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CONTENTS.

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I. *Osteological Contributions to the Natural History of the Anthropoid Apes.* No. VII. *Comparison of the Bones of the Limbs of the* Troglodytes Gorilla, Troglodytes niger, *and of different varieties of the Human Race; and on the general characters of the Skeleton of the Gorilla.* *By* Professor OWEN, *F.R.S.*, *F.Z.S.* *&c.*

Read September 9, 1851.

[PLATES I. to XIII.]

[The present section of this Paper on the Osteology of the Gorilla is a continuation of the part printed in Volume IV. Part IV. p. 113, of the 'Transactions of the Zoological Society.']

BONES OF THE UPPER LIMB.

Scapula.—Plate I.

THE blade-bone of the Gorilla (figs. 1, 2, 3) is a triangular plate of bone, resembling in general form, more than does that of any other animal, the scapula of Man (*ib.* figs. 7 & 8). The chief difference arises from the less unequal division of the dorsal or outer surface by the spine (*s*, *a*), which begins much nearer the middle of the basal or vertebral border (*o*, *s*, *u*).

The superspinal tract is concave, with a narrow median convexity extending along its middle part; its basal boundary (*o*, *s*) is convex. A short broad groove, leading to the canal for the nutrient artery of the bone, is below the superscapular notch (*n*). The infraspinal tract (*s*, *g*, *u*) is concave along the origin of the spine, becomes convex at the upper half, and concave at the lower half; the convexity subsides at the broad base of the acromion, the concavity extends to the neck of the scapula. The thick rounded rising, forming the anterior two-thirds of the lower boundary of this concavity, divides about one-third of the length of the scapula from the lower angle to define the rough tract (*m*) for the attachment of the teres major.

The upper border is moderately concave, and in old Gorillas is divided by a growth of bone (*n*) in the outer root of the transverse ligament bridging over the superscapular nerve and vessels as they traverse the superscapular notch, which is wide and shallow. The basal border (*o*, *u*) describes two convex curves, with an opposite one at the origin of the spine (*s*): it is thicker at the lower half of both the convex curves than at the upper half, but is nowhere so thin as is the upper border. The lower border (*g*, *m*) is almost straight: it forms a rough ridge an inch in length below the glenoid cavity (*g*) for the origin of the long head of the triceps muscle; beyond this extends the ridge, forming the lower part of the convex boundary of the subspinal tract, straight to the origin of the teres major, where the ridged border forms a slight convexity in the old Gorilla.

On the inner surface of the scapula, the deepest part of the concavity runs parallel with the attachment of the spine on the opposite surface: the origin of the subscapularis is bounded above near the upper and outer angle by a ridge dividing that muscle from the serratus magnus, which has a nearly flat triangular space at that angle of the scapula for its upper origin. The subscapular fossa is subdivided by six ridges of various lengths, having a direction converging towards the neck of the bone: the fourth and sixth ridges are the longest; the latter divides the subscapularis surface from the longitudinal channel bounded by the ridge for the teres minor, which forms the lower border of the bone.

The glenoid articular cavity (fig. 3), like that in Man (fig. 8), is of an oval or pyriform shape with the great end downwards; the inner margin is thicker than in Man, and like the outer one, shows concentric lines for the attachment of a strong capsular ligament—except at the upper and outer part, which is smoothly convex and broader than other parts of the margin. The spine of the scapula progressively rises, or augments in depth, as it approaches the base of the acromion; its sides are concave and thin between the supra- and infra-spinal muscles; the margin is rough, and increases in thickness as it approaches the great acromial expansion. The base of this process, rising clear of the blade-bone an inch or more from the glenoid cavity, curves outward, forward, and slightly upward, with a kind of twist as it expands into the broad rough acromion. This is convex and rough above, concave and smooth where it arches over the head of the humerus. The upper border is undulating but chiefly concave, and affords, near the apex, the articular surface for the clavicle; the opposite border is convex, with a well-marked protuberance, strengthening the origin of the deltoid. The extent of rugged surface afforded to this powerful muscle is very great. The coracoid process (*c*, figs. 1, 2, 3) arises by a thick basis from nearly two inches of the upper part of the scapula next the glenoid cavity: it is twisted inwards and forwards, and expands into a rhomboidal plate, almost flat on its outer surface (fig. 2). The upper border presents a convex prominence at its distal half for the attachment of the triceps; the lower border is thicker, with a facet near the base for the attachment of a strong ligament; the inner surface of the coracoid presents a deep and well-defined depression, beyond which it is convex.

The scapula of the Chimpanzee (*Troglodytes niger*, Pl. I. figs. 4, 5, 6) departs, like that of the Gorilla, from the Human type in the more equal division of the outer surface of the bone by the spine; but it approaches still nearer to the form of the blade-bone in the lower Quadrumana by its narrowness in proportion to the length. The superspinal tract is even and almost flat, or very slightly convex, the spine arising more abruptly from it. The subspinal tract is less undulated than in the Gorilla, and a greater proportion of it is concave. The upper border, convex outwardly by the curving in of the basal border (*o*), seems to have its concave part formed wholly by the wide superscapular notch. The basal border makes a slight concavity at the origin of the spine, but its convex curves are less marked than in the Gorilla. The lower border is straight, with a less extent of surface for the teres major than in the Gorilla. The inner surface of the scapula is relatively deeper than in the Gorilla, with only three short ridges at its lower half close to the basal border, for the attachment of the tendinous intersections of the subscapularis muscle, and with the straight ridge extending from near the inferior angle to the neck of the scapula, and defining, with the inferior border, the longitudinal channel for the teres minor. The glenoid cavity (fig. 5, *g*) is narrower in proportion to its length than in the Gorilla or in Man, but has a thinner border, except at the upper end, than in the Gorilla.

The spine of the scapula ascends more obliquely, and forms a more acute angle with the lower border of the bone than in the Gorilla, thus departing further from the Human type; the acromion is narrower in proportion to its length. The coracoid (fig. 6, *c*) is relatively less expanded and flattened externally, and consequently resembles more in shape that of Man (fig. 7, *c*); but the ridge for the trapezoid ligament is more marked.

The peculiarities of the Human scapula (Pl. I. figs. 7 & 8), as brought out by these comparisons, are the great breadth in proportion to the length, the more transverse direction of the spine and acromion, and the disproportionate extent of the subspinal as compared with the supraspinal tract. The upper angle (*o*) is less rounded; the extent of the upper border between that angle and the superscapular notch is relatively greater, and is more nearly straight; the notch itself is smaller and deeper. The smooth triangular surface near the origin of the spine (*s*), upon which the trapezius muscle glides, is relatively greater. The surface (*t*) for the teres minor muscle on the outer side of the bone near the lower border, is broader; as is that for the teres major, nearer the lower angle. The deep part of the subscapular bed, being parallel with the attachment of the spine of the scapula, is situated nearer the upper border than in the Gorilla or Chimpanzee. The surface for the upper origin of the serratus magnus is relatively less than in the Gorilla. The long narrow surface between the obtuse lower boundary of the subscapular fossa and the lower border of the scapula is flat, or is less concave than in either the Gorilla or Chimpanzee.

The greater relative breadth and length of the coracoid process in the Gorilla is in adaptation to the prodigious muscular powers of the arm ; but in all the more essential points in which the scapula differs from that of the Chimpanzee, it more nearly resembles the scapula of the Human subject.

Clavicle.—Plate II.

The clavicle of the Gorilla (fig. 1) presents a slight sigmoid curve, but in a less degree than in Man (*ib.* figs. 2 & 4), the body and sternal portion being straighter: it is thicker in proportion to its length. In the horizontal plane the curve of the sternal end is concave backward, that of the acromial end forward; and this end is slightly bent downward to join the acromion. The expansion for the sternal articulation is considerable; and in the old male there is a process behind, close to this surface, increasing the attachment of the cleido-mastoideus muscle and the rhomboid ligament. Below and close to this process is the depression for the cartilage of the first rib. The body of the bone is trihedral, smooth on the upper and outer facets, rather rough below. Near the sternal expansion is the rough surface for the attachment of the rhomboid ligament. The acromial expansion is obscurely divided into two rough tracts above, for the trapezius and deltoid muscles: it is flattened beneath, with a rough tract for the trapezoid ligament.

In the Chimpanzee (fig 3) the trihedral shaft is usually straighter than in the specimen figured, and the clavicle is always thicker in proportion to its length than in Man. The under surface of the acromial expansion is slightly concave. In the Gorilla that surface is more like that in Man.

The Human clavicle (fig. 2, European, and 4, Australian) is more slender in proportion to its length, and its curves, like those of the italic *f*, are always better marked than in the great Apes: the tubercle for the conoid ligament is usually more developed.

Humerus.—Plate III.

The humerus of the Gorilla (figs. 1–4), though surpassing so much in length that of Man (*ib.* fig. 8), is nevertheless thicker in proportion, and, in the old male, much stronger in all its ridges and processes; especially at the lower extremity, the transverse diameter of which surpasses that of the upper extremity of the bone in a greater degree than in Man. The articular head (fig. 2, *b*) closely resembles that of Man's humerus in shape and direction; the peripheral constriction or 'anatomical neck' is better marked: both tuberosities are relatively greater than in Man—the 'lesser' one (*d*) more especially, the lower end of which encroaches, in a front view of the bone, upon the contour curve (fig. 1, *a*) by which the lower part of the neck passes at the usual obtuse angle from the shaft to the head: the surfaces on the greater tuberosity for the insertion of the supraspinatus and infraspinatus (*e*) are well defined. The bicipital groove is deep, and the margin of the lesser tuberosity arches over it in the old male: the groove passes downwards and a little inwards, disappearing between the insertions of the latissimus dorsi and pectoralis major about one-fourth down the bone. The shaft of the humerus, at first cylindrical, shows a full elliptical section at the middle third of the bone, below which it becomes more compressed through the outward extension of the supercondyloid ridges. The ridge for the insertion of the pectoralis major (*g*) does not reach so low down proportionally as in Man, but is more produced in the old male Gorilla. That (*t*) for the latissimus dorsi and teres major forms a continuous rough ridge-like tract on the inner or ulnar side of the upper third of the shaft; beyond this the inner border of the shaft descends as an obtuse ridge, becoming gradually sharper and more produced (*a'*) to the internal condyloid prominence. The outer part of the humeral shaft, in its upper third, is smooth and rounded: near its middle third it shows a rough ridge for the attachment of the external head of the triceps, below which the termination of the musculo-spiral groove sweeps into the front view of the bone. At the fore part of the shaft, at and below the middle of the bone, is the rough ridge-like tract for the insertion of the deltoid, which must operate with greater force on this long humerus by being implanted lower down the bone than in Man. Below this ridge the fore part of the humerus is smooth, and expands to the supracondyloid prominences: it is convex transversely at its middle part, and concave between this and the supinator ridge, which is slightly bent forward. Immediately above the distal articular surface are two depressions divided by a ridge continued to the prominence between the radial and ulnar articulations; the outer or radial depression is the smaller and shallower; the inner or ulnar one is larger: it answers to the 'coronoid fossa' in Man, but becomes a foramen (*m*) in full-grown Gorillas, by absorption of the thin plate of bone dividing it from the anconeal fossa behind. The ectocondyloid prominence (*k*, *l*) is more marked than in Man: the entocondyloid one (*o*) is more produced, is angular, and compressed. The back part of the humerus shows, as in Man, the musculo-spiral tract dividing the ridges for the external and internal heads of the 'triceps extensor.'

The configuration of the lower articular surface is closely similar to that in Man; the whole surface extends a little further below the condyloid prominences than in Man, allowing to that extent a more free sweep of the fore-arm in flexion and extension, and adding power to the leverage of the tendons inserted into the antibrachial bones. The anconeal fossa (fig. 3, *r*) is more steeply, as well as deeply, excavated, and is of a subtriangular shape—besides becoming perforated, apparently as a rule, in the full-grown male Gorilla.

The humerus of the Chimpanzee (Pl. III. fig. 5) being more nearly the length of that of Man (fig. 8), shows at once the greater proportional thickness of the bone, with a smaller proportional articular head. I have not observed an instance of absorption of the bone in any Chimpanzee between the anconeal and coronoid depressions. The ulnar border of the ulnar trochlea (*q*, figs. 5 & 6) is more produced than in the Gorilla or in Man. In other respects the humerus of the Chimpanzee closely resembles that of the

Gorilla, save in size. The medullary artery enters the fore part of the shaft, but nearer the middle of the bone in the Gorilla (fig. 1, *i*) than in Man (fig. 8, *i*): in both, the course of the canal is towards the elbow-joint.

The humerus of the male Australian (Pl. III. figs. 8, 9, & 10) is more slender than that of the average male European, the difference of size and strength being illustrated by the lower end of the bone, fig. 11, as compared with that of fig. 8, in Pl. III. But fig. 11, taken from the bone of a robust European male, shows the inferior development of the condyloid processes (*k* and *o*) as compared with the Chimpanzee (fig. 5); and the same difference in relation to muscular attachments is exemplified by the tuberosities (*d* and *e*) at the upper end of the bone (fig. 8). The intercondyloid perforation is occasionally seen in the Human humerus; and, apart from the differences relating to size and strength of muscle, the most significant mark of nearer resemblance to Man which I have been able to observe in the subjects of comparison here illustrated, is the minor degree of production of the ulnar or inner border of the trochlea (*q*) in the Gorilla, as compared with that in the Chimpanzee.

The humerus of the Gorilla, fig. 1, is that of the full-grown but young male the skeleton of which is in the Museum of the College of Surgeons, and was the only one in England at the time (1851) when the subjects of Pl. III. were drawn on stone; the proximal epiphysis had not coalesced with the shaft of the bone. The humerus of the old male in the skeleton of the Gorilla (Pls. XII. & XIII.) in the British Museum, shows a striking development of all the processes and ridges for muscular attachment above described. The left humerus in this individual had been severely fractured, and the injury had been followed by inflammation, enlargement, exostosis, and partial exfoliation of the distal portion of the bone, without any union.

Radius.—Plate IV.

The radius of the Gorilla (figs. 1 & 2) is shorter than the humerus by $\frac{3}{14}$ths the length of that bone; in Man it is shorter by nearly $\frac{4}{14}$ths of the humerus; in the Gorilla it is relatively stronger and more bent from the ulna, leaving a wider space between the shafts of the two bones (Pl. XIII. fig. 2). The head (Pl. IV. fig. 2) is circular, depressed in the centre, with a convex thick circumference, which is deepest and smoothest next the ulna, for the marginal articulation with the 'lesser sigmoid cavity' of that bone. The smooth subcylindrical neck (*a*), becoming contracted as it leaves the head, gradually expands to the place of development of the tuberosity (*d*). This shows a well-marked oblong rough prominence for the insertion of the tendon of the biceps, behind or 'ulnad' of the smoother prominence supporting the bursa interposed between it and the tendon. Below the tuberosity the shaft assumes a pyriform transverse section through the development of the interosseous ridge, which extends to near the 'sigmoid cavity.' About one-third down the shaft a second but lower ridge begins, which extends to the process dividing the groove for the extensor digitorum communis from that for the extensor internodii pollicis: this second ridge gives a trihedral shape to the shaft, the outer and hinder surface being rather convex, the inner one flat, the anterior one becoming rather concave as the bone expands to its distal end. In the radius of the skeleton of the male Gorilla in the Museum of the Royal College of Surgeons (Pl. IV. fig. 1), the distal epiphysis was wanting, and the description is taken from that of the older individual in the British Museum (Pls. XII. & XIII. fig. 2).

The process called 'styloid' in the Human radius is less produced than in Man, and is represented rather by a large rough prominence above the radial or outer angle of the articular surface for the scaphoid. This prominence gives a proportionally larger surface than in Man for the insertion of the tendon of the 'supinator longus.' It is not impressed, behind or externally, so deeply by the two grooves for the extensor muscles of the metacarpal and first phalangeal bones of the thumb; those grooves, indeed, are scarcely marked in the Gorilla; the common shallow depression for them is separated by a short tuberosity from the grooves for the extensores carpi radiales. A still stronger tuberosity, pretty equally bisecting the posterior surface of the distal expansion of the radius, and in which the posterior ridge of the radial shaft terminates, divides the fossa for the radial extensors of the wrist, from the wider and deeper one for the strong tendons of the extensor communis digitorum. The semicircular depression for the lower end of the ulna is well marked: the distal articular surface is divided, as in Man, by two concave facets, the larger one for the os scaphoides, the lesser for the os lunare: the anterior border of the latter is much produced, giving a greater proportional antero-posterior extent to the 'lunar' surface than in Man. The orifice for the 'arteria medullaris' (Pl. IV. fig. 1, *r*) is situated as in Man, and the direction of the canal is 'proximad' or towards the elbow-joint. It may be noted that the hair covering the arm and fore-arm has a direction corresponding with that of the medullary arteries of the brachial and antibrachial bones.

The first and most significant difference presented by the radius of the Chimpanzee (Pl. IV. fig. 3), as compared with that of the Gorilla, is its equality of length with the humerus of the same limb; a less important difference is the greater projection of the margin of the upper articular end over the neck; in both of which it departs further from the Human type. In the greater relative thickness and longitudinal outward curvature of the shaft, it corresponds with the radius of the Gorilla. On the back part of the distal expansion of the bone (*ib.* fig. 5), the letter *l* marks the groove for the extensor carpi radialis longior; *m* that for the extensor carpi radialis brevior; *n*, *o* mark the depression for the tendons of the extensor digitorum communis, in which may be discerned an oblique groove for the extensor secundi internodii pollicis, better marked than in the Gorilla.

The characteristics of the Human radius (Pl. IV. figs. 7–10), as educed by the foregoing observations, are,—first, its greater shortness relative to the humerus (seldom noted in anthropotomical descriptions of the bone); secondly, its more slender and less bent shaft; thirdly, the better definition and greater depth of the grooves for the three tendons acting on the thumb, at the back part of the distal expansion; fourthly, the more produced styloid process (*f*); whilst the tuberosity above it for the attachment of the supinator longus is much less developed than in either the Gorilla or Chimpanzee.

Ulna.—Plate V.

The ulna of the Gorilla (figs. 1–3), like the radius, is less straight than in Man (fig. 8), contributing thereby to augment the breadth of the strong bony frame of the fore-arm. It is shorter than the humerus, but in a less degree than in Man. The upper half of the shaft is trihedral, the posterior surface being convex, the inner one flat, the outer one slightly concave; this half gradually expands, as it rises, to form the wide and deep surface (fig. 3, *b*, *c*), concave lengthwise, convex transversely, called 'great sigmoid cavity' in anthropotomy, for the interlocking articulation with the ulnar trochlea of the humerus; the back wall of the cavity developes a powerful tuberosity projecting 'ulnad' or inwards as well as backwards: the upper part of the olecranon (*e*) is a broad subtruncate bent plate of bone, smooth behind, and with its radial border gliding upon the articular surface extended from the humeral trochlea upon the corresponding boundary of the great anconeal depression. The olecranon is thicker and broader in proportion to its length than in Man. The coronoid process developes a large tubercle below its inner or ulnar border for the origin of the flexor sublimis digitorum. The articular surface, called 'lesser sigmoid cavity' (*d*), for the rotatory joint with the radius, has relatively more transverse extent than in Man. The fossa below the coronoid process and the tuberosity beneath the fossa, for the insertion of the 'brachialis anticus,' are very strongly marked.

The great sigmoid cavity is unequally divided into the facets *b* and *c*, fig. 3, by the longitudinal prominence, as in Man (fig. 12); but the marginal notches are less marked; there is a shallow depression for the synovial organ called 'Haversian gland,' whence a linear groove extends to the lesser sigmoid cavity (*d*, fig. 1). The shaft of the ulna, in a front view, as in fig. 3, presents two slight opposite curves, the upper one concave, the lower one convex, on the ulnar or inner aspect. Viewed sideways, as in fig. 1, the whole bone has a slight bend convex backwards. The lower half of the shaft becomes subcylindrical as it descends. The ridge, commencing below the lesser sigmoid cavity, is strongly marked and more vertical than in Man; the surface for the attachment of the anconeus muscle between this and the ridge descending from the outer side of the olecranon is well defined. The distal end of the ulna suddenly expands into a convex reniform articular surface, thickest at the middle, where it plays upon the lateral concavity of the radius. The styloid process (*g*) is less produced in the skeleton of the old male Gorilla (Pl. XIII.) than in the outline restoration in the

Plate[1]; it more resembles that of Man. The groove dividing it from the articular convexity is very deep.

In the Chimpanzee (Pl. V. figs. 4–7), the ulna equals the humerus in length, and both its backward (fig. 4) and double lateral (fig. 7) curves are more marked than in the Gorilla. In both these respects the bone departs further from the human type. In other respects it closely accords with the ulna of the Gorilla, except that the pits, ridges, and prominences for muscular attachment are less strongly marked. The breadth of the olecranon (fig. 7), in proportion to the length of that process, is less than in the Gorilla, and somewhat greater than in Man.

The chief distinctions presented, in this comparison, by the Human ulna are,—its minor length compared with the humerus; its greater relative slenderness; the less proportional expansion of the proximal end; the somewhat minor production of the coronoid process; and the greater straightness of the shaft, especially on the side view (comp. fig. 8 with figs. 1 & 4).

The difference in the size and strength of the bone between the male European and male Australian is exemplified in figures 8–10 and 12, 13, in Pl. V.

The skeleton of the old male Gorilla in the British Museum (Pl. XI.) exemplifies a consequence of the fracture of the humerus, in an interesting way and degree. Interstitial absorption has operated upon the whole extent of the uninjured long bones of the limb, viz. the radius and ulna, so as to slightly alter the shape of the ulna and reduce the length of both bones, thus accommodating to a certain degree the length of the second segment of the arm to the diminished strength and disadvantageous condition of the first segment. The left radius is shorter by one-eleventh, than the right. This, with the marks of disease in the fractured humerus, indicates the animal to have been able to obtain its sustenance for some time after its climbing powers were injuriously affected by the broken arm, and so far corroborates Mr. du Chaillu's account[2] of the terrestrial habits of the male Gorilla, and the great proportion of the food which it obtains from the ground.

Bones of the Hand.—Plates II. & X.

Carpal bones.—Plate II. figs. 5–22.

The bones of the wrist agree in number and relative position with those of Man; but the differences of shape and proportion give a greater breadth to the carpal segment, in proportion to its length, in the Gorilla. The radial surface is nearly circular in shape, instead of being oval and oblong as in Man.

The os scaphoïdes (Pl. X. fig. 1, *s*) presents a rather more prominent and regular convexity (Pl. II. fig. 5, *c*) for the radius; and a greater production and expansion

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[1] The distal epiphysis of the ulna, like that of the radius, was wanting in the only subject at my command, for the illustration of my Paper, in 1851.

[2] Explorations in Equatorial Africa, 8vo. 1861, pp. 275, 290.

of the radial tuberosity of the bone (ib. *b*). The articular surface for the trapezoïdes (ib. *z*) curves almost into contact with the radial surface at the back part of the bone; that for the trapezium (*d*) is less near the upper surface and radial (outer) end. The two surfaces are continuous, as in Man, but of relatively greater extent transversely. On the ulnar and inner side of the scaphoid (fig. 6) the surface (*l*) for the lunare is relatively larger; that (*a*) for the os magnum is relatively less and shallower than in Man (fig. 8, *a*). The production of the radial tubercle (figs. 5 & 6, *b*) is, however, the main difference, and relates to the greater lever-power of the flexor carpi radialis therein inserted. In the os lunare the ulnar side of the bone (Pl. II. fig. 9) shows, in the Gorilla, a more equal division between the articular part (*a*) for the cuneiforme and the non-articular part, than in Man (*ib.* fig. 10). The concave crescentic surfaces for the os magnum (*b*) and scaphoïdes are similar to those in Man; but the latter is more excavated, and they are divided by a sharper ridge. The os cuneiforme in the Gorilla (fig. 13) is distinguished from that of Man (fig. 14) chiefly by its greater transverse extent, with similar proportions of the articular surfaces for the unciforme and pisiforme (figs. 13 & 14, *a*). The tubercle at the ulnar end, for the attachment of the internal lateral ligament of the wrist, is more developed and better defined in Man than in the Gorilla. The pisiforme of the Gorilla (Pl. II. fig. 11) is much longer in proportion to its breadth than in Man; whilst the articular surface for the cuneiforme (*a*) is but little larger: its superior length gives stronger leverage to the great ulnar flexor of the wrist. The trapezium of the Gorilla differs most from its homologue in Man by the production of its outer unarticular surface into two diverging tuberous processes: the articular surface, moreover, for the metacarpal of the thumb is relatively much smaller than in Man, and it is divided by a wider non-articular tract from the surface for the base of the index digit: this is continuous, as in Man, with the surfaces for the trapezoïdes and scaphoïdes. The trapezoïdes (Pl. X. fig. 1, *z*) is a larger and especially a broader bone than in Man (*ib.* fig. 2, *z*); the surface for articulation with the base of the index metacarpal is longer from before backward, and more nearly approaches that for the scaphoïdes. The figures of the trapezoïdes, Pl. II. figs. 15 & 16, show the articular surface for the scaphoid in Man and the Gorilla, the bone of the latter being from a younger male specimen than in the hand figured in Pl. X. The rough dorsal surface of the os magnum (Pl. X. fig. 1, *m*) is somewhat broader but not more extensive than in the human os magnum (*ib.* fig. 2, *m*). The dimension in which this wrist-bone in the Gorilla most surpasses that in Man is from without inwards or towards the palm: the difference is illustrated in the views of the articular surface for the base of the middle metacarpal in figures 17 (Gorilla) and 19 (Man) of Pl. II.: the risings and hollows of this surface are also more marked in the Gorilla, giving a firmer attachment of the metacarpal bone to the wrist. On the radial side of the os magnum, that border of the articular surface for the metacarpal (*a* and *b*, fig. 20) runs along the upper part in Man: it is interrupted by a deep depression at the middle in the Gorilla (fig. 18). The unciforme in the Gorilla (Pl. II. fig. 21) is larger and broader on its dorsal surface, it has a greater extent of non-articular surface on its ulnar and inner side (*b*, *d*), beyond the surface (*d*) which articulates with the os cuneiforme, than in Man (*ib.* fig. 22) : the surface (*c*) for the os magnum is placed at a less acute angle with that for the cuneiforme, than in Man. The articular surfaces for the fourth and fifth metacarpal are larger from behind forward, and somewhat deeper than in Man. The chief difference is in the greater relative strength and length of the process (*d*) for the insertion, through the medium of the annular ligament, of the tendon of the flexor carpi ulnaris, which is prolonged to the base of the metacarpal bone of the fifth finger : the lever of this powerful flexor is thereby increased and made more powerful than in Man, in whom the process (fig. 22, *d*), by its more curved disposition, is called 'unciform,' and suggested the name to the entire bone.

