining membrane of the duodenum (*m*) soon became smooth.

For the use of the accurate and beautiful drawings, made after my dissections by Mr. H. V. Carter, formerly Anatomical Student in the Museum of the Royal College of Surgeons, which illustrate the present portion of the anatomy of the *Myrmecophaga jubata*, I am indebted to the liberal permission of the President and Council of the Royal College of Surgeons of England.



2/3 Nat. Size .

Nat Size

Fig 1

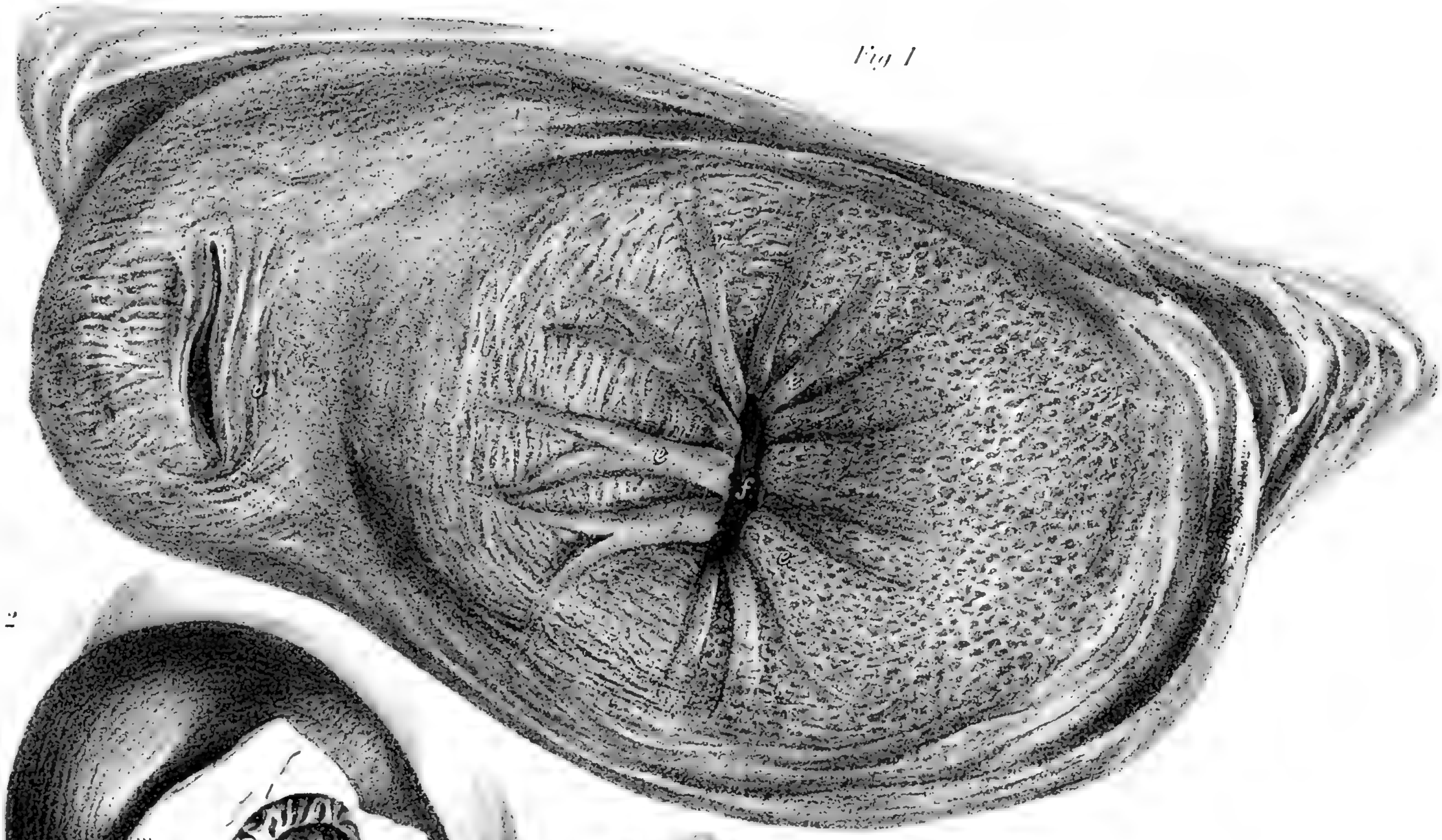


Fig 2

Nat Size

DESCRIPTION OF THE PLATES.

PLATE LI.

The stomach, moderately distended, with the spleen; two-thirds of the natural size.

PLATE LII.

Fig. 1. Longitudinal section of the stomach, moderately contracted; natural size.
Fig. 2. Transverse section of pyloric division; natural size.

PLATE LIII.

Fig. 1. The cardiac portion of the stomach inverted to show the termination of the œsophagus and the opening into the pyloric portion; natural size.
Fig. 2. The beginning of the duodenum slit open to show the form of the pyloric aperture; natural size.

The following letters indicate the same parts in each figure:—*a*, œsophagus; *b*, cardia; *c*, cardiac division of stomach; *d*, gastric tendon; *e*, *e*, folds converging to, *f*, orifice of, *g*, pyloric division; *h*, the muscular coat; *i*, the submucous cellular valve; *k*, dense plicated epithelial lining of the cavity; *l*, pylorus; *m*, duodenum; *n*, spleen.

THE DODO

Poland St W

[FROM A PICTURE BY ROLAND SAVERY]

XV. *Additional evidence relative to the Dodo.* *By* W. J. Broderip, *Esq., F.R.S., L.S., G.S., Vice-President of the Zoological Society of London.*

Read March 28, 1852.

THE interest which attaches to any communication relative to an extinct, and, at one time, a doubted species, must be my apology for offering the following addition to the evidences of the existence and habits of the Dodo.

My old and valued friend Professor Owen presented me, on his return from Holland some time since, with a short thick volume, bearing on its title-page (not without black letter) the following promise :—

"C. Plinii Secundi Des wijdt-vermaerden Natuurkondigers vijf Boecken.

Handelen van de Nature.

I. Van de Menschen.
II. Van de viervoetige en Kruypende Dieren.
III. Van de Vogelen.
IV. Van de Kleyne Beestjes of Ongedierten.
V. Van de Visschen, Oesters, Kreeften, &c.

"Hier zijn by-gevoeght de Schriften van verscheyden andere oude Authueren de Natuur der Dieren aengaende. En nu in desen laetsen Druck wel het vierde part vermeerdert, uyt verscheyden nieuwe Schrijvers en eygen oudervindinge: en met veel Kopere Platen verziert t'Amsterdam, By Abraham Wolfgangh, 1662."

The frontispiece presents the artist's notion of the Garden of Eden, with a very Dutch Adam and Eve, the latter with the apple in her hand, while the serpent twined round the tree looks sly and satisfied. Our first parents are surrounded by beasts, and in the foreground is represented a piece of water with waterfowl and "ill-shaped fishes."

The superscription is "C. Plinius S. van de Menschen, Beesten, Vogelen en Visschen."

Mr. Strickland, in his elaborate work on 'The Dodo and its Kindred[1],' in which he has done me the honour to adopt the arrangement and the information collected in my article "Dodo," in the 'Penny Cyclopædia[2],' gives some addenda in his postscript to Part I. of his and Dr. Melville's book. "The first of these," writes Mr. Strickland, "is a rare edition of Bontekoe's Voyage, kindly communicated to me by Dr. Bandinel, the Bodleian Librarian, entitled 'Journael van de acht-jarige avon-

[1] London, 4to. Reeve and Co., 1848.

[2] Vol. ix. p. 47 (1837).

tuerlijcke Reyse van Willem Ysbrantsz Bontekoe van Hoorn, gedaen nae Oost-Indien,' published in quarto at Amsterdam, by Gillis Joosten Zaagman. There is no date; but from a narrative introduced at the end, it must be subsequent (probably by a year or two) to 1646. The narrative is nearly a verbatim version of the other Dutch editions of Bontekoe; and the only variation of text which concerns us, is in the statement that the underside of the Dodo dragged along the ground, which is here qualified thus:—'sleepte haer de neers *by na* (i. e. *almost*) langs de Aerde.' But what gives a peculiar interest to this volume is, that it contains (alone of all the editions of Bontekoe which I have seen) a figure of the Dodo, which I here present." Then follows the cut.

"This highly ludicrous representation," continues Mr. Strickland, "is more like a fighting cock than a Dodo; and the black letter of the Dutch text omits to tell us whether this design was due to the pencil of Bontekoe or his publisher Zaagman, or whether it was copied from some contemporary painting now forgotten. But there can be no doubt that this figure refers to the true Dodo of Mauritius, and not to the 'Solitaire' of Bourbon, with which Bontekoe confounded it.

"We may regret that the rudeness of the original woodcut leaves us in the dark as to the nature of the object on which the Dodo appears about to feed. This figure would pass equally well for a testaceous mollusk, or for an arboreal fruit; so that the problem of the Dodo's food seems as far from a solution as ever."

In Wolfgangh's publication, p. 480, is the following description:—

"Op't Eylandt Mauritius in Oost-Indien, als mede op sommige andere plaetsen gelijck mede in West-Indien, vindt men voegels soo groot als Swanen, die men Dodaersen of Dronten noemt, sy hebben groote hoofden, en daer op een velleken in manier van een Kapken, sy hebben geen vleugels, dan in plaetsvan dien, 3 of 4 swarte pennekens, en daer haer staert behoorde te staen, daer Zijn 4 of 5 gekrulde Pluymkens, van graeuwachtige verwe. Sy hebben een dicke ronde Naers, daer uyt het schijnt, dat haer de naem van Dodaers toe gekomen is; in de maegh hebben sy gemeenlijck een Steen van een vuyst groot, dese is bruyn, graeuw van verwe, en vol gaetkens, en hollingheydt, doch soo hart als grauwe Bentemeer-steen. Het Boots-volck van *Jacob van Neck*, noemdense Walgh-vogels, om datse die niet recht gaer of murruw konden koken: of om datse soo veel Tortel-duyven konden bekomen, die leckerdev smaeckten, datse van dese Dod-aersen de walgh kregen. Aen 3 of 4 van dese Vogels had al't Scheeps volck van een Schip, voor een maeltijdt genoegh t' eeten: Dese Dod-aersen hebbense oock ingesouten en op de reys mede genomen."

This description may be thus rendered:—

"In the island of Mauritius in the East Indies, as also in sundry other places, likewise in the West Indies, men find birds as big as swans, which they call *Dod-aerses* or *Drontes*. They have large heads, upon the top of which is a skin (a little skin-membrane) in the shape of a cap (little cap). They have no wings, but in the place of them there are three or four black feathers; and there where the tail should be, there are instead four or five curling plumes of a greyish colour. They have a thick round rump, and from this it appears they got the name of Dod-aerses. In their stomachs they have commonly a stone as big as a fist; this stone is of a brown-grey colour, and full of little holes and hollows, bnt as hard as the grey Bentemer stone. The boat's-crew of the *Jacob van Neck* called them Walgh-vogels (surfeit birds), because they could not cook them till they were done, or make them tender; or because they were able to get so many turtle-doves which had a much more pleasant flavour, so that they took a disgust to these birds. Likewise it is said that three or four of these birds are enough to afford a whole ship's company one full meal. Indeed they salted down some of them, and carried them with them on the voyage."

At the top of the page in which this passage commences is printed "*Van de Dod-aersen.*" And immediately below it and above the description is a copper-plate of the bird, superscribed "*Dod-aers,*" in engraved italics.

The engraving of the bird is identical in position and accessories with the woodcut given by Mr. Strickland; but the sharpness of the work and the nature of the plate make the whole much clearer. The object at which the Dodo is looking, as if about to feed, is manifestly a testaceous mollusk with a turbinated shell, and between that and the raised foot of the bird is a half-buried spiny *Echinus.*

The locality on which the Dodo is walking has the appearance of a strand which the tide has left dry.

Wolfgangh's account confirms the opinion which I hazarded in the article "Dodo" in the 'Penny Cyclopædia.'

"As to the stories of the disgusting quality of the flesh of the bird found and eaten by the Dutch, they will weigh but little in the scale when we take the expression to be, what it really was, indicative of a comparative preference for the turtle-doves there found, after feeding on Dodos *usque ad nauseam.* 'Always partridges' has become proverbial, and we find from Lawson how a repetition of the most delicious food palls. 'We cooked our supper,' says that traveller, 'but having neither bread nor salt, our fat turkeys began to be loathsome to us; although we were never wanting of a good appetite, yet a continuance of one diet made us weary;' and again, 'By the way our guide killed more turkeys, and two polecats, which he eat, esteeming them before fat turkeys.'"

It does not follow that because the Dodo is represented as looking at the *frutti di mari,* he is about to devour them. But if it be granted he is, the admission would not militate against the opinion of those who would place the Dodo between the Struthious and Gallinaceous birds. It is well known that the turkeys in America come down to the shore and feed upon the "fiddler" crabs; and there would be nothing extraordinary in a quisquilious feeder, such as the Dodo probably was, varying its fruit and vegetable diet occasionally by resorting to such animal substances as it might find on the strand. Common poultry eagerly pick up insects and slugs in the fields, and, in the neighbourhood of tidal rivers and estuaries, may be seen availing themselves of the smaller *mollusca* and *crustacea* left by the retreating tide.

In my article "Struthionidæ[1]," under the section "Didus," is inserted the following extract from a letter written to me by Professor Owen:—

"Whilst at the Hague in the summer of 1848, I was much struck with the minuteness and accuracy with which the exotic species of animals had been painted by Savery and Breughel, in such subjects as *Paradise*, *Orpheus charming the beasts*, &c., in which scope was allowed for grouping together a great variety of animals. Understanding that the celebrated menagerie of Prince Maurice had afforded the living models to those artists, I sat down one day before Savery's *Orpheus and the beasts*, to make a list of the species, which the picture evinced that the artist had had the opportunity to study alive. Judge of my surprise and pleasure in detecting in a dark corner of the picture (which is badly hung between two windows), the Dodo beautifully finished, showing for example, though but three inches long, the auricular circle of feathers, the scutation of the tarsi, and the loose structure of the caudal plumes. In the number and proportions of the toes and in general form, it accords with Edwards's oil-painting in the British Museum; and I conclude that the miniature must have been copied from the study of a living bird, which it is most probable formed part of the Mauritian menagerie."

I little thought, when, with his permission, I published this graphic product of my kind friend's pen, what was in store for me. Not long afterwards, a friend informed me that he had seen a picture at a dealer's painted by one of the Saverys, and that he was pretty sure there was a Dodo in one corner of it. I sent for the picture, and there, sure enough, in the right-hand corner, and consequently to the left of the spectator, was the bird, in all the beauty of its ugliness. The Dodo stands on one foot with its back to the spectator, and turning round its head, which is represented with the huge bill picking the other uplifted foot. Like all the rest of the birds in this picture, which bears the name of Roland Savery, the Dodo is highly finished. The picture is now in my possession. The accompanying plate (Plate LIV.) is a faithful copy of the bird as represented in it.

[1] Penny Cyclopædia, vol. xxiii. (1842).

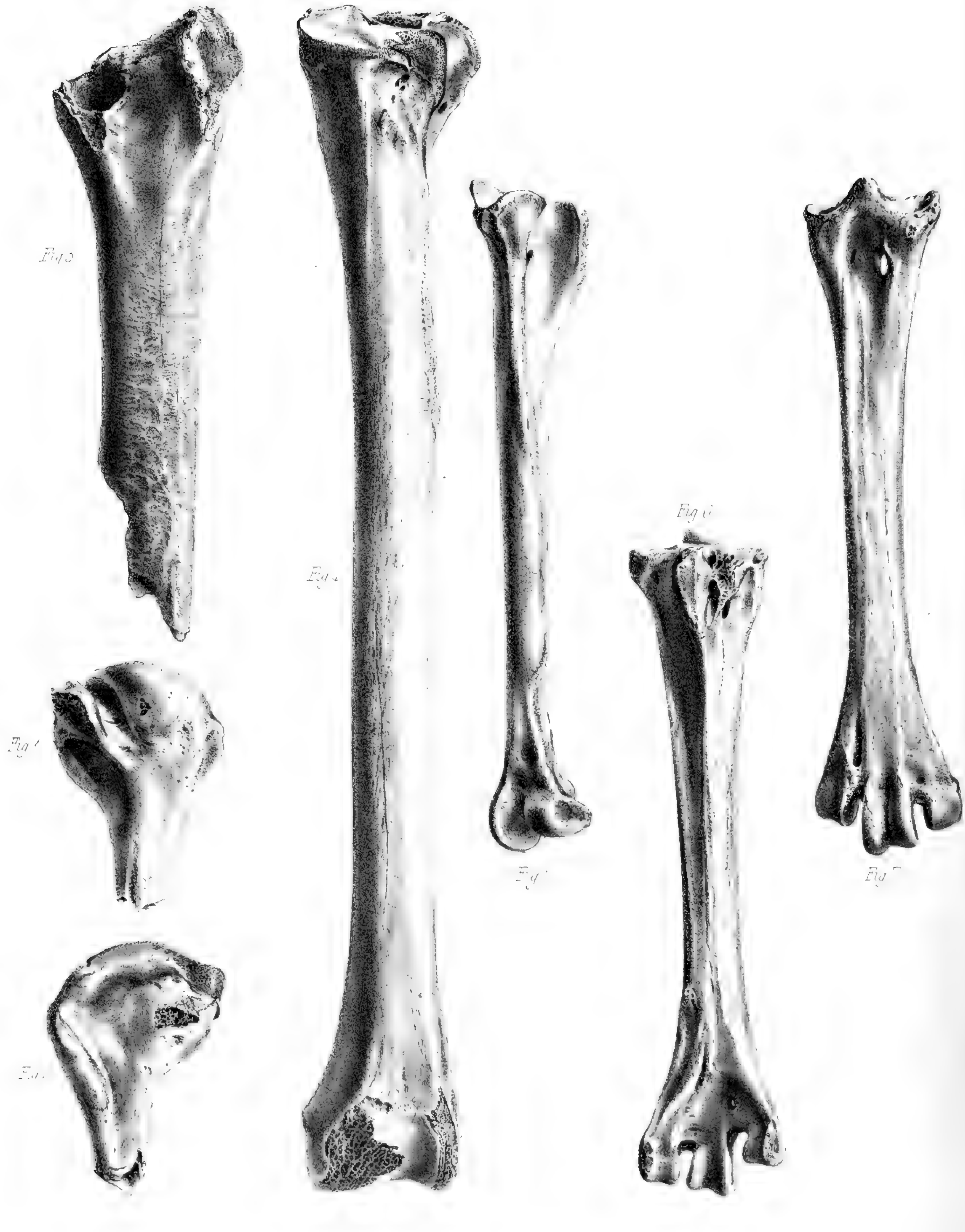


Fig. 3
Fig. 1
Fig. 2
Fig. 4
Fig. 5
Fig. 6
Fig. 7

XVI. *On some Bones of Birds allied to the Dodo, in the Collection of the Zoological Society of London.* *By* H. E. Strickland, *F.G.S.*

Read April 27, 1852.

An interesting series of bones, procured in the Island of Rodriguez in 1831, and presented by Mr. Telfair to the Zoological Society, which were unfortunately mislaid for twenty years, have lately been discovered by Mr. A. D. Bartlett among the Society's stores. As they throw some important additional light upon the osteology of the Dodo and other extinct birds allied to it, I considered that a description and delineation of these relics might be acceptable to the Society. It will also serve as a supplement to the work published in 1848, by Dr. Melville and myself, on 'The Dodo and its Kindred,' in which all the osteological materials, which were then available to us, were fully described and delineated.

An examination of these bones has shown that they must have belonged to more than one species of bird, and has enabled us to extend this conclusion to the other bones from the same locality, which were formerly referred to a single species. In order to show this, it is requisite to give a brief *résumé* of the entire evidence which we possess on this subject.

It will be remembered that the true Dodo, *Didus ineptus*, of which three heads and two feet are preserved in our museums, appears to have been wholly confined to the island of Mauritius. To expect a bird unable to fly or to swim, to recur, specifically identical, in the volcanic islet of Rodriguez, which is separated from Mauritius by three hundred miles of ocean, would be contrary to those views of "Specific Centres of Creation," which are now becoming generally adopted as zoological truths. On the other hand, the fact of the comparative proximity in geographical position of these two islands would lead us to expect in Rodriguez a recurrence of the same organic structures, but with specific or even generic modifications, which characterize the fauna of Mauritius. Accordingly, it is highly interesting to find, that the bones of extinct birds which have been found at Rodriguez do in fact present, at once, a close zoological affinity and a marked specific diversity, in their relations to that extraordinary bird, the Dodo, for which Mauritius has long been celebrated.

The bones of extinct birds which have been brought from Rodriguez are altogether eighteen in number, and were collected at two distinct periods.

First, is a collection of six bones found in 1789, in a cavern in Rodriguez, where they had become incrusted with stalagmite. Five of these are in the Museum of the Jardin des Plantes at Paris, and one is in my own collection.

Secondly, we have the series of bones, twelve in number, procured in 1831 by the exertions of the late Mr. Telfair. These were found in a cavern, probably the same one in which the former series were found; but instead of being exposed, on the floor of the cave, to stalagmitic incrustations, they were buried in the alluvial soil at the entrance (see Proceedings of Zool. Soc. Part i. p. 31). They are consequently in much better preservation than the bones of the former series, and are wholly free from incrustation. Of these bones, six are in the Andersonian Museum at Glasgow, one is in my possession, and five are the property of the Zoological Society, and form the especial subject of this memoir.

The bones of the *first* series, or those procured in 1789, consist of—

1. A portion of the cranium, figured in 'Dodo and its Kindred,' pl. xiii. figs. 1, 2, 3, 4.
2. Part of the sternum, figured in the same work, pl. xiii. figs. 5, 6.
3. A left humerus, figured *l. c.* pl. xiv. figs. 1, 2, 3.
4. A left femur, figured *l. c.* pl. xiv. figs. 8, 9, 10.
5. A right tarso-metatarsus, figured *l. c.* pl. xv. fig. 3.
6. A left tarso-metatarsus, mentioned in 'Annals and Magazine of Natural History,' 2nd Series, vol. iv. p. 335.

From the similarity in appearance of the above six bones, and the uniform thickness of their stalagmitic covering, it is evident that they have all been found near together in the same part of the cavern; and from the agreement in their proportions and the absence of duplicate bones, I infer that they all belong to the same individual. This is further confirmed by the following label attached to the bone No. 6 by Prof. Bojer, Curator of the Mauritius Museum, when he sent it to me in 1849:—"Tarsus of the Dronte, being a remaining fragment of a more perfect skeleton sent by M. J. Desjardins to the Baron G. Cuvier. The said skeleton was found in a cave at the island Rodrigue by M. Roquefeuille, inhabitant of Mauritius." This proof of the individuality of the above six bones enables us to draw some important conclusions regarding those of the second, or Mr. Telfair's series.

The latter consist of twelve bones, belonging to at least four different individuals. They are all evidently adult, but differ considerably in size, and may be accordingly divided into two sets.

A. Bones of the *larger* dimensions.

7. Proximal portion of a right humerus, belonging to the Zoological Society. See Pl. LV. figs. 1, 2.

8. An imperfect right femur in the Andersonian Museum, wanting both extremities, described in 'Dodo and its Kindred,' p. 117 (but erroneously said to be a *left*, not a *right* femur).

9. The distal half of a right femur, belonging to the Zoological Society. See Pl. LV. fig. 3.

10. A left tibia, wanting the proximal portion, figured in 'Dodo and its Kindred,' pl. xv. fig. 1.

11. A very perfect right tibia; exactly corresponding to No. 10; belonging to the Zoological Society. See Pl. LV. fig. 4.

12. An imperfect left tarso-metatarsus, figured in 'Dodo and its Kindred,' pl. xv. fig. 2.

13. Proximal portion of a right tarso-metatarsus, figured *l. c.* pl. xv. fig. 4.

B. Bones of the *smaller* dimensions.

14. A perfect right femur, figured in 'Dodo and its Kindred,' pl. xiv. figs. 4, 5.

15. A left femur corresponding to No. 14, but mutilated at the extremities, described in 'Dodo and its Kindred,' p. 117, line 6.

16. A nearly perfect right femur, belonging to the Zoological Society, agreeing in size with No. 14.

17. A perfect right tarso-metatarsus, belonging to Mr. H. E. Strickland, described in Ann. and Mag. Nat. Hist. 2nd Ser. vol. iv. p. 336. See Pl. LV. figs. 5, 6, 7.

18. A nearly perfect right tarso-metatarsus, similar to No. 17, belonging to the Zoological Society.

The bones which compose the series A. present a perfect agreement in size and proportions with each other, and also with those numbered 1 to 6, which I regard as members of a single skeleton. There seems therefore no reason whatever to doubt that the whole of the bones numbered from 1 to 13 belong to one and the same species of bird. So likewise the bones of the smaller-sized series, Nos. 14 to 18, agree together so completely in their size and proportions, as to leave no doubt that they likewise belong to a single species. We have next to inquire whether the larger bones Nos. 1 to 13 can be regarded as specifically identical with the smaller ones Nos. 14 to 18, or not.

At the time when Dr. Melville undertook his elaborate discussion of the Rodriguez bones (see 'Dodo and its Kindred,' p. 117), the only bones of the *smaller* series accessible to him were the two femora, Nos. 14 and 15. Being unwilling to found specific distinctions on a mere difference of size, exhibited in these two femora only, he supposed them to be either females or young birds of the same species as the bones of larger dimensions. As, however, we have now obtained an additional femur and two very perfect tarso-metatarsals, all closely agreeing in size, and unquestionably adult, presenting no signs of transition to the large-sized series, we shall probably be justified in drawing a different conclusion.

On comparing together the corresponding bones of the two series, we find that their proportions are to each other as 100 : 77, or very nearly in the ratio of 4 : 3, as the following measures will show:—

	Large series.			Small series.		
	Femur, No. 8.	No. 9.		No. 14.	No. 15.	No. 16.
	Lines.	Lines.		Lines.	Lines.	Lines.
Smallest circumference	29	30		23½	23	23
	Tarso-metatarsus, No. 12.			No. 17.	No. 18.	
	Lines.			Lines.	Lines.	
Total length	87			68	69	
Smallest circumference	23½			17	17	

But though the difference in size of the corresponding bones of these two series is thus considerable, I have not been able to detect any diversity whatever in the proportions of their parts. No question can possibly arise as to their *generic* identity; we have only to consider whether a diversity of size, amounting to the ratio of 4 : 3, suffices to indicate *specific* distinctness.

In the first place, it is evident that this difference of dimension cannot be due to age, the smallest-sized bones affording the same proofs of complete maturity as the largest. The small femur No. 16 in particular appears, from the rugose condition of its surface, to have belonged to an aged individual. Nor is it, I think, probable that these differences of size can be sexual. Were these bones referable to the Gallinaceous order, we might perhaps find examples in that polygamous group, of diversities of size in the two sexes, sufficient to justify such a conclusion. But the bones in question have been satisfactorily shown to belong to the order of *Columbæ* (see 'Dodo and its Kindred,' pp. 54, 114), a group in which the males and females present very nearly the same dimensions, and certainly never vary in so large a ratio as 4 : 3[1].

It seems to me equally impossible to believe that a difference of size amounting to 4 : 3 can come within the limits of ordinary or accidental variations in the same species. Such varieties of stature, if they ever occur to this amount among birds of the same species, are always due to peculiarities of food or climate, operating at remote localities, and never affecting the individuals inhabiting a small island, and all subjected to the same external influences. I cannot therefore avoid the conclusion, that we have here the proofs that two distinct species formerly inhabited the island of Rodriguez, differing greatly in size, and probably (like other birds) exhibiting some other distinctions of external appearance, of which no traces are left on the parts of their skeleton which have been yet discovered. Should, however, the bones of the beak of these two supposed species be ever obtained from the alluvia of Rodriguez, we may expect to find some indications of specific distinctions depending on form as well as on size.

In the work referred to, Dr. Melville and myself have uniformly spoken of the

[1] Leguat's statement regarding the *Solitaire*, that "some of the males weigh forty-five pounds," certainly indicates that the females were somewhat smaller; but as he does not mention the weight of the latter, his words prove nothing as to the amount of sexual disparity.

bones brought from Rodriguez as those of the *Solitaire*, which we now know to have existed in that island as recently as 1735 (see Ann. and Mag. of Nat. Hist. 2nd Ser. vol. iii. p. 138). That some of these bones have belonged to that extinct bird, there is no reason to doubt; but as I consider it proved that these relics indicate two distinct species, it is worth while to inquire which of these is to be regarded as the true *Solitaire* of Leguat and D'Heguerty. In this inquiry we have no other data but that of size to guide us. Now Leguat compares *Solitaires* in a general sense to Turkeys (*Meleagris gallopavo*), but adds that they are longer in the leg ("plus haut montés"). He states, that in the winter season, when they are "extraordinairement gras," some of the males weigh forty-five pounds. This statement is confirmed by D'Heguerty, who describes them as "plus gros qu'un Cygne."

It is evident from these statements that the *Solitaire* must have been larger than a Turkey, the males of which rarely exceed the weight of thirty pounds. And as the tarso-metatarsus of a large Turkey is barely 6 inches in length, that of a *Solitaire*, which was proportionally longer in the leg, must have considerably exceeded 6 inches. Now the tarso-metatarsi of the smaller series of bones are only 5 inches 8 lines in length, while those of the larger series measure from 7 inches 1 line to 7 inches 3 lines, and thus fully conform to the dimensions of the *Solitaire*, as indicated by Leguat.

I therefore conclude that it is the larger of the two supposed species which we are to regard as the *Solitaire* of Leguat and D'Heguerty, and for which therefore the names *Didus solitarius* of Gmelin, and *Pezophaps solitaria* proposed by Dr. Melville and myself, must be retained.

With regard to the smaller-sized species of which we possess bones, we may either conjecture that it had become extinct before Leguat's visit to the island, or we may suppose that in these bones we see the relics of the birds obscurely described by Leguat under the name of "Gelinottes" (see 'Dodo and its Kindred,' p. 55), and to which M. de Selys Longchamps has rather prematurely applied a scientific name, *Apterornis bonasia* (Revue Zoologique, 1848, p. 294). Our information respecting these *Gelinottes* is, however, at present too vague to justify any specific or generic identifications of them; and until our knowledge is advanced by procuring further osteological evidence from Rodriguez, I prefer to attach to the bones of smaller dimensions the provisional specific name of *Pezophaps minor*[1].

I will now conclude by briefly describing the five bones belonging to the Society, pointing out such structural peculiarities as their more perfect condition enables us to

[1] In a communication respecting these bones, made by Mr. A. D. Bartlett to the Zoological Society on Dec. 9, 1851, of which an abstract is given in the Literary Gazette, 1851, p. 923, it will be seen that he refers them to *three* distinct species—the true *Didus ineptus*, the supposed *D. nazarenus*, and the *Solitaire* of Leguat. I have, however, endeavoured to prove that they belong to *two* species only, neither of which can be referred to the Mauritian *D. ineptus*, nor to the *D. nazarenus*, which is merely a synonym of that bird, based on the erroneous description of Cauche (see 'Dodo and its Kindred,' p. 21).

add to our pre-existing information. I will also append a notice of the single bone in my own possession (No. 17), which has been obtained since the publication of Dr. Melville's chapter on the osteology of the Solitaire. The Nos. used in the list, p. 188 *supra*, are here retained.

No. 7. Proximal portion of the right humerus of *Pezophaps solitaria*. The conformity in size of this fragment to the humerus No. 3, proves that it belongs to this species, and not to *P. minor*. The perfect state of its surface exhibits several characters which in No. 3 are concealed by incrustation. In its general form it closely agrees with the humerus of the *Columbidæ*, but differs in the non-development of the anterior crest, to which the great pectoral muscle is attached. In Pigeons and most birds of strong flight this crest is expanded into a narrow ridge, projecting forwards and outwards, while in this bird we find only an obtusely rounded surface for the insertion of the pectoral muscle. In the incrusted humerus No. 3, the absence of this ridge induced Dr. Melville to suppose that it had been broken off before the bone became incrusted; but the specimen before us proves that its non-development is a characteristic feature in the structure of the bird.

As it is the projection of this crest in volatile birds which supplies the pectoral muscle with a powerful lever for producing the downward stroke of the wing, and thus sustaining the bird in the air, so we can see the probable reason why in the Solitaire, which we know from historical sources to have been incapable of flight, this ridge should remain entirely undeveloped.

I may add, that the small size of the humerus in this bird is alone sufficient to prove its inability to fly. In the volatile *Columbidæ* we find the humerus to be slightly *longer* than the femur. Thus in *Columba palumbus* the humerus is to the femur as 13 to 11, and in *Goura coronata* as 20 to 17. But in the species before us, the humerus No. 3, which I consider to belong to the same individual as the femur No. 4, is *shorter* than it in the very considerable ratio of 47 to 73.

The pneumatic foramen of this humerus is large, and proves that air was admitted into its interior,—a fact, however, quite consistent with inability to fly, as is shown in the case of the *Struthio* and *Rhea*, which, though non-volatile birds, yet possess a certain amount of pneumaticity in their bony skeleton.

The transverse fracture of the shaft enables us to see that its interior cavity is filled towards the upper part with coarsely interlacing cancellous fibres.

The measurements of this humerus are as follows:—

	inch.	lin.
Extreme width from the anterior to the posterior crest	1	$5\frac{1}{2}$
Smallest horizontal diameter of shaft	0	6
Smallest vertical diameter of shaft	0	$5\frac{1}{2}$
Horizontal diameter of medullary cavity	0	4
Vertical diameter of medullary cavity	0	3

Proceeding to the hinder extremities, we have next to notice the bone No. 9, a fragment of a right femur, comprising the distal half, of which the articular extremity is much injured. From the rugged condition of its surface, it seems to have belonged to a very aged individual. Its dimensions appear to correspond exactly with those of the femur No. 4, allowing for the thickness of the incrustation on the latter bone. The only measurements which the broken condition of this fragment enable us to take, are the following:—

	lines.
Transverse diameter of the shaft	10
Antero-posterior diameter of the shaft	8
Transverse diameter of medullary cavity . . .	7½
Antero-posterior diameter of medullary cavity .	5½

We will next speak of the very perfect right tibia, No. 11, which, from its precise conformity to the broken left tibia, No. 10, is probably a portion of the same individual. The distal portion of the tibia, No. 10, has been already fully described by Dr. Melville in 'Dodo and its Kindred,' pp. 116, 117.

The proximal extremity is nearly perfect, with the exception of the internal ridge, which is broken off. In general form it agrees with the same bone in the *Columbidæ*. The fibula is absent, but the rugose ridge to which it was attached is distinctly shown.

The dimensions of this bone are as follows:—

	inch.	lin.
Total length	10	1
Transverse diameter of proximal extremity	1	7
Antero-posterior diameter of proximal extremity . .	1	9
Length of fibular ridge	2	3
Distance from distal extremity of fibular ridge to inter-condyloid groove	6	2½
Smallest transverse diameter of shaft	0	8
Smallest antero-posterior diameter of shaft	0	6½
Breadth of lower extremity	1	4
Antero-posterior diameter of lower extremity . . .	1	3½

The discovery of this nearly perfect tibia has now enabled us to compare the dimensions of the three principal bones of the hinder extremity in the larger species of Solitaire. We are thus enabled to draw approximate conclusions both as to its absolute stature, and as to the proportions of its parts, as compared with other species of birds.

We may now therefore adopt as the maximum length, in *Pezophaps solitaria*, of the

	inch.	lin.
Femur	7	2
Tibia	10	1
Tarso-metatarsus . . .	7	0

In a skeleton of *Goura coronata* now before me, we find the

	inch.	lin.
Femur	3	4
Tibia	4	10
Tarso-metatarsus	3	7

The proportion between the three bones is nearly the same in these two birds. Now the measurements of the *Goura* are very nearly half those of the *Pezophaps*, and as the *Goura* when living measures about 19 inches from the ground to the crown of its head, we may assume the Solitaire to have been about 38 inches in height, a stature which sufficiently corresponds with the descriptions of Leguat and D'Heguerty.

Proceeding from these larger bones to the smaller series on which I have based the specific name of *Pezophaps minor*, we have, first, the right femur, No. 16. This differs from the femur No. 14, figured in 'Dodo and its Kindred,' pl. xiv. figs. 4, 5, 6, 7, only in being of rather smaller dimensions (a quarter of an inch shorter), though the rugose state of its surface indicates an aged individual. As it is less perfect at the extremities than the femur No. 14, which has been already figured and fully described by Dr. Melville, I need not notice this bone further than to append its dimensions:—

	inch.	lin.
Length from the intercondyloid notch to the upper surface of the neck	5	0
Transverse diameter of the shaft	0	8
Antero-posterior diameter of the shaft	0	$6\frac{1}{4}$
Transverse diameter of superior extremity	1	$5\frac{1}{2}$
Transverse diameter of inferior extremity	1	$4\frac{3}{4}$

The right tarso-metatarsus No. 18, belonging to the Zoological Society, is an almost exact duplicate of the bone No. 17, sent to me by M. Bojer, and noticed in 'Annals and Magazine of Nat. Hist.' Ser. 2. vol. iv. p. 336. As the latter bone is rather the more perfect of the two, I have given a figure of it (Pl. LV. figs. 5, 6, 7) in preference to the former. The only noticeable difference between these two bones consists in the form of the concavity beneath the proximal extremity, which is rather shallower and more expanded in No. 18 than in No. 17. This is especially the case in its lower part, beneath the internal interosseous foramen, at the insertion of the *tibialis anticus* muscle. So slight a modification in form must not be regarded as indicating any specific distinction. It will be seen from the following Table that the bone No. 18 is slightly the longer of the two.

	No. 17. inch.	No. 17. lin.	No. 18. inch.	No. 18. lin.
Length from lower border of middle trochlea to summit of intercondyloid tubercle	5	8	5	9
Transverse diameter of the shaft	0	6	0	6
Antero-posterior diameter of the shaft at the upper portion of articular surface for posterior metatarsal	0	4	0	4
Transverse diameter of lower extremity	1	$3\frac{1}{2}$	1	$3\frac{3}{4}$
Distance from upper border of posterior metatarsal articular facet to internal intertrochlear notch	1	3	1	$3\frac{3}{4}$
Length from external trochlea to external condyloid fossa	5	$1\frac{1}{2}$	5	$2\frac{1}{2}$
Length from internal trochlea to internal condyloid fossa	5	$2\frac{1}{2}$	5	$3\frac{1}{2}$
Breadth of upper extremity	1	2	1	$2\frac{1}{4}$
Antero-posterior diameter of upper extremity	1	1		
Projection of ento-calcaneal process	0	$5\frac{1}{2}$		

The tarso-metatarsus is the only bone of the genus *Pezophaps* (with the exception of the very imperfect fragment of the cranium No. 1) which we are at present able to compare with its corresponding member in the genus *Didus*. Fortunately also it is one of the most characteristic bones in the ornithic skeleton, presenting peculiarities of structure in each of the orders and families which enable us in most cases to identify with certainty the group of birds to which any example of this bone has belonged.

On comparing the bones Nos. 17 and 18 with the tarso-metatarsus of the Dodo, described at p. 102, and figured in plate xi. figs. 1, 2, 3, 4, 5, 6, of the work above referred to, we are struck at once by the much slenderer proportions of this bone in *Pezophaps* than in *Didus*. Although the tarso-metatarsus of the former is longer by 6 lines than the latter, its transverse diameter is one-sixth less. The width of both extremities of the bone is also considerably less in the *Pezophaps* than in the *Didus*.

These differences of proportion all indicate that the *Pezophaps* was a taller bird, but of lighter weight and more active movements than the *Didus*—a distinction, to which the historical accounts of the Solitaire and of the Dodo bear ample testimony.

With the exception, however, of this difference in the proportions of its length and breadth, the entire details of structure are almost identical in the tarso-metatarsus of these two birds. The elaborate description given by Dr. Melville of the tarso-metatarsus of the Dodo (' Dodo and its Kindred,' p. 103) would apply almost word for word to the bones before us, and afford the most convincing proof of their close affinity. There are indeed some very slight modifications of form which distinguish the tarso-metatarsus of the Solitaire from that of the Dodo, which are carefully pointed out by Dr. Melville, *loc. cit.* p. 118, and which I need not now adduce. I may, however, refer to two points, which the perfect state of the specimens Nos. 17 and 18 has now for the first time brought to light. These are, first, the considerably less development of the inner or longest calcaneal process in *Pezophaps* as compared with *Didus*. Thus, while the antero-posterior diameter of the proximal extremity in the tarso-metatarsus of *Didus* amounts to 1 inch 4 lines, the same measurement in *Pezophaps minor* reaches only 1 inch 1 line. Again, at the lower extremity we find that the three trochleæ are placed more nearly in the same vertical plane in *Didus* than they are in *Pezophaps*, in which latter bird the two lateral trochleæ are placed more obliquely and more posteriorly in reference to the middle one than they are in *Didus*. This arrangement seems to imply a greater divergence in the lateral toes of *Pezophaps* than in those of *Didus*, which would probably enable the former bird to run with a speed never attained by the latter.

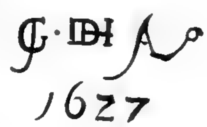
The peculiar position of the calcaneal canal on the *outer* side of the posterior ridge, which distinguishes the Pigeons, and the allied group of *Pteroclidæ*, from all other birds, and which forms one of the strongest proofs of the Columbine affinities of the Dodo, is well seen in the bone No. 18. It fully justifies our former conclusions not only as to the proximity of *Pezophaps* and *Didus*, but as to the position of both these birds, showing that they are a peculiar and exceptional, yet in all essential points a genuine subfamily of that great and isolated family the *Columbidæ*.

The views of ornithic structure, which the examination and comparison of these scattered relics have thus gradually developed, render it more than ever desirable to search for other portions of the skeleton of the different members of the group *Didinæ* which once inhabited the Mascarene Islands. Of the two species of *Pezophaps* from Rodriguez, many important parts of the skeleton, and especially the cranium, have yet to be discovered. Of the *Didus* of Mauritius we still want the femur, the tibia, and all the bones of the body and anterior extremities, while of the so-called "Solitaire" of Bourbon not even a fragment has yet been brought to Europe. After the success, however, which has attended similar researches in New Zealand, we cannot doubt that an active naturalist, by excavating the alluvia of these different islands, might restore the entire skeletons of these extraordinary birds.

XVII. *Notice of an Original Painting, including a Figure of the Dodo, in the Collection of His Grace the Duke of Northumberland, at Sion House.* *By* W. J. Broderip, *Esq., F.R.S., V.P.Z.S., &c.*

Read April 12, 1853.

PROFESSOR OWEN, at whose disposal the Duke of Northumberland placed the following additional pictorial evidence of the existence of the Dodo in the seventeenth century, has requested me to draw the attention of this Society to the highly interesting picture which the Duke has been so good as to send for the inspection of the Fellows. The size of the picture, which is in the finest preservation, is thirty-two inches by nineteen. It is executed in oil, and bears the following monogram and date.



Mr. William Russell, with his usual discernment, detected in this monogram the signatures of Jean Goeimare and Jean David de Heem, and proved the correctness of his judgment by a reference to Brulliot[1]. Jean Goiemare, who is not noticed by Descamps, Bryan, Sandrart, or Houbraken, is described by Brulliot as a Flemish artist who flourished

[1] Dict. des Monogrammes, 1 partie, pp. 201, 274.

at the commencement of the seventeenth century, and painted landscapes with many animals, executed with great care, but in rather a dry manner[1]. Of De Heem, the celebrated painter of still life, it would be superfluous to say anything. We may conclude, then, that in this joint production the landscape and animals were painted by Goeimare, and the shells by De Heem.

In this picture, which seems to have been intended as a record of rarities, the foreground represents a sea-shore from which the tide has retired, leaving empty shells of the following genera:—*Nautilus*, *Pteroceras*, *Strombus*, *Triton*, *Pyrula*, *Cassis*, *Cypræa*, *Conus*, *Mitra*, *Turbo*, *Nerita*, *Mytilus*, *Ostrea*, &c. Behind, on elevated ground, are two Ostriches; and below, to the right of the spectator, the Dodo is represented as in the act of picking up something from the strand. The head and body of the bird, covering an area as large as the palm of a man's hand, are seen; but the legs are hidden. The painter of the Dodo, in *my* picture, has given the only complete foreshortened back view of the bird known to me. In the Duke's picture the head and body are presented to the spectator on a larger scale; and I have nowhere seen the hood or ridge at the base of the bill, from which the bird obtained the name of *Cygnus cucullatus*, so clearly represented. Near the Dodo are a Smew and other aquatic birds, and further off Hoopoes and Terns. In the distance is the ocean, with a sea-monster awaiting the attack of Perseus, who descends on a winged steed to the rescue of Andromeda chained to a rock. Those who have had occasion to describe and figure new species of Testacea, know how difficult it is to find a draughtsman who can give a correct design of the shell to be represented. Unless the artist, like Mr. G. B. Sowerby, jun., is aware of the internal structure of the shell, and acquainted with its organization, a lamentable failure is generally the result. In the picture before us, with one exception—and even in that the specimen may have been distorted—so accurate was the eye of the painter, that if he had been aware of the organization of each shell—knowledge which he probably had not—he could not have represented the objects more correctly. The *Nautili*[2], *Strombus gigas*, *Triton*, and *Pyrula* are painted with great breadth and power, and all are drawn and coloured with wonderful truth; indeed a conchologist may name every species. One of the *Nautili* is partially uncoated, to show the nacre, and the other dissected, to display the concamerations. None of the shells have the epidermis, and all are of the natural size. The artificial condition of these subjects, and especially of the *Nautili*, is, it must be allowed, rather out of place in an assemblage of testaceans left on the sands by the retired tide, unless we are to suppose that the sea-nymphs had been amusing themselves by polishing the specimens and displaying the internal structure of one of them; but this very treatment shows that the designs were accurately made from real objects then considered as rarities. With the exception of the Dodo, none of the natural objects represented are now rare. The shells, especially those whose *habitats*

[1] I am indebted to Mr. Russell for this information.

[2] *Nautilus pompilius*.

are the seas of the Antilles, are at present very common; but at the date of the picture—the second year of the reign of our first Charles—the natural productions of the West Indies were not well known, and were, comparatively, very scarce. With the shells on the shore is the cranium of a carnivorous quadruped, apparently of the family *Canidæ*. The monster-cetacean in the distance has evidently no chance with the avenger who is coming down upon him mounted on a winged steed. But Pegasus, who, with other prodigies, sprang from the blood that dropped from Medusa's head, as the conqueror who had cut it off with his harpe traversed the air with his gory trophy, immediately winged its flight to Helicon, there to become the pet of the Muses. The best version of this mythological story relates, that when Perseus afterwards killed the sea-monster and delivered Andromeda on the coast of Ethiopia, he effected his purpose by raising himself in the air through the aid of the wings and talaria given to him by Mercury, and not with the help of the winged horse on which most of the painters mount him.

Professor Owen informs me that Roland Savery's picture containing the Dodo, in the Berlin collection, bears the date of 1626; and that the colour of the Dodo in the Duke of Northumberland's picture resembles that of the portrait of the bird, of life size, by the same painter, now at Oxford. L'Estrange describes the hue of the back of the living Dodo which he saw exhibited in London "about 1638," as of "dunn or deare colour."

XVIII. *Monograph of the* Strigidæ. *By* Dr. J. J. Kaup, *Director of the Museum at Darmstadt; Corresponding Member.*

Read June 8, 1852.

Subfamily I. SURNIINÆ, *Kaup*. Day-Owls.

I. *Glaucidium*. II. *Nyctale*. III. *Athene*. IV. *Surnia*. V. *Ieraglaux*.

Diagnosis.—They have the handsomest and roundest skull, with large brain, high rounded front, small pneumacity. The greater number of this genus have a little ear-orifice without operculum; the feather-wreath round the ear is mostly not so distinct as in the Night-Owls. No genus in this subfamily has feather-horns, or a dentellated claw on the middle toe, as *Strix*. Most birds of this genus are Day- or Twilight-Owls, except *Nyctale*, which is in this respect a true Night-Owl.

Genus I. Glaucidium[1], *Boie*.

a. *Glaucidium*. b. —— ? c. *Microglaux*. d. —— ? e. *Tænioptynx*.

Diagn.—The nostrils mostly in the middle of the swollen pea-shaped *cera*. The first wing-feather shorter than the tenth wing-feather. Wings short, only reaching to the upper coverts of the long and variegated tail. We find in this genus the smallest of all the Owls; their food is insects.

Description.—The yellow bill curves rapidly from the *cera*. The lower jaw is on the end and sides emarginated by four teeth-like points; the short wings only reach to the upper tail-coverts; the webs of the wing-feathers are small, the first to the fourth with emarginations; the first wing-feather short and dentellated. Tarsi and toes very well developed. The cross-banded or spotted tail as long as the body. The handsome skull shows a thorn-shaped prominence on the front part of the eye-margin (Plate LVI. fig. 1); and the *zygoma* has on its posterior part (fig. 2) a leaf-like prominence, of which all the true *Striginæ* are destitute, and which is in other *Surniinæ* not so well developed. All the species have a white, black and rufous spotted collar, which reminds us of the American *Tinnunculi*. Up to the present time we know only of three subgenera.

Subgenus a. *Glaucidium*, Boie.

Diagn.—Nostrils in the middle of the pea-shaped *cera*; inner webs of the wing-feathers broader, with emarginations more towards the end, and a spotted or unicolor plumage. All the species are found in the southern parts of America.

[1] Boie gives this name in the 'Isis' to *Strix nana* et *passerina*. The latter species belongs to the genus *Surnia*, with very different *cera* and nostrils. G. R. Gray and Bonaparte erroneously give this name to *passerina*.

1. Glaucidium pumilum, *Kp.*

Strix pumila, Ill. Temm. Pl. Col. 39.
—— *ferox*, Vieill. Azara, N. 49.
—— *minutissima*, Pr. Max.
Athene pumila, G. R. Gray.
—— *minutissima*, Bp.

Diagn.—Tail 53 mm. long only, with three to four white spots, not reaching to the shafts.

Descr.—The head-feathers light ash-grey; each with three round white spots, and margined with black. Shoulder-coverts partly unicolor, partly with three white or rufous-yellow-white spots, mostly on the outer webs, which do not form a large band. The smaller feathers of the wings with round white spots on the outer webs, sometimes on the shaft and concealed. Outer webs of the first and second wing-feathers unicolor; third and fourth with two to three rufous-yellow spots. The wing on the interior parts whitish, towards the end dusky, with five to six dark cross bands. The tail with three to four pairs of white spots, not reaching to the shafts. The lower parts white, with large rufous spots, and two long stripes along the belly. Tarsi rufous-yellowish-white, distinctly spotted with rufous.

Azara says that this smallest of all the Owls, or *Rapaces*, attacks with success the Turkey and Caracara. All the species of this genus feed on insects, and we cannot understand how this pigmy is able to kill birds which surpass him so greatly in weight and strength. Azara possibly observed this unusual courage in a captive one, and he therefore concluded it exercises the like boldness in a wild state. This, although possible, admits of doubt.

2. Glaucidium nanum, *Boie.*

F. Boie, Isis, 1826, p. 976.
Strix nana, King, Zool. Journ. iii. p. 426; Bonap. Consp. p. 37.
Athene nana, G. R. Gray, Genera of Birds, t. 12.
—— *leucolaima*, H. et Jacq. Voy. pl. 4. 2, 3.

Diagn.—Tail 63–70 mm. long, with eight to ten rufous cross bands reaching to the shaft.

Descr.—Head-feathers rufous or grey-brownish, with white shafts and shaft-stripes. Back rufous-brown, with two to three rufous-white spots round the shafts. Shoulder-coverts with rufous-yellowish-white spots, and long, white, dark-margined spots on the exterior margin, forming long stripes. Smaller feathers of the wing with large, round, black-margined spots on the outer webs, and smaller rufous-yellow concealed spots. Exterior web of the first wing-feather with two, second with two or three, third with three white spots. Interior wing-feathers whitish, darker towards the end, with four to six cross bands. Tail rufous, with eight to ten black cross bands. Lower parts white. Sides brownish, with white spots. Tarsi dirty white, cross-banded.

Dimensions.—Wings 92–99, tail 63–70 mm. in length.

Hab. Southern America; Straits of Magellan; Peru.

The figure given in the 'Voy. au Pôle Sud' is too large.

3. Glaucidium infuscatum, *Kp.*

Strix infuscata, Temm. Man. d'Orn. i. p. 97 (1820).
—— *passerinoides,* Temm. Col. 344 (1824); Pr. Max. Beitr. iii. 239.
Glaucidium gnoma, Wagl. 1832, mas juv.
Athene passerinoides et *gnoma,* G. R. Gray.
—— *infuscata,* Bp.

Diagn.—Tail 61–66 mm. long, black, with five to six pairs of white spots not reaching to the shafts.

Descr.—Head-feathers rufous-brown, with white concealed shaft-spots enlarged in the middle. Back unicolor, in young birds light-rufous spotted. Shoulder-coverts rufous-brown, with white spots on the margin of the outer webs, and with rufous concealed spots. Small feathers of the wings with pure white spots on the outer webs. First wing-feather with five light-rufous spots, the second with three to five, third with three light and four dark spots. Interior parts of the wings whitish, with dark ends, and five irregular stripes. Tail dark brown. The lower parts white, with small, distinct, light and dark brown shaft-spots. Sides of the breast when young with rufous-yellow spots. Tarsi whitish.

Dimens.—Wings 90–95, tail 61–66 mm. long.

Hab. Brazil; Mexico; California[1].

An old female from Uruguay, which I have received by the kindness of Professor Lichtenstein, under the name of *Strix eluta* (*elata*, Bp.), has smaller spots on the head and tail, darker back, and more predominant dark brown on the white underparts. It is 6″ long. Professor Lichtenstein gives as a synonymous species with *Strix eluta, Str. passerinoides,* Temm.

4. Glaucidium ferrugineum, *Kp.*

Strix ferruginea, Pr. Max. Col. 199 (♀ juv.); Beitr. iii. 234.
Athene —— ?, G. R. Gray.
Noctua —— ?, Cuv.

Diagn.—The largest and most rufous.

Descr.—The head-feathers rufous, with rufous-yellow shafts; in young birds with rufous-yellow stripes along the shafts. Back unicolor-rufous. Shoulder-coverts rufous,

[1] The Californian species is different—*Glaucidium californicum,* Sclater, P. Z. S. 1857, p. 4: see Cassin's 'Birds of California,' p. 189 (P. L. S.).

with large rufous-yellow or rufous-whitish spots on the outer webs. The smaller feathers on the wings rufous, with very few rufous-yellow, in the middle white, dark-margined spots. Exterior web of the first wing-feather unicolor, in young birds spotted; third wing-feather with traces of five rufous spots. Interior of wing rufous, with six to nine cross bands, in youth with five to seven. Tail unicolor-rufous, in young birds with eight blackish bands. The lower parts rufous-yellow, with large rufous spots, in young birds with long shaft-spots.

Dimens.—Wings 105–111, tail 76 mm. long.

Prince Maximilian of Neuwied states that this very handsome Owl is to be found in nearly all the forests of Brazil, where it is called Cabouré. In his travels he very often heard its voice, which has a great similarity to that of *Falco subbuteo*, and sounds nearly like Keck-Keck, quickly uttered and often repeated. On cautiously approaching, he invariably found a pair of these Owls sitting close together, having certainly their nest in the neighbourhood. They were quite active in motion, very tame, and less oppressed by daylight than other owls. Very often, when in bivouac round the fire in the melancholy forest, he heard these little Owls overhead on a tree. In their stomach he usually found remains of insects.

Subgenus c. *Microglaux*.

These have all the characters of the former; but the nostrils are placed on the margin, and not in the middle, of the pea-shaped *cera*.

5. GLAUCIDIUM HAVANENSE, *Kp.*[1]

Strix havanensis, Licht. in Mus. Berol.

Diagn.—Size of *Gl. infuscatum*. Wing 98–99, tail 65 mm. long, with six narrow bars of rusty-yellow colour.

Descr.—Lorum, face, a stripe over the eye, and stripe under the ear-coverts white. Ends of the long lorum-bristles black. Ear-coverts light rusty-yellow, with blackish spots. Head and neck brownish, with rusty-yellow shaft-spots. Back and shoulder-coverts with more concealed rusty-yellow band and spots. On the margin of the shoulder-coverts no white spots, only broad rusty-yellow bands on the outer webs. The feather of the thumb on the outer web with four rusty-yellow-whitish spots. Alongside this feather a series of coverts with rusty-yellow bands, which are on the outer web white-spotted. The wings with six to seven rusty-red bands, which are on the outer web whitish-spotted. The lower parts white, round the chin rusty-red. The throat white; breast, sides, and belly with irregular rusty-red and black shaft-spots. Tibiæ and the upper part of the whitish, black-spotted tarsi rusty-yellow.

Hab. Cuba. (Mus. Berol.)

[1] This species should stand as *Glaucidium sigu*, Cab. Journ. f. Orn. 1855, p. 465. *Noctua sigu*, D'Orb. (P. L. S.)

6. GLAUCIDIUM PERLATUM, *Kp.*

Athene perlata, G. R. Gray.
Nyctipethes perlatus, Sw. Cl. ii. p. 218.
Scotophilus perlatus, Sw. West Afr. Birds, p. 130.
Strix perlata, Vieill. N. D. d'H. Nat. vii. p. 26; Encycl. Méth. p. 1290.
—— *occipitalis,* Temm. Col. 34.

Diagn.—Size of *Surnia passerina.* Wings 108, tail 78 mm. in length. Lorum, stripe over and under the eye, ear-coverts, chin and throat white; end of the lorum-feathers black. Head reddish, with white, black-margined spots, three on each feather. Back down to the tail-coverts with white, black-margined, but mostly concealed spots. Shoulder-coverts similarly spotted, but bordered on the outer webs with larger, white, black-margined spots. Small feathers of the wing with white dots edged with black, which on the arm-coverts form a long stripe. Thumb-feather with two round white and rusty-yellow spots, and a white margin near the end. Arm and hand wing-feathers rufous-grey or dark brown, with reddish, black-margined spots. Inner wings with broader and more rufous-yellow cross bands. Tail blackish, at the base white, with seven pairs of white, black-margined spots, not reaching to the shaft. Breast spotted with rufous. Sides and belly with rufous and black shaft-stripes. Tibiæ and a part of the tarsi white, spotted with rufous-black. Tarsi thickly feathered, with a black stripe on the outer side.

Dimens.—Head 42 mm. Diameter of the eye 10 mm. Bill from the gape $17\frac{1}{2}$ mm.

Hab. The whole of Africa.

7. GLAUCIDIUM LICUA, *Kp.*

Athene licua, Bp. Consp. p. 37.
Strix licua, Licht.

Diagn.—Very near to *Gl. perlatum*, but with darker colouring, and more brownish on the upper parts. The white spots on the head and neck broader. The shaft-stripes on the sides and belly broader and blackish. The tail with five to six pairs of white spots not reaching to the shaft. Tarsi white, with black spots. Eye not so large as in *G. perlatum.* The male is smaller, and has on the under parts broader stripes, and only five pairs of spots on the tail.

Dimens.—Head 39–41 mm. Wing 100–102 mm. Tail 68–70 mm.

Hab. Caffreland.

Subgenus e. *Tænioptynx.*

Diagn.—Nostrils in the middle of the pea-shaped *cera.* Wings shorter; wing-feathers with the inner webs smaller, and emarginated more towards the quill; fourth and fifth wing-feathers of the same length. The whole plumage banded more frequently and distinctly. It represents the subgenus *Tænioglaux* of the genus *Athene.* We only know of one species, from India.

8. Glaucidium Brodii, *Kp.*

Noctua Brodiei, Burt, Proc. Zool. Soc. 1835, p. 152.
Athene Brodiei, Blyth, Journ. A. S. B. 1842, p. 163.
Noctua tubiger, Hodgson, Journ. A. S. B. 1837, p. 369; As. Res. xix. p. 175; Icon. ined. Accip. 82. 2, 3, et 83.

Diagn.—The whole body banded with rufous-yellow or whitish bands.

Descr.—Head brownish, with one to two rufous-yellow bands and ends to each feather. Back and tail-coverts brownish, with two to four small bands on each feather. Shoulder-coverts with three rufous-yellow bands, which are nearly pure white on the exterior web, and the small feathers with one or two small rufous-yellow bands without white spots. The first primary with two white spots on the external web, the second with three, the third and fourth with from three to four rufous-yellow spots. The under wing-coverts rufous-yellowish, with a black stripe. The wing-feathers before the emarginations light-coloured, afterwards dark, with two to seven cross bands. Tail blackish, with seven to eight small rufous-yellow cross bands, which do not continue quite to the shaft. Under parts white, with three brownish, dark-margined bands on each feather. Femur-coverts with large brown shaft-spots, which are partially and irregularly banded. Tarsi whitish, banded and spotted with brownish.

Dimens.—Male. Wing 87, tail 58 mm. long.—Female. Wing 97, tail 63–66 mm. long.

It is an error to place this species in the subgenus *Tænioglaux* of the genus *Athene*.

Hab. Nepal.

Genus II. Nyctale.

Brehm, Isis, 1828, p. 1271.

a. —— ? b. *Nyctale*. c. —— ? d. —— ? e. —— ?

Diagn.—Very large asymmetric ear-orifice with a well-developed operculum and veil. Bill short, not projected, with a rudimentary *cera* and nostrils on the margin.

Brehm has compared the skull of this genus with that of *Caprimulgus*; we may also compare it with that of *Otus*. Nitzsch says that the *furcula* is divided, and forms a pair of bones, which are connected by a membrane. All the known species are true Night-Owls in their mode of life. The first subgenus, with the first wing shorter than the tenth, is not yet discovered.

Subgenus b. *Nyctale*, Brehm.

Diagn.—First and second wing-feathers with inner webs broad, and emarginated only towards the end. Toes thickly feathered.

1. Nyctale acadica, *Bonap.*

Geogr. Comp. List of Birds of Eur. and N. Am. p. 7.
Strix acadica, Gmel.
—— *acadiensis*, Lath. Ind. Orn. i. p. 65; Syn. i. pl. 5. fig. 2.

Noctua acadica, Rich. and Sw. Fauna Bor. Am. Birds, p. 97.
Scotophilus acadicus, Sw. Cl. of Birds, ii. 217.
Ulula acadica, Aud. pl. 199.
Strix passerina, Wils. pl. 34. i.; Lichtenstein.

Diagn.—Wings 131, tail 70 mm. long.

Descr.—Smaller than the European *N. funerea,* and not so much spotted. The spots on the head are smaller and longer. Back brownish, without spots. Tail with three pairs of white spots. The first six wing-feathers have from one to four white marginal spots. The under parts are white, with rufous-brownish shaft-spots, and large spots on the sides. Bill black.

Specimens of this bird are rare in collections.

Hab. Northern parts of America.

2. NYCTALE FUNEREA, *Bp.*

Nyctale funerea, Bp.
Strix funerea, Linn. (diagn., not the description).
—— *passerina,* Pall. Zoogr. i. p. 323.
—— *Tengmalmi,* Gmel. Naum. t. 48. 2 & 3, adult and young.
Noctua Tengmalmi, Cuv.
Athene ——, Boie.
Nyctale Tengmalmi, Bp. Geogr. Comp. p. 7.
Strix dasypus, Bechst. Brehm's Beitr. p. 354; Gould, Birds of Eur. pl. 49.

Diagn.—Wing 163, tail 100–103 mm. long.

Descr.—Back with concealed white spots. Tail with five to six pairs of white spots, not reaching to the shafts. Under parts white, with obsolete rufous-brownish spots at the bases and the ends of the feathers. Bill horn-brown, with yellow base. Weight 4–4½ ounces. The young bird is dark brown, beneath light grey, tinged with dark brown; on the throat and on the sides of the breast dark brown; coverts of the wings brown.

We find this species thinly scattered through the northern parts of Germany in the pine and mountain forests. Its voice is like the *Athene noctua,* and sounds "Kêüw-Kêüw," after which follows three or four times "Kuick." The voice resembles very much that of *Otus vulgaris,* but the sound is higher. In the spring it is very difficult to discover any difference between the voices of these two species (*Naumann*). Its voice then sounds more like a continual barking of dogs—"Wa-wa" (*Brehm*). In a cage it is a perfect night bird at the commencement of its confinement, and in daylight seeks the darkest corner; but afterwards its habits are changed by the custom of feeding it only during the day, and it becomes a day-owl. As it hops it lifts the tail high, and leaps like an ape. If provoked, it knacks and bites with the bill. On a sudden surprise it throws itself on its back directly, and defends itself with its projected legs, although it may be at the same time very tame (*Brehm*). This Owl makes grimaces which usually much entertain the spectator, and possesses the remarkable faculty of dilating the feather-wreaths to such an extent, that over each eye is formed an elevated protuberance, which gives the appearance of two little feather-horns. Its flying is like the *Otus vulgaris*, but the strokes of the wing follow more quickly (*Naumann*). It lays four round white eggs, which Brehm describes as with smooth surface and few pores. One of these was 1 inch 5 lines long, and 1 inch $2\frac{1}{2}$ lines broad.

3. NYCTALE RICHARDSONI, *Bp.*[1]

It has nearly the same dimensions (wings 164, tail 96) as *N. funerea* (wings 163, tail 100–103). The only difference is a darker colour on the upper parts, and this is the reason that the white spots are more distinct. The character "longer tail" is not correct.

This is certainly not a true species.

Hab. Northern parts of America.

Genus III. ATHENE, *Boie.*

a. *Cephaloptynx.* b. *Athene.* c. *Pholeoptynx.* d. —— ? e. *Tænioglaux.*

Diagn.—The nostrils are situated on the margin of the swollen short *cera* (Plate LVI. fig. 3). Ear-orifice small. Wings moderately long, reaching nearly to the end of the short tail. Toes naked, with a few bristle feathers. The emarginations on the lower jaw not so distinct. These birds are very nearly connected with the first genus (*Glaucidium*), and the fifth genus (*Ieraglaux*), and are spread over the whole world.

Subgenus a. *Cephaloptynx.*

Diagn.—The first wing-feather shorter than the tenth. First, second, and third very clearly emarginated, fourth not so distinctly. The plumage not banded, but much spotted.

1. ATHENE PUNCTULATA, *G. R. Gray.*

Noctua punctulata, Quoy & Gaim. Voy. Astrol. Ois. t. i. fig. 1.

Descr.—A little larger than *Athene noctua*, with larger head and stronger bill. Front, a stripe over the eye, the whole chin, belly, tarsi, and under wing-coverts pure white. The lorum-feathers mixed with blackish bristles, and with black shafts, reach to the end of the yellowish bill. Ear-coverts brownish-rufous, spotted at the end of each feather. Head, the whole back, the little feathers of the wings dark-brownish, with rufous-yellow

[1] A fourth species of true *Nyctale* is *N. albifrons*, Cass., *Strix albifrons*, Shaw. See Cassin's 'Birds of California,' p. 187, in which book it is also figured as *N. Kirtlandi*, pl. 11. *Hab.* N. America, Wisconsin, and Canada (P. L. S.).

spots, from one to three pairs on each feather. A brownish band under the white chin; on the point of the breast a white spot; next this white spot a dark spot on each side of the rufous-banded breast. The sides and the lower parts of the breast more rufous, with rusty-yellow bands. The backs of the wing-feathers on the inner side yellowish-white; the upper parts with bands not reaching to the shafts; the parts below the emarginations nearly unicolor, because the bands are very indistinct; three to four spots on the margin of the external webs; five narrow bands not reaching to the shafts of the tail-feathers.

Dimens.—Head 57, from the gape 26, wing 158, tail 76, tarsus 35–36, middle toe with nail 30, without nail 22 mm. long.

Hab. Celebes.

Subgenus b. *Athene.*

Diagn.—The first wing-feather as long as the sixth or seventh; first to the fifth slightly emarginated. The first wing-feather dentellated on the external web; the second to the fifth with external emarginations. Tarsus not very high. Plumage spotted. Ear-orifices asymmetric (Pl. LVI. fig. 4).

2. Athene meridionalis.

Noctua meridionalis, Risso, Hist. Nat. de l'Eur. Mér. iii. p. 32.
—— *glaux,* Sav.
—— *passerina,* Rüpp.
Surnia noctua, v. d. Mühle.

Diagn.—Toes with bristly feathers. The lower parts with rufous shaft-stripes. Tail with three yellowish dark-margined cross bands.

Descr.—The head-feathers with smaller and more distinct white shaft-spots. Shoulder-coverts with large white spots.

Dimens.—Head 51, wings 152, tail 75 mm. long.

This Owl is a native of the southern parts of Europe and northern parts of Africa. In Egypt it lives in date-trees, and is very common (*Rüppell*). According to Graf von der Mühle, this Owl is the true 'bird of Minerva' of the old Greeks, and at the present time is very common throughout Greece, where the inhabitants protect it, although it shows little pity towards other birds. It makes its nest in the month of March in fissures of rocks and old walls, and is very often to be seen during daylight on projecting rocks. These birds see very well in the daytime, and fly away on the approach of the hunter. The little birds which live in their neighbourhood, as *Saxicola aurita, S. stapazina, Monticola cyanea, Emberiza cæsia,* &c., have no fear of them, as they never attempt to attack them. They feed their young during daylight, and v. d. Mühle frequently shot the females in the act of doing so. They had only insects in their stomachs. In its manner of living this Owl is very similar to a diurnal hawk, and its voice may be heard the whole day; but no mention is made of hearing it in the night-time. On uttering their peculiar cry they bow their head,—it sounds like *Kukou-wa*. The Grecian name κοηχούβαια is an imitation of it. Savi pronounces it 'Cucutio.' Its name in Lucca is 'Cucca-megia.' No traveller mentions having seen this species in forests, or on a single tree, but all the rocks and naked hills abound with it[1].

3. ATHENE NOCTUA, *Bp.*

Strix noctua, Retz. Fauna Suec. p. 85.
—— *passerina*, Lath.; Temm. Naum. t. 48. 1; Gould, B. of Eur. pl. 48.
Athene passerina, Boie.

Diagn.—Toes with bristly feathers, which have some radii at the base on each side. Tail with four rufous-yellow bands.

Descr.—The head-feathers with large shaft-spots, which are broader at the ends. Shoulder-coverts with large white spots. The lower parts with rufous-brownish shaft-stripes.

Obs.—This is more a twilight bird than the *A. meridionalis*, and belongs to the temperate parts of Europe. It seems to seek the neighbourhood of man, and is found very often in old buildings; also in thin woods, in stone-pits, in the hollows of trees, and in high banks. It is capable of being tamed very quickly. Naumann contends that its flight in the day-time is like that of a woodpecker or hoopoe, descending in arcs. At night it is attracted by a light, and on approaching, utters its peculiar cry with much vehemence, which has given this poor bird an unenviable reputation amongst the superstitious.

Dimens.—Head 50–52, wing 159–180, tail 72–100 mm. long.

4. ATHENE BRAMA, *G. R. Gray.*

Strix brama, Temm. Col. 68.
—— *indica*, Frankl. Proc. Zool. Soc. 1831, p. 115.
Athene indica, Blyth, Journ. A. S. B. p. 369.

Diagn.—Toes with bristly feathers. Tail with four to five distinct small white cross bands. Lower parts with arrow-like black cross bands.

Descr.—The head-feathers with white bands in the middle, and two spots on the ends. Shoulder-coverts with small white spots. The white bands of the tail do not reach to the shaft.

Dimens.—Head 50, wing 152, tail 75 mm. long.

Asia and its Archipelago.

[1] This gave rise to the old Greek adage—when speaking of an unnecessary or superfluous act,—that it was "bringing owls to Athens." This in later days has been anglicised, and we read of men advised "not to carry coals to Newcastle" (K.).

Subgenus c. *Pholeoptynx.*

Diagn.—Middle toe (without the nail) half as long as the long thin tarsus. Wings long. The first wing-feather shorter than the fourth; the first and second clearly, third and fourth indistinctly emarginated.

They live in the southern parts of America and its islands, and make their nests in the holes of Armadillos and of the prairie dogs (*Arctomys ludovicianus*).

5. Athene cunicularia, *Bonap.*[1]

Geogr. Comp. List of Birds of Eur. and N. Am. p. 6.
Strix cunicularia, Mol. Chili, p. 233; ? Aud. Birds of Am. pl. 412; Azara, N. 47 (Urucuru).
Noctua coquimbana, Briss. Orn. i. p. 72.
Strix grallaria, Temm. Col. 146.
Noctua urucuru, Cuv.

Diagn.—Rufous-grey. Tarsus $1\frac{3}{4}$ inches long, feathered to the toes.

Descr.—In the colouring very similar to our *Athene noctua,* but with smaller and more numerous spots, which on the back are black-margined. Breast-sides grey-brown, with rufous-yellow-whitish dark-margined spots, which do not extend to the shaft. Tail with white root and margins, and four pairs of spots, which do not always reach to the shaft. The young bird is darker; the bands especially are darker and more distinct.

Dimens.—Head 54, wing 182, tail 88 mm. long.

Hab. S. America; San Paolo; nests in holes of Armadillos, &c.

Subgenus e. *Tænioglaux.*

Diagn.—The first wing-feather shorter than the tenth. The plumage with many cross bands. Size of *Athene noctua.*

Found in Asia and Africa.

6. Athene castanoptera, *Blyth.*

Blyth, Journ. A. S. B. p. 164 (1842).
Strix castaneoptera, Horsfield, Linn. Trans. xiii. 140.
—— *spadicea,* Reinw. Col. 98.

Diagn.—The head rufous, black-banded. Shoulder-coverts unicolor, brown, with large, white, brown-margined spots on the margins. Tail with six rufous-yellow bands.

Descr.—Each head-feather with four black bands. Back unicolor-rufous. The tail-coverts with three rufous bands on each feather. Shoulder-coverts rufous or brown, with large, white, brown-margined spots on the external web. Arm- and hand-wings dark brown, irregularly banded. The inner webs rufous, with six to seven irregular,

[1] *Athene dominicensis,* Bp. Consp. p. 38, from the Antilles, and *Athene hypogæa,* ibid., from N. W. America, are now often considered as distinct species from this (P. L. S.).

broad, black bands. Breast black, with small rufous bands. Lower parts white, with dark shaft-spots. Tail dark brown at the base, rufous-yellowish, with six bands and the extremity yellowish.

Dimens.—Wing 147, tail 79 mm. long.

7. Athene erythroptera, *Blyth.*

Strix erythroptera, Gould, Proc. Zool. Soc. 1837, p. 136.
Noctua perlineata, Hodgs. Journ. A. S. B. 1837, p. 369.
Strix radiata, Tick.
—— *cuculoides,* Jerd.
Athene undulata, Blyth.

Diagn.—The head blackish, with rufous-yellow or whitish bands. Shoulder-coverts with very small bands, with larger white spots on the margins of the wings. Tail black, with nine to ten irregular small bands.

Descr.—The head with two rufous-yellow or whitish bands on each feather. Back to the tail-coverts with three to four cross bands and margins on each feather, which are on the back rufous-yellow, and on the tail-coverts whitish. Shoulder-coverts similarly banded, five to six bands on each feather. The small feathers of the wings dark brown, rufous-spotted, with some large white spots on portions of the exterior webs. Arm and hand wing-feathers black, banded with rufous. The inner wing light reddish along the shafts, spotted and banded with blackish; on the coverts white and rufous, with dark spots. Sides of the breast rufous-yellowish. Belly and its sides with blackish bands. Tail-bands in a crooked direction irregularly connected with the shaft. Tarsus white, with irregular dark spots.

Dimens.—Wing 130, tail 76 mm. long.

Hab. Northern Hindostan.

8. Athene cuculoides, *Blyth.*

Noctua cuculoides, Vig.
—— *auribarbis,* Hodgs.; Gould, Cent. Him. Birds, t. 4.

Diagn.—Total colour of the wing brownish. Tail with seven cross bands.

Descr.—Very much like *A. erythroptera,* but larger, and in the drawing of the feathers broader. The young bird is more spotted than banded on the upper parts.

Dimens.—Wing 140–149, tail 83–85 mm. long.

Hab. Northern Hindostan.

9. Athene capensis, *A. Smith.*

Ill. S. Afr. Zool. t. 33.

Diagn.—Tail with fourteen small rufous bands.

Descr.—Head brownish-grey, spotted with white, two spots on each feather. Back dark brown, each feather with two small, rufous, arrow-like bands. Shoulder-coverts similarly coloured, with three bands on each feather, and the margins white margined with black. The small feathers of the wings banded with rufous; the outermost having the external web white, terminated with black. Arm- and hand-wings dark brown, with small rufous cross bands, which are white-spotted on the margin of the hand-wings. The inner wings rufous-yellowish, with eight to ten irregular blackish bands. Breast rufous and white, with black bands. Belly and sides pure white, with large, round, black end-spots.

Obs. A very handsomely coloured species.

Dimens.—Wing 143, tail 86 mm. long.

Hab. S. Africa.

Genus IV. Surnia, *Dum.*

Diagn.—Nostrils situated on the margin of the rudimentary cera. Ear-orifice small, without operculum. Bill curved from the cera, and covered with feathers. Toes more or less thickly feathered. Shafts of the wing-feathers strong and stiff.

a. *Microptynx.* b. *Nyctea.* c. ——? d. ——? e. *Surnia.*

Subgenus a. *Microptynx.*

Glaucidium (pars), Boie.

Diagn.—First wing-feather shorter than the tenth. First to fourth wing-feathers emarginated. Toes very thin, covered with feathers. No bristle-feathers.

It represents in its genus the genus *Glaucidium.*

1. Surnia passerina, *Kp.* (Pl. LVI. fig. 5 *a*, bill; *b*, wing.)

Strix passerina, Linn.
—— *pusilla,* Daud.
—— *pygmæa,* Bechst.
—— *acadica,* T. Naum. t. 43. 1, 2.
Glaucidium passerinum, Boie.
Athene passerina et africana, G. R. Gray; Lev. Afr. t. 46; Nils. Scand. Faun. t. 3.

Diagn.—Tail 56–62 mm. long, with five arrow-like cross bands reaching to the shafts.

Descr.—Head ash-grey, with white dark-margined spots. Back and tail-coverts with concealed white spots, the feathers on these parts having a white band near the base, and a spot at the end. Shoulder-coverts with three to four whitish shaft-spots or bands on each feather. The small feathers on the wing with white spots. Arm- and hand-wings blackish, with rufous and small rufous-brownish bands, which on the external and internal margins are spotted with white. The wings are crossed by six to eight lighter-coloured bands, which are white over the emarginations. Sides of breast brownish, banded with white. Breast and belly white, striped with blackish. Tarsi and toes white.

Dimens.—Wing 95 (♂), 99 (♀), tail 56 (♂), 62 (♀) mm. long.

Hab. Northern and eastern parts of Europe and Asia.

Subgenus b. *Nyctea*, Steph.

Diagn.—The long wings cover two-thirds of the tail, which is as long as the body. The first wing-feather is shorter than the fourth. First to fourth wing-feathers have broad inner webs, and are emarginated to the end. Ear-orifice larger than the diameter of the eye (perhaps asymmetric).

2. Surnia nyctea, *Selby*.

Strix nyctea, Linn.
—— *candida*, Lath.
—— *erminea*, Shaw.
Nyctea erminea et cinerea, Steph.
Strix nivea, Thunb.; Daud.
Nyctea nivea, Bp. Pl. Enl. 458; Edw. B. t. 61; Naum. taf. 41; Vieill. Am. Sept. t. 18; Levaill. Afr. t. 45; Wils. Am. Orn. pl. 32. fig. 1; Aud. pl. 121; Gould, Eur. t. 43.

Descr.—Bill and nails black. Whole plumage in advanced age pure white, in youth black-spotted. Size of *Bubo maximus* (♀).

Hab. High northern latitudes of Europe, Asia, and America.

Subgenus e. *Surnia*, Dum.

Diagn.—The first wing-feather as long as the seventh. First to third wing-feathers distinctly emarginated. Ear-orifice less than the diameter of the eye. Tail longer than the body.

3. Surnia ulula, *Bp.* (Pl. LVI. fig. 6 *a*, bill; *b*, wing.)

Strix ulula, Linn. Fauna Suecica, 78.
—— *Hudsonia*, Gmel.
—— *funerea*, Lath.
—— *canadensis et freti-hudsoni*, Briss.
—— *doliata*, Pall.
—— *arctica*, Sparrm.
—— *nisoria*, Mey., Naum. 42. 2.
Surnia borealis, Less.
—— *funerea* (Lath.), Cuv.; Enl. 463; Edw. t. 62; Wils. pl. 50. fig. 6; Aud. 378; Gould, t. 45.

Diagn.—A broad black vertical stripe from the ear to the neck.

Descr.—A little smaller than *Otus vulgaris*. It is distinguished from all other European owls by its banded plumage. The bill is horn-brown, posteriorly yellow. Head and after part of neck white, with black bands and margins. On the hinder neck three black spots, one next to the ear-stripe. Shoulder-coverts white, banded and spotted with brownish, towards the interior part more brown, and towards the exterior nearly pure white. Smaller feathers on the wing lighter or darker brown, with white spots on the exterior webs. Wings blackish, with seven to ten white cross-spots, of which those on the inner webs do not reach to the shaft. The ends of the wing-feathers margined with white. Tail long; the first exterior feather one inch shorter than the centre feathers; all with light or nearly white cross bands, which on the middle feathers do not come together with regularity. Beneath the chin black; on the sides of the breast a black cross band; the other parts white, with two to five bands on each feather. The face, throat, and upper parts of the breast nearly white, without spots.

Hab. The same countries as *S. nyctea*, coming very rarely to England and Germany.

Genus V. Ieraglaux, *Kp.*

Athene, Auct.

Diagn.—The nostrils situated on the margin of a long, strongly-developed cera, which covers the last half of the bill. Toes long, thinly covered with bristles. Wings long, with long wing-end[1]. Tail always long.

Descr.—Head mostly small, with very small ear-orifice, smaller than the diameter of the eye. No distinct feather-wreath. The wings with pretty strong quills, and not reaching to the end of the tail.

In size middling or large; the species chiefly occurring in Australia and its vicinity. Bill mostly black, with yellowish back.

a. *Cephaloglaux*. b. *Spiloglaux*. c. *Sceloglaux*. d. *Ctenoglaux*. e. *Ieraglaux*.

Subgenus a. *Cephaloglaux*.

Diagn.—Head large. Bill strongly curved. *The first wing-feather shorter than the tenth.* Toes shorter than the tarsi. Tarsi covered with stiff shafts. Toes with strong bristles.

Three species, from India and Oceania.

1. Ieraglaux superciliaris.

Athene superciliaris, Puch.
Strix superciliaris, Vieill.
—— *Sonnerati*, Temm. Col. 21.
Noctua ——, Less.

Diagn.—Wings and tail-feathers rusty-red, with white traces only on the margins of

[1] I call 'wing-end' that part of the end of the hand-wings which is not covered by the arm-wings.

the inner webs, and some of the outer webs. Breast and belly white, banded rather broadly with brown.

Descr.—Nearly the size of *I. scutellatus*, but with larger head and bill, shorter wings and tail, and stronger tarsi and toes. Face, chin, and a stripe over the eye dirty yellowish-white. Bristle-feathers on the cere very long, with black points. Head and occiput brown, with small round white spots. Back uniform brown. The small feathers on the wings and the arm-wings with larger, round, white spots. The hand-wings with white spots next to the emarginations only, and with their ends uniform reddish. Under tail-coverts whitish. The strong bristle-feathers of the tarsi rusty-yellowish. Bill, nails, and toes yellowish.

Dimens.—Bill from the cere 20, head 56, wing 190, tail 110, tarsus 29 mm.

Description taken from the unique specimen in the Paris Museum.

2. IERAGLAUX JACQUINOTI.

Athene Jacquinoti, Homb. et Jacq. Voy. au Pôle Sud, t. iii. 2.

Diagn.—Chin white, with a reddish-brown black-banded collar. Belly yellowish-white.

Descr.—Size of *I. superciliaris*. Face and a stripe over the eye white. Bristle-feathers over the nostrils white, with black shafts. Feathers of the cheeks and anterior ear-coverts reddish, with black spots. Over the yellow eyes a small black stripe. The crown of the head black; each feather with two pairs of reddish spots. The back dark brown; each feather with three to four rusty-yellow bands, which very often do not reach to the shaft. The wings dark brown; on the outer web spotted with yellowish, white spotted; on the inner web spotted or banded with yellowish-white. The end of the hand-wings uniform, with traces only of cross bands. The tail of the same colour, with about six bands, clearer on the inner webs. Tarsi with traces of brown spots. Bill yellow. Toes yellowish. Nails black.

Dimens.—Head (♂) 56, bill from the gape 25, wing 188, tail 105, tarsus 41, bill from the cere 18 mm.

Hab. Oceania; Salomon Islands. (Mus. Paris. Spec. unicum.)

3. IERAGLAUX VARIEGATUS, *Kp.*

Athene variegata, G. R. Gray.

Noctua variegata, Quoy & Gaim. Voy. Astr., Ois. t. 1. 2.

Diagn.—Wing 194–198, tail 114–120 mm. long. Tail with ten light narrow bands. Breast and belly white, with three rusty-brownish bands on each feather.

Descr.—Size of *I. marmoratus*, with stronger bill. The front, face, and chin whitish, with black shafts on the lores. Concealed light spots on the greatest part of the greyish-brown head-feathers. The under parts of the neck with two pairs of white spots on each feather. The shoulder-coverts with white bands. Back brownish. Upper tail-coverts with light spots. The smaller plumage on the wings with light rusty bands, which are white on the exterior margin. The arm- and hand-wings banded on the upper and inner side, on the under side with eight or nine bands. Tibiæ and tarsi rusty-yellowish.

Dimens.—Head 56, bill from the gape 26 mm.

Hab. New Ireland.

Subgenus b. *Spiloglaux.*

Diagn.—The first quill longer than the tenth, and the fifth distinctly emarginated on the inner web. Wings with rather long wing-ends. Toes shorter than the tarsi. Bill more curved, and not so much projected as in the other subgenera.

All from Australia.

4. Ieraglaux bubuk, *Kp.*

Strix boobook, Lath. Ind. Orn. Suppl. p. xv.
Noctua ——, Vig.
Athene ——, Gould, Birds of Austr. t. 32.
—— *ocellata,* Hombr. & Jacq. Voy. tab. 3. 2.

Diagn.—Head 55–58, wing 217–241, tail 140–150 mm. long.

Descr.—Equals in size *I. marmoratus,* in colouring resembles *I. connivens.* Front, a stripe over the eye and the throat white. Cheeks ash-grey, inclining to brown. The superior parts ash- or reddish-brown, with uniform back, reddish-yellow shining through the feathers. White spots on the wings more or less concealed. Inferior parts reddish-yellow, with scarcely distinguishable dark shaft-spots, and round white spots on the sides and belly. Inferior wing-coverts reddish-yellow, spotted oblongly with reddish-brown. Interior of the wing-feathers with five clearer bands, of which the three uppermost are white on the outer webs, and the two lowest are silver-grey, like the upper surface of the wings. Tail above uniform, beneath with seven cross bands. Tarsi white or reddish, with traces of dark spots.

The smaller dimensions are taken from two examples in the Jardin des Plantes, which are the types of *Athene ocellata,* from Oceania.

5. Ieraglaux maculatus, *Kp.*

Noctua maculata, Vig. & Horsf.
Athene maculata, Gould, Birds of Austr. tom. i. pl. 33.

Diagn.—Tail blackish, with six whitish bands. Head 58, tail 120 mm. long.

Descr.—Size of *I. bubuk.* Plumage dark brown, with white spots on the nape of the neck, back and wings. The interior of the wing dark reddish, with white spots and margins on the end of each feather. The inferior wing-coverts reddish-yellow, spotted or banded with dark brown. The lighter bands on the exterior tail-feathers are nearly entirely margined with black. Tarsi reddish-brown.

Hab. Australia.

6. IERAGLAUX MARMORATUS, *Kp.*

Athene marmorata, Gould, Birds of Austr. Intr. p. xxvi.

Diagn.—Occiput, neck, margin of the shoulder-coverts, and lower middle part of the small feathers of the wing white, spotted on the outer webs. Whole plumage of the superior parts light ash-brown.

Descr.—Size between *I. connivens* and *I. bubuk*, and colouring similar to *I. maculatus*. Superior parts light ashy-brown, with white spots; inferior parts reddish-yellow, white-spotted. Tail ash-grey, with scarcely perceptible bands on the upper surface, and seven bands on the under side. The under wing-coverts reddish-yellow, dark-spotted, the longest with three black cross bands. Wings blackish, with six to seven whitish bands.

Hab. Australia.

7. IERAGLAUX NOVÆ ZEALANDIÆ, *Kp.*

Strix novæ zealandiæ, Gmel.
Noctua ——, Quoy & Gaim. Astr., Ois. t. 2. f. 2.
Strix fulva, Forst. Descr. Anim. p. 71.
Athene ——, G. R. Gray.

Diagn.—Wing 204, tail 117–129 mm. long. Upper parts nearly black.

Descr.—Head rather small. Upper parts nearly black, sometimes with reddish spots on the nape of the neck. Small feathers of the wing- and shoulder-coverts reddish-yellow, with white spots. Near the margin of the wing small white spots. Breast black, with reddish margins to the feathers. Belly and sides reddish-yellow, with white spots. The upper surface of the tail with faintly-coloured bands; under surface with seven narrow light-coloured bands. The inferior wing-coverts reddish, spotted with black. Wings nearly black, with seven to eight cross bands, which near the base are almost white.

Hab. New Zealand.

8. IERAGLAUX FUSCUS, *Kp.*

Athene fusca, Puch.
Strix fusca, Vieill.
—— *Maugei,* Temm. Pl. Col.

Diagn.—Head 51, wing 212, tail 117 mm. Tail with nine whitish bands.

Descr.—In size very near to *I. scutellatus* and *I. maculatus*, but with larger head and stronger bill. The upper parts like *I. scutellatus*, brownish ash-grey, with concealed white spots on the shoulder-coverts and sides of the neck, and round white spots on the exterior webs of the smaller wing-coverts. The coverts of the first ten hand-primaries nearly black. Eight whitish or yellowish-white bands on the exterior and interior webs of the wings. Front, chin and lores dirty-white, with black shafts. Breast and belly brown, with white spots and stripes on the webs of each feather. Under tail-coverts white, with brown ends and shaft-spots. Tibiæ and the superior part of the tarsi rusty, the other under parts dirty-white.

Hab. Porto Rico (*Maugé*).

Subgenus c. *Sceloglaux.*

Diagn.—With projected bill. First to fifth wing-feathers emarginated on the inner web, and second to sixth on the outer web. The first wing-feather a little longer than the tenth. Tarsi very long, twice as long as the middle toe without the nail. Outer toe half as long as the middle toe. Toes with very much developed bristles. Plumage like that of *Otus vulgaris.*

9. Ieraglaux albifacies, *Kp.*

Athene ——, G. R. Gray, Voy. of Erebus and Terror, Birds, pl. 1.

Diagn.—Size of *Otus vulgaris.*

Descr.—Face and front dirty-white, with black shafts; next to the ear with black shaft-stripes. Head, nape, back, wings and lower parts dark brown, with reddish margin-spots and margins on each feather. On the hand- and arm-wings are six bands, which are reduced on the outer webs to light reddish spots. Tail very dark brown, with six narrow white cross bands, and reddish-yellow end bands. Tarsi whitish or rusty-reddish, with dark longitudinal spots.

Dimens.—Head 68, bill 19, from the gape 29–31, wing 245–280, tail 150 mm.

Hab. New Zealand.

Subgenus d. *Ctenoglaux.*

Ninox, Hodgs.

Diagn.—Head extremely small. Margins of the toes with small warts and bristles like a comb. Bill curved from the *cere.* First wing-feather longer than the tenth, and first to fourth wing-feathers emarginated on the inner web.

Distributed over Asia.

10. Ieraglaux scutellatus, *Kp.*

Diagn.—Bill black, with yellow back.

Descr.—Upper parts dark brown or greyish-brown, without spots. Front and lores whitish, some of the feathers which cover the bill black. Head with greyish tint. Shoulder-coverts with large white spots, concealed like the white spots on the arm-wings. Throat reddish. Under parts white, with large longitudinal stripes or arrow-like cross bands. Tarsi banded. Upper tail-coverts banded with white or uniform. The tail like that of the common Sparrow-Hawk, with three to six cross bands, one narrow base-band, and the end light greyish; the end margined with white. Wings with some lighter bands.

Dimens.—Male. Head 45, wing 180 or $6\frac{1}{2}''$, tail 102 or $3''\ 7\frac{1}{2}'''$.—Female. Head 46, wing 196 or $7\frac{1}{2}''$, tail 120 or $4''\ 4'''$.

Subgenus e. *Ieraglaux.*

Diagn.—The first wing-feather longer than the tenth. First to fifth wing-feathers very distinctly emarginated; sixth very feebly. Tarsi and toes very strong and long. Middle toes (without the nail) as long as the tarsi.

11. IERAGLAUX CONNIVENS, *Kp.* (Pl. LVI. fig. 7 *a*, bill; *b*, wing.)

Falco connivens, Lath. Ind. Suppl. p. xii.
Athene ——, G. R. Gray; Gould, Birds of Austr. tom. i. pl. 34.

Diagn.—A little larger than *Syrnium aluco*. Tarsi equal to the middle toe, and 43 mm. long.

Descr.—Body a little larger than *S. aluco*, but head smaller and tail longer, consequently the whole bird longer and more slender. Upper parts dark grey and brownish; under parts whitish, striped with dark grey and brownish. Upper tail-coverts with concealed whitish spots. Shoulder-coverts and small feathers of the wing with white spots on the outer webs. Second wing-feather to the sixth on the outer web with oblique white spots, which next to the shaft are coloured with clear brownish-grey. The six to seven corresponding bands of the inner webs are oblique. Under wing-coverts reddish-yellow, with black shaft-stripes; the longest of them black, with white margins. Tarsi whitish and reddish yellow, with dark-grey longitudinal spots. Tail above with six, beneath with eight silver-grey bands and light ends. Eye orange. Bill black, with yellow back.

Dimens.—Head 71, wings 303–316, tail 170–184, after-toe 17 mm. long.

12. IERAGLAUX STRENUUS, *Kp.*

Athene strenua, Gould, Birds of Austr. tom. i. pl. 35.

Diagn.—Tarsi equal to the middle toe (without nail), and 58 mm. long.

Descr.—One of the largest, most powerful, and finest Owls, and in these respects not inferior to *Surnia nyctea*. Plumage very variegated, the dark-brown back being reddish-yellow, banded and spotted with white; inferior parts white, with black arrow-like spots. Arm-wing-coverts, arm-wings, hand-wings and tail with clearer end-margins;

the lighter bands of the wings form arrow-like figures, the points of which are directed towards the bill. The tail with seven to eight bands.

Dimens.—Head 86, bill 33, from the gape 45, wings 400, tail 230 mm. long.

Hab. Australia.

13. Ieraglaux rufus, *Kp.*

Athene rufa, Gould, Birds of Austr. tom. i. pl. 36.

Descr.—Very much resembling the last, but distinguished, according to Gould, by the reddish lower parts and the dark reddish cross bands, which are nearer together and more numerous.

I have not yet seen a specimen of this bird. The only example in Europe was in the collection of Mr. Gould, which was transferred to the Museum of the Academy of Natural Sciences of Philadelphia.

14. Ieraglaux humeralis, *Kp.*

Athene humeralis, Hombr. & Jacq. Voy. au Pôle Sud, Ois. t. 4. 1.

Diagn.—With black face, white chin, and plumage frequently banded with narrow bands. Upper parts dark brown, with three rufous bands on each feather.

Descr.—In size between *I. connivens* and *I. strenuus.* Tarsi shorter than in any other known Owl. Toes very strong and short, and with powerful nails. Bill yellow on the margin, with the base black. The upper parts dark brown, with narrow rufous bands. The lower parts whitish, with three to six rusty-brownish or rusty-yellow bands. Under tail-coverts at the base blackish, in the middle white, and at the ends banded with rusty-red. Tarsi dirty-white, with traces of rusty-red bands. The wing-margin between the top of the hand and the first hand-wing white, near the inner side brown-banded. Inner hand-coverts rusty-white, banded with rusty-red. The longest coverts white, with three to seven black bands. Hand- and arm-wings blackish or greyish, with six to seven clearer bands. Tail long, blackish, with six to eight very indistinct bands.

Obs.—The specimen in the Jardin des Plantes is a female. The figure of MM. Hombron and Jacquinot gives the colouring of the head and neck too brilliant, and too distinct from the breast. The tail is too broad and short.

Dimens.—Head 82, bill from the gape 43, wing 305, tail 200, tarsus 50–51, middle toe 36–37 without nail, with the nail 58 mm.

Hab. New Guinea.

Subfamily II. STRIGINÆ, *Kaup*. Night or true Owls.

I. *Scops*. II. *Otus*. III. *Bubo*. IV. *Strix*. V. *Syrnium*.

In this more numerous subfamily we find a greater ear-orifice, with large operculum, feather-horns, a very pneumatic skull, enlarged at the occiput. The plumage is softer and more darkly coloured. The inner webs of the wings are broader, and covered with a silk-like, very soft felt.

This subfamily is more nocturnal, and has a more noiseless flight than the former. The smaller birds of this group live upon insects, small birds, and mammalia, but the larger confine themselves to larger mammalia and birds.

Genus I. Scops, *Sav.*

a. ——? b. *Scops*. c. *Acnemis*. d. *Ptilopsis*. e. *Megascops*.

Diagn.—Very small Owls, with an ear-orifice not so large as the diameter of the eye, and with feather-horns.

Descr.—They show a very handsome round skull, nearly without pneumacity, and have the largest and most perfect brain.

They prefer warm to cold countries, and we find the species spread over the whole earth.

Subgenus b. *Scops*.

Diagn.—The nostrils placed on the margin of the cere. Wings long and pointed. The first wing-feather distinctly emarginated at the end, the second and third not so distinctly. The first wing-feather longer than the tenth, the third or fourth the longest. Tarsi feathered. Toes always naked and scaled. Confined to the Old World.

1. Scops ephialtes, *Sav.*

Strix scops, Linn., Naum. t. 43. 3.
—— *zorca* et *carniolica,* Gmel.
—— *pulchella,* Pall.
—— *giu,* Scop.
Scops zorca, Swains, Aldrovandi, Flem.
—— *europæus,* Less.
Ephialtes scops, Pl. Enl. 436; Gould, Birds of Europe, t. 41.

Diagn.—The wing 141, the tail 62 mm. long. First wing-feather as long as the fifth.

Descr.—Whole plumage ash-grey, with elegant white spots; with oblong black shaft-spots and fine cross lines. Face silvery ash-grey, sprinkled with fine dark spots. Margin-feathers of the ear near the root reddish, with black cross lines and broad dark brown margins. A series of white and black pointed spots on the outer webs of the margin of the shoulder-coverts. Wings with eight to ten white spots, which are continued over the inner webs in narrow bands. On the chest and belly here and there some rusty-red colouring.

Hab. The southern and western parts of Europe and Africa.

2. Scops pennatus, *Hodgs.*

Scops sunia, Hodgs. Journ. A. S. B. 1837, p. 369; Jerd. Ill. Ind. Zool. t. 41.

Very near to the common *Scops ephialtes*, but shows more rusty-red on the head, with shorter wings, and mostly finer and more elegant markings.

Hab. North India.

3. Scops senegalensis, *Sw.*

Birds of Western Africa, i. p. 127.

Also very near to *Scops ephialtes*, but has a stronger bill, shorter wings, and coarser markings of the plumage. The feathers on the hinder margin of the ear not so distinctly margined with black. The bars on the inner side of the wing very distinct. The first wing-feather as long as the seventh.

Hab. Western and Southern Africa.

4. Scops latipennis.

Strix latipennis, Licht.

Also very near to *Scops ephialtes*, but with coarser markings, and the webs on the wing and tail broader. The anterior ear-coverts not so finely pointed with black. Bars on the inner side very indistinct, and the first wing-feather before the emargination only with four rusty-yellow traces on the margin of the inner web, and six white and rufous spots on the outer web. *Scops ephialtes* has ten such spots. The toes not so long. The wing 140, the tail 67 mm. long.

Hab. South Africa.

5. Scops longipennis.

Strix longipennis, Licht.
—— *striolata,* H. & E.

Still nearer to *Scops ephialtes*, but also with coarser markings; the lighter bars on the inner webs of the wing reaching to the shaft. The outer web of the first wing-feather with nine smaller, pronged, whitish rusty-yellowish spots. First wing-feather as long as the sixth. Longer wings 150, tail 70 mm.; middle toe the same length as that of *Scops ephialtes*.

Hab. Syria.

Obs.—I have seen but one specimen, but it is necessary to examine a greater number. I consider most of these species, so very nearly connected with *Scops ephialtes*, as subspecies.

6. Scops leucopsis, *Kp.*

Athene leucopsis, Hartl.

Diagn.—The wings on the inner side uniform blackish, without bands. First wing-feather as long as the ninth.

Descr.—A very distinct species, which cannot be confounded with any of the other species of this natural subgenus. It nearly resembles *Scops ephialtes*, in form very much, has the same long wings, but longer tail and thinner tarsi, which on the hind part are not feathered, but scaled. In its colouring it is very different. Round the eyes black, like *Otus brachyotus.* Lores white, partly rusty and black spotted, with black shafts or black shaft-ends. Stripe over the eye pure white, part of it with black margin on the inner side next the head, part with zigzag cross bands. The middle part of the front dark brown and rufous spotted. The feathers near the stripe of the eye with white spots on the outer webs. In the middle of the occiput some white feathers, with broad black shaft-spots and rufous or black pointed margins. The face is white, with black spots and black inner webs, which gives the face a variegated colouring. Below the middle of the eye next to the lorum more mixed with rufous and black. The feathers of the hinder ear-margins black, the next following with rusty cross bands, and the next series with white ends. The feather-horns, which are not very well distinguished, are dark brown, with rusty spots. The back rusty-yellow, white-spotted. Each feather with blackish root, white band in the middle, and rufous black-pointed margin. The under parts of the back to the tail-coverts dark brown, rusty-spotted. Shoulder-coverts similarly coloured, and on the exterior margin white, with black end-spots and points. The ten coverts of the ten hand-wings uniform black. The ten hand-wings black, near the end pale rufous, pointed with blackish. The two exterior feathers with rufous outer webs, and the following with two to three dirty-white longitudinal spots. The thumb-feathers black, on the outer web with white spots and end-spots. Some of the small coverts of the thumb-feathers similarly white-spotted. The wrist dark brown, with rufous spots. On the arm-wings the rusty colour predominates, and there are black shaft-stripes and dark zigzag drawing. The margin of the interior web at the base is dirty yellowish-white. The colouring of the tail is similar. The exterior feathers only with white spots on the exterior web. The lower parts are white; some feathers, as in *Scops ephialtes*, with broad bronzed shaft-stripes and pointed zigzag bands. The middle of the belly dirty rusty-brown. Over all these feathers pronged cross bands. The under tail-coverts white, with light-brown spots near the shafts, and with the margins dark-bounded.

Dimens.—Head 40, bill from the gape 17, wing 148, tail 69, tarsus 27, middle toe without nail 19 mm.

Hab. Island of St. Thomas, Western Africa.

I have described the original specimen, which I received through the kindness of Dr. Gädechens, the worthy President of the Museum at Hamburg. A second specimen is in the Museum at Bremen.

Subgenus c. *Acnemis.*

Diagn.—The nostrils situated on the margin of the cere. The first wing-feather longer than the tenth. Tarsi over the toes naked. Toes completely naked.

7. SCOPS GYMNOPODUS, *G. R. Gray.*

Diagn.—Resembles in size and colour *Scops ephialtes,* but has shorter tarsi and wings. The wings on the inner side near the base with three small, dirty whitish-yellow bands not reaching to the shaft, and directed from the tail towards the bill.

Hab. India.

Subgenus d. *Ptilopsis,* Kp.

Ephialtes, Bp.

Diagn.—The nostrils placed on the margin of the cere. The first wing-feather very long, emarginated near the end, shorter than the second and third. Bill projected forwards, and covered with very long bristly feathers. Toes with thin bristle-feathers.

8. SCOPS LEUCOTIS, *Swains.*

Strix leucotis, Temm. Pl. Col. 16.

Descr.—The whole face, feathers of the lorum, and front pure white; over and under the margin of the eye a grey spot, the first of which is connected with the ear-horns; upper parts ash-grey, with fine black shaft-stripes and very fine cross lines. Margin-feathers of the shoulder-coverts on the exterior web pure white. Wings with a large number of narrow blackish bands on a grey ground; on the inner side of the wings the bands are more numerous, and form small arcs on the inner web directed towards the bill; the small feathers of the wings with some black stripes. Tail with fourteen blackish bands. The breast and belly rusty-red, with black shaft-stripes and fine cross lines. Feathers of the tibiæ, tarsi, and under tail-coverts pure white. The under parts of the young bird are paler, without cross lines, and the toes nearly naked.

Hab. W. Africa.

Obs.—This species shows, by the projected bill, the broad, black, horizontal margin-stripe next the ear, and by the finely drawn plumage, some analogy with *Bubo lacteus,* which belongs also to the fourth subgenus in its genus, *Bubo.*

If we may draw conclusions by analogies, we may expect some time or other to find two species of this subgenus to represent the *Bubo orientalis* and *coromandus*, which are spread over Asia.

Subgenus e. *Megascops.*

Diagn.—Nostrils on the margin of the cera. First wing-feather as long as the seventh or tenth; first to fourth wing-feather emarginated on the inner web. Tarsi feathered; toes mostly naked.

Hab. Asia and America; the largest birds of the genus.

Descr.—They resemble in some respects the true *Scops*, but the upper parts are darker, and the bill in old age is yellowish or dark brownish, and never black. The ground colour is mostly rusty-red or grey, with irregular black shaft-spots and interrupted cross lines. Between these lines are small spots and rusty-red bands. Round about the occiput a white or rusty-red band, and nearer the back a second collar of the same colour: near the eyes darker: the face mostly lighter; there is also on the front a small stripe of white extending from the lorum over the eye. The feathers of the hinder margin of the ear have black or dark-brown points, with a black horizontal stripe. Along the shoulder-coverts a series of white or ferruginous spots, also some feathers of the same colour on the margin of the wing.

The first ten feathers of the wing are brown, pointed with from five to eight whitish or light rusty-yellow, black-margined spots. These inner webs are clearer in the young bird, and the under parts more lightly coloured, white or rusty-red, with black shaft-stripes and irregular cross lines, which come from the shaft-stripe. On the blackish ground-colour of the tail are irregular stripes and cross bands, which are clearer on the under side.

9. Scops flammeola.

Strix flammeola, Licht. in Mus. Berol.

Diagn.—Wing 120–130, tail 56–66 mm. long. Mexico.

Descr.—The smallest of all the species in this section, as also in the whole genus and subfamily *Striginæ*. I know of two specimens in the Berlin Museum[1]. The larger one is very elegantly grey, spotted with white, black, and rusty-yellow. The bristle-feathers very long, like *trichopsis*, white on the root and black on the end. The face is white and grey, with black points, and rusty tint next the eye. A stripe over the eye white with black margin. The veil white with rusty-yellow and black end. Under the chin with three black bands and rusty-yellow margin on each feather. Ear-horns with black cross bands, on the inner web white, on the outer web rusty-brown. The upper part coloured and with drawing like the other; round the occiput a band of white, black-lined and spotted feathers. A second neck-collar, similarly coloured and drawn, is

[1] Specimens of this species have been lately obtained by M. Sallé in Vera Cruz. See Proc. Zool. Soc. 1858, p. 96. (P. L. S.)

tinged with rusty-yellow. The margin of the shoulder-covert on the outer web white, with rusty-yellow margin, and black-spotted or black margin-end. Large white spots on the exterior web of the smaller feathers of the wing. The first wing-feather with seven rusty-yellow spots on the outer web; on the following feathers the spots are more white, and only near the shaft rufous. The black, grey-pointed tail with five lighter zigzag bands. The lower parts white, with fine-pointed, zigzag black lines, near the broader shaft-stripes tinged rufous. Under tail-coverts with long blackish shaft-stripes and spots. Tarsus thick-feathered and fine black-spotted.

On the smaller specimen the rufous colour predominates; the feather-horns are not developed; on the under parts the cross lines are in very small number. I think it is a young male.

Dimens.—Head 37, bill from the gape 15, wing 130, tail 66, tarsus 24, middle toe without nail 14 mm.

The following species from America are so intimately connected, that we can discover the distinct character of each only by a close scrutiny. It is certain that they are only subspecies from one and the same type.

10. Scops trichopsis, *Wagl.*

Isis, 1832, p. 276.

Diagn.—Toes with bristle-feathers.

Descr.—This species is a little smaller than *S. brasiliensis*, but it has the bristle-feathers of the lorum over the cere longer. The drawing is darker and not so elegant as that of *S. brasiliensis*. The series of feathers on the margin of the shoulder-coverts is white, the outer webs with black margins and broad point, the inner webs with zigzag black lines. The outer webs of the hand-wings have seven irregularly spotted bands, nearly white in the middle. On the under side the bands nearer the end are not so clear. The arm-wings have seven regular rusty-yellow bands, of which the two near the end are more grey and dark spotted. On the exterior side are seen only five cross-bands. The breast is darker-coloured, because the shaft-stripes and cross lines are broader. The under tail-covert white, with a black and reddish arrow-like figure on the point. The tail grey-brown, with from five to six bands, which are reduced on the middle feathers to little spots of a rusty-yellow. The face is white, with one or two black bands or spots on the feathers; between the eyes and ears are long bristles. The feathers along the anterior margin of the ear have a broad black margin. The veil-feathers on the hind margin of the ear round the throat are rusty-yellow, with black points and cross lines and white spots. The toes covered with thin bristle-feathers as in *Athene noctua*.

Head 46, the longest of the bristle-feathers 28, wing 149, tail 69, tarsus 30, middle toe 22 mm. long.

There exists only one specimen, from Mexico, in the Museum of Würzburg. By the liberality of Prof. D. Leiblein I was obligingly furnished with the original bird, from which Prof. Wagler took his description. I doubt whether it is an old bird.

11. Scops asio, *G. R. Gray*[1].

Strix asio, Linn.
—— *nævia,* Gmel.
—— *albifrons,* Lath.
—— *lineatus* et *striatus,* Vieill., Wils. 19. 1, 42. 1; Aud. t. 97.

General plumage greyish or rusty red; toes with feathers. The wings 160, tail 76 mm. long.

Hab. N. America.

12. Scops brasiliensis, *Bp.*

Strix brasiliana, Gmel.
—— *choliba,* Vieill.
—— *crucigera* et *undulata,* Spix.
—— *decussata,* Licht.
Scops portoricensis, Less.: des Murs, Iconogr. Pl. p. 26.

The cape very dark brown, and rusty-red banded and spotted. Toes naked.

Hab. Brazil.

Prince Maximilian of Neuwied represents the female as reddish-brown, and the male grey-brown. The male shows more white on the belly and underside.

The wings 155, tail 85 (according to the Prince 95 mm. long), head 47, tarsus 29, middle toe 24 mm. long.

I cannot find any true difference between this and the preceding species, because the feathers of the toes sometimes vary very much in members of the same species without giving the bird a distinctive character. We find this the case in the genera *Bubo* and *Scops.*

13. Scops atricapillus, *Cuv.*

Strix atricapilla, Natt. Pl. Col. 145.

With the crown of the head black, and pointed feather-horns. The back and covering parts of the wings, throat, and upper part of the breast dark-coloured, like a *Caprimulgus.* Breast and belly similar to *Otus vulgaris.* Margin of the wings with from six to eight rusty-red, black, zigzag-spotted cross bands, which are clearer on the inner webs. Tail blackish rusty-red, spotted with eight ocellated cross bands of yellowish-white.

Wings 177, tail 87 mm. long.

Hab. Brazil.

I cannot find any difference between this species and *Scops lophotes,* Less., from Cayenne. It has nearly the same dimensions: wings 179, tail 90, wing end 47 mm.

[1] Nearly allied to this bird is the recently described *Scops maccalli,* Cassin, B. of California p. 108. (P. L. S.)

14. SCOPS RUTILUS, *Pucheran.*

Arch. du Mus. d'Hist. Nat. iv. p. 326. tab. 22; Rev. et Mag. de Zool. 1849, p. 29.

Diagn.—Toes, and also the small, scaled, hind part of the slender tarsi, naked; whole plumage rusty-red; occiput and neck without collars.

Descr.—A very handsome and interesting species, the size of *Scops lempigi.* The whole colouring is rusty-red. Front and eye-stripe white, pointed with white. Lorum feathers whitish at the base, black-spotted, with very long black or reddish bristles. Face and anterior ear-coverts reddish with lighter shafts. The hind ear-margin with black cross bands and ends. Head and back reddish, with black zigzag bands from the black shaft-stripes. Margins of the shoulder-coverts on the external web pure white, pointed with black. Two or three large white spots on the wing-coverts. Breast, sides and belly rufous, with black central stripes and white, black-margined cross bands. Wings blackish, light-banded; bands on the external webs sometimes white. Tail very irregularly pointed, with about eight lighter cross bands.

The example described is the one figured by Dr. Pucheran. Another smaller specimen in the Paris Museum is more rufous; it has on the head, back, and under parts only black stripes in the middle of each feather; wing and tail-feathers with very indistinct bars; only traces of some white bands on the external and internal margins of the webs.

Head 45, wing 156–147, tail 86–76, tarsi 27 mm.

Hab. Madagascar.

The Indian species, like *Scops asio*, &c., are also so intimately connected, that it is very difficult to make out their differences. It is only necessary to give an exact description of the oldest known species, and the trifling differences by which the others may be distinguished from it.

15. SCOPS LEMPIGI, *Bp.*

Strix lempigi.
—— *noctula,* Reinw. Pl. Col. 99.
Scops javanicus, Less.

Descr.—A little stronger and larger than *Scops ephialtes*, larger head, bill and toes. The ground colour is dark rusty-brown, not grey, with an immense number of fine spots and zigzag bands. Around the occiput a rusty-yellow band, and a second collar a little lower on the neck. The face is light, nearly white, with black spots. The bristle-feathers of the lores are either with white shafts, or spotted and with black shafts. Near the anterior corner of the eye a dark spot. The white front and stripe over the eye have black cross lines. The ear-horns on the exterior web black, with rusty-yellow spots; on the inner webs the ground colour is rusty-yellow, with fine black points and cross bands. The head-feathers black, spotted with rusty-yellow. The shoulder-coverts have on the margin a series of rusty-yellowish spots on the exterior webs; these webs are spotted and sometimes margined with black. The outer webs of the hand-wings are whitish or light rufous, with from five to nine black, regular or irregular pointed bands. The under wing-coverts white or rufous, black-spotted. The inner webs have indistinct bands towards their terminations; near the base they have white or rufous bands like flames. The tail brownish, with seven or eight light-rufous pointed bands. The breast and belly rufous, with innumerable black points, shaft-stripes and cross lines; sometimes the belly is nearly white, with finer points and smaller shaft-stripes. Tarsi spotted, or like the under tail-coverts pure white.

Dimens.—Wings 137–145 or 5″ 3‴–4‴; tail 69–73. Toes naked; middle toe without the nail, 18 mm. long.

16. Scops semitorques, *Bp.*

Otus semitorques, Schleg. Fauna Jap. t. 8.

Diagn.—Larger: the feathers on the toes reaching to the scales of the nails.

Dimens.—Wing 179 or 6″ 6‴; the middle toe without the nail 21 mm. long.

Hab. Japan.

Obs.—Differs from *S. lempigi* as *S. asio* from *S. brasiliensis*, and like *S. asio*, lives in a colder climate. *S. brasiliensis* and *S. lempigi* inhabit the torrid zone.

17. Scops manadensis, *Quoy et Gaim.*

Voy. Astrol. pl. ii. 2.

Obs.—This species is very near to *S. lempigi*, and of the same size. The wings 142–148, or 5″ 2‴–5″ 4‴; tail 67–70 mm. long. But the occiput has not the two collars. The shoulder-coverts on the margin have white and black spots. The head and the whole back are darker. No clear horizontal stripe on the hind margin of the ear.

I cannot find any difference between this species and *Scops mantis*, Bp. (*Otus mantis*, Müll. Fauna Japon. p. 25), which also comes from Celebes. Bonaparte gives us the dimensions of the wings (nearly 5 inches). A female individual presented by M. Bernier to the Museum at Paris is of larger dimensions (wings 160, tail 87 mm.). It is said to come from Madagascar, but I doubt whether this is so.

In the same section must be placed G. R. Gray's *Scops megalotis*, from Manilla. It is a young bird; therefore I have not given a description.

Genus II. Otus, *Cuv.*

a. *Pseudoscops.* b. *Otus.* c. *Rhinoptynx.* d. *Brachyotus.* e. *Phasmaptynx.*

Diagn.—The ear-orifices like the gill of a fish, reaching from the top of the head to the lower jaws; they are *asymmetric.* Very clear veil and more or less distinguished feather-horns.

Descr.—They are of middling size, and have a rich plumage, which, with their long wings, gives them the appearance of being much larger than they really are. Plate LVI. fig. 8, *a*, shows a great part of the occiput, *a a a*, and the end of the lower jaw, *g*; *d d* shows the *sclerotica* through the skin; *e* and *f* is the *meatus auditorius*, which is divided on the right side of the head by a membrane, *i*, into two cavities: this membrane, *i*, can be divided into two separate, fine skins; *h* is the operculum, and *b* is the hind margin of the exterior ear.

Compare the left side (Plate LVI. fig. 8, *b*): the cavity for hearing is quite differently constructed; the membrane, *i*, which divides the right cavity into two, does not divide the *meatus*, but goes in an oblique direction to the end of the cavity. From this construction the left ear-hole is larger. Such asymmetry is found in no other family of Birds.

On the operculum we see some series of stiff feathers, like those of the hind margin of the ear. The latter shows the feathers of the middle of the under part directed towards the top of the head, and those of the middle of the upper part directed towards the lower jaw; where these two series come together they form an obtuse angle. The operculum is covered with series of feathers placed on folds of the skin, which are smallest and shortest next to the eye. The plumage of these species of *Otus* is very much developed and very soft. The concealed parts of the wing and tail webs are crossed with the finest felt. The first feather of the wing has a more or less dentellated margin on the outer web, like a comb. The skull near the occiput is very large, and can be compared only with that of the *Caprimulginæ*, which constitute the raptorial type in the family *Hirundinidæ*. On comparing the form of the bill, the configuration of the wings, and the covering of the toes, we find it necessary to divide the species, though small in number, into five different subgenera, which doubtless will be very considerably increased when the different parts of the earth are fully explored.

Subgenus a. *Pseudoscops*.

Diagn.—With smaller ear-orifice without operculum, larger and projected bill. Wing short. First wing-feather as long as the tenth. First to fourth wing-feathers feebly emarginated on the inner web. Toes completely naked and scaled, like the greater number of species of the genus *Scops*.

1. OTUS GRAMMICUS, *Kp.*

Ephialtes grammicus, Gosse, B. of Jamaica, t. 19.

Diagn.—The tail 118 mm. long, with ten small bands on a pointed ground.

Descr.—The upper parts like the feather-horns rusty-yellow, with a great number of fine zigzag cross-lines and zigzag shaft-spots, especially on the shoulder-coverts. The wings on the interior side show six to seven cross-bands. Size of *Otus vulgaris*, but not so elegantly formed.

Dimens.—Head 70, bill from the cere 22, from the gape 34, wings 233, tarsus 47, middle toe 30 mm. long.

Hab. St. Domingo; Cuba; Jamaica.

2. Otus macrurus, *Kp.*

Diagn.—The tail brown, 148 mm. long, with five small whitish bands and end.

Descr.—The upper parts dark brown, with two to three irregular rusty-yellow cross-bands on each feather. The lower parts white, on each feather a broad dark-brown shaft-stripe. The under tail-coverts pure white. Wings on the inner side blackish, with from three to five whitish pronged bands and spots. Tarsi rusty-yellowish-white with rusty-yellow cross-lines. The bristle-feathers of the *lorum* white with black shafts. The stripe over the eye dirty-white, extending to the ear-horns, which are not very well distinguished. Veil white, each feather with rusty-yellow, black-margined shaft-spots.

Dimens.—Head 70, bill from the root 20, from the gape 34, wing 250, tarsus 60, middle toe without the nail 39; left ear-hole (taken on a stuffed specimen) 14, right ear-hole 22 mm. long.

Hab. Mexico. (Würzburg Museum.)

Subgenus b. *Otus*, Kp.

Diagn.—With small curved bill and long wings. The first wing-feather not so long as the fourth. The first wing-feather distinctly emarginated near the end, the second not so distinctly. Toes mostly covered with feathers to the scales next the nails. The dentellated margin of the first wing-feather very much developed. This subgenus is connected with the fourth subgenus, *Brachyotus*, Gould.

It appears that this subgenus contains species which are more night-birds than the other subgenera. *O. vulgaris*, *O. americanus*, and *O. zonurus* are formed on one and the same type. *Otus stygius* is a second type species.

3. Otus vulgaris, *Flem.*

Strix otus, Linn. Naum. t. 45; Gould, Birds of Eur. t. 39.

Diagn.—The wing 275–279 mm. long. The wing with 4–7, the tail with 6–8 cross-bands.

Descr.—From the lorum to the hind angle of the eye, like the chin, pure white, the first with black points; near the anterior corner of the eye black. The three anterior folds of the operculum covered with rusty-yellow feathers, having blackish shaft-points, and some not very distinct blackish spots. The margin of the operculum with two series of feathers placed in pairs, which are white, tinged with rusty-yellow; they have a broad black margin, and blackish roots with white shafts in the centre. The first series of feathers on the hinder ear-margin is stiff and black, except those of the superior and interior margins, which are softer and have white ends. The front and cap-feathers black, with white and rusty-yellow spots on the margins. The long ear-horns (of which the longest is 40 mm. in length) are black, on the concealed outer webs rusty-yellow, and on the upper middle of the inner webs along the margin white, with small black cross-bands. Neck, back, shoulder-coverts, and the small covert-feathers of the wing near the roots rusty-yellow, with blackish-brown pronged shaft-spots, and white and black pointed spots on the end of each feather. Large white and black spots on the margin of the shoulder-coverts and on the points of the outer webs. Some coverts of the arm-wings are similarly spotted. The roots of the wing rusty-yellow; the ends of the wing brownish ash-grey, blackish-pointed, with from six to seven irregular broad cross-bands. On the inner side of the wing the soft coverts are pale rufous, on the hand-wing there are single black-brown shaft-spots. The first series of the coverts of the arm- and hand-wings have the anterior middle more or less grey-black. The wing-feathers are pale rufous on each web, with six to eight broad and line-like bands, of which those next the root are of no decided colour. The feathers on the under parts rufous, near the point white, with black shaft-spots and three to four zigzag cross-lines. Under tail-coverts with arrow-like shaft-spots, on the point small pronged cross-bands. Tail at the base rufous, with five to seven small pronged cross-bands. The tail has on the upper part nearly ten bands, of which the most distinct are pointed, and sometimes ocellated.

Hab. The whole of Europe; also found in India.

4. Otus americanus, *Bp.*

Strix americana, Gmel.

Otus wilsonii, Less. Tr. d'Orn. p. 110; Wils. 51; Aud. 383.

Diagn.—The inner wing with five to seven broad bands; the underside of the tail has nine line-like cross-bands. Wing 290 mm. long.

Descr.—Very much like *Otus vulgaris*, but differs from it in having longer wings, darker and broader drawing. The tail shows on its upper parts no predominant rufous, but is more of a black colour, and the broader webs of the middle tail-feathers are grey, dark-pointed, with light-margined arrow-like butterfly-shaped spots. The side-feathers of the *tibiæ* have blackish shaft-spots and five cross-bands, which in *O. vulgaris* are pointed zigzag lines.

Hab. The northern parts of America and Mexico, and possibly found still farther south.

5. Otus stygius, *Puch.*

Otus stygius, Puch. Arch. du Mus. d'Hist. Nat. p. 336. pl. 24.

Nyctalops stygius, Wagl. Isis, 1832.

Otus siguapa, d'Orb. Voy. Cuba, t. 2.

Strix melanopis, Licht. Berlin Mus.

Diagn.—Head and the upper parts dark brown. The largest of all the species of the whole genus. Toes naked, like the species of the subgenus *Pseudoscops*.

Descr.—A handsome and very distinct species. The bill yellow, the lower jaw black. The face black, with large whitish spots on the roots of some bristle-feathers and feathers of the anterior ear-coverts. The front and hind ear-margins covered with black feathers spotted with white and rufous. Under the dirty-white chin are long rusty-yellow narrow feathers with a black stripe along the shaft, and on the sides next them pure white feathers with black ends. Feather-horns black, with a rusty-yellowish spot at the base of the inner web. Head and neck rusty-yellow, black predominating at the top of each feather. Shoulder-coverts and wings blackish-brown, some feathers only with whitish and rusty-red marbled drawing on the exterior web. The inner side of the wings has the shafts of the feathers white, with a large triangular white spot next to the shaft, a second, more round, in the middle, and a third, more indistinct, near the emargination. The inner coverts of the wings are rusty-yellow spotted with black. Under parts rusty-yellow with broad black shaft-stripes, and white spots on the webs pointed with black at the end. The tail black, at the base white, with seven narrow white bands and broad white end-margins. The upper part only with four rusty-yellow, blackish-pointed bands no reaching to the end of the feather-margins. Tarsi rusty-yellow, blackish-spotted, near the toes black. The toes are in a great measure naked ; but I think this is an accident, and not found in all the specimens. The figure of d'Orbigny gives the yellow toes completely naked.