The sum of the differences in the several carpal bones of the Gorilla, as compared with those of the human skeleton, consists in giving greater proportional breadth, as compared with the length, to the carpal segment in the great Ape.

The most marked distinction in the framework of the pectoral limb is met with in the bones of the thumb of the Gorilla (Pl. X. fig. 1, ɪ). The metacarpal does not exceed in length that of the same bone in the European male (*ib.* fig. 2, ɪ). It is articulated with its fore and back parts more nearly on the same plane with those of the other metacarpals, *i. e.* with its inner or radial border turned less forwards, than in Man. Its base shows a deeper concavity from before backward, chiefly due to the greater and more pointed production of the palmar boundary, whereby the bone is more securely articulated with the trapezium, with less extent and freedom in its movements, than in Man. The shaft is relatively stronger than in Man, chiefly by the ridge-like production of its outer border. The first phalanx is shorter than in Man, and is more flattened from before backwards ; the second is shorter and much more slender beyond the articulation. In Man the length of the three bones of the thumb nearly equals one-third the length of the humerus : in the Gorilla it is little more than a fifth of that length. The metacarpal of the index digit in the Gorilla is twice the length of that of the pollex : in Man it is little more than one-fourth larger : like the succeeding metacarpals, it is of great strength in the Gorilla, and presents a greater relative expansion of the distal end. The tuberosity on the palmar side near the proximal articulation, for the insertion of the flexor carpi radialis, is more developed ; the dorsal side of the bone is flatter. In the metacarpals of the third, fourth, and fifth digits the transverse rough ridge at the back part of the base of the convex condyle is singularly developed. At the palmar aspect, where the interossei diverge near the distal condyle, there is a tuberosity which is most prominent in the metacarpal of the index ; a strong ridge is continued from it to the condyle in the third and fourth metacarpals : it is wanting on the dorsal side in the fifth. The distal expansion is most strongly marked in the third and fourth metacarpals, in which the articular surface begins with a slight concavity on the dorsal side in the Gorilla. The proximal phalanges are chiefly peculiar for the thick and prominent lateral ridges, bounding and deepening the groove for the flexor tendons: the massive quadrate proportions of these bones are also very striking. The same characters are shown, in a minor degree, by the second phalanges, with greater predominance of the transverse over the antero-posterior diameter: the third phalanges are chiefly characterized by their more slender tapering shaft, and their more tuberous and less flattened terminations, than in Man.

In the Gorilla the hand is an instrument for great power of grasp, and for sustaining on the metacarpals of the fore fingers great weight: the length and strength of the whole pectoral limb accord with these mechanical powers and requirements. In Man the framework of the hand bespeaks an organ of varied and delicate prehension; and the form and proportions of the whole upper limb relate to the free motions and complex functions of the instrument.

The bones of the hand in the Chimpanzee agree in most particulars with those of the Gorilla; but they depart further from the Human type and approach nearer to that of lower Quadrumana in the shorter thumb, and in the greater length, in proportion to the breadth, of the whole hand.

Bones of the Lower Limb.

Os innominatum.—Plate VI.

The ilium being the homotype or correlative of the scapula, the ischium of the coracoid, and the pubis of the clavicle, I commence therewith the description and comparison of the bones of the lower limb. In the upper limb the coracoid becomes confluent with the scapula, the clavicle remaining free; but in the lower limb the ilium, ischium, and pubis coalesce with each other, forming that single composite bone which in Anthropotomy is specified as the ‘ os innominatum.’

The iliac portion of the bone shows in the Human species alone that degree of expansion and forward inflexion of its upper and anterior border occasioning the form that suggested the term ‘ pelvis ’ or basin for the segment of the skeleton composed of the ossa innominata and sacrum (Pl. XII. fig. 1). Every ape, until the Gorilla became known to the anatomist, had presented an iliac bone, not only long and narrow, but flat, or, if hollow, with the concavity directed backwards instead of forwards. Such is the strictly quadrumanous condition of the bone in the common Chimpanzee (*Troglodytes niger*, Pl. VI. fig. 3), as well as in the Orang-utans and Gibbons. In the Gorilla the iliac bone (*ib.* fig. 1, *a*, *b*, *c d*), besides showing a greater relative breadth in proportion to its length than in the Chimpanzee, has the upper and outer border a little bent forward (Pl. XII. fig. 2), giving a moderate concavity or pelvic character to that part of the skeleton; it is, however, much inferior in degree to the Human pelvis.

The difference of size between the os innominatum of the Gorilla and that of Man is enormous: this part of the great ape's frame would fit a human giant of ten feet in height. But, besides size, there are well-marked differences in form and proportion.

The crest of the ilium (Pl. VI. fig. 1, *a*, *e*) describes a portion of a curve of a much larger circle than that described by the same part in Man (fig. 4, *a*, *e*, *c*); but the crest of the ilium of the Chimpanzee (fig. 3, *a*, *e*) is less curved than in the Gorilla. In the full-grown but young male Gorilla, the ilium, with the whole breadth in view, presented the regular curve of the crista, as shown in fig. 1, Pl. VI.: but in the old male subsequently acquired (Pl. XII. fig. 2), the stimulus of the exercise of the powerful muscles had led to the prominence of the crest at the part where the origin of the latissimus dorsi terminates outwardly by the strongest part of its tendinous sheath. The line of the anterior border (*a* to *b*, fig. 1, Pl. VI.) is more angular in the young and more regularly curved in the old male (Pls. XII. & XIII. fig. 2); in neither is the process (called 'antero-inferior spine' in Anthropotomy) for the origin by its straight tendon of the rectus femoris muscle developed as in Man (Pl. VI. fig. 4, *b*). This muscle has an important share in maintaining the erect position, and is, proportionally, much more developed in Man, than in the Gorilla and other Apes. In like manner the backward development of the ilium in Man, as from *e* to *c*, fig. 4, favouring the origin of the gluteus maximus, is wanting in the Gorilla,—a comparatively small proportion of the outer surface of the bone being applied to the attachment of the more feeble gluteus, which, by its inferior breadth and thickness, loses all title to the term 'maximus' in Apes. The inequalities on the outer surface, indicating the origins of the gluteus medius and gluteus minimus in Man, are less marked in the ilium of the Gorilla. From the arrest of the backward development of the ilium in the Gorilla, the great sacro-sciatic notch (Pl. VI. fig. 1, *f*) is much less deep than in Man (*ib.* fig. 4, *f*); but it is deeper in the Gorilla than in the Chimpanzee (*ib.* fig. 3, *f*).

The anterior surface of the ilium (Pl. XII. fig. 2) presents a smooth and slight equable concavity for the iliacus internus muscle, and a narrower but longer articular surface for the sacrum, which includes one, and in old subjects two vertebræ (*ib.* $_4$ & $_5$) homologous with the lower lumbar vertebræ in Man. Through this consequence of the elongation of the iliac bone, and the development of the ribs of the vertebra answering to the first 'lumbar' in Man, the number of vertebræ retaining the anthropotomical characters of 'lumbar' ones becomes reduced to two in the Gorilla (ib. $_2$, $_3$), which greatly diminishes the flexibility of the massive trunk in that animal. The weight of the trunk at the same time requires that increased extent of grasp of the spine by the ossa innominata, afforded by the superadded sacrals, by means of which the superincumbent weight is received and adequately transferred by the pelvis to the lower limbs, when the animal assumes the erect posture. From this character of the spine and pelvis I inferred a more frequent assumption and easier maintenance of the erect or bipedal posture by the Gorilla, which Mr. du Chaillu's subsequent observation of the animal in his native haunts[1] has shown to be one of its distinctions from the Chimpanzee.

The ascending part of the ischium, called the 'ramus,' is not only longer, but is broader and thicker in the Gorilla (Pl. VI. *h*, *l*), than in Man, and the tuberosity (ib. *l*) is

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[1] *Op. cit.*

much larger, especially in breadth, the outer part being produced in an angular form, and giving a concave instead of a convex contour to the lower and lateral outline of the pelvis, in a front view (comp. figs. 1 & 2, Pl. XII.).

The lower portion of the os innominatum formed by the ischium and pubis is bent or twisted upon the upper portion in different degrees in Man, the Gorilla, and the Chimpanzee, as is shown in the position of the bone selected for the figures of Plate VI. In Man, when you look directly upon the plane of the outer surface of the ilium, as in fig. 4, the same plane is seen, but obliquely, of the ischium (*l*) and pubis (*o*). In the Gorilla the twist at the acetabular junction of the bones is such as to cause the lower half of the innominatum to present only its ischial margin (*h*, *l*) to view. In the Chimpanzee, the twist, being carried further, brings the inner surface of the pubis (*o*, *m*) obliquely into view. We have, at the same time, as many different views of the acetabular cavity; the whole of which is seen, but obliquely, in Man, but only a very small portion (*k*, *l*) in the Chimpanzee, the Gorilla being intermediate in this as in most other respects.

The most marked distinction from the Human type in the pelvis of the Gorilla is, perhaps, the expanse of the ischial tuberosities, which form outward angular projections, and cause a concomitant change in the pelvic contour, as already remarked. The symphysis pubis, also, is longer, and descends less obliquely to the point of divergence, than in Man.

In the acetabulum (Pl. VI. fig. 2) the depression (*i*) for the synovial gland and for the attachment of the ligamentum teres is relatively larger, and the cotyloid notch is narrower and deeper, than in Man (*ib.* fig. 4, *i*).

The obturator foramen (Pl. XII. fig. 2) is smaller in proportion to the size of the bones composing it than in Man (Pl. VI. fig. 4, *p*): the oblique groove at the upper and outer part is less deep. The 'linea ileo-pectinæa,' dividing the 'false' from the 'true pelvis,' is less marked in the Gorilla than in Man; but its continuation from the ilium upon the sacrum determines the homology of the vertebra below the one marked 5 in fig. 2, Pl. XII., with the *first* sacral vertebra in the Human skeleton (fig. 1): the second and part of the third sacral vetebræ, so determined in the Gorilla, articulate with the iliac bones as in Man. The 'false pelvis' is relatively longer and more shallow in the Gorilla. The inlet of the 'true pelvis' is less contracted anteriorly, less cordate and more fully elliptical in shape: the axis of the pelvis is less oblique, and forms a more open angle with that of the trunk in the Gorilla.

Femur.—Plate VII.

The chief or most obvious characters which distinguish the Human femur from that of the Quadrumana, up to and including the Gibbons, are,—the greater length of the bone, both absolute and relative to the trunk; the more angular and less cylindrical shape of the shaft; the forward bend of the shaft; the greater length of a well-defined neck; the more sudden and greater proportional expanse of the distal end, especially at and above the inner condyle; the greater backward production of both condyles, especially of the inner one; and the more flattened or less prominent surface above the outer condyle.

The foregoing characters all distinguish the Human femur from that of the Gibbons and lower Quadrumana.

The first approaches to the Human characters of the bone are found in the femora of the Chimpanzee (Pl. VII. fig. 4) and Gorilla (*ib.* fig. 1). The tendency to a minor convexity of the fore part of the shaft, to the production of a ridge at the back part, and to the forward bend of the whole shaft, is seen in the Chimpanzee; the departure from the cylindrical shape and the forward bend are more manifest in the Gorilla (Pl. XIII. fig. 2). Both Apes show a cervix femoris relatively as long as in the Human femur.

The first strongly-marked difference is seen in the proportional size of the bone to the entire body and upper limb (Pls. XII. & XIII). In Man (fig. 1) the femur is the longest, as well as the largest and heaviest bone in the skeleton; it exceeds by two-sevenths of its own length that of the humerus. In the Gorilla (*ib.* fig. 2) the femur is one-sixth of its own length shorter than the humerus. It is, moreover, thicker both absolutely and in proportion to its length. The neck of the bone (Pl. VII. figs. 1 & 2, *c*) is longer, and stands out at a more open angle, and the head is directed more inward and less upward than is usual in Man: the degree of forward direction is almost equal. The depression for the ligamentum teres (*ib.* fig. 1, *b*) is nearly the same in size, depth, and position as in Man. The neck is broader in the vertical than in the antero-posterior diameter. The great trochanter is a broad thick subquadrate prominence, rising higher than the head of the bone; it does not project outwardly, as in Man, beyond the shaft of the bone. The lesser trochanter is a more oblong and less prominent conical process than in Man; it does not project from so near the inner margin of the bone; so that in the view of the upper end of the femur, given in fig. 2, Pl. VII., this trochanter (*e*) appears less near the head of the bone than in Man (fig. 7). It is connected with the great trochanter by a rough intertrochanteric tract (between *d* & *c*, fig. 1); but this is less marked than in the Human subject (*ib.* fig. 6). This difference in the proportion and direction of the neck of the femur affords greater freedom, extent and variety of motion to the lower limb, but is less favourable for the transmission of the weight of the trunk from the head to the shaft of the bone. The shaft is slightly bent from before backwards (Pl. XIII. fig. 2); it presents an irregular subquadrate transverse section with the angles rounded off and the long diameter transverse, increasing gradually in breadth and diminishing in fore-and-aft diameter as it approaches the condyles, the greater extension being towards the inner side; and it grows proportionally less convex transversely at the fore part. The outer part above the middle of the shaft shows a strongly marked oblong rough surface for the attachment of the ecto-gluteus muscle[1]; below this a narrower ridge is continued, giving advantageous origin to the short head of the biceps flexor cruris. The

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[1] The three muscles, answering to *Gluteus maximus, medius,* and *minimus* in Man, do not present the proportions indicated by these names in any inferior animal. The property common to them throughout the mammalian series is relative position, which might be conveniently indicated by the terms 'ecto-,' 'meso-,' and 'ento-gluteus' respectively.

inner commencement of the linea aspera, called the 'spiral line' of the femur, is well marked in the Gorilla (Pl. VII. fig. 1, *g*), but begins close to the inner side of the lesser trochanter; what are called 'middle' and 'outer lines' of the linea aspera are less definitely marked than in Man. A rough tract is continued from the ecto-gluteal[1] ridge (*f*) obliquely downwards to the middle of the linea aspera, where the medullary artery penetrates the bone, the direction of the canal (fig. 1, *m*) being, as in Man, obliquely upward and forward. Below this the linea aspera is continued more faintly to the entocondyloid prominence (*h'*). There is no ridge continued from the linea aspera to the outer condyle, as in Man; that ridge (Pl. VII. fig. 6, *g*, *a'*) is lost in the Gorilla upon the outer border of the bone. The production of the buttress-like ridge of dense bone from the middle of the back part of the shaft of the femur in Man, forming the most prominent part of the linea aspera, and strengthening it for the habitual support of the erect superincumbent trunk, is not present in the Gorilla; nor was it called for in the occasional assumption of the erect posture by that Ape. The ectocondyloid prominence (*ib.* fig. 1, *i'*) is much more marked in the Gorilla than in Man; the outer condyle (*i*) is relatively smaller and projects less backward. The popliteal space is more shallow and less defined; the intercondyloid space is wider and less deep, and its greatest width is anteriorly—the converse of that in Man. The entocondyloid tuberosity (*k'*, fig. 1) is less defined and less prominent than in Man. The rotular surface is much less concave transversely, and the condyloid convexities less produced from before backwards, than in Man; that of the inner condyle (*k*) is broader than that of the outer condyle (*i*); and the whole distal surface (fig. 3) is relatively broader transversely, than in Man.

The femur of the Chimpanzee (Pl. VII. fig. 4) is more slender in proportion to its length, and is straighter than in the Gorilla. In the smaller proportional size of the head of the bone (fig. 5), and in the more backward position of the trochanter minor (*e*), it recedes further from the human femoral type; but the axis of the neck forms with that of the shaft of the bone a less open angle than in the Gorilla. The shaft of the thigh-bone is more cylindrical, approaching nearer the shape of that part in inferior Apes. In the well-marked surface for the insertion of the ectogluteus muscle, in the origin of the linea aspera from the spiral line (fig. 4, *g*), in the minor production of the 'linea' at the middle of the shaft, in its continuation to the inner rather than to the outer condyle, in the more developed ectocondyloid prominence (*i'*), in the shape and depth of the rotular and intercondyloid spaces, and in the proportions of the two condyloid convexities, the femur of the Chimpanzee repeats the characters by which the femur of the Gorilla departs from the Human type of the bone.

The thigh-bone in Man has an articular head (Pl. VII. fig. 7) composed of a larger proportion of a sphere than in the Gorilla (fig. 2) or Chimpanzee (fig. 6); the depression for

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[1] The idea that the cause of the prerogative of the human organization, for supporting the body *in æquilibrio* on *one foot only*, is to be found "in the length of the cervix femoris," was formed and expressed before the organization of the adults of the genus *Troglodytes* was known.

the insertion of the ligamentum teres is relatively larger and deeper. The articular cartilage is co-extensive with the head at the upper half of the ball; but it is defined by a groove at the lower half from a rough non-articular tract, beyond which the neck begins: the ridge defining the rough tract from the neck is most strongly marked below and behind, where it forms a curve encroaching upon the head; the non-articular tract of the head is broader before than behind, and the head projects from or beyond the neck at this part. The neck (fig. 6, *c*), having its least circumference near the head, expands quickly to join the shaft, and much more so vertically than transversely; so that it is subcompressed, with the anterior and posterior surfaces rather oblique from above downward and backward. The upper part of the neck is continued into the fore part of the great trochanter, and forms the pretrochanterian protuberance there; the lower part curves more rapidly down to the shaft than in the Gorilla or Chimpanzee, the base of the neck being more extensive, especially vertically, than where it expands to join the head. The trochanter presents a rough convex subquadrate surface externally, is very thick and irregular with protuberances and hollows anteriorly, thinner with an obtuse curved border behind, and concave towards the head; the upper part, terminating in the apex or upper and hinder angle of the trochanter, is bent towards the head, but does not rise so high as that part: on the concave side of the base of the trochanter is a large pit. On the outer convexity a rising, more or less marked, extends from the upper and hinder angle diagonally to the lower and front angle; to which rising or line the tendon of the meso-gluteus is attached. On the smoother surface below the line a bursa is placed, over which the tendon of the ecto-gluteus glides to its insertion. The posterior prominent border of the great trochanter is continued, with a slight subsidence, to the small trochanter (*e*); which is more prominent in proportion to its size than in the Gorilla or Chimpanzee, and projects and is placed more inwards. A much lower ridge is continued from the upper and fore part of the great trochanter obliquely downward and inward to opposite the lower part of the base of the small trochanter, below which it passes in its way backward to join the linea aspera. In its whole extent this ridge is called the 'spiral line,' and to the upper half is sometimes applied the term 'anterior intertrochanteric line;' but it does not join the small trochanter. Between this and the head is a nearly parallel linear indication of the line of reflexion of the synovial bag: the capsular ligament is attached to the anterior intertrochanteric line.

The shaft, with a full oval transverse section at its upper fourth, gradually decreasing in breadth, becomes more convex anteriorly in the transverse direction; and the same section, in the middle two-thirds of the shaft, presents a full pyriform shape, the linea aspera forming the apex.

A ridge (ecto-gluteal) beginning below the middle of the base of the great trochanter, a rough tract from the small trochanter, and the 'linea spiralis' converge as they descend to form the 'linea aspera' (*g*, *g*, fig. 6): this is most prominent along the midde third of the shaft, forming there a production of dense osseous matter, which must afford, like a buttress, additional power to the femur in sustaining superincumbent weight or pressure. The canal of the medullary artery (*m*) usually begins just above this prominent part, passing obliquely upward into the bone. Near the lower third of the shaft the linea aspera bifurcates,—one ridge, the best marked (*a*'), passing to the outer condyle, the other diverging towards the inner condyle, but being widely interrupted by a smooth tract where the femoral artery bends obliquely backward to the popliteal space. Of the two supracondyloid protuberances, the entocondyloid one (*k*') is the largest and usually the most prominent, and the terminal expansion of the bone is chiefly towards that side, especially on an anterior view (Pl. XII. fig. 1). The major part of the rotular surface is on the outer division or condyle, and the transverse concavity of the rotular surface is well marked though irregular, and deeper towards the inner side. Both condyloid surfaces are continued from the rotular one backwards, the condyles diverging, with concomitant expansion of the intercondyloid space, as they pass backwards. The inner condyle descends lower, or has more vertical extent than the outer one, this being rather longer from before backward.

The great proportional length of the femur, the well-defined trochanters with their connecting ridge, the forward curvature of the shaft, the buttress-like development of the linea aspera, the proportions and directions of the distal condyles necessitating the oblique position of the shaft to bring them on the horizontal line, and the extent of surface in that plane which the condyles present to the tibia, are all brought out saliently by the foregoing comparisons, as the principal characteristics of the Human femur, in relation to the peculiar upright posture and bipedal gait and progression of the Human species[1].

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[1] Since the foregoing descriptions were communicated to the Zoological Society, I have been favoured by Dr. Kaup with the cast of a fossil femur from the Eppelsheim miocene, near Darmstadt, and with the request that I would compare it with the femora of the large Anthropoid Apes in our metropolitan Museums. This femur is 11 in. 3 lines in length, is 2 in. across the proximal, and 1 in. 7 lines across the distal end, and measures 2 in. 4 lines in circumference. It retains all the lower quadrumanal characters of the bone, with nearly the Gibbon-like proportions as to length and slenderness. The shaft is straight, without the least forward bend; the distal end becomes gradually and almost symmetrically expanded, and in an inferior degree to that in the Chimpanzee, Gorilla, and Man; the backward production of the condyles is much less. The linea aspera is as little marked as in the Gibbons; the neck of the thigh-bone is as short, and the head as small, relatively, as in the Gibbons: all the modifications, in fact, relating to the use of the lower limb in maintaining the erect position, and which in their respective degrees are found in the Chimpanzee and Gorilla, marking their progressive approaches to the peculiar Human attitude, are as completely wanting in the fossil femur as in that of the recent Ungkas and Gibbons; whence we may infer that, during the miocene period, there existed in the locality haunted by the Ape that has left its remains at Eppelsheim, a richly wooded tract, in which a Gibbon, or 'long-armed Ape,' of twice the size of those of the Eastern Indian Archipelago, enjoyed a strictly arboreal life.

The shape of the shaft of the supposed humerus of the *Dryopithecus*, from the miocene of the South of France, as figured in M. Lartet's Memoir (Comptes Rendus de l'Académie des Sciences, Juillet 28, 1856), agrees with that of the Eppelsheim femur.

Tibia.—Plate VIII.

In Man the tibia (fig. 9), after the femur, is the longest bone of the skeleton; but in the Gorilla (fig. 1) the tibia is the shortest of all the long bones of the limbs, being barely two-thirds the length of the humerus. It is nearly one-fifth shorter than the Human tibia, but is of equal thickness in the shaft, and of greater thickness at the upper end.

The upper surface of the head of the bone (fig. 2) is nearly flat, with slight inequalities, of an irregular oblong form, relatively broader from side to side than in Man (fig. 10); it is divided into two articular and two non-articular facets. The inner articular facet (fig. 2, *n*) presents an almost semicircular form with the nearly straight border outward; the very slight concavity of the surface is due chiefly to the rising of the middle part of the straight border into a low eminence (*b*), giving attachment to the extremity of the semilunar cartilage of that side. The outer facet (*e*) is rather more elevated along its oblique inner border, which rises to the tuberosity (*b′*) for the attachment of its semilunar cartilage; this surface occupies a smaller proportion of the head of the bone than in Man. The anterior non-articular tract is of a triangular form with a slight anterior eminence (*c*), and a depression for the attachment of the crucial ligament near the spine (*b*). The tuberosity (fig. 1, *d*) overhanging the fibula is more developed than in Man; that (*f*) for the rotular ligament is rather less prominent. The head rapidly contracts to the shaft. The straight line of the inner border (*t*) bends very little at the expansion (*a′*) for the inner malleolus (*i*), the concavity there being much less than in Man: the outer border differs still more by its concave sweep, leaving the wide interosseous space between the tibia and fibula. Below and external to the rotular tuberosity (*f*) is an extensive rough shallow depression for the attachment of the sartorius, semitendinosus, and gracilis muscles. The ‘crest’ of the tibia curves towards the inner and fore part of the lower end of the shaft with its concavity outward, giving a greater proportional extent of origin to the ‘tibialis anticus’ than in Man. The anterior contour of the tibia is principally convex, instead of being concave; the posterior contour is slightly concave. The oblique line for the origin of the ‘soleus’ is strongly marked at the upper and back part of the shaft; a little below this is the orifice of the canal for the medullary artery leading down to the cavity of the bone, as in Man. The inner malleolus is more angular in form and projects rather more downward, but is less extended outward, than in Man. The quadrilateral articular surface on the lower end of the bone (fig. 3) is less concave from before backward than in Man, and becomes slightly convex anteriorly, allowing a freer movement of the foot upon the leg.

The tibia of the Chimpanzee (Pl. VIII. fig. 5) deviates further than that of the Gorilla from the Human type, in the proportionally more expanded extremities and more slender shaft. The inner articular facet of the proximal end (fig. 6, *n*) is less defined and relatively smaller than in the Gorilla or Man; the tubercles of the spine (*b*) are more nearly confluent; the rotular protuberance (*f*) is less prominent. As in the Gorilla, the analogy of the leg with the forearm is maintained by the width of the interosseous space, the modification of the lower limb for a special office not being carried out so far as in the Human subject. The inner malleolus is thicker and more truncate at its lower extremity (fig. 7, *i'*); the distal articular surface is more convex transversely, and the outer and front angle (fig. 7, *k*) is more produced, than in the Gorilla.

The Human tibia (Pl. VIII. figs. 9, 10), besides its greater length, differs in the more equable diameter of the shaft, and more parallel contour of the outer and inner sides, with a considerable reduction of the interosseous space. The crest (*h*) descends, near the middle of the anterior surface of the shaft, with a slightly sigmoid or wavy course. The distal articular surface (*m*) is uniformly concave from before backward, and is straight from side to side at the bottom of the tibia; it is continued at a less open angle, and to a greater extent, upon the articular side of the inner malleolus (*i*), the articulation with the astragalus being deeper and firmer than in the Gorilla or Chimpanzee.