Dimens.—Head 70–71, bill from the gape 32, wing 325, tail 178, tarsus 46, middle toe without nail 35 mm. long.

Hab. Cuba.

6. Otus zonurus, *G. R. Gray.*

Diagn.—The under part of the wing and tail with twelve cross-bands.

Descr.—The plumage is also darker: black predominates on the upper and lower parts.

Hab. ——?

Dimens.—*Otus vulgaris*: head 58, bill from the gape 30, wing 275–279, tail 150, tarsus 39–40, middle toe 29. *O. americanus*: head 59, bill from the gape 30, wing 290, tail 148, tarsus 39, middle toe 29. *O. zonurus*: head 58, bill from the gape 30, wing 276, tail 148, tarsus 44, middle toe 30. *O. stygius*: head 70–71, bill from the gape 32, wing 325, tail 178, tarsus 46, middle toe 35 mm. long. The dimensions of the first three species are very nearly the same.

Subgenus c. *Rhinoptynx.*

Diagn.—Bill long and projected. Wing short and obtuse. The first wing-feather longer than the sixth to ninth. The first and second wing-feathers clearly emarginated. Toes feathered.

7. Otus mexicanus, *Cuv.*

Strix mexicana, Gmel.
—— *longirostris,* Spix.
—— *maculosa,* Wied.
Bubo clamator, Vieill.
Vieill. Ois. d'Am. Sept. t. 20; Spix, Av. Bras. 9 *a*; Aud. 412.

Diagn.—With white face and fine zigzag lines on the superior parts.

Descr.—A little larger than *O. vulgaris*, with larger head, bill, and feet. The face, lores, eye-stripe, chin, and throat pure white. The superior eyelid and anterior angle of the eye with single black bristle-feathers. The two folds on the operculum have white feathers, which at the base and top are black. The downward-directed feathers of the hinder ear-margin dark brown with white ends. The ascending feathers uniform dark brown; the inward-turned feathers at the base of the ear white, with blackish bases; under these a black spot, in which the feathers are white at the base. The continuation of the veil under the chin white, spotted with black and rufous. The cap of the head, like all the upper parts, rufous, with broad dark-brown shaft-spots, and with fine cross and irregular bands on the rufous margins. The ear-horn-feathers are black, on the inner webs banded with rufous. The shoulder-coverts have large white spots on the margins, as also have some small feathers on the margin of the hand-feathers. The wing-feathers are pale rufous, with five to six irregular blackish bands far apart from each other; those on the outer web are placed higher than those on the inner web. Near the ends of the hand- and arm-wings the bands are lighter and more grey- and brownish-marbled. On the inner side of the wing the coverts are white, rufous-tinted, with narrow and not very distinct blackish shaft-stripes. The superior part of the interior coverts of the hand-wings grey-black, as in the greater number of Owls. The tail rufous, brownish-marbled, with seven or eight irregular, blackish, rufous-pointed cross-bands. On the under side the tail is nearly white, and the bands, as usual, narrow. The under parts white, tinted with rufous, and with black shaft-spots, which are broadest on the breast and narrowest on the under tail-coverts. Tibiæ and toes light yellow. Eyes yellow.

Hab. Mexico and South America.

8. Otus madagascariensis, *A. Smith.*

Catal. of S. Afr. Mus.
Bubo madagascariensis, Puch. Arch. du Mus. tom. iv. pl. 23.

Diagn.—With dark face. Tarsus 37 mm. long.

Descr.—A little larger. The drawing of the whole body is not so fine and elegant. On the upper parts the spots are more distinct and more speckled. The under parts rufous, each feather with black-brown shaft-spots without cross-bands or lines. The wings rufous-grounded like the tail, with six black cross-bands. The ear-horns are nearly 51 mm. long, black- and rufous-margined.

Hab. Madagascar.

Dimens.—Otus mexicanus: head 60, from the gape 34, wing 253–264, tail 142, tarsus 55. *O. madagascariensis*: head 56, from the gape 32, wing 320 (*Puch.*), tail 152, tarsus 37–45 mm. long (*Puch.*).

Subgenus d. *Brachyotus*, Gould[1].

Diagn.—With small curved bill and long wings. The first wing-feather shorter than the second, and nearly as long as the fourth. The first wing-feather near the end clearly, the second not so distinctly emarginated. The dentellated margin of the first wing-feather not so developed. Toes covered with feathers down to the scales of the nails.

The type of this small subgenus differs very much in its habits from the other species; it lives in meadows and fields and amongst reeds. In the northern part of Europe it makes its nest in the reeds.

9. OTUS BRACHYOTUS, *Boie.*

Strix brachyotus, Gmel. Naum.
—— *ulula*, Gmel.
Noctua major, Briss.
Strix ægolius, ulula, et *accipitrina*, Pall.
—— *caspia*, Shaw.
—— *arctica*, Sparrm.
—— *tripennis*, Schrank.
—— *brachyura*, Nils.
Otus ulula, Cuv.
Brachyotus palustris, Gould.
—— *palustris europæus*, Bp.
Gould, Birds of Eur. t. 40; Enl. 438; Nozeman, t. 33, 34; Frisch, t. 98.

Diagn.—Black around the eye. Wing 295–300, tail 150 mm. long.

Descr.—The upper parts dark brown, with white and rufous margin-spots. The wing rufous, with three to four irregular broad dark-brown bands. Arm-wings with four ocellated and clouded rufous spots on the outer webs, and three narrow bands near the end on the inner webs. The operculum with white feathers, the last series blackish at the root, with black spots on the top. A black spot on the hinder ear-margins. Tail rufous, with five broad dark-brown cross-bands. The exterior tail-feather, as also the end of the tail, nearly white; the rufous bands of the middle feathers sometimes ocellated and spotted. The under parts rusty-yellow, with small dark-brown shaft-spots, which are broadest next the throat.

[1] An exact comparison of this subgenus with the subgenus *Otus* and the others, shows at once not the least generic difference in its osteology. To prove this, I figure the skulls of the two European species (see Pl. LVII. figs. 1, 2, 3, 4). Subgenera never have anatomical, but only exterior characters. I find this also the case in all the other genera and subgenera of the families *Falconidæ* and *Strigidæ*.

Hab. This species is spread over the whole world, with the exception of Australia.

Obs.—I have seen an immense number from all parts of the world, but can find no difference. I am not able to distinguish the *O. galapagoensis* of Gould, or the *Brachyotus palustris americanus*, Bp. The only specimen which I have seen of the *O. galapagoensis* is a little larger, and the upper tail-coverts have more rusty-yellow round spots and zigzag stripes.

I cannot find, amongst a very great number of specimens from all parts of America, any material difference.

Dimens.—Head 60, breadth 38 (*Otus vulgaris* 41), from the gape 34, wing 300, tail 50, tarsus 46, middle toe 31 mm. long.

Subgenus e. *Phasmaptynx.*

Diagn.—The bill small and curved. Wings long. First wing-feather not so long as the fifth. First to third wing-feathers beginning at two inches from the end more or less emarginated. The first wing-feather, as in *O. brachyotus*, very short and dentellated. Toes thinly feathered.

10. Otus capensis, *A. Smith.*

Ill. S. Afr. Zool. t. 67.

Descr.—Upper parts ash-brown, with more or less indistinct zigzag bands. Arm-wings with rusty-yellow end-margins. The hand-wings rufous, with dark-brown bands. The inner side of the wings very variable. The tops of the wings have a large emarginated spot. Through this spot on the hand-wing a black stripe runs over the emarginations. Other specimens show three black bands. The four middle tail-feathers are brown, on the exteriors more white with five cross-bands. Breast ash-brown, the other under parts with brownish, pointed, arrow-like spots and cross-bands, and broad white margins before the spotted end-band.

Dimens.—Head 67, bill from the gape 29, wing —?, tail 153, tarsus 58, middle toe 25 mm. long.

Hab. Whole of Africa. I have received specimens from Tunis and Algeria, and there is no perceptible difference in them.

Genus III. Bubo, *Cuv.*

a. *Lophostrix.* b. *Bubo.* c. *Ketupa.* d. *Urrua.* e. *Pseudoptynx.*

Diagn.—Large Owls with ear-orifice as large as the diameter of the eye, without operculum. Feather-horns more or less distinct. The skull very much enlarged on the occiput.

The greater number of these are large birds. They are spread over the whole world, with the exception of Australia.

They must be divided into five different subgenera, of which the greater part are erroneously considered as true genera by the later authors. This is a very grave fault.

Subgenus a. *Lophostrix*, Less.

Diagn.—The bill long and projected. *The first wing-feather, as in all the subgenera of the first rank, as long as the tenth*; second longer than the eighth; third longer than the seventh; fourth as long as the sixth; fifth nearly as long as the sixth and the longest. Tail as long as the whole body. Toes naked, with broad soles, and the nails falcated (as in the third subgenus, *Ketupa*, and the fifth subgenus, *Pseudoptynx*).

Obs.—This subgenus represents the genus *Scops* in its genus. This is the reason why some authors place it next to that genus, which is quite wrong.

1. Bubo cristatus, *Kp.*

Strix cristata, Daud. Tr. Orn. ii. p. 207.
Ephialtes cristatus, G. R. Gray.
Lophostrix cristata, Bp.
—— *griseata*, Less.
Strix griseata, Lath.
—— *superciliosa*, Shaw.
Bubo griseatus, Cuv.
Le Vaill. Afr. t. 48; Strickland in Jard. Contr. Orn. cum. fig. var.* (1848).

Descr.—Nearly the size of *Otus vulgaris*, but apparently larger from its long tail. Bill yellow. Front whitish, brownish-banded. A white stripe over the eye to the long ear-horns. On the hind margin of the ear a white spot. Upper parts chestnut-brown, with innumerable fine zigzag cross-lines and spots. Margin of the shoulder-coverts and the small coverts of the wings with irregular white spots on the exterior webs. The arm-wings rufous-brown, black-pointed, with six narrow zigzag bands, and rusty-yellow spots on the outer webs, which are rufous on the blackish inner webs. The interior of the wing from the emarginations is banded with rusty-yellow on a large clear rusty-yellow field. The inner coverts of the margins of the wings rufous, with blackish spots. The under parts finely and elegantly cross-banded and spotted, darkest on the chest. Tail on the superior part rusty-brown with fine blackish spots, with lighter points on the inner webs, and with ten irregular white or rusty-yellow cross-bands. Tarsi with rusty-yellow cross-bands.

Dimens.—Head 73, bill from the gape 33–35, wing 300, tail 200, the longest ear-horn-feather 58, tarsus 44, middle toe 32 mm. long.

Hab. Guiana and Cayenne.

Subgenus b. *Bubo*, Kp.

Diagn.—With small, curved, and black bill. Wings long. The first wing-feather shorter than the fifth. The first very clearly, second to fifth obtusely emarginated. (See Pl. LVII. fig. 5.)

These are the representatives of the genus *Otus* in its own genus.

* Since separated as a distinct species, *Lophostrix stricklandi*, Sclater and Salvin, in 'The Ibis,' 1859, p. 221.

2. Bubo bengalensis, *G. R. Gray.*

Otus ——, Frankl.
Bubo (*Urrua*) *cavearius,* Hodgs.
Gould, Cent. Him. B. t. 3.

Diagn.—The black vertical margin-feathers of the ear bound the veil. The feather-horns 62–67 mm. long, black at the roots, and on the interior webs rufous-margined.

Descr.—Smaller than the common *Bubo maximus.* Sides and belly rufous, with fine black shaft-stripes, and finer pointed arrow-like drawing. Tarsi uniform fawn-coloured.

Dimens.—Head 95–98, bill from the gape 49–51, tarsus 74–78, middle toe 44–50 mm. long.

3. Bubo ascalaphus, *Sav.*

Expéd. Egypt. Ois. 3. 2; Gould, Eur. t. 38; Pl. Col. 57; Brit. Zool. pl. B. f. 3.
Otus ascalaphus, Cuv.
Ascalaphia savignyi, I. Geoff.

Diagn.—A black vertical stripe bounds the veil of the ear. The ear-feathers short, 44 mm. in length, rusty-yellow, with black points. Sides and belly rusty-yellow, with round white, black-margined spots.

Descr.—The most slender species of all, having some analogies with *Otus.* The whole plumage rufous, with irregular dark-brown drawing on the superior parts, except the tail-coverts, which are nearly uniform rufous with some bands at the end. Along the shoulder-coverts and the superior parts of the wing a series of white spots. Sides and inferior tail-coverts elegantly pointed and banded. Near the *furcula* are large spots. The slender thighs and toes pale rusty-yellow. Under side of the tail nearly white, with six narrow black bands; the upper side with irregular drawing on the middle feathers.

Hab. Egypt and Nubia. Strays sometimes into Sardinia, Sicily, and even England.

Dimens.—Head 91, bill from the gape 49, wing —?, tarsus 79, middle toe 43 mm. long.

4. Bubo maximus, *Sibb.*

Strix bubo, Linn.; Gould, Birds of Eur. t. 37; Naum. t. 44.
—— *atheniensis* et *alba,* Daud.

Diagn.—The veil of the ear not bounded by a black stripe. Ear-horns nearly 80 mm. long, black, on the margins of the inner webs rufous-spotted. The wings 460 mm. in length.

Descr.—The largest bird in this subgenus. The face rufous-grey, with fine cross-bands. The upper parts rufous, with black shaft-spots and lighter cross-lines. The under parts of the back and tail-coverts rusty-yellow, with irregular brownish cross-bands, and darker rusty-yellow-pointed margins on each feather. The shoulder-coverts dark brown, at the base rufous, blackish-banded, on the margins white-spotted and pointed with black. The smaller feathers of the wing are similarly coloured; the interior part of the wing rufous, near the points darker, with six irregular, zigzag, pointed cross-bands, which are more nearly uniform near the ends. The exterior tail-feathers rufous, the others black-brown, with seven to nine irregular, lighter, and pointed cross-bands. The under parts of the body rusty-yellowish, with innumerable zigzag cross-lines and darker shaft-stripes, which are broadest next the *furcula*. *Tibiæ* rufous, not distinctly banded.

Obs.—In the northern regions there exists a very light-coloured variety, nearly white. This is the *Bubo sibiricus*, Eversmann (Gray and Mitchell, Genera of Birds; Susemihl, Vögel Europa's). From Prince Bonaparte we hear that the *Bubo virginianus* in high northern latitudes also changes to a similar colour.

The *Bubo capensis*, Daud. (*africanus*, Steph.) (Levaill. Ois. Afr. t. 40; Sir A. Smith, Ill. S. Afr. Zool. B. t. 70), is also not a distinct species; it has not sufficient characters to separate it from the *Bubo maximus*.

It is possible that these two varieties are subspecies of the common *Bubo maximus*.

5. BUBO AFRICANUS, *Boie*.

Strix africana, Temm. Col. 50.
Otus africanus, Cuv.
Bubo maculosus, Cass.
Strix maculosa, Daud.
Otus maculosus, Less.
Bubo cinerascens, Guér.
—— *Dilloni*, Desm. & Prév.

Diagn.—Larger than *Syrnium aluco*. A black vertical stripe bounds the veil. Ear-horns 60–70 mm. long, black, with whitish rusty-yellow bands or spots. Wing 308–365 mm. long.

Descr.—The smallest species of the whole subgenus. The whole plumage is black-brown, with numerous white spots. Face and chin white, brown-banded like the side of the neck. The under parts white, with large spots near the *furcula*, otherwise with broad, black, zigzag cross-bands. Tail on the inner side with four to five broad black cross-bands; on the upper side with lighter rufous, sometimes with pointed bands. Tarsi nearly white, with irregular narrow brownish bands.

Obs.—*Bubo cinerascens*, Guér., is a very small male of this species; and *Bubo dilloni* is an exceedingly large, not very old female, with more rusty-red colour, and broader bands on the under side. It has the tarsi more thickly feathered, and dirty-white, with some traces of dark bands.

		africanus.	cinerascens.	dilloni.
Dimens.—	Head	77	75	85
	Bill from the gape	40–43	38	43
	Wing	320–330	308	365
	Tail	186–188	162	—

Hab. The whole of Africa.

6. Bubo virginianus, *Briss.*

Strix virginiana et *Strix Bubo magellanicus,* Gmel.
Bubo virginianus et *arcticus,* Rich. & Sw. t. 30.
—— *ludovicianus,* Daud.
—— *magellanicus,* Cuv.
Strix crassirostris, Vieill. Ois. Am. Sept. t. 19.
—— *macrorhyncha,* Temm. Pl. Col. 62.
Bubo magellanicus, Cuv.; Puch. Arch. du Mus. t. iv. p. 331; Wilson, t. 50; Aud. t. 61; Enl. 385.

Diagn.—The veil bounded with a black vertical stripe. The ear-horns 62–84 mm. long, black at the root, the inner web rufous. Wing 360 mm. long.

Descr.—In size between *B. africanus* and *B. maximus.* The under parts of the body mostly with large black bands on a rufous and white ground; on the breast near the *furcula* and on the broad white throat with larger spots. White spots on the margin of the shoulder-coverts, sometimes very indistinct. The tail on the under side with six narrow bands. The light-rufous bands on the upper parts of the wings very irregularly zigzag pointed and margined. Tarsi banded or uniform.

We find varieties with more white, rufous, and grey; others are nearly black; others, again, with white ground-colour.

This species has, in proportion to its body, the largest bill.

Dimens.—Head 95–106 (♀), bill from the gape 43–47, tail 205, tarsi 62–73, middle toe 42–45 mm. long.

Hab. The whole of the colder parts of America, as far as Mexico, California, Chili, &c.

I cannot find any true difference between *B. virginianus* and *B. magellanicus.*

Subgenus c. *Ketupa,* Less.

Diagn.—Tarsi and toes naked. The nails, except the middle toe, sharpened and falcated. The wing short; first wing-feather as long as the eighth; the first to the sixth feebly emarginated in the middle on the inner web. (See Pl. LVII. fig. 6.) Bill large, projected, and yellow.

In the form of the falcated nails this division shows great affinity to the first subgenus (*Lophostrix*) and to the fifth subgenus (*Pseudoptynx*).

Most of the species live in Asia, and only one species in Africa. Its flight must be with a rush, like that of the next subgenus, because the wing-feathers are not so elastic as in the true *Bubo.*

7. Bubo ceylonensis, *Kp.*

Strix ceylonensis, Gmel.
Ketupa ceylonensis, G. R. Gray.
Strix Leschenaulti, Temm. Col. 20.

Ketupa Leschenaulti, Less.
Strix Hardwickii, J. E. Gray, Ill. Ind. Zool. pl. 31.
Cultriunguis nigripes, Hodgs.
Brown, Ill. t. 4.

Diagn.—The size of *B. virginianus.* The under side grey, with black shaft-stripes and numerous fine cross-lines. Feet blackish.

Descr.—Head, neck, and feather-horns rufous-grey, with dark-brown shaft-spots. Feathers on the back dark brown, rufous-spotted and cross-banded on both webs. The lower parts of the back and tail-coverts more of an ash-grey, with narrow shaft-spots and rusty-yellow whitish spots. On the margin of the shoulder-coverts a series of white-margined feathers. The small feathers of the wing dark brown, white-spotted. Arm-wings brownish, with clear, brownish-tinged cross-bands. Tail dark brown, with four to five narrow, more lightly-coloured cross-bands, and with lighter margins.

Hab. India.

8. Bubo flavipes, *Kp.*

Cultriunguis flavipes, Hodgs. As. Soc. Beng. 1836, p. 364. pl. 26.
Ketupa flavipes, G. R. Gray.

Diagn.—Size of *Bubo maximus.* Under parts of the body rufous, with black shaft-spots. Feet yellow.

Descr.—Dark brown, with rufous spots and bands. On the margin of the shoulder-coverts no white spots, *but a large rufous stripe.* Tail with three rusty-yellow bands and margin. One specimen in the British Museum has the upper part of the tarsus covered with a fine down.

Hab. Nepal. Rare in collections. Discovered by Mr. Hodgson.

9. Bubo ketupa, *Kp.*

Ketupa javanensis, Less.
Strix ceylonensis, Temm. Col. 74.
—— *ketupa*, Horsf.
Scops ketupa, Cuv.

Diagn.—Size of *Bubo africanus.* Under parts rusty-yellow, with narrow black shaft-spots.

Descr.—Front and chin pure white. Upper parts dark brown, with rufous margins, spots, and bands. Margin of the shoulder-coverts rufous. The small feathers of the wing dark brown, with rufous bands and white margins. The inner side of the wing light rufous-yellow; wing-feathers black, with three rufous bands and nearly white margins. Tail dark brown, with three rufous-yellowish bands and white points. The wing 350, tail 165 mm. long.

Hab. Java, where it is quite common. Discovered by Dr. Horsfield. An outline of the skull is given in Pl. LVII. fig. 7.

Subgenus d. *Urrua*, Hodgs.

Diagn.—Bill very strong and projected. The first wing-feather to the sixth clearly emarginated on the inner web, nearer to the base of the wing-feathers. Tarsi feathered; toes thinly feathered. Nails of the usual form.

The birds of this division show a greater affinity to the second subgenus, *Bubo*, than to the first, third, or fifth subgenera. Like *Ketupa*, they must have a rushing flight. From their very strong bill, powerful tarsi, and longer toes and nails, they would appear to be more rapacious than the second subgenus, *Bubo*.

Possibly they are not sleepy by daylight, as is the case with the true *Bubo*, which represents the genus *Otus* in its genus.

10. Bubo coromandus, *G. R. Gray.*

Strix coromanda, Lath.
Urrua coromanda, Hodgs.
J. E. Gray, Ind. Zool. pl. 20.

Diagn.—Size of *Bubo africanus*. Whole plumage ash-grey, with dark shaft-stripes and fine cross-lines.

Descr.—The smallest species of all. Feather-horns on the outer webs dark brown. White spots on the exterior webs of the shoulder-coverts and on the small feathers of the wings. The wing-feathers light brown, pointed with broad dark-brown cross-bands. Tail with four or five blackish cross-bands. Under tail-coverts often with brown, black-margined, arrow-like spots.

Hab. India.

11. Bubo orientalis, *G. R. Gray.*

Strix orientalis, Horsf. Linn. Trans.
—— *sumatrana*, Raffles.
—— *strepitans*, Temm. Col. 174 ♂, 229 juv.
Bubo strepitans, Cuv.

Diagn.—Size 370–475 mm. The veil not bounded by a black stripe.

Descr.—A male specimen, of smaller dimensions, in the British Museum has the upper parts dark brown, with a great number of narrow rusty-yellowish bands, four to six on each feather; the under parts whitish, with a great number of black bands, four to six on each feather. A stripe over the eye to the longest feathers of the ear-horns nearly black. The base of the wings on the inner side whitish. The wings near the emarginations brownish, with two whitish irregular spots not reaching the shafts. The tail brown, with three to four narrow, very indistinct cross-bands, and broader greyish-white-spotted terminations. The under side of the tail at the base and the inner webs more whitish, and with three to four very irregular bands. Tarsi black, cross-banded. The bill and toes, which are completely naked, yellow.

Dimens.—Head 90, bill from the gape 48, wings 315, tail 167 mm. long.

Obs.—The figure given by Temminck much resembles *B. nepalensis*, and has very few resemblances to the male, which I have described. I am not quite sure that these two species are not subspecies of one and the same type.

12. Bubo nepalensis, *Hodgs.*

Diagn.—Size of *Bubo maximus* (600 mm.). Ear-horns, ear-margin, occiput, and under-parts with black arrow-like spots. Toes mostly thinly covered with feathers.

Descr.—The largest species, with the longest ear-horns. Front dark brown, with rufous margins and cross-bands. Cheeks ashy-grey. Occiput-feathers white at the base, dark brown at the end, in the middle rufous-banded. Under parts rufous, with from two to four black cross-bands on each feather, which are arrow-like at the extremity. Wings very much variegated, rufous-spotted, with irregular cross-bands and rusty yellowish-white, dark-brown-spotted margins. Tail on the under side whitish, with six black bands; on the upper side brown, with five pointed rusty-yellow bands and broad white ends.

Dimens.—Head 125, bill from the gape 55, wing 470, tail 250, tarsi 72 mm. long.

Hab. Nepal.

13. Bubo lacteus, *Cuv.*

Strix lactea, Temm. Pl. Col. 4.

Diagn.—The veil bounded by a black vertical stripe. Whole plumage rufous and ash-grey, with fine lacerated drawing.

Descr.—Size of *Bubo coromandus.* Ear-horns shorter, black-banded and pointed. Cheeks white, with blackish zigzag bands; near the *furcula* often darker. Along the shoulder-coverts and on the small feathers of the wing are white, dark-pointed spots: on the tarsi and under tail-coverts white spots. I have seen specimens with naked and with feathered toes.

Hab. Africa.

Subgenus e. *Pseudoptynx.*

Diagn.—*Ketupæ* with feathered tarsi, and feather-horns not distinct.

14. Bubo philippinensis, *Kp.*

Syrnium philippinense, G. R. Gray, Brit. Mus.

Descr.—Size of *Bubo ketupa.* Upper parts dark brown, with rusty-yellow or rufous margins. The shoulder-coverts have white margins on the outer webs, which form a stripe. The wing-feathers have from four to five rufous spots, not reaching to the shaft. The arm- and hand-wings have whitish margins. The end of the tail has distinct cross-bands. The lower parts are whitish, with rufous tint and black shaft-spots. Tarsi grey; bill yellow. The not very distinct ear-horns black.

Dimens.—Head 90, bill 30, from the gape 43, wings 320, tail 162, tarsus 61, middle toe 37 mm. long.

Hab. Philippine Islands.

In its dimensions this species comes very near to *Bubo ketupa*. The only specimen of this rare bird as yet known is in the rich Collection of the British Museum.

Genus IV. Strix, *Linn.*

a. *Phodilus*. b. *Strix*. c. *Scelostrix*. d. *Dactylostrix*. e. *Megastrix*.

Diagn.—The nail of the middle toe on the interior margin clearly *pectinated*.

Descr.—The bill projected, near the cere straight, and of light yellowish colour. The ear-orifice square, placed between two skin-flaps, and bounded on the upper and lower margin by a membrane (Pl. LVII. fig. 8, *a a*). The hind ear-lap is as broad as long; the anterior ear-lap or operculum is broadest in the middle of its height. The whole ear-slit begins over the eyes and reaches nearly to the gape, as in *Otus*. The eyes separated by a thick bony wall. No asymmetry. The tarsi slender, and more thinly covered with feathers, more at the bottom than next to the *tibiæ*. The outer toes stronger, and as long as the middle toes. The plumage very much developed, with much down, and finely and elegantly coloured. The eyes always brown.

These birds are spread over all parts of the world. The smaller ones live on mice and little birds; the larger species attack mammalia and birds.

Subgenus a. *Phodilus*, Is. Geoffr.

Diagn.—Wing short. First wing-feather as long as the tenth. Toes naked, scaled, and without bristle-feathers.

1. Strix badia, *Horsf.*

Linn. Trans. xiii. 139; Zool. Res. pl. 37; Temm. Pl. Col. 318.
Phodilus badius, Is. Geoffr. Ann. de Sc. Nat. xxi. p. 201.

Descr.—Smaller than *Strix flammea*, but very near to it in colour. Front, veil, and lower parts white, tinged with rufous ash-grey. On the lower part are two round black spots on each feather. The small feathers on the upper parts rusty-yellow, with round black spots, which on the wings are margined with white. The margins of the wings white, black-spotted. On the inner side of the wing are seven or eight bands. The tarsi pretty thickly feathered, and the nails in comparison very long and strong.

Dimens.—Head 64, bill from the gape 33, wing 213, tail 73 mm. long.

Hab. Java (Horsfield).

Subgenus b. *Strix.*

Diagn.—Of middling size and very lightly built. The first wing-feather nearly as long as the second, the third a little shorter. Only the first wing-feather on the end of the inner web feebly emarginated. Toes finely scaled, and provided with bristle-feathers. The long wings reach beyond the short tail.

The members of this subgenus all bear very near relation to each other, and we have for a long time considered them as climatic varieties of the common *Strix flammea.* They are spread over the whole world.

2. STRIX PUNCTATISSIMA, *G. R. Gray.*

Voy. of Beagle, B. p. 34. pl. 4.

Diagn.—The wings are only 235 mm. long. The first wing-feather shorter than the fourth.

Descr.—The smallest of all the group, with the darkest plumage. Upper parts with fine rufous and white drawing. All the feathers with white end-spots. The inferior parts, like the interior shoulder-coverts, rusty-yellow, with two to three blackish arrow-like spots on each feather. Tail with four black bands and white spots on the end-margins. The veil rufous, dark-coloured on the point, with fine black drawing.

Dimens.—Head 71, bill from the gape 39, tarsus 58, middle toes 58, tail 108 mm. long.

Hab. Galapagos Islands.

Obs.—A very distinct species, only in the Collection of the British Museum.

3. STRIX GLAUCOPS, sp. nov.

Diagn.—With silver-grey face. The first wing-feather as long as the fourth.

Descr.—Face silver-grey; feathers of the hind ear-margin rusty-red, some with darker shaft-spots and points on the top; under the chin, the ends of the wreath-feathers nearly black. Back blackish, with a great number of zigzag spots and lines. Tail rusty-red, black-pointed, with seven black cross-bands. The wings are similarly coloured. The lower parts rusty-red; on each feather are black spots and zigzag bands.

Dimens.—Head 80, bill from the gape 44, wing 245, tail 125, tarsus 64 mm. long.

Hab. Jamaica. British Museum.

4. STRIX FLAMMEA, *Linn.*

Naum. t. 31; Gould, Birds of Eur. t. 36; Enl. 440.

Diagn.—The outermost series of feathers on the hinder ear-margin pure white, or along the shafts with an indistinct drawing, which ends in dark-brown points.

Descr.—The arm- and hand-wings are never white, but rufous, with black and white bands on the inner side.

Dimens.—Head 67–68, bill from the gape 44, wing 268–275, tail 122, tarsus 59–60, middle toe 35 mm. long.

Hab. Europe, and southern and northern parts of Africa and Asia.

I can find no difference in specimens from the Cape of Good Hope.

5. Strix perlata, *Licht.*

Strix furcata, Temm. Col. 432.
—— *pratincola,* Bp.
—— *flammea,* Wils. 50. 2.
—— *americana,* Aud. 171.

Diagn.—Tarsus 73–79, wing 300–315 mm. long.

Descr.—Very similar to *Strix flammea,* but different in dimensions. In this species we find specimens in which the wings are nearly white. The end of the tail is more forked than in *Strix flammea.*

Hab. Northern and southern parts of America.

6. Strix delicatula, *Gould.*

Birds of Austr. tom. i. pl. 31.
Strix javanica, De Wurmb.

Diagn.—Tarsus 66–67, wing 255–280 mm. long. The webs of the feathers of the hinder ear-margins have along the shaft a black stripe, which is crossed at the top with a zigzag band or an arrow-like figure.

Descr.—Very similar to the European *Strix flammea,* but the predominant ground-colour is ash-grey.

Obs.—I cannot find any difference between the examples of this species from Australia and those from Java, and I feel quite sure that *S. delicatula* and *S. javanica* belong to one and the same species.

7. Strix santi-thomæ, *Hartl.*

Diagn.—The feathers on the hinder ear-margins all rusty-yellow, with black shafts or black shaft-stripes; near the gape and chin with dark-brown margins. Upper parts nearly black-grey, with white black-bounded spots.

Descr.—Very nearly allied to *Strix flammea,* but the whole colour on the upper parts is darker, and the lower parts are more rufous and have larger black spots, one, or sometimes two on each feather. The face is darker, and the bands on the wings and tail are broader.

Dimens.—Head 70, from the gape 37, tarsus 59–60, middle toe without the nail 31, with the nail 40 mm. long.

I cannot give the dimensions of the wings and tail, because the only known specimen in the Museum at Hamburg is a young bird.

Hab. The island of St. Thomas, on the western coast of Africa. I think that this bird is spread over a great part of Western Africa.

This species ought to be compared with *Strix poensis*, Fraser, Proc. Zool. Soc. 1842, p. 187, from the island of Fernando Po.

Subgenus c. *Scelostrix.*

8. Strix candida, *Tick.*

Journ. A. S. B. ii. p. 572 (1833).
Strix longimembris, Jerd. Madr. J. Lit. & Sc. 1839, p. 86.
—— *capensis*, A. Smith, Ill. S. Afr. Zool. pl. 45.

Diagn.—Tarsus 80 mm. long; upper parts more or less uniform brown or blackish.

Descr.—In size near to *Strix personata*, but the bill and toes thinner. The upper parts with little end-spots on each feather. Here and there more or less rufous. The inferior parts more or less rusty-yellow, with reddish-brown spots on the points of the greater part of the feathers. The young bird has these parts, as well as the tail, pure white, and the spots are smaller. The tail shows four bands.

Dimens.—Head 82, bill from the gape 44–46, wing 340–349, tail 123, tarsus 80, middle toe 35–40 mm. long.

Hab. Cape of Good Hope and Madras.

Subgenus d. *Dactylostrix.*

Diagn.—With shorter wings and shorter wing-ends, which do not reach beyond the end of the tail. Second wing-feather the longest, third as long as the second.

Descr.—Without the light aërial body of the second subgenus, *Strix*, and with stronger bill, more powerful toes, and stronger shafts to the wings. The toes yellow, with fine scales and bristle-feathers. Large-sized Owls, preying upon larger animals than mice.

9. Strix castanops, *Gould.*

Birds of Austr. tom. i. pl. 28.

Diagn.—Middle toe 57–58 mm. long.

Descr.—Differs greatly from the preceding species in its large size, strong tarsi, and long toes. The upper parts black and rufous-yellow, with irregular white zigzag spots. The lower parts with large irregular black spots, with white bands on the top of each feather. Tail with six irregular cross-bands. The margin of the veil usually dark brown. Some with brown, others with a white face: it varies very much in this respect.

Dimens.—Head 89, bill from the gape 50, wing 359, tail 162, hind toe 26 mm. long.

Hab. Van Diemen's Land.

10. Strix personata, *Vig.*

Proc. Zool. Soc. 1831, p. 60.
Strix cyclops, Gould, P. Z. S. pt. 4. p. 140.

Diagn.—Wing 312, tarsus 61–63, middle toe 42–46 mm. long.

Descr.—A rusty-yellow is the predominant ground-colour of the upper parts, on which appear more or less large spots. The dark plumage shows no white spots, but the feathers have sometimes fine white points. The tail has six dark-brown bands traversed by white points, which do not come together with regularity at the shafts. The veil is dark brown at the points, and the single feathers have no drawing along the shaft.

An old bird has less rusty-yellow on the upper part, and shows white and arrow-like spots on the dark parts; these have their points sometimes directed to the bill, sometimes towards the tail: the lower parts are also more spotted, and the thickly feathered tarsi whitish.

Dimens.—Head 82–85, bill from the gape 47, wing 310–312, tail 147 mm. long.

Hab. Australia.

Subgenus e. *Megastrix.*

Diagn.—With short wings and short and obtuse wing-ends. The first wing-feather as long as the sixth, the second and fourth a little longer, the third the longest. Toes completely naked and scaled, as in *Phodilus*, or thinly covered with bristles.

11. Strix tenebricosa, *Gould.*

Austr. Birds, tom. i. t. 30.

Descr.—With dark-grey face and blackish plumage, which on the smaller feathers is grey-marbled. On the point of each feather are white shaft-spots and a black margin. The concealed part of the margin-feathers of the ear white, with zigzag drawing and dark-brown points. The wing-feathers on the exterior webs spotted, without bands, on the inner side uniform. Tail light-coloured, pointed with blackish-grey. The margin of the tail with black spots, and two white arrow-like spots before the end-band. Toes yellow.

Dimens.—Head 86, bill from the gape 47, wing 286, tail 127 mm. long.

Hab. Australia.

Genus V. Syrnium, *Sav.*

a. *Ciccaba.* b. *Syrnium.* c. *Bulaca.* d. *Pulsatrix.* e. ——?

Diagn.—Without feather-horns, with regular nail on the middle and other toes, and a distinct veil; the first wing-feather shorter than or just as long as the tenth.

Descr.—The species yet discovered are all either of middling or large size. All have a round, regular, but very cellulous head and greatly developed plumage. The first wing-feather to the fourth or sixth emarginated. The first wing-feather completely, the following only on the emarginations, dentellated.

Subgenus a. *Ciccaba*, Wagl.

Diagn.—Ear-orifice very small, like a Day-Owl, and without operculum. Toes naked and scaled, like *Scops*. The second wing-feather to the sixth on the exterior web, and the first to the fifth on the interior web emarginated. Bill feeble and projected. Of middling size.

1. Syrnium huhula, *Kp.*

Strix huhula, Lath., Le Vaill. Afr. 41, 44.
Surnia huhula, Less.
Athene ——, G. R. Gray.
Strix lineata, Shaw.
—— *albomarginata*, Spix, pl. 10 *a*.

Diagn.—Black, with numerous white cross-bands.

Descr.—Veil and chin pure white, or black- and white-spotted. Wings nearly black, with narrow, light, often white bands. Tail with four to six cross-bands. Bill and toes yellow. An old bird figured by Le Vaillant has the wings more white-spotted than banded. Chin and veil black, white-spotted. One specimen in the British Museum has the ground-colour of the lower parts white, with black bands; tail with six bands. Another has the ground-colour black, with white bands; the tail has only four bands (Spix's *albomarginata*).

Dimens.—Head 68–72, bill from the gape 31–33, wing 244–262, tail 148–152–162, middle toe without nail 29 mm. long.

2. Syrnium nudipes.

Strix nudipes, Daud.
La Chouette nudipède, Vieill. Am. pl. 16.

Diagn.—Size of *Athene noctua*. The greater part of the tarsus without feathers.

Hab. Porto Rico.

Descr.—Two examples in the Museum at Paris, one of which is more reddish-brown, and the other more rufous.

The first has the front dirty-white, with four dark cross-bands. The lorum-feathers also dirty-white, with black shafts reaching beyond the yellow bill. The face and anterior ear-coverts dark, spotted with rufous-yellowish, like *S. cayennense*. The veil pure white, black-margined, like *S. albopunctatum*, and reaching to the lorum-feathers. The head-feathers dark brown, on the margins rufous. The back-feathers on both webs with three to four pairs of rusty-yellow points. The margins of the shoulder-coverts with irregular white, black-bounded spots. Some of the coverts on the margin of the wing are similar. The hand-wings are dirty-white, spotted on the external webs. On the inner side the wings are nearly black, and only above the emarginations have narrow white bands not reaching to the shafts. The inner wing-coverts white, with a longitudinal dark stripe in the middle. Tail with red shafts and brownish webs, with fine, very small lighter spots. On the inner webs seven to eight small white bands not reaching to the shafts. The under parts (like a *Scops*) are white, with the feathers brownish in the middle, and blackish shaft-spots and cross-bands.

The other, more rufous, specimen has the front purer white, and the veil without a black margin. Chin and the upper parts of the breast more rufous. This is certainly a younger bird.

Dimens.—Head 49, from the gape 21, wing 146–153, tail 80–81, tarsus 38, middle toe without nail 21 mm. long.

I have no doubt that the naked tarsus is natural. A very young bird out of the nest, from St. Domingo, has the same character, and has the greater part of the tarsi scaled.

3. Syrnium albogulare, *Cassin.*

Scops albipunctatus, G. R. Gray.
Syrnium albogulare, Cass.
—— *macabrum,* Bp.

Diagn.—Tail 128 mm. long, with fourteen regular bands on the under side.

Descr.—Head, neck, upper part of breast, and back dark brown, spotted with rusty-yellow and whitish. A stripe over the eyes: chin with white ground-colour: the sides and thigh-feathers are rusty-yellow, the first with dark-brown shaft-stripes, fine cross-lines, and white spots. The exterior webs of the wings with from seven or eight to eleven rusty-yellow spots. The interior part of the wing rusty-yellow, spotted with black; but the greater part is uniform blackish, and the dark cross-bands are not very distinct. The tail on the superior part is of a dark rusty-yellow, finely spotted with eleven zigzag rusty-yellow spot-bands.

Dimens.—Wings 193 mm. or 7″, tail 128 mm. or 4″ 7‴.

Hab. New Grenada.

4. Syrnium cayennense, *Kp.*

Strix cayenennsis, Gmel. (juv.).
—— *fasciata,* Vieill. Enc. p. 1288.
Syrnium zonocircum et *polygrammicum,* G. R. Gray.
Strix suinda, Vieill. (juv.).
—— *squamulata,* Licht.

Diagn.—The lower parts rufous with dark-brown shaft-spots. Wings 240–265, tail 143–157 mm. long.

Descr.—The upper parts dark brown with numerous rufous zigzag stripes. Along the shoulder-coverts a rufous stripe. The wing-feathers with from four to nine rusty-yellow, black-margined, sometimes dark-pointed cross-spots. A very dark-coloured bird (*S. zonocircum*) with black tail, which has four white, grey-pointed cross-bands, shows the spots on the wings, near the emarginations, nearly white. Another (*S. polygrammicum*) shows more rufous, and the dark-brown tail has seven lighter zigzag cross-bands, which are very clearly bounded, and in the middle pointed like bands. This is a young bird. In the nest-plumage there is rufous on the smaller feathers of the body. Wings and tail very variegated by the distinct black margins of the lighter bands.

Dimens.—(*S. zonocircum*): head 68, bill from gape 32, wing 250, tail 153 mm. long.
(*S. polygrammicum*): ,, 67, ,, ,, 33, ,, 240, ,, 145 ,,

Under the name of *Syrnium squamulatum*, Bp. (*Strix squamulata* et *chrysosticta*, Licht.), I received two specimens from the Museum at Berlin, which are not different from *S. cayennense*. The lighter and larger specimen, certainly the female (*Strix squamulata*), has the lorum white, with black shafts, which reach beyond the bill. Stripe over the eye white; some feathers of it nearer the front rusty-yellow and black-banded at the base. Feathers of the hinder ear-margin on its anterior side black, with a rusty-yellow zigzag shaft-stripe and a pure white end: the white ends of these feathers make the hinder margin of the ear pure white. All the feathers on the front, head, and neck brownish, with two rufous bands at the base, and near the end with one or two white or light-rufous spots or bands. The shoulder-coverts with rufous bases and bands, and with one or two pairs of white or lighter rufous spots. The margin-feathers of the shoulder-coverts on the outer web with large white spots, which form a long stripe. On the marbled, variegated smaller feathers of the wing are white, black-bounded spots. The wing-feathers light reddish, with from four to six white, black-bounded bands, reddish-coloured in the middle. On the inner side the wing-feathers are blackish, with rusty-yellow or greyish bands. The ends of all the feathers white. The tail on the upper and under side has four white bars. Tarsi whitish, with indistinct fine reddish cross-bands.

The darker and smaller specimen, which is possibly a male (*S. chrysosticta*), has a dark face, and the feathers on the hinder ear-margin reddish-banded and spotted at the ends. All the spots on the head and neck are rufous, on the back greyish. The white bands on the wings are dark grey, and the ground-colour of the under parts is rufous, with the exception of the under tail-coverts, which are white, some of them with a narrow black shaft-stripe and black end. As in *S. squamulata*, the first joint of the middle toe is covered with feathers. Tarsi on the outside brownish-spotted.

Dimens.—Head 63–66, bill from gape 30–33, wing 240–265, tail 143-157 mm. long.
A young bird: ,, 59, ,, ,, 30, ,, 240, ,, 143 ,,

A young bird from the Berlin Museum, under the name of "*Strix dominicensis*, Gmel." (*suinda*, Azara), has a dark-brown head, with from three to five narrow rusty-red cross-lines. A stripe over the eye white. The anterior ear-coverts very dark rusty-red-brown, with lighter shafts and black spots. The feathers of the hinder ear-margin white, rusty-yellow at the base. The back is lighter, because the lighter rufous cross-bands are broader. The margins of the shoulder-coverts rusty-yellow on the outer webs, black-spotted and margined. The smaller feather of the wings without white spots, and rusty-yellow with brown, black-margined cross-bands. Inner side of the wing-feathers with from six to nine rusty-yellow bands. Tail with nine lighter reddish bars on a blackish ground. The greater number of bars is a sign of youth.

5. SYRNIUM HYLOPHILUM, *G. R. Gray.*

Strix hylophila, Temm. Col. 373.
Syrnium albotarse, G. R. Gray.
Ulula fasciata, Des Murs, Pl. Peint. 37.

Diagn.—Size of *Syrnium aluco.* Breast and belly with dark cross-bands, one or two on each feather.

Descr.—Rufous, with dark-brown zigzag cross-bands. Margin of the shoulder-coverts with a rusty-yellow stripe. Chin, belly, and sides pure white, banded with black and rufous. Tail with six cross-bands, in the middle nebulous, margined with lighter rufous and blackish; the end of the tail whitish. Tarsi rufous, darker-banded. Young birds show white spots on the wings and concentric rings on the face.

Dimens.—Head 70, wing 250, tail 150 mm. long.

The older bird is G. R. Gray's *Syrnium albotarse,* with whitish lorum and eye-stripe. No concentric rings on the face. The rusty-yellow bands on the wings and tail are without spots. The coverts of the ten hand-wings wholly black, without spots. Tarsus white.

A young bird in the British Museum, with nebulous spotted bands on the wings and tail, has concentric rings on the face, and rusty-red and dark cross-banded tarsi.

6. SYRNIUM WOODFORDI, *Cassin.*

Athene woodfordii, A. Smith, Ill. Zool. S. Afr. 71.

Diagn.—The lower parts with four line-like cross-bands on each feather. Between the last cross-bands a white band with the margin rufous.

Descr.—Bill yellow. Front greyish-white. Around the eyes darker; face banded. Chin-feathers white, with from five to six dark-brown cross-bands. The smaller feathers of the lower parts dark brown, with rusty-yellow dark-margined cross-bands, and rhomboid black-margined spots at the end of each feather. Margin of the shoulder-coverts rusty-yellow, with white spots, and three bands on the exterior web of each feather. Margins of the wing black-brown, with from four to six yellowish-grey cross-bands with light ends. The small feathers on the arm-wings have white margins. Tail blackish, with seven rusty-grey cross-bands, more regular and distinct at the sides. The rusty-yellow tarsi dark-spotted.

Hab. S. Africa.

7. SYRNIUM SINENSE, *G. R. Gray.*

Strix sinensis, Lath. Ind. Orn. i. p. 53.
—— *orientalis*, Shaw; Gray, Ill. Ind. Zool. t. 21.

Diagn.—Lower parts rufous, with large white spots. Each feather with two fine narrow black cross-bands. Head, neck, and back whitish, variegated on a rufous ground-colour.

Descr.—Larger than *Otus vulgaris*. Lorum-feathers white with black ends. Plumage above the eye white, black-banded. Face rusty-brown, each feather with a blackish band and a broad white margin, which form concentric rings. Chin white. Feathers on the hinder margins of the ear black, the last with rufous. Head-feathers burning rusty-red, with black points and with a broad black band. Shoulder-coverts and wing at the base rusty-red, at the top black, with ash-grey zigzag drawing. The exterior margins of the shoulder-coverts light rusty-red, with large white spots and narrow black cross-bands. The arm-wings with seven dark-brown bands, and with lighter whitish-bounded bands, which are pointed with dark brown. The wings on the exterior webs rusty-yellow, from the beginning of the emarginations blackish-ocellated and pointed, with from six to eight blackish bands. On the interior part of the wings the coverts are rusty-yellow and whitish, with fine black bands and arrow-spots; near the base of the wing-feathers a large spot of rusty-yellow. Base of the tail reddish-brown, the top black, with seven lighter, pointed, black-bounded cross-bands. On the under side the tail is rusty-yellow, with seven line-like cross-bands. The margins are grey, nebulous, and show three broader bands. Tarsi whitish, blackish-banded.

Dimens.—Head 77–80, wing 327–330, tail 190 mm. long.

8. SYRNIUM SELOPUTO.

Strix seloputo, Horsf.
—— *pagodarum*, Temm. Col. 230.

Diagn.—Cheeks, lorum, and front burning rusty-red.

Descr.—A handsome Owl with very variegated plumage, of the size of *Syrnium nebulosum*. On the superior parts brownish, intermixed with rusty-yellow and white, and with black-bounded cross-bands. Margins of the shoulder-coverts white, with five narrow black cross-bands across the two webs of each feather. The small feathers of the wing have white spots, are black-bounded, and have cross-bands on the outer webs. On the outer webs of the wing-feathers from five to seven lighter cross-bands, which are white from the beginning of the emarginations, black-bounded. The lower parts white, intermixed with rusty-yellow down. Each feather with from three to four pretty large black cross-bands. Tail brown, with single white spots, forming on the exterior feathers eight lighter cross-bands; the under side with twelve whitish bands, near the base blackish-bounded. Tarsi dirty-white, blackish-banded.

Dimens.—Bill from the front 49, from the gape 45, wing 340, tail 180 mm. long.
Hab. Java.

9. SYRNIUM LEPTOGRAMMICUM, *Cass.*

Strix leptogrammica, Temm. Col. 525.

Diagn.—Breast rusty-red, without bands. Head without spots or bands. Cheeks and lores whitish ; a black-brown stripe from the front round the ear-coverts.

Descr.—Head, neck, and breast near the *furcula* lighter or darker rufous. Wings and tail rufous or dark brown, with numerous dark-brown cross-bands. The lower parts light rusty-yellowish white with blackish cross-bands. Tarsi banded. Length 14 inches. Description taken from a younger bird, after Temminck.

In the British Museum there is a specimen of an old bird which shows some differences. The bristle-feathers of the lorum are black, the cheeks are rufous, and the head, except a stripe over the eye, is black, bounded with a light rufous neck-collar. Shoulder-coverts on the margin white, black-striped. Tail with ten narrow rufous bands and end. Tarsi only with traces of bands.

Dimens.—Head 70, bill from the gape 33, wing 285, tail 156, tarsus 47 mm. long.
Hab. Borneo.

Subgenus b. *Syrnium*, Sav.

Diagn.—Bill feeble and yellow. Ear-orifices of middling size and asymmetrical, with large opercula. Toes thickly feathered. First wing-feather all round, and the second to the fifth on the emargination dentellated.

Between the size of *Syrnium aluco* and *Bubo maximus.*

Found in every part of the world except New Holland.

10. SYRNIUM NIVICOLUM, *Hodgs.*

Journ. As. S. B. xiv. p. 185.
Icon. ined. Accipitr. 96.

Diagn.—Head 74, wing 286, tail 185, bill 23 mm. long.

Descr.—Larger than *Strix aluco*, and the colour more variegated and brilliant. The feathers of the belly and sides rusty-yellow, with white spots and bands and dark end-margins. The six bands of the wing have blackish edgings : the tail is rather long, and has nine distinct marbled cross-bands.

Hab. N. India.

11. SYRNIUM ALUCO, *Cuv.*

Strix aluco et *stridula,* Linn. Naum. t. 46, 47; Enl. 441, 437; Gould, Birds of Eur. pl. 47.
Syrnium ululans, Sav.
Strix sylvestris, alba, noctua, et *rufa,* Scop.
—— *sylvatica,* Shaw.

Diagn.—Head 70, tail 170 mm. long.

Descr.—Ash-grey or reddish-brown. Face whitish, with blackish shafts, which are longer than the webs. On the margin of the ear a trace of a brownish band. The cap brown or grey, on each side with a whitish stripe extending to the occiput. The head-feathers with dark-brown zigzag shaft-spots, on the margin rusty-yellow and white-spotted. The neck-feathers are spotted, or rather banded, in a similar manner. Shoulder-coverts with dark-brown shaft-spots and fine zigzag lines. The margins pure white, with black bands and points. Smaller feathers of the wings with white spots on the outer webs. On the variegated wing-feathers six dark cross-bands on a lighter ground; these are sometimes white on the margin of the outer webs. The lower parts white, with blackish- or rusty-brownish-margined shaft-spots, which are cross-banded and rusty-yellow-spotted. The variegated tail has six dark-brown cross-bands, except the two middle feathers, which are more pointed, having light yellow-brown- or grey-pointed end-margins.

Dimens.—Head 70–72, wing 271 mm. long.

Hab. The woods of Europe and Asia. In the daytime very somnolent.

12. SYRNIUM CINEREUM, *Bp.*

Strix cinerea, Gmel.; Naum. Nachträge; Gould, Birds of Eur. pl. 42.
—— *lapponica,* Retz.
—— *barbata,* Pall.
—— *fuliginosa,* Shaw.
Ulula lapponica, Cuv.
—— *microphthalma,* Fyzenski.
Syrnium cinereum et *microphthalmum,* G. R. Gray.
Sparrm. Mus. Carls. t. 5; Pall. Zoogr. Ross.-As. i. t. 11; Nilss. Ill. Fig. Skand. Faun. t. 71; Aud. Am. t. 351.

Diagn.—The face ash-grey, with concentric rings.

Descr.—Whole colour blackish, with numerous white zigzag stripes and spots. Wings with pointed light-bounded bands.

Shows, in comparison with its size, the smallest bill of all Owls.

Hab. Found in the high northern parts of Europe, Asia, and America.

13. SYRNIUM NEBULOSUM, *Boie.*

Strix nebulosa et *chichictli,* Gmel. Wils. 33. 2; Vieill. Ois. d'Am. Sept. 17.
Gould, Europe, 46; Aud. pl. 46.

Diagn.—Size between *S. aluco* and *uralense.* Head 84, wing 320, tail 205 mm. long.

Descr.—A handsome Owl, with very distinct rusty-yellow and white bands on the head, neck, and breast. Belly and sides whitish and light rusty-yellow, with broad dark-brown shaft-spots. Arm-wings with four, the hand-wings with five lighter cross-bands. Tail with four cross-bands.

Hab. Northern parts of America: never found in Europe. Vieillot gives a drawing of one with naked toes.

14. Syrnium uralense, *Brehm.*

Strix uralensis, Pall.; Naum. 42. 1; Gould, 44.
Ptynx uralensis, Blyth.
Scotiaptex ——, Sw.
Strix liturata, Retz.
Ulula liturata, Cuv.
Strix macroura, Natt.
—— *macrocephala*, Meisn.
Syrnium macrocephalon, Brehm.
Lepech. Voy. t. 3.

Diagn.—Face grey or whitish, without concentric rings. Margin of the shoulder-coverts with large white spots. Size of a little specimen of *Bubo maximus*, or 26 inches long.

Descr.—The margins of the eyes yellow. General colour white, the face with dark feather-shafts. The superior parts white, with blackish shaft-spots. The hinder margin-feathers of the ears brown, whitish-spotted. Chin with black shaft-spots. The long tail with five broad, irregular, white cross-bands.

Hab. North-eastern part of Europe and Siberia.

Subgenus c. *Bulaca*, Hodgs.

Diagn.—Ear-orifice not larger than the diameter of the eye, with small operculum. Bill strong, straight, projected, and nearly black. First to the sixth wing-feather emarginated near the middle. Toes feathered. Rather large in size.

15. Syrnium indranee, *G. R. Gray.*

Strix indranee, Sykes, Proc. Zool. Soc. 1832, 82.
Gray & Mitch. Gen. of Birds, pl. 14.
Bulaca newarensis, Hodgs.
—— *monticola*, Jerd.
Urrua umbrata, Blyth.

Diagn.—The lower parts white, with numerous black cross-bands. Head, neck, and back uniform dark brown.

Descr.—Larger than *S. aluco*. Feathers of the lorum ash-grey, with black shafts. Face blackish-brown, near the ear lighter, with concentric rings. Front to the middle of the eye white, black-banded. The feathers on the hind margin of the ear black, without drawing; sides of the neck, margin of the shoulder-coverts, and upper tail-coverts banded with dark brown. Head, neck, and back uniform dark brown. The wing-feathers with ten regular dark-brown cross-bands and white margins. The two series of coverts on the arm-wings elegantly banded with rusty-yellow and brown. Tail dark brown, with eleven brownish bands, which near the shaft and on the inner webs of the five exterior are whitish. Eyes reddish-brown. Bill on the back yellowish.

Dimens.—Head 85, wing 345, tail 227 mm. long.

Hab. Hindostan; country of the Mahrattas: rare (*Sykes*).

Subgenus d. *Pulsatrix.*

Diagn.—Bill strong, high, curved from the base, with sharpened back. Ear without operculum, and not so large as the diameter of the eye. First wing-feather to the sixth emarginated rather near the base. Toes feathered down to the scales of the nails.

16. Syrnium torquatum, *Kp.*

Strix torquata et *personata,* Daud., Le Vaill. 42, 44 (juv.).
—— *perspicillata,* Lath. (tab. 6. in Bechst. Uebersetzung.)
—— *superciliosa* et *larvata,* Shaw.
Syrnium personatum (juv.), G. R. Gray.
Strix pulsatrix, Wied, Beitr. ii. (♀).
Ciccaba perspicillata, Cass.
—— *torquata,* Bp.

Descr.—Blackish, with white front and stripe over the eye. Lower parts white, with brown chin- and breast-band. Arm- and hand-wings pale-banded. Some single smaller feathers of the wings with white spots. On the inner side of the wings the coverts are white, the wing-feathers with from five to seven not very distinct bands. The dark-brown tail has from five to seven lighter bands and broad white margins.

Le Vaillant gives a figure with grey, whitish-banded shoulder-coverts and small feathers of the wing.

Dimens.—Head 84, bill from the cere 27, from the gape —?, wing 290, tail —? mm. long.

Hab. Guiana; Brazil.

Arrived at the end of my dissertation I have only to request that it may be received with forbearance, for no one can feel more sensibly than myself how much it falls short of being complete.

This Monograph, like all human works, has its wants and faults, some of which might have been avoided if I could have had daily access for a year to the scientific materials in Europe from which to make the necessary recapitulations.

The only thing which renders this Monograph of value is, that I have reduced the three subfamilies of Bonaparte, the four of G. R. Gray, and the five of J. Cassin into two natural subfamilies of Day and Night Owls, and that I have degraded to the rank of subgenera eleven genera which have been adopted by late authors as true genera.

In order to guard against the fault of too great subdivision, I first distinguished the species, and then looked for the characters of the small subgenera. After fixing the limits of the subgenera, there was no difficulty in arranging them according to their true genera.

I have, as far as was in my power, examined the skulls of all the ten genera, and have found that genera like *Nyctea*, *Brachyotus*, *Ketupa*, *Lophostrix*, *Ciccaba*, *Ulula*, and *Ptynx* have no important osteological characters to separate them from *Surnia*, *Otus*, *Bubo*, and *Syrnium*.

It would have been conformable with my plan to have given figures of the skulls and skeletons of all the genera and subgenera, for the mind more readily receives these distinctions when presented through the eye than by written descriptions; but I have been unable to furnish more than a portion of them.

I request that those *savants* who may in future number the subgenera as true genera will establish their position by showing good osteological points of difference,—such as exist between *Scops* and *Otus*, *Otus* and *Bubo*, *Bubo* and *Strix*, *Strix* and *Syrnium*.

Any German, English, or French ornithologist who can give proof, in the manner stated, that one of these subgenera is a real genus (as for example *Ketupa* or *Scotopelia*), will have the satisfaction of overthrowing the whole of my opinions, because I advance the bold maxim that all the genera of the *Strigidæ* belonging to our Creation are already discovered, and that the only new species which will ever come to light will prove to be some small subgenera in the genera *Glaucidium*, *Nyctale*, *Surnia*, &c.

I found a great part of my subgenera already named, and have therefore continued them in the same form; for it is a matter of no great moment whether the small groups bear Latin names or are signified by letters or numbers: for my own part, I prefer a name bearing some signification rather than a senseless letter or number. All the small subgenera exist, and having some distinct external characters, must consequently bear separate names.

Whether ornithologists will persist, in defiance of reason, still to class as genera the subgenera *Nyctea*, &c., or conform to my plan of placing newly discovered species in one or the other of my small subgenera, time only can show. If they should hold to the opinion that they can, by mere outward appearances, distinguish the true genera without consulting the comparative osteology and anatomy, and upon such inconclusive grounds elevate the small subgenera to true genera, then I must beg that so great a fallacy may never be connected with my name.

In regard to species, and their rank in every subgenus, I leave a large field for corrections. The greater part of my materials were collected whilst travelling, and I had not then the time to determine the true rank of each species. This can only be done by comparing it with all its allied species, and not with some two or three only.

When we have discovered the greater part of the species, we shall find that most of these are divided into subspecies; for example, all the Asiatic species which are near to *Scops lempiji*, and all the American species which are near to *Scops asio*, are subspecies. In a similar manner to the arrangement of each subgenus within the limits of its proper genus, so also must the subspecies be placed under its true species.

Here is a rich field to cultivate, destined for some happy *savant* having rich collections at his command.

In conclusion, I beg to express my best acknowledgements to Dr. Gray and Mr. G. R. Gray for their kindness and liberality; it is to these gentlemen, and the information derived from the British Museum, that I owe what serves for the foundation and what is of most value in this Monograph.

But the aid of these gentlemen would have been unavailing to carry this Monograph to a conclusion without the pecuniary assistance of Mr. Edward Wilson, of Hên Castle in South Wales, formerly of Philadelphia, whose liberality enabled me to visit the Museum at Paris, and there make the necessary additions by personal inspection of all the species which it contains. I also give my best thanks to Professor I. Geoffroy, Dr. Pucheran, and M. Kiener of Paris for their kindness and liberality.

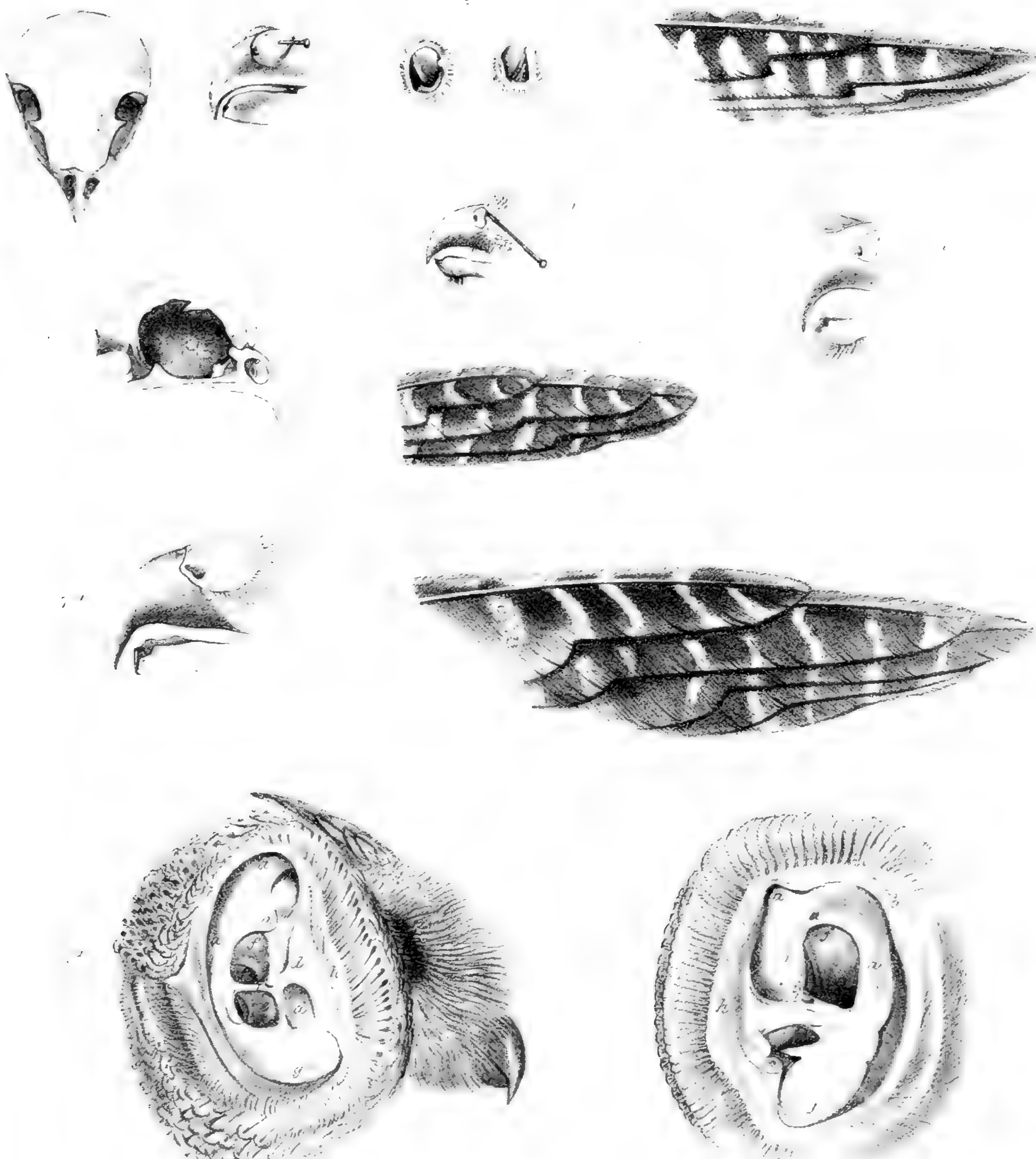
EXPLANATION OF THE PLATES.

PLATE LVI.

Figs. 1, 2. Skull of *Glaucidium ferrugineum.*
Fig. 3. Bill of *Athene,* showing the position of the nostrils.
Fig. 4. Ear-orifices of *Athene,* showing their asymmetry.
Fig. 5. *a.* Bill of *Surnia passerina*; *b.* wing of the same, showing the emarginations.
Fig. 6. *a.* Bill of *Surnia ulula*; *b.* end of wing of the same.
Fig. 7. *a.* Bill of *Ieraglaux connivens*; *b.* end of wing, showing emarginations.
Fig. 8. *a.* Right ear of *Otus brachyotus*, *b.* left ear, showing their asymmetry.

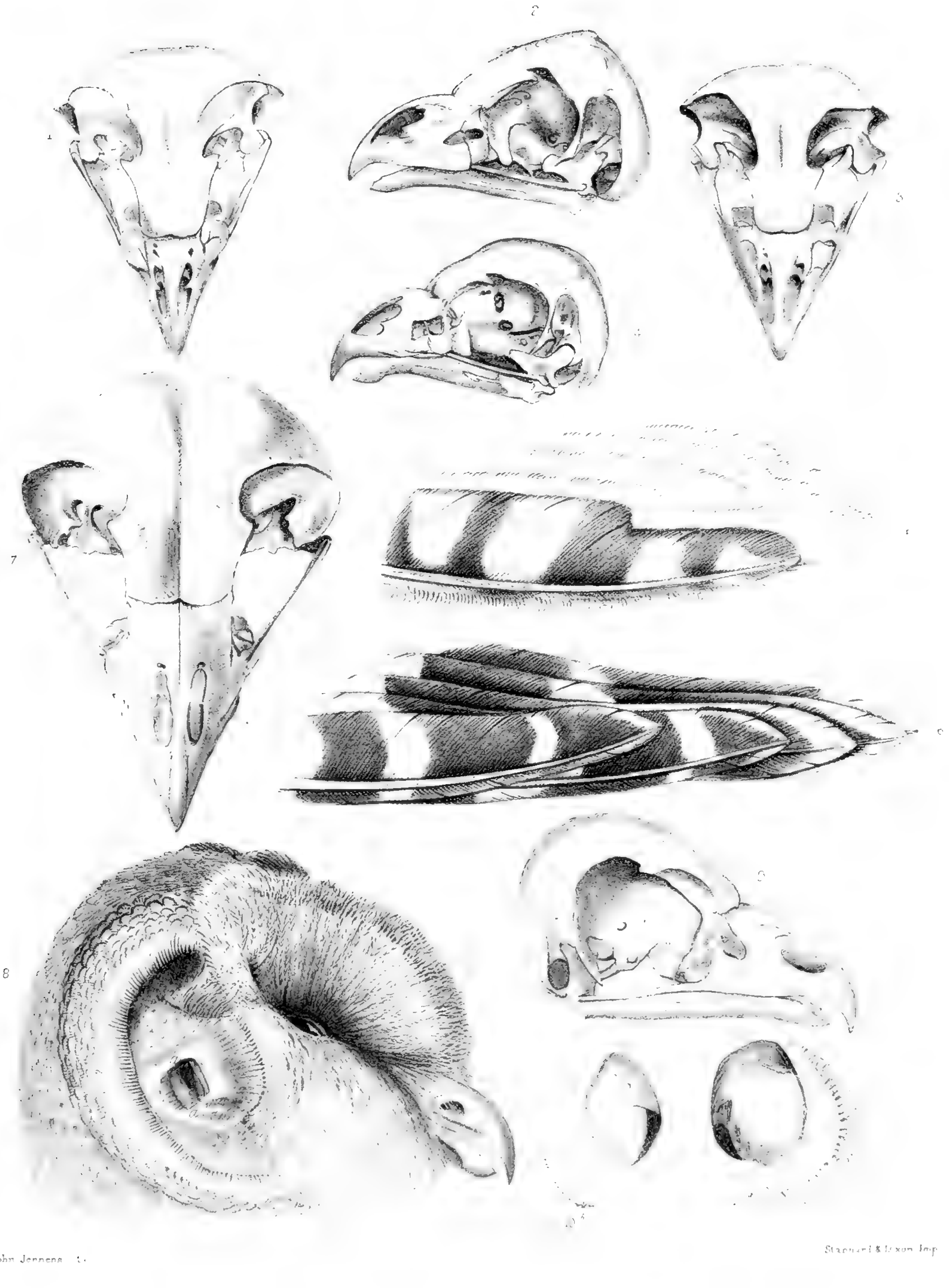
PLATE LVII.

Figs. 1, 2. Skull of *Otus vulgaris.*
Figs. 3, 4. Skull of *Otus brachyotus.*
Fig. 5. Wing-end of *Bubo africanus*, showing emarginations.
Fig. 6. Wing-end of *Bubo ketupa*, showing emarginations.
Fig. 7. Skull of *Bubo ketupa.*
Fig. 8. Head of *Strix flammea*, showing ear-orifice (*a*, *a*).
Fig. 9. Skull of *Syrnium aluco.*
Fig. 10. Ear-orifices of *Syrnium aluco*: *a.* right side; *b.* left.



John Jennens lith. Stannard & Dixon Imp.

KAUP'S STRIGIDÆ



John Jennens

Stannard & Dixon Imp.

KAUP'S STRIGIDÆ.

XIX. *On some New or little-known Species of* Accipitres, *in the Collection of the Norwich Museum. By* Philip Lutley Sclater, *M.A., F.L.S., &c.*

Read March 9, 1858.

At the request of Mr. J. H. Gurney, I exhibit to the meeting some interesting birds belonging to the fine series of specimens of the order Accipitres, which that gentleman has collected for the Norwich Museum. Among them appear to be several new or little-known species, concerning which I beg to offer the following remarks.

1. Urubitinga schistacea. (Pl. LVIII.)

Asturina schistacea, Sund. Ofv. af K. Vet. Ak. Förh. 1849, p. 132.
Falco ardesiacus, Licht. in Mus. Berol.
Morphnus schistaceus, Sclater, P. Z. S. 1857, p. 261.

♂ *adultus. Totus nigro-cinerascens, cauda nigra, fascia media angusta margineque apicali albis: orbitis subnudis: rostri apice nigra, hujus basi cum pedibus flavis.*

Long. tota 16·0, alæ 11·0, caudæ 7·0, rostri a rictu 1·4, tarsi 3·3.

Sundevall has given an excellent description of this bird, which does not appear to have been recognized by any other writer except Prince Bonaparte. By the latter author it is alluded to in an article entitled "Revue générale de la classe des Oiseaux," in the 'Revue et Mag. de Zool.' for 1850, p. 474, and again in the 'Comptes Rendus' for 1855, under the specific name *ardesiacus*, the synonym "*Falco ardesiacus*, Licht. in Mus. Berol." being said to refer to it.

Of the two examples of this species belonging to the Norwich Museum, one was procured by Mr. H. W. Bates[1] on the Rio Javarri, a branch of the Upper Amazon; and the other, I have no doubt, from the ticket with which it is labelled, is from the interior of Bolivia. So we may conclude that the interior wood-region of Peru and Bolivia is its natural *habitat.*

There are at least three birds of this group which are in their adult plumage slaty-black or blackish, with a white bar across the tail. The first of these and largest in size is the *Falco urubitinga* of the older authors. Lesson in 1839 proposed to convert the term *Urubitinga* into a generic name, and it was so adopted by Lafresnaye in 1842, before the creation of Cabanis' genus *Hypomorphnus* for the same type. See M. de Lafresnaye's remarks on this subject in the 'Revue Zoologique' for 1848, p. 240. With regard to the specific name to be employed for this bird, we cannot use Brisson's "*brasiliensis,*" as is done in Strickland's 'Ornithological Synonyms,' because Brisson's[2]

[1] See Proc. Zool. Soc. 1857, p. 261.
[2] See British Association's Report on Zoological Nomenclature, rule 2, p. 5.

names are not to be employed in a binominal system of nomenclature. Nor is it proper to adopt Illiger's MS. term "*longipes*," as proposed in Prince Bonaparte's 'Conspectus,' while there are many other names for this bird already published. So the earliest specific name available seems to be Shaw's *zonurus* (*Falco zonurus*, Shaw's Zool. vii. p. 62), and this species should stand as *Urubitinga zonura*. It appears to have an extensive range, extending from Paraguay, all over Bolivia, Peru, Brazil, Guiana and New Granada into Southern Mexico, where specimens were obtained by M. Sallé (see Proc. Zool. Soc. 1857, p. 227).

The second allied species of *Urubitinga* is the "*Falco anthracinus*, Licht. in Mus. Berol.," under which name it is described by Nitzsch in a note to his 'Pterylographie' (p. 83). This is the same as Du Bus's *Morphnus mexicanus* (Bull. Ac. Brux. 1847). See M. de Lafresnaye's observations in the 'Revue Zoologique' for 1848 (p. 240), where he clearly points out the differences between this bird and the *Urubitinga zonura*. The *Urubitinga anthracina* inhabits the northern portion of South America, Guiana[1] and New Granada[2], Guatemala and Southern Mexico[3], where MM. Botteri and Sallé both procured it, and M. DuBus's types were collected. The third species is *Urubitinga schistacea* as characterized above, which is distinguishable at once from the preceding by its inferior size and narrower tail-band. The following diagnoses are sufficient to point out the differences between these three species[4]:—

1. U. zonura. *Major, caudæ dimidio basali et margine apicali albis.*
2. U. anthracina. *Media, caudæ fascia lata et margine apicali albis.*
3. U. schistacea. *Minor, caudæ fascia angusta et margine apicali albis.*

Such are these birds in their adult plumage: in their immaturity they are quite different. I have not yet seen the young of *U. schistacea*, as I now think the specimen in one of Sallé's Mexican collections called *Morphnus schistaceus*, juv. (Proc. Zool. Soc. 1857, p. 227), does not really belong here; but the other two species in their immature state are both irregularly flammulated on the lower surface and back, and have numerous buffy-white cross-bars on the tail and under tail-coverts. Specimens of *U. zonura* in this state are in the British Museum, and we have a fine example of a similar bird now alive in our Gardens.

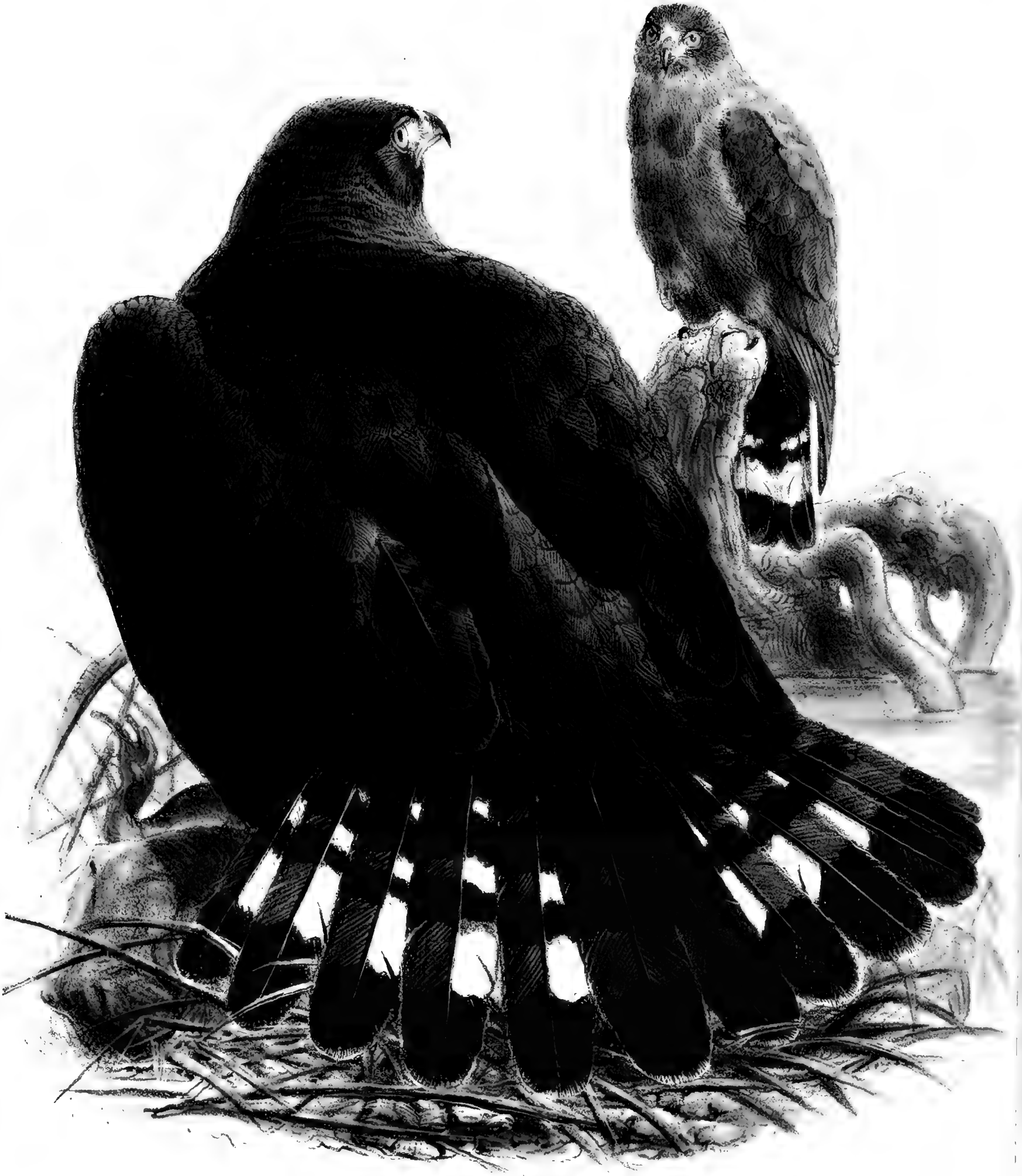
I have hitherto used for these birds the generic term *Morphnus*, following Mr. Gray and other writers; but on considering that the true type of *Morphnus* is the *Falco guianensis* of Daudin—a bird of different structure, and more nearly allied to *Thrasaëtus*, I think they stand better disconnected. But the *Falco unicinctus* of Temminck and *Falco meridionalis* of Latham—two allied species, for which Kaup's term *Spizigeranus*

[1] Schomburgk, Reisen in Britisch Guiana, iii. p. 740.

[2] MM. Verreaux have received examples from Santa Martha.

[3] See Proc. Zool. Soc. 1857, pp. 211 & 227.

[4] A fourth black *Urubitinga* from Cuba, allied to *U. anthracina*, has lately been described by Cabanis under the name *Hypomorphnus Gundlachii*. See Cab. Journ. f. Orn. 1854, Erinnerungs-heft, p. lxxx.



may be employed subgenerically—ought, as M. de Lafresnaye[1] has observed, to come close to the true *Urubitingæ*; and *Buteogallus* with its two species (*æquinoctialis* and *nigricollis*) follows next. A bird more closely corresponding to the *Urubitingæ* in its changes of colouring is *Urubitornis solitaria*, of which M. Jules Verreaux has described the several stages of plumage in our 'Proceedings[2];' but it is distinguishable by its shorter and much more robust tarsi.

2. Buteo zonocercus, sp. nov. (Pl. LIX.)

Schistacescenti-niger unicolor, alis extus brunnescente tinctis: remigum pogoniis interioribus albo obsolete transfasciatis: cauda nigra; vitta inferiore lata, et alteris duabus superioribus angustioribus et imperfectis cum margine apicali albis: rostro nigro, cera aurantia, pedibus flavis.

Long. tota 17·0, alæ 14·7, caudæ 7·5, rostri a rictu 1·3, tarsi 2·9.

Hab. Guatemala.

In plumage this bird is very much like the typical *Urubitingæ*, being of a nearly uniform ashy-black, tinged with brown on the scapularies and secondaries, and with a broad white band across the tail. Above this are two other bands, much narrower and not quite complete, and the tail is likewise tipped with white. The colour of these bands is pure white on the under surface; on the upper surface it is cinereous on the outer webs of the lateral rectrices, and on both webs of the medial pair, but pure white on the inner webs of the lateral tail-feathers. The lowest band is about $1\frac{3}{4}$ inch in breadth, the second not half an inch, and the highest is quite narrow. There are distinct traces of white cross-bands on the inner webs of the wing-feathers. The wings are, however, much more elongated than in the *Urubitingæ*, the third primary (which is longest) extending 4 inches beyond the secondaries. The fourth and fifth primaries are only slightly shorter than the third, the first being nearly of the same length as the longest secondary. The general form seems to be that of the *Buteones* appertaining to the subgenus called *Tachytriorchis*; and the nearest ally of the present species among the specimens of the British Museum appears, as has been pointed out to me by Mr. G. R. Gray, to be his *Buteo albonotatus* (Cat. Accipitres [1848], p. 36). This latter bird does not appear to me to differ from Cabanis' *Buteo abbreviatus*, described in Schomburgk's 'Reisen in Britisch Guiana,' vol. iii. p. 739, and I should be inclined to consider the two names as synonymous.

3. Syrnium albitarse, sp. nov. (Pl. LX.)

Syrnium albotarse, G. R. Gray in Mus. Brit.

Supra brunnescenti-nigrum, plumis omnibus pallido rufo semel aut pluries late transfasciatis; pileo unicolore nigricante, plumis subtus pallide rufis: alis caudaque nigricantibus; remigum pogoniis exterioribus quinque sive sex maculis quadratis pallide

[1] Revue Zoologique, 1848, p. 240. [2] See P. Z. S. 1856, p. 145.

rufis marginatis; rectricibus vittis quinque et altera terminali latiore supra pallide rufis, subtus magis albidis apparentibus transfasciatis: facie, loris, mento et plumis supra-ocularibus albis: subtus pure album, rufescente mixtum, plumarum terminationibus latis interdum etiam scapis saturate brunneis; tibiis et tarsorum parte superiore rufis, horum parte inferiore albis: rostri plumbei apice flavo, pedibus fuscis.

Long. tota 15·0, alæ 11·0, caudæ 6·5, tarsi 1·9.

The name of this Owl was inserted in the List of Specimens of Accipitres in the Collection of the British Museum published in 1848; but no description of it has yet appeared. The type in the British Museum is immature, and nearly agrees with one in my own collection. Mr. Gurney's specimen, from which my description is taken, appears to be nearly adult. All these three examples were received in collections from Bogota, and they are the only individuals of this species that I have yet met with. The face of this bird is white; the head above brownish-black outside, with the bases of the feathers bright rufous. The whole upper surface is brownish-black varied with this rufous colouring, every feather being crossed with a broad subterminal band of rufous, sometimes with a second, and these bands being occasionally incomplete in the middle across the shaft. The primaries and secondaries are marked externally with rather square-shaped rufous spots, four or five in number. The tail has five cross-bands besides the terminal one formed in the same way, which bands appear whitish on the lower surface. Below, the colouring is creamy-white tinged with pale rufous, the breast-feathers, particularly on the sides, having broad terminations of black-brown, the belly-feathers narrower terminations and also lateral margins of the same colour. The tarsi are creamy-white with a yellowish tinge in both my specimens, more nearly pure white in that in the British Museum; they are thickly feathered down to the fissure of the toes. The form is that of other South American *Syrnia*, the fourth and fifth wing-feathers being equal and longest, only slightly exceeding the third. The specimen which I take for the younger bird only differs in having the head varied like the back, and being generally more rufous.

The other American species of this genus of which I have seen specimens are:—

1. *Syrnium hylophilum* (Temm. Pl. Col. 373), from Brazil. Mus. Brit. et Acad. Philadelph.

2. *Syrnium rufipes* (King, Zool. Journ. iii. 426), from Tierra del Fuego. Mus. Brit. Perhaps the same as the Chilian species figured by Des Murs as *Ulula fasciata*, Icon. Orn. pl. 37.

3. *Syrnium virgatum*, Cass. (Journ. Ac. Phil. vol. ii.) (*S. squamulatum*, Bp.; *S. zonocercum*, G. R. Gray), from S. Mexico and Central America.

4. *Syrnium polygrammicum*, G. R. Gray in Mus. Brit. ex Brasil. An undescribed species very nearly allied to the last.

5. *Syrnium albigulare*, Cass. (Journ. Ac. Phil. vol. ii. pl. 4. p. 52).—*S. macabrum*, Bp.; *S. albipunctatum*, G. R. Gray in Mus. Brit. From Bogota.

4. Scops usta, sp. nov. (Pl. LXI.)

Supra saturate castaneo-brunnea, plumis omnibus nigro subtilissime vermiculatis: facie et gula pure castaneo-brunneis, hac pallidiore: linea post regionem auricularem, cornuum capitis extantium marginibus latis et pileo supero nigris: alarum pennis pallide castaneo-brunneis nigro punctulatis, intus autem ochracescenti-albidis, quinque aut sex fasciis latis in pogonio externo, maculas quadratas efficientibus, nigris trans-vittatis; cauda ex eodem colore sed fasciis nigris pæne obsoletis: subtus clarius brunnea, lineis angustis longitudinalibus, scapas plumarum occupantibus, nigris parce notata: tectricibus alarum inferioribus sordide albis: tarsis pallide fulvis: rostro et pedibus flavis.

Long. tota 8·5, alæ 7·0, caudæ 4·0, tarsi 1·2.

Hab. Ega, on the Upper Amazon (H. W. Bates).

This species is founded on the *Scops* which I have mentioned as occurring in Mr. Bates' collection from the Upper Amazon, in the 'Proceedings of the Zoological Society' for 1857, p. 261. It is distinguishable from every other South American member of the genus, as far as I am acquainted with them, by its rich brown colouring above and below, and by the longitudinal lines below not being crossed as in *Scops choliba* and *S. atricapilla*. I am inclined to refer the *Scops* which was contained in M. Verreaux's collection from the Rio Napo to this species. It presents nearly the same appearance on its lower surface; but the colouring above is more like that of *Scops choliba*, and I think it is probably a young bird. The birds of this genus are difficult to distinguish, and I have been unable to identify the present example with any of ten species which have been already described as inhabiting different parts of America, as follows:—

1. *Scops asio* (Linn.), Cassin, Birds of Californ. p. 179.

Hab. Whole of N. America; chiefly Atlantic States. Mus. Brit.

2. *Scops maccalli*, Cassin, Birds of Californ. p. 180.

Hab. Texas and N. Mexico.

3. *Scops flammeola*, Kp.—*Strix flammeola*, Licht. in Mus. Berol.

Hab. Southern Mexico.

4. *Scops choliba*, Vieill.—*Strix crucigera* et *undulata*, Spix.

Hab. Cayenne, Brit. Guiana, Brazil, Eastern Peru, Bolivia, and New Granada. Mus. Brit.

5. *Scops portoricensis*, Less.: Des Murs, Icon. Orn. pl. 26.

Hab. Puerto Rico and New Granada. Mus. Paris.

6. *Scops watsoni,* Cassin, Pr. Ac. Sc. Phil. iv. p. 123, et Journ. Ac. Phil. ii. pl. 12. fig. 1. p. 95.

Hab. Venezuela and Surinam.

7. *Scops atricapilla* (Temm.), Pl. Col. 145.

Hab. Brazil. Mus. Brit.

8. *Scops lophotes,* Less. Tr. d'Orn. i. p. 107 ; Puch. Rev. et Mag. de Zool. 1849, p. 22.

Hab. Cayenne.

9. *Scops grammicus,* Gosse, B. Jam. p. 19, Illustr. pl. 4.

Hab. Jamaica. The type of Kaup's proposed genus *Pseudoscops*: see Bp. in Compt. Rend. Oct. 22, 1855. Mus. Brit.

10. *Scops nudipes.*—*Ephialtes nudipes,* Cassin, List of Strigidæ, sp. 13.—*Bubo nudipes,* Vieill. Ois. de l'Am. Sept. pl. 22.

XX. *Description of a new Species of the Genus* Buteo *from Mexico.* *By* PHILIP LUTLEY SCLATER, *M.A.*, *F.L.S.*, *&c.*

Read July 13, 1858.

MR. J. H. GURNEY has requested my attention to a specimen of a species of the genus *Buteo* belonging to the Norwich Museum, which I now exhibit. It was formerly in the collection of this Society, and was originally received along with other birds from the State of Tamaulipas, in Northern Mexico, by Mr. Gould. I have never seen any other bird quite resembling it—the nearest ally known to me being the *Buteo albonotatus* of G. R. Gray, from which, however, on comparison, it appears to be perfectly distinct. I agree with Mr. Gurney in considering it as probably undescribed; and in allusion to its nearly uniform sooty-black plumage, propose to characterize it as

BUTEO FULIGINOSUS, sp. nov. (Pl. LXII.)

Saturate fuliginoso-brunneus unicolor; capite, dorso medio et alarum primariis extus paulo nigricantioribus: primariorum et secundariorum vexillis internis subtus albis, sex aut septem vittis nigris transversim notatis; tectricibus alarum inferioribus nigro-brunneis: cauda supra fuliginoso-brunnea, vittis quinque aut sex nigris obsolete trans-fasciata et nigro late terminata; cauda subtus alba et vittis dilutioribus: rostro nigro, pedibus flavis.

Long. tota 15·5, alæ 12·0, caudæ 6·5, tarsi 2·6.

Hab. In Mexico Boreali.

XXI. *Description of a New Species of Owl of the Genus* Ciccaba.

By Philip Lutley Sclater, *M.A.*, *F.L.S.*, *&c.*

Read April 12, 1859.

Mr. J. H. GURNEY has invited my attention to the example of an Owl of the genus *Ciccaba*, which I now exhibit. It has already passed through my hands once, having been submitted to my examination by M. Verreaux, along with other birds from Southern Mexico, of which I gave some account in our 'Proceedings' for last year. As will be seen by referring to my remarks given on that occasion[1], I then somewhat unwillingly referred it to *Ciccaba huhula*. Mr. Gurney, however, having acquired the specimen for the Norwich Museum, agrees with M. Jules Verreaux (whose opinion to that effect I have already recorded) in insisting on its distinctness. Having lately had an opportunity of examining a second specimen of this bird, in the collection of the Jardin des Plantes at Paris, I am now quite prepared to coincide with their views, and to characterize this Mexican *Ciccaba* as an independent species, differing from, though closely allied to, the S. American *Ciccaba huhula*. It may be recognized at once by the more uniform colour above, there being hardly a trace of white transverse markings, except on the elongated feathers of the neck-collar, and by the ground-colour below being pure white, crossed by frequent narrow bands of black, each feather showing three or four of such cross-bands. I propose to call this bird

Ciccaba nigrolineata. (Pl. LXIII.)

Schistacescenti-nigra, colli postici plumis elongatis et albo ter quater transfasciatis: maculis in regione superciliari et auriculari quibusdam albis: subtus alba, lineis nigris crebro transfasciata: mento nigro: subalaribus albis, nigro variegatis: cauda nigra, albo quinquies transfasciata: rostro et pedibus flavissimis: tibiis nigris, albo sparsis.

Long. tota 15·0, alæ 10·5, caudæ 6·78, rostri a rictu 1·35, tarsi 2·1.

Hab. In Mexico Meridionali.

Mus. Norfolciensi et Parisiensi.

[1] See P. Z. S 1858, p. 96.

XXII. *On the Osteology of* Balæniceps rex (*Gould*). *By* W. Kitchen Parker, *Mem. Micr. Soc.*

Read June 26, 1860.

[Plates LXIV., LXV., LXVI., & LXVII.]

Introduction.

No lover of nature can read Mr. Petherick's vivid and delightful description[1] of the native home and playground of those royal children of the Tropics, the Hippopotamus, the Crocodile, and the Balæniceps, without longing to see with his own eyes all this overflowing life.

'The miry places and the marishes' of these wild regions are appropriately tenanted by these portentous-looking representatives of the three great air-breathing Classes, the Mammals, Birds, and Reptiles.

Nor do such creatures harmonize less with each other than with their savage home; for one cannot even think of the great River-horse without the idea of his scaly neighbour at once suggesting itself; and the Balæniceps has certainly in its strange countenance an artistic, if not a family likeness to the Crocodile.

Like many of its large congeners, the Balæniceps is not merely a fish-eating bird,—carrion, especially intestines, being equally acceptable with fish. This is also the case with certain piscivorous birds belonging to other natural groups, *e. g.* the Sea-Eagles and Gulls; whilst the Pelicans, Cormorants, and Gannets feed more cleanlily, and abide by a purely fish-diet.

It is to the stilted, wading group of scavengers that the Balæniceps belongs, being one of the *Ardeæ affines*, and therefore intimately related to the White Stork, the Marabout, and the Adjutant. Its nearest relations, however, are the South American Boat-bill (*Cancroma cochlearia*) and the Little South African Umbre (*Scopus umbretta*).

The latter bird, before the discovery of its gigantic relation, seemed to be unique amongst the near relations of the Common Heron (*Ardea cinerea*), in having a strong hook to the upper beak; the Balæniceps, however, has this character in the highest degree, and it is not absent from the flat upper jaw of the Boat-bill. It is difficult for the systematist to choose his *type-form* amongst the Ardeine genera, including *Ciconia, Leptoptilus, Mycteria, Anastomus, Aramus, Ardea, Botaurus, Herodias, Nycticorax, Scopus, Cancroma*, and *Balæniceps*; but as the Heron is best known, and has the characters of the family moderately, but markedly developed, it is the most available.

Ardea is, moreover, one of the original genera of Linnæus; and the names and terms

[1] Proc. Zool. Soc. 1860, p. 195.

of that great man are classical and almost sacred: his genera and species are also exceedingly useful as starting-points. This bird, whose 'visage darts forth melancholy,' and whose head and jaws are not unlike (as the Arabs say) an upturned Arabian shoe, has necessarily many interesting points in its osteology. The purpose of this paper is to point out these peculiarities; and we shall take this opportunity of noting the analogies and homologies that occur to us in the osseous structure of the Vertebrata generally, and of Birds in particular. No anatomist can look at the skull of the Balæniceps without desiring very strongly to know the history of all that melting and coalescence of cranial 'elements' which he sees before him.

The rich literature for which we are indebted to the extraordinary labours of such men as Cuvier and Owen, who have principally used the gradational method, will not, however, satisfy the mind of him who would see Nature at her work, and behold the quiet formation of each part and member—'when as yet there are none of them.'

We are not without light on this subject: Baer, Vogt, Remak, Reichert, and other excellent Embryologists abroad, and Professors Goodsir and Huxley nearer home, have made us their deep and lasting debtors; and we are not without hope that more of our own countrymen will labour in this high field, incited thereto by such teachers of so pleasant and noble a science.

In describing the skeleton, and especially the skull of the Balæniceps, we shall use freely the published observations of the writers above-mentioned, depending, however, principally upon our own labours (as it regards the class of Birds especially), which have extended over some twenty years. And it seems to be a more natural and proper thing that each man should cautiously and honestly put down his own views, than that he should be content to become a stereotyped copy of any great master, multiplying his errors a thousand-fold, whilst he makes no addition to his truths.

It will be more convenient to begin the description of the skull of the Balæniceps at its more perfect part, the occipital region, than to take the *ethmo-vomerine sclerotome* as the starting-point; and a regional description will perhaps be better than one based on any theory of its essential segments. Those segments or sclerotomes must, however, be discussed; and it will be well to say at once that our own views on this subject approximate much more nearly to those of Professor Huxley than to the doctrine of the archetype of the vertebrate skeleton as taught by Professor Owen,—or to the views of Professor Goodsir, which are not less transcendental than those of his illustrious contemporary. Our references to the works of Professor Owen will be as follows:—

1. The article *Aves* in Todd's 'Cyclopædia of Anatomy and Physiology,' 1835.

2. Lectures on Comparative Anatomy, vol. ii. 1846.

3. Report on the Archetype and Homologies of the Vertebrate Skeleton, read at the Meeting of the British Association held at Southampton, 1846.

4. "On the Nature of Limbs:" a lecture delivered at the Royal Institution, Feb. 19, 1849.

5. Descriptive Catalogue of the Osteological Series contained in the Museum of the Royal College of Surgeons of England, 1853.

6. Principal forms of the Skeleton and the Teeth, in 'Orr's Circle of the Sciences,' 1856.

Professor Goodsir's profound views upon this most difficult and tangled subject will be found in the Edinburgh New Philosophical Journal for 1857, in an Abstract of Papers submitted by him to Section D. at the Cheltenham Meeting of the British Association, August 5—12, 1856.

Professor Huxley's opinions are published in his invaluable Croonian Lecture (in which are to be found several references to valuable works on the subject by Germans and others), published in the Proceedings of the Royal Society, Nov. 18, 1858; also in his paper on *Stagonolepis robertsoni*, Quart. Journ. Geol. Soc. vol. xv. 1859. Other important papers of Professor Huxley's are to be found in the same Journal, vol. xv. for 1860; namely, an account of some Amphibian and Reptilian remains from South Africa and Australia,—on *Rhamphorhynchus bucklandi*,—on a fossil bird and cetacean from New Zealand, and—on the dermal armour of *Crocodilus hastingsiæ*.

Dr. Humphry's beautiful work on the "Limbs of Vertebrate Animals," 1859, and Messrs. Strickland and Melville's description of the Anatomy of the Dodo and allied forms, in their noble work on the Dodo, 1848, will both be referred to.

The late Professor MacGillivray's works on the Birds of Great Britain; the excellent articles on Anatomy and Natural History in the 'Penny Cyclopædia'; Griffith's and Pigeon's translations of Cuvier's works; and the late Dr. Johann Müller's Book "on Generation," in his 'Elements of Physiology,' as translated by Dr. Baly, will all yield us some assistance. Those long-beaked mammals, the *Cetacea*, are profitable for reference when we consider the structure of birds; and an admirable article on these creatures will be found in Todd's 'Cyclopædia of Anatomy and Physiology,' by M. Frédéric Cuvier.

There is a very important and valuable paper by Dr. John Cleland in the Edinburgh New Philosophical Journal (vol. xii. No. 2. p. 242, October 1860), "on the Vomer in Man and the Mammalia, and on the Sphenoidal Spongy Bones." This is a model paper for unbiassed observation, and freedom from that pleasant mode of *supposing* instead of *ascertaining* what is the true nature of an anatomical element.

Occipital Region of the Skull of Balæniceps. (Pl. LXV. fig. 3.)

The shape of the occipital sclerotome of the Balæniceps, as seen from behind, is subpentagonal; the upper margin is formed by two tubercular ridges, which meet at a very obtuse angle above, at the mid-line—the part from which the small crista occipitalis passes downwards. The lateral margins are vertical above, but turn inwards below, curving downwards, inwards, and forwards. The basal line is concave, being arched in such a manner as to slope downwards anteriorly; at its middle is placed the single hemispherical condyle, which is directed backwards, and slightly downwards, to form with the atlas a 'procœlian' articulation. Above this condyle is the 'foramen magnum' (fig. 3, *f m*), in shape slightly pentagonal, and nearly half an inch in diameter.

The supra-occipital region is one inch across, and besides its tiny mesial crest, has a pair of supero-lateral eminences (Pl. LXV. figs. 1, 3, 6, *ep*), the centre of the 'epiotic' pieces of the young bird: these elevations contain part of the superior and external semicircular canals. The epiotic eminences are separated from the upper mastoid eminences (Pl. LXV. figs. 1, 3, 6, *m*) by a depression of the marginal ridge, and by the vascular grooves which burrow in the occipital bone.

The outer half of each side of the upper margin is occupied by the upper mastoid eminences; they are therefore external to, and somewhat below, the epiotics, and are separated from the so-called par-occipital processes by a deep fossa. These upper mastoid projections help to wall-in the external semicircular canals and to bound the temporal fossa behind: they answer to the upper part of the mastoid of the Turtle (the 'par-occipital' of Owen, '*occipital externe*' of Cuvier).

The elegantly curved 'par-occipital' processes (Pl. LXV. figs. 1, 3, 7, *e o* & *p r o*) pass downwards, forwards, and inwards: passing insensibly into the basal region, they bound the ear-cavity behind and below, and contain part of the external and anterior semicircular canals. The upper margin of these processes laterally is the lower boundary of the temporal fossa, the two regions being separated by a ridge, below which ridge the 'par-occipital' forms a beautiful shell-like process, the anterior sigmoid margin of which very nearly reaches the huge 'os quadratum' (Pl. LXV. figs. 1, 3, 6, 7, *q*). Below and in front of this part the substance of the bone contracts, and passes on to join the delicate crescentic 'pterapophysis,' which forms the boundary of the basi-temporal, a bone to be described presently.

The basi-occipital and basi-temporal regions are, however, separated laterally by a notch, mesiad of which is a large reniform passage; the bridge over this passage being the connecting link between the basal part of the occipital and sphenoidal sclerotomes. This very pretty reniform opening is apparently the external outlet of the vagus nerve (Pl. LXV. figs. 3 & 7, *v g*). The basi-occipital region is of small antero-posterior extent, and lies directly between these foramina; it is slightly scooped and convex all round the condyle, and is perforated by a number of vascular openings. The condyle (fig. 3, *c*) is one-third of an inch in diameter, the entire breadth of the occipital bone is more than two inches, the height of the supra-occipital above the foramen magnum is two-thirds of an inch, and the wing-like par-occipitals are one inch deep.

Internal to the foramen magnum the bony labyrinth projects mesiad on each side, these projections being the line of anchylosis of the lateral occipitals (ex-occipitals of Professor Owen) with the largely developed petrosals. The external union of these elements is indicated by the *fenestra ovalis* (fig. 1, *f o*) and *rotunda* (the latter being of an oval shape in birds). The substance of the occipital bone is thick and richly cellular in the Balæniceps.

In the Chick, the occipital sclerotome is developed from five centres ; one basal, a pair of laterals, and a pair of upper or ' epiotic ' pieces. The basi-occipital of the Chick may be seen, on the eleventh day of incubation, as a short rod of bone in the upper stratum of the cartilage of the primordial basis cranii ; it encloses the tapering anterior extremity of the evanescent chorda dorsalis, but has not yet penetrated the thick cartilage beneath it, and is only just entering the substance of the, as yet, cartilaginous hemispherical condyle.

The basal centre lies on the same plane as the centre of ossification, which already occupies the posterior third of the basi-sphenoidal rostrum. The lateral or ex-occipitals may be seen at the same period as thin scales of bone of a somewhat crescentic shape, bounding the sides of the foramen magnum (hence their crescentic margin), sending upwards a process to join the epiotics, and another forwards and outwards to form the 'par-occipital' ala, and to ossify that part of the occipital sclerotome which in the Chelonia exists as a distinct ' mastoid.'

On the eleventh day of incubation most of the upper occipital region is still cartilaginous ; but on each side of the mesial line, a little above the foramen magnum, a pair of small oval osseous centres already exist ; they are about a line apart.

On the fourteenth day they are still nearly the same distance from each other ; but they are creeping up to the upper margin of the cartilaginous cranial wall, downwards nearly to the foramen magnum, and laterally they have begun to wall-in the superior semicircular canals.

On the sixteenth day these pieces (called ' epiotic bones ' by Prof. Huxley, Croon. Lect. p. 13) have reached each other, as well as the upper margin of the occipital cartilage and the superior boundary of the foramen magnum.

On the nineteenth day only the upper and lower fourths of the line of union of these ' epiotics ' are visible, and the external margin has reached the external as well as the superior semicircular canal.

In young Pigeons, a day after hatching, these ossifications have not commenced ; on the eighth day these rapidly-growing birds have a large single ' supra-occipital ' deeply notched in the middle, inferiorly, in the place of the oval membranous deficiency, or *fontanelle*, in the primordial occipital wall. In adult Pigeons, and also in the Dodo and Didunculus, traces of this structure still remain (see Strickland and Melville),—all the Columbinæ hitherto examined having a mesial ' supra-occipital ' foramen. These birds must be examined on about the third day for the separate epiotic pieces[1].

The broad smooth supra-occipital region of birds does not require a distinct interparietal, or central supra-occipital element ; but in the Chelonia, and probably in most

[1] As early as the third day after incubation, we find (from dissections made since the above was written) that in these *typical* birds there is only one osseous centre in the supra-occipital cartilage : it is shaped like a horseshoe and is very rapid in growth.

reptiles, the central is the chief element. In *Coluber natrix* and in *Lacerta agilis*, Rathke has observed the epiotic centres before they had coalesced with the main part of the supra-occipital, and the mastoid element before it was fused to the ex-occipital (see Huxley, Croon. Lect. p. 61). In most osseous fishes the three supra-occipital elements continue distinct throughout life.

According to Professor Goodsir, the interparietal of the mammals is part of another sclerotome, being the homologue of the divided roof-bone of the temporal cincture, the so-called 'parietals' of oviparous vertebrata: Professor Goodsir calls these upper temporal elements temporo-parietals.

The mastoid would appear to be present in *Colymbus cristatus* (in very young birds), from some observations made by Dr. Hallman (Croon. Lect. p. 54); but examination of the development of Divers, Auks, Penguins, and allied birds is very desirable; and perhaps the Struthionidæ, taken early enough, might reveal a distinct osseous centre for this bone.

We consider Cuvier's 'rocher' in fishes and Professor Owen's 'petrosal' to be the mastoid; the large bone notched or perforated in front by the trigeminal nerve being, as Professor Huxley has unanswerably shown, the true petrosal (Croon. Lect. p. 24).

In the Common Mole, *Talpa europæa*, the mastoid is very large, and forms more of the cranial wall than its serial homologue, the squamosal; in this creature the petrosal forms nearly the whole of the labyrinth.

That the mastoid is not necessarily connected with the petrosal is shown in the skull of the Common Bat, *Vespertilio murinus*; for in this instance (and apparently in the Brazilian, *Molossus obscurus*), the mastoid is anchylosed to the ex- or lateral-occipital, and is only connected by membrane to the squamosal and petrous bone, the latter bone being totally distinct from all the surrounding elements.

We now return to the occipital bone of adult birds.

In the Hornbills (*Buceros*), where the mere size of the head (although extremely light) causes the expenditure of much muscular force, a tubercle exists above the foramen magnum, for the attachment of a very thick elastic ligament: this tubercle is wanting in the Balæniceps and the Adjutant.

In the Common Heron the occipital resembles that of the Balæniceps, but it is higher in proportion to its width; its upper boundary is almost straight, there being only a slight angle in the centre, where the transverse occipital crest is confluent with the sagittal; the par-occipital processes also are relatively much smaller. But the elegant basi-cranial pterapophyses, and the open Eustachian groove between the proper basi-sphenoid and the basi-temporal, are singularly like what we find in the Balæniceps. The Adjutant and the Albatros have this canal open in the dry skull, but in most birds it is more or less covered in, leaving only a central aperture.

In the Pelican the line of junction between the occiput and the upper part of the skull forms a very obtuse angle, these surfaces being at nearly a right angle in the

Balæniceps and Adjutant. There is only a general class-resemblance between this part of the Pelican's skull and that of the Balæniceps.

The occipital cincture in the Boat-bill (*Cancroma*) is intermediate between that of the Heron and the Balæniceps; the crests marking its boundary are thicker, but not more distinct than in the Heron; in Balæniceps these ridges are fainter, at least in the skull of this scarcely mature captive.

Upper Cranial Surface. (Pl. LXV. fig. 6.)

The upper surface of the skull in this strangely interesting bird is formed (as in the rest of its class) principally by the parietals (figs. 1 & 6, *p*) behind, and the principal frontals anteriorly. The lacrymals (figs. 1 & 6, *l*) generally assist the principal or sphenoido-frontals (figs. 1 & 6, *fr*) in front; but in the Balæniceps and a few other birds these bones are facial, being anchylosed to the nasals (figs. 1 & 6, *n*), or ethmoido-frontals of Goodsir, and intermaxillaries. The parietal region is eked out laterally in all birds by the squamosals (Pl. LXV. figs. 1, 3, 6, & 7, *sq*)—the temporals of Cuvier, and the mastoids of Owen, but incontestably shown to be the homologues of the mammalian squamosals in the masterly Croonian Lecture of Professor Huxley, p. 13.

The only birds having a broad, flat, smooth cranial surface at all comparable to that of the Balæniceps are the Maccaws (*Ara*); although some of the Totipalmatæ make some approach to it, *e. g.* the Pelican and the Gannet.

In *Cancroma* the distance between the orbits is proportionally much less, and the general surface, although smooth, is more irregular, whilst in the Adjutant it is convex and rough. In the Heron, the upper part of the skull is as polished and smooth as that of the Balæniceps; but its shape is very different, its length being very great in proportion to its breadth. The relative proportions of the upper part of the Balæniceps will be best shown by a few comparative measurements, the width and length being taken at the following points.

Measurements of Crania.

First measurement,—across the cranio-facial hinge.
Second measurement,—across the middle of the orbital margins.
Third measurement,—across the post-frontal processes.
Fourth measurement,—entire sagittal line of the skull proper.

	First measurement. in.	Second measurement. in.	Third measurement. in.	Fourth measurement. in.
1. Adjutant, *Leptoptilus*	2	$2\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$
2. Whale-bird, *Balæniceps rex*	$1\frac{7}{8}$	$1\frac{11}{12}$	$3\frac{1}{10}$	$2\frac{1}{2}$
3. Boat-bill, *Cancroma cochlearia*	$\frac{6}{7}$	$\frac{2}{3}$	$1\frac{2}{5}$	$1\frac{5}{6}$
4. Goatsucker, *Podargus humeralis*	$\frac{5}{8}$	$\frac{6}{11}$	$1\frac{7}{8}$	$1\frac{1}{2}$
5. Grey Heron, *Ardea cinerea*	$\frac{6}{9}$	$\frac{7}{8}$	$1\frac{5}{13}$	$2\frac{1}{3}$
6. Hornbill, *Buceros bicornis*	$2\frac{1}{4}$	$2\frac{3}{7}$	$2\frac{1}{5}$	$2\frac{1}{3}$
7. Maccaw, *Ara ararauna*	$1\frac{2}{5}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$
8. Pelican, *Pelecanus onocrotalus*	$1\frac{2}{5}$	$1\frac{2}{5}$	$2\frac{1}{4}$	$2\frac{1}{2}$

In Balæniceps, as in the great Maccaws, the orbital margin of the frontal is higher (in the former $\frac{1}{8}$th of an inch) than the mesial part of the bone; and this marginal elevation in both kinds subsides gently into the slightly concave upper interorbital surface of the frontals. In the Maccaws and in the Balæniceps, the highest part of the cranium is between the post-frontal processes; and in the latter the shape of the cranial cavity is in some degree marked out on the external table of the frontal and parietal bones. The orbital margin of the frontal (or, as Professor Goodsir calls it, the sphenoido-frontal) in Balæniceps is, as is usual in this class, more or less notched or perforated by vessels. In the Boat-bill and in the Heron, the large eye-ball has elevated the orbital margin of the sphenoido-frontal; but this takes place most in the latter, in which bird the concavity between these margins is unusually deep.

In the rough, unevenly convex cranium of the Adjutant, the orbital margin is nearly half an inch below the mid-line of the frontal.

In Balæniceps, a gentle ridge of bone, arising from the posterior edge of the post-frontal process (figs. 1, 3, 6, *pf*) passes upwards and backwards to the distance of about two-fifths of an inch from the mesial line of the skull in the parietal region, and to one-third of an inch in front of the epiotic eminence. This gently curved ridge is the anterior boundary of the temporal fossa (Pl. LXV. figs. 1 & 3, *tf*), which is subtriangular in shape, and has for its posterior margin a line, nearly at right angles to its anterior boundary, which line runs outwards, downwards, and backwards, losing itself in the ridged crest of the upper mastoid eminence. The inferior margin of the temporal fossa is incomplete in front, there being a large semi-oval space between the post-frontal process and the articular surface of the base of the squamosal for the external condyle of the head of the os quadratum. Behind this external quadrato-squamosal facet a rough ridge of bone runs horizontally across, losing itself in the fossa between the upper mastoid eminence and the 'par-occipital' ala; this ridge defines the temporal fossa below and behind.

These fossæ are ten lines apart in Balæniceps; in the highly arched head of the Adjutant they do not meet by two inches; the distance of these fossæ in *Buceros bicornis* is one inch and four lines, in the Maccaw one inch and six lines; and in the Pelican they do not approximate more than in the Maccaws.

But in many birds, *e. g.* the Heron, Boat-bill, Podargus, Diver (*Colymbus*), and the larger Grebes (*Podiceps*), the temporal fossæ are only separated by a sharp interparietal crest, whilst their anterior and posterior boundaries are almost parallel. This is like what obtains in many other vertebrata, the extreme conditions of this sagittal ridge being found in such fishes as the *Ephippus*, *Pagellus*, and *Platax arthriticus*; in the Chameleon amongst the reptiles; and, in the mammals, in such skulls as those of the Tiger, Hyena, and certain Bats, *e. g. Molossus obscurus.*

The post-frontal process of the Balæniceps is strong, and descends downwards, and also slightly outwards and forwards, its length being eight lines. The end of this process is, according to Owen, formed in the Emeu by a distinct ossific centre[1]. We possess a sketch of it, from a dissection made by us many years ago of an Emeu only six weeks old.

This exceptional ossific centre appears to be the actual representative of the post-frontal of the cold-blooded vertebrates, and to be the upper neurapophysis of the pre-sphenoidal sclerotome. Professor Goodsir places it to the account of the post-sphenoid, the roof-bones of which, he says, are deficient in all the Ovipara[2]. In many birds, *e. g.* Parrots, Gallinæ, and the Adjutant, &c., the lower part of the temporal fossa is bridged over in front by the union of the post-frontal with a sort of zygomatic process of the squamosal.

In Balæniceps, the Heron, and the Boat-bill, the spur of the squamosal is quite rudimentary.

Professor Goodsir (*loc. cit.*) considers that the so-called 'frontals' of the Ovipara are not the homologues of the Mammalian frontals; these latter bones, besides roofing-in the ethmoidal region of the Mammal (which in that class is included in the cranium), contribute largely to the formation of the great cranial dome. The homologues of these latter bones are, according to him, to be found in the so-called 'nasals' of the Bird and prefrontals of the Reptile; but this requires much renewed investigation. The upper surface, therefore, of the Bird's skull is formed in front by sphenoido-frontals, and behind by the parietals. In Mammalia, the temporo- or inter-parietal, as a rule, is single[3]; but in the Muridæ, and in the Common Mole, this piece is relatively as large as both the parietals in many of the Ovipara. In the latter animal the proper frontals, called ethmoido-frontals by Goodsir, are very little extended beyond the ethmoidal region.

Squamosal (Pl. LXV. figs. 1, 3, 6, & 7, *sq*).—The element to which the 'quadratum' is suspended Cuvier calls 'temporal' in birds, and 'mastoid' in reptiles and fishes; Agassiz calls it '*écaille du temporal*'; and Professor Owen considers it to be the 'mastoid' in all the Ovipara. Dr. Hallman calls it 'squama temporis'; and we quite agree with Professor Huxley when he says (speaking of it in the bird), "there is not a single relation (save the connexion with the jugal) in which this bone does not resemble the squamosal of the *Mammalia*; there is not one in which it does not differ from the mastoid" (Croon. Lect. p. 14).

In the Chick, on the eleventh day of incubation, the sphenoido-frontals exist as a thin osseous scale along each orbital margin; the bony piece at its widest part extending about a line both above and below the upper orbital boundary. At the same time the parietals are small ovoid patches just above the squamosals, which are already ossified, and fully twice the size of their meta-neurapophyses, the parietals. In the Pigeon, one

[1] Owen, Osteol. Catal. vol. i. p. 260. [2] Edinb. New Phil. Journ. 1857, p. 170.

[3] The inter- or temporo-parietals have two centres in the young Dugong, and probably in the 'Lissencephala' at an early age.

day after hatching, these three pairs of osseous centres are about equal to what may be seen in the Chick on the eleventh day (nine days before hatching).

Looking at the side of the Balæniceps' skull between the post-frontal and squamosal, there may be seen, eight lines mesiad of the anterior spur of the latter, a large oval foramen, which has a conjugational relation between the petrosal, ali-sphenoid, and basi-sphenoid. This passage (the foramen ovale) transmits the chief part of the trigeminal nerve, and is one of the best landmarks in the study of the anatomy of the cranium in all the Vertebrata. This aperture is wide below and narrow above; it is four lines in extent in its long diameter, the direction of which is backwards and outwards. A bristle passed across the floor of the cranium through both the foramina ovalia lies one line behind the posterior clinoid processes.

Ali-sphenoids. (Pl. LXV. fig. 1, *a s.*)

The ali-sphenoid of Balæniceps is crossed at its upper third by an ascending crescentic ridge which joins the post-frontal process and forms the antero-inferior boundary of the temporal fossa. At one-eighth of an inch in front of the foramen ovale there is a triangular eminence in a line with the middle of that passage; and at the same distance in front of this eminence, but higher up, a twin passage exists. This divided passage is a little below and behind the great optic foramen, which opens freely into its fellow of the opposite side, and which notches the posterior border of the connate orbito-sphenoid. The optic foramen of Balæniceps is half an inch in front of the foramen ovale and one-third of an inch higher up. A bristle passed through both the optic foramina lies in front of the anterior margin of the very deep sella turcica, and passes across the middle of the anterior or, rather, internal margin of the ali-sphenoids. The optic foramen is four lines in diameter; its shape is ovoid, the narrow end pointing outwards and a little downwards. Half an inch above this foramen another exists, half its size; this is the remains of that membranous tract in the primordial cranium between the cartilaginous interorbital septum and the cartilage in which the ali-sphenoid was developed: through a passage in the lowest part of this tract the optic nerve passed. By means of the extension of ossific matter from the growing ali-sphenoid, and the diverging alæ of the orbito-sphenoid, this membranous tract becomes bony for more than its middle half, its upper part continuing membranous, and its lower third becoming the large well-margined optic foramen.

There is a considerable eminence on the ali-sphenoid, two lines above the foramen ovale, which breaks into two elegant crescentic ridges, the anterior ridge passing at the distance of a line behind the one already described to the base of the post-frontal, whilst the posterior ridge passes outwards and backwards to the quadrato-squamosal joint. The bone across this middle part is very thick and cellular.

The ali-sphenoids wall-in a great part of the up-turned base of the brain ; the diverging alæ of the connate orbito-sphenoids contributing but little to the cranial cavity, whilst the ethmoidal sclerotome is wholly facial and catacentric.

In the Chick, on the eleventh day of incubation, the cartilaginous ali-sphenoids have coalesced with the cartilage of the base of the cranium (although, from Rathke's observations on the Snake, they are perhaps separately formed at first in the membranous wall), but no osseous deposit has taken place. In the Pigeon, one day after hatching, the centre of this cartilaginous patch is still membranous, and this is the last part to ossify, but it is filled up at the end of the first week. In the Chick, on the fourteenth day, there is a wide ring of bone round the ali-sphenoid, the centre being still cartilaginous. This bone is bounded above by the sphenoido-frontal, in front by the orbito-sphenoid, supero-laterally by the squamosals, below by the basi-sphenoid, and behind by the petrosal.

Petrosal. (Pl. LXV. figs. 1 & 7, *pt.*)

This latter bone, the petrosal, has a very cellular character externally ; its anterior margin is the foramen ovale, and its posterior termination is indicated by the fenestra ovalis, in which the base of the columella is fixed. Seen through the foramen magnum the petrous bones project considerably into the cranial cavity, passing as thick beams of bone upwards and backwards to lose themselves in the diploë of the combined parietals and epiotics, and downwards and forwards to coalesce with the basi-sphenoids just outside the posterior clinoid processes.

Speaking of the petrosal in the young Ostrich, Professor Huxley says (Croon. Lect. p. 12), "The par vagum passes out between the bony mass under description and the ex-occipital: the third division of the trigeminal leaves the skull between it and the ali-sphenoid. The portio dura and portio mollis enter it by foramina very similarly disposed to those in the Sheep: superiorly there is a fossa on the inner face of the bone, which corresponds with a more shallow depression in the Sheep, and like it supports a lobe of the cerebellum. Finally, the anterior inferior edge of the bone traverses the middle of the fossa which receives the mesencephalon. In every relation of importance, therefore, this bony mass corresponds with the petro-mastoid of the Sheep, while it differs from it only in its union with the ex-occipitals and the supra-occipital posteriorly, and its contact with the cranio-facial axis below."

In the Chick, on the eleventh day of incubation, and in the Pigeon, one day after that period, the petrosals are still entirely cartilaginous, the semicircular canals shining through the cartilage, which will be differentiated into these elements, the epiotics, and the mastoid margin of the ex-occipitals. In the Chick, on the fourteenth day, much ossific matter has been deposited, and two days later the relation of these parts can be well seen ; but the most projecting parts of the semicircular canals still shine through the connecting cartilage. The mass of the petrosal lies internal to, or mesiad of, the ali-sphenoids in front, and the ex-occipitals behind, whilst externally they are hidden by the large ossa quadrata—the proximal hæmal elements of their own sclerotome, of which they are, if Professor Goodsir be right, the inferior neurapophyses: Professor Huxley prefers calling them, as well as the contiguous mastoids and epiotics, 'periotic bones.' The determination of the petrosal in the different classes of Vertebrata seems to Professor Huxley and to the writer to be a very straightforward and simple piece of work; but its bibliography is frightful; and although the form, functions, and relations of this element speak one language, its very existence has often been ignored when well developed, as it is almost invariably, whilst the somewhat inconstant 'mastoid' has been often mistaken for it.

That the exit of the main nerves can be depended upon for the determination of special homologies there can be but little doubt (see Huxley, Croon. Lect. p. 36): to us, the denial of this is the weakest point in one of the most masterly disquisitions on the subject of homologies we have ever had the pleasure and the advantage to read (see Professor Goodsir, *op. cit.* p. 171).

Bàsi-temporal (Parker). (Pl. LXV. figs. 3 & 7, *b t.*)

Above the petrous bone is the squamosal, and below it we have what might be the broad centrum of the 'temporal sclerotome' of Goodsir. In describing the basi-occipital, elegant crescentic laminæ, the pterapophyses (confluent in front) of the basi-temporal, were spoken of. This thin, free, horizontal margin of the base of the skull in the temporal region surrounds a semicircular mass of bone, the round border of which is in front, its mesial part is concave, and its sides thick, mammillate, and somewhat ridged transversely. These elevated tubercular masses are each one-third the width of the thick part of this bony base, the middle third being elegantly concave. This concave part alone lies in the same plane as the basi-occipital; the two original halves of this, the basi-temporal, being cortical ossifications of the original cartilaginous basis cranii. We have already said that the alar margins of this basi-temporal are confluent with the par-occipital alæ by the bridge of bone which forms the large lateral reniform foramen. These alar productions form the floor of the tympanic cavity, and are evidently the actual homologues of a pair of 'pterapophyses,' which are very largely developed in certain *lissencephalous* mammals, *e. g.* the Mole and the Hedgehog. In the latter animal the tympanics are mere osseous rings (these bones becoming fainter as we approach the Ovipara); but the internal and inferior part of the tympanic cavity is all formed by supplementary 'pterygoid plates,' which encroach upon the basi-occipital region, and have between them, in front of the basi-occipital, a large dome-shaped recess. Professor Owen's elegant term 'pterapophysis' is very convenient for these productions of the cranial centra—the analogues of the vertebral parapophyses and hypapophyses (processes that run insensibly into one another).

Now it is evident that these temporal pterapophyses of the Hedgehog are something supplementary, for they are a line and a half behind the pterygoid bones and the post-sphenoidal ento- and ecto-pterapophyses; whilst the basi-sphenoid itself is double its usual size, and looks very much like two coalesced pieces. Observations on the crania of young Insectivora are a great desideratum; for we shall see that the Ovipara have what might be taken for the centrum of a temporal sclerotome!

From our early days we have been in the habit of looking at the lower part of the sphenoido-temporal region in birds as something structurally distinct from the upper—that part which forms the 'sella,' and runs forward as the strong basal beam of the interorbital septum.

Looking at this region of the skull of the Chick on the eleventh day (a little past the middle of the incubating period), we find three centres to the 'basi-sphenoid,' one mesial and anterior, on the same high plane as the basi-occipital, and two symmetrical pieces below and between these higher osseous centres; the latter two are developed in the lowest stratum of that basi-cranial cartilage which fills-in the hypophysial space. These cortical ossifications lie exactly between the ossa quadrata, the fenestra ovalis being on a line with the posterior end, the foramen ovale lying over the anterior; their shape inclines to a right-angled triangle, the bases being opposed to each other. Each of these ossifications is a very thin shell, convex below and somewhat cupped above; and they never encroach much upon the primordial cartilage, forming (as they do in the adult bird) the thin lower table of the basis cranii, and connected to the single mesial element above by delicate threads of bone and by the osseous canal of the internal carotid. These pieces curve upwards both before and behind; the basi-occipital is horizontal; and the basi-sphenoid points steadily upwards, being ultimately anchylosed to the descending plate of the pre-sphenoid in front, and of the connate orbito-sphenoids in the middle, whilst its posterior extremity becomes fused to the basi-occipital, thus excluding the basi-temporals altogether from the cranial cavity. Professor Goodsir (*op. cit.* p. 154) says, "The passage of the anterior acuminated extremity of the centrum behind, beneath the lower margin of the pre-sphenoidal centrum, so as to support it, is merely an example of that longitudinal obliquity in the setting on of the cranial centrums against one another, which may be considered as the rule rather than an exception." These basi-temporals appear to be another pertinent instance; yet, after all, they do not necessarily belong to an additional segment of the cranium.