The fibula is a thicker and stronger bone in proportion to its length in both the Gorilla (Pl. VIII. fig. 1, *f*) and Chimpanzee (*ib.* fig. 5, *f*) than in Man: its proximal end in the Gorilla (fig. 4) shows a well-marked articular depression, of a larger proportional size than is the corresponding flattened facet in Man (fig. 11); and the rough prominence external to this is more developed in both the great Apes (figs. 4 & 8). The shaft is straighter, and shows no inclination towards the tibia as in Man. The expanded lower end inclines more outward, and does not descend to the level of the inner malleolus. In Man (fig. 9, *l*), it is more vertical, and descends lower than the inner malleolus—interposing a greater obstacle to lateral inflections of the foot upon the leg than in either the Gorilla or Chimpanzee.

Bones of the Foot.—Plate XI.

The chief departure from the Human type of foot, exemplified by the figures in the above Plate, is the angle at which the innermost toe in the Gorilla (fig. 2, *i*) articulates with the tarsus; whereby it becomes an opposable thumb, as in other Quadrumana.

In the Orang-utan the foot is longer than the leg; in the Gorilla it is nearly as long; in Man it is shorter: thus, the length of the tibia in a Man being 16 inches, that of the foot-bones is 10 inches (as in Pl. XIII. fig. 1); whilst in the Gorilla, the length of the tibia being 12½ inches, that of the foot is 12 inches (as in Pl. XIII. fig. 2). The foot is so articulated with the leg in the Gorilla, that the sole is turned a little inward; the concavity of the sole lengthwise is greater than in Man by reason of the permanent partial flexure of the toes, the disposition of the articular ligaments being such as to oppose some force to the attempt to press the toes into a straight line, such as they generally present in Man. The transverse arch or concavity is less deep across the tarso-metatarsal joints than in Man. The tarsus is shorter in proportion to the foot, and is broader than in Man. There is less inequality in respect of thickness between the hallux (*i*) and the other digits (*ii–v*), and greater inequality in respect of length, than in Man: above all, the innermost digit, by express modification of size and shape of the entocuneiform (*i*), is set at nearly a right angle to the other toes, converting the foot into a hand, and one gifted with a prodigious power of grasp (Pl. XI. fig. 2). These peculiarities involve modifications of greater or less degree in all the tarsal bones.

The naviculare or scaphoid (*n*), answering to the carpal bone of the same name, is broader than in Man and less deep,—the dorsal surface being more on the same plane, not bent down so abruptly as the inner (tibial) side, increasing also more in breadth towards that end which is produced, as an obtuse process (*n*), beyond the contiguous parts of the astragalus (*a*) and entocuneiform (*i*). This strong tubercle of the naviculare receives part of the insertion of the tibialis posticus muscle, and shows a smooth facet for the bursa interposed between it and the major part of the tendon proceeding to the entocuneiform. The proximal concavity for the astragalus is broader and deeper transversely than in Man, and less extended vertically. The distal articular surface covers a smaller proportion of that part of the bone, both transversely and vertically, than in Man. The inner facet, for the entocuneiform, is more convex than in Man; the middle facet is also convex, but is flat in Man; the outer facet is more concave than in Man. The feeble concavity of the outer, and convexity of the inner, facets in the Human naviculare, seldom noticed in Anthropotomy, receive a new significance from this comparison with the Gorilla. The proximal and distal articular surfaces of the naviculare are separated by a less thickness of bone at the outer (fibular) end in the Gorilla than in Man; nevertheless the facet for the cuboïdes, inconstant in Man, is present in the four instances of the Gorilla examined by me. The naviculare of the Gorilla is nearly twice the weight of that in Man; its 'tibial' production, with the corresponding inclination of the coarticulated part of the astragalus, more plainly shows its true character, as the innermost of the proximal row of tarsal bones, than could be seen in Man.

The astragalus (Pl. XI. fig. 2, *a*), answering to the lunare of the wrist, exclusively affords the articular surface to the bones of the leg. In the Gorilla it expands more as it advances, and becomes broader in front; it slopes more from without inward and downward, and the facet for the malleolar process of the tibia is less vertical and less defined from the upper surface than in Man (fig. 1, *a*); that surface is less convex from behind forward, and is rather more concave transversely than in Man, showing a less extent of the raising and depressing movements of the foot, and greater freedom and frequency of the movement from side to side, especially of inversion of the sole. The fibular facet resembles that in Man; but its lower angle is turned rather more outward. The groove for the flexor longus pollicis at the back part of the bone is wider than in Man; the posterior concave surface is less deep transversely, the tibial border being less produced downward. The groove dividing this from the anterior articular surface is deeper in the Gorilla. The anterior surface for the calcaneum resembles that of Man; it joins at a similar angle the convexity for the scaphoid, which has a greater transverse extent and convexity: this, called in Anthropotomy the 'head' of the astragalus, has relatively a shorter 'neck' in the Gorilla, but more essentially differs by its direction obliquely inward, giving a corresponding aspect to the naviculare.

The calcaneum answers to the combined cuneiform and pisiform bones of the carpus; it takes no share in joining the foot to the leg, but affords the chief lever to the great flexor muscles of the foot. It is mainly distinguished in the Gorilla (Pl. XI. fig. 2, *cl*, & fig. 3) from that of Man (*ib.* fig. 1, *cl*) by the greater length and inner depth of the posterior production or lever of the bone; and the lower surface of the bone (fig. 3), instead of being straight from before backward, broad and flattened from side to side, is concave in the longitudinal direction, chiefly due to a terminal expansion of the heel-bone, which bends downward and inward (tibiad); the lower surface is likewise convex from side to side, and smooth except along the outer border. The outer articular surface for the astragalus is divided by a deep and narrow groove from the outer side of the bone, which it overhangs, and it is more convex from before backwards than in Man; the inner surface is more concave, broader and shorter. The breadth of the articular part of the calcaneum is greater in the Gorilla than in Man. The calcaneum in the Gorilla projects beyond the articular part, like a large lever-bone,—its terminal expansion being supported on a subcylindrical constriction or neck, smooth, save along the narrow tract on the lower and outer border (*x*,*x*, fig. 3), which shows a rough surface like that on the broader under part of the Human calcaneum, indicative of a similar application to the ground in moving along its surface. Whilst the chief modifications in the Human calcaneum for habitual application of the heel to the ground for erect posture are absent, the action of the gastrocnemial tendon upon the foot is favoured and strengthened by the superior backward production and terminal expansion of the calcaneum in the Gorilla. The cuboidal articulation is flatter and more vertical in position than in Man. The groove for the passage of the flexor tendons beneath the 'lesser process' upon which they act in the raising of the heel with its superincumbent weight upon the toes, is wider and more shallow in the Gorilla than in Man.

The entocuneiform of the Gorilla (fig. 2, *i*) differs chiefly in the form and aspect of the surface for the metatarsal of the hallux; in Man (fig. 1, *i*) this surface is nearly flat, and forms or covers the fore part of the bone, presenting there a reniform figure; in the Gorilla the surface is convex transversely, curving from the fore to the inner side of the bone, and forming almost the anterior half of that side. The outer (fibular) third of the fore part of the entocuneiform is rough or non-articular, and encroaches by a notch upon that border of the articular surface. The navicular surface is concave, and continuous with a narrow vertical tract for the entocuneiform. A second surface for the same bone is afforded by the posterior facet of an articular surface on the upper and outer part of the entocuneiform, the anterior facet of which articulates with the base of the second metatarsal.

The articular surface on the outer side for the mesocuneiform (fig. 2, *m*) is divided into two in the Gorilla; the upper surface of the bone is broader transversely, shorter from behind forward than in Man (fig. 1, *m*). That of the ectocuneiform (*e*) shows the same difference in a greater degree: it is not produced forward to articulate with the outer side of the base of the second metatarsal (*ii*) as in Man.

The cuboid is also shorter and broader in the Gorilla; the fore and hind articular surfaces incline more to each other at the outer part of the bone, where they are separated by a narrower non-articular tract, which is more deeply notched (fig. 2, *b*). The surface on the inner side of the bone, for the ectocuneiform, is single and occupies the upper half of that side; it is continuous with the surface at the fore part for the fourth metatarsal, which is concave; that for the fifth metatarsal is flat, and is larger than in Man (fig. 1, *b*).

The metatarsal of the hallux in the Gorilla (fig. 2) shows a corresponding modification to that of the entocuneiform (*i*) in regard to the shape and direction of its proximal articular surface, which is concave from side to side, and looks obliquely backward and a little outward, affording a favourable position and much freedom of motion of the innermost toe, as a flexible prehensile thumb of great power. The whole metatarsal is shorter and more slender than in Man; the distal articular surface is more convex and bent down.

The metatarsals of the four other toes are characterized in the Gorilla by their greater proportional length and their slight bend downwards. Those of the second, third, and fourth toes are also thicker. The fifth metatarsal is more slender in proportion to its length; but the basal process for the attachment of the *peronei brevis* and *tertius* is more developed and inclined outward. The phalanges are distinguished by their greater breadth, as well as length; the proximal and middle phalanges are more bent towards the sole; and on each side of the concave surface there is a ridge for the attachment of the aponeurotic sheath of the strong flexor tendons.

In all the characters by which the bones of the foot depart, in the Gorilla, from the Human type, those of the Chimpanzee recede in a greater degree, the foot being in that smaller Ape better adapted for grasping and climbing, and less adapted for occasional upright posture and motion upon the lower limbs. The lever of the heel is relatively shorter and more slender, the hallux has still more slender proportions, and the whole foot is narrower in proportion to its length, more curved towards the planta, and more inverted, in the Chimpanzee.

The Skeleton.—Plates XII. & XIII.

On comparing the skeleton of the Gorilla with that of Man, one is impressed by the general massiveness and strength of the bony framework in the great Ape, combined, as these characters are, with superior dimensions in the trunk, and with greater length in the upper limbs. If the subjects of comparison be, as in Plates XII. and XIII., adult males, the contracted cranium, masked and overshadowed by the expansion and production of every other part of the skull for brute force, must strike the eye at once as the leading distinction between the Ape and the Man.

The superior size of the trunk in proportion to the height of the Gorilla, and the disposition and arrangement of the ribs and pelvis for the support and defence of a more capacious thoracic-abdominal cavity, are more especially conspicuous on a front view (Pl. XII.). The trunk of the Gorilla, according to the Human standard, would represent that of a giant of some eight feet in height; and the jaws and upper limbs have a proportional or corresponding magnitude: but the size of the constituent bones is such as to exhibit, in this part of the skeleton, much greater breadth, strength, and massiveness than is present in the Irish Giant of that height in the Museum of the Royal College of Surgeons[1].

The plane of the scapula looks less backward in the Gorilla, the glenoid angle being inclined rather more obliquely forward than in Man; a greater proportion of the posterior surface of the scapula is thus seen in a direct side view of the Gorilla's skeleton; but the position of the thorax in the Human skeleton, photographed for Pl. XIII., exaggerates the difference. The effect of the actual difference is to bring the shoulder-joints in the Gorilla more forward than in Man, with a concomitant difference in the usual position of the clavicles, which extend from the sternum more directly outward and less obliquely backward to join the acromion, than in Man. In like manner the joints of the femora, through the shape and direction of the ossa innominata, are brought more forwards, being in advance of, instead of posterior to, the lumbar vertebræ or basis of the true vertebral column. All this, while it favours the application of the limbs to the grasping of the trunk or branch of a tree, takes away, in the same degree, from their adaptability to sustain the body in the erect posture.

The blade-bones, with their proportionally broader coracoid and acromion, are spread out, by their long clavicular buttresses, beyond the upper part of the thorax, to a greater proportional degree than in Man; giving a greater breadth across the shoulders, with corresponding advantage and power in the working of the upper extremities.

These extremities, though so long in respect of the whole body, bear to the trunk nearly the same proportions as in Man. Take away the lower limbs in both skeletons, and this similarity becomes more obvious. In both the lower ends of the antibrachial bones, as the arm hangs down, reach the same transverse line as the ischial tuberosities; and they descend scarcely an inch below those parts in the Chimpanzee. The embryonal proportions of the lower limbs brings down the stature of the Gorilla below that of the average in the well-formed European.

In a skeleton of such, measuring 5 feet 9 inches from the vertex to the sole, the length of the trunk is 2 feet 6 inches; in the skeleton of a male Gorilla, measuring

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[1] The trunk in this skeleton, from the atlas to the ischial tuberosities, measures 3 feet 4½ inches, that in the Gorilla measuring 3 feet; but the trunk is supported in the Irish Giant on limbs of nearly twice the length of those in the great Gorilla.

5 feet 6 inches, in as erect a position as it can naturally be brought, the length of the trunk is 3 feet. From the vertex to the ischial tuberosities in the Man measures 3 feet; in the Gorilla it measures only 3 feet 5 inches, owing to the inferior height of the cranium, even with the parietal crest fully developed. The similarity of proportion of the upper limb to the trunk, in length, is due mainly to the greater proportional length of the pelvis in the Gorilla. The humerus in Man extends as low as the interspace between the third and fourth lumbar vertebræ; in the Gorilla it extends to that between the vertebræ answering to the fourth and fifth lumbars; but in Man the humeral condyles hang nearly two inches above the iliac labrum, while in the Gorilla they extend as far below that labrum. The tips of the fingers in Man, when he stands erect, usually reach to the middle of the femora; in the Gorilla they reach to about an inch from the lower end. The length of the bones of the upper limb in the Human skeleton (Pl. XII. fig. 1) is 2 feet 9 inches; in the Gorilla (*ib.* fig. 2) it is 3 feet 8 inches; in the Irish Giant[1] it is 3 feet 2½ inches.

In the side view (Pl. XIII.) the single curve of the true vertebræ, especially if carried along the tips of the spinous processes, strongly differentiates the skeleton of the Ape from that of Man; but this, in the Gorilla, is due in part to the enormous length of the spines of the cervical vertebræ, especially of the lower five: along the fore part of the true vertebræ, there is a slight convexity at the cervical and lumbar regions, but of less extent longitudinally than in Man. After the seventh vertebra, counting downwards, thirteen pairs of pleurapophyses are developed as free, moveable ribs, in the Gorilla; and they are relatively longer, thicker, broader, and with minor intercostal spaces, especially behind, than in Man. The first seven pairs reach the sternum by their cartilages, as in Man, the supernumerary pair being developed from the segment answering to the first lumbar in Man. The fore-and-aft diameter of the bony thorax at the fore end of the eighth rib, in the medium state of respiration, in the Gorilla, is 1 foot 1 inch; in Man it measures 7 inches. The transverse diameter of the bony chest, under the same circumstances, in the Gorilla, at the ninth pair of ribs, is 1 foot 2 inches; in Man it is 9½ inches. The length or vertical extent of the bony thorax in the Gorilla is 1 foot 5 inches, in Man it is 1 foot 2 inches. Estimating the volume of the entire cavity of the thorax in the Human skeleton figured in Plates XII. and VIII. at 330 cubic inches, that of the Gorilla would be about 500 cubic inches; but the vital capacity, or measure of the mobility of the chest, does not differ in the same degree,—that in Man, through the lighter character of the thoracic compages, being proportionally greater than in the more strongly and stiffly girt thorax of the great Ape. The superior absolute capacity or area of the chest in the Gorilla is in harmony with its superior muscular development and the exercise of greater force in that animal.

The breast-bone, though one-third longer than that of Man, is relatively broader,

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[1] Mus. Coll. Chir., Osteol. Ser., No. 5905.

being sometimes, as in the skeleton figured in Pl. XII., of more than twice the breadth of that in the Human subject: the Chimpanzee retains more of the human proportions in its sternum than does the Gorilla. But the sternum shows a marked difference of breadth in the few adult individuals of the Gorilla already acquired, as may be seen by comparing the skeleton of the male figured by Du Chaillu[1], with that of the skeleton photographed by Fenton, and figured in Plates XII. and XIII. fig. 2.

In Plate IX. are figured, of the natural size (figs. 1 and 2), the manubrium sterni of the young adult male Gorilla in the Museum of the Royal College of Surgeons, London (No. 5178, Osteological Series), with that (figs. 2 & 3) of the Chimpanzee and that of a European (figs. 5 & 6). Figures of the first pair of ribs, articulated with the manubrium, are also given, showing the more regular curve of that rib in Man.

The great length of the cervical spines and depth of the jaw tend to obliterate the appearance of a neck in the skeleton of the Gorilla, whilst the inclusion of the last two lumbar vertebræ by the iliac bones and the development of the ribs of the first lumbar reduce the length of the loins. The sacrum (Pl. XII. fig. 2, 5, *s* 5), through this reduction, appears to be longer, as it is, actually, narrower, than in Man; but nearly the same proportion of the Gorilla's sacrum, truly homologous with the human (ib. *s* 1, *s* 5), projects free from the embrace of the iliacs as in Man.

The sacrum of the not quite adult male Gorilla, figured in pl. xxxvi. fig. 1, 'Zool. Trans,' vol. iv., included only the five vertebræ answering to those forming the human sacrum; but the last lumbar vertebra of that Gorilla had become united, at the periphery of its centrum, with the first true sacral (fig. 2), and would soon have coalesced therewith, as in the sacrum of the old male Chimpanzee figured in the same Plate (fig. 3), and in that of the old male skeleton of the Gorilla in the British Museum, figured in Pl. XII. of the present memoir.

The lower limbs, measured from the head of the femur to the under surface of the calcaneum, rather exceed in length that of the head and trunk together in Man; in the Gorilla they are nearly one foot shorter.

	Man, 5 feet 9 inches.		Gorilla, 5 feet 6 inches.	
	feet.	inches.	feet.	inches.
Length of head and trunk . .	3	0	3	5
,, lower limb . . .	3	1[2]	2	6

The shorter lower limb of the Gorilla is terminated by a longer foot than in Man; the bony frame of that part measures 12 inches in length in the Gorilla, and 9½ inches in the human skeleton compared. The bony hand of the Gorilla is 10 inches in length, in the Man it is 7⅓ inches.

Other differences between the Human and Gorillan skeletons have been noted in the special descriptions of the bones, and their signification in reference to the transmutative

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[1] *Op. cit.* p. 370.

[2] In the skeleton of the Irish Giant the length of the lower limb is 4 feet.

hypothesis has been more especially set forth in Parts III.[1] and IV.[2] of the series of communications on the Anthropoid Apes. In concluding the present Part I would remark that, whilst the bony frame of the Gorilla shows the nearest approaches, among Apes, to the truly human characteristics of the skeleton, it differs in a greater degree than does that of lower Quadrumana by its adaptive developments. These differences relate to the great bodily strength and power of bite of the Gorilla, and do not approximate it to any lower form, assuredly not to the Baboons with their short and narrow thorax, long and narrow pelvis, long loins with anapophysially interlocked vertebræ, and short-spined neck-bones.

DESCRIPTION OF THE PLATES.

PLATE I.

Fig. 1. Left scapula, back or outer surface, of an adult but young male *Troglodytes Gorilla.*
Fig. 2. Front view of the coracoid process of the same.
Fig. 3. The glenoid angle, showing the articular surface (*g*) and the contiguous acromial (*a*) and coracoid (*c*) processes of the same scapula.
Fig. 4. Left scapula, from the same aspect, of an adult male *Troglodytes niger.*
Fig. 5. Glenoid angle of the same scapula.
Fig. 6. Upper costa and acromion process of the same.
Fig. 7. Left scapula of an adult male European.
Fig. 8. Glenoid angle of the same scapula.

PLATE II.

Fig. 1. Right clavicle of an adult but young male *Troglodytes Gorilla.*
Fig. 2. Right clavicle of an adult male European.
Fig. 3. Right clavicle of an adult male *Troglodytes niger.*
Fig. 4. Right clavicle of an adult male Australian.
Figs. 5, 6. Os scaphoïdes of a Gorilla.
Figs. 7, 8. Os scaphoïdes of a Man.
Fig. 9. Os lunare of a Gorilla.
Fig. 10. Os lunare of a Man.
Fig. 11. Os pisiforme of a Gorilla.
Fig. 12. Os pisiforme of a Man.
Fig. 13. Os cuneiforme of a Gorilla.

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[1] Trans. Zool. Soc. vol. iii. p. 381.

[2] Ib. vol. iv. p. 175.

Fig. 14. Os cuneiforme of a Man.
Fig. 15. Os trapezoïdes of a Gorilla.
Fig. 16. Os trapezoïdes of a Man.
Fig 17. Metacarpal surface of the os magnum of a Gorilla.
Fig. 18. Radial side of the os magnum of a Gorilla.
Fig. 19. Metacarpal surface of the os magnum of a Man.
Fig. 20. Radial side of the os magnum of a Man.
Fig. 21. Os unciforme of a Gorilla.
Fig. 22. Os unciforme of a Man.

(The os trapezium was wanting in the series of carpal bones of the adult Gorilla's skeleton which first reached me, in 1851, when the above Plate was drawn; that bone is represented in the wrist of the older male Gorilla, Pl. X. *t*.)

PLATE III.

Fig. 1. Right humerus of an adult but young male *Troglodytes Gorilla*.
Fig. 2. The head of the same bone.
Fig. 3. The back part of the condyles, with the perforated anconeal fossa; of the same bone.
Fig. 4. The distal articular end of the same bone.
Fig. 5. Right humerus of an adult male *Troglodytes niger*.
Fig. 6. The head of the same bone.
Fig. 7. The back part of the condyles of the same bone.
Fig. 8. Right humerus of an adult male Australian.
Fig. 9. The head of the same bone.
Fig. 10. The back view of the condyles of the same bone.
Fig. 11. The front view of the distal end of the right humerus of an adult male European.

PLATE IV.

Fig. 1. The right radius, wanting the distal epiphysis, of an adult but young male *Troglodytes Gorilla*.
Fig. 2. The articular head of the same bone.
Fig. 3. The right radius of an adult male *Troglodytes niger*.
Fig. 4. The articular head of the same bone.
Fig. 5. The back part of the distal end of the same bone.
Fig. 6. The articular surface of the same end.
Fig. 7. The right radius of an adult male Australian.
Fig. 8. The articular head of the same bone.
Fig. 9. The back part of the distal end of the same bone.

Fig. 10. The articular surface of the same end.
Fig. 11. The back part of the distal end of the right radius of an adult male European.
Fig. 12. The articular surface of the same end.

PLATE V.

Fig. 1. The radial side of the right ulna, wanting the distal epiphysis, of an adult but young male *Troglodytes Gorilla.*
Fig. 2. The back part of the olecranon of the same bone.
Fig. 3. The front surface of the same bone.
Fig. 4. The radial side of the right ulna of an adult male *Troglodytes niger.*
Fig. 5. The back surface of the olecranon of the same bone.
Fig. 6. The distal end of the same bone.
Fig. 7. The front surface of the same bone.
Fig. 8. The radial side of the ulna of an adult male Australian.
Fig. 9. The back part of the olecranon of the same bone.
Fig. 10. The front part of the same bone.
Fig. 11. The distal end of the same bone.
Fig. 12. The front part of the proximal end of the ulna of an adult male European.
Fig. 13. The back part of the proximal end of the same bone.

PLATE VI.

Fig. 1. The back surface of the left os innominatum of an adult but young male *Troglodytes Gorilla.*
Fig. 2. The acetabular cavity of the same bone.
Fig. 3. The back surface of the left os innominatum of an adult male *Troglodytes niger.*
Fig. 4. The back surface of the left os innominatum of an adult male Australian.

PLATE VII.

Fig. 1. The back view of the right femur of an adult but young male *Troglodytes Gorilla.*
Fig. 2. The upper end of the same bone.
Fig. 3. The lower end of the same bone.
Fig. 4. Back view of the right femur of an adult male *Troglodytes niger.*
Fig. 5. The upper end of the same bone.
Fig. 6. Back view of the right femur of an adult male Australian.
Fig. 7. The upper end of the same bone.

PLATE VIII.

Fig. 1. Front view of the left tibia and fibula of an adult but young male *Troglodytes Gorilla.*
Fig. 2. The upper end of the same tibia.
Fig. 3. The lower end of the same tibia.
Fig. 4. The upper end of the same fibula.
Fig. 5. Front view of the left tibia and fibula of an adult male *Troglodytes niger.*
Fig. 6. The upper end of the same tibia.
Fig. 7. The lower end of the same tibia.
Fig. 8. The upper end of the same fibula.
Fig. 9. Front view of the left tibia and fibula of an adult male Australian.
Fig. 10. The upper end of the same tibia.
Fig. 11. The upper end of the same fibula.

PLATE IX.

Fig. 1. Manubrium sterni, and first pair of ribs, of an adult but young male *Troglodytes Gorilla.*
Fig. 2. The upper margin of the same manubrium.
Fig. 3. Manubrium sterni, and first pair of ribs of an adult male *Troglodytes niger.*
Fig. 4. The upper margin of the same manubrium.
Fig. 5. Manubrium sterni, and first pair of ribs, of an adult male European.
Fig. 6. The upper margin of the same manubrium.
Fig. 7. The sternal end of the second rib of the same skeleton.
Fig. 8. The first rib of an adult male Australian.

The following letters indicate the same parts in each figure :— *a.* articular surface for the clavicle ; *d.* capitulum or 'head' of the rib ; *e.* 'neck' of the rib ; *f.* 'tubercle' of the rib ; *pl.* pleurapophysis, or osseous part of the rib : *h.* hæmapophysis, or cartilaginous part of the rib. The figures in the above nine Plates were drawn in 1851, by permission of the President and Council of the Royal College of Surgeons of England, from specimens in the Museum of the College.

In the foregoing illustrations of the comparative osteology of the European and Australian the physical superiority of the civilized man is exemplified. No known conditions of climate are more favourable to a perfect natural development of the 'noble savage in his native wilds,' free from all the restraints of so called 'artificial' society, than that of Australia. The wild mammals of the woods and plains, and the teeming life of the sea, excite and reward the healthy exercise of the senses and muscular system of the Aboriginal Sportsman of that dry, sunny, and healthful land. Yet the advantage in regard to size and strength of body, especially as exemplified by the bony framework, is decidedly with the civilized European.

PLATE X.

Fig. 1. Back view of the bones of the hand of an adult male *Troglodytes Gorilla.*
Fig. 2. Ditto of an adult male Australian.

In both figures, *s* is the scaphoid, *l* the lunare, *c* the cuneiforme, *p* the pisiforme (seen obliquely), *t* the trapezium, *z* the trapezoides, *m* the os magnum, *u* the unciforme, *i* pollex, *ii* index, *iii* medius, *iv* annularis, *v* minimus.

PLATE XI.

Fig. 1. Back, or upper view, of the bones of the foot of an adult male Australian.
Fig. 2. Ditto, of an adult male *Troglodytes Gorilla.*
Fig. 3. Under view of the calcaneum of the same foot.

In both figures, *n* is the naviculare, *a* the astragalus, *cl* the calcaneum, *i* the entocuneiforme, or internal cuneiforme bone, *m* the mesocuneiforme, or middle cuneiforme bone, *e* the ectocuneiforme, or external cuneiforme bone, *b* the cuboides; *i* hallux, *ii* second toe, *iii* third toe, *iv* fourth toe, *v* little toe.

PLATE XII.

Fig. 1. Skeleton of an adult male European.
Fig. 2. Skeleton of an adult male *Troglodytes Gorilla.*

PLATE XIII.

Fig. 1. Side view of the same skeleton of the Gorilla.
Fig. 2. Ditto of the same Human Skeleton.

In both Plates the figures are reduced according to the scale appended: the basis of the engravings was afforded by the 'Photographs' executed, under my direction, by Mr. Fenton, and published, in 1859, by the Trustees of the British Museum. The defects of proportion and indefinite outline incident to Photographic impressions have been rectified from the skeletons themselves in the engravings.

Scapula.

From Nature on Stone by J Erxleben.

Day & Son Lithrs to the Queen

1 3 Troglodytes gorilla. 4 6 Troglodytes niger 7_8 Homo –

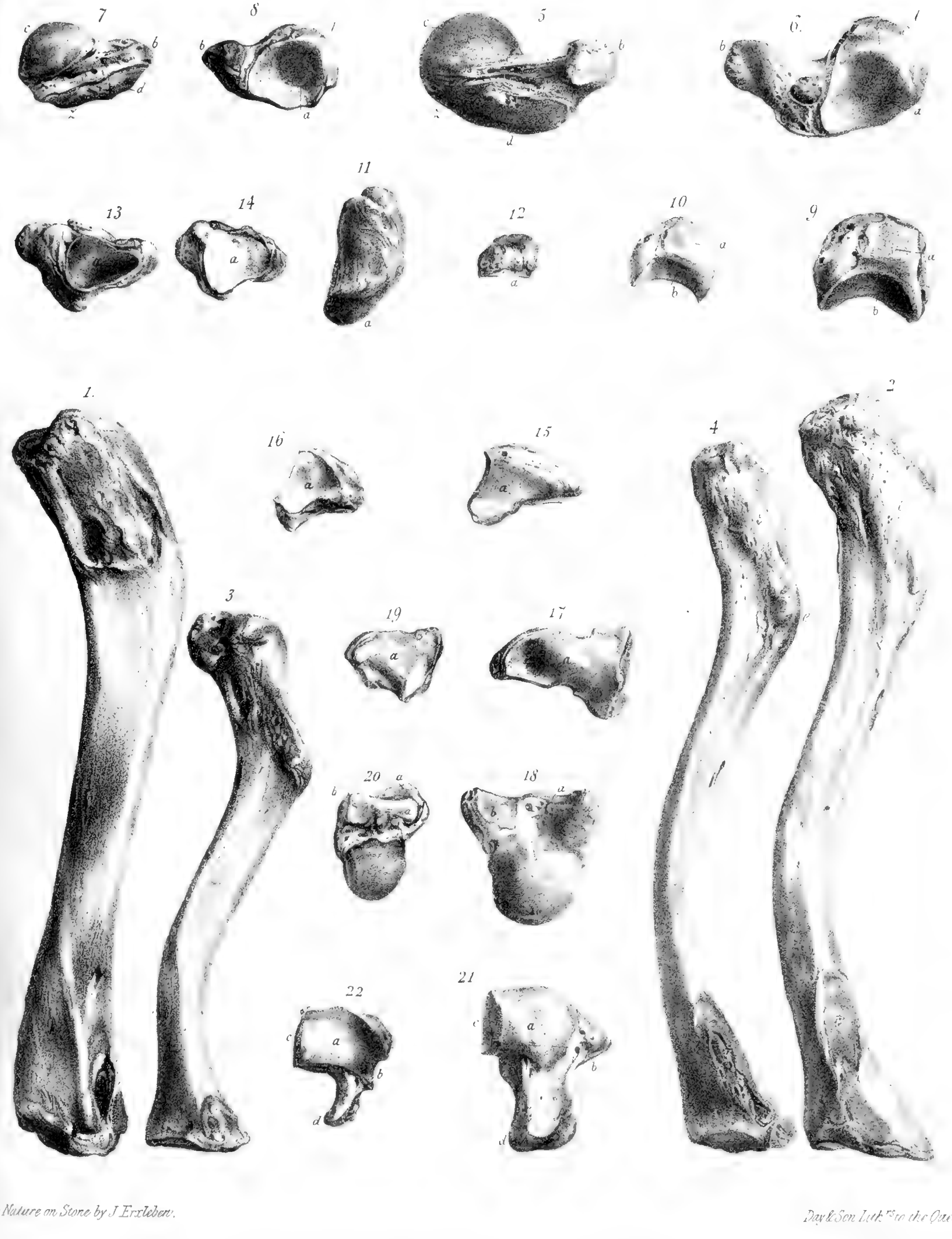
Scapula

From Nature on Stone by J Erxleben

Day & Son Lith^rs to the Queen

1–3 Troglodytes gorilla 4–6 Troglodytes niger 7–8 Homo —

Clavicula. ossicula carpi



rom Nature on Stone by J. Erxleben.

Day & Son Lith^rs to the Queen

.2.5.6.9.11.13.15.17.18.21. *Troglodytes Gorilla.* 3. *Troglodytes niger.* 4.7.8.10.12.14.16.19.20.22. *Homo*

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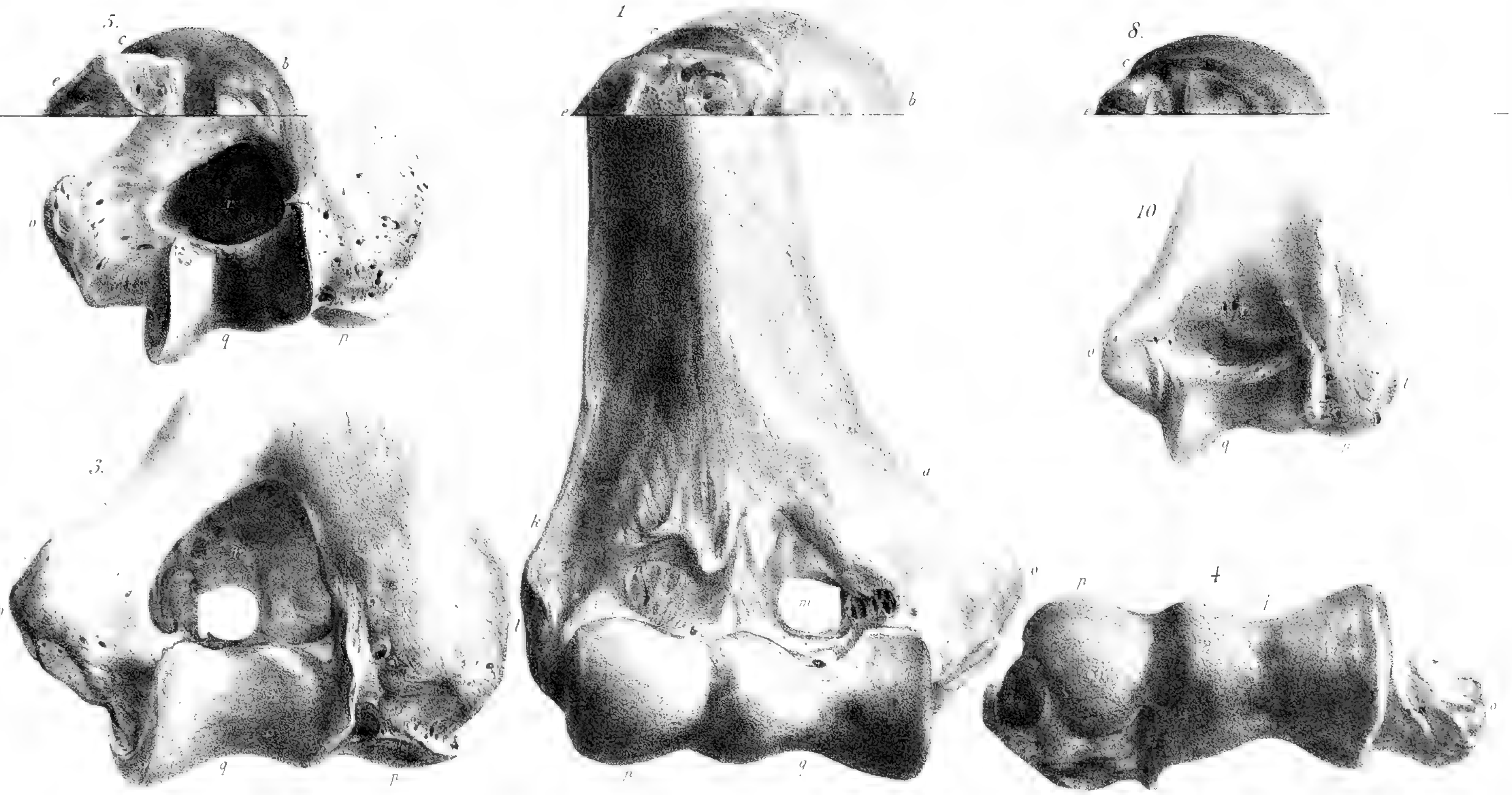
Humerus



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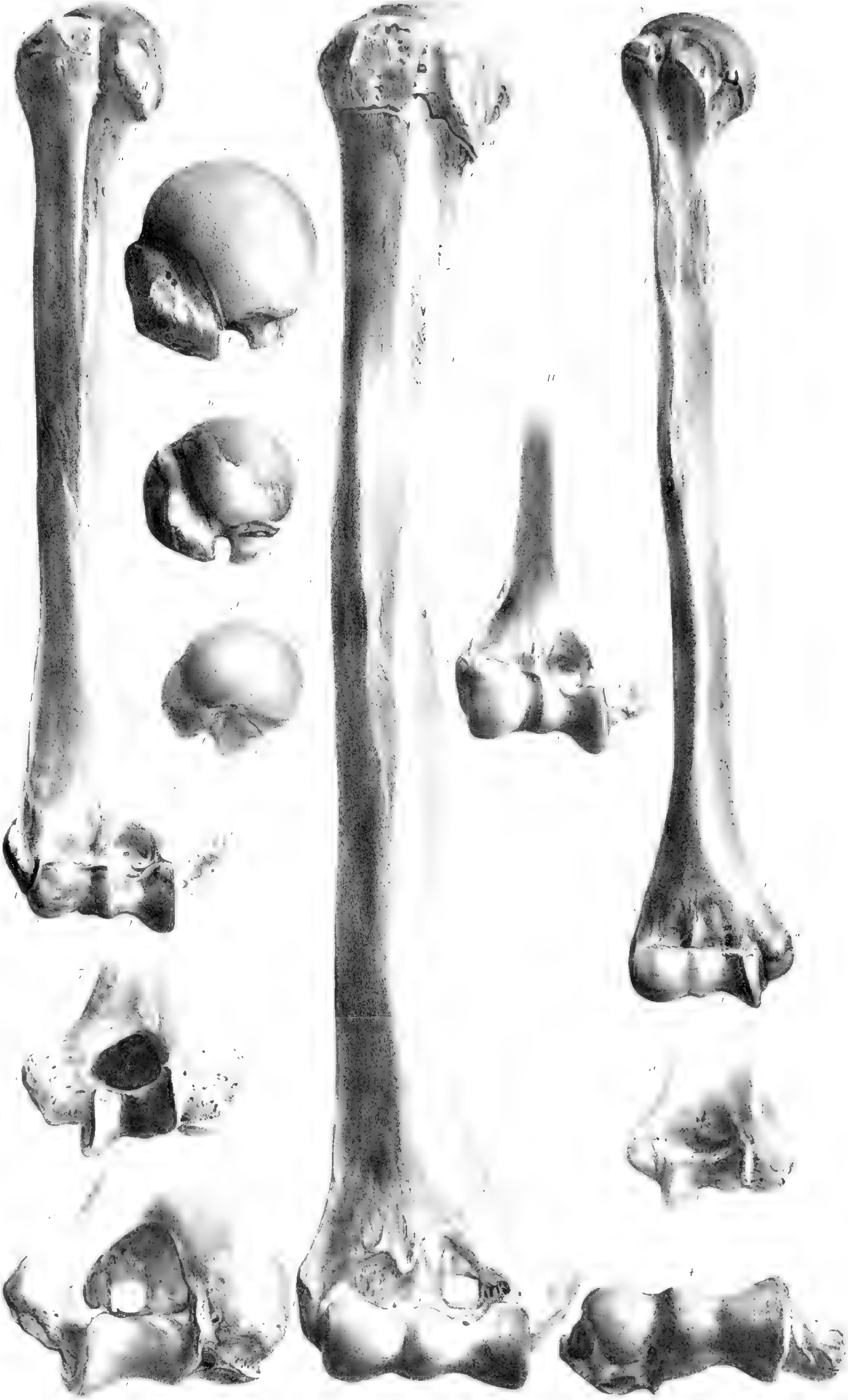
[illegible]

1.4. Troglodytes Gorilla. 5.7. Troglodytes niger. 8.10. Australian. 11. European



1.4 Troglodytes Gorilla 5.7 Troglodytes niger 8.9.10 Australian 11 European

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Radius.

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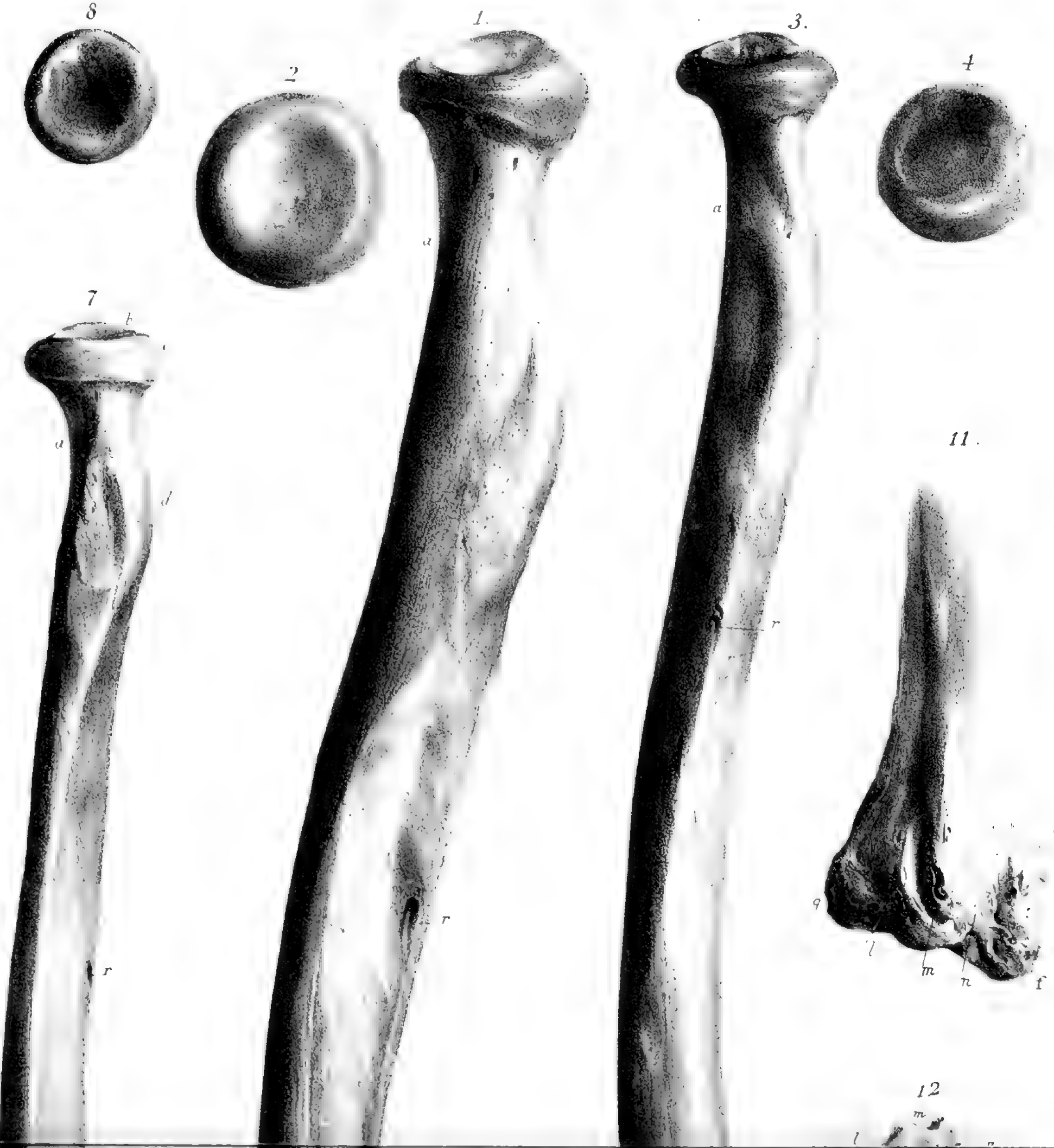

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Day & Son, Lith^rs to the Queen

1.2 Troglodytes Gorilla. 3.6 Troglodytes niger. 7.10 Australian 11.12 European.

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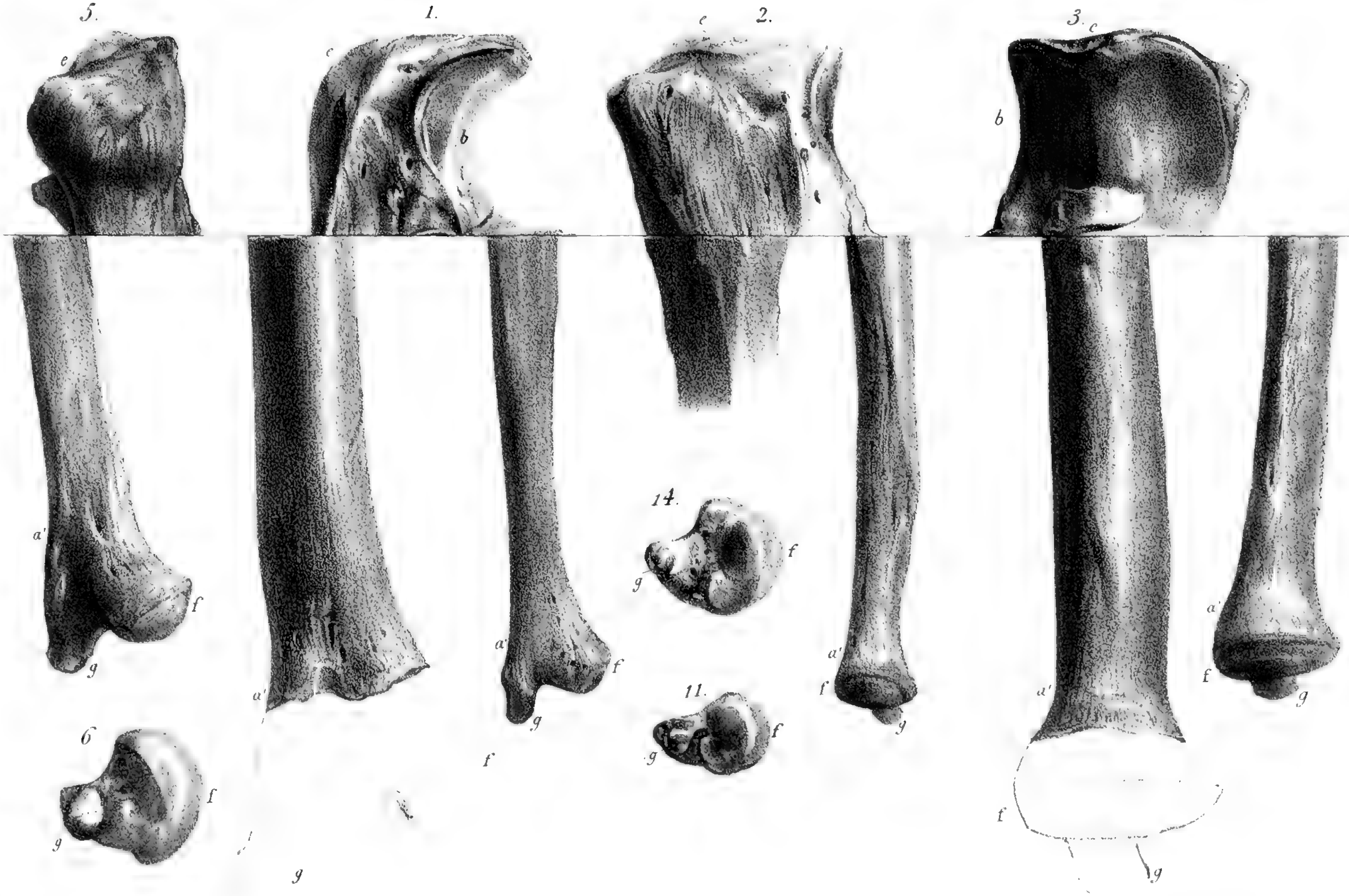
NATURAL HISTORY

Ulna.



From Nature on Stone by J. Erxleben

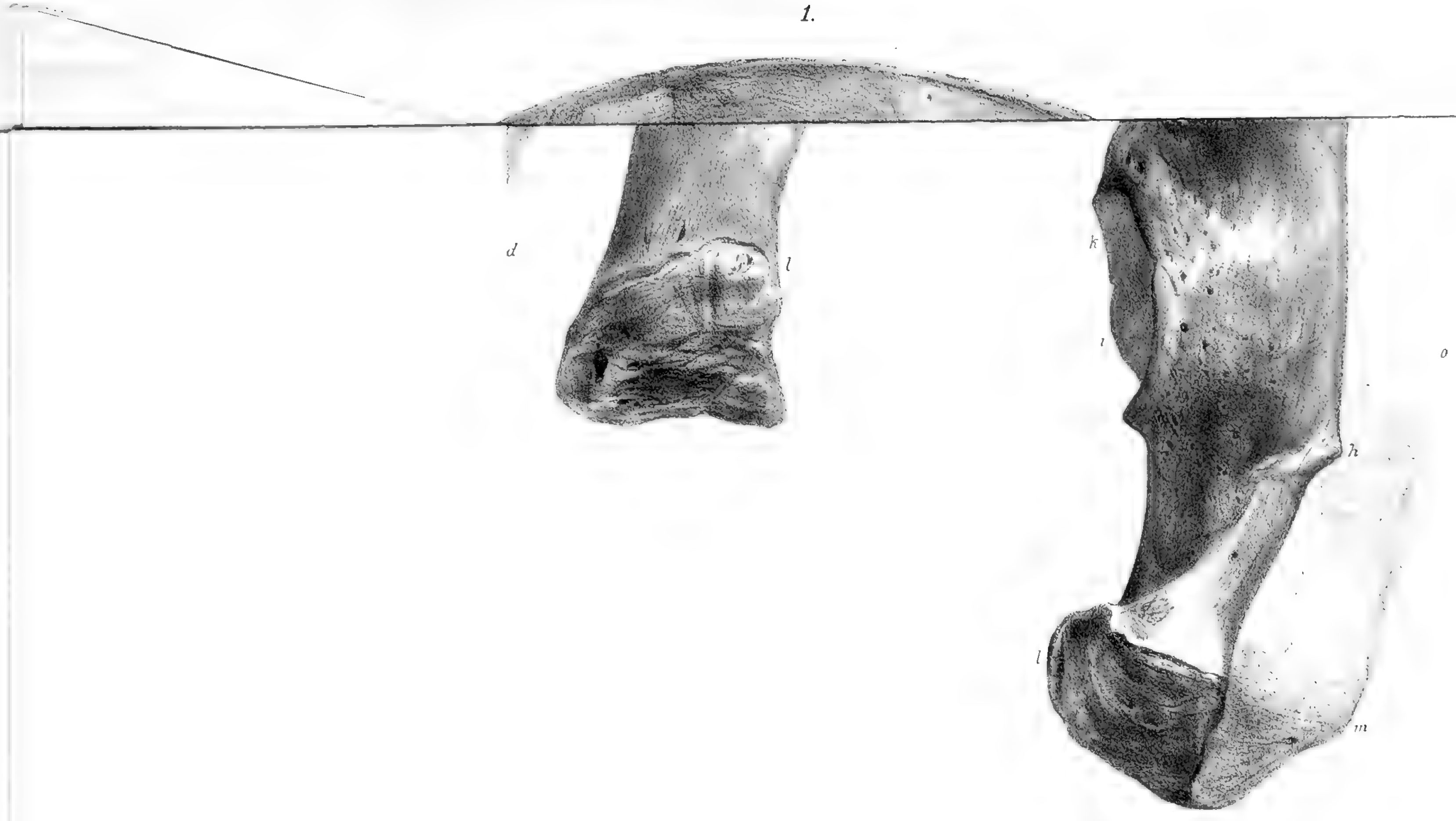
Day & Son Lithrs to the Queen

1.2. Troglodytes Gorilla. 4.7. Troglodytes niger. 8.10. Australian. 12.14. European

Ulna

1-3. Troglodytes Gorilla 4-7. Troglodytes niger 8-11. Australian 12-14. European

Os innominatum.



Troglodytes niger. – 2 Homo, var. Æthiopica.