The anterior margin of these ossific centres continues free throughout life in many birds, the Eustachian canal being completed by membrane; this is especially the case in *Balæniceps*, *Ardea*, and *Diomedea*.

In young Rooks of the fourth week the basi-temporal is separate from the basi-sphenoid, and in the adult Merlin (*Falco æsalon*) and in the Lapwing (*Vanellus cristatus*) much of the suture still remains. The external margin of each basi-temporal forms the floor of the tympanic cavity, like the temporal pterapophyses of the Hedgehog and Mole. In the Chick, the ossification of these parts proceeds *pari passu* with that of the pre-maxillaries; they have coalesced with each other on the fourteenth day, at which time the pre-maxillaries are fused together, and the evanescent frontal process on which they were modelled has begun to shrink.

That the 'rostrum' of the Chelonians and Crocodiles is an unsymmetrical mesial ossification we have no doubt; not so the lower part of the so-called basi-sphenoid. Rathke says (Croon. Lect. p. 60) that "the body of the basi-sphenoid is (in the Snake) formed between the posterior fontanelle of the basis cranii and the pituitary space, therefore far from the cephalic part of the chorda! It ossifies by two lateral centres, each of which forms a ring round the carotid canal." This is exactly what occurs in the Chick; and we find that in the Chameleon (where the rostrum is feebly developed) these basi-temporal centres retain the posterior half of their connecting suture, whilst a trace of it still remains in the adult Blind-worm[1] (*Anguis fragilis*).

In young specimens of the *Crocodilus acutus* from San Domingo (for which we are indebted to Henry Power, Esq.), we find that the rostrum had coalesced with the basi-temporals, and these with each other, leaving a large open space between the tables of bone; and yet these specimens were only recently hatched when taken, the abdomen being nearly full of unused yolk-substance.

In the Pigeon, one day after hatching, the two halves of this lower piece, which Professor Goodsir would call the temporal centrum, had coalesced; but in large 'squabs' a week old, this *underlapping* piece was easily separable from the upper piece or true basi-sphenoid.

Nothing that we have ever seen in anatomical structure is more elegant than the condition of these parts in the Balæniceps and the Heron; in the latter they are essentially a miniature of those of the former: this is certainly not a faint and superficial mark of affinity.

That cranial centra may be developed from a pair of lateral centres is seen in the morphology of the human sphenoid bone (Meckel, as quoted by Professor Owen, Report on Archetype, p. 318), in the double ethmoid and vomer of the great Sudis (*Arapaima gigas*), and in the condition of the vomer and turbinals of the Lacertian and Ophidian,—the former (the vomer) being evidently a pair of latero-basal ossifications of the ethmoid, and the turbinals the corresponding pterapophyses or outgrowths of the ethmoidal sclerotome.

Basi-sphenoid. (Pl. LXV. figs. 1 & 7, *b s.*)

Many birds have, like the Mammalia, two pairs of basi-sphenoidal pterapophyses, an inner pair abutting against a process from the pterygoid (its proper cranial attachment),

[1] Since the above was written, we have dissected a young specimen of *Emys europæa*, and find that the basi-sphenoid is developed from a pair of lateral inferior centres, which soon coalesce in front, and then send forwards a triangular wedge of bone to fit-in between the pterygoids. In this specimen the 'rostrum,' which is the homologue of the basi-sphenoid of the Bird, is a knife-like plate of cartilage, which never ossifies in this and other small Chelonia. In the Crocodiles, in the Green Turtle, and in the 'Loggerhead' it does ossify.

and a posterior expanded pair that form the anterior wall of the tympanic cavity and the superior and anterior boundary of the Eustachian tubes. The anterior or inner pair are represented in Balæniceps by two bevelled articular surfaces on the sides of the great rostrum near its middle. We shall give some tables showing the modifications of these parts in various birds relatively to the pterygo-palatine apparatus. In front of these facets the basi-sphenoid of Balæniceps becomes gradually thinner, ending in a quadrate wedge-like process two lines anterior to its proper preceding homologue, the descending plate of the pre-sphenoid; to this plate the rostrum of the basi-sphenoid is anchylosed. Behind the articular facets the rostrum expands, at first gradually, forming a thick beam of bone three lines across, and then it suddenly expands on each side into the elegant, conchoidal, anteriorly incurved ecto-pterapophyses, the counterparts of the marginal wings of the basi-temporal. This element has most substance at the part where its tables and diploë pass into the descending plate of the orbito-sphenoids, just below the optic foramina.

That this is a most important basi-cranial element in birds is seen from its connexion, which must be studied in immature specimens. In the Chick, on the eleventh day of incubation, more than the posterior third of the rostrum is ossified, and this ossific centre, convex below and scooped above to receive the cartilaginous plate of the pre-sphenoid, bifurcates behind, each posterior wing-like moiety lying just in front of, and above, the basi-temporals. This single mesial osseous centre appears to be identical with the distinct so-called *pre-sphenoidal* ossification spoken of by Dr. Kölliker (Berichte von der Königlichen Zool. Anstalt zu Würzburg, 1849, p. 40) and Huxley (Croon. Lect. p. 11).

In the Chick, on the fourteenth day, this ossification of the true basi-sphenoid has already occupied all but the tip of the rostrum, and posteriorly has grown upwards in the direction of the ali-sphenoids and petrosals, and backwards towards the basi-occipital.

On the sixteenth day, however, these parts and their relations can be still more advantageously seen; for by this time the anterior cartilaginous tip is very small, whilst the posterior end of this large and most elegant osseous centre has reached the basi-occipital on the mid-line of the cranial floor, about a line behind the sella turcica, thus entirely excluding the basi-temporals. The groove on the upper surface of the gradually widening rostrum is bounded behind by the anterior wall of the sella turcica with its middle and lateral 'clinoid processes,' whilst opposite these processes the basi-sphenoid expands into the large ecto-pterapophyses, on the upper part of which the ali-sphenoids are attached; nearly the anterior half mesially being occupied by the deep 'sella,' the posterior margin of which is even and smooth, whilst its fundus is perforated by a large foramen (in adult birds) which communicates with the internal carotids. Behind the ecto-pterapophyses the basi-sphenoid contracts, its sigmoid converging margins articulating with the base of the petrosals, and its narrow terminal portion being exactly adapted to the basi-occipital.

We now return to the structure of the basi-sphenoid in the adult bird.

The structure of the basi-sphenoid of the Adjutant is less elegant indeed, but much resembles that of the Balæniceps; but its rostral portion is more like that of the latter than is the same part in the Heron. In this latter bird, at the point where the wing-like ecto-pterapophyses meet, in front of the aperture of the Eustachian tubes, the base of the skull becomes rather sharply carinate, and just in front of these coalesced ridges about one-fifth of an inch of the rostrum becomes synovial, the articular cartilage rising on each side of the mesial line about the twentieth of an inch. In the Boat-bill the rostrum is less carinate than in the Heron, and for four lines in extent the rostrum is coated with articular cartilage. We shall now show how the palato-maxillary fittings are attached to the rostrum in different birds; and these modifications may be conveniently thrown into groups, the characters of which will sometimes have considerable *family* or *relational* value; whilst we shall often find that the same teleological modifications will occur in the most dissociated tribes.

Modifications of the Basi-sphenoid in Relation to the Pterygo-palatine Apparatus.

Group 1.—The ethmoido-frontals (the so-called 'nasals[1]') and nasal processes of the pre-maxillaries being confluent with the principal or sphenoido-frontal, and the palatines having coalesced with each other and with the vomer, the carinate basi-sphenoid has no synovial cartilage. Motion is here limited to the pterygo-palatal and pterygo-quadrate articulations. The vomer is arrested.

Example:—*Buceros*, various species (the Hornbills).

Group 2.—In this group there is a strong transverse synovial hinge, formed by the contiguous margins of the coalesced lacrymals and sphenoido-frontals posteriorly, and of the 'nasals or ethmoido-frontals' and nasal processes of the pre-maxillaries anteriorly, which hinge is further strengthened by the *procœlian* articulation of the ethmoid with the pre-sphenoid. The motion of this cranio-facial hinge is very free, the pterygo-palatal joints gliding along a considerable tract of the rostrum; this process is adapted to them by being round, polished, and well covered with synovial cartilage. Answering to this structure, the pterygoids are long and slender, the quadrate bones and palatines high, or deep, and the vomer arrested.

Example:—*Psittacidæ* (the Parrot-tribe).

N.B. The *Ramphastidæ* or Toucan-tribe seem to connect this group with the next.

[1] We have not the least doubt of the homology of these bones: they are evidently the representatives of the 'nasals' of the Mammalia; the 'sphenoido-frontals' of Professor Goodsir being simply the counterparts of the mammalian 'frontals.'

Group 3.—The great fronto-maxillary hinge is here composed of splint-like laminæ of the nasal processes of the pre-maxillaries and nasals, which overlap the sphenoido-frontals; or the lacrymals and sphenoido-frontals are adapted to the contiguous bones of the facial sclerotome by a dentate suture, the margin of the hinge being more or less synovial. The rostrum of the basi-sphenoid in this group is either patched on each side or completely covered with synovial cartilage for a definite extent, on which lubricated space the pterygo-palatals glide. Vomer variable.

Examples:—

Aquilinæ (Eagles).
Accipitrinæ (Hawks, Falcons, Harriers, Kites, Buzzards).
Vulturinæ (Vultures).
Serpentarius (Secretary-bird).
Podargus humeralis (Giant Goatsucker).
Alcedo ispida (Common Kingfisher).
Dacelo giganteus (Giant Kingfisher).
Cuculus canorus (Common Cuckoo).
Phœnicophaus (a Cuculine genus).
Picus viridis (Green Woodpecker).
Trochilus colubris (Humming-bird).
Sylviinæ (Soft-billed Songsters).
Passerinæ (Hard-billed Songsters).
Corvinæ (Crow-tribe).
Lophyrus cristatus (Crowned Pigeon).
Didus ineptus (Dodo).
Didunculus strigirostris (Owl-billed Pigeon).
Hæmatopus ostralegus (Oyster-catcher).
Œdicnemus crepitans (Stone Curlew).
Platalea leucorodia (Spoonbill).
Otis tarda (Great Bustard).
Grus americana (American Crane).
Grus pavonina (Crowned Crane).
Ciconia alba (White Stork).
Balæniceps rex (Shoe-bill).
Cancroma cochlearia (Boat-bill).
Ardea cinerea (Heron).
Botaurus stellaris (Bittern).
Phœnicopterus ruber (Flamingo).
Rallus (Rail).
Gallinula chloropus (Water-hen).
Fulica atra (Coot).
Tribonyx mortieri (Native Hen).
Brachypteryx australis (Short-winged Rail).
Podiceps (Grebe).
Colymbus (Diver).
Uria (Guillemot).
Alca (Auk).
Eudyptes demersa (Penguin).
Sula bassana (Gannet).
Phalacrocorax carbo (Cormorant).
Pelecanus onocrotalus (Pelican).
Sterna (Tern).
Larus (Gull).
Procellaria (Petrel).
Diomedea exulans (Albatros).

Group 4.—Fronto-maxillary hinge more or less splint-like and elastic, palatines loosely connected with basi-sphenoid. Near the anterior end of the pterygoid there is, on its inner surface, an oval, flat-faced, elevated process, which looks upwards and inwards, and which is articulated to an exactly similar process on the basi-sphenoidal rostrum; this latter process being the well-known ento-pterapophysis of the post-sphenoidal centrum—the homologue of the internal pterygoid plate of the Mammalia and Man. Vomer variable.

Examples:—The typical Gallinaceous genera, *e. g.*, *Pavo cristatus*, *Meleagris gallopavo*, *Talegalla*, *Gallus*, *Perdix*, &c.

The Lamellirostres, *e. g.*, *Anas*, *Querquedula*, *Rhynchaspis*, *Mergus*, *Anser*, *Cygnus*; certain Fissirostres, *e. g.*, *Caprimulgus europæus*, *Cypselus apus*, and the one of the *Pro-*

cellaridæ, *e. g.* the Short-tailed Petrel (*Puffinus brevicauda*), from Green Island, Bass's Straits (1224, Osteol. Cat. Mus. Coll. Chir. vol. i. p. 230).

Group 5.—Fronto-maxillary hinge more or less moveable and splint-like; palato-pterygoid joints freely gliding on a more or less synovial 'rostrum'; ento-pterapophysis longer and more delicate, as is its answering apophysis on the pterygoid; the facets of this little apophysis are rather round than oval, and their position more backward, being midway between the palatine and os quadratum: in this group the vomer is often well developed and cellular.

Examples:—

Strix, Ulula, Asio, Bubo (Owls).
Columba, Palumbus, Treron chlorogaster, Goura victoriæ, Geophaps smithii (the typical Pigeons).
Vanellus cristatus (Lapwing).
Charadrius hiaticula (Ring Dotterel).
Scolopax (Snipes and Woodcocks).
Limosa melanura (Godwit).
Numenius arquata (Curlew).
Tringa variabilis (Sandpiper).

Group 6.—No movement of the facial on the cranial sclerotomes, the differentiation of the ethmoid and pre-sphenoid in the cranio-facial axis being soon obliterated by the fusion from below upwards of these vertical centrums. The rostrum is large, and the ento-pterapophyses unusually well developed; but they are not connected with the anterior part of their own hæmal bones, the pterygoids, as in Fowls and Geese, nor with the middle, as in Owls, Pigeons, and Snipes, but articulate with a facet on the distal end of these bones, which are wedged in between the ento-pterapophyses and the quadrate bones.

In these *non-typical* birds the pre-maxillaries are relatively small and feeble (as the rule), the maxillaries unusually large, and lying in the same plane as the pre-maxillaries; the palatals small, and pushed aside (so as to resemble the 'transverse bones' or 'ecto-pterygoids' of the Crocodile) by the unusual development of the vomer, which, thin, broad, and split at both ends, passes backwards to articulate with the pterygoids. These latter bones are not at all *bird-like*, but have taken on much of the laminar character of their homologues in the Reptilia, and are adapted to the vomer by a squamous suture, whereas in typical birds they articulate with the palatines by a synovial joint.

Example:—*Struthionidæ* (the Ostrich family).

Orbito-sphenoid. (Pl. LXV. fig. 1, *o s.*)

Looking at the middle part of the well-formed orbital roof of Balæniceps towards the axis, we see a small foramen two lines above the oval membranous space already mentioned as a landmark between the ali- and orbito-sphenoids. This small foramen pierces the sphenoido-frontal just above its union with the diverging plate of the orbito-sphenoid. Five lines in front of and a little above this passage is another, scarcely larger, which is continued as an open groove forwards and a little upwards into the nasal fossa. This groove is on the side of the upper thick part of the pre-sphenoid: the foramen itself, although single, answers to the many foramina of the cribriform plate of the ethmoid in mammals in function (for it carries the olfactory nerve), but not actually, seeing that the ethmoid of birds is facial and not cranial. The recess in which the 'rhinencephala' lie is formed by the diverging plates of the connate orbito-sphenoids below and by the frontals above; and although these lobes are the most anterior part of the brain, they are pitched up, as it were, against the roof-bones. The optic foramina mark the point where the orbito-sphenoid has become single and passes downwards and forwards, losing itself in front in the pre-sphenoid, and becoming confluent below with the 'rostrum' of the basi-sphenoid.

A fossa above the optic foramen is the upper landmark of the connate orbito- and pre-sphenoids—the neurapophyses and centrum of this semi-catacentric sclerotome, so curiously modified in relation to the large eye-balls. The centre of the originally membranous wall between the orbits is unusually well developed in Balæniceps, being generally arrested more or less in the Bird-class; it is, however, in this bird all converted into bone, the diploë of which is scarcely absent from even the central part. Although, for convenience-sake, we have separated the orbito-sphenoid from the pre-sphenoid in description, they are nevertheless only parts of one large inter-orbital ossification in the class of Birds.

The thick anterior part of the pre-sphenoid is the first to ossify; this process commencing in the Chicken about the twelfth day of incubation, and in the Pigeon near the time of hatching. The latter bird is able to fly before any of the orbito-sphenoidal region is ossified; and both the Chicken and the Emeu have attained a considerable size before the ossific matter reaches the ali-sphenoids.

In such birds as the Rail and Water-hen, the Grebe and the Cormorant, the interorbital septum is very incomplete. The leg of the inverted Y-shaped process bounding the common optic passage in *Gallinula chloropus* is an exogenous spur growing backwards and downwards from the pre-sphenoid; but nearly at right angles with this, another spur projects forwards and downwards. This latter spur, with the diverging alæ that coalesce with the ali-sphenoids just above each optic foramen, might easily be mistaken for the actual representative of the little Y-shaped interorbital bone of such fish as the Perch and the Sea-bream (*Pagellus centrodontus*). This latter ossicle has indeed been a 'bone of contention:' it is the 'sphénoïde antérieur' of Cuvier, the 'entosphénal' of Geoffroy, the 'os innominatum' of Hallman, and the 'ethmoïde cranien' of Agassiz; whilst Professor Owen, calling it the 'ento-sphenoid,' considers it to be the internal part of the centrum of the pre-sphenoidal vertebra; but its real nature was well seen by Professor Goodsir, who considers it to be a feebly developed centrum of the post-sphenoid, or perhaps even of the temporal sclerotome. We do not agree with Cuvier that it is part of the anterior sphenoid, nor with Professor Owen that it represents the "conjoined bases of the orbito-sphenoids in mammals:" we quite coincide with Dr. Hallman and Professor Huxley that its supposed representative in the Carp is the orbito-sphenoid; but not with Agassiz (with whom Professor Owen once agreed in this matter) that it is a cranial ethmoid. It does not agree with that hinder part of the connate orbito-sphenoids in the Carp which props up, and therefore lies *below* as well as in front of the ali-sphenoids (see Professor Huxley's figure of the section of the Carp's skull, Croon. Lect. p. 24)[1]. This is not really a digression (for the crania of the Vertebrata mutually explain each other); we will therefore give one word more about this elegant little bone. In the Sea-bream (*Pagellus centrodontus*) the structure of a typical fish can be well seen. Looking at the floor of this creature's skull, three remarkable bridges of bone are seen along the medial line: the hindermost of these is formed by the meeting of the ex-occipitals above their centrum; the middle bridge is formed in the same way by the petrosals, the basi-sphenoid lying at a great distance below the cranial floor; whilst the first bridge is formed by a single bone (this 'ento-sphenoid'), as though it were the serial homologue of these two pairs of bones behind. If this most anterior bridge belong to the same category as the petrosals and lateral occipitals, it should not directly precede the former were it the orbito-sphenoid; and it is not a lateral element; for perched up above and between it and the petrosals are the ali-sphenoids—pretty constant in fishes, but always high up, being feeble ossifications of the antero-lateral parts of the primordial skull, and lying in the midst of the still unossified cartilage that projects forwards on each side from the boundary of the great fontanelle. In the Reptilia proper the orbito-sphenoid is seldom present as a distinct bone; for, although the roof-bones of the pre-sphenoidal sclerotome are largely developed as the 'principal frontals,' the neurapophyses and centrum are arrested. In the Batrachia they break out again, the neurapophyses forming the ring, and the centrum (pre-sphenoid) the septum, of the 'os en ceinture' (see Goodsir, *op. cit.* p. 157).

Pre-sphenoid. (Pl. LXV. fig. 1, *psp* & *eth.*)

The pre-sphenoid of the Balæniceps is large and well-developed: no part of it can be seen from above, the roof-bones being very perfect; but it projects a line or so in front of them, just touching its serial homologue the ethmoid. All trace of the union of the orbital processes of the sphenoido-frontals with the pre-sphenoid is lost; but the groove for the olfactory nerve, and a descending process on each side marking the limits of the nasal fossæ (which are continued backwards for four lines on each side of the pre-sphenoid at its upper part) show where we are. This descending process is just behind the 'hinge,' half an inch mesiad of the orbital margin. A strong fascia connects it with another smaller projection on the side of the thick carinate anterior part of the pre-sphenoid, half an inch below the widely-dilated part which props up the

[1] The so-called 'ento-sphenoid' is properly an 'orbito-pre-sphenoid' in such fishes as the Carp and Salmon; but we class the little Y-shaped bone of the Percoids with the 'rostrum' of birds and the higher reptiles.

'principal frontals.' In the Heron these processes are bridged over by bone, thus walling-in the olfactory nerve. The anterior keeled margin of the pre-sphenoid of Balæniceps is sinuous, but vertical above, whilst its lower half retires a little before coalescing with the projecting 'rostrum.' In the Heron this centrum retires very much more, and the inferior antorbital process, after bridging over the olfactory nerve, sends an elegant curled lamina downwards, outwards, and forwards. This process, so large in the Albatros and many other birds (*e. g.* Snipes, Woodcocks, Pigeons, Goatsuckers, Owls, Parrots, &c.), but almost obsolete in the Balæniceps, Boat-bill, and Adjutant, in Gallinæ, Anatinæ, and in those wading, swimming, and diving birds in which the orbital margin is very incomplete, is a 'pterapophysis',[1] and its special homologue may be well seen in such mammals as the Rabbit. Serially, it is homologous with those 'pterygoid plates' spoken of as pertaining to the post-sphenoidal and occipital centrums.

The pre-sphenoid of Balæniceps is thick and cellular above, in front, and below; its middle part behind helps the orbito-sphenoid to finish the flat inter-orbital septum. In our description of the orbito-sphenoids, we spoke of the deficient ossification of this septum; we will add, that its extreme development, as to thickness and cellularity, is in Owls, especially the Screech Owl (*Strix flammea*), and in Goatsuckers (*Caprimulgus*). In the diurnal Raptores it is more or less imperfect, as also in the Pigeons and Gallinaceæ; in Parrots, Toucans, Woodpeckers, and most of the Scansores, it is very perfect, but not in the Hornbills. It is very imperfect in the Corvine, Passerine, and Sylviine groups, so nearly related to each other, and so potent in genera and species. In the smaller Ardeine birds (*e. g. Ardea, Botaurus*, and *Cancroma*), in Cranes, Spoonbills, Curlews, Plovers, Godwits, Rails, Coots, Jacanas, Grebes, Divers, Auks, Gulls (the smaller species), Gannets, Cormorants, Penguins, Petrels, and even in the Albatroses, the inter-orbital septum is more or less incomplete. In the larger relations of Balæniceps this septum is perfect (*e. g. Ciconia alba*, and in *Leptoptilus*), and the same may be said of the *Struthionidæ*. For an account of the manner in which the olfactory chambers encroach upon the sides of the pre-sphenoid in such birds as the Ostrich, Dinornis, Apteryx, Cassowary, and Dodo, &c., see Professor Goodsir's paper (*op. cit.* p. 156). We may remark, however, that the Common Duck and the Albatros are familiar but very beautiful instances of birds in which these pre-sphenoidal nasal cavities are large and well-developed.

Lacrymal. (Pl. LXV. figs. 1 & 6, *l.*)

The next bone to be spoken of (the lacrymal) belongs properly to the face, but its important relations with the sphenoido-frontals and antorbital processes (pterapophyses) of the pre-sphenoid make it convenient for it to be dealt with at once.

[1] Where there is a distinct centre for this process, it is something more than a 'pterapophysis,' as may be seen in young Pigeons; in these birds it evidently is, what Professor Owen calls it, the homologue of the human 'os planum.'

The lacrymal (prefrontal of Dr. Melville) becomes confluent with the sphenoido-frontal in many genera of birds,—*e. g. Trochilus, Picus, Ramphastos, Buceros, Psittacus, Columba, Hemipodius, Ciconia, Recurvirostra, Limosa, Numenius, Vanellus, Parra, Apteryx, Anas, Anser, Pelecanus, Sula, Phalacrocorax, Gavia, Sterna, Larus,* &c.

In a large number of genera it articulates with both the sphenoido-frontals and nasals or ethmoido-frontals; the latter receiving about one-third of the internal margin of the lacrymal, the former two-thirds.

In many birds the lacrymal *coalesces* with the antorbital 'pterapophyses,' but *articulates* with the sphenoido-frontal,—*e. g.* in the Thrush and Lark; whilst in others it articulates with the antorbital process, but becomes confluent with the sphenoido-frontal,—*e. g.* in the Lapwing (*Vanellus cristatus*).

In those birds which have the upper part of the nasals well developed, *e. g.* the Pigeons, Gallinaceous Birds, and Ostriches (*Struthio, Rhea, Dromaius, Casuarius*), the lacrymal articulates entirely, or nearly so, with the nasal or ethmoido-frontal; also in the Divers (*Colymbus septentrionalis* and *glacialis*) the small lacrymal is in the same way entirely facial in position. The rarest condition of this bone is seen in certain large Australian Goat-suckers, *e. g. Podargus humeralis*, and in *Balæniceps*, in which birds it is not only altogether in front of the sphenoido-frontal, but also coalesces with the nasal above, and with the maxillary below. In these instances its upper and posterior portion forms the outer and anterior part of the great fronto-maxillary hinge, instead of being behind that hinge, and assisting the coalesced sphenoido- or principal frontals in forming it, as in Parrots, and indeed in most birds.

In *Cancroma* the lacrymal is small, much smaller in proportion than in its congeners, *Ciconia, Leptoptilus, Ardea, Botaurus*, and *Balæniceps*, and three-fourths of its articulation is cranial, or rather supra-orbital. In *Podargus* the lacrymal does not appear to extend down far, but bounds the orbit above and in front; in *Balæniceps*, however, it passes down to be articulated with the zygoma, and forms the whole of the anterior crescentic margin of the orbit. The most concave part of this margin is at the upper third: above that part the lacrymal is thick and rugous; below it becomes sharp, forming a very perfect anterior boundary to the enormously expanded orbits. Inside and a little in front of this clear sharp posterior margin of the deep lacrymal of *Balæniceps*, a thin plate of bone extends inwards to the extent of nearly four lines: in the upper part of this lamina (which is convex in front and concave behind) there is a large oval foramen, the upper border of which is three lines from the roof, and the lower below the middle of the bone; its shape is oval; its length six lines, and its width three. This is the proper opening of the lacrymal canal; it is quite external to the nasal fossæ, which in the dry skull open widely into the orbit in *Balæniceps*. The width of the lacrymal of *Balæniceps* above cannot be clearly seen; but for the lower two-thirds it appears (by a series of vascular passages along a more or less imperfect vertical tract of bone) to be about two lines. These marginal holes and grooves are on a plane with the pre-maxillary, but the orbital margin of the lacrymal is turned outwards at a considerable angle. This facial development of the lacrymal is like what we see in the Crocodile, and still more fully in certain mammals, *e. g. Bos, Ovis, Sus.* In the Albatros, a thin bone, broad above and pointed below, articulates with the lacrymal near its base in front, and passes downwards to be attached by a ligament to the palatine. In Eagles, Falcons, and Hawks, a small supra-orbital is articulated to the long outstanding process of the lacrymal, and helps to give them their peculiar frowning aspect. This supra-orbital is seen again in certain Crocodiles, and also in some fishes, *e. g.* the Carp. That the lacrymal is not a dermal bone (as Professor Owen says), but 'an actinapophysis of the ethmoidal neural arch,' see Professor Goodsir's arguments in the work already referred to (p. 152). This far-seeing anatomist's writings will not admit of condensation. If the lacrymal of the bird should turn out to be a 'prefronto-lacrymal[1],' then Professor Goodsir's views concerning the next bone, the 'nasal' of authors, will be seen to be mistaken.

Nasal or "Ethmoido-frontal." (Pl. LXV. figs. 1 & 6, *n.*)

As a rule, those cold-blooded oviparous vertebrata with horny toothless jaws (the Chelonia) have no distinct nasals. Professor Owen, who stands unrivalled in osteological experience, has, we believe, seen only three exceptions,—*e. g.* in the recent *Hydromedusa*, and in the fossil *Chelone planiceps* and *pulchriceps* (see 'Rep. on Archet.' p. 224).

The views of Professor Goodsir upon this very difficult subject deserve the most attentive consideration; and it is possible that even in the whole class of Birds there may be no distinct 'nasals;' in that case, that down-turned broad surface of the ethmoid, in such birds as the Vulture, the Hawk, and the Parrot, which, becoming ossified, converts the nostril into a small round anterior opening, would be an exogenous nasal. The nasal of the bird, however, has no descending antorbital process bounding the olfactory nerve externally, for the antorbitals of the bird belong to, or coalesce with, the sclerotome next behind. Perhaps the 'pre-frontals' continue membrano-cartilaginous in birds, or the so-called 'nasals' represent their upper and outer surface; or the lacrymals may be compound in their nature, although this is very unlikely; for it seems to us that the only ossified part of the prefrontal of the bird is the autogenous antorbital.

In those birds which have a broad nasal with its bifurcations widely apart, *e. g.* the Rook and the Fowl, the nasal fossa is oval, the anterior bifurcating margin of this bone being its posterior boundary; where the bone splits itself sharply, *e. g.* the Crane and Plover, the nasal fossa is of necessity angular behind.

In Fowls and Ostriches, the pre-sphenoid appears on the roof between the nasals and sphenoido-frontals; but in most birds these bones form a very perfect covering to this

[1] This is evidently the case when it coalesces with an autogenous antorbital process.

region. In the latter non-typical birds, *e. g. Dromaius* and *Rhea*, the process is obsolete which in ordinary birds descends from the nasal to the maxillary; and in *Rhea* the broad single nasal process of the coalesced pre-maxillaries is unusually short, being succeeded by the nasals, which here meet at the mid-line for some distance, divaricating again as they pass, narrow and splint-like, between the large lacrymals. This meeting of these bones along the mid-line is very exceptional in birds; yet they really do approach each other more nearly than would appear from a casual view of the matter. In such birds as the Pigeon, the thin splint-like mesial and lateral processes form but a small part of the bone, which, higher up, becomes cellular, meets its fellow, and forms a large mesial oval part of the forehead, pushing the narrow anterior portions of the great sphenoido-frontals aside. In birds with very cellular foreheads,—*e. g.* the Owls (*Strix*, *Ulula*, *Asio*, &c.), the Balearic Crane (*Grus pavonina*), the Woodcock (*Scolopax*),—the thin tips of the pre-maxillaries pierce the bone of this frontal region, wedging themselves in between the roof-bones and upturned centrum of the anterior sphenoidal cincture. But the nasals do more than this—they lose their lath-like character, and help to form the rich diploë of this region, most of which is contributed by the sphenoido-frontals. Generally in birds these ethmoidal roof-bones may be distinguished more easily than most of the elements of the upper surface of the head, if we except the lacrymals; and in several Struthious birds, Galline birds, and Rails, they continue pretty distinct throughout life, whilst in a great proportion of species traces of the sutural lines are persistent. This character, combined with their thin, fibrous, elastic condition, makes them very traceable. But this is not always the case; for in birds with a dense, close skull-wall, *e. g.* Parrots, Hornbills, Toucans, and Balæniceps, —and even with a cellular skull, as in the Podargus,—the traces of composite structure in these regions are most of them entirely obliterated. In most typical birds, the nasal either overlaps, pushes aside, or passes under the great frontal (its successor), becoming more or less anchylosed with it: anteriorly it splits or bifurcates, the upper process passing along the inferior and outer margin of the nasal process of the pre-maxillary, whilst the lower process passes downwards and forwards to join the palatal process of the maxillary and the maxillary itself. The extreme degree of coalescence which has taken place in this somewhat immature skull of the Balæniceps makes it impossible to point out the boundaries of the nasals; but some large skulls of the Common Duck scarcely half a year old, in which the sutures are still very evident, and the skull of the Heron will give a good idea of the relations and extent of this bone. The Adjutant (*Leptoptilus*), moreover, even in old age shows the sutural lines in this region, in rows of canals and passages, just as the facial extent of the lacrymal of Balæniceps is shown. In the latter bird, the width of the bone in front of the great cranio-facial hinge is barely two inches; in the former it is slightly above that measurement, and yet the width is not eked out by the lacrymals as in Balæniceps. The nasal processes of the pre-maxillaries in the Adjutant are each half an inch wide at the hinge, the nasals being of the same extent; but in birds which are flat in this region, as the Heron and the Duck, each nasal is nearly four times as wide as the delicate splint-like process of the pre-maxillary, instead of being merely the same width as in the Adjutant. Besides this, the extreme height and convexity of the posterior part of the ridge of the broad face of the Balæniceps must be considered, and also the distance between its nasal fossæ, as measured from the posterior boundary of each. In the Adjutant this distance is ten lines, in the Balæniceps fourteen, which makes it very probable that each nasal process of the pre-maxillary was, in the young bird, even wider than the nasal. Most birds in which the sutures can be seen show that the upper margin of the nasal passage is almost entirely bounded by the nasal, the posterior margin entirely, and a great part of the inferior margin. In Balæniceps this latter line separates the posterior part of the large pre-maxillary internally, as it passes towards its posterior angle, from the horizontal inferior turbinal, which, with its fellow, forms a nearly perfect palatal floor to the nasal fossæ. An arcuate line, its convexity upwards, passing from the middle of the inferior margin of the nasal passage to the point where the maxillary meets the lowest part of the lacrymal and the posterior angle of the pre-maxillary, will indicate, as near as may be, the anterior boundary of the lateral portion of the nasal.

Fronto-maxillary hinge. (Pl. LXV. figs. 1 & 6.)

Adhering to our plan of working *regionally*, we shall leave the ethmoid and ethmoidal hæmapophyses until the præ-maxillæ, nostrils, and cranio-facial hinge have been described.

In the great transverse hinge of the upper jaw on the head, the most external tooth-like process, which passes backwards outside a similar tooth of the frontal going forwards, belongs to the lacrymal, that bone having escaped from its usual connexion with the principal frontal. A third tooth inside these, and which, like the first, looks backwards, belongs to the 'nasal,' and is the outer part of its posterior boundary. This frontal margin is then continued nearly straight towards the mesial line, where about two-thirds of an inch of the hinge belongs to the pre-maxillary. The most projecting part of the hinge is mesial, the pre-maxillary encroaching upon the principal frontal; and, curious enough, this is the place for the great ball-like process of the Maccaws and Parrots, the cup being made in the pre-sphenoid. The lacrymal and 'nasal' tooth-like projections, as well as the corresponding parts in the frontal, are evidently coated in the recent state with articular cartilage, whilst the rest of the hinge seems to be something intermediate between 'harmony' and 'dentate suture.'

To return to the 'nasal.' Anterior to the hinge this bone is smooth, and gently inclines downwards, the smooth and bevelled surface being about half an inch square; it then rises, becoming very rough and punctate, and at five-sixths of an inch from the hinge forms the posterior boundary of the nasal fossa. The nostrils are at this part $1\frac{1}{6}$ inch apart, but further forwards only an inch of bone separates them. The upper margin of these passages, formed by the nasal, is rough, and their bony roof about a line thick; the lower, formed partly by the same bone, is smoother, but strongly grooved by vessels; whilst the posterior boundary of the fossa is curiously scooped, the upper scooped concavity being small, and the lower large, and reaching to within one-third of an inch of the orbit. The actual nasal passage is less than half an inch long, and one-sixth of an inch broad; but the grooved and scooped parts of the osseous boundary beneath project both behind and in front of it, so as to make its vestibular part full an inch long. The nasal fossæ and passages in *Cancroma* are very similar to these structures in the Balæniceps, save that they are relatively larger, and the surrounding parts composed of thinner and smoother bone. In the Heron, the nasal passages, which freely open into each other, are actually longer than in the Balæniceps; and in the Adjutant they are not so wide, but are twice as long.

The large, well-made nostrils in Balæniceps have no affinity with those of the Pelecaninæ, which are extremely small, and actually become obsolete in the adult of some species, *e. g.* the Cormorant.

Præ-maxilla. (Pl. LXV. figs. 1, 6, & 7, *pmx.*)

Fishes are curiously like birds in the condition of their proper maxillary bones, the 'ossa mystacea,' which were not for some time recognized as the true homologues of the mammalian and reptilian maxillaries. In most typical fishes they are above and behind the dentary margin of the inter-maxillaries, and are themselves edentulous,—the exceptions being in the Salmonidæ, *Sudis*, &c. Passing from the study of any ordinary mammal, or from the Chelonia or Crocodilia to *Balæniceps*, it would seem at first blush difficult to put down nine-tenths of the huge face of the latter to the pre-maxillary elements; yet such is apparently the fact. Nor is this bird exceptional, for in all the Gallinæ the maxillary bones are, as in most typical fishes, above and behind the dentary margin; and they are relatively small in all *typical* birds. We have, however, as in the class of Fishes, some instructive exceptions. In the Rhea, a bird whose nasals meet at the mid-line, and in which the sacrum is, much of it, as abortively developed as in the Frog, the maxillaries form half the region of the 'hard palate' and one-third of the dentary margin. In the Emeu (*Dromaius ater*) a similar state of things exists, save that the premaxillary sends a long posterior, angular process, which hides the large maxillary laterally. The rest of the Struthionidæ are more or less like the Rhea and the Emeu in this respect. We have also a similar state of things in the smaller genera of the Fissirostres, as may be seen in the Common Goatsucker (*Caprimulgus europæus*) if examined when quite young. In this bird two-thirds of the palatal region and one-third of the dentary margin are formed by the superior maxillary bone. In the Duck, about half of the margin is *maxillary*.

It was thought necessary to premise these remarks before passing on to describe the rest of the Balæniceps' face. Certainly a large amount of territory has this same premaxillary: the whole sweep of the broad and massive ridge, from the wide but anteriorly scanted sphenoido-frontals to the end of the great hooked beak, belongs to it, and much of the dentary margin; the extreme posterior angle is, however, evidently maxillary in its origin. Nor can it be said that the lacrymals and nasals have come

. . . . "cranking in,
And cut it from the best of all its land,
A huge half moon, a monstrous cantle out;"

for the lacrymals, although actually of good size, form but a narrow crescentic strip down the orbital margin; while the so-called 'nasals' have relatively but a small 'lot,' and that all shot into strips and angles. We shall see, moreover, that the pre-maxillary has the hard palate almost entirely to itself, the broad palatines overlapping a little behind; whilst the spongy ethmoidal pterapophyses run forward between and in front of the palatines, nearly filling up that postero-mesial space which, in many birds, is principally composed of membrane. Seen in profile, the dorsal ridge of the *Cancroma* is convex in its whole extent: but in Balæniceps the rise into the rough boss in front of the hinge is rather sudden, the dorsal line in front of the boss descending very gently to the middle; then rising again as gently as it descended, it gradually becomes the upper outline of the great terminal beak. The 'dip' of the dorsal outline is rather more than four lines.

The length of the upper jaw of Balæniceps (not measured along the curve, but in a straight line) is rather more than 7 inches, its broadest part, a little behind the middle, being nearly 3 inches. The same measurements in *Cancroma* are 3 inches, and 1 inch 8 lines. In the Adjutant the widest part is at the zygoma, which is 2 inches 2 lines, its length being 13 inches; and in the Pelican the length is 15 inches and 6 lines, and the broadest part (near the anterior fourth) is rather more than 1 inch 6 lines. Thus we see that in the elegant, broad pre-maxilla of the Boat-bill the breadth is more than half the length (its shape being like that of the distal two-thirds of the leaf of *Magnolia grandiflora*); that of the 'Whale-head' is more than twice as long as it is broad. If, however, the latter were less arched, its width would be relatively as great as that of its small relation. Drawing a basal line from margin to margin of the præmaxilla, we find its palatine concavity to be 1 inch 2 lines high; this most hollowed part being one-fourth from its hinder margin, from which part the bony plate descends rather rapidly to join the palatines. The greatest concavity of the hard palate is more anterior in the Boat-bill, and it is two-fifths of an inch high; whilst the greatest height in the Adjutant is two-thirds of an inch, at one-fifth of the whole length from the posterior angle.

The 'hard palate' in the præ-maxilla of the Pelican is very flat between the great internal ridges, and, in some respects, the upper jaw of this bird has more resemblance to that of the Flamingo, save for the strange bend in the latter, than to the same part in the Balæniceps.

In most birds the highest part of the upper jaw is between the nasal fossæ, but in Balæniceps it rises just behind them into a sort of rough boss, the bone then becoming smoother for a quarter of an inch as it gently descends to the middle of the great transverse hinge. This character, with the backward extension of the jaw, the shortness of the principal frontals, and the very forward position of the enormous, well-margined orbits, helps to give a solemn, wise, but somewhat sinister aspect to the bird. Looking at the bird in his paddock, the first impression is that we have before us some strangely ancient form with "the breath of life" in it, and "standing upon its feet," concerning which Geology had taught us that "its bones were dried up, and its hope lost."

Passing from the rough boss forwards, we find the bone again becoming smoother, but it continues gently convex along the whole ridge until it expands in the large, terminal, hooked beak. On each side of this convex ridge the bone is scooped by vessels, is concave, and then suddenly rises into a sharp ridge, which overhangs a deep groove, forked at its commencement, as it rises above and below the nasal fossa, and becomes deep and narrow towards the middle, and wider and shallower as it turns off on either side to give boundary to the great terminal hook.

These sharp boundaries to the great sub-mesial grooves are at first seven-eighths of an inch apart, at the anterior third they are scarcely more than a quarter of an inch apart, and are three-quarters of an inch asunder at their termination on the lower margin.

In the dry skull of birds there is generally near the zygoma a large triangular space, its base being the anterior third of the zygoma, its front side the descending plate of the nasal, and the hinder side generally imperfectly bounded by the lacrymal. In the Balæniceps no such space exists, or only in rudiment, there being, on the anterior margin of the lacrymal, at its upper third, a groove terminating in a small oval passage passing inwards, which passage is then followed by a series of small vascular punctæ, indicating the place where the lacrymal, nasal, and angle of pre-maxillary have so completely coalesced. The outer broad surface of the præ-maxilla is not nearly so smooth as the crown of the head; its substance is lighter, more marked by vessels, and its weight diminished by open areolar spaces,—an approach to the structure of the Pelican's upper jaw. The terminal beak is stronger than, but not so long and sharp as that of the Albatros; it is thrice the size and strength of that of the Pelican; and the curved tip of the Boat-bill's jaw and that of the Umbre are its feeble representatives. The tip of this strong beak is not sharp, but is slightly emarginate, being one-eighth of an inch broad, the emargination being still greater in the mandible. The outline of the lower margin of the præ-maxilla is very elegant, more so than in the Boat-bill. Looking at its anterior commencement, we find it rising gently up to the middle of the side of the great hook; it then as gently descends, swelling outwards into the arc of a very large circle to within ten lines of the angle,—the rest of the marginal line being nearly straight.

The thinnest part of the bone is at the middle of the sides, as it is thick at the grooves, and again thickens so much towards the rather sharp margin as to give it the appearance of curving in.

In the Boat-bill all these characters are softened and feeble: the mesial portion is, as it were, pinched into a keel, convex along the mid-line and concave at its sides; whilst the grooves are wider and more open, and the sides of the jaw smooth and evenly convex as they turn slightly inwards to form the sharp margin. The great upper grooves are nearly obsolete in the Adjutant; in the Heron they are well marked in front of the nasal fossæ, but only pass halfway to the straight tip. In the Pelican they are distinct for two inches from the nasal fossæ, when they lose themselves in the large cellular scoopings that occupy so much of the interspace between the moderately convex ridge and the margin; yet the upper margins are indicated all the way by a row, on each side, of large oval vascular apertures, and again become distinct as they form the boundaries of the beaked tip of the bill. In the Spoonbill these upper pre-maxillary grooves are very distinct: diverging as they pass out from each nasal fossa, they run within one-tenth of an inch of the margin in the narrow part, and one-eighth in the broad spatulate end, round which they pass to become confluent above, a little posterior to the broad and gently curved tip. The large concave 'hard palate' of the Balæniceps is not a whit less elegant than the upper and lateral aspects of the jaw—indeed more so, if possible; the vascular grooves being here very perfect, as they pass out at right angles to the great mesial sinus, forking and inosculating laterally like the veins of a beautiful leaf.

To the distance of $1\frac{1}{8}$ inch from the tip, the mesial line below is keeled, at first rather sharply, but the ridge soon becomes convex, and widening as it passes backwards, is in reality continued along the greater part of the palate; but at the distance above-mentioned it is laid open—no longer a ridge, but a large vascular sinus.

For more than the anterior half this groove is sharply margined, and, besides the vascular openings into the lateral dendritic grooves, exhibits large open spaces which communicate with the rich diploë occupying the thick mesial ridge of the jaw. The margins then become smoother and more rounded, and the groove widens as it passes backwards to descend rather suddenly to the posterior boundary of the hard palate.

Turbinals or Ethmoidal Pterapophyses[1]. (Pl. LXV. fig. 7, *t b.*)

From the inner part of the articulation of the palatine with the pre-maxillary there is, on each side, a smooth convex ridge, which runs forwards for above an inch, slightly converging towards its fellow. A little behind where these ridges lose themselves in the surrounding bone there is an irregular opening about two lines in length, which opens from the mesial groove obliquely into the space above. Behind this there are several smaller passages scarcely true to the mid-line. These openings are all of them the remains of a membranous space, which is large in many birds, and lies in front of and

[1] We have adopted this term provisionally; Professor Goodsir would have us believe that these elements are neurapophyses (see *op. cit.* p. 144).

between the coalesced ethmoidal pterapophyses—elements which seldom combine with each other on the mid-line of the palate. The anterior largest passage just spoken of and the smooth convex ridges are the anterior and lateral landmarks of these bones; whilst their posterior margin terminates on each side in a small, elegant spur of bone, the point of each spur curving outwards, and each tip lying two lines from the deeply-grooved posterior line of union of the two bones. The palatals at their inner margin articulate with these palatal elements of the ethmoidal sclerotome[1].

This descending portion of the hard palate is easily understood by means of these landmarks, and by a careful comparison of their unusually developed condition in the Balæniceps with the skulls of birds in which ossification has not proceeded so far. The Adjutant, the Heron, the Duck, and the Common Rook, all help to explain these homologues of the cornua attached to the lower parts of the 'vomer' of certain Chelonia, and of the turbinals of the Lacertian and Ophidian.

The pterapophyses of the ethmoid have united along the mesial line of the palate in the Adjutant (*Leptoptilus*), in the Cancroma, in the Great Goatsucker (*Podargus humeralis*), in the Merlin (*Falco æsalon*), but not in *Aquila chrysaëtos* nor in *Accipiter nisus*, or in the Vulture. This floor of the ethmoidal neural space is complete beneath in the Kingfishers (*Dacelo* and *Alcedo*) and in the Spoonbill and other birds with large mandibles. In most birds, however, they do not meet mesially, and in the Ostrich group they are feebly represented. The condition of these parts is very exquisite in the smaller Fissirostres, *e. g. Caprimulgus europæus*—a good subject for the examination of an ossified true 'ethmoid,' and of these pterapophyses of the ethmoidal sclerotome.

At one-eighth of an inch external to the outer margin of the palatines of Balæniceps, a strong groove is scooped in the upper jaw, shallow at first, where it divides the angle of that bone into an outer larger and an inner smaller portion; it passes forwards, gradually rising within the sides of the hard palate, until at the anterior fourth it is midway between the margin and the mesial sinus. It then passes forwards to the base of the great beaked tip, where it meets the grooves already spoken of on the upper surface.

Seen from beneath, the upper jaw of the Balæniceps, from its elegantly curved outline, suddenly narrowing towards the tip, its submarginal grooves, at first parallel, and then taking a sigmoid curve inwards, to become nearly parallel again as they blend with the margin, and lastly, the mesial sinus with its transverse dendritic branches,—is certainly an object of great beauty. Before leaving this part, we may notice that the bifurcating vascular grooves passing from the mesial sinus open into a smaller lateral sinus which burrows the interior sharp edge of the great submarginal sigmoid groove. This great groove at its posterior end cuts away, as it were, part of the angle of the maxilla, to allow the mandible to fit tighter and to lock itself into the upper jaw; and the interior portion of the angle is thus always on a lower plane than the exterior.

[1] We have not been able to detect any separate osseous centre for these elements; they are evidently mere outgrowths from the maxillaries, and are the homologues of the inferior turbinals of Mammals.

This is almost the whole function of this groove in the Adjutant and many other birds, the dental margin at its posterior part being, in a manner, pushed up high by the action of the mandibular ramus; whilst in the anterior part of the upper jaw the groove is obsolete, and the mandible lies wholly under the maxilla.

This may be seen in the curious jaws of the Spoonbill: but in the Boat-bill the mandible passes within the zygoma, at the junction of the dentary with the surangular, and then soon liberates itself, adapting its margin very accurately to that of the maxilla; and this latter bird has no trace of this submarginal groove with its internal ridge, its hard palate being as simple as that of the Giant Goatsucker (*Podargus humeralis*).

In the Heron, which has a subterminal notch to the horny sheath of the maxilla, and very elegant lozenge-shape recurved horny teeth along the sheaths of both maxilla and mandible, the jaws fit together as in the Adjutant. But in the former bird submarginal ridges may be seen, faintly in the bone, clearly in its horny sheath, running along the posterior three-fifths of the hard palate, nearer the dentated margin than the mesial sharp ridge, but rather parallel with the mid-line than with the margin. In the anterior half of the hard palate of the Spoonbill, and in that part of the mandible adapted to it, a similar, rather faint ridge may be seen, running somewhat concentrically to the outline of these spatulate jaws.

In the Pelican (*P. onocrotalus*) the hard palate is subdivided into a broad mesial and two narrower marginal portions by two strong ridges, the mid-line being gently and evenly concave, and marked with large oblong passages.

These marginal portions, narrow behind, but becoming gradually broader towards the somewhat spatulate anterior part of the jaw, are strongly scooped, or concave; and in these concavities the mandibular rami lie, in the closed condition of the mouth. This scooping of the hard palate reaches nearly to the mid-line in the Flamingo, the mesial part of the hard palate in this bird being merely a rounded keel. Into these nearly semicylindrical spaces the round, thick, upper and inner parts of the mandibular rami are accurately fitted.

If space would permit, all these manifold but, anatomically, gentle modifications of structure might be explained and their final purpose illustrated; but every intelligent naturalist will at once see their meaning in the habits of each bird. Undoubtedly the Balæniceps comes nearest to the Turtle in this part of its structure, notwithstanding the difference of function of the homologous parts. These secondary ridges give perfection to the beautiful dentated shears of Turtles, so well constructed to "graze the sea-weed, their pasture"; whilst the additional maxillary ridges of this large-headed Heron, the Balæniceps, serve to break the spine of its finny prey.

Ethmoid. (Pl. LXV. fig. 1, *n p g*.)

The anterior portion of that mass of bone in the Ostrich which Professor Owen calls the connate 'prefrontals' (Rep. on Archet. p. 190. fig. 8. no. 14) is in the Balæniceps, the Adjutant, the Heron, the Rook, the Goatsucker (*Caprimulgus*), the Swift (*Cypselus*), and in various other birds, developed as a distinct centre of bone in the cranio-facial axis. The posterior osseous centre has already been described as the pre-sphenoid; the anterior element (which in a large number of birds consists principally of persistent cartilage, with a membranous space between it and its successor, the pre-sphenoid) is the true ethmoid, the catacentric centrum of the ethmoidal sclerotome (Goodsir, *op. cit.* p. 143). Cuvier called the posterior piece the 'ethmoïde.' It is evident that the axial parts of two cinctures, one of the *cranium* and the other of the *face* of the Struthionidæ, have been considered to belong merely to one segment of the skull. But evidence is not wanting to show that the large axial mass of bone figured 14 by Professor Owen (Rep. on Archet. fig. 8. p. 190) is developed even in the aberrant Brevipennes from an anterior and a posterior osseous centre. Many years ago we dissected and figured the cranio-facial axis of an Emeu (*Dromaius ater*) only six weeks old, in which the orbito-sphenoidal region, the antorbitals, and the anterior part of the so-called 'pre-frontal mass' were still cartilaginous. The flat-topped pieces, however (the anterior of which props up the 'nasals,' the posterior forming the buttress of the sphenoido-frontals), formed one V-shaped piece of bone, the upper portions being quite distinct, whilst the flat descending plates had evidently *coalesced*; for ossification commences, not at the point where these pieces had become confluent, but just below the horizontal outspread upper part, where, in this young Emeu, they were still widely distinct.

Looking at the lower part of the great fronto-maxillary hinge in the Balæniceps, we see, between the incurved plates of the lacrymals, a large mass of thinly-coated spongy bone, which forms the posterior part of the axis of the greatly-developed face. This broad-topped mass of bone acts as a buttress to the nasal processes of the pre-maxillaries and to the nasals, besides forming a large and important part of the 'great hinge,' and articulating with its immediate successor the pre-sphenoid below the hinge, thus adding strength to the junction of the roof-bones. This is the true 'ethmoid'; at least, it is the homologue of the mesial part of the human ethmoid, the out-standing process of which is called the 'crista-galli.' This centrum of the *face* of Balæniceps is as well developed as its *cranial* successor the pre-sphenoid; and the posterior aspect of the former is so much like the anterior aspect of the latter, that it seems like an illusion, and as though a mirror had given us a backward reflexion of the front of the pre-sphenoid.

The posterior face of the ethmoid of Balæniceps is sharply carinate for about two-thirds of its depth, the keel ceasing and a groove commencing opposite the projecting end of the basi-sphenoid. This groove, very shallow at first, runs downwards until it loses itself between the spur-shaped posterior processes of the ethmoidal pterapophyses in the mesial palatal groove. Where the keel ends, there the ethmoid, the centrum of this sclerotome, has coalesced with its low-lying pterapophyses. The mass of the ethmoid a few lines in front of the keel is much thicker than that of the pre-sphenoid; but the external bony table begins soon to be deficient on each side, and all trace of boundary between it and the surrounding bones is lost in a profusion of diploë, delicate as the veins of a leaf, and light as a downy feather. On each side of the shallow groove between the posterior edge of the coalesced pterapophyses there is a considerable pneumatic foramen, and from each spur-like point outside these passages there is a delicate ridge, which converges towards its fellow at the base of the vertical keel of the ethmoid, and then expanding forms on each side a wing-like crest of bone, which lies behind and strengthens the diploë of the pterapophyses as they pass upwards and a little outwards to coalesce with their roof-bone just within and behind the nostril. The lacrymals contribute of their substance to strengthen the bone at the same point; but in front of the incurved lacrymal plates, inside the pre-maxillary wall, outside the ethmoid, and above the up-tilted zygomatic plates of the maxillaries, there is on each side, in the dry skull, a large triangular space which opens freely into the orbits behind, and into the proper nasal fossæ above. Below these maxillary zygomatic plates there is another open space about half the size of the former; it is open behind; its floor is the extreme end of the palatal plate of the maxillary outside, and the broad origin of the palatine mesiad; whilst it is bounded internally by diploë common to the maxillary and the ethmoidal pterapophyses, and externally by the posterior angle of the maxillary.

We shall speak of the development of the facial sclerotome in birds, and of its general relations, after the maxillary and the 'zygoma' have been described.

Maxillary. (Pl. LXV. figs. 6 & 7, *m x.*)

At its origin the maxillary is broad, and its inner portion is principally composed of diploë, which passes insensibly into that of the ethmoidal pterapophyses mesiad, whilst, above and below, it arises in the fine diploë already mentioned as lying in front of the two large open posterior facial spaces; externally it is more compact, and is continuous with the posterior part of the wall of the pre-maxillary in front of the maxillary angle. The broad cellular origin of the maxillary soon contracts, the bone becoming compressed into a thin obliquely descending plate of bone, which lessens rapidly in width from the inner side. Whilst lessening in width it acquires a thick inner margin, and at about two lines behind the anterior zygomatic joint, the external part of which is evidently formed by the 'malar' or 'jugal,' it suddenly thickens as it is lost on the inner side of the zygomatic arch: just in this swelling region of the maxillary there are some pneumatic holes. The width of the up-tilted slanting portion of the maxillary is nine or ten lines at first; at an inch further backward, where it becomes lost in the malar, its width is four lines.

Zygomatic arch. (Pl. LXV. figs. 1, 6, & 7, *m x*, *m r*, *q j.*)

Where we can see the elements of the 'zygoma' in birds, we find that the zygomatic process of the maxillary forms about a third of the arch, lying within and below its successor. This next piece forms about another third, and lies in a supero-external position anteriorly; posteriorly it lies below and within the third moiety, the 'quadrato-jugal'—this latter element articulating with the external part of the base of the os quadratum. This zygomatic arch is nearly two inches long, its vertical breadth six lines or thereabouts (its middle being rather less), whilst its average thickness is three lines.

The upper and lower margins of this compound zygoma are rounded, but slightly thinned off and keeled, the former most so. The internal surface is smooth and convex, the external convexo-concave, the thickest and most convex part being near the lower margin, at the posterior third. The anterior end of the external part is articulated with the lacrymal and the posterior angle of the maxillary, which lies outside the base of the lacrymal above; it then sends a process into the substance of the maxillary, whilst below it is overlapped by it. There is evidently some articular cartilage here in the fresh state, as this hinge is rather freely moveable, notwithstanding the complete coalescence of the interior part of the zygoma with the upper jaw or maxilla. The extreme elasticity of the zygomatic plate of the maxillary allows of this movement; and we may remark that this anterior zygomatic joint has the compound character of arthrodia, gomphosis, dentate suture, and anchylosis. The upper margin of the bone is at first convex, and then concave, and convex again behind; and here, at the posterior fifth, there is a rough notched tubercle. The margin then suddenly falls, is crescentic in shape, and at the hinder tip of the crescent sends inwards a strong subconical process a quarter of an inch long, and at right angles to the main bone. The lower margin of the bone is nearly parallel with the upper, but is more internal, and is very convex as it lowers itself to become nearly parallel with the large crescentic notch above. The posterior internal process of the zygoma, best developed in Herons of any group, fits into a deep concavity of the os quadratum. The compound zygomatic bone is one of the rich and unique parts of the structure of Balæniceps. No other bird has anything comparable with it. The strongest of all birds' skulls is that of the Helmet Hornbill (*Buceros galeatus*), where the surface of the cranium is as deeply pitted as in the Crocodile; but here the zygoma is only one-third the size of that in *Balæniceps rex*. The zygoma in the Boat-bill and the Herons is more like an ossified tendon than anything else; and in the Adjutant it is relatively no stronger.

Development of Præ-maxilla.

In the Balæniceps all trace of suture between even the nasal processes of the pre-maxillaries is entirely lost, as much as in the Parrots and Hornbills; faint traces of this mesial suture may be seen in old Adjutants and Herons; whilst in a great number of birds it is distinct throughout life nearly down to the main body of the bone. In both the Chick and the young Pigeon, coalescence takes place rapidly between the lateral pieces up to the anterior end of the nasal passages. On the eleventh day of incubation the pre-maxillaries of the Chick are quite distinct, and a considerable oval space exists at the anterior end above, showing the long spatulate process of the primordial cranium *on* which the inter-maxillaries are moulded. The pre- or inter-maxillaries have, however, at this early period, much of their adult form, except that the nasal processes are short, and the sub-mesial palatine processes for articulation with the palatals are not yet developed; they may be seen three or four days later. The nasals are already ossified and have nearly their permanent form, overlapping the still cartilaginous pre-sphenoid behind, lying upon the ethmoid, and articulating below with the already ossified maxillaries. The spatulate 'rostrum' of the ethmo-vomerine cartilage is very elegant in birds: in the Chick it has attained its full size by the eleventh day; at this time it may be seen quite uncovered *beneath* the two pre-maxillary centres, like a small model of the Spoonbill's jaw.

This cartilage is very transitory; on the fourteenth day it has greatly shrunk, and by the nineteenth day of incubation it has become a mere thread of cartilage, being absorbed *pari passu* with the distal part of Meckel's cartilage. In the Snake the ossific centre for the pre-maxillary is azygous, like the cartilage *in* or *upon* which it is developed (Huxley, Croon. Lect. p. 60). In the Stickleback there are two cartilages *in* which the pre-maxillaries are developed (Croon. Lect. p. 29). The malars are ossified before the eleventh day in the Chick. The anterior part of the ethmo-vomerine axis of birds is always feebly developed; and in some birds the fibro-cartilage of which it is composed is deficient between the nostrils, *e. g.* in the Swan. The nostrils in Crocodiles and Mammals are pierced *in front* of the pre-maxillaries (just where the bones ossify latest in the Bird), "whereas in the typical Lacertians, and in the extinct Plesiosaurs, Ichthyosaurs, and Pterodactyles, in the Ophidians, Amphibians, and Birds, they open behind these bones" (Goodsir, *op. cit.* p. 139). There is, therefore, as Professor Goodsir shows, no *rhinal sclerotome* in these latter vertebrata. In the Bird, according to Professor Goodsir, the vomerine sclerotome is composed of the anterior fibro-cartilaginous portion of the primordial cranium (its catacentric centrum), and of the pre-maxillaries (its hæmal arch), whilst the neurapophyses are absent. The "marginal processes of the cartilaginous vomerine centrum extend down in front, so as to line the under- and fore-part of the nasal fossæ, projecting somewhat behind the inter-maxillary margin of the external nostril. The broad projecting upper portion of the cartilaginous septum occupies the position of the nasal bones, while the inferior portions project from behind the inter-maxillaries, like opercular actinapophyses" (Goodsir, *op. cit.* pp. 139, 140)[1].

The ossification of the posterior hyaline ethmoidal portion of the nasal septum is very varied, and takes place later than that of the pre-sphenoid. The ossified ethmo-vomerine axis of Balæniceps is nearly four lines thick between the nostrils, and consists of one mass of bone, as is the case indeed in most birds when these parts are ossified. In the Heron and Adjutant, only the flat upper surface of the ethmo-vomerine cartilage is ossified; in the Rook the ethmoid is knife-like, but small in longitudinal extent, whilst there are

[1] We think, with Professor Huxley, that the whole of this subject requires to be tested by the patient study of development, and that the existence of this vomerine sclerotome is very doubtful.

traces of ossification of the nasal septum below the nasal passages in front. In the Woodpecker (*Picus viridis*) there is more or less ossification of the septum both in the anterior and posterior ethmoidal regions.

We quite agree with Professor Goodsir in his determination of the maxillaries as bones having a hæmal relation to the facial sclerotome, but not that the 'quadrato-jugal' of the Bird is the representative of the 'squamosal' of the Mammal. The views of this excellent anatomist "on the actinapophyses of the ethmoidal sclerotome" are too long to be transcribed here, but are likewise too concentrated to be given in abstract (see *op. cit.* p. 151). We may, however, mention that Professor Goodsir classes the upper and middle turbinals in the same category; but they are, according to him, the internal or posterior actinapophyses of this cincture: the posterior of these processes becomes ossified in Parrots and in *Picus viridis*, and is anchylosed to the anterior and inner face of the antorbital: the same author considers the palatine or inferior turbinals to be 'neurapophyses.' In the Vulture there are an upper and a lower pair of ethmoidal pterapophyses; the former having an ethmoidal, and the latter a maxillary origin.