Os innominatum

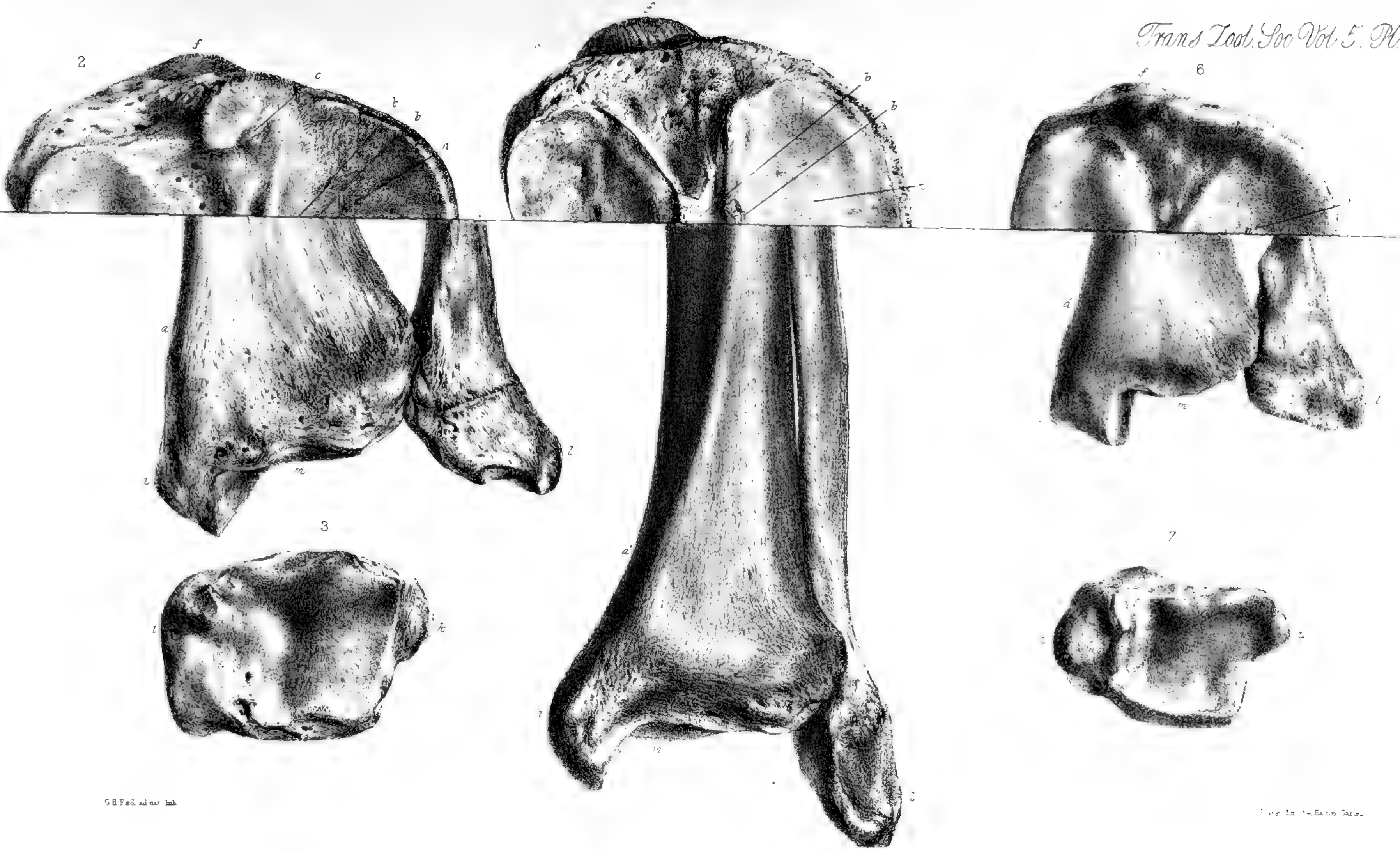
2 Troglodytes Gorilla 3 Troglodytes niger 1 Homo, var. Æthiopica

G.H. Ford ad nat. lith.

1.2.3. [illegible]

[illegible]

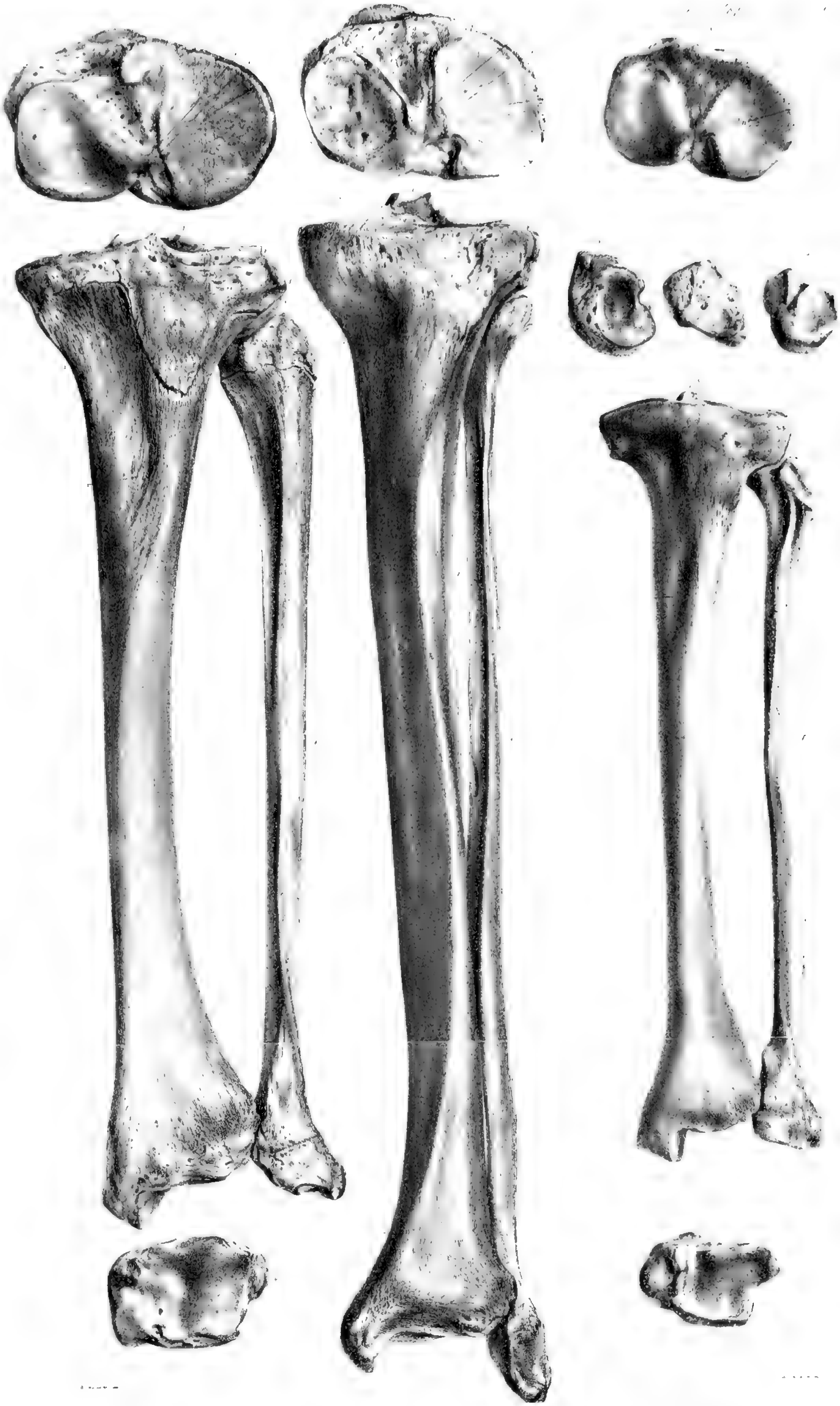
Trans. Zool. Soc. Vol. 5. Pl. 8.



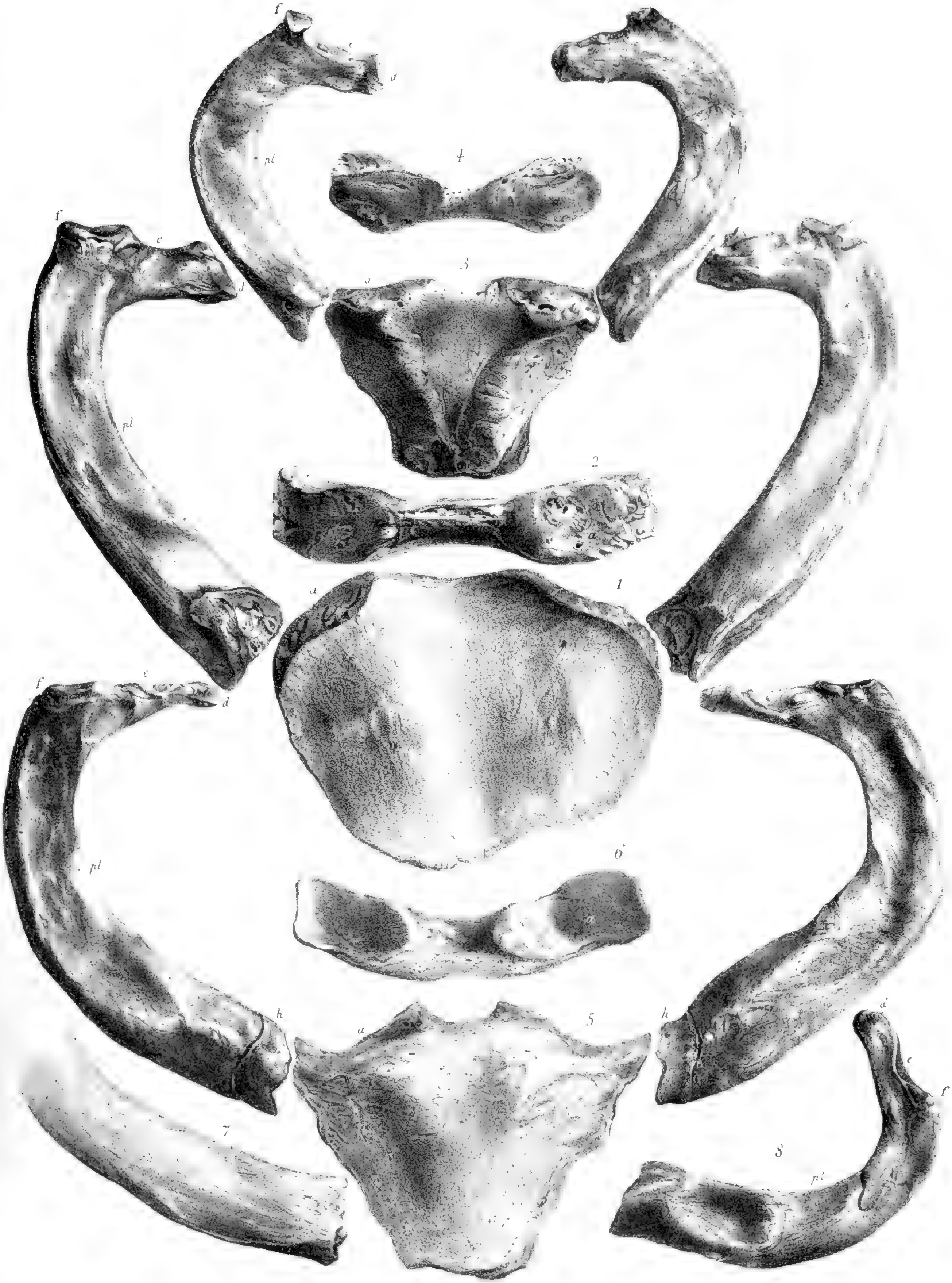
G H Ford ad nat lith.

Ford & West Imp.

1.2,3,4, Troglodytes Gorilla. 5,6,7,8, Troglodytes Niger. 9,10,11, Homo.



Manubrium Sterni.



From Nature on Stone by J. Erxleben

Day & Son, Lith^rs to the Queen.

1.2. Troglodytes Gorilla. 3.4. Troglodytes niger. 5.7. European. 8. Australian.

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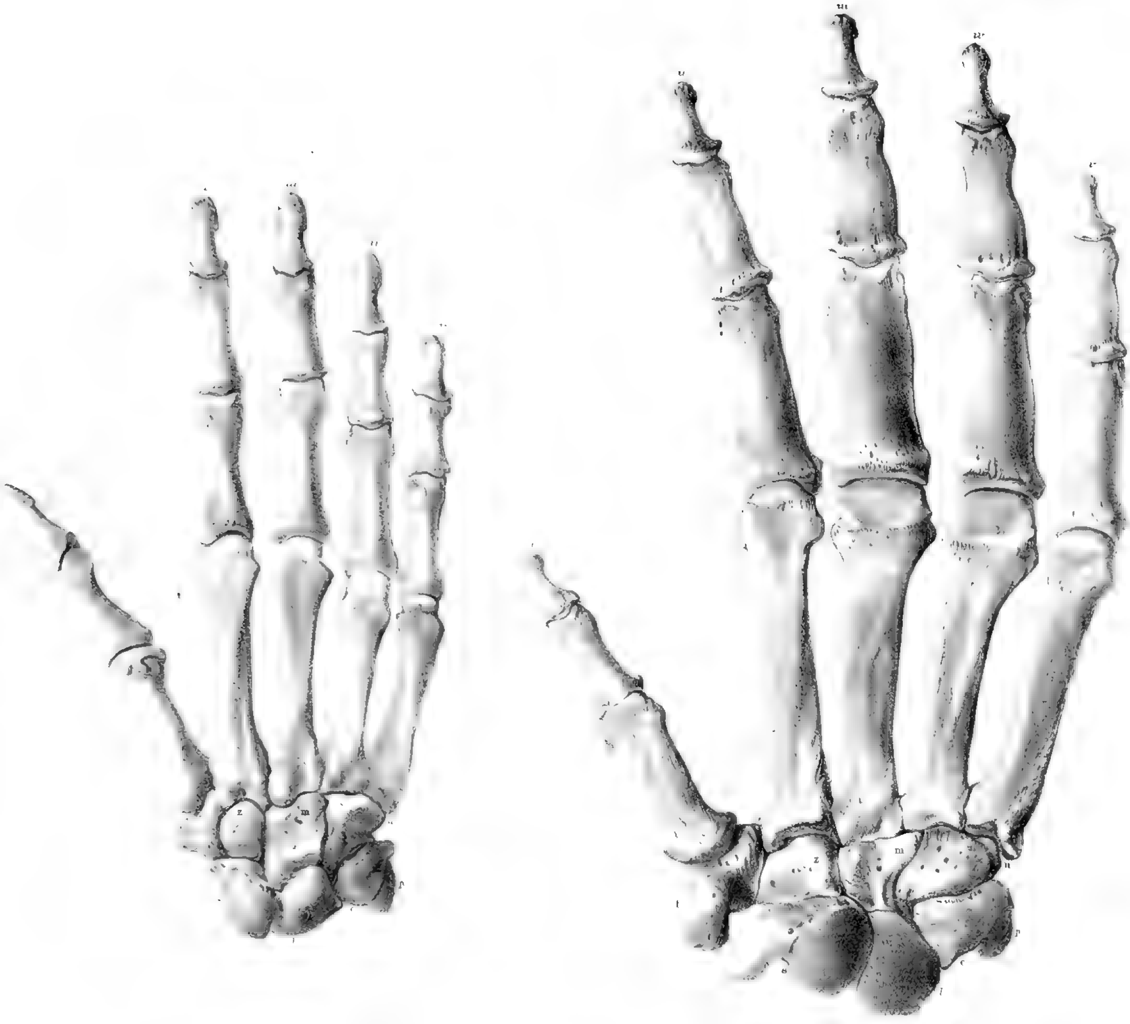

Fig. 1. Troglodytes Gorilla. Fig. 2. Homo

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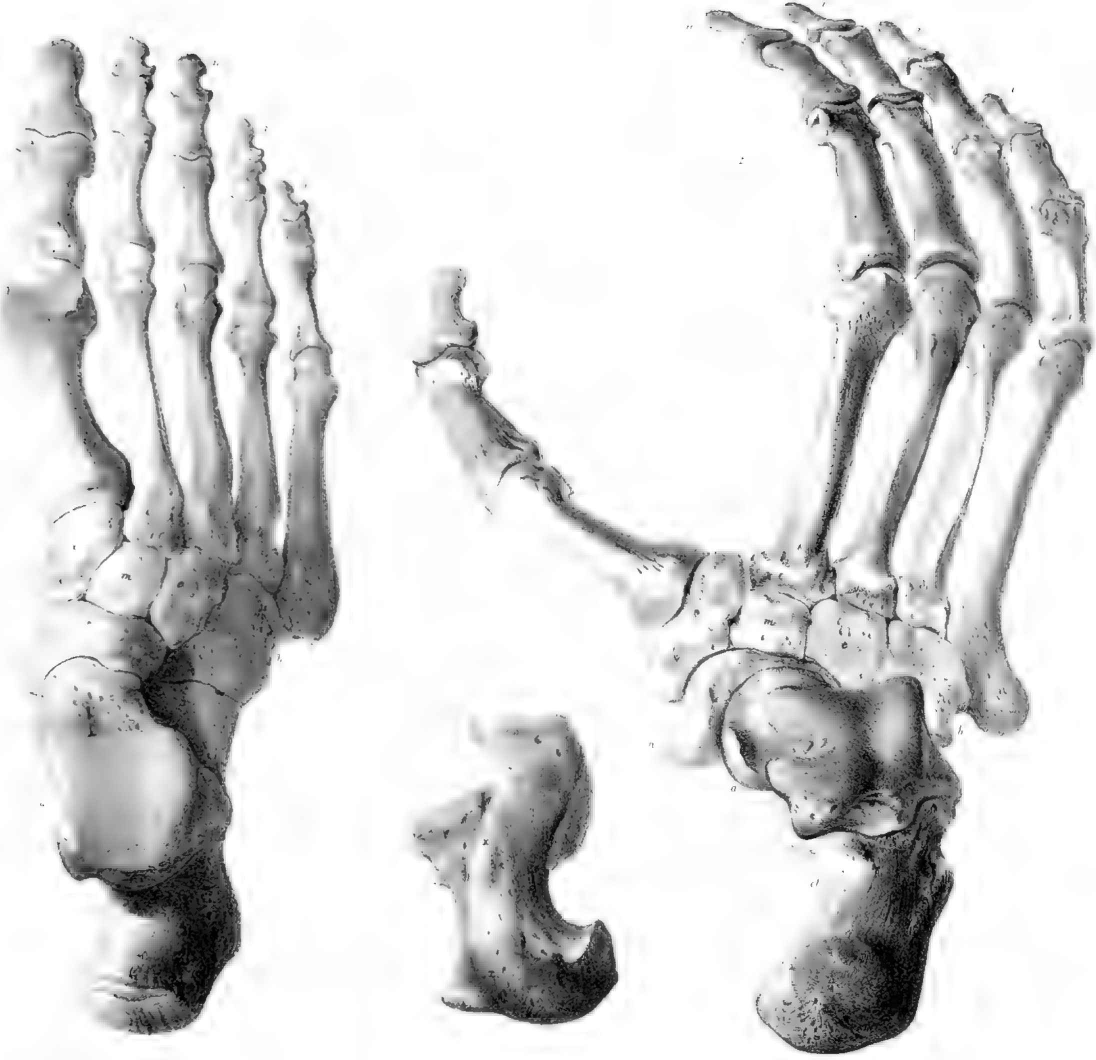

Fig 1 Homo Fig 2 & 3 Troglodytes Gorilla

Trans. Zool. Soc. Vol. 5. Pl. 12.

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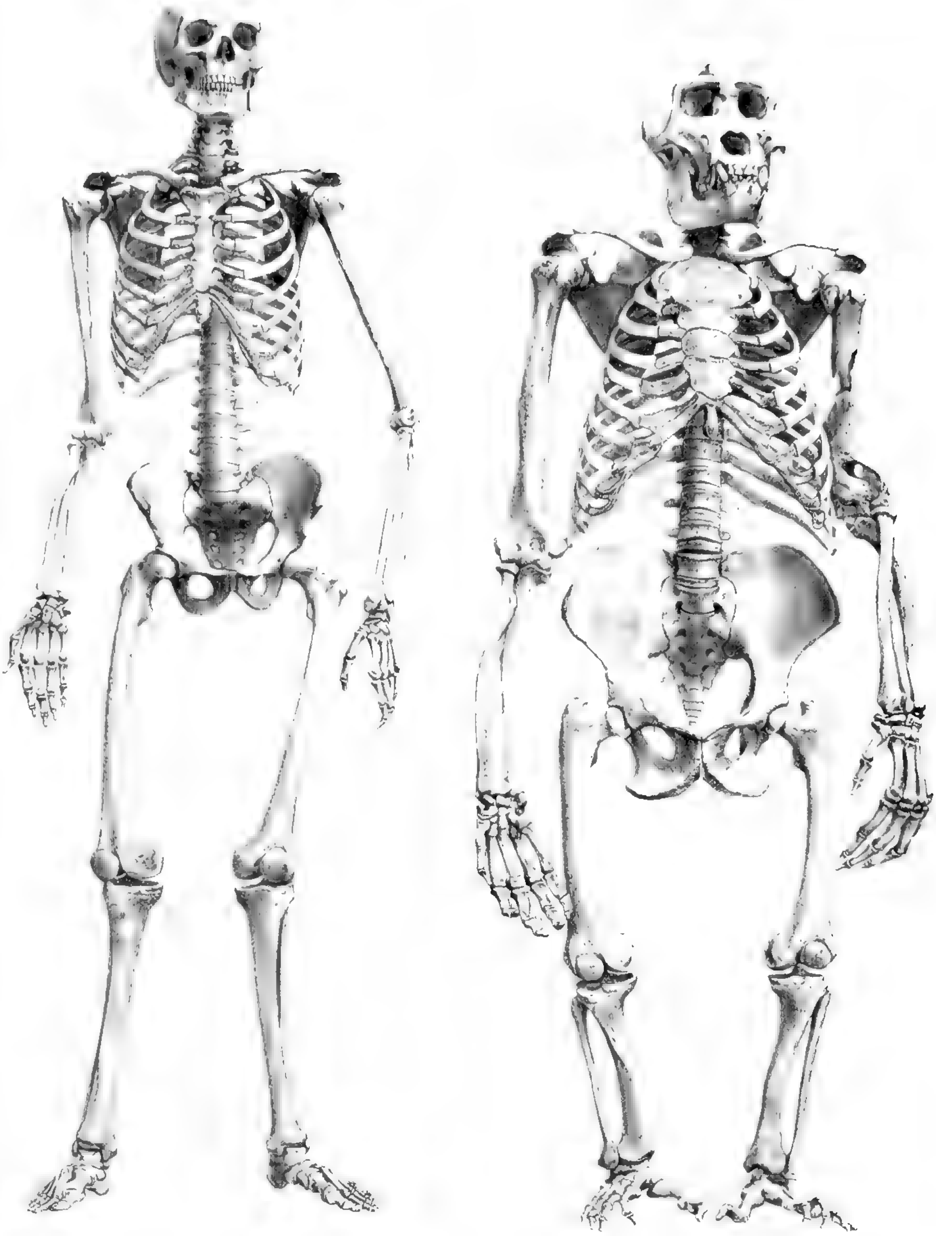
1



Homo 2 Troglodytes Gorilla

2

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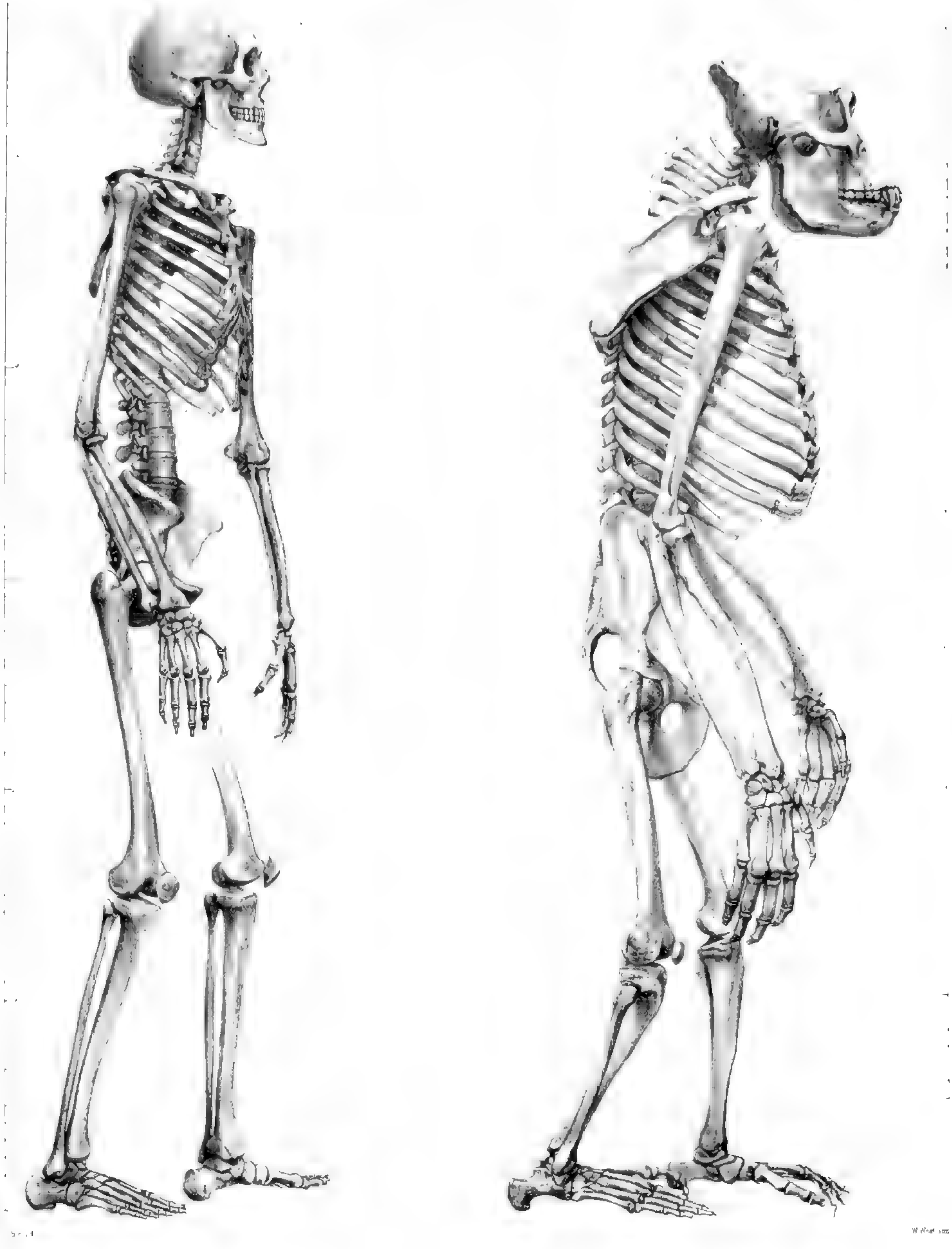
NATURAL HISTORY

1



1 Homo 2 Troglodytes Gorilla

II. *On the Aye-aye* (Chiromys, *Cuvier*; Chiromys madagascariensis, *Desm.*; Sciurus madagascariensis, *Gmel.*, *Sonnerat*; Lemur psilodactylus, *Schreber*, *Shaw*). *By* Professor OWEN, *F.R.S.*, *F.Z.S.*, *&c.*

Read January 14 and 28, 1862.