Palatines and Vomer in Vertebrata.

The imperative necessity for a thorough re-examination of the subject of the development of the bones of the palatine region in the Vertebrata must be felt by every one who has endeavoured to make Professor Goodsir's views on this subject clear to himself, whilst for the time all "old experience" is forcibly set aside (see *op. cit.* pp. 142–154, & pp. 159–162).

What the 'squamosal' and 'tympanic' have been to Professor Owen, that the 'palatine' and 'vomer' have been to Professor Goodsir; and, once wrong, we all know that the noblest minds go farthest astray.

There is evidently every reason to suppose that the ossified anterior and inferior part of the ethmo-vomerine cartilage of the osseous Fish is the true homologue of the divided 'vomer' of the Batrachian, Lacertian, and Ophidian, of the vomerine splints of the Crocodile, of the 'vomer' of the Chelonian, the Bird, and the Mammal. Even in Fishes it is sometimes double, as in *Sudis gigas*. What the 'transverse bones' or 'ectopterygoids' of the Crocodile, Lacertian, and Ophidian agree with in other vertebrata, it is impossible to say at present; it is not certain, at any rate, that Cuvier's 'transverse' and Owen's 'pterygoids' are their representatives in the Fish; they may be; and then it might turn out that Professor Owen's 'pre-tympanics' (Professor Huxley's 'metapterygoids') were the actual homologues of the ornithic and mammalian 'pterygoids': even then the ento-pterygoids would have to be accounted for. Evidently there are no ecto-pterygoids or transverse bones in these two latter classes, the Birds and Mammals, nor in the Chelonians and Batrachians[1]. The palatines of the Crocodilian are very peculiar,

[1] Query:—How can the ento-pterygoids of the Fish represent the 'bones of Bertin' in Man and their representatives in other mammalia? They seem to have a very slight connexion with the vomer, whilst the mammalian ossicles are evidently dismemberments of it.

and their meaning not at first sight evident; we have been only lately enlightened upon this subject by Professor Huxley himself, who has kindly demonstrated their structure to us in the Gavial.

In these reptiles (the Crocodilia), both the external, or *anterior*, and the posterior nares have a mammalian character; for the latter openings are not simply bounded externally and posteriorly by the palatines, as in birds, but those openings which agree with the posterior nares of the Bird are entirely shut from view in the palatine aspect of the skull. This is caused by the development of a very perfect *palatine* inferior plate to these elongated bones, the long palatine groove beneath the basis cranii being thus converted into a canal which is more or less divided into two parallel passages by the vomerine slips of bone, whilst the passages or tubes open on the posterior half of each pterygoid on its inner margin, where it joins its fellow of the opposite side and sends forwards a sharp process to join the vomer, just as the palatine does in the Bird.

The palatines of the Fowl are ossified before the eleventh day of incubation. The vomer of the Fowl is ossified by the end of the fourteenth day of incubation in the blastema that connects the rudimentary upper maxillary apparatus of each side; not apparently in pre-existent cartilage, but evidently in the membrane coating the ethmo-vomerine cartilage behind, and the sphenoidal rostrum in front. In the air-breathing Ovipara generally, the vomer seems to belong to the palato-maxillary apparatus quite as much as to the cranio-facial axis, and to be a sort of morphological bond between the skull and facial arches. In the Fish, however, it is an inferior ossification of the ethmo-vomerine cartilage, and bears upon it the ethmoid in the mid-line and the pre-frontals on each side. The relation of the vomer to the lateral masses of the ethmoid is exceedingly important, these masses being evidently the mammalian condition of the pre-frontals; Dr. Cleland has shown this with great clearness in his valuable paper; and one cannot help comparing the thin cortical mammalian vomer, becoming on each side one with the ethmoidal masses, to the thin basi-temporals of the Bird, which are so intimately connected with the structures of the ear, and which bear a similar relation to the basi-sphenoid that the vomer of the Mammal does to the central plate of the ethmoid.

Professor Owen (quoted by Professor Goodsir, *op. cit.* p. 146) describes (in the Osteological Catalogue, p. 166, No. 764) the skull of the Black Alligator (*A. niger*), in which "the vomer is divided at the median line, and the anterior expanded part of each moiety appears upon the bony palate, between the pre-maxillary and the maxillary; the palatine suture between the same bones bending down to the hinder border of the palatal anterior aperture of the nostrils."

Now, there are conditions of the vomer in other vertebrates curiously illustrative of this exceptional structure in the Crocodilian. Perhaps the Chelonian that comes nearest to the Crocodile in structure is the Logger-head Turtle (*Caretta caouana*); in this creature the maxillary palatal plates meet and articulate, but are separated posteriorly by the lower plate of the vomer and by the palatines. The latter bones are kept apart by the palatal plate of the vomer, but they have begun to form that tube-like prolongation of the posterior nares which attains its fullness in the Crocodile. In the Green Turtle (*Chelone mydas*) the inferior vomerine plate reaches the pre-maxillaries anteriorly, thus keeping the maxillary palatal processes widely apart ; in this species the palatine plate of the palate bone is not so well developed as in the Logger-head. In the smaller Tortoises the descending portion of the vomer is less decidedly *palatal*, and we have now before us the skull of a small *Emys* which has articulated to the sides of its vomer a pair of ' turbinals,' which are evidently the proper homologues of the ethmoidal palatal plates of Birds and of the turbinals of Lizards and Snakes. Professor Goodsir thinks that the palatine plate of the vomer of Tortoises and Turtles always consists essentially of these turbinal elements, which he names 'ethmoidal neurapophyses' (*op. cit.* p. 145). The study of its development would prove or disprove this opinion.

These small Chelonians with their feebly-developed and widely-separated ' palatines ' lead us to the Lacertians and Ophidians, creatures that expose their double vomer on the anterior palatine aspect of the skull, and have articulated to each moiety a very perfect osseous ' turbinal,' which bone Professor Goodsir now (in these orders) considers to be a mere exogenous outgrowth or cortical ossification of the ethmoid (p. 155). We agree with him here, but not with his finding ' ethmoidal neurapophyses in the divided vomer,' nor with his non-recognition of the actual homology of these Lacertian and Ophidian ' turbinals ' with those of the little Chelonian and of Birds generally.

We now come to the structure of these parts in birds and mammals. The vomer of the Goatsucker (*Caprimulgus europæus*), slightly grooved above and carinate below, appears in the palate, between the inferior or palatine turbinals. In the Merlin (*Falco æsalon*) these latter processes are anchylosed together, and form a large oblong mass behind the palatine plate of the pre-maxillary, and between the laminar origins of the palatine bones. The vomer, thin above and round below, articulates behind with the palatines, being wedged between their ascending plates ; in front it descends and forms a lozenge-shaped little block, notched in front and flat below, the inferior surface being quite palatal. This descending anterior part wedges itself in between and behind the palatine turbinals exactly as in the little Tortoise, supposing these bones not to have coalesced, which they seldom do, the Merlin itself being somewhat exceptional in this respect even among the Raptores. In the Rook, and in Corvine and Passerine birds generally, the broad emarginate anterior end of the vomer descends, and appears in front of and between the palatine turbinals. One more instance from the class of birds :—in the Albatros (*Diomedea exulans*) we have an exception to the rule mentioned by Mr. Goodsir (*op. cit.* p. 159), that the vomer is feeble when the palatines are large, and *vice versâ*. In this large palmiped the vomer is two inches and a half long, the palatines being relatively large. Thin and laminar below, at its junction with the palatines, the vomer of the Albatros diverges above into two very considerable laminæ, whilst it is smoothly carinate below.

The whole bone ascends gently until its lower margin is half an inch above the horizontal palatine plane; it then descends more rapidly anteriorly, and appears on the palatal floor a little between, but more in front of, the palatine turbinals; this part is more than half an inch long and rather more than a line in thickness, and is notched in front. The upper part of the descending portion loses its groove, becomes filled with pneumatic foramina, and is rounded and smooth anteriorly. In the Common Hare (*Lepus timidus*), with its almost obsolete palatine processes of the maxillary and palate bones, its one large palatine foramen, and large, deep, widely-open posterior nares, the vomer descends to the mesial palatine region, becoming thick and broad below, to articulate with the long narrow palatine processes of the pre-maxillaries. This is the most favourable of all creatures in which to see the complete fusion of the posterior lateral laminæ of the vomer with the lateral masses of the ethmoid, and to judge how easy it must be for the too rapid extension of the cranio-facial axis to break up the thin vomer during its ossification into distinct pieces (as the cranial roof-bones are often dismembered in Man), such as the 'bones of Bertin' in Man, and their representatives in the Pig, Fox, Chimpanzee, and the Cetaceans. In the Rodentia generally (*e. g. Arctomys, Mus, Arvicola*, &c.) the vomer does not reach the palatine plane.

Palatines, Posterior Nares, and Vomer. (Pl. LXV. figs. 1 & 7, *pal, p n, v.*)

The posterior nasal passages in the Balæniceps (and it does not differ essentially from other typical birds) are bounded in front by the palatine turbinals, on each side by the internal margin of each 'palatal,' whilst they are partially separated from each other by the 'vomer,' the partition being completed by membrane. The palatals in Balæniceps being obliquely placed and meeting behind, the posterior nares are defined by them posteriorly. The entire transverse extent of the palatals in front is two inches and a third, their antero-posterior extent being nearly two inches.

The coalesced palatines seen from beneath form a large, triangular, deeply and strongly concavo-convex mass of bone; the posterior nares being, as it were, cut out of the broad anterior base of the triangle, in front of which space there are the palatine turbinals, and along its middle the thin arrested vomer, whilst the apex is notched, truncate, and toothed to receive the pterygoids. Thin and laminar at their origin, the palatines are connected by suture with the pre-maxillaries and maxillaries (with the former internally, and with the latter externally); but the middle portion of this suture soon becomes converted into anchylosis. From the internal part of the suture a strong convex ridge, $\frac{3}{4}$ of an inch long, passes outwards, downwards, and backwards; the bone above the middle part of this ridge becoming thick and spongy, whilst it thins off behind. Internal and posterior to this broad convex ridge the bone becomes less broad, as it first passes upwards and backwards, and then curves suddenly downwards to meet its fellow and form a strong mesial keel. The hinder carinate part of the palatines, at their line of coalescence, is half an inch in extent. At its front part the mesial keel bifurcates, the bifurcation at each side becoming a crescentic portion of the inner margin of each ramus. The inner margin of each half is then notched once or twice, and then becomes again crescentic in outline, just behind the articulation with the palatine turbinals. The vertical middle portion of the palatines, at their coalescence, is full of large vacuities, the mesial line becoming more consistent where these bones coalesce with the triangular knife-like vomer. This bone (the vomer) is one-third of an inch long, the same at its base, convex in outline above, and concave below; the latter part having a round margin, whilst the former is sharp. The large coalesced palatines of this bird—each half of which, from its broad anterior origin, may be said to be plano-convexo-concave (the concavity on each side the mesial keel, and for an equal distance anterior to it, being very large)—form a very noble structure. No other bird seen by the writer has similar palatines. Those of the Boat-bill are distinct, broad, and flattened out, like the same bones in the Podargus, although in the latter bird they are coalesced. The vomer also is larger in the Boat-bill, and unites with the palatines on each side. In the large Adjutant the palatines are considerably less than in the Balæniceps, and are partly coalesced, but retain the type of structure common to the Storks and Herons, viz. a strong external and a sub-mesial keel to each bone, whilst the mesial line itself is concave below. In the Heron the palatines are very long and delicate, and are totally distinct from each other, except that at their middle they are tied together, as it were, by each of them sending an internal process forwards to be anchylosed to the vomer, which is here rather more developed.

In other fish-eating birds, where the motions of the upper jaw on the cranium are strong, we find that the coalesced palatines have the same essential structure as in the Balæniceps. In the Pelican, for nearly an inch, the palatines are flat, elastic, and quite separate; they then unite together, become stronger, have at first a thick, and then a thin margin, as in their hinder third they contract in width to articulate with the pterygoids. Between these thick margins a very strong keel is developed both above and below at the mesial line; and these keels run backwards, the upper to the articular surface on the basi-sphenoid, and the lower to the part where the pterygoids are attached. Behind the upper keel the palatines are scooped neatly to receive the basi-sphenoid, and behind the lower they are slightly notched. The end of each moiety of the bone, besides contributing to form the sphenoid groove, has two articular facets for each pterygoid, and there is a notch between the upper and lower facets. The palatines are nearly three inches and a half long in the Pelican. In the Cormorant and Gannet the structure is essentially the same; but they are long and parallel in outline, like those of the Heron. In these smaller Totipalmatæ the whole concave line of coalescence glides along the base of the orbital septum, just as in Balæniceps. In this great Heron (*Balæniceps*) we have a modification of the palatines not entirely unlike what is found in the Pelican, for the sake of strength and mobility in the upper jaw. In the Hornbill, as well as in the great Goatsucker, the palatines are coalesced; but this is an exceptional condition in birds. These bones are relatively small in Struthious birds, and they coalesce both with the maxillaries and the pterygoids in the Apteryx. In the Gallinæ they are mere flattened styles, just expanding at their distal extremities to send upwards and inwards a thin orbital plate; so that in these birds there is nothing startling in the idea of their being the ribs (pleurapophyses) of the nasal vertebra; nor would it be difficult, were we looking for cranial vertebræ, to suppose that the small simple bones (the pterygoids) attached to them behind were their appendages.

Pterygoid. (Pl. LXV. figs. 1 & 7 *p g.*)

The pterygoid of the Balæniceps is nearly an inch long, flat in the middle, clubbed at both ends, carinate above, and thicker and more rounded below, especially at the distal end; whilst the proximal end is marked with three ridges, one outside, one inside, and one beneath. The inside of the pterygoid, which is altogether the most concave, is scooped with three cavities, one in the middle, and one at each end; they communicate with pneumatic passages. The outer part of the proximal end has a slightly convex oblong condyle; the inner has three large and some smaller teeth, which fit into the end of the palatines. The distal end is obliquely scooped on its outside to form a shallow cup to articulate with the convexity of the os quadratum. Above this cup are some pneumatic holes, and above them a small spur, looking forwards. Synovial cartilage covers the oblong condyle at the proximal end, and lines the concavity at the distal, creeping on to the end of the bone. This small, oblong, thinnish, but really strong bone communicates the motion of the quadratum to the palatines, as the zygoma does to the premaxillaries. Were the same bone in the Heron magnified twice its size, it would be scarcely distinguishable from that of the Balæniceps. The pterygoids are almost ossified by the eleventh day of incubation in the Chick.

Os quadratum. (Pl. LXV. figs. 1, 3, 6 & 7 *q.*)

The os quadratum of the Balæniceps is a large, strong, quadrate bone, its upper side being $1\frac{1}{2}$ inch in extent, its posterior the same, its anterior $\frac{3}{4}$ inch, and the inferior side, measured in a straight line across the condyles that fit into the lower jaw, $1\frac{1}{4}$ inch. The large upper condyloid processes are 1 inch across; the outer appears externally, articulating with the squamosal, whilst the inner passes inwards and somewhat backwards, and partly encroaches on the par- and ex-occipitals. These upper condyloid processes are not, like the lower, completely covered with articular cartilage; for the cellular nature of the squamosal, petrosal, and occipital at this part allows them to touch the bone only at certain points, these more projecting parts being alone covered with articular cartilage: hence the discontinuity of that tissue on the head of the quadratum. The upper margin of the quadratum is sharp-edged and gently concave in outline; it expands a little at the anterior end to form the crescentic tip of the orbital process, which is a quarter of an inch across at its enlarged end. This orbital process is smooth and flat, gently convex externally and slightly concave within; it is at least two-thirds of an inch across at its junction with the body of the quadratum. The descending anterior margin of this part of the bone is considerably thicker than the upper, and it passes downwards and backwards for two-thirds of an inch. The bone then suddenly swells out internally, forms first the convex condyle for the distal end of the pterygoid, and then sends upwards and backwards a smooth crescentic ridge, with its concavity upwards, to the inner side of the posterior division of the great upper condyle. Above this ridge, at the centre of the inner face of the quadratum, there is a large sulcus, bounded above by a sharp ridge, and containing two or three large oval pneumatic foramina.

The external part of the quadratum is thick, smooth, and convex; but the outline from the anterior upper condyle to the deep round concavity for the nail-like process of the quadrato-jugal is concave. The distance between these parts is one inch, and the width at the surface of the cavity for the quadrato-jugal is nearly a quarter of an inch. Below this cup the bone expands to form the large posterior condyle for articulation with the mandible. This condyle passes backwards, inwards, and slightly downwards, being convexo-concavo-convex in its long diameter, and convex across. Nearly at right angles to the inner part of the posterior condyle, a double articular process passes equally forwards and inwards: its condyloid portions are nearly equal and parallel; but the outer lies on the lowest plane, whilst the inner, which is the smallest, terminates where the bone is elevated to articulate with the pterygoid. Between these large double condyles the base of the tympanic bone is smooth, concave, and pierced with several small pneumatic foramina.

Perhaps no English bird has a deeper 'gomphosis' for the posterior zygomatic articulation than the Common Heron; but a similar structure exists in the Storks and in many fish-eating birds, *e. g.* the Albatros, whilst this articulation is very shallow in the Pelican. In the Parrots it is moderately deep, and in these birds the orbital process is small; whilst the condyloid structures for articulation with the mandible are reduced to one large rounded crescentic internal ridge, with a small rudiment of an external articular process, just below the deep pit for the quadrato-jugal. Answering to this state of the quadratum, the mandible in these birds is deeply scooped to form an articular sulcus, which passes forwards, and slightly downwards, and inwards. The modifications of this bone in Birds, although gentle, as we pass from family to family, are nevertheless almost innumerable; yet it may be remarked here, that in Struthious birds they have none of that elegance which is so conspicuous in typical birds. Professor Huxley in his Croonian Lecture (1858) proves, from the labours of the great embryologists, Reichert, Rathke, and Goodsir, and also from his own researches, that this 'os quadratum' of Birds is the homologue of the 'incus' of Mammals, and of that lower articular portion of the great hyo-mandibular series of bones in the Fish, which has been named 'jugal' by Cuvier and 'hypo-tympanic' by Professor Owen.

Mandible. (Pl. LXV. figs. 1, 4 & 5.)

If the lower jaw of the Balæniceps were the only part of the osteology of this bird in our possession, the same element of the Boat-bill's skeleton would have sufficed for its interpretation. Yet the differences between the larger and the smaller bone are great, exactly answering to the modifications of the pre-maxilla in these two birds. The likeness and dissimilarity of these birds is something similar to that which exists between one of the smaller Antelopes, such as the Gazelle, and one of the massive species, *e. g.* the Eland. The necessary modifications in the structure of the skeleton required by *delicacy* on the one hand, and by *strength* on the other, are well seen in these two very congeneric species. The mandible of the Cancroma is just one degree stronger than that of the Giant Goatsucker (Podargus)—a bird whose relations, Caprimulgus and Cypselus, have the feeblest mandibles in the whole class, whilst the same bone in Balæniceps almost rivals the lower jaw of the Hornbills—birds in which this arch has its most massive growth. The *præ-maxilla* of Balæniceps is less outspread than that of Cancroma: but there is a reason in the structure of the bill in the former bird why the *mandible* should be still more narrowed; this is caused by the edge of this bone having to fit exactly in between the marginal and submarginal ridges of the upper jaw. Having been adapted in its anterior portion between these ridges, the rami diverge gently, so as to lie (in a vertical plane) outside the posterior half of the pre-maxilla, and also outside the zygoma to its end. Hence the lower jaw of the Balæniceps is in outline much less like the Magnolia leaf; it is more triangular, and keeps gradually widening for the anterior three-fourths of its length, when it takes a gentle turn inwards for the rest of its extent. In Cancroma the mandible is almost exactly adapted to the pre-maxilla at its edges, just passing within the margin as it approaches the zygoma; its lower thick part only lying a little outside that arch. This is very much like what takes place in the Goatsuckers, large and small. Moreover the tips of the pre-maxilla and mandible are not notched or emarginate in Cancroma, whilst they are very decidedly so in Balæniceps, especially in the latter organ. The extent of the confluent symphysis mandibulæ is much greater in proportion in the large bird than in the smaller one, as will be seen below, in a tabular comparison of this part in several species of birds. In Cancroma the dentary elements of the mandible (which form more than two-thirds of the rami) are quite distinct from the articular and angular portions, and the angular elements are scarcely confluent with the articular. None of these sutures exist in Balæniceps; although, from the analogy of its congeners, it must have had all the twelve centres of ossification, in its young state, that are found throughout life in the Crocodile. This *mammalian* solidity of the lower jaw is found in but few birds, *e. g.* the Parrots, Hornbills, and Toucans. The sharpest part of the edge of the mandible in Balæniceps is the first inch and a half; it then becomes more and more blunt and rounded, until we arive at that thick, rough, elevated posterior end of the dentary which seems to have worn away the margin of the maxilla at its zygomatic end. The mandible at this part rises to an obtuse angle, and is here $1\frac{1}{3}$ inch high, or deep, whilst its thickness here is more than one-third of an inch, lessening to one-eighth towards the smooth rounded inferior margin. A row of vascular holes lies a little below the upper margin all along the dentary element; and the whole of the part which is covered with strong horn is grooved and rough, especially towards the upper part. A rough thick margin also passes within the ramus below; whilst the inner surface, although richly dendritic with vascular grooves, is smoother than the outer. Three-fifths of the lower margin of the jaw is rough and covered with horn; the thickened tubercular structure then passes upwards, almost parallel with the upper margin of the jaw, but converging slowly to meet and blend into that margin at the most elevated part of the mandible. There is, towards the end of the symphysial line above, a triangular fossa, passing on each side into an inner submarginal groove, which groove slowly becomes obsolete in the posterior inner part of the dentary[1]. All that posterior part of the mandible which is not covered with horn is very smooth and polished, both without and within. The thickness of the dentary part of the mandible is pretty uniform, averaging about five lines—the thickest or widest part being at the symphysis. The height is very uniform for the first three inches, being about half an inch; it then gradually increases, until at the zygoma it is one inch and a third. The upper edge of the mandible at first rises for one-third of an inch; it then forms one gentle concave sweep to nearly the highest point; the ideal basal line to this arc being $5\frac{2}{3}$ inches in extent, and the mid-portion of the arc three-fifths of an inch from this basal line. From the gradual rise of the upper margin, and the increasing depth of the jaw behind, the outline of the lower margin is not so convex as the upper is concave.

The extent of the symphysis is $1\frac{1}{6}$ inch; it is grooved below, and above has at first a convexity, then a slight keel, whilst the latter third is occupied with the triangular fossa above mentioned. Behind the highest part on the upper margin the bone descends, at first slowly, then rapidly, to the external articular facet, which, more than three-fourths of an inch in extent, passes backwards and inwards. The widest part of this facet is the middle, which is also the most convex; the narrowest and most concave part is the inner. Anterior and interior to this is the deep double articular sulcus for the anterior condyles of the quadratum; the deepest and longest of these twin sulci is the external. They are together nearly half an inch across, and their anterior margin $1\frac{1}{3}$ inch from the posterior edge of the outer articular surfaces. These exquisitely-cut and adapted surfaces answer, as will be seen at once, to the lower condyles of the os quadratum.

The internal angular process projects inwards and backwards half an inch from the innermost articular groove; a ridge passes across and connects it with the posterior end of that groove, and behind this ridge there is a large oval pneumatic foramen

[1] This fossa, and these diverging grooves are imprints of a very important embryological structure; they show where the cartilages of Meckel ran and met each other (*infra*, p. 315).

leading to the rich diploë of the light, expanded, articular portions of the jaw. Several other pneumatic holes lie in the deep smooth concavity between the articular facets; and there is here and there a larger passage of the same nature on the internal face of the broad part of the ramus. The posterior angle of the jaw is half an inch below and a little behind the external articular facet; this angle is tubercular, and soon loses itself in the strong convex inferior margin of that flat, crescentic, smooth end of the mandible, the inner extremity of which has been described above. This broad end of the mandible, which passes a little forwards as well as inwards, is $1\frac{1}{3}$ inch in extent; and here the two inner angular processes of the opposite rami are only two-thirds of an inch apart. The large vascular foramen (inferior dental) is within, and half an inch behind the highest coronoid part of the jaw; it has a tubercle for muscular attachment close above it, another behind, and another still larger on the external margin, one-third of an inch external to it. The smooth, rounded, narrow inferior edge of the hinder part of the mandible, at $1\frac{1}{2}$ inch from the end, swells out and rises gently, becoming again slightly carinate as it nears the external angular process.

Subjoined is a Table of comparative measurements showing the length of the mandible measured along the curve, and the extent of the coalesced symphysis, in different birds, in inches and lines (or twelfths of an inch); also their proportion to each other.

	Length of Mandible.		Length of Symphysis.		Proportion.
	in.	lines.	in.	lines.	
Caprimulgus europæus . .	1	6	0	$\frac{1}{2}$	$\frac{1}{36}$
Podargus humeralis . . .	2	8	0	$1\frac{1}{2}$	$\frac{1}{21}$
Cancroma cochlearia . . .	4	8	0	$3\frac{1}{2}$	$\frac{1}{16}$
Balæniceps rex	8	6	1	2	$\frac{1}{7}$ nearly.
Ardea cinerea	6	3	1	3	$\frac{1}{5}$
Ciconia argala	15	4	4	8	$\frac{1}{3}$ nearly.
Buceros bicornis	11	8	7	8	$\frac{2}{3}$
Macrocercus ararauna . .	2	6	1	1	$\frac{2}{5}$
Calyptorhynchus naso . .	2	4	1	0	$\frac{1}{2}$ nearly.
Diomedea exulans . . .	9	6	0	10	$\frac{1}{11}$ nearly.
Platalea leucorodia . . .	8	0	2	8	$\frac{1}{3}$
Pelecanus onocrotalus . .	17	9	0	3	$\frac{1}{71}$

We see by the above table that the symphysis, in the Common Goatsucker, is twice as long, in proportion to the length of the jaw, as in the Pelican, and that the Boat-bill is four and a half times as strong at that part of the jaw, whilst the Balæniceps has just ten times as much symphysis as the Pelican. *Buceros bicornis* is quite without a peer in this part of its anatomy, although the Parrots come very near it. The relative length of the dentary portion of the mandible to the entire ramus is another very important point in the anatomy of the Bird's head; for, as a rule, the strong horny sheath reaches to the posterior end of this element of the mandible.

In the next table the length of the mandible is put into parallelism with the extreme length of the dentary, which overlaps the articular moiety of the ramus at its posterior end.

	Entire Ramus. in.	lines.	Dentary. in.	lines.
Caprimulgus europæus	1	6	0	$10\frac{1}{2}$
Podargus humeralis	2	8	1	10
Cancroma cochlearia	4	8	3	6
Balæniceps rex	8	6	7	0
Ardea cinerea	6	3	4	6
Ciconia argala	15	4	13	0
Buceros bicornis	11	8	10	0
Macrocercus ararauna	2	6	1	2
Calyptorhynchus naso	2	4	1	2
Diomedea exulans	9	6	7	0
Platalea leucorodia	8	0	7	3
Pelecanus onocrotalus	17	9	6	9

Here it will be seen that the relative length of the dentary is, as a rule in birds with long bills, in direct proportion to the strength of the jaw, and that the Little Goat-sucker has in this respect the advantage of the Pelican; for both the dentary bone and the symphysis are larger in relation to the rest of the jaw in the little bird than in the great one. In *Caprimulgus* the dentary reaches more than halfway towards the end of the ramus, whilst in the Pelican it reaches very little above one-third. In *Buceros bicornis* five-sixths of the jaw is dentary, and in *Balæniceps* it bears the proportion of seven to eight and a half. In the Parrot tribe, the unique state of curvature of the upper jaw, which passes down in front of the mandible, causes that organ, especially the dentary part, to be short; but here what is lost in length is gained in depth, and the jaws of these birds are amongst the strongest in the class. The number of ossific centres in the mandible of birds can be seen only in young specimens, although a great proportion of the class retain parts of the sutural lines—the bones at these places being thin and elastic. But we have seen that whilst complete coalescence of these parts is the rule in such families as the Parrots, the Hornbills, and the Toucans, yet the Balæniceps is very peculiar, in its own group, in possessing this structure.

Professor Owen does not mention the existence of the 'coronoid' bone in the mandible of the young Ostrich; nor have we seen it in that bird, nor in the young Emeu. The same may be said of Owls, Pigeons, Gallinaceous birds, and the Crow tribe. In a very beautiful skeleton, however, of the Australian Jabiru, *Mycteria australis*, at the British Museum[1], this piece has a very similar size and form to that of the Crocodile, and is quite distinct, although coalescence has taken place to a very considerable extent in the other elements of the mandible.

In the Boat-bill it appears to have been large, but coalescence has defaced all but its anterior boundary, although probably it was distinct in the young bird; and as that part of the jaw is extremely well developed in the Balæniceps,—most likely in it too.

In the Heron it is large, and can still be traced even at the posterior part of its upper

[1] Prepared by Mr. E. Gerrard.

and lower margin, where it has contracted adhesion with the sur-angular and angular pieces: here it is lozenge-shaped, whilst in the Jabiru it is reniform.

The development and condition of the coronoid in the Adjutant is very much like what obtains in the Heron; the Albatros also has the same element large, and although bony union has taken place between it and the sur-angular above, as also with the articular and angular behind and below, yet its outline is easily traced. In Cranes and Geese the thin splint-like oblique 'coronoid' is either connate, or has coalesced with the 'articular' behind. In *Grus americana* there is an oblong membranous space anterior to the inferior dental foramen; in the Rook this space is oval, and is behind that passage; Passerine birds and Owls have a similar structure, but the Diurnal rapacious birds have a stronger and more completely ossified mandible. In the Little Goatsucker, *Caprimulgus europæus*, the articular moiety of the lower jaw is thick and cellular, compared with the dentary; it has no membranous part, and being curiously bowed outwards, the dental foramen enters it on the lower margin. Such modifications (which are endless, and in each case beautifully adapted to the life of the bird) are here mentioned only to show that the massive development of the mandible of the Balæniceps is to a great extent teleological. The embryological researches of Reichert and Rathke have proved that the articular element of the Bird's mandible is the ossified proximal end of Meckel's cartilage, and is the homologue of the 'malleus' of Mammals: see Professor Huxley's Croonian Lect. p. 16.

Development of the Mandible.

We must refer the reader to the excellent writings of Professors Goodsir and Huxley for an account of the morphological meaning of the mandible in birds and in vertebrates generally; the views of the former author will be found in the papers so often referred to (p. 173), and those of the latter in the Croonian Lecture (p. 16).

It must, however, be borne in mind that the mandible belongs to the same sclerotome as the squamosal and petrosal. Meckel's cartilage has attained its largest development in the Chick by the eleventh day of incubation, but it has become separate from its fellow of the opposite side at the distal end. The proximal cartilage (the 'quadrate') of this, the first proper facial arch, has begun to ossify in its thickest part at this time, but the 'articular' (or 'malleal') portion is entirely cartilaginous. The dentary elements are not only ossified, but, getting the start of the pre-maxillaries, they have become fused together at the symphysis. The angular and sur-angular pieces are also ossified; but the 'splenial' is still membranous; and there is no 'coronoid' in the Fowl. All the mandibular elements except the articular are formed (like the pre-maxillaries) in perichondrial membrane. From the fourteenth to the nineteenth day the cartilages of Meckel are seen to be wasting fast, just as the ethmo-vomerine process for the pre-maxillaries does. At the end of the second week of incubation the 'splenial' element is ossified, and there is a small square osseous centre in the thick 'articular' portion of

Meckel's cartilage. The external angular process is principally ossified from the 'angular' element (but it derives its cartilaginous base from Meckel's cartilage); the internal angular process is ossified directly from the 'articular.' All these processes may be seen equally well in the Pigeon or any common bird. Meckel's cartilage lasts a long while in the Chelonia and Batrachia. In osseous Fishes it becomes large, and is often persistent. In the Chondropterygii there are no distinct osseous elements formed upon the simple mandibular cartilage.

Tympanic Bone.

Before entering upon the description of the spinal column of Balæniceps, it is necessary for us to say a word or two about the tympanic bone.

The writer quite agrees with Köstlin, Goodsir, and Huxley, that the quadratum of birds is the homologue of the mammalian incus; if this is the case, where do we find the counterpart of the mammalian tympanic? Professor Huxley says[1], very truly, "that the tympanic of the Mammal does *not* articulate with the lower jaw, nor with the pterygoid, nor with the jugal or quadrato-jugal." Seventeen years ago we came upon a bony piece in the skull of a Pea-hen, which was carefully drawn at the time, and although examined and thought on again and again, it still continued to be an enigma,—the quadratum (as we were taught) standing for the homologue of the tympanic. Renewed study, however, of the development of the skull in Birds and other Vertebrata, by various labourers, having restored the quadratum to its proper category, we are now at liberty to reconsider and to classify our nameless bone.

This osseous piece of the skull of *Pavo cristatus* is of a spatulate shape, and is attached to that part of the auditory opening which is formed by the descending (paroccipital) ala of the occipital bone, just where it is confluent with the posterior angle of the squamosal. The narrow posterior end of the bone being thus articulated, the broad anterior part, which is somewhat notched and bifid, passes forwards and outwards, protecting the membrana tympani, and partly serving to give origin to that membrane at its posterior superior margin. The length of the bone is three lines, and its greatest breadth two lines, so that it is sufficiently large to protect the membrana tympani for two-thirds of its extent at its upper margin. The attachment and relations of this ossicle exactly agree with those of the tympanic bone of Mammalia, and its notched broad anterior margin appears to us to foreshadow the condition of the tympanic in the Human fœtus and in the adult Shrew and Echidna. We have searched in vain for this bony piece in any other bird, although the skulls of a great number have been examined. Hoping to find this bone again, at least in the Gallinæ, we have made fruitless search for it in the skulls of the undermentioned Gallinaceous genera; yet it may have been lost in those skulls that were prepared by maceration, and even in natural skeletons such a piece of bone would easily be dissected away, so that future

[1] Croonian Lecture, p. 15.

research may perhaps be rewarded by the discovery of this interesting element in other genera besides *Pavo*. The genera in which no tympanic has been found are—*Gallus*, *Phasianus*, *Meleagris*, *Oreophasis*, *Numida*, *Tetrao*, *Lagopus*, *Talegalla*, *Perdix*, *Coturnix*, *Hemipodius*, and *Pterocles*[1]. In the Common Green Woodpecker, *Picus viridis* (a solitary, shy, suspicious bird), we find very beautiful tympanic bullæ, as large in proportion to the skull as in ordinary Mammalia. These ear-drums are exceedingly like a pair of small cowrie-shells (*Trivia*), the oblong hourglass-shaped opening looking downwards and a little outwards. The posterior end of the opening, which is the narrowest, does not reach to the extremity of the bulla, but the wider anterior end is open and receives the posterior condyloid process of the os quadratum. The inferior part of the bulla is the most dilated, and its edge is the most incurved. This incurving of the edges, as well as the smooth surface and oval shape, give the bone its peculiar cowrie-like appearance. The upper part of the bulla of the Woodpecker appears to be formed by an ossification downwards and forwards from the squamosal and ex-occipital at their point of coalescence; the lower part would appear to be formed by an ossification forwards of the ex-occipital, the inner margin of which becomes anchylosed to the side of the basi-sphenoid. If, however, an opportunity occurs for us to examine this part in an embryo of the Woodpecker, we shall very probably find a separate tympanic ossicle of a V-shape; which would come still nearer to the U-shaped tympanic ring of Mammalia than the emarginate tympanic of the Pea-hen. The Common Duck has its tympanic cavity nearly as well developed as it is in the Woodpecker.

Os hyoides. (Pl. LXVI. fig. 2.)

The Balæniceps has a very small tongue, as is also the case in the Pelecanine birds, so that all that exists of the second facial arch is a small triangular basi-hyal (Pl. LXVI. fig. 2 *b h*) (not one-third of an inch long, and less in width), and a small subcylindrical uro-hyal, about one-sixth of an inch in length. The two pieces of the thyro-hyals (Pl. LXVI. fig. 2 *t h*) belong to the third facial or *branchial* arch (the first post-cranial arch), and are moderately developed; they measure together rather more than three inches and a half. The proximal piece is thin and scooped on its upper surface; the distal, smaller portion is round, and gradually decreases towards the end, which is tipped with cartilage.

Professor Goodsir (*op. cit.* p. 176) says that "in the second visceral lamina of the Bird the auditory columella is developed superiorly, and the feeble anterior horn of the hyoid below, while the elements of the suspensory or posterior horn of the hyoid are formed in the third visceral lamina."

At the end of the second week of incubation, the large proximal piece of the thyro-

[1] Since the above was written we have carefully prepared several skulls of each of the following species of *Gallinæ*, viz. *Gallus domesticus*, *Phasianus colchicus*, *Meleagris gallo-pavo*, *Tetrao tetrix* and *T. cupido*, *Perdix rubra* and *cinerea*, *Lagopus scoticus* and *Coturnix dactylisonans*; only in the Turkey and Grey Partridge do we find a rudiment of the tympanic, and that not constantly. It does not exist in *Crax globicera*.

hyal is nearly ossified in the Chick; but the small triangular glosso-hyal, the short terete divaricating cerato-hyals, the basi- and uro-hyals, as well as the distal thyro-hyal, are all entirely cartilaginous. In the Pigeon, at the time of hatching, we have the same state of things. In many birds the glosso-hyal, and the tips of the uro-hyals and thyro-hyals (distal pieces) remain cartilaginous.

Sclerotic Bones and Columella.

The sclerotals form a ring $1\frac{1}{6}$ inch across; their largest pieces are about a quarter of an inch wide: they are well-ossified. The 'columella' has not been preserved in this specimen; and the complex structures of the internal ear are formed principally by the petrosal, yet impinge upon and are partly formed by the surrounding bones, *e. g.* the epiotic and the mastoid portion of the ex-occipital. The basi-occipital and basi-sphenoid also contribute some part of their substance to the formation of the hard parts of this sense-organ.

Recapitulation of the Cranial 'Elements.'

We will retrace our steps a little, and look again at the constituent parts of the skull and face.

It is very convenient to consider the skull as a 'sys-sclerotome,' divided into a certain number of 'sclerotomes.' This method is more convenient than safe; but we will, as much as possible, avoid theorizing; yet we cannot, we think, go very far wrong if we consider what amount of segmentation is to be seen along the base of the most perfect skulls, *e. g.* those of the Mammalia.

In these creatures we have, from behind forwards, four basal parts or 'centra,' viz. the basi-occipital, the basi-sphenoid, the pre-sphenoid, and the mesial portion of the ethmoid; this latter bony mass having appended to it in front a large vertical cartilaginous apophysis, the ethmo-vomerine cartilage, whilst the thin cortical 'vomer' is related to it (indirectly) below. That great modern anatomist whose mind is most opulent in knowledge of these structures, Professor Owen, has only been able to make out four 'vertebræ' in the skull of the Vertebrata. Whilst we use Professor Owen's 'homological' terms for the cranial 'elements,' we still consider them only the 'analogues,' and not the true 'homologues,' of the pieces that go to make up a corporal vertebra. Moreover we shall find that the lateral and upper pieces do not correspond in number to the basal, and that the same bone may be a 'neurapophysis,' a 'diapophysis,' or a 'sense-capsule.' Whatever we may call this confusing abundance of upper and lateral pieces, whether segmentation, 'vegetative or irrelative repetition,' or 'intercalation of splanchnic bones' or 'sense-capsules,' we are still under the necessity of referring back to the unsegmented primary skull of the embryo; and any attempt to explain the nature of the skull which shall not be based upon a very extended 'embryology' will turn out to be mere waste of time.

Occipital Sclerotome in the Vertebrata.

1. The centrum or basal part—the ' basi-occipital.'
2. Infero-lateral elements—the ' ex-occipitals.'
3. Supero-lateral elements—the ' mastoids.'

N.B. These elements coalesce very early with the petrosal in Mammalia generally; but in the smaller Cheiroptera, *e. g. Vespertilio*, *Plecotus*, and *Molossus*, they coalesce with the ex-occipitals, and remain quite distinct from the petrosals. In many, if not most Birds, the mastoids are not distinct from the ex-occipitals, the outer margins of these bones having a ' periotic function.' In Chelonia the mastoids are large and permanently distinct; but in the Crocodilia and Ophidia they coalesce very early with the ex-occipitals; in the Lacertilia they are often distinct, but small; whilst in the Batrachia they are not distinct from the ex-occipitals. In Fishes the mastoids are often distinct, and are very large in the Gadidæ.

4 *a*. Supero-mesial elements—the inter-parietals.

N.B. These are evidently often formed from a pair of lateral elements in the Mammalia. The single piece in the adult is largest in the ' lissencephalous ' mammals, *e. g. Mus, Talpa.* In Birds they do not exist. In the Abranchiate Reptilia the inter-parietal is single, and coalesces very early with the supero-sub-mesial elements. They have no separate existence in ordinary Batrachia. In Fishes the inter-parietal is single and generally remains distinct.

4 *b*. Supero-sub-mesial elements—the ' squama occipitalis,' or the ' epiotics.'

N.B. These elements form the principal parts of the supra-occipital region in the Mammals, and may be developed from a pair of lateral centres. In Birds their inner margin is thin and squamous—the outer margin taking on the ' epiotic ' function; they coalesce very early, or are originally single in this class. In the Abranchiate Reptilia they are small as compared with the inter-parietal, and very early coalesce with it. In Fishes they are generally distinct, and are filled with the upper part of the semicircular canals.

Post-sphenoidal Sclerotome.

1 *a*. The centrum or basal part—the ' basi-sphenoid.'

N.B. This developes a very long exogenous ' rostrum ' in typical Birds, and a short upper rostrum in Crocodilia and Chelonia.

1 *b*. Cortical inferior elements—the ' basi-temporals ' (nobis).

N.B. These coalesce very early with each other and with the basi-sphenoid in Birds. They probably exist in the embryos of the higher Reptilia; for to us it is evident that in struthious Birds, and in all the cold-blooded Ovipara, the great ' rostrum ' is a cortical ossification.

2. The posterior infero-lateral elements—the ' petrosals.'

N.B. These are amongst the most constant cranial elements in all the Vertebrata, and are the most important of the 'periotics.'

3. The anterior infero-lateral elements—the 'ali-sphenoids.'

N.B. These elements are very constant in Mammals and Birds. They are large in the Crocodilia, but feeble and inconstant in the rest of the Abranchiate Reptilia. They are not ossified in the Batrachia, and are generally very small in osseous Fishes.

4. The supero-lateral elements—the 'squamosals.'

N.B. These elements are large and well-developed in Mammalia, Birds, and Abranchiate Reptiles; they are scarcely differentiated in the Batrachia, and they are large and constant in the osseous Fishes.

5. Upper elements—the 'parietals.'

N.B. These are very constant throughout the Vertebrata, but are separated from each other in certain Carnivora, and in some osseous Fishes, by the inter-parietal.

The Pre-sphenoidal Sclerotome.

1. The centrum or basal part—the 'pre-sphenoid[1].'

N.B. This element, distinct and normal in the Mammalia, is high and compressed in Birds. It is not ossified, as a rule, in the Reptilia, but, according to Goodsir, forms part of the bony septum of the 'os en ceinture' in Snakes and Frogs: it has no distinct osseous representative in Fishes; the interorbital septum in this latter class being an orbito-pre-sphenoid.

2. The infero-lateral elements—the 'orbito-sphenoids.'

N.B. These elements—usually well-developed in the Mammalia, but extremely feeble in the Mole—are short and connate in Birds even when they have a distinct osseous centre[2], which is not always the case. In the Chelonia, Crocodilia, and Lacertilia they are fibro-cartilaginous, and appear to have no centre of their own in the Ophidia and Batrachia. They are generally unossified in Fishes.

3. The supero-lateral elements—the 'post-frontals.'

N.B. These elements are exogenous in Mammals, and, with one or two rare exceptions, they are not distinct in Birds. They are well developed in Crocodiles,

[1] In our description of the pre-sphenoid we have followed Professor Goodsir (*op. cit.* p. 154); if, however, Cuvier, Hallman and Huxley be right, not only the detached ossifications anterior to the 'hinge,' but also the upper and anterior portion of the great inter-orbital ossification, is essentially ethmoidal in its nature.

[2] Dr. Hallman (Die Vergleichende Osteologie des Schläfenbeins, Pl. I. fig. 2) represents the Goose as having a distinct V-shaped osseous centre for the orbito-sphenoids. In the African Ostrich there is one large osseous centre, an 'orbito-pre-sphenoid' exactly as in the Carp; whilst in the young Emeu of the sixth week after hatching, the posterior margin of the orbito-pre-sphenoidal cartilage is already ossified,—a condition precisely like what is seen in the half-grown Pike. Recent observations on Birds scarcely mature have yielded us a distinct osseus pre-sphenoid, with exogenous orbital alæ, in very many species: its absence is quite exceptional.

Chelonians, Lacertians, Ophidians, but not in the common Batrachia, *e. g. Rana, Bufo*. In osseous Fishes they are large and well-developed.

4. The superior elements—the 'frontals.'

N.B. These constant bones are often the largest of the cranial elements in the oviparous Vertebrata.

The Ethmo-vomerine Sclerotome.

1 *a*. The basal part or centrum—the 'ethmoid.'

N.B. The mesial part of the ethmoid in Mammals, including the 'crista galli,' is the central element of their most anterior sclerotome. In Birds this central piece is very variably developed, and soon coalesces with the pre-sphenoid in the Struthionidæ. In Crocodiles, Chelonians, Lacertians, and indeed in most Reptiles (except in some extinct forms, *e. g. Dicynodon*) (Huxley, Quart. Journ. Geol. Soc. vol. xv. pl. 22. p. 655), it is cartilaginous or membranous; and the same might be said of the Ophidians and Batrachians, if Professor Goodsir's views were correct[1]. In osseous Fishes it is usually ossified,—from one centre in most species, but from two in the giant Sudis, and in the little Smelt (*Salmo eperlanus*).

1 *b*. Cortical element or elements—the single or double 'vomer.'

2. The internal-lateral elements—the 'pre-frontals.'

N.B. These form the lateral masses of the 'ethmoid' in Mammals, are often cartilaginous in Birds, and are distinct and large in the Crocodiles and Batrachians; but in the Chelonians, Lacertians, and Ophidians they coalesce, or are connate with the 'lacrymals.' They are large and distinct in osseous Fishes.

3. The external lateral elements—the 'lacrymals.'

N.B. These bones are generally distinct in Mammals: there is scarcely an exception to this rule in Birds: they are large and distinct in Crocodiles; in the rest of the class of Reptiles they are not, as a rule, distinct from the pre-frontals. In Fishes they form the sub-orbital chain of bones.

4. The superior elements—the 'nasals.'

N.B. These pieces generally meet each other at the mid-line, and are sometimes single, in Mammalia; in the Manatee they do not meet; nor do they, as the rule, in Birds—the Rhea and the Pigeons being exceptional. In Crocodiles they are distinct and meet as in Mammals, but are seldom distinct from the pre-fronto-lacrymal in Chelonia. In Lacertians they may be single or double; in Ophidians they are large and meet on the mid-line; in Batrachians and in osseous Fishes they are small and widely apart.

We have already spoken largely of the elements of the lower parts of the face: for

[1] A careful investigation of the development of the ethmo-vomerine axis in Birds will, we have no doubt, fully explain the meaning of this part of the skull in the Ophidians and Batrachians; to us it appears that it is the pre-sphenoid which is abortively developed in all the lower Vertebrata.

the signification of these parts we refer the reader to the translation of Müller by Baly (1843, vol. ii. p. 1616), and to Professor Huxley's Croonian Lecture.

Vertebral Column. (Pl. LXVI. fig. 1, 3, 4, 5, 6 & 7.)

In studying the corporal vertebræ of the Balæniceps, we shall follow Professor Owen's plan, and consider all those vertebræ "'cervical' in the Bird that extend from the skull to the first vertebra with the hæmal arch complete, and those 'dorsal' that extend from that vertebra inclusive to the first vertebra embraced by, and anchylosed to, the iliac bones[1]." And again, "All those vertebræ may be called for convenience 'sacral,' in the Bird, which are confluent both by centrums and neural arches with each other and with the iliac bones." The remaining vertebræ are 'caudal,' and the last of these is formed of several embryonic vertebræ which are very imperfect in their development, become coalesced together, and are modified for their special function[2].

We here subjoin a Table of the number of vertebræ in the spinal column of different birds—some nearly related to the Balæniceps, and others from very distantly-related families.

	Total number of cervicals.	Number of cervicals with distinct pleurapophyses—floating ribs.	Number of true dorsals.	Number of vertebræ with ribs that articulate with hæmapophyses, most of which reach the sternum	Number of sacral vertebræ.	Number of free sacral ribs on each side.	Number of distinct caudal vertebræ.	Total from occiput to the end of the coccyx.
Balæniceps rex . . .	17	2	4	5	17	1	6	44
Cancroma cochlearia .	15	4	4	5	14	1	8	41
Ardea cinerea . . .	19	3	4	5	14	1	7	44
Ciconia argala . . .	17	2	4	5	15	1	7	43
Ciconia alba	17	2	3	5	15	2	7	42
Grus americana . . .	19	2	6	8	17	2	7	49
Phœnicopterus ruber .	18	2	5	6	13 or 14	1	9	?45
Grus pavonina . . .	20	2	6	7		1	6	
Psophia crepitans . .	18	2	6	7	17	1	6	47
Parra jacana. . . .	16	3	4	5		1	7	
Fulica atra	15	1	7	8		1	9	
Cygnus olor	25	2	5	9		4	8	
Anser palustris . . .	18	1	5	7	18	3	7	48
Anas boschas	16	1	5	8	17	3	8	46
Pelecanus onocrotalus .	17	1	4	5		1	7	
Dromaius ater . . .	21	3	5	5	22	1	9	57
Caprimulgus europæus .	13	2	4	6	12	2	7	34
Alcedo ispida . . .	15	2	4	5	13	1	7	39
Cypselus apus . . .	13	2	4	6	11	2	8	36
Accipiter nisus . . .	15	3	5	7	15	2	8	43
Falco æsalon. . . .	15	3	5	6	14 or 15	1	8	?43
Trochilus colibris . .	14	1	5	7	9	2	6	34
Passer domesticus . .	14	1	5	6	12	1	7	38

[1] Nature of Limbs, p. 103.

[2] The absolute number of vertebræ in any bird can only be ascertained by examining the spinal column at a very early stage: in some cases the last caudal is a compound bone formed of at least ten embryonic vertebræ.

This table of the numerical relations of the vertebral columns of certain birds, several of which birds are related to *Balæniceps*, will be referred to more than once in the description of this part of the skeleton. The great difficulty has been in enumerating the sacral vertebræ; but much care has been taken to examine sections and immature specimens; and where these have not been obtainable, the twin nerve-outlets on each side have been carefully counted. In some cases a doubt has been expressed; and in others, rather than err, we have left out the number in that column. The most important birds for comparison with the Balæniceps are those Grallæ which have short but compressed bodies, or short, stout, robust bodies, with only five pairs of thoracic hæmapophyses, the last pair of which may reach the sternum, as in the *Ciconiæ*, the Balæniceps having the same structure, or may be floating and imperfect, as in *Ardea* and *Cancroma*. The latter birds, as well as those of the genera *Aramus*, *Scopus*, *Botaurus*, *Nycterodius*, *Erodius*, and *Balæniceps*, have the chest flat, or compressed, whilst the *Ciconiæ* and *Mycteriæ* have a round full-shaped body. In the more distantly-related Cranes, and in the still more unrelated Gallinules, Rails, and Coots, the thorax is long as well as compressed, the compression being greatest in the latter group.

Flat compressed bodies are the rule amongst the Grallæ, the Rallidæ carrying that character to its extreme condition, whilst most of the Palmipeds have broad depressed bodies. The extreme of this opposite character occurs in the genera *Podiceps* and *Colymbus*.

We see by the above table that the Balæniceps has the same number of vertebræ in the entire spine as the Heron, three more than the Boat-bill, one more than the Adjutant, and two more than the White Stork. The diminution of the number of vertebræ in the Boat-bill is explained by its being a small and comparatively feeble form of the same type; for, other things being equal, a large bird has a greater number of vertebræ than its smaller congeners; and small birds, generally, have relatively shorter spines than large ones—the neck and sacrum being the parts in which this diminution most takes place. A glance at the table makes this clear, although the instances are but few; yet they could have been multiplied indefinitely. However, it is worth while to remember that the little Humming-bird has only thirty-four vertebræ in all; the Swift (best of fliers) only thirty-six; whilst the Emeu has fifty-seven. It is not intended to say here that the three last-mentioned birds are in the least congeneric; yet the rule will be found to hold good, as a general principle, in families as well as in the broad class.

Looking at the skeleton of this great Wader, we see one of the most striking instances of an aberrant form, conformable in all essentials to its type, and yet having structural affinities with all the families that lie in the region round about that central type.

When the skeleton has been described, and the curious affinities of the bird, whether patent, or more secret, have been shown, then perhaps some attempt will be made to prove that the Balæniceps is only one amongst many wanderers from typical restraint, and that all these *aberrants* are still 'under law.'

The cervical vertebræ of the Balæniceps are relatively stronger and shorter than those of the great Adjutant, whilst they form a remarkable contrast to those of the Heron—a bird which not only has more of these joints than its relations, but in which the individual vertebræ are exceedingly long and narrow. The difference between the structure of the neck in the typical Heron and in the Balæniceps is remarkably like what we see in the Mammalia, when we contrast the cervical vertebræ of the Vicugna with those of some large Stag, such as the Wapiti, or the Sambur Deer. The large, broad, spoon-shaped jaws and the flat head of the Boat-bill require a shorter neck and individually shorter vertebræ than those of the Heron with its long narrow cranium, and its narrow, straight, tapering, pointed mandibles.

Yet in nothing but in the decrease of number and the shortening of each joint do the cervical vertebræ of *Cancroma* differ from those of *Ardea*; whilst all the change that has taken place between those of *Balæniceps* and *Cancroma* is that in the former two vertebræ have been added, and the relative as well as real strength of each bone greatly increased.

Atlas. (Pl. LXVI. figs. 1, 3, 4 *at.*)

The atlas is small, as in all birds, and its 'procœlian' cup for the articular condyle of the occipital bone is large in proportion. This cup is imperfect, a large crescentic piece being cut away, as it were, from the top, to make room for the 'odontoid' process, which process, although ossified to the axis, in reality belongs to the atlas, being the internal or 'diaphysial' part of its centrum. Behind where the upper edge of the cup is cut away, there are two small articular facets of a semi-elliptical shape for articulation with the sides of the tip of the odontoid process. In *Balæniceps* and its allies there are no foramina for the vertebral arteries on the sides of the atlas. The post-zygapophyses of the atlas send backwards a rather broad triangular process for muscular attachment: these are obsolete in *Cancroma* and the Small-headed Heron; but they are largest in the Adjutant, in which bird they divaricate outwards. The posterior articular surface of the centrum of the atlas is of the usual U-shape, and the inferior surface is marked in its latter half by one mesial and a pair of lateral tubercles. The upper concave aspect of the centrum is full of small pneumatic holes.

Note.—In the Woodpecker and other arboreal birds, the cup of the atlas has a very perfect rim, but it is perforated below for the passage of the odontoid ligament; here also the vertebral arteries are bridged over. In the young Emeu the lower or 'hypophysial' part of the atlas is distinct from the neural arch as well as from its odontoid element. *Query*, does not this part of the Bird's centrum answer to the marginal parapophyses of the abdominal vertebræ of the Fish, as well as to the mesial hypapophyses of the Vertebrata generally?

It is not easy to draw a line between these processes or elements (which are so seldom autogenous), and to say where one begins and the other ends; at any rate the lateral processes of the base of the atlas are the homotypes of the parapophyses of the succeeding vertebræ, whilst the mesial tubercle is a rudimentary 'hypapophysis.'

Axis. (Pl. LXVI. fig. 1 *a x.*)

The 'axis' of *Balæniceps* is a short, high, swollen bone,—the low neural spine, the small hypapophysis, and the large post-zygapophyses being very cellular. The short odontoid process is flat above and convex below, having at each side near the tip an inferior facet to articulate with the atlas behind the rim of the cup. There is a distinct neck to this process, which is very cellular, as is also the front of the centrum between the branches of the U-shaped articular surface, corresponding with the posterior aspect of the atlas. The pre-zygapophyses are small, and lie on the margin of the neurapophysis; the post-zygapophyses are subtriangular, large, and concave. The posterior articular facet of the centrum is perfectly ornithic, being convex from side to side, and concave vertically. There is a rough oval facet in front, and another behind the low spine for the elastic ligament. The upper and lower transverse processes together form a vertical mass of thickened bone, perforated behind for air, but having extremely small openings in front for the vertebral arteries. This is similar to what occurs in its nearest congeners, *Cancroma* and *Ardea*, whilst the Storks, *e. g. Ciconia argala* and *alba*, have these vessels bridged over by a well-defined convex arch of bone. *Grus americana* possesses not only this bridge, but also a small 'rib,' which does not appear ever to have existed in the Stork and Heron groups, nor does it exist in the young Emeu. In the Common Fowl there is a pair of lateral bridges on the atlas, but none on the axis.

In the immature skeleton of the Emeu the anterior end of the centrum of the axis, including the odontoid process, all belongs to the atlas, and is quite distinct from the axis for the first few months; so that, if the atlas had all its rights, it would be much nearer in size to the axis. In the Goose one-third of the centrum of the axis belongs to the atlas, and the former bone has in this bird a small 'rib.' The neural canal of the axis of Balæniceps is narrower than that of the atlas; in the latter it is one-third of an inch wide, in the former one-quarter of an inch in front, but full one-third behind, the bone being bevelled away here between the post-zygapophyses. In the axis, and the two next vertebræ in this bird, the posterior tubercle for the elastic ligament lies in a recess formed by the projection backwards of the upper part of the bone. The margin of this projecting portion is rounded and smooth, and forms a very elegant arch over the inter-spinous tubercle, the piers of which arch lose themselves behind the thick tubercular mass of bone which forms the upper part of the post-zygapophyses. The articular facets of these latter processes lie directly under these tubercular masses.

Cervical Vertebræ. (Pl. LXVI. fig. 1 *cv*, and figs. 5 & 6.)

The facets of the post-zygapophyses of all the remaining cervical vertebræ are less concave and look a little more outwards (as well as downwards) than those of the axis; they are sub-oval, and, measured in the antero-posterior direction, are more than a quarter of an inch long in the upper part of the neck, and nearly half in the lower, diminishing again in the dorsal region. The pre-zygapophyses are exactly adapted to them, and necessarily look upwards and inwards. The articular surfaces of the centrums maintain their true ornithic character from the axis to the pelvis. The posterior surface of the axis already described has its counterpart in the rest of the post-central facets; whilst answering to these, those at the anterior end of each centrum are concave from side to side, and convex vertically. This beautifully strong mode of articulation allows of pretty free movement backwards and forwards between any two vertebræ; but it also permits some motion from side to side. From the third to the fifteenth cervical vertebra (inclusive), there are anchylosed rudimentary ribs or 'pleurapophyses,' and the first pair of these send down the strongest process; this inferior process of the short rib becomes more pointed and smaller until we reach the eleventh cervical vertebra, where it is obsolete. In this and in the succeeding vertebræ to the fifteenth the pleurapophysis scarcely projects downwards beyond the upper and lower transverse processes between which it lies, and to which it is anchylosed. The sixteenth cervical has a short two-headed rib, and that of the seventeenth is only half an inch shorter than the first dorsal rib, but it is narrower, very narrow in the middle, and has no appendage. This short condition of the cervical pleurapophyses is very much like what we find in the Boat-bill, the Herons and the Storks, as also in the Pelican; but in other Totipalmatæ—*e. g.* the Gannet and Cormorant—these 'ribs' are very long and styloid, especially in the latter bird, where they nearly reach the lower end of their own vertebra. The Colymbi are like the Cormorant in this respect, and so are the Flamingos, although these latter birds have very elongated cervical vertebræ, such as are only found again in the (typical) Herons and the Pelicans. But in the Cranes we have not only the long styliform pleurapophyses, but the tendons of the lateral muscles are ossified and continuous with the base of the small rib and with the diapophyses. These osseous splints are all parallel with each other and give a peculiar character to the skeleton of the neck in these birds. The ninth cervical of the Balæniceps (Pl. LXVI. figs. 5 & 6) may be taken as of a medium size, and its measurements are as follows:—Length $1\frac{1}{4}$ inch, breadth across the diapophyses $1\frac{1}{8}$ inch, and thickness at the middle two-fifths of an inch, and depth or height at the same part three-fifths of an inch. The third and fourth cervical are here not so quadrate in shape, seen from above, as in most birds. There is along the upper lateral margin in these two bones a large crescentic notch between the massive pre- and post-zygapophyses; but in the Adjutant this notch is bounded before and behind by a sharp spur of bone in the third, whilst in the fourth vertebra it is converted into a large oval foramen. This foramen is relatively smaller in the Fowl, but it exists in both the third and fourth joints. In the extremely compressed and elongated cervicals of the Heron, this foramen exists even on the fifth, whilst it is sometimes obliterated in the fourth. The third and fourth cervicals of the Balæniceps have low thick neural spines, marked before and behind by the large tubercle for the elastic ligament. The centrum of the fourth is compressed and has two oblong parallel tubercles beneath, the meaning of which will soon be explained. The compression of the centrum of the third cervical in Balæniceps is very great, and towards its hinder part there is a blunt rudimentary hypapophysis, marked below by three parallel lines. The fifth cervical of the Balæniceps begins to take on the normal shape of the vertebræ of the cervical region in birds: the spine without being higher is more compressed than in the fourth; the anterior inter-spinous tubercle is vertical, whilst that behind the neural spine is, as in most of the cervicals, very oblique. The centrum in this vertebra is thicker, having attained the normal proportions; but it is still convex beneath, and its anterior half is marked by two nearly parallel ridges about two lines apart from each other.

In this fifth vertebra, as well as in the fourth and the third, there is a pair of strong bridges for the vertebral arteries. These bridges are completely closed by an undivided bony ring to the fifteenth (inclusive), and they increase in size gradually; those of the third cervical being only a line and a half in diameter, whilst those of the fifteenth are nearly four lines across. The spine of the sixth cervical in Balæniceps is smaller than that of the fifth, and these processes decrease regularly to the thirteenth; but in the fourteenth the neural spine is more evident, whilst in the fifteenth to the seventeenth we have an approach to the condition of the process in the true dorsals. The inferior surface of the sixth cervical is concave, and at its anterior end the parapophyses send inwards a blunt process on each side, which processes, in the fresh state, are connected together by inter-osseous membrane, thus forming a canal for the carotid arteries. But in the seventh to the thirteenth (inclusive), these processes of the parapophyses meet at the mid-line (Pl. LXVI. fig. 5 *cc*), at which part they are somewhat carinate externally, whilst the passage itself is circular. The inferior margins of the centrums of these vertebræ, with four perfect canals, are marked by a sharp and rather scabrous ridge; between these marginal ridges the inferior surface of the centrum is rather flat, whilst it is more concave at each end. The concavity of the posterior third is formed by the swelling of the bone both outwards and downwards, on each side, to form the posterior articular facet. This lateral expansion leaves the bone scooped and concave at the mid-line, thus exactly adapting it to the anterior end of the next succeeding vertebra.