[PLATES XIV.–XXVI.]

§ 1. *Historical Introduction.*

THIS mammal was discovered by Sonnerat, in the island of Madagascar, about the year 1780, and was first described and figured in the work by that traveller, entitled 'Voyage aux Indes Orientales et à la Chine, depuis 1774 jusqu'en 1781,' Paris, 2 vols. 4to, 1782.

In the second edition (8vo, 4 vols.) of this work, published in 1806, from which I quote, the description is given in vol. iv. p. 121; and the engraving of the animal, copied into subsequent works treating of the Aye-aye, down to Ellis's 'Madagascar,' of 1858[1], forms plate 99 of the quarto volume of 140 plates accompanying the 8vo text of Sonnerat.

The stuffed skin which is the subject of the above engraving was presented by Sonnerat to Buffon[2], and is now in the Museum of Zoology, in the Garden of Plants, Paris, where, until very recently, it was the unique representative in Europe of the singular animal in question

Sonnerat commences his description by stating that, "although the Aye-aye much resembles a Squirrel, yet it differs therefrom by some essential characters, being also allied to the Lemur and the Monkey[3]." Describing the fore foot, Sonnerat specifies the long, slender, naked joints of the middle digit, "which the animal," he says, "makes use of to draw out of holes in trees the worms which form its food[4]."

Sonnerat had both a male and female, which, on board ship, were fed on cooked rice, and lived only two months. He obtained them from the west coast of Madagascar, which he affirms to be the part of the island they inhabit. The natives of the east coast declared that his specimens were the first they had seen; and their cry of

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[1] 'Three Visits to Madagascar,' by the Rev. William Ellis, 8vo, 1858, p. 144.

[2] "J'ai examiné de près la peau d'un de ces animaux que M. Sonnerat m'a donné pour le cabinet du Roi." —*Buffon,* Hist. Nat. Suppl. tom. vii. 4to, 1789.

[3] "Ce quadrupède se rapproche beaucoup de l'Écureuil; cependant, comme on le verra, il en diffère par des caractères essentiels: il tient aussi du Maquis et du Singe" (*op. cit.* p. 122). M. de Blainville can scarcely have had this passage in memory when he wrote, "mais jamais Sonnerat n'a cherché ses rapports naturels avec d'autres animaux connus" ('Ostéographie,' "Mémoire sur l'Aye-aye," 4to, 1840, p. 34).

[4] "Les deux dernières articulations du doigt du milieu sont longues, grêles, dénuées de poils: il s'en sert pour tirer des trous des arbres les vers qui sont sa nourriture" (*ib.*).

astonishment, "aye-aye!" on beholding the odd-looking quadruped, suggested the name which Sonnerat gave to it[1].

Buffon, after his close examination of the skin of the Aye-aye presented to the Royal Museum by Sonnerat, concludes that it is more closely allied to the genus of Squirrels than to any other, and that it also has some relation to the kind of Jerboa which he (Buffon) had called "Tarsier" in his 13th volume, 1769[2]. This animal is now recognized as a Lemurine quadrumane. After describing the hind feet, Buffon remarks that "the opposable character of the thumb, with the flattened nail, separates the species widely from the genus of Squirrels; and that, of all the animals that have the flattened thumb, the 'Tarsier' is that which most resembles the Aye-aye[3]." Buffon's acute discernment of resemblances is thus well exemplified; but as he believed the Tarsier to be a kind of Jerboa (it is the "Woolly Jerboa" of Pennant), it is plain that he ranked the Aye-aye with the Rodents.

Gmelin, accordingly, entered the species as "*Sciurus madagascariensis*" in the 13th edition of the 'Systema Naturæ,' 1790.

Cuvier, placing it under the same name at the end of the Squirrels, in his 'Tableau Elémentaire de l'Histoire Naturelle' (8vo, 1798, p. 136), remarks, in reference to the opposable thumb on the foot, that "it is, amongst the Rodents, what the Opossums are amongst the Carnassials;" and he adds,—"Sonnerat alleges that it subsists on the worms which it extracts from the hollows of trees and fissures of the bark by means of its slender digit[4]." Sonnerat, however, speaks only of the burrows or holes ("des trous des arbres") whence the Aye-aye extracts its larval food.

Schreber, in whose system the limb-characters preponderated, placed the Aye-aye in the genus *Lemur*, as *L. psilodactylus*; and Dr. Shaw adopted the name and the implied affinities[5]. De Blainville gave it a like position in his "Prodrome d'une Nouvelle Distribution Systématique du Règne Animal," published in the 'Bulletin de la Société Philomathique' (Paris, 1816), where the Aye-aye is placed amongst the "Pithécoïdes," or the group that follows the "Singes"[6].

In the meanwhile, however, Cuvier had availed himself of the means at his command

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[1] *Op. cit.* p. 124. Not the cry of the animal, as some writers have supposed.

[2] "Il m'a paru se rapprocher du genre des Écureuils plus que d'aucun autre; il a aussi quelque rapport à l'espèce de Gerboise que j'ai donnée sous le nom de Tarsier, vol. xiii." (Hist. Nat. Supplément, vol. vii. p. 269).

[3] "Ce caractère de doigt l'éloigne beaucoup du genre de l'Écureuil. De tous les animaux qui ont le pouce aplati, le Tarsier est celui qui se rapproche le plus de l'Aye-aye" (*ib.* p. 270).

[4] "Qu'il est parmi les Rongeurs ce que les pédimanes sont parmi les Carnassiers." "Sonnerat prétend qu'il vit des vers qu'il tire des creux des arbres et des fentes des écorces, au moyen de son doigt plus grèle" (*op. cit.* p. 136).

[5] "Long-fingered Lemur" (General Zoology, vol. i. part 1. p. 109, pl. 34, 1800).

[6] "Pithécoïdes, les Makis, les Loris, l'Aye-aye," p. 117. In a later work on the Aye-aye, published in 1841, as part of his 'Ostéographie,' M. de Blainville alludes to a memoir on the animal read by him to the Société Philomathique in May 1816; but the 'Bulletin' for that year contains merely the reference above cited, and in a note the author states that want of space prevents his adding the explanatory remarks which his table of Mammifers needed.

for obtaining further insight into the affinities of the Aye-aye. The skull and such limb-bones as were in Sonnerat's stuffed specimen were carefully extracted and prepared. The skull of the Aye-aye is figured in the first edition of the 'Règne Animal,' in the plate (pl. 2) containing those of anomalous quadrupeds; and M. de Blainville, in the subsequent account of these specimens in his 'Ostéographie,' alludes to them as due to these researches of his great predecessor. It was scant justice, however, to say that, in both editions of the 'Règne Animal,' Cuvier, while ranking the Aye-aye among the Rodentia, restricts himself to indicating its transitional character to the Lemurs[1]; for, in the description of the plate (figs. 1, 2, 3) in which the skull is figured, Cuvier states,—"To the teeth of a Rodent the Aye-aye unites a head very similar to that of the Quadrumana, principally in regard to the zygomatic arch, the orbit,"[2] &c.

It was through a mistake of M. de Blainville's that his astonishment was excited, which he so emphatically expresses, by Cuvier's hesitation to class the Aye-aye with the Lemurs after having obtained a knowledge of the tarsal structure. Had the ankle bones, figured by De Blainville in pl. 5 of his 'Ostéographie des Lemurs,' been actually extracted by desire of Baron Cuvier from the skin of the *Chiromys*, as stated in the above-cited part of that work (p. 46), one can scarcely doubt but that the great naturalist would have recognized the full force of their indications of its affinity. As I shall afterwards show, however, those tarsal bones do not belong to the Aye-aye, but to a true Galago—probably *Otolicnus crassicaudatus*, Wagn., of which Cuvier figures a stuffed specimen in pl. 1. fig. 1 of the same volume of the 'Règne Animal' in which the figure of the Aye-aye's skull appears. I suspect it to have been from the skin of the "Grand Galago" there figured that the bones of the leg and foot referred to below had been extracted[3].

By the figure and brief notice of the Aye-aye's skull, Cuvier, in fact, supplied the first rectification of the ground derived by Buffon, from the head of the Aye-aye, for approximating it to the Squirrels; and it has the more significance, in regard to the value of the affinity supposed to be indicated by the dentition, through the presence of

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[1] "M. Cuvier ait persisté, dans les deux éditions de son 'Règne Animal,' à ranger l'Aye-aye parmis les Rongeurs, à côté des Écureuils, en se bornant à dire qu'il fait le passage aux Makis."—*De Blainville, op. cit.* p. 27.

[2] "Planche ii. figs. 1, 2, 3, l'Aye-aye (*Cheiromys*, C.), qui, à des dents de Rongeurs, unit une tête fort semblable à celle des quadrumanes, principalement pour ce qui regarde l'arcade zygomatique, l'orbite," &c. (Règne Animal, ed. 1. tom. iv. 1817, p. 181; ed. 2. tom. iii. 1830, p. 429).

[3] "M. Laurillard m'a remis, en outre, les quatre os principaux du métatarse, c'est-à-dire, l'astragale, le calcanéum, le scaphoïde et le cuboïde, qui avaient, sans doute, été tirés de la peau bourrée de la collection zoologique, sur la demande de M. Cuvier. Or, à eux seuls ils devaient suffire pour déterminer la place de l'Aye-aye à côté du Tarsier et des Galagos; car le calcanéum et le scaphoïde offrent la même forme et le même allongement singulier qui a déterminé Daubenton à donner au premier de ces animaux le nom sous lequel il est encore désigné; ce que j'avais supposé autrefois d'après le seul examen de l'individu monté. La figure que nous en donnons dans la planche (v.) de notre Ostéographie des Lemurs suffira pour mettre cette assertion hors de doute; aussi est-il véritablement étonnant que M. Cuvier, qui avait à sa disposition ce tarse," &c.—*De Blainville*, "Mém. sur l'Aye-aye," p. 27.

the figure of the skull of the Wombat, with a like rodent pattern of teeth, in the same plate with that of the Aye-aye, where they are associated together as "Mammifères anomaux." In my 'Odontography,' I cite other instances of glirine dentition in mammals of non-rodent orders; where, treating of the teeth of *Chiromys*, in chap. ix., *Quadrumana*, I remark,—"In this genus of Lemurine animals, as in *Desmodus* amongst the Bats, and *Sorex* amongst the Insectivores, the dentition is modified in analogical conformity with the rodent type" (4to, 1842, p. 435). In my "Classification of the Mammalia" ('Proceedings of the Linnean Society,' April 1857), I state,—"The flying Lemurs (*Galeopitheci*), the rodent Lemurs (*Chiromys*), the slow Lemurs (*Loris*, *Otolicnus*), forbid any generalization as to teeth or nails in the *Quadrumana*" (p. 35).

One need merely allude to the idea of the affinities of the Aye-aye to the Opossums, emitted by Geoffroy St.-Hilaire in the early notice in which he proposed first the generic name of *Daubentonia*[1]: the idea, however, was adopted by Lacépède in the constitution of his Order "Pédimanes" in the 'Classification des Mammifères,' published in 1798.

Illiger, in rectifying the heterogeneous character of Lacépède's "Pédimanes," places the Aye-aye in his Family "Leptodactyli," where it is associated with the Tarsiers and Galagos[2].

MM. Fischer de Waldheim[3], Oken[4], and Waterhouse[5] adopted this view, which is also supported argumentatively by M. F. Cuvier in the 'Supplément' of the third volume of the 'Dictionnaire des Sciences Naturelles,' 1816.

Notwithstanding, however, these testimonies, and the remarks, depreciating Baron Cuvier's share in the elucidation of the nature of the Aye-aye, published by De Blainville, unbiassed zoologists of note and experience have testified their sense of the need of further knowledge of the organization of the *Chiromys* by the place assigned to it in their justly esteemed works. Prof. Milne-Edwards, for example, in his useful 'Elémens de Zoologie,' retains the *Chiromys* in the Ordre "Rongeurs," and the "Tribu des Sciuriens," with the admission that "it belongs almost as much to the Quadrumana as to the Rodentia[6]." Professor Van der Hoeven, also, whose careful researches into the anatomy of certain *Lemuridæ* justly add weight to his estimate of the signification of the little that was then known of the organization of *Chiromys*, nevertheless, in both editions of his richly stored 'Handbuch der Zoologie,' retains the Aye-aye among the Rodents, remarking that it

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[1] 'Décade Philosophique,' no. 28, 1796. This term, having been appropriated by botanists for a genus of *Leguminosæ*, has been allowed to lapse by the general consent of zoologists, including Geoffroy himself, who, with De Blainville and all original investigators of the animal, have communicated their observations on it as the *Chiromys* of Cuvier (Leçons d'Anat. Comp. vol. i., 1800).

[2] 'Prodromus Systematis Mammalium et Avium,' 8vo, 1811.

[3] 'Tableaux de Zoographie,' 1813.

[4] 'Handbuch der Naturgeschichte, &c., Zoologie,' 8vo, 1816.

[5] "Observations on the Classification of the Mammalia," Ann. and Mag. Nat. Hist. vol. xii. p. 408 (note).

[6] "Mais qui tiennent presque autant des Quadrumanes que des Rongeurs" (p. 348).

"has the external form of *Galago*, a genus of Lemurids, and forms (by its arched skull also) in some degree the transition from the Rodents to the Quadrumanes."

In the admirable translation of this work, for which English naturalists are indebted to the laborious and accomplished Professor of Anatomy in the University of Cambridge, the verdict of the Dutch zoologist is left unchallenged[1], and it is from the point of view thus attainable in 1858 that I have started in availing myself of the materials at command for gaining further and surer insight into the nature and affinities of the so-called *Chiromys madagascariensis*.

In that year the Hon. H. Sandwith, M.D., C.B., proceeded to the Mauritius, of which he had been appointed Colonial Secretary; and, prior to his departure from England, he applied for, and received from me, special instructions as to the most interesting and desirable objects of natural history in that colony. Amongst these, besides the bones of the Dodo and Solitaire, I specified, as obtainable from the neighbouring island of Madagascar, the bones and eggs of the *Epyornis*, and, above all, a specimen, alive or preserved in spirits, of the Aye-aye (*Chiromys*).

In March 1859, I was favoured with the following letter from my accomplished and energetic correspondent:—

"Mauritius, January 27, 1859.

"My dear Mr. Owen,—After very great difficulty and much delay, I have at length obtained a fine, healthy, male, adult Aye-aye, and he is enjoying himself in a large cage which I have had constructed for him. And now I have some questions to ask you. Do you want him dead or alive? It will, of course, be much easier to send his dead body home, if that will do; and, if so, how am I to preserve him? If you want him alive, you must tell me so without delay, as I think it would be dangerous to send him home so as to arrive in the cold season. I observe he is sensitive of cold, and likes to cover himself up in a piece of flannel, although the thermometer is now often 90° in the shade. He is a most interesting little animal, and from close observation I have learned his habits very correctly. On receiving him from Madagascar, I was told that he ate bananas; so of course I fed him on them, but tried him with other fruit. I found he liked dates, —which was a grand discovery, supposing he be sent alive to England. Still I thought that those strong rodent teeth, as large as those of a young Beaver, must have been intended for some other purpose than that of trying to eat his way out of a cage—the only use he seemed to make of them, besides masticating soft fruits. Moreover he had other peculiarities,—*e. g.*, singularly large, naked ears, directed forward, as if for offensive rather than defensive purposes; then, again, the second finger of the hands is unlike anything but a monster supernumerary member, it being slender and long, half the thickness of the other fingers, and resembling a piece of bent wire. Excepting the head and this finger, he closely resembles a Lemur.

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[1] 'Handbook of Zoology,' by J. Van der Hoeven, translated by the Rev. Prof. Clark, F.R.S., 8vo, vol. ii. 1858, p. 695.

"Now, as he attacked every night the woodwork of his cage, which I was gradually lining with tin, I bethought myself of tying some sticks over the woodwork, so that he might gnaw these instead. I had previously put in some large branches for him to climb upon; but the others were straight sticks to cover over the woodwork of his cage, which *alone* he attacked. It so happened that the thick sticks I now put into his cage were bored in all directions by a large and destructive grub, called here the *Moutouk.* Just at sunset the Aye-aye crept from under his blanket, yawned, stretched, and betook himself to his tree, where his movements are lively and graceful, though by no means so quick as those of a Squirrel. Presently he came to one of the worm-eaten branches, which he began to examine most attentively; and bending forward his ears, and applying his nose close to the bark, he rapidly tapped the surface with the curious second digit, as a Woodpecker taps a tree, though with much less noise, from time to time inserting the end of the slender finger into the worm-holes as a surgeon would a probe. At length he came to a part of the branch which evidently gave out an interesting sound, for he began to tear it with his strong teeth. He rapidly stripped off the bark, cut into the wood, and exposed the nest of a grub, which he daintily picked out of its bed with the slender tapping finger, and conveyed the luscious morsel to his mouth.

"I watched these proceedings with intense interest, and was much struck with the marvellous adaptation of the creature to its habits, shown by his acute hearing, which enables him aptly to distinguish the different tones emitted from the wood by his gentle tapping; his evidently acute sense of smell, aiding him in his search; his secure footsteps on the slender branches, to which he firmly clung by his quadrumanous members; his strong rodent teeth, enabling him to tear through the wood; and lastly, by the curious slender finger, unlike that of any other animal, and which he used alternately as a pleximeter, a probe, and a scoop.

"But I was yet to learn another peculiarity. I gave him water to drink in a saucer, on which he stretched out a hand, dipped a finger into it, and drew it obliquely through his open mouth; and this he repeated so rapidly, that the water seemed to flow into his mouth. After a while he lapped like a cat; but his first mode of drinking appeared to me to be his way of reaching water in the deep clefts of trees.

"I am told that the Aye-aye is an object of veneration at Madagascar, and that if any native touches one, he is sure to die within the year; hence the difficulty of obtaining a specimen. I overcame this scruple by a reward of £10.

"I quite despair of obtaining the bones of the *Epyornis* or *Dodo*, though I have made every effort. I shall always be proud to be of service.

"Believe me, yours very faithfully,

"H. SANDWITH."

On the receipt of this acceptable and interesting communication, I wrote to say that, in the event of there being any misgiving as to effecting a safe transmission of the living Aye-aye to England, it might be more advantageous to science if the animal were killed by chloroform, its arterial system injected, the cranial cavity exposed, the abdominal cavity and alimentary canal injected with alcohol, and the whole animal then immersed in a keg of colourless spirit.

Before my reply reached Dr. Sandwith, the Aye-aye had escaped. It was, however, recaptured on a neighbouring sugar-plantation in the Mauritius. Accordingly, on the receipt of the above instructions, Dr. Sandwith at once proceeded to fulfil them; and the result was the reception, at the British Museum, of our now unique example of the *Chiromys madagascariensis*, in the excellent state of preservation which has admitted of the following description being taken from it.

Before, however, entering upon this, I may remark that other testimony than my correspondent's had been given of the accuracy of Sonnerat's original statement of the office of the slender middle digit of the fore paw. M. Liénard, of the island of Mauritius, communicated, in 1855, to the French Academy of Sciences[1] some of his observations on a young male Aye-aye, which was brought from Madagascar, and lived some weeks in captivity. When a mango-fruit was offered, the Aye-aye first made a hole in the rind with his strong fore teeth, inserted therein his slender middle digit, and then, lowering his mouth to the hole, put into it the pulp which the finger had scooped out of the fruit. When one hand was tired, he used the other, and often changed them. On presenting him with a piece of sugar-cane, he held it by both hands, and, tearing it open with his teeth, sucked out the juice.

A third observer, M. A. Vinson, affirms, in reference to an Aye-aye brought from Madagascar to the Ile de la Réunion in 1855, where it lived about two months in captivity, that it selected the larvæ it liked best by the sense of smell; and that, when "café au lait" or "eau sucrée" was offered, it drank by passing its long and slender digit from the vessel to its mouth with incredible rapidity[2].

§ 2. *External Characters.*

The male Aye-aye, transmitted to me in spirits by the Hon. Dr. Sandwith, is represented of one-half the natural size in Pls. XV., XVI. and XVII., and a profile of the

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[1] Comptes Rendus, Septembre 3^{me}, 1855.

[2] "Il ne voulait pas des larves de tous les arbres indistinctement; il les reconnaissait en les flairant. Il était très-friand de café au lait, d'eau sucrée, qu'il buvait à l'aide de ce long doigt qu'il passait et repassait incessamment du vase à la bouche avec une incroyable agilité" (Comptes Rendus de l'Acad. des Sciences, Oct. 1855, tom. xli. p. 640). [In the female Aye-aye, now living in the Gardens of the Zoological Society (August 1862), Mr. Bartlett informs me that, "in feeding, the fourth, which is the longest and largest finger, is thrust forward into the food, while the slender middle finger is raised above the others, and the first and second fingers are lowered: in this position the hand is drawn rapidly backward and forward, the side of the fourth finger passing between the tips of the animal's mouth as the head is somewhat turned sideways; and in this manner the food is deposited in the mouth."]

head with the fore limbs of the natural size in Pl. XVIII.[1] I may, however, give the following dimensions:—

	Ft.	in.	lin.
Total length from the muzzle in a straight line to the end of the tail	3	0	0
Total length from the muzzle in a straight line to the root of the tail	1	3	6
The tail to the end of the terminal hairs is thus rather longer than the body.			
The length of the head	0	4	6
Its breadth between the ears	0	2	7
———— below the ears	0	4	0
———— across the zygomata	0	2	10
———— across the base of the muzzle	0	1	2
———— across the eyes, from one outer canthus to the other	0	2	2
Interspace of eyes, from one inner canthus to the other	0	1	1
Breadth of nose external to the nostrils	0	1	0
From the internal canthus to the end of the nose	0	1	4
Length of the ear	0	3	4
Breadth of the ear	0	2	2
Length of fore limb, from the head of the humerus	0	11	5
——— of hind limb, from the head of the femur	0	13	0
——— of antibrachium	0	4	0
——— of fore foot	0	4	10
——— of the leg	0	5	0
——— of the hind foot	0	4	6
——— of digits of fore foot:—			
pollex (*i.*)	0	1	2
index (*ii.*)	0	1	11
medius (*iii.*)	0	2	10
annularis (*iv.*)	0	3	4
minimus (*v.*)	0	2	1
Length of digits of hind foot:—			
hallux (i.)	0	1	6
second (ii.)	0	1	6
third (iii.)	0	1	9
fourth (iv.)	0	1	9½
fifth (v.)	0	1	8

The Aye-aye resembles in size, and somewhat in shape, a domestic Cat; but its head, especially with the ears, is larger; the hind limbs are longer, and the tail is still more so

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[1] To the illustrations accompanying this paper, when transmitted to the Society in January 1862, is now added the characteristic figure, by Mr. Wolf, of the living female Aye-aye, which has been subsequently received at the Gardens of the Zoological Society. It is reduced to one-half the natural size in Pl. XIV.

in proportion to the body. Both fore and hind limbs have a greater proportion of the first segment free of the trunk, but especially the femoral one; and both thigh and leg are longer in proportion to the foot than in the Cat. The trunk presents its greatest circumference about the hinder third of the thorax, measuring here about ten inches round. The head is short, broad, and rather deep, convex lengthwise, and rather flattened transversely above, becoming suddenly contracted and compressed at the short and deep muzzle. The neck is short and thick. The tail is rather longer than the body, straight, but flexible, and covered with long and rather loose and coarse hairs, growing pretty equally all round, and making the terminal half rather thicker than the basal one, the end quickly narrowing to the terminal fascicle of hairs. On the trunk the pelage consists of an inner woolly coat, almost concealed by the long hairs which form the outer coat and impart the colour to a great proportion of the animal. The prevailing tint is a deep fuscous, approaching to black; overspreading the back, the flanks, the tail, and limbs, becoming subrufous upon the belly and inner side of the arm and thigh, and lightening into yellowish grey upon the throat and sides of the head. The dark colour is relieved by scattered long white hairs, most conspicuous upon the dorsal aspect, from the occiput to the base of the tail; more scantily dispersed upon the arm and part of the forearm, and upon the thigh and leg. Upon the face, the throat, the forearms, the inner side of the legs, on the sessile scrotum and inguinal region, the longer hairs are wanting or very scanty. The chief part of the ears, the end of the nose, the palm from the pisiform prominence onward, the sole from the calcaneal prominence, and the corresponding aspect of the digits, are naked. The wool, or short coat of hair, is close-set, finely and irregularly wavy, from its lustre rather silky than woolly; where it is shortest, it is of a light grey; where it grows longer, as on the cheeks, forehead, dorsal part of the wrists and ankles, and about the privy parts, this hair usually presents three colours—light fuscous near the root, light grey or brownish grey at the middle, including two-thirds of the length, with a dark fuscous tip. Upon the forearms this tint prevails. The long hair is deep fuscous, or with a white tip, usually about one-third the length of the hair; and these bicoloured hairs are most numerous on the parts of the pelage above mentioned as being relieved by their scattered silvery-white colour. On the back and tail the hair attains a length of from three to four inches, is slightly wavy or straight, and greyish at the root.

The profile of the head (Pl. XVIII.) describes a slight convexity from the vertex to the interorbital space, is then straight to the end of the nose, where it bends abruptly down at nearly a right angle, and curves back over the mandibular symphysis, which makes no chin, to the slightly concave under border of the head, where, about two inches from the symphysis, the outline curves down into the neck.