The principal pneumatic foramina enter the axis behind the upper transverse process, or diapophysis, but in the rest of the spine to the last caudal, the largest pneumatic openings are on the front face of these processes. The last carotid arch—that on the thirteenth cervical—is marked beneath by two small sub-mesial keels. The last four cervicals have no carotid arch or canal, but in their place there is, at the anterior end, a rather thick, subquadrate azygous process (Pl. LXVI. fig. 1 *hp*); that on the seventeenth, or last cervical, being the smallest, whilst that on the fifteenth is the largest, being about five lines broad and four lines deep. These are, according to Professor Owen, 'hypapophyses,' and the carotid canals, although formed by a pair of laminæ, he considers to be of the same nature.

From the thirteenth to the seventeenth cervical (inclusive) there is a much greater cellularity of the bone, and these lower vertebræ gradually increase in width; so that the seventeenth is more than $1\frac{1}{2}$ inch across the diapophyses, the ninth being only $1\frac{1}{8}$ wide at the same part. In the two last cervicals the upper articular surface for the 'tubercle' of the rib is flat, that for the round smooth 'head' is rather deeply concave, as in the dorsal vertebræ.

The formation of the carotid 'hæmal' canal in the neck of birds is exceedingly interesting, but its anatomy is not a little obscure. In 1844 Professor Owen[1] taught that these were typical vertebræ; but this mistake was soon corrected by him, and the true nature of these canals as productions of the centrum (in a part of the body of the bird where there are only very small rudiments of ribs and no hæmapophyses or hæmal spines) was shown. To the writer's mind, the distinction between parapophyses and hypapophyses is faulty, dividing as it does parts that are essentially one in signification. In his masterly memoir the 'Croonian Lecture[2],' Professor Huxley has shown the great uniformity and simplicity of the structure of the vertebral column in all the Vertebrata, and to his views our own have for a long time been approximating. But many a passage from Professor Owen's most invaluable works might be brought to show that these structures are far more simple and uniform than would appear from their nomenclature.

In Professor Owen's Report 'On the Archetype and Homologies,' read at the Meeting of the British Association held at Southampton in 1846, we have the following remarks (page 254 of the General Report):—

"In the Sturgeons (*Sturio*, *Polyodon*) the inner layer of the fibrous capsule of the gelatinous notochord has increased in thickness, and assumed the texture of tough hyaline cartilage. In the outer layer are developed distinct, firm, and opake cartilages, the neurapophyses, which consist of two superimposed pieces on each side, the basal portion bounding the neural canal, the apical portion, the parallel canal filled by fibrous elastic ligament and adipose tissue; above this is the single cartilaginous neural spine. The parapophyses are now distinctly developed, and joined together by a continuous expanded base, forming an inverted arch beneath the notochord for the vascular trunks, even in the abdomen. Pleurapophyses are articulated by ligament to the ends of the laterally projecting parapophyses in the first twelve or twenty abdominal vertebræ; in the anterior ones those 'vertebral ribs' are composed of two or three distinct cartilages. The posterior pleurapophyses are short and simple. The parapophyses gradually bend down to form hæmal arches in the tail, at the end of which we find hæmal cartilaginous spines corresponding to the neural spines above." And again in page 255:—"In the osseous fishes I find that the centrum is usually ossified from six points, four of which commence, as Rathke describes, in the bases of the two neurapophyses and the two parapophyses; but the terminal concave plates of the centrum are separately ossified[3]. They coalesce with the intermediate part of the centrum, which is sometimes completely

[1] See his Lectures on Comp. Anat., vol. ii. p. 44. [2] Delivered at the Royal Society, June 17, 1858.

[3] Vogt, Williamson, and Huxley speak of this annular 'diapophysis' as being ossified from only one centre.

ossified, but commonly a communicating aperture is left between the two terminal cones, and in many cases the plates by which calcification attains the periphery of the body leave interspaces permanently occupied by cartilage, forming cavities in the dried vertebræ, especially at their under part, or giving a reticulate surface to the sides of the centrum. The expanded bases of the neur- and par-apophyses usually soon become confluent with the bony centrum—sometimes first expanding so as wholly to enclose it; as, for example, in the Tunny, where the line of demarcation may always be seen at the border of the articular concavity, though it is quite obliterated at the centre, as a section through that part demonstrates." Again, page 256:—"In saurians, birds, and mammals, the notochord is enclosed by cartilage before ossification begins, which cartilage is continuous with the cartilaginous neurapophyses. In birds, the two histological processes, chondrification and ossification, do not precisely follow the same route. In the centrums of the dorsal and cervical vertebræ of the Chick chondrification is centripetal: it begins from two points at the sides, and proceeds inwards, the middle line of the under surface of the primitive notochord resisting the change longest. But, when the lateral cartilages have here coalesced, ossification begins at the middle line and diverges laterally; the primitive nuclei of the bony centres appearing as bilobed ossicles, and its direction is centrifugal. The lobes ascend to embrace the shrivelled remnant of the chorda, like the hollow vertebral centres in fishes. Only in the sacral vertebræ has ossification been seen to begin from two distinct points at the middle line. The bases of the separately ossifying neurapophyses extend over much of the centrum, and soon coalesce with it." Remark here, that the carotid canals are formed by exogenous marginal processes from the lower centre of ossification. We must be allowed to make another quotation. Speaking, in page 260, of the development of the anterior vertebræ of 'a large South American siluroid fish,' which has 'the first five centrums rigidly fixed together by continuous ossification below,' although 'the concave articular cavities, with the elastic capsules and contained fluid,' were seen in a vertical section, Professor Owen says, "The continuous bony plate supporting those centrums was perforated lengthwise by the aorta, offering another mode of the formation of a hæmal canal—viz. by exogenous ossification in and from the lower part of the outer layer of the capsule of the notochord; the carotid hæmal canal in the necks of birds seems to be similarly formed; and the neck of the Ichthyosaurus derives additional strength and fixation from apparently detached developments of bone in the lower part of the capsule of the notochord, at the inferior interspace between the occiput and atlas, and at those of two or three succeeding cervical vertebræ."

Note.—The odontoid process of the mammalian axis is considered by our author to belong to the same category[1]; but in that delightful little work of his on 'The Nature of Limbs' (1849), this ossific centre is described as the main or internal part of the centrum of the atlas, whilst the basal part of the atlas is considered to be the cortical or hypapophysial portion of that bone. See pages 94, 107, and 112.

[1] See page 261 of the same Report.

If we compare together the hæmal canals arising from vertebral centrums, without the help and intervention of hæmapophyses and hæmal spines, we must come to the conclusion that they are essentially formed in one manner. The posterior abdominal and caudal arches of the Sturgeon, Herring, Dory, Sea-bream (*Pagellus centrodontus*), the open caudal passages in the Ophidia, the closed arches in the Slow-worm, and lastly, the carotid canals in the neck of birds, thus have a homological unity.

Nor does the structure of the anterior vertebræ of the siluroid fishes (*Silurus*, *Bagrus*) present anything essentially new; for, as Professor Owen himself has shown, the passage for the aorta along the base of the coalesced centrums of these fish, is formed "by exogenous ossification in and from the lower part of the outer layer of the capsule of the notochord."

In distinguishing between diapophyses and parapophyses in the vertebræ of birds, we have to bear in mind the embryological fact, that during ossification "the bases of the separately ossifying neurapophyses extend over much of the centrum, and soon coalesce with it." But this fact is quite in harmony with what we find in the adult bird, for the bases of the upper transverse processes or 'diapophyses,' exogenous growths in the corporal vertebra from the neural arch, expand over the upper half of the sides of the centrum. The distinct ossification of the cortical part of the centrum in the atlas of birds is a pretty good guide as to what processes may be called 'parapophyses,' viz. just above the lower margin of the centrum, as well as at and beneath that margin.

The 'centrum' in oviparous vertebrata is almost as rich in processes having a teleological meaning as the 'neurapophyses;' yet parts arising from the neural arch are as a rule more definite in shape and function, and are consequently more easily classified than those spurs and processes which arise from the body of a vertebra.

So that the single median processes called 'hypapophyses' may be seen by tracing them in successive vertebræ in birds, to be formed by the gradual coalescence of parapophyses that have become in each succeeding bone nearer and nearer each other. Or the opposite method may be used in tracing them, and then we shall see a hypapophysis gradually bifurcating, the bifurcations becoming sessile, and forming distinct and true parapophyses. The Penguin is one of the best birds in which to see the 'specific unity' of these exogenous processes of the lower part of the centrum. In this bird (*Eudyptes demersa*) the two last cervicals have distinct floating ribs, and these vertebræ are followed by seven distinct dorsals, having the 'opisthocœlian' mode of articulation of their centrums.

In the penultimate cervical, which is very broad beneath, there is a pair of anterior cupped parapophyses for the heads of the small ribs, and a small mesial process between and a little behind these. In the last cervical, in addition to these three processes, there is a pair of broad thin widely divaricating processes passing backwards and outwards from the mesial one. In the first dorsal the anterior articulating processes are higher up on the side of the centrum, and the mesial process has vanished from between the two posterior pieces. In the second dorsal the two hinder processes are rather nearer the anterior end of the centrum, and are now evidently only one bifurcating piece. In the third dorsal this piece is losing its lateral processes; in the next three vertebræ they have become simple and further backwards in position, whilst in the last joint, that which articulates with the sacrum, this mesial process has vanished.

Retaining the familiar and valuable term 'parapophysis' for all these processes, we would distinguish the most marked varieties by a prefix, which should indicate their place and function. Thus *Pre-parapophysis* will indicate in birds that process which is anchylosed above to the rudimentary rib, and which sends down a spur of bone below to form half the carotid canal; in *Ophidia* it may be seen as a short and blunt spur beneath the articular diapophysis.

The posterior outstanding processes below the lower cervical centrums in the Penguin, Cormorant, and Fowl, and the pair of processes which form an open hæmal canal in the true Ophidians, and a closed canal in the Blind-worm, may be called *Post-parapophyses.*

The single inferior median process, so common in the centrums of the Vertebrata, can take on the prefix *hypo*; then, instead of hypapophysis, we shall have *hypo-parapophysis.* The caudal hæmal spine in the little *Anguis fragilis*, and in those fishes where there is no sign of its being anything but an exogenous growth from the down-bent parapophyses, may be termed a *meta-parapophysis.* Lastly, where this lower transverse process arises from near the middle of the side of the centrum, as in many osseous fishes, no prefix need be used: it is simply a *parapophysis.*

Professor Huxley shows that the ribs themselves, and the 'chevron bones' of the caudal vertebræ of many of the higher Vertebrata, are all developments of the 'centrum,' but having a distinct ossific centre[1].

Several of the middle cervical vertebræ have perfectly bony carotid canals in the following genera—viz. *Balæniceps, Cancroma, Ardea, Botaurus, Mycteria* (*M. australis*), *Pelecanus, Sula,* and *Picus*; the number is variable in skeletons of the same species, being greatest in old birds. However, as a rule in the class of birds, the mesial part of this canal is completed by interosseous membrane.

Dorsal Vertebræ and Ribs. (Pl. LXVI. figs. 1 & 7.)

The four true dorsal vertebræ of the Balæniceps are quite distinct from each other and from the sacrum. In the Pelican, and in one of the Humming-birds, the Mango Colibris (*Trochilus colibris*), the last two dorsals have entirely coalesced with the sacrum; that they are dorsal and not sacral vertebræ is proved by their anterior position with regard to the iliac bones, the true sacrals being over-canopied by these large 'pleurapophyses.'

The neural spine of the first dorsal is the longest, being seven-eighths of an inch in

[1] Croon. Lect., pp. 48 and 71.

extent, the rest are rather shorter, and are about the same length as the spine of the last cervical. These spines gradually increase in height, the first being one-fourth, and the last half an inch high. The upper ridge of the spine is the longest part; it is bifurcate behind and sometimes in front. The spines are thickest below, and thicker at their posterior than at their anterior margin. Their shape is oblong, the last being nearly square, but pitched, as it were, obliquely forwards. The anterior and posterior edges are rough for the attachment of the elastic ligament. The dorsal vertebræ are $1\frac{1}{2}$ inch wide across the strong thick diapophyses (Pl. LXVI. fig. 7), the last being the widest by a line or two; the diapophyses are widest in the first and narrowest in the last dorsal. These latter processes rise a little as they pass out from the neural arch; they are concave in outline in front and very arcuate behind, the terminal third being extended in the antero-posterior direction, and is on an average more than half an inch broad at this part.

The terminal part of the diapophysis is bevelled downwards, becomes narrow again, and just beneath its tip forms the flat oblique articular surface for the 'tubercle' of the rib. The diapophyses are very broad where they are one with the neural arch, and at this part in front each diapophysis has two or three large pneumatic foramina, and there is another large one on each side higher up at the junction of the diapophysis with the neural spine. The large oblique zygapophyses are much like those in the lower cervicals, but they gradually become smaller and nearer together as we pass backwards. Beneath each pre- and post-zygapophysis there is a large rounded, smooth, crescentic notch, which is formed into a foramen by the corresponding notch in the contiguous vertebra; this foramen is for the exit of the spinal nerves. These round notches have much the same character from the axis to the pelvis; they are formed at the expense of the strong vertical neurapophyses, which elements dilate above into the zygapophyses, and below into the expanded part which becomes confluent with the centrum. A large space, between the zygapophyses, of the spinal canal is left unprotected by bone. The arch formed by the confluent neurapophyses has a large crescentic notch both before and behind in the upper cervical vertebræ and in the dorsals, being smallest in the dorsal region. But in many of the middle cervicals the emargination between the post-zygapophyses is very large and triangular. These upper inter-laminar spaces are filled up in the fresh state by strong interosseous membrane. The spinal canal, very wide in the lower cervical region, becomes narrower in the dorsal, expands very much in the middle part of the sacrum, to narrow more and more down to the last caudal. The ribs are relatively inferior in strength to those of the more robust, thick-bodied Adjutant; the second dorsal rib is strongest and has a medium width of a quarter of an inch. Only the four true dorsal ribs have appendages (Pl. LXVI. fig. 1 *ap*), the longest of which on the second rib is less than an inch in length. The cupped short parapophyses that receive the rounded head of each rib rise higher, as we pass backwards; those of the last two dorsals being at the upper margin of the centrums.

The bodies (centrums) of the dorsals are more like those of the Storks than those of the Herons, being comparatively shorter and thicker than those of the more elongated and feebler typical bird—viz., the Heron. There is a very thick but small hypo-parapophysis at the anterior part of the first dorsal in Balæniceps, but none in the others. There are some rather large pneumatic foramina on the middle of the sides of the centrums of the dorsals rather high up. The dorsal and pelvic ribs dilating below, form at their tip a flattish articular surface for the hæmapophysis. The first of these ossified 'sternal ribs' is but little more than half an inch in length; the fifth, which joins the pelvic rib, is $2\frac{2}{3}$ inches long. These bones are broad above, narrow in the middle, and then expand considerably from side to side to form the transverse synovial surface for articulation with the sternum.

In certain birds, several of the dorsal vertebræ become anchylosed together; this is seen in one group of the Raptores—the Falcons, but not in the other families. In *Falco peregrinus, subbuteo, æsalon,* and *tinnunculus*; and (according to Professor Owen) in the Australian Hawk (*Ieracidea berigora*), five of these joints are thus anchylosed, one free vertebra intervening between these and the sacrum. The first of the five coalesced bones has a floating rib, and belongs to the cervical region. The same thing occurs in the Gallinæ and Columbinæ, but they have only four bones thus joined, the first of which has floating (cervical) ribs.

The Flamingo has the same structure as these latter birds, save that the ribs of the first in the anchylosed piece reach the sternum by hæmapophyses. Of the six true dorsals in the Agami (*Psophia crepitans*), the three first are anchylosed into one piece as perfectly as in the fowls. *Grus pavonina* has distinct dorsals, but *G. americana* has the second and third true dorsals combined into one bone. In the Grebes (*Podiceps*) and in the Dab-chick (*Sylbeocyclus europæus*) there are five true dorsals, the first four of which are quite confluent; this confluence in the latter bird affecting the hypo-parapophyses as in the *Gallinæ*. These inferior median processes are in some birds widely bifurcate. This may be best seen in the three first true dorsals of *Colymbus septentrionalis*, and in the three last cervicals and first true dorsal of *Alcedo ispida*. It is not, however, so common a character even as the confluence of the dorsal vertebræ; this latter state of the dorsal region being, after all, exceptional as to the entire class. Another modification of the dorsal vertebræ has to be noticed;—in birds with very compressed dorsal centrums, as the Lapwing, or with compressed and carinate centrums, as Parrots, Gannets, Cormorants, Puffins, and also in the Penguin, where the centrums are not so flat, the articulation of these elements is '*opisthocœlian.*' This character of an anterior ball and a posterior cup to the dorsal centrums is not found in the Pelican, which, added to the strange modification of its jaws, and the highly pneumatic state of its bones, make it very aberrant from the other Totipalmatæ. There is no floating abdominal hæmapophysis in the *Balæniceps*—although this is very common in birds (especially raptorial and insessorial species), it occurs however in the Adjutant. In the skeleton of a Red-necked Grebe (*Podiceps rubricollis*) prepared by the writer, there was one of these free hæmapophyses on the right side with the rudiment of a second near its tip; whilst on the left side there were two such bones, the anterior piece being very long, passing downwards more than an inch behind its homotype of the pelvic rib, and upwards of an inch behind the rib itself. A structure this well worth noticing, bringing us, as it does, so near to the condition of these parts in the Crocodile. In the Puffin (*Fratercula arctica*), and in the genera *Alca* and *Uria* the posterior ribs and hæmapophyses are prolonged so far backwards that the very angular articulation of the last or pelvic nearly reaches as far back as the tip of the very long and slender os pubis.

Sacral and Caudal Vertebræ. (Pl. LXVI. fig. 1 *sc*, *cd*; & Pl. LXVII. figs. 2 & 3 *sc*, & *cd*.)

The first two sacral vertebræ are almost as large as the dorsals, and their boundaries are very distinct; they then rapidly decrease in size and in distinctness; yet the next four are indicated by their short blunt pleurapophyses, the last two of which scarcely reach the ilium. The stunted pleurapophysis of the right side of the second sacral is not anchylosed to its parapophysis. After the first six, the next five sacrals have their extremely small pleurapophyses confluent with the sides of the centrums, without any out-standing part. The remaining six sacrals have out-standing coalesced pleurapophyses, the second and third of which are extremely thin, and are principally composed of threads of diploe. The neurapophyses of all the sacrals except the last have in this bird completely coalesced. Between the first and second sacral there is a large oval foramen for the exit of nerves, but it is much less than the passage formed in the dorsals between the neurapophyses of contiguous vertebræ. The posterior and anterior roots of the spinal nerves have separate outlets in the rest of the sacrum; and from these passages to the roof of the pelvis there is a large quantity of very rich diploe involving the substance of the neurapophyses, neural spines, diapophyses, and pleurapophyses. The neural spines of the sacrum are at first equal to those of the dorsals, but between the acetabula they spread, become rounded, and then obsolete. There is in this, as in most birds, a large triangular space for the insertion of the dorsal muscles on each side the sacral spines; the roof of this space is oblique and is formed by the ilium; the floor is horizontal, and consists of the diapophyses.

Looking at the pelvis from above (Pl. LXVII. fig. 2), there may be seen two pairs of small passages between the spine and the iliac bones, just as these large bones begin to divaricate before they turn outward on each side towards the acetabula. Behind these, as the spine gains breadth but loses height, there is a deep fissure divided by oblique septa on each side of the spine; these septa are the diapophyses of the middle part of the sacrum. The iliac bones become further and further apart; and where they join the coalesced dia- and neur-apophyses, four pairs more of oval passages, most of them quite small, indicate from above the boundaries of four more of the sacral vertebræ. Two additional pairs of large transversely oval openings or interspaces, the anterior pair of which is bridged over by a thread of bone near its outer end, bring us to the last sacral vertebra. This bone is united by its centrum to the centrum of the one before it, and by the tips of its coalesced ribs (which turn forwards near their ends) to the iliac bones, now $1\frac{1}{4}$ inch apart. The pleurapophyses of this last sacral are one third of an inch longer than its diapophyses; these latter processes are bevelled at their ends, so that the transverse process is suddenly smaller where it is only composed of a rudimentary 'rib.' The neural canal can be seen between the two last sacrals. The counterpart of this last sacral vertebra of the Balæniceps forms the first of the caudal series in the Heron and the Adjutant; and perhaps this would be the case in the next Balæniceps that should be dissected. The structure of the caudals is extremely like that of the last sacral, but they gradually acquire short neural spines, the last compound 'ploughshare bone' (which is composed of nine or ten embryonic vertebræ) being sharply carinate along nearly the whole of its upper margin. The ends of the coalesced caudal pleurapophyses project three lines below and external to the ends of the diapophyses, and are blunt, smooth, and clubbed. In the last three these transverse parts are gradually lost, whilst they gain on their inferior surface small forward-projecting coalesced 'hæmapophyses' (hypophyses of Huxley). A small distinct 'sesamoid bone' of this nature lies between the second and third centrum, and belongs to the latter. The last caudal is one inch and two lines long, measured along its base. These caudals of the Balæniceps have a very beautiful structure. They are not oily as in the Heron, but pneumatic as in the Adjutant; and the air enters them principally by a large oval opening, which in the two first joints occupies the entire front of the broad basal part of the compound transverse process; this large recess communicating by apertures with the whole of the interior of the bone. The external table of bone is extremely thin, the threads and areolar plates of diploe are delicate in the extreme, and the short diverging 'ribs' are mere hollow tubes, having extremely thin walls.

Pelvis. (Pl. LXVI. fig. 1 *il, ism, pb*; and Pl. LXVII. figs. 2 & 3.)

The pelvis of this bird is very pleasing both to the anatomist and to the systematist. It has little in it even of a *generic* nature to distinguish it from that of our native grey Heron, and indeed, of all the true *Ardeæ* and *Botauri*: it might belong to a gigantic form of *Ardea* proper.

If this 'stranger in a strange land' (too early lost to the zoologist to gladden prematurely the anatomist with its rich spoils) had lived as long as the four Grey Herons did, whose bones now lie before the writer, the difference between their pelves would have been chiefly a difference of size. The comparative smoothness of the bone and its softer and more rounded outline would, with the lapse of years, have given it that sharpness and angularity which is seen in these Herons' pelves, arising from the strong crests on the margins of the iliac bones. The upper margin especially of each iliac bone as it diverges to overhang the acetabulum, and then form the upper and outer margin of the pelvic roof in the Heron, is feebly developed in the skeleton of this Balæniceps. The narrowness of the entire pelvis, and especially the contracted waist-like part, before the bone expands to articulate with the os femoris, is precisely what we find in all the true Ardeine birds, including *Cancroma*. But in the Storks the first thing that strikes the eye is the broad, expanded, foliaceous condition of this part of the skeleton. The narrow little pelvis of *Botaurus minutus* (so much like that of the Crake and Water Rail) is at once seen to be the diminutive counterpart of the same structure in the Balæniceps. We shall see, when we come to the bones of the feet, that Ralline affinities are not absent from this aberrant 'giant,' whilst such relationship appears in the structure of that more normal 'dwarf'—the little Bittern.

The pelvis of the Balæniceps at its narrow pre-femoral 'waist' is 1 inch and 3 lines wide; but it is $2\frac{1}{2}$ inches across the iliac crests where they rest upon and overhang the sacral ribs. The breadth across the pelvis behind its articular surfaces for the great trochanters is 3 inches and a line, being exactly the width of the widest part behind, which is one-third of an inch in front of the blunt in-turned terminal tips of the iliac bones. The margin of the pre-femoral part of the ilium is rather wide, (Pl. LXVII. fig. 2 *il*) and the bone itself here is not very concave, but passes rather steeply down for two-thirds of its width, to become more horizontal near the lower and outer margin. There is a large crescentic emargination on the front of the ilium, and the inferior and outer sharp boundary of this wide notch does not pass so far forwards as the upper and inner.

Half an inch behind the sacral rib there arises a sub-marginal muscular ridge which is crescentic, and runs backwards nearly to the acetabulum. This latter cup-like articular cavity is not perfected by bone, there being in the skeleton an internal oval passage as wide as the head of the thigh-bone. The anterior and upper two-thirds of this scooped articular ring is formed by the ilium; the rest belongs to the pubis below and to the ischium behind. Above and behind the 'acetabulum' is the slightly concave oval articular surface for the great trochanter; it passes obliquely upwards, outwards, and backwards. Exactly behind this part is the large sacro-ischiadic notch, or rather *foramen*—it is irregularly oval (Pl. LXVI. fig. 1 *in.*), its inferior margin being rather angular; it is one inch long—and behind it is the concave line of junction of the ilium and ischium, which is one inch and a line in extent.

The outer margin of the post-femoral part of the ilium is rounded and smooth; the bone then passes inwards and downwards to unite with the ischium below. There is a notch between these (coalesced) bones at the posterior end. The posterior inner margin of each iliac bone receives the rib of the last sacral vertebra and then passes, with a very elegant concave outline, bevelled, rounded, and smooth, to its extreme outer tip. This terminal end of the ilium lies on a lower plane than the upper and outer margin; so that, on a side view, the end of the ilium is very oblique, as is also the sinuous sharp posterior margin of the ischium (Pl. LXVI. fig. 1 *ism*). The inferior margin also of this bone (the ischium) is sharp, but it becomes thicker beneath the ischiadic foramen, the sharp inferior ridge first passing obliquely upwards to form the anterior margin of that foramen; and then the rest of the anterior part of the ischium is round below, convex within, and concave externally. The posterior end of the ischium is thin, incurved, and nearly touches the pubis, which reaches half an inch further backwards. That part of the ischium which, having coalesced with the ilium, passes downwards and a little outwards, is moderately thick, and is half an inch deep. The ischium passes obliquely backwards eight or nine lines further than the ilium; in this it resembles the Heron; in the White Stork it terminates in the same vertical line, but in the Adjutant and Boat-bill the ilium projects behind the ischium. In certain birds—*e. g.* the Fowl—a short but strong process projects forwards where the ilium joins the pubis beneath and rather in front of the acetabulum. In the Balæniceps and its congeners, the Herons and Boat-bills, as well as in the Storks, this spur is absent; yet the os pubis is very thick, rounded, and smooth at this part (Pl. LXVII, fig. 3 *il, ach*), but soon becomes thin and flat more posteriorly, where it is distinct from the mass of bone forming the lower part of the acetabulum. Its width is at first two lines, gradually expanding to more than three, two inches further on; it then contracts a little for half an inch, widens again, and then rapidly runs to a point as it curves inward to form its tip. This bone is of unusual width (Pl. LXVI. fig. 1 *pb*) twice as wide as in the large Indian Adjutant; but it has all the essential characters of the same bone in its congeners. This os pubis is flat externally, at first convex and ridged within, and then at its widest part slightly concave. The distance between the pubic bones is at first two inches, then at their widest part, which is in the same vertical line as the tips of the ilia, they have divaricated seven lines more. They now make an elegant curve inwards, below and a little external to the ischia, and their tips are but one inch and two lines apart. Seen from above, the curving inwards of the ilia, ischia, and ossa pubis is a very beautiful structure. Opposite the widest part of the ischiatic foramen, the pubis is four lines apart from the ischium; it gradually nears that bone, and they almost touch behind. An interosseous membrane perfects the great obturator foramen, here two inches and three-quarters in length.

Sternal Apparatus. (Pl. LXVI. fig. 1, and Pl. LXVII. fig. 1.)

The scapula, coracoid, and sternum, in this bird, are relatively stronger than in the Herons, being quite equal, in proportion to the size of the bird, to what they are in the Adjutant. A few comparisons will make this evident; the measurements are in inches and lines.

The scapula (Pl. LXVI. fig. 1 *sc*) is a very exact counterpart of that of the Adjutant, and so is the coracoid except at its head, which is more than an inch and a half broad in the great Indian bird, whilst in the Balæniceps this part has only half that breadth. There is also in the latter bird a flat oval articular surface in front of the head of the coracoid for the thick part of the furculum, which does not exist in the Adjutant. The coracoid of the Balæniceps (Pl. LXVI. fig. 1, and Pl. LXVII. fig. 1 *cor*) is half an inch

	Balæniceps.		Adjutant.		Grey Heron.	
	inches.	lines.	inches.	lines.	inches.	lines.
Length of scapula	4	3	5	6	3	2
Greatest breadth of scapula (*flat part*)		5½		8		2
Greatest length of coracoid	3	10	5	9	2	7
Breadth of lower articular surface of coracoid	1	5	2	1		9½
Length of sternal keel from apex to end	5	0	5	7	3	6
Breadth of sternum across costal processes	3	0	4	2	1	10½
Breadth of sternum across hyposternals	2	6½	2	10½	1	6
Length of hyposternal processes	1	4		8		8
Thickness of keel at the margin near the furculum		4		5½		1
Greatest depth of keel	1	3	2	0	1	0

broad at the middle part, and five lines thick; it then expands, is deeply grooved in front, has its internal edge sharp, which sharp edge at the top forms that incurved flat process which articulates by ligament with the tip of the ramus of the furculum, and with a similar but thicker process at the upper part of the proximal end of the scapula. The shallow glenoid cavity belongs equally to the scapula and the coracoid.

The sternum of Balæniceps (Pl. LXVI. fig. 1 *st*, and Pl. LXVII. fig. 1) differs from that of the Heron and agrees with that of the Adjutant in being very thick and cellular, except at its hinder part. Notwithstanding the thinness and delicacy of the sternums in the genera *Ardea*, *Botaurus*, *Nycticorax* (*Nycterodius*, Macg.) and *Cancroma*, they agree in all essentials with those of the true Storks. In Balæniceps, however, we encounter a host of difficulties both in the sternum and also in the furculum (Pl. LXVI. fig. 1 *fc*, and Pl. LXVII. fig. 1 *sy*), although its general shape and proportions agree well with that of the gigantic Storks. The hyo-sternals, or costal processes, are exactly like those of the Adjutant, but the epi-sternal process, which is distinct in the Adjutant, and long in the typical Herons, is not differentiated in Balæniceps. In Parrots, Woodpeckers, and Horn-bills, that emargination is absent which separates the epi-sternum in most birds from the tip of the sternal keel. The same thing occurs in the Balæniceps; so that in this Wader, as well as in those arboreal birds, the keel of the sternum projects some distance in front of the coracoid grooves. In all the more delicately formed Ardeine birds that we have examined, there is an ascending process within the angle and between the rami of the furculum; this is absent in Balæniceps, although it is present in Cancroma. In the latter bird, in the Bittern (*Botaurus stellaris*), and the Purple Heron (*Ardea purpurea*), the furculum is connected by ligament to the tip of the sternal keel; a state of things which occurs in the great majority of birds.

In *Ardea cinerea* (and most of the larger Herons), in *Nycticorax griseus*, *Botaurus minutus*, and in the genera *Ciconia* and *Mycteria*, the end of the furculum has a gliding synovial joint with the tip of the keel of the sternum; and this appears to be persistent even in very old birds. The same thing occurs in Gannets and in Cormorants. In the Secretary Vulture and in the White Pelican there is this claviculo-sternal articulation; but it becomes anchylosed in old age. In young Cranes—*e. g. Grus antigone*—this joint may be seen; but in full age, when the trachea has gone some distance into the sternum, it is entirely obliterated. We have not seen this structure in the somewhat aberrant Balearic Crane, nor in the Agami (*Psophia crepitans*), in which bird unmistakeable Gallinaceous characters are present. But in this young Balæniceps not only is all trace of a joint gone, but the amount of ossification and the actual strength of this part are very great indeed; it is a seven-times strengthened anchylosis. The upper surface of the sternum is deeply and evenly concave, its depth in the mid-part being one inch and a quarter, whilst the same part is only a line deeper in the Adjutant. These two birds agree also in the number of large pneumatic holes, especially at the anterior and middle region, and between the five hinges for the hæmapophyses on the upper margin of the sternum. In some of the Storks there are very small rudiments of a pair of sub-mesial emarginations besides the large lateral ones, which are constant.

In Balæniceps, however, these notches are nearly half an inch broad, leaving between them a xiphoid mesial process three lines wide at its extreme end. The outer notch is nine lines across, its external outline being the inner margin of the long narrow hyposternal process; the upper and external margin of this process running forwards to the joint for the 'sacral' hæmapophysis, is elegantly sigmoid. The great length of the hyposternal process (twice as long as that of the Adjutant) reminds us very strongly of the Rails and Coots, and still stronger Ralline features will show themselves towards the end of our task. The sub-mesial emarginations (very common in birds, but not present in the typical Ardeinæ) tell us of another Wader with strangely modified jaws—viz. the Spoon-bill, a bird which seems to stand, in Nature, between the Storks and the Ibises. The very thick strong keel of the sternum passes on to the end of the bone; in the Totipalmatæ—*e. g.* Pelican, Gannet, &c.—it only reaches half-way. In many birds—*e. g.* the Boat-bill, Herons, Storks, Cranes, Geese, &c.—the rami of the furculum are flat at the upper end, and passing within the head of each coracoid are there articulated. But in many other groups of birds—*e. g.* the Balæniceps, Diurnal and Nocturnal Raptores, Swifts, Goat-suckers, and different genera of the Totipalmatæ, as the Cormorants, Gannets, and Pelicans—the rami of this bone expand and become very thick before passing between the coracoids. In these latter cases the outer thickened part of the furculum forms an oval flat synovial surface which articulates with a similar surface on the front of the head of the coracoid, whilst the inner part of the ramus passes on, flat and triangular, to articulate with the inner side of the head of the coracoid. Measured in a straight line the symphysis of the furculum of the Balæniceps is $3\frac{2}{3}$ inches from its inner tip. These upper ends are 3 inches apart and the width across the thick anterior articular processes is $3\frac{2}{3}$ inches. It is therefore U-shaped as in the wide-bodied Storks, and not V-shaped as in the flat-bodied Herons. In the Pelican the enlargement formed by the furculum in front of the head of the coracoid, begins at the middle of the furcular ramus—in the Balæniceps at the upper third. In these two birds the enlargement is sudden (being thick and oval in Balæniceps, and flat and wide in the Pelican); but in Cormorants, Gannets, Eagles, Hawks, Swifts, &c., the enlargement is very gradual. The sudden turn backwards which the ramus takes at the thick part is very peculiar in the Balæniceps, a more perfect angle being formed there than in the Pelican and Gannet; but it is still a very obtuse angle; whilst in the Cormorant the thick articular third of each ramus is at a right angle with the lower contracted two-thirds. The middle contracted part of each furcular ramus is oval in section; the enlarged inferior part is convex without and concave within, whilst above their junction there is a transverse fossa full of pneumatic holes. The furculum is a peculiarly ornithic bone, but its feeble development in the struthious birds explains its nature as the homologue of the human clavicle; whilst Professor Owen considers it is also homologous with the large hæmapophyses of the atlas of Fishes[1].

The scapula in typical fish is composed of two pieces, and in them the coracoid attains its greatest dimensions. The former element (although composed of two pieces) is, in Professor Owen's opinion, the pleurapophysis of the occipital vertebræ; whilst the latter, the coracoid, is its hæmapophysis. This scapulo-coracoid hæmal arch, according to Professor Owen, always follows the heart and respiratory organs in the Vertebrata; so that the protection of these parts being in birds confined to such posterior vertebræ, gives rise to this enormous displacement of these inferior elements of the occipital vertebra. In Fishes the pelvis often swings beneath the occipital hæmal arch, and is as much displaced as the scapula, coracoid, and clavicle are in birds. In the latter class the pelvis is not displaced, the ilium being (in Owenian nomenclature) the extremely enlarged distal piece of a sacral pleurapophysis, whilst the ischium and pubis are hæmapophysial in their nature; one of the pairs of bones belonging to the ilium, whilst the other has its single-centred pleurapophysis[2] stunted and unconnected with its hæmapophysis. The terms epi-, hyo-, ento-, hypo- and xiphi-sternal processes are very convenient; but in his little work 'The Skeleton and the Teeth,' p. 215, Professor Owen says that Geoffroy St. Hilaire was wrong in supposing that these parts (with the exception of the ento-sternal) are homologous with the epi-, hyo-, hypo- and xiphi-sternal bones of the Chelonia. The circle of bones which in this latter class articulate with the expanded pleurapophyses above, and with the epi-, hyo-, hypo and xiphi- sternals below, are mere dermal plates; whilst the lateral pairs of the bones of the plastron are the

[1] There are, however, very grave reasons for doubting whether the clavicle of birds belongs to the same vertebra;—our opinion is that it does not.

[2] Professor Owen's views of the nature of limbs have not been corroborated by the researches of embryologists; Mr. Huxley says that 'the pectoral arch is originally totally distinct from the skull'; and Dr. Falconer has drawn my attention to Professor Goodsir's view that the pectoral members belong to, and are developments from, several somatomes and meta-somatomes. (Goodsir, *op. cit.*, p. 178; Huxley, *op. cit.*, p. 53.)

true hæmophyses. In typical birds the sternum is ossified from five centres; and this extreme expansion of hæmal spines, by pairs of lateral, with an intercalated central carinated piece, is the exact counterpart of the so-called neural spines of the skulls in certain mammals—*e. g.*: the Hyæna, Badger, &c.

Upper Extremities. (Pl. LXVI. fig. 1.)

Before proceeding to describe the bones of the extremities, we insert a table showing the comparative lengths of the arm, fore-arm, hand, thigh, leg, shank, and toes (in inches and lines) in various birds.

	Length of humerus.		Length of ulna.		Length of metacarpus and mid-digit.		Length of femur.		Length of tibia.		Length of tarso-metatarse.		Length of hallux.		Length of inner-toe.		Length of mid-toe.		Length of outer-toe.	
	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.	in.	l.
Balæniceps rex	9	3	10	10	7	3	5	0	11	0	8	10	3	3	4	7	6	3½	5	9½
Cancroma cochlearia	3	6	4	2	3	2	2	4	4	5	2	11	1	3	1	8½	2	3	1	11½
Ardea cinerea	6	4	7	7	5	7	3	3	7	2	5	5	1	9½	2	8	3	5	2	11
Leptoptilus argala	12	6	17	5	11	3	5	10	16	10	12	8	2	4	4	2	5	8	4	8
Phœnicopterus ruber	7	2	7	7	5	8	3	4	11	8	10	3		9	2	5	3	0	2	9
Fulica atra	3	1	2	7	2	10	2	2	4	0	2	3	1	2	2	5	3	4	3	0
Parra jacana	1	5	1	8	1	6	1	1	3	3	2	6	1	5½	2	1½	2	7	2	4
Podiceps rubricollis	4	1½	3	9	3	0	1	9	4	7	2	5		8	1	11	2	4	2	8
Pelecanus onocrotalus ..	12	0	13	8	8	9	4	3	7	4	4	2	2	2	3	1	4	3	4	3
Phalacrocorax carbo	6	3	6	9½	5	8	2	7	5	1	2	8	1	6	2	1	3	3	4	0
Diomedea exulans	15	8	15	7	10	9	4	4	9	8	4	6	......		5	8	6	10	6	6
Apteryx australis	1	10		9		6	4	3	6	7	3	0		9½	1	10	2	8	2	0
Dromanis ater	3	9	2	2	3	0	9	0	17	0	14	8	......		3	6	5	6	3	6
Cypselus apus		6½		9½	1	9		9	1	1		5		3½		5		5½		4
Trochilus colibris		3½		3½		9½		4		7		3		2		3		4		4½
Himantopus melanopterus	2	6	2	9	2	7	1	3	5	1	4	6	......		1	4	1	8	1	6

For a description of the structure of the bones of the upper and lower extremities in birds, the reader is referred to that invaluable little book in 'Orr's Circle of the Sciences,' viz. 'The Skeleton and the Teeth,' by Professor Owen, page 222. Notwithstanding the variety there is in the relative proportions and comparative strength of these parts, there is a truly wonderful uniformity of structure in the bones of the limbs; so that Professor Owen considers them to be merely "teleologically divided appendages of the occipital and pelvic vertebræ." As compared with the size of the head, the strength of the cervical vertebræ, and the great development of the sternal apparatus, the bones of the limbs in this young Balæniceps have a somewhat delicate and feeble appearance. To say nothing of the very strong wing and leg-bones of the larger Storks, the Balæniceps has these parts relatively weaker than those of the Grey Heron. The Boat-bill (*Cancroma*) and the Umbre (*Scopus*) appear to be about equal in this respect (considering their size) to the Balæniceps. The anterior articular head of the humerus (Pl. LXVI. fig. 1 *h*), the upper and lower crests (the latter with its internal pneumatic foramen), and the posterior condyles for articulation with the radius and ulna, are the exact counterparts of the same structures in the humerus of the Heron. The ulna in this captive[1] (Pl. LXVI. fig. 1 *u*) scarcely shows the knobs on its outer side for the secondary quills. The radius (Pl. LXVI. fig. 1 *r*) is very long and slender. The two carpals that continue free (Pl. LXVI. fig. 1 *cp* 1, *cp* 2), and the one, the "os magnum," which has coalesced with the middle metacarpal, answering to the third of a pentadactyle member; the outer and inner metacarpals, each with one phalangeal bone; and the middle metacarpal with its two phalanges (Pl. LXVI. fig. 1 *mc*), have all the same structure in Balæniceps as in the Heron. The humerus alone receives air; the rest are filled, in the living bird, with medulla.

Both in length and thickness, the bones of the wing are one-third larger in the Balæ niceps than in the Grey Heron, but this is certainly not in proportion to the size of the two birds. If the head, neck, and feet had been in the Balæniceps relatively no greater encumbrance than the same parts are in our common Heron, yet the greatly increased magnitude of the bird would have demanded much larger wings for it to have been as capable as its smaller relative of high, buoyant, sailing, long-sustained flight. Our more solitary and wandering native bird flies at great heights, with little apparent labour,—his breeding-place being often at a great distance from his favourite fishing-stations. According to Mr. Petherick, the Balæniceps is much more social; and the habit, which he notices, of the bird taking itself off to high neighbouring trees when disturbed, is very unlike what our Heron does under like circumstances,—this bird being evidently aware of the fact that "its best defence is absence, and that all its safety is in remotion[2]." Judging from the large volume (for the weight is not considerable) of the neck and head, and from the large size of the feet, we are inclined to place the Balæniceps, as a flier, between the Water-hen and the Heron. The wing-bones of the Adjutant are nearly twice the diameter of those of the Balæniceps; the humerus of the latter is three-fourths the length of that of its great Indian relative; whilst the latter, the Adjutant, has its fore-arm and hand one-third longer than those of the Balæniceps.

The comparatively short and exceedingly strong humerus of the Adjutant, coupled with a line of insertion for the 'secondary' quills nearly eighteen inches long, and room for a series of 'primaries' almost a foot in extent, are most liberal allowances of skeletal basis for the Phœnix-like wing-quills of this huge bird.

Note.—The temptation to expatiate on the structure of the wing in this most fasci-

[1] That ardent and accomplished ornithologist Dr. Anton Fritsch, of Prague, informs me that he has examined a large and well-developed skeleton of *Balæniceps rex* in the possession of M. Schimper, of Stuttgart. This bird was several inches higher than the subject of this paper; and Dr. Fritsch's recollections of it are, that it was an old bird when taken, and, never having endured captivity, had much stronger and larger wing-bones.

[2] Familiar with the Heron from his childhood, the writer has only once seen it take to a tree near by when alarmed; on this sole occasion a fine old male bird had ventured too near the nest of a pair of Kestrils, and being hawked by them into a large tree and from that into some bushes, was easily taken alive. As a rule, when alarmed, a few minutes suffice for it to fly so far out of reach as to appear a mere speck in the sky.

nating class of Vertebrates, is very great, but must be resisted; yet the foregoing table, although purposely exceedingly limited, might serve as prologue for a discourse of any length[1].

The main bones of the leg in Balæniceps are nearly exactly one-third longer than those of the Grey Heron, and one-third thicker. They have also very much the same structure. There is nothing particular to remark in the very straight cylindrical os femoris (Pl. LXVI. fig. 1 *fm*), with its roundish head, short neck, and its broad and externally rugose great trochanter—the upper facet of which is coated with articular cartilage, to glide upon the supra-acetabular facet of the ilium. The articular ends of the 'tibia' (Pl. LXVI. figs. 1, 8 & 9 *tb*) are well developed—the two upper facets for the condyles of the femur being very flat as in most birds; and the ecto-, ento-, and epicnemial ridges are as well developed as in the Heron. This part of the tibia has a separate epiphysis in the young Emeu. There is a fibular ridge outside for the fibula, which bone is thick at the top where it glides under the fibular condyloid process outside the lower external condyle of the femur. The lower part of the fibula (Pl. LXVI. fig. 1 *fb*) is styloid, and this bone is short in the Balæniceps, being less than three inches long, whereas it is nearly an inch longer in the Heron, and nine inches in the Adjutant. The sigmoid curve at the lower part of the tibia is very slight, as in the Heron—this bone being straighter in the *Ardeæ* than in the *Ciconiæ*. The large inferior trochlea of the tibia (Pl. LXVI. figs. 8 & 9 *tb*) is well developed, as is the osseous bridge in front and above it, and the internal and external tubercles on its sides. These parts are larger in proportion in the Balæniceps than in the Heron. This inferior or distal end of the tibia is developed from a distinct osseous centre in young birds, which piece forms all the articular part, and sends upwards a wedge-shaped process in front—the seat of the ossification which makes the large, wide, oblique tendon-bridge. Below this bridge the bone is deeply scooped, and the concavity between the condyloid margins of the trochlea is very considerable. Query—Is this lower articular portion of the tibia an epiphysis of the tibia itself, or is it the homologue of the mammalian astragalus? There is no 'sesamoid' os calcis in the Balæniceps, in which it agrees with the Herons and Storks.

The tarso-metatarse of Balæniceps (Pl. LXVI. figs. 1, 8, 9, 10 & 11 *tmt*) has its articular extremities more strongly developed than in the Heron,—its length and thickness still retaining the same relative size as the tibia, femur, and the bones of the wing. This bone is one-third longer than the same bone in the Heron, and one-third thicker in its shaft; but the ecto- and ento-condyloid cavities and their margins are more strongly developed. The concavity also below and in front of the head of this bone is unusually deep; but the intercondyloid tuberosity is not better developed than in the Boat-bill and the Herons, being very inferior to the same part in the Adjutant. In the

[1] In the works of Sir C. Bell, Dr. R. Grant, and Professors Owen and Rymer Jones, the reader will find this subject treated of as it should be.

latter bird there are only two calcaneal processes behind the head of the tarso-metatarsus; the external of these being the most extended parallel to the metatarsus, whilst the internal projects furthest at right angles to the shaft. These processes in the Adjutant do not form a tendon-bridge, but there is a deep fossa between them. The structure of these parts in the Heron and in the Balæniceps is very different from that of the Adjutant, these birds having ecto-, meso-, and ento-calcaneal processes behind the head of each tarso-metatarsus. The ento-calcaneal process is by far the largest in these two birds, the meso-calcaneal being of intermediate size. These projections are very thick, and enclose two bridges or canals for tendons, besides forming two deep external grooves or sulci. The ento- and meso-calcaneal processes are principally formed by the middle metatarsal (Pl. LXVI. figs. 8 & 9 *tmt*), the head of which lies between and behind the external and internal pieces, whilst its distal end passes between and in front of the outer and inner coalesced portions. This distal end of the middle metatarsal (Pl. LXVI. figs. 10 & 11 *tmt*) has a grooved articular surface for the middle toe, whilst the articular surfaces of the inner and outer metatarsals are simple. The small suspended innermost metatarsal bone is 1 inch and 2 lines long, and has a large simple convex articular surface for the long hallux (Pl. LXVI. fig. 1 *tmt* 2). In young birds the proximal end of the tarso-metatarsus is separate from the three long bones that afterwards coalesce with each other and with it; this broad thick piece of bone belongs to the tarsal series.

The hallux of the Balæniceps (Pl. LXVI. fig. 1 *d* 2) is nearly one-third longer than that of the Adjutant; and the other toes (Pl. LXVI. fig. 1 *d* 3, 4 & 5) are much longer really, and therefore are relatively very disproportionate in size in the Balæniceps. The toes of the Heron are but little more than half the length of those of the Balæniceps, and are only half as thick; the actual weight of the feet of the latter bird must therefore be eight times as much as those of the former. This disproportionate size of the feet in the Balæniceps as compared with those of the Heron—the bones of the wing and the main leg-bones being relatively weaker in the large bird—must be considered when the power of flight in the two birds is compared. There is nothing particular to remark upon in these large, well-formed phalanges of the Balæniceps: the arching of the hallux and of the claw-bones and the relative length of the latter are precisely like what are seen in the Heron.

The hallux of the Balæniceps, like that of the Heron, lies in nearly as low a plane as the other toes; and in the former the hinder and outer toe are very mobile; so that in walking the Balæniceps can turn the hallux very far inwards, and the outer toe very far outwards.

In its own circle, the Balæniceps represents the Macrodactylous Rails—*e. g. Fulica*, *Porphyrio*, *Gallinula*, *Parra*, and perhaps *Palamedea*; but a knowledge of the structure of this last bird is still a desideratum.

From the feebleness of the wings and legs as compared with those of many of its congeners, from the length and thickness and great mobility of the toes, and from the unusual size (for an Ardeine bird) of the hyposternal processes, it seems fair to conclude that the Balæniceps is an oblique link between the Herons and the Rails; nevertheless the Ralline characters are feeble compared with those that are truly Ardeine. The Balæniceps is not more mysterious in its relationships than the Flamingo, the Secretary-bird, the Hemipodius, the Sand Grouse (*Pterocles*), or even than those beautiful little creatures, half *Warbler* and half *Swift*, the Swallows and Martins. It will be seen by the table (*supra*) that the outer toe of Balæniceps is only half an inch shorter than the middle toe; this is a disproportionate length of the outer toe as compared with what is seen in the Heron, and is equal to what is found in the Jacana (*Parra*), and the Coot (*Fulica*). In the Zygodactyles (*e. g.* the Parrot) the outer toes are long, for turning backwards; and this elongation of the outer toe is also the rule in the Palmipeds.

In the Duck the middle toe is only a line longer than the outer; in the Pelican they are equal; but in the Cormorant the outer is nine lines longer than the inner toe. This disproportion also occurs in the beautifully lobed feet of the Grebes (*e. g. Podiceps rubricollis*) and in the Divers (*Colymbus*). The middle toes are disproportionately long in the Diurnal Raptores and in the typical Goat-suckers (*Caprimulgus*) It will be seen from the table that the little arrested toes of the Swift somewhat reverse the order of things, the inner toe being longer than the outer. This little child of the sky has not more than three phalanges in any of its toes; but the forward-turned hallux has two joints like other birds.

We have only space here to refer to Dr. Humphrey's invaluable work on the 'Limbs of Vertebrate Animals,' and to say that he is quite opposed to Professor Owen's theory, which makes the scapulæ and iliac bones to be 'pleurapophyses:' they are not, in his (Dr. H.'s) opinion, '*pleural*,' but '*hæmal*.' Like most other anatomists, Dr. Humphrey is entirely opposed to the idea of the scapular arch being the hæmal part of the occipital sclerotome; he very truly says that the hyoid arch belongs to the occipital segment. (See Dr. Humphrey on 'The Human Skeleton,' p. 597; Report of the British Association, 1858, part 2, p. 126; and his work on the 'Limbs,' p. 32.)

Professor Goodsir classes the segments of the limbs of the Vertebrata in the same category as the 'appendages' or 'epi-pleural spines'—his 'actinapophysis' (*op. cit.*, p. 178).

In recapitulating the structural characters of the Balæniceps, only general remarks will be necessary. Truly, if the Boat-bill had been as yet undiscovered, with its beautiful, leaf-like, broadly arched upper jaw, and the little Umbre (*Scopus umbretta*) with its grooved and hooked beak, we might then have found our task difficult. Yet even then the highly modified conditions of the bill in other groups would have plentifully supplied us with helpful analogies. Even the families very nearly related to the Herons, as, for instance, the Ibis group, which contains the Spoonbill; the frailer forms of Waders, yielding us the Avocet; the Plovers with their knife-billed Oyster-catchers—all teach us what licence may be taken with the shape of the jaws for special reasons in the life of the bird, whilst the general structure is quite normal. In the Scansorial and Insessorial Orders (so potent in families, genera, and species), we are scarcely surprised at anything we meet with as to the form of the jaws and consequent modification of the structure of the outworks of the cranium. Seeing how many genera and species there are with such modifications of the jaws and cranium as we meet with in the Parrot group, the Woodpeckers, the Toucans and Araçaris, the King-fishers, the Hornbills, and the Humming-birds, we can scarcely forbear supposing that numberless links have been lost amongst the *Grallæ* and *Palmipeds*[1]. Looking at the *Totipalmate* family of the latter order, what great gulfs intervene between the Pelicans and the Cormorants, and respectively between the Gannet, Frigate-bird, and Tropic-bird (*Phaëton*)! With regard to Pelicans, Cormorants, and Gannets, their structure is certainly essentially the same, and can be confounded with no other group whatever; yet what a number of species, generic groups of species, ought to intervene between *Pelecanus* and *Phalacrocorax*, and between the latter and *Sula*! Nature is still more silent as to how she connected the Flamingos with the Geese: one of the links indeed has been found at the Goose end of this great gap, the *Cereopsis Novæ Hollandiæ*; but where are the others? Then, if these were found, we have to run up a long chain of forms between the Heron and the Flamingo; and we scarcely possess a link. Again, the great embryo-shaped reptilian Ostriches are only like a few widely distinct species belonging to family after family lost and gone for ever from the earth.

Compared with the paucity of species of the Ostrich group, the numbers without number of Corvine, Passerine, and Sylviine birds are truly wonderful; and all these families, with many more, have the same essential structure. It would require many a genus, each with its suite of species, to connect together, in the way the Passerine birds are connected together, the different members of the Ardeine group, especially if we include *Ciconia*, *Mycteria*, and *Anastomus*. Nevertheless the typical Herons (*e.g. Ardea*, *Botaurus*, *Nycterodius*, and *Egretta*) are rather numerous; and the modifications that have taken place in the Boat-bill and the Balæniceps do not at all affect the essential structure of these birds; these modifications may all be put down to the score of teleology.

A certain similarity has been mentioned between the structure of the Balæniceps, and that of the Pelican; but these are not relational modifications; and no arguments can be brought to prove the Balæniceps to be a Pelican but would almost equally serve to prove it to be a Parrot, a Serpentarius, or a Podargus.

If all the birds that have been, could be seen side by side with those that now are, it would be a goodly sight; no gaps *to leap* over, no missing links. Our knowledge of these things is in ' shreds and patches'; but still we can imagine that He who provided

[1] Whether this net-work of affinities owes its present incompleteness to losses of the past, or is to be filled up by future creations, it is after all impossible for us to determine. On the question of the potency of genera and species, see an admirable paper by the late Hugh E. Strickland, Ann. and Mag. Nat. Hist., Nov. 1840, p. 184.

the feast and invited the guests, did not set unrelated strangers side by side. George Herbert saw this long ago: he says,—

"Thy creatures leap not, but express a feast
"Where all the guests sit close, and nothing wants.
"Frogs marry fish and flesh; bats, bird and beast;
"Sponges, non-sense and sense; mines, the earth and plants*."

* Since this paper was written, the very interesting and important researches of Mr. A. D. Bartlett (see Proc. Zool. Soc. 1861, p. 131) have proved, beyond all dispute, that the *Balæniceps*, like the Boat-bill, is essentially a Heron. The structure of its dermal system is, in all important respects, the same as that of *Ardea*, *Cancroma*, *Eurypyga*, and *Botaurus*.

Our very first impression was that it would turn out to be much nearer akin to our native *Ardea cinerea* than to the Storks (*Ciconia*, *Leptoptilus*, and *Mycteria*).

The genus *Cancroma* might be placed sub-generically to *Balæniceps*; yet although the former has the most out-spread bill, it is less aberrant from the true Herons than the latter. Indeed the Balæniceps seems, as it were, to have borrowed characters from the Umbre (*Scopus*)—a bird not so nearly related to the Herons as itself,—and also from the Ibises on one hand, and from the Macrodactylous Rails on the other.

Not only does the Umbre differ from the true Herons, the Boat-bill, and the Balæniceps in the absence of the curious and characteristic powder-down patches, but its whole style of colouring is different; moreover the grey tint and the mealiness of the feathers of Balæniceps are truly ardeine, whilst the sad yet sinister aspect of its eyes leaves no doubt upon the mind as to its real affinities.

The skull of *Cancroma* would have been a perplexing study without the rest of its skeleton, which is remarkably normal, being that of a true Heron shortened in joint and limb. Now add to that shortening of the joints and members of a truly ardeine skeleton which we see in *Cancroma* the necessary robustness, and we have the osseous structure of Balæniceps at once.

But even in the enormous face and skull of this latter bird we have still nothing but teleological modifications; and the character of the Heron's skull is impressed upon every part.

The only real difference between the vertebræ of *Cancroma* and those of *Ardea* is the comparative shortness of those of the former; the vertebræ of *Balæniceps* are simply those of a gigantic Boat-bill.

The sternal apparatus of *Balæniceps* is the most extraordinary part of its structure; for although the scapulæ and coracoids are normal, yet the furculum and the sternum have undergone very unlooked-for changes. The furculum has very much the structure of that of the Totipalmatæ, and its angle is still more completely fused with the anterior end of the sternal keel than in birds of that family. In many respects the sternum is intermediate between that of the Heron and the Adjutant; but its anterior part is modified like that of the Scansores,

EXPLANATION OF PLATES.

PLATE LXIV.

Figures of male BALÆNICEPS REX from the living bird in the Zoological Gardens.

PLATE LXV.

Skull of BALÆNICEPS REX (Nat. size).

Fig. 1. Side view of skull.
- *pro.* Par-occipital process.
- *fo.* Passage leading to the fenestra ovalis.
- *m.* Upper mastoid eminence.
- *ep.* Epiotic eminence.
- *p.* Parietal.
- *fr.* Frontal.
- *tf.* Temporal fossæ.
- *sq.* Squamosal.
- *pf.* Post-frontal.
- *tr.* Passage for trigeminal nerve—foramen ovale.
- *op.* Optic foramen.
- *as.* Ali-sphenoid.
- *pt.* Petrosal.
- *bs.* Basi-sphenoid.
- *os.* Orbito-sphenoid.
- *psp.* Pre-sphenoid[1].
- *of.* Groove for the olfactory nerve.
- *l.* Lacrymal.
- *n.* Nasal.
- *npg.* Nasal passage. (The dotted line is on the septum.)
- *pmx.* Pre-maxillary.
- *eth.* Ethmoidal or anterior margin of pre-sphenoid of Goodsir; ethmoid of authors.
- *mr.* Malar; an oblique tract in front of the malar is the maxillary.
- *qj.* Quadrato-jugal.
- *q.* Os quadratum.
- *pal.* Palatine.
- *pg.* Pterygoid.

Fig. 2. Side view of mandible.
- *d.* Dentary.
- *sy.* Symphysis menti.
- *sag.* Surangular.
- *ag.* Angular.
- *art.* Articular.

Fig. 3. End view of skull.
- *c.* Hemispherical occipital condyle (end of basi-occipital).
- *fm.* Foramen magnum.
- *vg.* Passage for the vagus nerve.
- *eo.* Ex-occipital, spreading into the par-occipital process.
- *m.* Upper mastoid eminence.
- *ep.* Epiotic eminence.
- *so.* Supra-occipital crest.

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whilst the posterior part has marked Ralline and even Ibidine characters. The long toes, moreover, are like those of the Macrodactyli; but the leg-bones and the bones of the upper extremities are, save in point of size, exactly the counterpart of those of the common Grey Heron.

[1] The letters *psp* are on that part of the intero-orbital septum where the 'ethmoid' of authors has coalesced with the true pre- or rather orbito-pre-sphenoid: in the text we have followed Professor Goodsir (whom we now believe to be wrong) in attributing most of the septum to the pre-sphenoid.

tf. Temporal fossa.
sq. Squamosal.
pf. Post-frontal.
bt. Basi-temporal.
q. Os quadratum.

Fig. 4. Upper view of mandible.
d. Dentary.
sy. Symphysis menti.
sag. Surangular.
art. Articular.
cr. Coronoid.
sp. Splenial.

Fig. 5. End view of mandible.
sag. Surangular.
ag. Angular.
art. Articular.
iap. Internal angular process.

Fig. 6. Upper view of skull and mandible.
m. Upper mastoid eminence.
ep. Epiotic eminence.
sq. Squamosal.
p. Parietal.
pf. Post-frontal (mesial of this process —the bone belongs to the frontal).
n. Nasal.
l. Lacrymal.
npp. Nasal processes of pre-maxillaries (these letters are in front of the hinge).
npg. Nasal passages.
g. Great sub-mesial groove.
pmx. Pre-maxillaries.
mx. Zygomatic process of maxillary.
mr. Malar.
qj. Quadrato-jugal.
q. Os quadratum.
d. Dentary.
sag. Surangular.

Fig. 7. Basal view of skull.
c. Condyle of basi-occipital.
fm. Foramen magnum.
eo. Ex-occipital.
pro. Par-occipital process.
bt. Basi-temporals.
pt. Fissure between basi-temporal and basi-sphenoid leading to petrosal.
bs. Basi-sphenoid.
eu. Groove for eustachian tubes.
sq. Part of quadratum articulating with squamosal.
fr. Frontal.
eth. Lateral ethmoidal region beneath the hinge.
pmx. Pre-maxillaries.
mg. Mesial groove.
lg. Lateral groove.
tb. Inferior turbinals (pterapophyses).
pn. Posterior nares.
v. Vomer.
pal. Palatines.
pg. Pterygoids.
mx. Maxillary.
qj. Quadrato-jugal.
q. Os quadratum.

PLATE LXVI.

Skeleton and Hyoid Bones.

Fig. 1. Side view of skeleton of *Balæniceps rex*, half nat. size.
at. Atlas.
ax. Axis.
cv. Cervical vertebræ.
cc. Carotid canals.

hp. Hypo-parapophysis.
sc. 1st dorsal vertebra (the dotted line leads to the scapula).
sc. Lower part of sacrum.
cd. Caudal vertebræ.
ap. Appendages of ribs.
il. Ilium.
in. Ischiadic notch or *foramen.*
ism. Ischium.
pb. Pubis.
st. Sternum.
cp. Costal process.
fc. Furculum (behind this bone is the coracoid).
sc. Scapula (upper letters).
h. Humerus.
r. Radius.
u. Ulna.
ol. Olecranon.
*cp*1. Upper carpal.
*cp*2. Lower carpal.
mc. Metacarpus (the bones below these are the phalanges).
fm. Os femoris.
tb. Tibia.
fb. Fibula.
tmt. Tarso-metatarsus.
*tmt*2. Metatarsal of second toe or hallux.
*c*2. Condyle of hallux.
*d*2. Hallux or true second toe.
*d*3. Third or inner toe.
*d*4. Fourth or middle toe.
*d*5. Fifth or outer toe.