The eyes are rather prominent, directed forward; their openings round, exposing only the cornea and iris, which appears to be of a yellowish-hazel hue[1]. The eyelids

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[1] [The iris is of a light bright brown in the female Aye-aye now living at the Zoological Gardens.—August 1862.]

close, with a slit almost transverse, 7½ lines (0·016) long, with the outer canthus higher than the inner one, and the plane of each opening inclines a little outward. There is a large nictitating fold at the inner canthus.

The muzzle is short, but deep,—the peculiarly developed incisors and their sockets, with the concomitant deep 'symphysis mandibulæ,' giving it great vertical and small transverse extent; the latter character is heightened by contrast with the great expansion of the head to the setting-on of the ears, which expansion suddenly begins with the outspanning of the fore part of the zygomata, supporting the thick masseter muscles. The fore part of the 'rictus oris' is very narrow, and the whole extent to the angles, following the semi-elliptical curve which it makes, does not exceed 2½ inches. The opening of the mouth, in profile, is straight, and scarcely an inch in length. The lips have an obtuse but not prominent border; they increase a little in thickness at the angles of the mouth; the inner surface is smooth, with a fuscous pigment. The upper lip is short or shallow; it is connected at its fore and inner part by a kind of frænum or fold of the inner membrane, which extends into the basal interspace of the upper incisors: a few short black whiskers project from it. The interspace between the lower lip and the mandible is much deeper, extending below the frænal fold that penetrates the basal interspace of the lower incisors; from the margin of the lower lip to the reflexion of its smooth inner skin upon the incisive alveoli measures 9 lines. There is a slight protuberance of an oblong form from the inner part of each side of the lower lip. The short fine hairs or down of the lower lip, gradually gaining length as they recede from the lip-border, are of a lighter grey than those of the upper lip. From amongst them there project a few scattered longer hairs, also increasing in length as they approach the chin, where a few of the longest form black whiskers, the others retaining the greyish tint.

The naked end of the nose, pink-coloured in the living animal, is of a triangular form (Pl. XXII. fig. 4), including the nostrils, which, from their inner rounded and wider part, curve slitwise upward and outward to the corresponding angles of the naked space. This is impressed by a median and two lateral grooves which meet upon the middle of the upper lip, at its frænum within the mouth. The lateral less deep grooves begin at the lower and wider part of the nostrils. There may be also seen a feeble linear impression extending across the end of the nose from between the inner and lower ends of the nostrils. The concavity, directed upward and inward, of the obliquely curved nostrils is formed by a slight prominence of an obtuse 'ala,' which does not quite touch the thick, rounded lower and outer border of the aperture. The breadth of the nose is 11 lines (0·024); the length of the nostril 5½ lines (0·011); between the upper ends of the nostrils measures, in a straight line, 7 lines (0·015); between their lower ends, 3 lines (0·006); from the lower end of the nostril to the mouth is 3⅓ lines (0·007). The fine silky hairs at the circumference of the naked tract commence very short, and gradually lengthen as they recede therefrom. Many longer hairs project through the down, forming a kind of scattered moustache along each upper lip and external to the nostrils; the longest of these hairs are nearly black.

The shorter hairs below the orbits on the fore part of the cheeks are of a grey brown, with lighter tips; and this colour extends round the outer and upper part of the orbit, where it expands in simulation of eyebrows. But the latter name may better be given to a tuft of about a dozen long, black, slender vibrissæ which project from a slight swelling above the inner angle of the eye-slit, and diverge as they rise.

The base of the nose and the interorbital space present a deeper or subfuscous yellowish-grey colour, which also prevails upon the hind half of the cheeks, where several of the longer hairs have whitish tips. Here, however, are about six long black vibrissæ projecting about an inch below the outer angle of the eye-slit.

Nine dark-coloured hairs grow from the inner surface of the upper eyelids near to, but not from, the palpebral border, and form a defensive series like short eyelashes. Such are not developed from the lower eyelids; but short fuscous hairs grow from the outer surface of both lids close to the palpebral border, and gradually lengthen as they recede therefrom, marking a well-defined dark border, like the kohl-pigment of Eastern beauties, of from 2 lines to 3 lines broad, round the eyes, the adjoining circle of lighter grey heightening the difference by contrast. The grey colour of the cheeks, a little deepened at their middle, is continued over the lower part of the face and the chin, upon the neck, graduating into the fuscous upon the chest; but the hair of the belly is of a lighter fuscous than that of the back.

From the forehead the long hairs gradually increase in length to the occiput, and from the cheeks to the setting-on of the ears.

The auricle presents a subelliptic form, 3 inches 4 lines by 2 inches 2 lines in the chief diameters. The anterior hollow very gradually deepens from the obtusely rounded tip to the tragus; expanding also to the middle of the ear, and then contracting to where the concavity becomes semitubular by the forward production of the basal borders of the auricle. At this part is shown a distinct 'tragus,' along the base of which the hair abruptly ceases. The lower and hinder part of the basal border forms an 'antitragus,' on the outside of which grow hairs of an inch or more in length. This antitragus is continued above into a ridge gradually subsiding upon the inner surface of the auricle, and representing the lower part of the prominence called 'antihelix.' Above the 'tragus' a vertical fold projects backward, as it were, formed by the reflected border of the upper and fore part of the base of the auricle: it gradually subsides as it rises, and represents the beginning of a 'helix.' Long, wavy, silky hairs grow from its outer side. Similar hairs project from the basal fourth of the outer or back part of the auricle, which elsewhere consists of a seemingly smooth, but minutely granulate, shining, naked skin, like parchment, but of a dark fuscous hue, showing the ramifications of blood-vessels on the outside, and numerous whitish dots on the inside, and giving a deep vinous tint by transmitted light. The fuscous pigment is not developed on the tragus and antitragus. These large ears appear, by their muscles and contracted attachment, to have much and varied movement: at rest they usually stand out horizontally, adding greatly to the breadth of the head; but their conch can be directed wherever the sound is to be caught that attracts the animal's attention.

The neck is short and thick. The shoulder-prominence is about the ear's breadth behind the ear. The elbow, with the lower half of the humerus, stands freely from the chest. The forearm is robust, subcompressed, slightly tapering to the wrist; it cannot be brought in extension to a line with the humerus. The hand turns freely in the prone or supine position, the former being the habitual one. The hair is continued upon the back part of the wrist, and sparingly, by short hairs, upon the same side of the fingers: these hairs are so few, fine, and short, as to be scarcely discernible on the attenuated middle digit, the skin of which is darkened by pigmentum. The naked palm, continued back upon the 'os pisiforme,' presents a protuberance there, matched by one on the radial side; there is also one at the base of the thumb, and smaller ones at the base of the index, annulus, and fifth digits. The thumb stands out at an acute angle with the index, slightly enlarging to its tumid extremity, beyond which the compressed, obtuse claw hardly projects: it is an opposable member, and makes a prehensile hand, but in a less perfect degree than in the Catarrhine Quadrumana. The second, fourth, and fifth digits present a conformable and ordinary thickness, have a cushion on the palmar side of their penultimate joint, and a more tumid one upon their last phalanx, beyond which the obtuse claw, narrower and longer than that of the thumb, freely projects. The fifth finger is rather longer than the second; the fourth is almost twice as long as the second. But the most singular feature of the hand is the attenuated middle finger, which seems as if stricken and withered by palsy: it is rather shorter than the fourth, but is less than half its thickness. The cleft between the second and third fingers is deeper than that between the third and fourth. The base of the third is slightly tumid: its first phalanx is slender and longer than that of the corresponding phalanx of the fourth finger; but the second and third phalanges are shorter. The animal can freely divaricate and approximate the digits for a variety of applications of the long-fingered hand (Pl. XVIII.).

The hind limb is longer than the fore limb, and rather stronger. A great proportion of the thigh is free. The knee consequently projects much below the abdomen. The foot is comparatively short; the heel low, and naked below, with the rest of the sole, which is black, save on the prominences. The sole gains breadth to the base of the hind thumb, or 'hallux,' which stands out at a rather more open angle with the other digits than in the hand. The hallux is longer and thicker than the pollex, especially at its last joint, which is backed by a true nail, broader than long, and not reaching to the end of the terminal expansion. The four other toes are nearly of equal length and thickness, the second being the shortest by a little, the fifth next in length. Each is armed with a slightly curved, rather thick, subacute claw. The hair on both fore and hind limbs is nearly black, with a little admixture of white-tipped hairs at their thick beginning.

The tail shows no habitual twist or bend, but hangs straight from the trunk in the dead animal[1]. It is flexible in all directions, and the long, coarse, slightly wavy hairs grow equally from it all round: most are nearly black, but reflect a rufous tint in some lights, through admixture of hairs that retain that colour at the base. The penis, unerect, projects about an inch from the pubis; of a subconical form, with a terminal transverse orifice of the prepuce, which is of a whitish colour. The testes make slight prominences below and at the sides of the penis (Pl. XVI.).

From the foregoing description we may infer that the small quadruped is arboreal, the limbs being organized chiefly for grasping; and this power is given in the greater degree to the hind feet, as in all climbers. The wide circle of the 'open eye' or fully expanded eyelids, the large iris, and the pupil reducible to a minute point when the iris is contracted, indicate a climber of nocturnal habits[2]. The development of the organ of hearing bespeaks the acute possession of that sense. The chief office of the tail may be inferred to be that of adding to the protective non-conducting covering of the body when the animal is in repose. In taking this attitude, Dr. Vinson states that the Aye-aye depresses the head between the fore paws, bends over it the tail, which is for that purpose depressed and curved forward; then, slowly rolling its body into a ball, covers the whole by the outspread hairs of the encircling tail[3]. Thus Dr. Vinson's animal slept the greater part of the day, moving about and making its efforts to escape during the night. Having once succeeded, it climbed the nearest tree and moved about, leaping from branch to branch with the agility of the *Lemur catta*; but its ordinary life in captivity suggested the idea of its being an indolent and rather slow-moving animal. Its cry is a plaintive grunt[4].

§ 3. *Skeleton* (Pls. XIX.–XXI.).

The bones of the Aye-aye have a compact texture, and, although the specimen was transmitted in spirits, they show, after a short maceration, a pure white colour. The number of vertebræ between the skull and sacrum is twenty-six, of which thirteen are dorsal, six lumbar, and seven cervical. The sacral vertebræ are two by anchylosis and connexion with the ilia, but three by antero-posteriorly extended and co-articulated transverse processes; the caudal vertebræ are, accordingly, twenty-three or twenty-two,—the sum-total of vertebræ being fifty-one, exclusive of the four cranial. The true vertebræ describe one slight curve convex backward from the middle

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[1] [In the living female the tail is usually carried in a curve, concave downward.—August 1862.]

[2] [The pupil is widely open at dusk, when the animal is most active; it contracts to a small circle by day, in the living female.—August 1862.]

[3] [The female, now in captivity, shows the same use and disposition of the tail, in repose.—August 1862.]

[4] Comptes Rendus de l'Acad. des Sciences, Paris, 22 Octobre, 1855.

dorsal to the penultimate lumbar, beyond which there is a slight bend in the opposite direction to and including the sacrum. The bodies of the dorsal vertebræ gradually lengthen and deepen as they approach the loins, with a narrower and at last almost carinate under surface. The last two ribs join their own centrum close to the front intervertebral space; the rest have the usual intervertebral articulation of the head. The first rib is the shortest (9 lines) and thickest; the others increase in length to the ninth, and then gradually shorten to the thirteenth, which is 1 inch 3 lines in length. The tubercle and diapophysial articulation exist to the eleventh rib; the twelfth and thirteenth articulate only by the head. The diapophysis, longest on the first dorsal, very gradually shortens to the eleventh, where the beginnings of the metapophysis and anapophysis are manifest. These processes become widely separated in the twelfth and thirteenth dorsals, and the diapophysis is lost. The neural spines are of equal length throughout the dorsal series; suddenly extending to 3½ lines on the first, they gain gradually in fore-and-aft extent from the fifth dorsal to the last (Pl. XIX. D). The vertical spine is on the eleventh dorsal, towards which the rest of the dorso-lumbar series slightly incline.

The vertebræ go on increasing in size to the fifth of the lumbar series,—the diapophyses more especially, which recommence in the first lumbar; these processes are directed forward and downward, as well as outward, are truncate, with the anterior angle a little produced (*d*, fig. 8, Pl. XXI.); that of the last lumbar is similar in shape and direction, but is smaller than the two preceding. The anapophysis (*ib. a*) overlaps the front margin of the following vertebræ to the fifth lumbar, in which it becomes too short; it disappears in the sixth. The metapophysis (*ib. m*) overhangs the back part of the neural arch of the preceding vertebra. The neural spine decreases from the third to the last lumbar (Pl. XIX. L), where it has 3 lines of length. The cartilage of the first rib is flattened, 5½ lines long, and 2½ lines broad; in the rest it is more slender and rounded, increasing in length to the tenth, where it equals in length the bony part, and is attached to near the end of the ninth cartilage, which is the last that joins the sternum; the remaining cartilages are pointed, and rapidly shorten to the thirteenth, which is 8 lines long (*ib. h*). The first cartilage articulates with the manubrium (Pl. XXI. *h*, $_{59}$), the second to the seventh inclusive with the joints of seven sternebers, the eighth with the seventh sterneber, and the ninth to the joint between the seventh and eighth sterneber (*ib. h*, $_{61}$). Of these eight bones, the first, from its superior size, carinate outer surface, and clavicular articulations, is termed the 'manubrium;' the next six are narrow in proportion to their length, and similar in size and shape. The last, long and slender, may be regarded as the peduncle of the broad 'cartilago ensiformis.'

The bodies of the cervical vertebræ are broad, short, and flattened below in the last five. The last three (Pl. XXI. fig. 6, $_{5,6,7}$) have no neural spines: there are tubercular beginnings of these in the fourth and third; in the second it is 2 lines long, thick, and produced anteriorly; in the atlas it is as a small tubercle. The seventh cervical has a simple slender diapophysis, 2 lines in length; in the sixth it coalesces with the tubercle of a short pleurapophysis (*ib.* $_{6,\,pl.}$), also confluent by the head with the centrum, and projecting outward, backward, and downward, with an obtuse end. The vertebral artery, in its forward course, enters the canal between the pleur- and di-apophyses. The pleurapophysis simply completes that bony canal in the fifth cervical, making a short angular projection outward and forward in the fifth, fourth, and third cervicals. The low, flat neural arch is narrowest in the fifth. The shape and disposition of the zygapophyses give an imbricate character to the union of those arches in the last six cervicals. The body of the axis is carinate below; that of the atlas has the usual state of an 'odontoid process' (*ib.* fig. 4, *ex*); the hypapophysial bar (*ib.* fig. 1, *ex*) uniting with the neurapophysial pillars or crura of the atlas is carinate. Besides the wide canals for the vertebral arteries in the 'transverse processes' of the atlas, the neural arch is perforated above the base of that process on each side for the passage of a nerve.

The Skull.—The curve of the cranial vertebræ brings, in the usual position of the occiput on the atlas, the premaxillary extremity (Pl. XIX. $_{22}$) parallel with the xiphoid cartilage (*ib.* $_{61}$), in the direction of the trunk's axis. The skull of the Aye-aye, in comparison with ordinary quadrupeds of its size, is remarkable for the large proportion of the cranium to the face, and the extreme shortness of the latter in advance of the orbits. Its profile contour, from the upper border of the foramen magnum, is a convexity curving rapidly from the occipital to the parietal region, and continued with a bold convexity to the root of the nose, whence it slopes straight to the nostril. The cranium is still more convex transversely (Pl. XX. figs. 1 & 4); it expands a little in advance of the lambdoid ridge, and gradually, but very slightly, contracts to the postorbital processes; these, meeting with the malar, complete the bony rim of the orbit, which opens widely beneath that part of the frame into the temporal fossa.

The basioccipital extends to the fore part of the large tympanic bullæ (*ib.* fig. 2, *m*), to abut against which its margins are slightly produced; it is smooth and slightly convex below, without hypapophyses. The occipital condyles are long and narrow, about 2 lines apart at their under ends, and extending upward and outward to the middle of the foramen magnum. The plane of this opening forms with the basioccipital an angle of 125°, its aspect being downward and backward: the foramen is nearly circular, $6\frac{1}{2}$ lines in diameter, that of the cranial cavity being 1 inch 7 lines across its widest part transversely. The paroccipital is a low eminence, and the mastoid (*ib.* figs. 1 & 2, $_{8}$) in front of it is hardly more prominent; neither process extends freely downward. The superoccipital is a thin plate moulded on the middle and lateral lobes of the cerebellum, and showing outwardly their respective prominences. The mastoid is impressed by the pit for the cerebellar appendage (*ib.* figs. 5 & 6, *e*). The lambdoid suture is nearly in the line of the low transversely arched ridge; it is a little in advance above, where the suture shows slight crenulations, and gets behind the ridge before it passes down between the mastoid and superoccipital.

The interparietal (*ib.* fig. 1, 3) is a small triangular bone, without trace of sagittal suture, 10 lines in length, and the same across the base, which is posterior, forming the middle part of the lambdoidal suture. The outer surface of the interparietal is divided into three nearly equal longitudinal tracts by the back part of the temporal ridges. The exposed inferior surface of the basisphenoid is rather shorter and broader than the basioccipital, but it is prolonged further along the cranial floor, where it is expanded by a large sinus (*ib.* fig. 6), and coalesces with the presphenoid. The alisphenoid developes the ectopterygoid ridge, extending from between the squamosal and tympanic to the outer side of the entopterygoid; both plates are imperforate. Above the back part of this ridge is the foramen ovale (*ib.* figs. 2 & 5, *f*), three lines in advance of which is the foramen rotundum. The natiform protuberances form deep depressions in the alisphenoid, on each side the flat square platform of the cranial surface of the basisphenoid, in the middle of which is the subcircular pituitary pit (*ib.* fig. 5, *k*). There are no clinoid processes. The alisphenoids join the parietals, which contribute the greatest share to the formation of the calvarium. The tympanic (*ib.* fig. 2, 28), coalescing with the petrosal, is, together with that element, expanded into an oval bulla (*ib.* *x*) on each side of the basisphenoid. The sagittal suture is almost a harmonia, 11 lines in length. The temporal ridges extend each to within 1½ line of the hind part of the sagittal suture, but diverge as they pass to the postorbitals. The parietals, impressed from within to transparent thinness by the longitudinal convolutions of the cerebrum, do not exceed half a line in thickness elsewhere. Between the root of the zygoma and the lambdoid ridge there extends a ridge at right angles to the latter.

The coronal suture crosses the cranium transversely three lines behind the postorbitals: the frontal suture remains; its length is 1 inch 5 lines; like the sagittal, it is a harmonia. The fore part of the frontals (Pl. XX. fig. 1, 11) projects a little between the origin of the nasals (*ib.* 15), and also between the nasals and maxillaries; they then join the lacrymals, form the upper half of the inner wall of the orbit, and unite behind with the orbitosphenoid, alisphenoid, and parietal. The postorbital process is three-sided, almost 5 lines in length, contracting to its junction with the malar (*ib.* 26): there is a slight depression at its base, defining the superorbital ridge. This ridge is entire, neither perforated nor notched. The olfactory fossa, within the cranium (*ib.* fig. 5), is subcircular, 7½ lines in breadth, and 6 lines in length. The median septum is produced with a ‘crista galli.’ The frontal sinuses (*ib.* *j*) give no outward indication, but are large and extensive, about 3 lines at their widest part from front to back wall, extending 1 inch 4 lines transversely into the bases of the postorbitals, and backward to within 5 lines of the coronal suture; they are divided from each other by a median bony septum; each division communicates with the nasal chamber by a median orifice, and by a lateral one with the antrum. The nasals (Pl. XIX. 15) are straight lengthwise, convex across, and the more so as they approach their free ends; they join above with the frontals (*ib.* 11), and at the sides with the premaxillaries (*ib.* 22). The presphenoid is short, smooth on the under surface, and concave there transversely. The vomer quickly assumes the form of a vertical plate, with the free hind border concave.

The palatines form the hinder third of the bony palate; the suture of each with the maxillary is slightly convex forward: they are divided from the inner alveolar wall of the last two molars by a groove which deepens into a fissure, bounded beyond the last molar by the pterygoid (Pl. XX. fig. 2). The maxillary forms more than the middle third of the palate, leaving the smallest share of the roof of the mouth to the premaxillary (*ib.* 22). The facial plate of the maxillary (Pl. XIX. 21) extends by a narrow produced apex to the lacrymal, but is excluded from the frontal by the junction of the lacrymal with the premaxillary; it is, transversely, convex at its outer, concave at its inner or fore part, both in a slight degree; its middle is perforated by a small antorbital foramen; its hinder angle is produced a little way beneath the molar. The anterior half of the alveolar border is edentulous, but sharp: the posterior half is excavated by the sockets of the four grinders; of these sockets the first is the smallest, and is a simple cavity; the second (Pl. XX. fig. 8, m_1) divides into three depressions for one large inner and two small outer fangs; the like divisions of the third socket (*ib.* m_2) are less deep; the fourth socket is simple, larger and more oblong than the first. These four sockets are in a straight line and parallel with those of the opposite maxillary.

The premaxillaries (Pl. XIX. 22) constitute a larger share than the maxillaries to the facial wall; on the palate they form merely the fore and outer boundaries of the incisive fissures (Pl. XX. fig. 2, *o*), and extend only one line behind the incisors. On the face they reach the frontals, rising as high as the nasals, between which and the maxillaries they interpose a broad plate, circumscribing, with the nasals, the external nostril. The socket of the incisor curves upward and backward to the maxillary, in which it is continued to beneath the orbit.

The malar bone (Pl. XIX. 26) is long and deep, especially below the orbit, of which it forms the lower half; and where it bends outward to expand that cavity, it unites with the lacrymal and extensively with the maxillary anteriorly, and bifurcates behind,—the narrower branch (Pl. XX. fig. 4, 26) mounting to the postorbital (*ib.* 12), the broader one (*ib.* fig. 2, 26) continuing backward to the squamosal (*ib.* 27).

This essentially facial or maxillary element (Pls. XIX. & XX. 27) is anchylosed not only with the mastoid (8) and petrosal (16), but also with the tympanic (28); its cranial plate forms the outer and back part of the depression for the natiform protuberance (Pl. XX. fig. 5, 27), and terminates by a convex upper border overlapping the contiguous borders of the alisphenoid and parietal (Pl. XIX. 27). The surface for the mandible (Pl. XX. fig. 2, *x*) is broad and flat, save where its inner border bends down upon the side of the petro-tympanic bulla (*ib.* 16). There is no ridge behind it to prevent the free movements of the mandible backward and forward, accompanying the rodent action of the great scalpriform incisors. The outer facet of the zygomatic process shows a depression in front of the meatus auditorius.

The mandible (Pl. XX. figs. 3, 7, & 9) is short and deep: each ramus is compressed and straight; they converge at an acute angle to a short ligamentous symphysis. The condyle (*x*) is sessile, narrow, rather long, convex both across and lengthwise, and the latter most so, looking backward and upward, and placed on the level of the grinding-teeth. The thin borders of the ascending ramus diverge from the condyle as they pass, the one downward and inward to the low angle (figs. 7 & 9, *y*), and the other forward and upward to the better-marked and more advanced coronoid (*ib.* *z*), the obtuse end of which is nearer the last molar (fig. 7, $m\ 3$) than the condyle. Both sides of the postmolar half of the ramus are almost flat. A slight ridge above the angle bounds the surface for muscular insertion behind; and here the angle is a little inflected.

The entry of the dental canal (figs. 3, 7, *t*) is on the line from the back molar to the condyle, but rather nearer the latter. The fore border of the coronoid (*z*) is almost straight, and slopes forward, parallel with the hind border (*y*, *x*) of the ascending ramus, to the outside of the jaw, below the alveolus of the middle molar (fig. 9, $m\ 2$). The lower border of the ramus from the angle undulates, first convex, then concave, finally convex as it curves slightly upward to the alveolar border of the great incisor. The short diastema (figs. 7, 8, *d*), almost equal to the fore-and-aft breadth of the incisor (*i*), is concave and sharp. The small single outlet of the dental canal (Pl. XIX. 32, *o*) is below the fore part of the first molar. The symphysis does not reach to the angle between the anterior and inferior borders of the horizontal ramus.

The sockets of the three molars occupy an extent of 5½ lines (·0012): the first and second sockets are divided into two depressions; the third is a simple oblong-conical cavity.

The socket of the incisor (fig. 9) has the external border of the outlet sinuous, the internal border convex; it is very narrow in proportion to its length, and makes no projection on either the outer or inner side of the ramus; it extends in a regular curve beneath the molar series to the base of the coronoid process, the tooth it contains (*i*, *p*) describing a semicircle.

Bones of the fore limb.—The scapula (Pls. XIX. 51, XXI. figs. 12, 13) is 2 inches long, with a basal breadth of 1 inch; the base is straight between the root of the spine and the beginning of the lower angle, but curves forward to that and to the upper angle. The supraspinal fossa is less than half the breadth of the infraspinal one; and the upper costa inclines at its fore part to near the spine, before it curves out again to the coracoid (Pl. XXI. figs. 12, 13, 52). The infraspinal fossa is made deep by the height of the spine and the outbending of the lower border. The spine rises to a height of 5 lines before expanding into the acromion, which attains a breadth of 4 lines, and is slightly twisted on itself. The surface on its anterior or inner border which it gives to the clavicle (*ib.* fig. 12, 58) is 3 lines long. The length of the acromion (fig. 13, *a*) is 6 lines; that of the coracoid (*ib.* 52) is 7 lines: it is a simple compressed process, 2 lines in breadth. The subscapular surface (Pl. XXI. fig. 13) has a shallow channel parallel with the origin of the spine, below which it is convex transversely; it is gently concave lengthwise at the fore part; there are no intermuscular ridges or crests on this surface. The glenoid cavity (*ib.* fig. 12, *o*) is a long oval, 6 lines by 3 lines, with the apex above, and rather produced. The clavicle (*ib.* 58), 1 inch 5 lines in length, has a double bend upward and outward, and a half twist on itself: the sternal end expands to a breadth of 3 lines; the acromial end is more gradually and less expanded.