Fig. 2. Hyoid bones, half nat. size.
bh. Basi-hyal, with rudiment of uro-hyal.
th. Thyro-hyal (the joint between the proximal and distal pieces is not shown in this figure).

Fig. 3. Posterior aspect of atlas, nat. size.
z. Post-zygapophysis.

Fig. 4. Lateral aspect of atlas, nat. size.

Fig. 5. Inferior aspect of 9th cervical vertebra, nat. size.
pl. Pleurapophysis.
pr. Parapophysis.
cc. Carotid canal.
c. Centrum.

Fig. 6. Superior aspect of 9th cervical vertebra, nat. size.
c. Centrum.
d. Diapophysis.
prz. Pre-zygapophysis.
ptg. Post-zygapophysis.

Fig. 7. Superior aspect of a dorsal vertebra (middle dorsal region), nat size.
sp. Spine (metaneurapophysis).
d. Diapophysis.
prz. Pre-zygapophysis.
ptz. Post-zygapophysis.

Fig. 8. Anterior aspect of tibio-tarsal joint, nat. size.
tb. Tibia, distal end.
tmt. Tarso-metatarsus, proximal end.

Fig. 9. Posterior aspect of tibio-tarsal joint, nat. size.
tb. Tibia, distal end.
tmt. Tarso-metatarsus, proximal end.

Fig. 10. Anterior aspect of distal end of tarso-metatarsus, nat. size.
tmt. Tarso-metatarsus, proximal end.
*c*3, *c*4 & *c*5. Condyles for 3rd, 4th & 5th toes.

Fig. 11. Posterior aspect of distal end of tarso-metatarsus, nat. size.
tmt. Tarso-metatarsus.
*c*3, *c*4 & *c*5. Condyles for 3rd, 4th & 5th toes.

PLATE LXVII.

Sternum and Pelvis of BALÆNICEPS REX.

Fig. 1. Inferior aspect of sternal apparatus, nat. size.
sy. Symphysis of furculum.
cor. Coracoid.
k. Keel of sternum.
cp. Costal process of sternum.
ap. Articular processes for hæmapophyses.
mp. Median or xiphoid process.
smp. Sub-median process.
hy. Hypo-sternal process.

Fig. 2. Superior aspect of pelvis, nat. size.
sp. Spine of 1st sacral vertebra.
sc. Middle sacral region.
cd. Caudal vertebræ.
pl. Pleurapophysis of 2nd caudal.
d. Diapophysis.
sp. Spine of 4th caudal.
il. Ilium.
ism. Ischium.
pb. Pubis.
ac. Acetabulum.
aem. Articular eminence for great trochanter.

Fig. 3. Inferior aspect of pelvis, nat. size.
as. Anterior articulating surface of centrum of 1st sacral.
pr. Parapophysis of 1st sacral.
dd. Diapophyses of 1st and 2nd sacral.
pl. Pleurapophyses.
hy. Hypophysis of 4th caudal.
il. Ilium.
ism. Ischium.
pb. Pubis.
ach. Region of anchylosis of pelvic elements.
aem. Articular eminence for great trochanter.

Fig 6

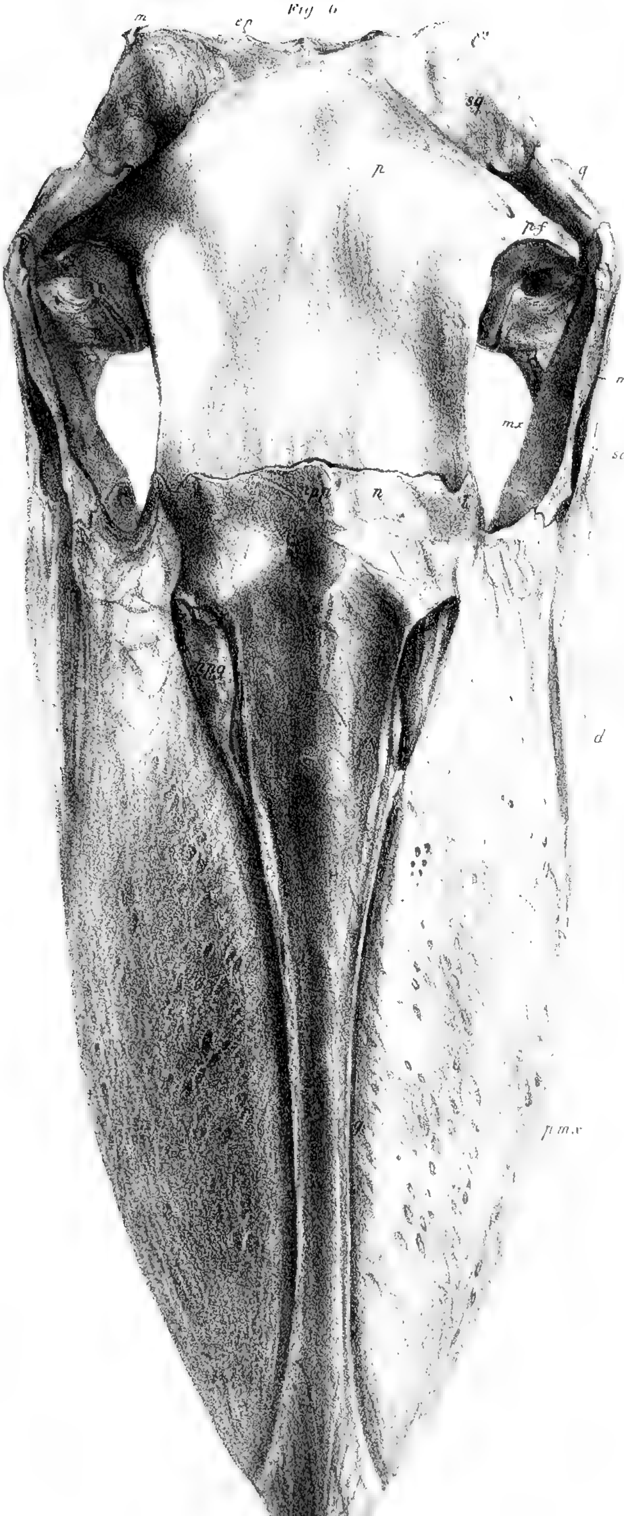
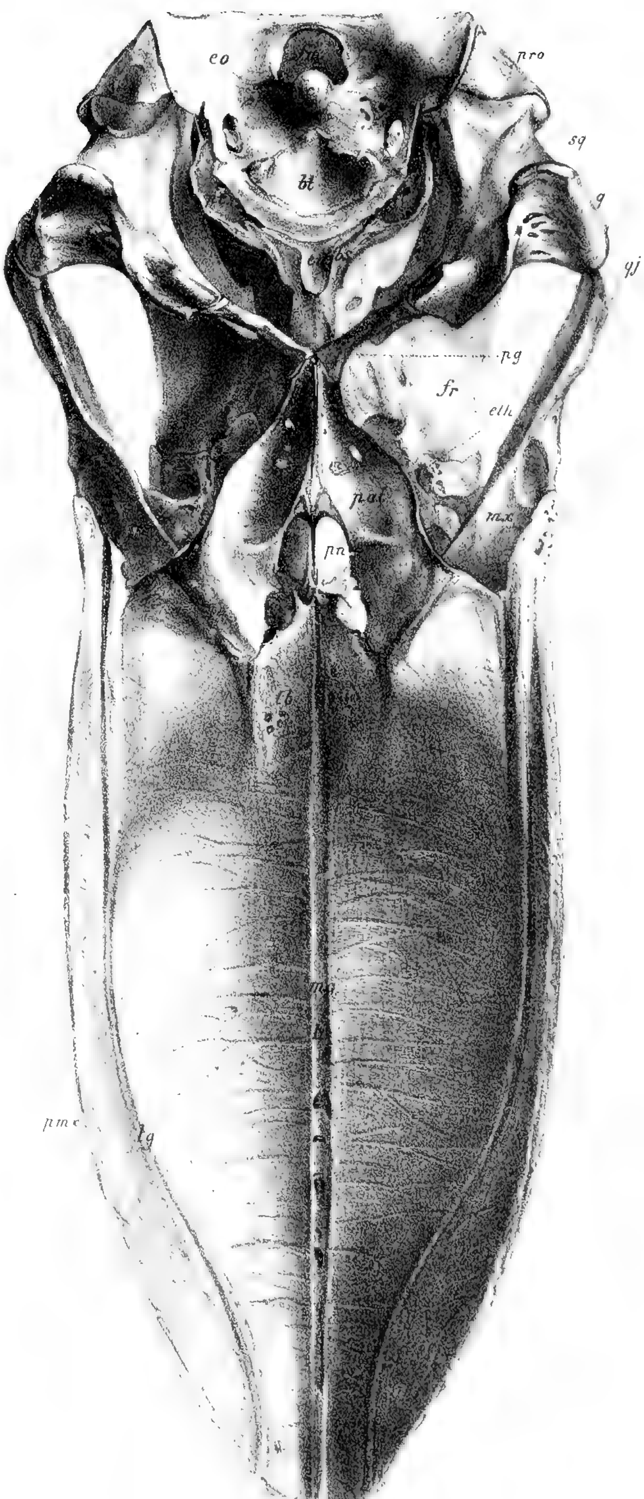


Fig 7



Printed by M & N Hanhart.

[illegible] Gould

From Nat. on Stone by J. Erxleben.

Printed by M. & N. Hanhart.

Balæniceps rex, Gould.

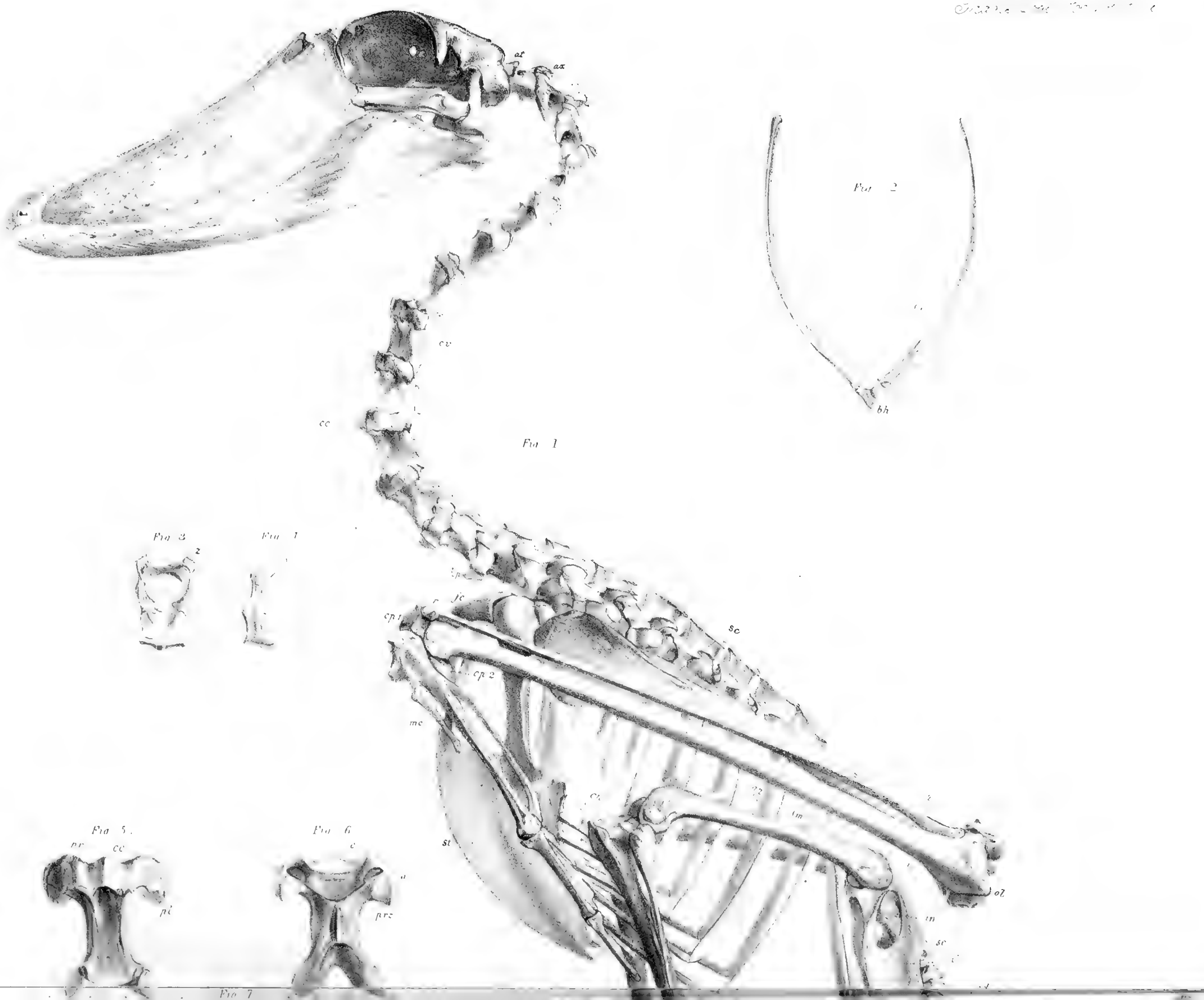


Fig. 1
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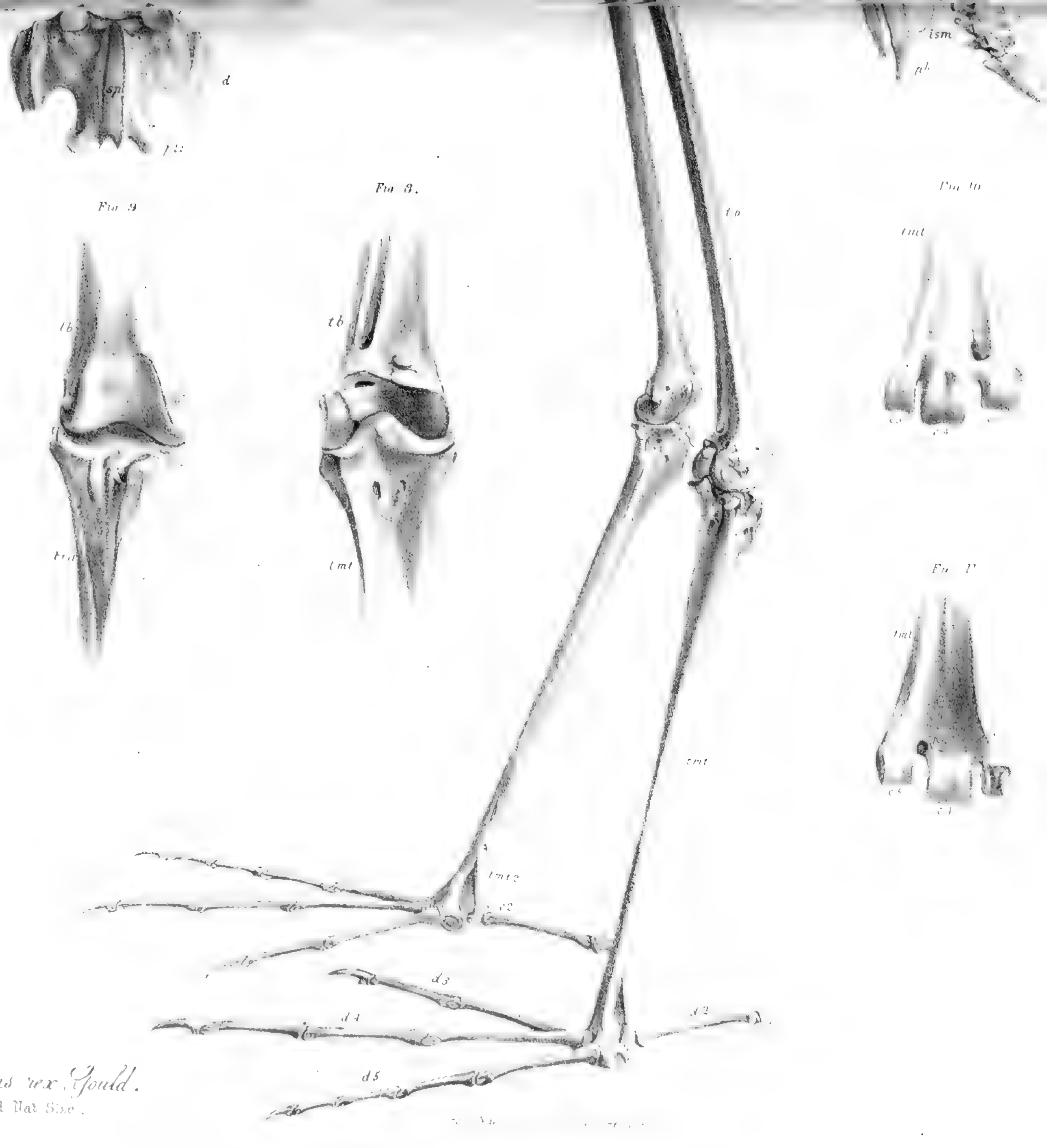


Balæniceps rex, Gould.
⅓ ord Nat Size.

Fig. 3

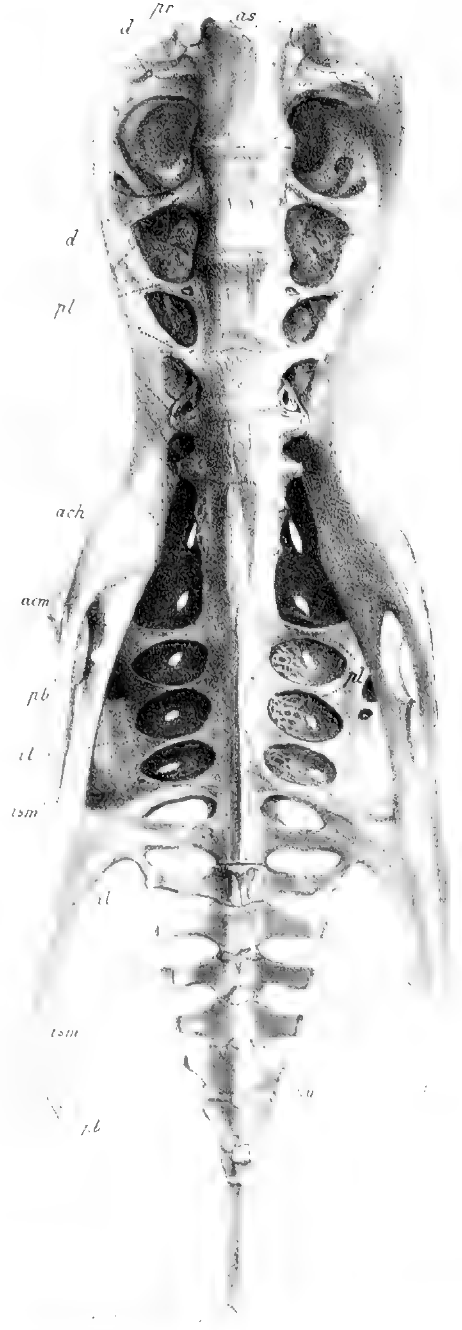


Fig. 2

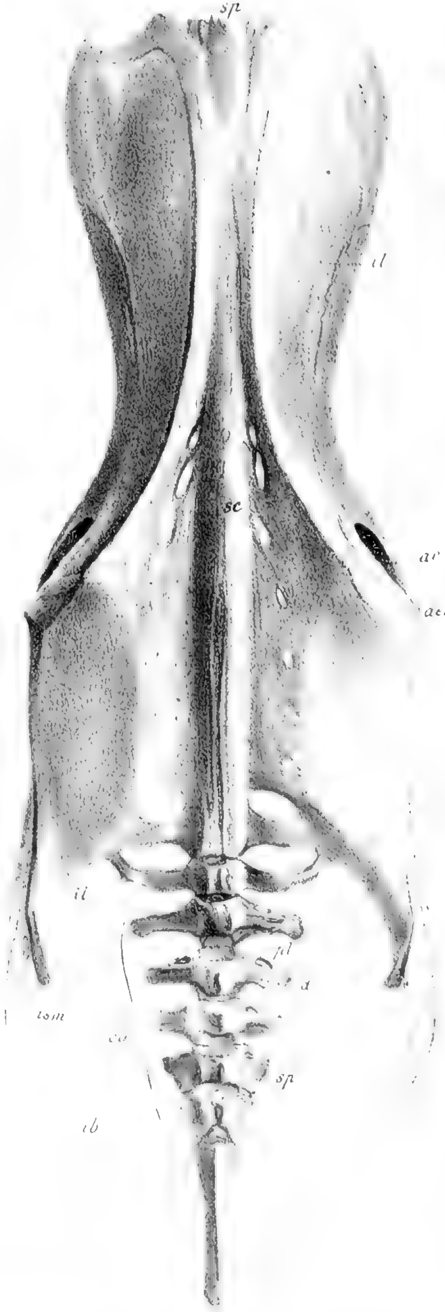


Fig. 1

XXIII. *On the Struthious Birds living in the Society's Menagerie.* By PHILIP LUTLEY SCLATER, *M.A., Ph.D., F.R.S., &c., Secretary to the Society.*

Read April 24 and May 8, 1860.

[PLATES LXVII. *a.*—LXXVI.]

THE collection of Struthious birds now living in the Society's Gardens is by far the finest and the largest ever yet brought together, embracing, as it does, examples not only of all the older known members of the group, but likewise of several others, which appear to be new and hitherto undescribed species or varieties of these birds. The able pencil of Mr. Wolf has produced a series of beautiful sketches of these birds, from which the accompanying illustrations have been chiefly drawn on stone by Mr. J. Jury. The occasion seems favourable for attempting to give a general *résumé* of the present state of our knowledge of the species of this interesting family, which was until lately supposed to consist only of four or five recent representatives, but has received within these last few years so remarkable an addition to its number of known species.

The Order *Struthiones*, or *Cursores* as it is also called, embraces those birds which, not requiring their wings for purposes of flight or for movement in the water, have the sternum unprovided with the normal crest which usually serves for the attachment of the pectoral muscles. In this and other points of their osteology and anatomy, they are so different from the more typical birds, that more than one authority has divided the class "Aves" into two great divisions—one of them containing only the *Struthiones*, and the other all the remainder of the class of Birds[1].

Though the members of the Order *Struthiones* now existing on the earth's surface are but few in number, we have good reason to believe that at a comparatively recent geological epoch they were, in some localities, numerous. Treating, however, at present only of the recent species, we find them constituting two very distinct groups or families. The first of these, the *Struthionidæ* or Ostriches, embraces the largest and in some respects the most Mammal-like of the whole class of Birds; in the other, the *Apterygidæ* or Kiwis, the species are of small size, and present, in some respects, almost Reptilian characters. The Order *Struthiones* thus embraces two of the most abnormal types of the whole Class, which are nevertheless allied by unmistakeable characters into one group.

The following table will serve to show some of the more noticeable characters by

[1] Merrem, who calls these divisions *Aves carinatæ* and *Aves ratitæ*, and De Blainville, who applies to them the terms *Tropidosterniens* and *Homalosterniens* ('Organisation du Règne Animal'). Nitzsch, in his treatise on the Carotid Artery of Birds, places this order at the end of his system, under the name *Platysternæ*.

which the six known generic types of *Struthiones* may be distinguished from one another.

Fam. I. STRUTHIONIDÆ.

Majores: rostro brevi, robusto: naribus basalibus: digito postico nullo.

a. STRUTHIONINÆ: plumis simplicibus, hyporrhachide obsoleta: alis plumosis.

α. Pedibus didactylis . . . . 1. *Struthio.*

β. Pedibus tridactylis . . . . 2. *Rhea.*

b. CASUARIINÆ: plumis duplicibus, hyporrhachide ipsam plumam fere æquante: alis fere implumibus.

α′. Capite nudo, galeato: digiti interioris ungue elongato valido . . . . 3. *Casuarius.*

β′. Capite plumoso: digitorum unguibus brevibus . . . . 4. *Dromæus.*

Fam. II. APTERYGIDÆ.

Minores: rostro elongato: naribus apicalibus: plumis attenuatis, criniformibus, simplicibus: alis fere evanescentibus: digito postico brevi, ungue armato . . . . 5. *Apteryx.*

Taking these genera in order, I now proceed to give some account of the various species which compose them. As my notes are taken from living birds, it is obviously impossible to attempt to found accurate diagnoses of the species upon them.

I. STRUTHIO.

The Æthiopian type of the *Struthionidæ* (the most perfect of the kind, as is the Æthiopian type of the Anthropoid Apes) requires our first attention. I have long suspected that the Ostrich of Southern Africa, when closely compared with the bird of the Sahara, will turn out to be a different species, and I know that many other naturalists share my views. The eggs, as Mr. Bartlett has shown, when exhibiting his fine series of the eggs of *Struthionidæ* before the Society[1], seem to present well-marked differences. That attributed to the Southern bird is smaller and very much smoother and less deeply pitted, the granulations in some specimens being nearly evanescent. But I have reason to believe that the Southern bird is the larger in size. Through the unfortunate loss of both the young Ostriches presented to the Society by Sir George Grey last summer, we have missed the opportunity which we should otherwise have had of comparing them with the noble examples of the Northern bird which grace our Menagerie; but as Sir George Grey, who is now returning to the Cape Colony, has promised to obtain for us other adult examples, there is every reason to believe that we shall ere long be able to make the desired comparisons[2].

[1] See Proc. Zool. Soc. 1860, p. 205.

[2] On the 1st of November, 1861, three fine birds of the Southern Ostrich arrived at the Gardens, from the

Prince Bonaparte has invented a name, *Struthio epoasticus* (!) (Compt. Rend. xliii. p. 785), which refers, I believe, to the story that one species of Ostrich has been stated to sit upon its eggs (*ἐπωάζειν*); but I do not believe that this is intended for either the Northern or Southern bird as distinguished from each other.

The Ostrich of the Syrian and Arabian Deserts, mentioned by Col. Chesney (Journ. Euphr. Exp. i. p. 588), Dr. Layard (Nineveh, i. p. 324), and other writers, and frequently referred to in the Holy Scriptures[1], should also be carefully examined. It is not improbable that it may turn out to be a third species or well-marked local variety.

In the interior of Africa there is said, by some of the older writers, to exist a diminutive Ostrich (*L'Autruchon*). I have lately received some information on this subject from Mr. J. Petherick, H.B.M. Consul for the Sudan, who tells me that his hunters have actually had this bird alive; and I have requested him to endeavour to procure further evidence on this point.

The figure (Pl. LXVII. *a.*) represents a very fine adult male of the Northern Ostrich, received with two females from Barbary in 1859, and presented to the Society by Her Majesty The Queen.

II. Rhea.

Of the American form of the *Struthionidæ* we have living examples of three species.

1. Rhea americana. (Pl. LXVIII.)

Struthio rhea, Linn.
Rhea americana, Lath.

Fig. 1.

Cape, under the care of the Society's agent, Mr. Benstead. They are now placed next to the Society's former examples, which were received from Barbary in 1859. The most noticeable differences observable in the living birds are that the naked skin in the Cape examples is bluish (not reddish), and the neck thickly feathered, the top of the head being also covered with hair-like feathers. In the Barbary bird the top of the head is *bare*.

[1] Isaiah, ch. xiii. ver. 21: Lamentations, iv. 3: Job, xxxix. 13 *et seq.*

Of the Common American Rhea we have an adult female, from which the figure has been taken. She is kept in company with the male of the next species.

2. Rhea macrorhyncha. (Pl. LXIX.)

Rhea macrorhyncha, Sclater, P. Z. S. 1860, p. 207.

In November 1858 the late Mr. Thompson purchased for the Society, in Liverpool, a young *Rhea,* which now seems to have nearly attained its adult growth. It proves to be so remarkably different from the Common Rhea (*Rhea americana*) and the Darwin's Rhea (*Rhea darwinii*), examples of which are kept in the same inclosure with it, that I have little hesitation in characterizing it as of a different species; and in so doing I believe I have the concurrence of Mr. Gould, Mr. Bartlett, and other naturalists who have had an opportunity of examining the bird.

Fig. 2.

The Long-billed Rhea (*Rhea macrorhyncha*), as I propose to call it, is a much smaller bird than the Common Rhea. The example in the Gardens (a male) stands about 6 inches lower than the female of the American Rhea which is in its company; and we may reasonably suppose that the female is proportionately smaller. The bill is much longer than that of the Common Rhea, as may be seen from the drawings (woodcuts, figs. 1, 2, 3), which represent the heads of the three species; and the head-feathers are longer and more closely flattened down. On the other hand, the tarsi are much more slender, and the toes much shorter. The thighs are less thickly clothed than in the Common Rhea; but the scutellation of the tarsi seems to be nearly the same in both these birds, and offers a marked contrast to that of *Rhea darwinii,* in which the tarsi are for the greater part covered with reticulated scales. The feathers of the body are longer in the Long-billed Rhea, and curve round it, hiding the outline, in a manner not observable in the Common Rhea. With regard to colouring the new species is also very different, being of a brownish-grey mixed with black, and altogether much darker than *Rhea americana.* The bird, which is a male, is represented (Pl. LXIX.) in the act of setting his feathers, as he constantly does, when in company with the female *R. americana,* throughout the spring and summer.

3. Rhea darwinii. (Pl. LXX.)

Rhea darwinii, Gould, P. Z. S. 1837, p. 35 ; Darwin, Zool. Voy. Beagle, iii. p. 123. pl. 47.

Fig. 3.

Of this very distinct species of *Rhea* we have the fine male bird, purchased October 20th, 1858, which is represented in the accompanying plate (Pl. LXX.). Judging from this specimen, Darwin's Rhea, instead of being smaller than the common species, as is usually supposed to be the case, seems to be the finest and the largest of the group, and certainly most *Ostrich*-like in its characters of the three. I cannot, therefore, help thinking that the "Avestruz petise" which Mr. Darwin alludes to in his Journal[1] may possibly be the *Rhea macrorhyncha,* and not the *Rhea darwinii,* as he has been inclined to suppose. It would be very interesting to learn the exact geographical distribution of these three species.

III. Casuarius.

This genus, of which until very recently the *Casuarius galeatus* was the only known representative, has lately received a remarkable addition to its number of species. Three different Cassowaries are at the present moment living in our Gardens ; and two others have been recently described, one of which certainly appears to have every claim to be considered a distinct species.

[1] Journal of Researches, &c. (1860) p. 93.

1. Casuarius galeatus. (Pl. LXXI.)

Struthio casuarius, Linn.
Casuarius emeu, Lath.
Casuarius galeatus, Vieill.

The true locality of this Cassowary (which is usually supposed to be found in New Guinea) I believe to be Ceram[1]—specimens in the Leyden Museum having been collected in that island by Forsten. We have a nearly adult male of this species, purchased in 1859, at present in the Menagerie.

2. Casuarius bicarunculatus. (Pl. LXXIII.)

Casuarius bicarunculatus, Sclater, P. Z. S. 1860, pp. 211, 248.

Under this name I distinguish a young Cassowary now living in the Gardens, which we have lately received in exchange from the Zoological Gardens of Rotterdam. It presents the general outward characteristics of the immature *Casuarius galeatus*; but, instead of having the neck-wattles joined at base, as in that species (fig. *a*), it has them perfectly separated, and the space between them occupied by the continuation down-

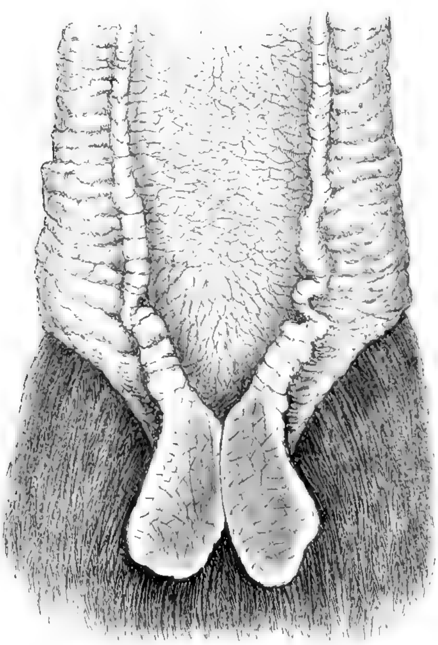


Fig. *a*.

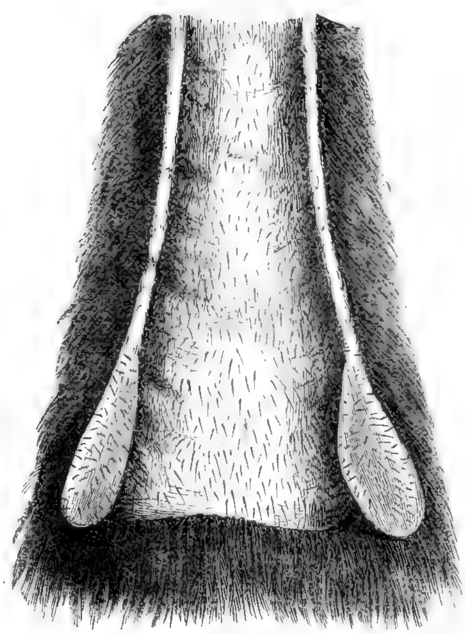


Fig. *b*.

[1] Mr. Wallace says ('Ibis,' 1861, p. 286), "the Cassowary occurs rather plentifully over the whole interior of Ceram; but I was never able to obtain or even to see a specimen."

wards of the smooth skin of the neck above (fig. *b*). I have never observed any variation in this point in any specimens of the Common Cassowary, and can hardly doubt this bird being the young of some other unknown species.

3. Casuarius uniappendiculatus. (Pl. LXXIV.)

Casuarius uniappendiculatus, Blyth, Journ. A. S. Beng. xxix. p. 112.

This Cassowary has been lately described by Mr. Blyth from a specimen living in the Menagerie of the Babu Rajendra Mullick at Calcutta[1] in March, 1860. The figure has been enlarged from a sketch of the bird kindly furnished to me by Mr. Blyth. The following are Mr. Blyth's remarks on this new species:—

"*Casuarius uniappendiculatus*, nobis, n. s., from its peculiarity of having but a single pendulous caruncle in front of the neck. Specimen apparently more than half-grown, and much paler in the colouring of its plumage than specimens of the same age of the common *C. galeatus*, two fine examples of which are associated with it in the same paddock. In lieu of the two bright-red caruncles of the latter, the new species has but a single small oblong or elongate oval *yellow* caruncle; and the bright colours of the naked portion of the neck are differently disposed. The cheeks and throat are smalt-blue, below which is a large wrinkled yellow space in front of the neck, terminating in front in the oval button-like caruncle, and its lower portion being continued round behind, while on the sides of the neck the yellow naked portion is continued down to its base, the bordering feathers more or less covering and concealing this lateral stripe of unfeathered skin: on the hind part of the neck the bare yellow skin is not tumous and corrugated as in the Common Cassowary, where also this part is bright red. The casque is about equally developed at this age in the two species. The legs of the new species are smaller, from which I doubt if it attains to quite so large a size as the other."

4. Casuarius bennettii. (Pl. LXXII.)

Casuarius bennettii, Gould, P. Z. S. 1857, p. 268, pl. 129, et Birds of Austr. Suppl. pt. iii. pls. 7 & 8; J. E. Gray, P. Z. S. 1858, p. 271; Bennett, P. Z. S. 1859, p. 32.

We have now in the Gardens three examples of this very distinct species of Cassowary, for all of which we are indebted to the energy and liberality of Dr. Bennett. The plate represents the adult male, received May 17th, 1857. The female of the pair subsequently received (May 25th, 1858) has laid several eggs in confinement. One of them (laid April 21st last) has been accurately figured in the Society's 'Proceedings' (1858, pl. clxii.).

[1] An example doubtless referable to this same species of Cassowary has since been received in Europe, and is now living in the Gardens of the Zoological Society "Natura artis magistra" of Amsterdam. See 'Ibis,' 1860, p. 402, where a figure is given of the head of this bird, and a letter relating to it from Dr. G. Bennett.

5. CASUARIUS AUSTRALIS.

Casuarius australis, Wall, Illustrated Sydney Herald, June 2nd, 1861; Gould, P. Z. S. 1857, p. 270.

This Cassowary is only known from the account of it furnished to the newspaper above-named by Mr. William Sheridan Wall, late Curator of the Australian Museum at Sydney, and reprinted by Mr. Gould in the Society's 'Proceedings.' It is said to be distinguished by a "bright-red helmet and blue and scarlet caruncles." There is no example of this bird in any museum, the original skin obtained by Mr. Wall having been unfortunately lost[1].

IV. DROMÆUS.

1. DROMÆUS NOVÆ-HOLLANDIÆ. (Pl. LXXV.)

This well-known bird appears to inhabit the interior of New South Wales and the whole eastern portion of the Australian continent. The figure is taken from a bird presented to the Society's Menagerie by the Marchioness of Londonderry in 1857.

2. DROMÆUS IRRORATUS. (Pl. LXXVI.)

Dromæus irroratus, Bartlett, P. Z. S. 1859, p. 205; Sclater, P. Z. S. 1860, p. 248.

The Emeu of Western Australia may, as was pointed out by Mr. Bartlett, when he first described it at a meeting of this Society in May 1859, be easily distinguished from the well-known Eastern bird by its spotted plumage. On comparing the feathers of the two species together, the mode in which this spotting is produced is clearly apparent. The feathers of *D. irroratus* are barred alternately with silky white and darkish grey throughout their length, terminating in a black tip margined posteriorly with rufous. Those of *D. novæ hollandiæ* are uniform blackish grey from the base to the extremity, which is black with a broad subterminal band of rufous. On comparing the two living birds together, we find *D. irroratus* generally of a much more slender habit. The tarsi are longer and thinner, and the toes longer and much more slender. The tarsal scutes are smaller. The irides are of a pale hazel instead of a reddish brown as in *D. novæ hollandiæ*.

The example of *D. irroratus* in the Gardens of the Zoological Society of Amsterdam was brought by a Dutch vessel from Albany, King George's Sound. I have reason to

[1] A sixth species of Cassowary has been described since the paper was read, under the name *Casuarius kaupi*, by Herr G. von Rosenberg, of Amboyna, in Cabanis's Journal für Ornithologie (1861, p. 44). It is from New Guinea and the island of Salawatty, and has *no caruncles* on the neck. The species will therefore now stand as follows:—

1. *C. galeatus,* ex Ceram.
2. *C. bicarunculatus,* ex loc. ignot.
3. *C. uniappendiculatus,* ex loc. ignot.
4. *C. kaupi,* ex Nov. Guinea et Salawatty.
5. *C. bennettii,* ex Nov. Britannia.
6. *C. australis,* ex Nov. Holland. Bor.

believe that our specimen is from the same locality. As Mr. Bartlett's original skin of *D. irroratus* was obtained in the interior of Southern Australia, the range of this Emeu must be supposed to extend over the western portion of Australia into the latter colony, where it probably inosculates with *D. novæ-hollandiæ*.

V. Apteryx.

But one example of this form of the *Struthionidæ* is believed to have ever been brought alive to Europe. This bird, which was presented to the Society in 1852 by Lieut.-Governor Eyre, and brought to England by Captain Erskine, R.N., of H.M.S. 'Havannah,' is still living in the Society's Menagerie, and in good health. It is a female bird of the species called *Apteryx mantelli*, if that be really distinct from *Apteryx australis*.

On the 9th June, 1859, this bird laid an egg. The egg when deposited weighed 14½ oz., the contents thereof weighing 13½ oz. The weight of the living bird was ascertained to be 60 oz.; so that in this species the egg nearly equals one-fourth of the whole weight of the bird[1].

To conclude my enumeration of the species of existing *Struthiones*, I add the following particulars concerning the known species of *Apteryx*, as drawn up by myself and Dr. F. v. Hochstetter for a Report to be presented at the next Meeting of the British Association.

1. Apteryx australis.

Apteryx australis, Shaw, Nat. Misc. xxiv. pls. 1057, 1058, and Gen. Zool. xiii. p. 71; Bartlett, Proc. Zool. Soc. 1850, p. 275; Yarrell, Trans. Zool. Soc. i. p. 71, pl. 10.

The *Apteryx australis* was originally made known to science about the year 1813, from an example obtained in New Zealand by Captain Barclay, of the ship 'Providence.' This bird, which was deposited in the collection of the late Lord Derby, was afterwards described at greater length in 1833, in the 'Transactions of the Zoological Society,' by Mr. Yarrell, and was still, at that date, the only specimen of this singular form known to exist. Examples of *Apteryges* subsequently obtained, though generally referred to the present species, have mostly belonged to the closely allied *Apteryx mantelli* of Bartlett, as we shall presently show, though specimens of the true *Apteryx australis* exist in the British Museum and in several other collections.

The original bird described by Dr. Shaw is stated by Mr. Bartlett (Proc. Zool. Soc. 1850, p. 276) to have come from Dusky Bay, in the province of Otago, Middle Island, whence Dr. Mantell's specimen, upon which Mr. Bartlett grounded his observations as to the distinctness of this species from *Apteryx mantelli*, was also procured.

Dr. Hochstetter was able to learn nothing of the existence of this *Apteryx* in the

[1] Several other similar eggs have been laid by the same bird since that date.

province of Nelson in the same island. In fact, the species is so closely allied to the *Apteryx mantelli* as to render it very desirable that further examples of it should be obtained, and a rigid comparison instituted between the two. For the present, however, we must regard this form of *Apteryx* as belonging to the southern portion of the Middle Island.

2. APTERYX OWENII.

Apteryx owenii, Gould, P. Z. S. 1847, p. 94; Birds of Australia, vi. pl. 3.

Owen's *Apteryx*, which is readily distinguished from the preceding species and *A. mantelli* by its smaller size, transversely barred plumage and slender bill, was first described by Mr. Gould in 1847, from an example procured by Mr. F. Strange, and "believed to have been obtained from the South Island." Since that period other specimens have been received in this country, which have sufficed to establish the species; and, from the information obtained by Dr. von Hochstetter, there is no doubt of this being the common *Apteryx* of the northern portion of the Middle Island.

"In the spurs of the Southern Alps on Cook's Strait, in the province of Nelson," says Dr. von Hochstetter, "that is, in the higher wooded mountain-valleys of the Wairau chain, as also westwards of Blind Bay, in the wooded mountains between the Motucka and Aorere valleys, Kiwis of this species are still found in great numbers. During my stay in the province of Nelson I had myself two living examples (male and female) of this species. They were procured by some natives, whom I sent out for this purpose, in the upper wooded valleys of the river State, a confluent of the Aorere, in a country elevated from 2000 to 3000 feet above the sea-level. It appears that this *Apteryx* still lives very numerously and widely spread in the extended southern continuations of the Alps."

3. APTERYX MANTELLI.

Apteryx australis, Gould, Birds of Australia, xi. pl. 2.
Apteryx mantelli, Bartlett, P. Z. S. 1847, p. 93.

The characters which distinguish this commoner and better-known *Apteryx* from the true *A. australis* of Shaw were pointed out by Mr. Bartlett at the meeting of the Zoological Society held on the 10th Dec. 1850:—"This bird differs from the original *Apteryx australis* of Dr. Shaw," says Mr. Bartlett, "in its smaller size; its darker and more rufous colour; its longer tarsus, which is scutellated in front; its shorter toes and claws, which are horn-coloured; its smaller wings, which have much stronger and thicker quills; and also in having long straggling hairs on the face."

Mr. Bartlett tells us that, as far as he has been able to ascertain, all specimens of *Apteryx mantelli* are from the Northern Island; and this is completely confirmed by Dr. von Hochstetter's observations, which are as follows:—

"In the northern districts of the Northern Island this species of *Apteryx* appears to have become quite extinct. But in the island called Houtourou, or Little Barrier Island (a small island, completely wooded, rising about 1000 feet above the sea-level, and only accessible when the sea is quite calm), which is situated in the Gulf of Hauraki, near Auckland, it is said to be still tolerably common. In the inhabited portions of the southern districts of the Northern Island also, it is become nearly exterminated by men, dogs, and wild cats, and is only to be found here in the more inaccessible and less populous mountain-chains—that is, in the wooded mountains between Cape Palliser and East Cape.

"But the inhabitants of the Northern Island speak also of two sorts of Kiwi, which they distinguish as Kiwi-nui (Large Kiwi) and Kiwi-iti (Small Kiwi). The Kiwi-nui is said to be found in the Tuhna district, west of Lake Taupo, and is, in my opinion, *Apteryx mantelli*. The Kiwi-iti may possibly be *Apteryx owenii*, though I can give no certain information on this subject."

4. Apteryx maxima.

"*The Fireman*," Gould in Birds of Australia, sub tab. 3. vol. vi.
"*Apteryx maxima*, Verreaux," Bp. Compt. Rend. Acad. Sc. xliii. p. 841.
"*Roa-roa*" of the natives of the Southern Island.

The existence of a larger species of *Apteryx* in the Middle Island of New Zealand has long ago been affirmed; and though no specimens of this bird have yet reached Europe, the following remarks of Dr. von Hochstetter seem to leave no reasonable doubt of its actual existence:—

"Besides *Apteryx owenii*, a second larger species lives on the Middle Island, of which, although no examples have yet reached Europe, the existence is nevertheless quite certain. The natives distinguish this species not as a *Kiwi*, but as a *Roa*, because it is larger than *A. owenii* (*Roa* meaning 'long' or 'tall').

"John Rochfort, Provincial Surveyor in Nelson, who returned from an expedition to the western coast of the province while I was staying at Nelson, in his report, which appeared in the 'Nelson Examiner' of August 24th, 1859, describes this species, which is said to be by no means uncommon in the Paparoa elevation, between the Grey and Buller Rivers, in the following terms:—'A Kiwi about the size of a turkey, very powerful, having spurs on his feet, and which, when attacked by a dog, defends himself so well as frequently to come off victorious.'

"My friend Julius Haast, a German, who was my travelling companion in New Zealand, and in the beginning of the year 1860 undertook an exploring expedition to the southern and western parts of the province of Nelson, writes to me, in a letter dated July 1860, from ten miles above the mouth of the river Buller, on the mountains of the Buller chain, which at a height of from 3000 to 4000 feet were at that time (it being winter in New Zealand) slightly covered with snow, that the tracks of a large Kiwi of the size of a turkey were very common in the snow, and that at night he had often heard the singular cry of this bird, but that, as he had no dog with him, he had not succeeded in getting an example of it. He had, nevertheless, left with some natives in that district a tin case with spirits, and promised them a good reward if they would get him one of these birds in spirits and send it to Nelson by one of the vessels which go from time to time to the west coast."

EXPLANATION OF THE PLATES.

PLATE LXVII. *a.* Adult male *Struthio camelus*, from an example in the Society's Menagerie, received in February 1859 from Morocco.

PLATE LXVIII. Adult female *Rhea americana*, from an example in the Society's Menagerie, presented by George Wilks, Esq., July 15, 1856.

PLATE LXIX. Male *Rhea macrorhyncha*, from an example in the Society's Menagerie, purchased in November 1858.

PLATE LXX. Male *Rhea darwinii*, from an example in the Society's Menagerie, received in October 1858.

PLATE LXXI. Male *Casuarius galeatus*, from an example living in the Society's Menagerie, received in 1859.

PLATE LXXII. Male *Casuarius bennettii*, from the specimen presented by Dr. G. Bennett, F.Z.S., May 17th, 1857.

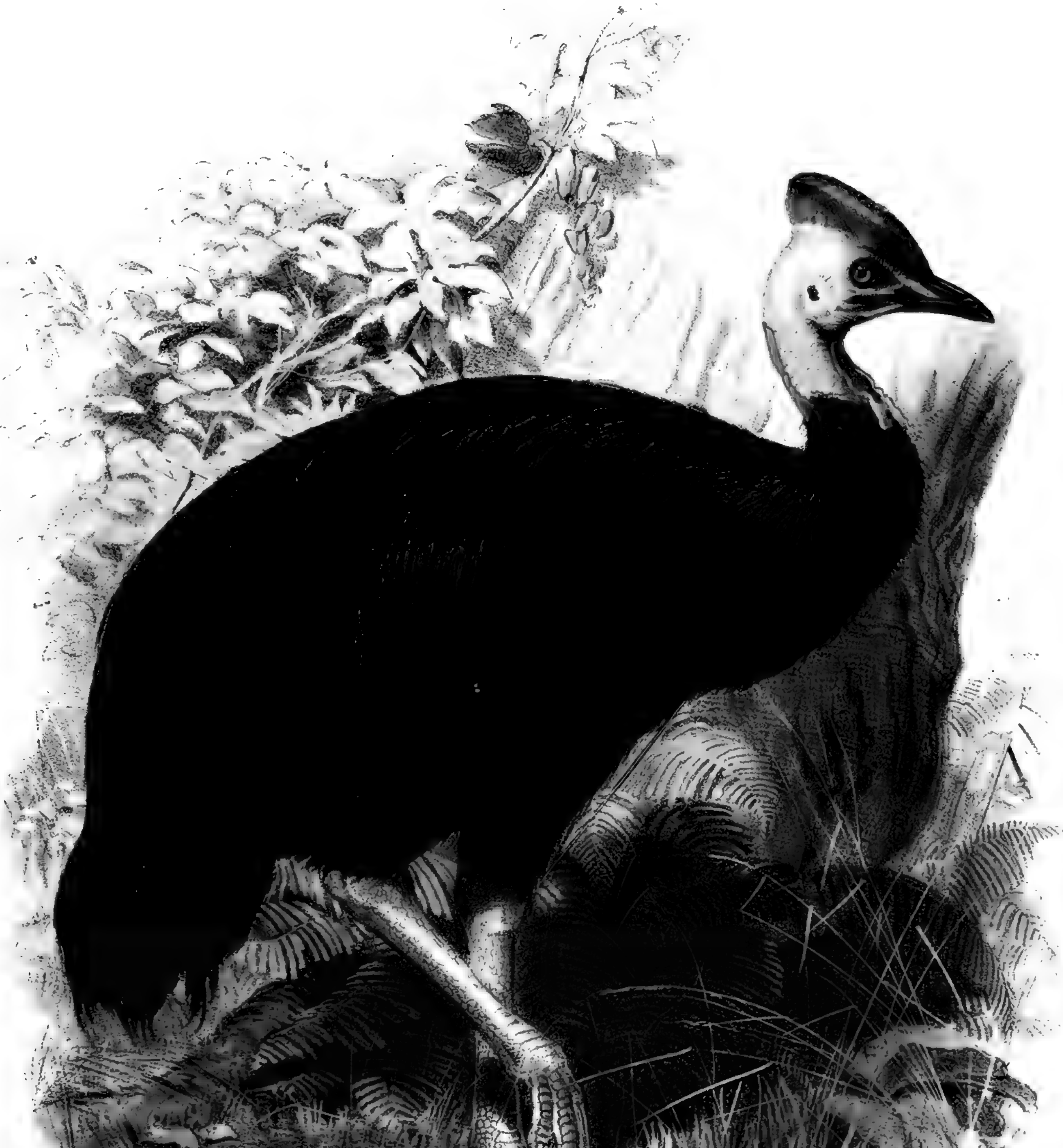
PLATE LXXIII. *Casuarius bicarunculatus*, juv., from the only example known, received in May 1860, now living in the Society's Menagerie[1].

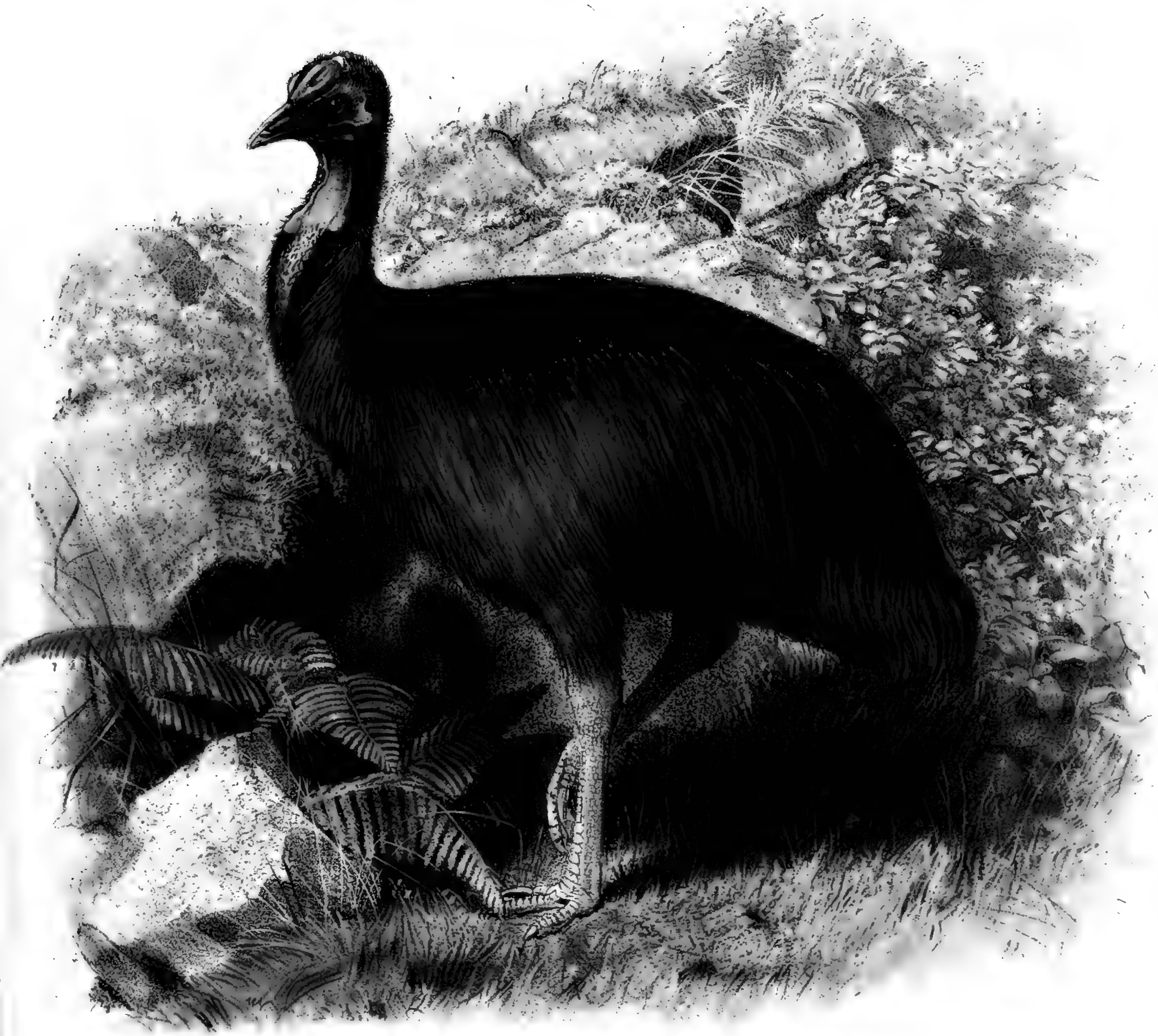
PLATE LXXIV. *Casuarius uniappendiculatus*, enlarged from a sketch of the bird living in Calcutta in 1860, by a native Indian artist.

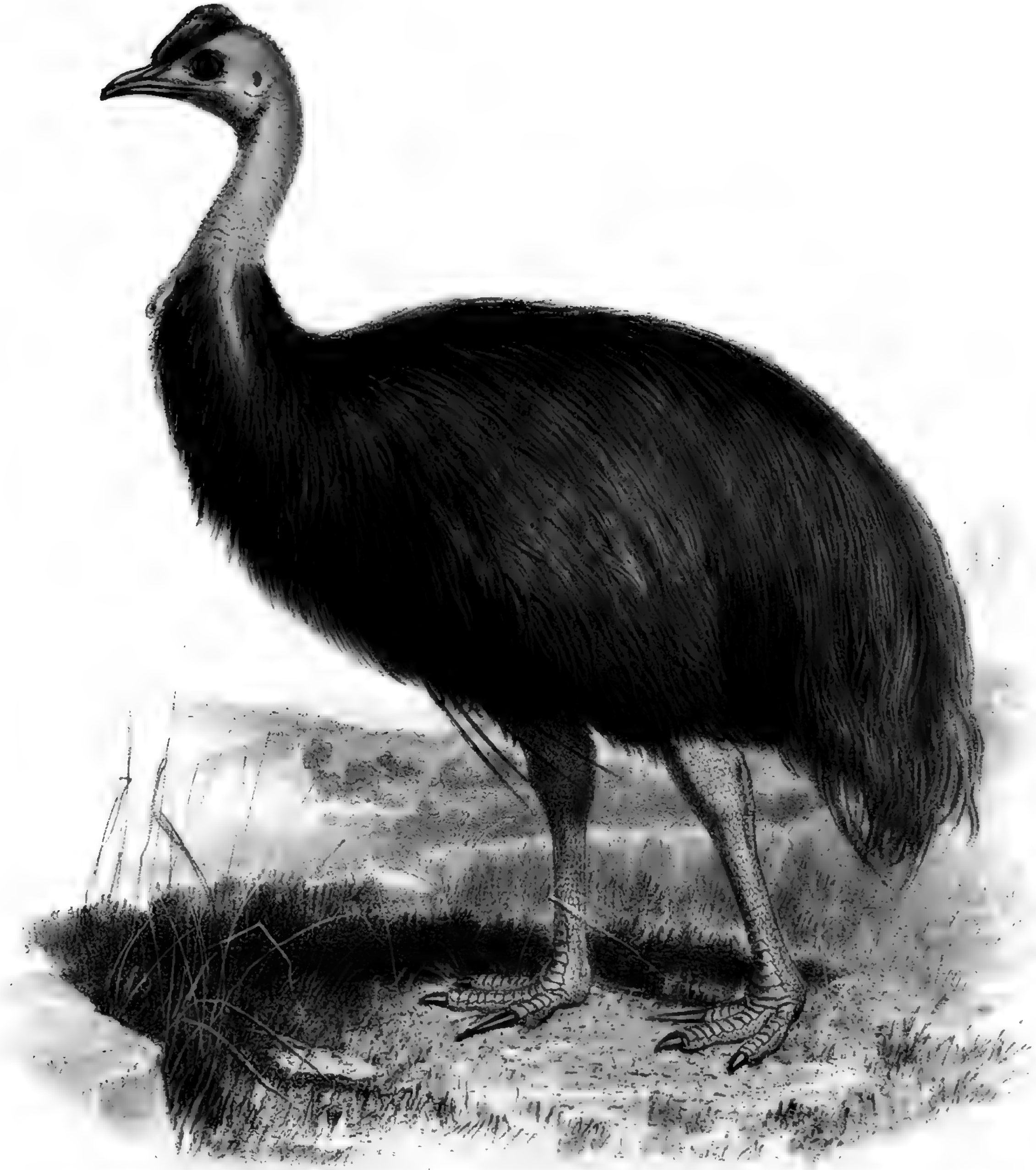
PLATE LXXV. *Dromæus novæ-hollandiæ*, from an example living in the Society's Gardens, 1861, presented by the Marchioness of Londonderry in 1857.

PLATE LXXVI. *Dromæus irroratus*, from a bird, not quite adult, living in the Society's Menagerie in 1861, purchased May 18th, 1860.

[1] This bird died in November 1861, and was purchased for the National Collection in the British Museum.







XXIV. *Remarks on* Aquila desmursii.

By J. H. Gurney, *M.P.*, *F.Z.S.*

Read May 27, 1862.

[Plate LXXVII.]

M. Jules Verreaux, who first recognized this Eagle as distinct from its congeners, communicated his description of it to Dr. Hartlaub, by whom the species was made known to ornithologists in his admirable work on the 'Ornithology of West Africa.'

My present object is to put on record some information as to this interesting bird, with which M. Jules Verreaux has been so good as to supply me, and also to give some indications of the changes of plumage to which this species appears liable, and which I have had the opportunity of examining in several examples which now form part of the collection of the Norwich Museum.

It may, however, be well to premise a few general remarks with reference to the geographical distribution of this Eagle, and to some of the peculiarities by which it is distinguished.

Aquila desmursii has hitherto only been found in Tropical Africa, north of the Equator,—specimens having been obtained at Bissao on the western coast, and also in Nubia and Abyssinia, and on the banks of the White Nile.

It is a small species, intermediate in size between *Aquila pennata* and *Aquila nævia*. From the former it is readily distinguishable by the greater length of all its measurements; from the latter (as also from *Aquila nævioides*) it may, on the contrary, be distinguished by its less size and, as Dr. Hartlaub well remarks, "by the more delicately shaped bill, and by the greater length of the tail" as compared with that of the wings.

Another well-marked distinction to which Dr. Hartlaub does not allude is to be found in the presence in *Aquila desmursii* of a well-defined, though small, occipital crest, consisting of from eight to nine pointed feathers, the longest of which are fully an inch and a half in length.

The colouring of this Eagle, described in Dr. Hartlaub's work, is that which characterizes what I believe to be the adult bird after it has newly moulted and has acquired its fresh plumage. In this dress the general colouring of *Aquila desmursii* closely resembles that of the adult of *Aquila nævioides* under similar conditions, being of a rufous brown, varying in intensity in different portions of the same feather.

Other specimens of *Aquila desmursii* exhibit a plumage of an extremely dark and almost uniform chocolate-colour. These individuals I believe to be immature birds, in which the feathers have been also newly acquired, and which in this stage bear a considerable general resemblance in point of colouring to the immature specimens of *Aquila pennata*, though I have never met with an immature *Aquila pennata* quite so dark as some specimens I have seen of *Aquila desmursii.* In *Aquila desmursii*, as also in *Aquila nævioides*, both adult and immature birds appear liable to have their plumage exceedingly bleached by the action of the tropical sun; but it is remarkable that the feathers composing the occipital crest of *Aquila desmursii* appear to retain their original tint, notwithstanding the partial loss of colour from the above cause in the portions of the plumage immediately adjacent. It should also be remarked that in some immature specimens nearly the whole under surface is of a very pale whitish brown—a variety from the ordinary darker colouring which cannot be accounted for by the effect of sun and weather only.

In conclusion, I will add the remarks on this species communicated to me by M. Jules Verreaux, which are as follows:—" According to the notes of the collectors, the irides of the adult birds are of a chestnut-brown tinged with yellow; whilst in the young birds the yellow tint is absent, and the brown is deeper, with but little tinge of chestnut. The natives (at Bissao) give the name of 'Socolas' to this species only, it being well known to them as a very courageous bird, attacking even the small Gazelles (*Cephalophorus maxwelli*) which inhabit the same localities, and also preying on various birds, and especially the *Francolinus bicalcaratus*."

The figures in the accompanying plate, by Mr. Wolf (Pl. LXXVII.), represent three specimens of *Aquila desmursii*, from the collection of the Norwich Museum, in the three different states of plumage above referred to.

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RED LION COURT, FLEET STREET.