The head of the humerus (Pl. XXI. fig. 15) has a long-oval form, regularly convex, and surpassing in both breadth and length those dimensions of the glenoid cavity. The great tuberosity projects on one side to the same height; the small tuberosity is somewhat lower. A sharp deltoid ridge (*ib.* fig. 14, *d*) extends from the fore part of the great tuberosity halfway down the shaft. The anterior flattened surface meets the posterior convex surface of the upper half of the shaft at an obtuse ridge along the inner side. The supinator crest (*ib.* *s*) begins below the middle of the shaft, near its back part, standing well out, and thence passes in an almost straight line to the ectocondyloid tuberosity (*c*): it equals two-fifths the length of the humerus. The internal ridge projects from nearly the fore part of the distal fourth of the shaft, bridging over the humeral artery and median nerve on its way to the entocondyloid tuberosity (*e*), where it coalesces with a shorter and sharper ridge, completing the epicondyloid foramen. The inner tuberosity is much more prominent than the outer one. The fore part of the lower third of the shaft is convex transversely; the back part (fig. 15) is concave. The anconeal fossa is oblong, of moderate depth, and imperforate. The tubercle (*r*) for the radius forms nearly half of the fore part of the elbow-joint; the back part is exclusively formed by the well-defined trochlear cavity (*u*) for the ulna. The humerus (Pl. XIX. 53) reaches to the tenth rib, when bent upon the chest.

The radius (*ib.* 54) is of equal length with the humerus, and offers no peculiarities for description; the head is nearly circular. The articular cavity at the head of the ulna (*ib.* 55) forms a laterally emarginate semicircle; below its outer side is a flat surface for the radius; the ulnar side of the bone below the cavity shows a longitudinal fossa: the upper half of the bone is bent, with the convexity backward. The ulna is the longest bone of the fore limb; it is compressed below the humeral joint, and gradually narrows to the lower fifth of the shaft, which is three-sided, with two of the dividing angles sharp ridges.

The wrist-bones (Pl. XIX. 56, Pl. XXI. figs. 17, 18) are ten in number, including a supplemental sesamoid on the outer side of the scapho-trapezial joint. The scaphoid (*ib.* fig. 18, *s*) is the longest, presenting its convex articular surface to the outer two-thirds of the radial concavity (*ib.* fig. 17, 54), and articulating with the lunare (*ib.* fig. 18, *l*), which completes the wrist-ball; at its distal surface it joins the 'intermedium' (*i*), the trapezium (*t*), and the trapezial sesamoid (*o*): the cuneiform (*c*) offers a cup for the hemispheric end of the styloid process of the ulna (fig. 17, 55), and a flatter surface for the pisiform (*ib. p*); this wrist-bone is long, and its articular surface is divided between the ulnar process and the cuneiform. The intermedium and cuneiform combine to form the cup for the ball common to the magnum (*m*) and unciform (*u*), of which the latter bone contributes the largest share. The intermedium (*i*) articulates with the trapezoid (*z*). The distal series of carpal bones have the usual relations to the metacarpals.

The metacarpal of the pollex (Pls. XIX. & XXI. fig. 17, I) articulates with the trapezium, and touches the trapezoid and the base of the second metacarpal: this (*ib.* II) is supported by the trapezoid. The base of the middle metacarpal (*ib.* III) is notched for a firmer articulation with the magnum, as that of the fifth metacarpal (*ib.* V) is for the outer division of the distal surface of the large unciform. The first, second, fifth, and fourth metacarpals progressively increase in length, with similar proportions as to thickness; but the middle metacarpal is double the length of the second, and suddenly contracts into a shaft more slender by half than the contiguous metacarpals. The proximal phalanx of the thumb is the shortest; that of the index is one-third longer; that of the minimus is rather thicker, and is one line longer than that of the index; that of the annulus is rather thicker, and is one-third longer than that of the minimus. The proximal phalanx of the middle finger is a slightly bent filamentary bone, about two lines shorter than that of the fourth finger. The second phalanx of the fifth is 1½ line longer than that of the second; that of the fourth finger is almost twice the length of that of the second; the filamentary one of the third is not longer than that of the fifth finger: all these phalanges are slightly bent, concave towards the palm. The ungual phalanges are all modified for the support of claws, are short, and are less unequal in length, that of the thumb being the shortest and broadest. The hand is the longest segment of the fore limb; it exceeds that of the ulna by 1 inch.

Bones of the hind limb.—The pelvis is long and narrow; the os innominatum equals in length the last five lumbar vertebræ.

The ilium (Pl. XIX. 62, Pl. XXI. figs. 19, 20, 62) is a long narrow bone, slightly expanded at both ends, and subcompressed at its upper half, where the sides look outward and inward, the borders forward and backward; of these the anterior one is the thinnest, and is slightly concave. The ilium articulates with the two first sacral vertebræ, just touching the second by a projection above its middle (*ib.* fig. 19, 62); about half an inch of the lamelliform part of the bone (*ib.* fig. 20, *l*, 62) projects freely in advance of this attachment, on each side the transverse processes of the last lumbar vertebra, with a slight divergence. The iliac bones incline to the acetabula at an angle of 140° with the lumbo-sacral axis. There is an elongate tuberosity above the acetabulum for the origin of the rectus femoris. The ischia (*ib.* 63) are continued almost in a line with the ilia, the posterior contour describing a very feeble curve concave backwards. They diverge to the tuberosities (*t*) for an extent about equal to that of the ischio-pubic symphysis, the tuberosities being slightly everted: a small projection (fig. 19, 63) behind the lower part of the acetabulum divides the great from the small ischiadic notches, both of which are very shallow. The obturator foramina (*o*) are oval, 9 lines by 6 lines in the two diameters. The pubic bones (*ib.* 64) pass from the acetabula (fig. 19, *a*) at almost a right angle with the ilio-ischial axis; they converge to the symphysis (64, *s*) at an angle of 80°. There is a slightly marked ilio-pectineal prominence.

The femur (Pl. XIX. 65) has a straight shaft, with the upper end a little inclined forward, and the lower joint projecting as much backward: it is one-third longer than the humerus. The head (Pl. XXI. fig. 21, *a*) is an oblong or subelliptic convexity, with the longer axis from behind forward and downward, having the pit for the round ligament near its lower border. The neck is short: the great trochanter (*t*) rises to the height of the head; it diminishes in breadth as it descends, and at the outer and lower part is developed into a small tubercle (*u*). Opposite to this the lesser trochanter (*s*) projects from the inner side to a greater degree. The shaft of the femur is, transversely, less convex behind than before; it preserves its shape and thickness to the beginning of the condyloid expansion. The orifice for the medullary artery is at the back part, one-fourth of the length from the head: the canal ascends. The inner condyle is rather the largest. The outer border of the rotular groove projects most. There is a sesamoid bone (Pl. XIX. 65') in each origin of the gastrocnemius.

The tibia (*ib.* 66) is about two lines shorter than the femur, and soon contracts below the head to a compressed shaft, giving a long and narrow subelliptic section; at the upper half it is very slightly bent, with the convexity forwards. A roughish surface is continued from the tuberosity nearly one-third of the way down the fore and outer part of the shaft. The orifice of the medullary canal is one-fourth of the way down, just within the posterior border: the canal slopes downward. The malleolar part of the distal expansion is long: two slight vertical ridges at the back part of the expansion bound a wide and shallow groove for the flexor tendons. The tibia is one-fifth longer than the ulna. The fibula (*ib.* 67) touches the tibia only by the two extremities articulating with that bone, leaving an interosseous space co-extensive with their shafts. The outer malleolus is shorter and thicker than the inner one. There is a sesamoid in the external lateral ligament of the knee-joint, at its insertion into the head of the fibula.

The tarsal bones (Pl. XIX. 68, Pl. XXI. fig. 22) are seven in number. The naviculare (*s*) has its shallow concavity for the astragalus (*a*) supplemented by the strong ligament arising from its posterior and inferior margin, and inserted into the fore part of the inner malleolus; anteriorly it articulates with the three cuneiform bones, and externally at its fore part with the os cuboides; its depth exceeds its length. The astragalus (*a*) has a grooved posterior border; the upper articular surface is broader before than behind. The part thence extending to the anterior ball, with the rest of the bone, is of equal length, and is inclined inward to the naviculare. The calcaneum (*d*) offers two articular surfaces to the astragalus, rather far apart; the lever projects moderately beyond the hinder surface, and is curved a little upward and inward. The lower border is narrow and straight. The anterior surface for the cuboid is concave at the lower part. The ento-cuneiform (*i*) presents a concavity to the lower and outer half of the great convexity of the naviculare; it offers at the anterior half of its outer part a trochlear surface, concave in one direction, convex in the opposite, to the powerful hallux, between which and the second toe the ento-cuneiform projects upon the dorsum of the foot. The meso- (*m*) and ecto- (*e*) cuneiform bones are narrower; the outer one (*e*) is of nearly equal length with the inner (*i*), the middle one (*m*) being the shortest. The cuboid (*b*) is large and long, with the lower half of its calcaneal surface convex, the upper half concave, for an interlocking joint with that bone; it is almost square and flat above, grooved externally and beneath for the peroneus longus, and, as usual, it supports the two outer toes.

The base of the metatarsal of the hallux (*i*) is broad, and its under border is produced into contact with that of the second metatarsal. The base of this metatarsal (*ii*) is interlocked for a small extent between the ento- and ecto-cuneiforms; it is half as thick as the first metatarsal, and of the same length, but appears longer from its more advanced articulation and the greater proportion of the shaft to the articular ends. The third metatarsal (*iii*) is a little longer than the second; the fourth (*iv*) has nearly the same length, and so has the fifth (*v*) by reason of the backward production of the outer angle of its base. The proximal phalanx of the fourth toe is the longest; that of the middle toe is about one line shorter; those of the second and fifth are half a line shorter than that of the third; the proximal phalanx of the hallux is the shortest and thickest. The middle phalanx of the second toe is the shortest; that of the fourth, which is the longest, exceeds it by three lines; those of the third and fifth are of intermediate length. The ungual phalanx of the hallux is short, broad, expanded, indicating the nail-shaped appendage which it bears; the ungual phalanges of the other toes are subcompressed and obtusely pointed, conformably with their more claw-shaped weapons.

The following parts retained their epiphysial condition:—the head of the humerus, the carpal ends of the radius and ulna, the femoral condyles, the upper end of the tibia, the lower end of both tibia and fibula. The animal may not, therefore, have attained its full size.

	Ft.	in.	lin.
Length of skull (including incisors)	0	3	5
——— of vertebral column	2	3	6
——— from occiput to sacrum	0	9	0
——— of sacrum (by anchylosis)	0	1	6
——— of tail	1	5	3
——— of cervical	0	1	8

	Ft.	in.	lin.
Length of dorsal	0	4	6
——— of lumbar	0	3	2
——— of sternum	0	3	3
——— of scapula	0	2	0
——— of clavicle	0	1	5
——— of humerus	0	3	3
——— of radius	0	3	3
——— of ulna	0	3	10
——— of manus	0	4	9
——— of pollex (including metacarpal)	0	1	8
——— of index (including metacarpal)	0	2	9
——— of medius (including metacarpal)	0	3	11
——— of annularis (including metacarpal)	0	4	4
——— of minimus (including metacarpal)	0	3	0
——— of pelvis	0	3	0
——— of femur	0	4	9
——— of tibia	0	4	7½
——— of pes	0	4	4
——— of hallux (metatarsal included)	0	1	10
——— of fourth medius (metatarsal included)	0	3	4

§ 4. *Teeth.*

The dental formula of *Chiromys* is—

$$i.\,\frac{1-1}{1-1},\ c.\,\frac{0}{0},\ p.\,\frac{1-1}{0-0},\ m.\,\frac{3-3}{3-3},=18.$$

The incisors (Pl. XX. figs. 6 & 8, *i*, *ï*) are long, large, much compressed, regularly curved in segments of equal circles, the upper pair describing one-fourth, the lower pair one-half of such circle. The upper incisor (*ib.* *i*), 1 inch 4 lines long, following the convex border, is 3½ lines from before backward, and one line across (*ib.* fig. 4); the outer side is flat, the inner side rather convex; the worn cutting surface is concave, with the fore part produced, forming an obtuse point. The front or convex border of the tooth is coated by enamel, extending nearly a line's breadth upon the outer side (fig. 8, *e*), and for a rather less extent upon the inner side: it is one-third of a line in thickness. The dentinal body of the tooth (*ib.* *d*) has a central slightly discoloured axis of osteodentine. The exposed part of the tooth measures six lines at the fore, and two lines at the back, border in length; the implanted part (fig. 8) extends through the premaxillary into the maxillary to above the molars, where the pulp is situated close to the thin convex plate of bone below the orbit. The pulp-cavity of the tooth is a long cone with a widely open base; the apex reaches to near the opening of the socket. As they approach this outlet, the teeth converge and come into contact at the anterior half of their cutting surfaces for an extent of two lines from the point (fig. 4). The exposed part of the tooth resembles the crown of a canine rather than of an ordinary rodent incisor, and projects more forward than downward; but, in the partial investment of enamel, the hollow base, and persistent pulp, the Aye-aye's incisor is a true chisel-tooth.

The lower incisor (fig. 9, *ï*), which has greater fore-and-aft breadth, but hardly so much transverse thickness as the upper one, has the enamel (*e*) continued further upon the sides, especially the outer one; here it is extended fully two lines from the front border, and upon the inner side (fig. 7, *ï*) rather more than one line. The long diameter of the incisor is 5 lines; the length, following the convex curve, is 2 inches 7 lines; the depth of the pulp-cavity (fig. 9, *p*) is 1 inch 8 lines. The exposed part of the tooth measures nine lines at its fore part; but the cutting surface slopes thence, with a deep concave curve, to the back part of the alveolar border, where scarcely a line's extent of the concave border of the tooth protrudes. The exposed part of the tooth has thus more the shape of the crown of a canine than has that of the incisor above. The implanted part of the tooth extends to within five lines of the apex of the coronoid process (*ib. z*). The pulp-cavity, in both upper and lower incisors, is deeply stained by the hæmatosine of the active reproducing matrix.

In the upper jaw (figs. 6 & 8) the first grinder (*p* 4) is six lines distant from the incisor; it answers to either the last premolar or last milk-molar in the placental diphyodont type; it has an obtuse crown, covered by thick enamel, of a subtrihedral shape, the longest side backward, the shortest outward; it is implanted by a simple, thick, subconical fang. The second grinder (*m* 1), answering to the first true molar in the type-formula, has an unequal-sided quadrate crown, with the narrowest side forward; the grinding surface is channelled from before backward; the outer wall is feebly divided into two low lobes by an external notch; the inner wall has a convex bulge next the palate. The whole crown has a simple but thick coat of enamel: it is implanted by two small and short outer roots and one thick and longer inner root: the longest diameter of the crown is 2 lines. The third grinder (*m* 2) resembles the former, but its front side is as long as the back one: it is similarly implanted. The last grinder (*m* 3) has a full oval crown, with the small end outward; the grinding surface has a middle depression surrounded by three low tubercles, the inner one the largest, the hind one much the smallest. It is implanted by a short thick fang, slightly notched at the apex. The position of the crowns of these teeth is such that the direction of their interspaces is oblique, from within, outward and forward; but the grinding surface looks directly downward. A magnified view of that surface is given at fig. 10, Pl. XX.

The three lower grinders are true molars, and are a little in advance of the crowns of their homotypes above. Each has a shallow longitudinal depression on its grinding surface, with simple undivided outer and inner boundaries, uniting at their fore part in the first grinder, and with a very small lobe interposed behind in the last. Each has a simple cap of enamel, like the molars above. The mid-molar (*m* 2) is rather the largest, the first (*m* 1) is the narrowest; in this and the second the implanted base is divided into an anterior and posterior root (fig. 9); it remains simple in the last (*m* 3). The longest diameter of the mid-molar does not exceed 2 lines; these teeth are, therefore, very small in proportion to the incisors, and the molar series is singularly small in proportion to the entire skull and body of the Aye-aye[1].

The very compressed form of the incisors, the obliquity of their narrow working surface allowing the enamelled ends only of the upper and lower pair to come into contact, gives almost a pointed form to those ends, which are thus adapted to pare away very narrow strips of the bark and the wood they may be operating on; whilst the great fore-and-aft breadth of the incisors, and the angle at which their front or enamelled borders converge in each pair, adapt them to penetrate deeply and quickly into the substance of a bough. In all these characters their special adaptation to the work of exposure of the slender canals of the wood-boring caterpillars becomes very obvious. The length and curved implantation of the teeth, and the provision for their perpetual renovation, are conditions of equal fitness for the daily repetition of such eroding operations. By these adaptive modifications the front teeth of the Aye-aye doubtless resemble in their broader features the scalpriform incisors of the true Rodents; but to infer that, therefore, the food of the Aye-aye was similar, and that it subsisted, like the Squirrel and Beaver, *e. g.*, on the coarser vegetable products, would be as fallacious as to conclude, from the shape and proportions of the canine teeth in the male *Troglodytes*, that the Gorillas and Chimpanzees were flesh-eaters. The diet is best indicated by the molars; and the functions of specially developed teeth in a state of nature are made known by observations on living animals. The true relations of the dental characters by which the highest Quadrumane resembles a Carnivore, and the lowest one resembles a Rodent, are elucidated by the totality of their organization respectively[2].

§ 5. *Muscles.*

In this section I restrict myself to a description of those parts of the muscular system which seem to throw most light on the affinities of *Chiromys*, and my remarks chiefly relate to the muscles of the limbs.

The *platysma myoides* (Pl. XXII. fig. 1, $_8$) is well developed, covering all the muscles

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[1] Since this sheet was in type, I have learnt from Prof. Gervais, of Montpellier, that the jaws of a young *Chiromys*, presented by M. de Lastelle to the Museum of Natural History, Paris, exhibit a molar anterior to the three in the lower jaw, corresponding to, but smaller than, the anterior one above. In this immature specimen, the last of the three true molars has not cut the gum. By the time this takes place, the first small molar is shed in the lower jaw: it is retained in the upper one: it may be a deciduous or milk-molar, *d* 4 instead of *p* 4, in both jaws. M. Gervais has figured this phase of dentition in his 'Histoire Naturelle des Mammifères,' vol. i. p. 176.

[2] The following is the result of a microscopic examination kindly undertaken by my friend James Salter, Esq., F.L.S., of the teeth of the *Chiromys*:—"The transverse section of the Aye-aye's incisor is singularly like the outline of a vertical section of the lower cuspidatus of man, the *outer* surface of the former corresponding with the *front* of the latter. The enamel is thick and hard; it clothes the tooth on the outer surface by about

on the front and sides of the neck, and extending upon the sides of the deep mandibular rami.

The *sterno-cleido-mastoideus* consists of two portions, which are more than usually distinct to their insertions. The sternal portion (*ib.* 9), commencing by a short roundish tendon from the outer angle of the manubrium, becoming fleshy, expands to the breadth of five lines, is flat, and covers the cleidal portion (9′), arising fleshy from the median third of the clavicle. The sternal portion is inserted into the mastoid, and the ridge continued thence upon the occiput. The cleidal portion contracts to its insertion, which is tendinous, at the back of the mastoid. The two portions are continuous along the front margin, and separate behind, the sternal overlapping the other.

The *omo-hyoideus* arises fleshy from the upper costa of the scapula, and passes obliquely upward and forward, crossing the carotid artery, becoming flattened, with a breadth there of three lines, to be inserted into the hyoid, along with the sterno-hyoideus, and to the aponeurosis connecting the beginning of the tendon of the digastricus to the hyoid.

The anterior bellies of the pair of *digastrici* muscles are closely blended together, and fill up the anterior interspace of the rami of the lower jaw. The tendon of each digastricus, commencing at the hyoid, is about five lines in length; the posterior belly consists of two fasciculi of muscular fibres, and arises from the lower part of the mastoid.

The *sterno-hyoidei*, each five lines in breadth at their origin, gradually contract as they ascend towards their insertion, and are closely connected at the middle line, covering the larynx and trachea.

The *sterno-thyroidei* are much smaller muscles; they arise behind and externally to the sterno-hyoidei, and pass along the side of the trachea, to be inserted below the thyro-hyoideus into the thyroid cartilage.

The *longus colli* is a powerful muscle, especially thick at the part which is attached to the pleurapophyses of the sixth and fifth cervicals.

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twice the extent that it does on the inner; it is naked, except just at its edge, where it is slightly overlapped by crusta petrosa, which extends up to the worn part of the tooth, and covers all the dentine which is not protected by enamel. The crusta petrosa at the part of the incisor examined (its distal extremity) is very thin, and only a transparent layer, without lacunæ. The pulp-cavity was sealed by an exceedingly thin layer of secondary dentine, so thin that the vessels of the pulp reached within less than a line of the surface. The point where the section was made exposed the vascular pulp. In the molar tooth the bulk of the crown is composed of enamel, which is bare,—not covered, that is, by crusta petrosa.

"It can scarcely be said that the teeth present any *histological* characters of marked peculiarity. If, however, one thing is more noticeable than another (especially in my incisor section), it is the large number of dentinal tubes which enter the enamel, as is conspicuous in marsupials. This, however, is an inconstant structural condition; it is found in many mammalian teeth, differing in individuals of the same species, and also in different teeth of the same individual, and is not of the zoological value that has been imagined. I should, therefore, attach very little importance to the circumstance as seen in a single specimen only."—J. S.

The principal muscle of the lower jaw is the *masseter*, of a quadrate form, one inch five lines in breadth by one inch four lines in depth; it arises from the lower margin of the zygoma, and from a very strong aponeurosis continued thence over the greater part of the outer surface of the muscle. It consists of two portions, an external and an internal. The external fibres pass downward almost parallel, to be inserted into the lower border of the posterior half of the mandible; they are separated by a thin glistening aponeurosis from the internal portion, the fibres of which pass a little forward as well as downward. These two portions blend together anteriorly; the inner portion is inserted into the outer surface of the broad ascending ramus. There is no trace of an accessory masseter, such as exists in most Rodents.

The *temporal* muscle attains four or five lines in thickness: besides its cranial origin, it derives many fibres from the strong temporal fascia, attached to the upper border of the zygoma, before passing under the arch to be inserted into the coronoid process.

The *pterygoideus internus* arises by a strong narrow tendon from the outer part of the base of the spheno-pterygoid ridge, and expands, its fibres diverging, to be inserted into the slightly inflected angle and the lower border of the inner depression of the ascending ramus of the mandible. The inner or exposed surface of the pterygoideus internus is in great part covered by a glistening aponeurosis.

The *pterygoideus externus* has a broader and more extended origin; its fibres run more parallel, and slightly converge to their insertion into the upper half of the inner surface of the ascending mandibular ramus.

Muscles of the Upper Limb.—The muscles (*trapezius* and *levatores*) which attach the scapula to the head and neck are large and strong. The *latissimus dorsi* arises from the back part of the last five ribs, and from the broad tendon common to it with the sacro-lumbalis and longissimus dorsi: the fibres converge, as they pass over the lower part of the scapula, to terminate in the strong flattened tendon (Pl. XXIII. fig. 1, 16), which is inserted into the internal ridge of the proximal third of the humerus. Near the beginning of the tendon, on its inner side, is attached the accessory muscle (*ib.* 22 *d*) of the long portion (*ib.* 22 *a*) of the *triceps*, by which the influence of the great dorsal muscle, most effective in the action of climbing, is extended to the lower end of the humerus and the olecranon.

The *teres major* (Pl. XXIII. figs. 1 & 2, 12) arises from the lower costa of the scapula; its tendon, passing along the upper part of that of the *latissimus dorsi*, is inserted into the lesser tuberosity of the humerus.

The *teres minor* (*ib.* fig. 2, 10) is not much inferior in size: it arises from the infra-spinal space beneath the origin of the scapular spine; extends forward over the origin of the triceps, and under the deltoid, to be inserted into the greater tuberosity.

The *subscapularis*, of which a portion is shown in Pl. XXIII. fig. 1, 13, has the usual origin from the inner surface of the scapula, by three principal fasciculi, which converge to a broad thin tendon, closely attached to the part of the capsule of the shoulder-joint over which it passes, to be inserted into the lesser tuberosity of the humerus above the *teres major.*

The *deltoïdes* (Pls. XXII. & XXIII. figs. 1 & 2, 15) has the usual extensive origin from the outer part of the clavicle, contiguous to the clavicular part of the pectoralis major, and from the acromion to near the beginning of the scapular spine. The fibres converge to their insertion into the strong ridge along the middle of the fore part of the upper half of the humerus.

The *pectoralis major* (Pls. XXII. & XXIII. fig. 1, 17) consists of an upper smaller (17*a*) and a lower larger (17*b*) portion. The first derives its origin from the sternal half of the clavicle and the manubrium sterni; its fibres pass transversely outward, overlapping the insertion of the second portion, and passing to the lower part of the pectoral ridge of the humerus. The larger portion of the pectoralis major arises from the fore and lateral part of the body of the sternum, and from the cartilages of the eighth, ninth, and tenth ribs. The fibres converge to their insertion into the upper two-thirds of the pectoral ridge.

The *pectoralis minor* arises from the side of the manubrium, and from the sternal ends of the first to the fifth ribs: it is inserted by a broad tendon, spreading over the head of the humerus, to be attached to the great tuberosity.

The *biceps brachii* (Pls. XXII. & XXIII. fig. 1, 20) rises by a short and thick tendon (*a*), which soon becomes distinct from the coraco-brachialis, from the coracoid process, and by a long flattened and strong tendon (*ib. b*) from the upper border of the glenoid cavity. The two portions of muscle unite about one-third down the humerus, and the muscle passes over the fore part of the elbow-joint, becoming tendinous (*ib. c*), to be inserted, as usual, below the proximal tubercle of the radius.

The *coraco-brachialis* (Pls. XXII. & XXIII. fig. 1, 14) arises from the whole lower border of the coracoid process by a broad tendon, which is closely attached to the capsule of the shoulder-joint where it passes over the joint, becomes fleshy near its origin, and is inserted along the inner side of the middle third of the shaft of the humerus; the portion (14 *b*) which has its insertion extended to the entocondyloid ridge seems to have an almost distinct origin by a larger tendon, from the end of the coracoid process.

The *brachialis anticus* (*ib.* fig. 1, 21) lies to the outer side of the lower half of the coraco-brachialis; arising from the outer side of the deltoid ridge, and from the outer and fore part of the middle and lower third of the humerus: it is inserted into the coronoid process of the ulna. The inner fasciculus of this muscle, described by Vrolik[1] in *Stenops tardigradus*, is wanting in *Chiromys*, as in *Tarsius*[2] and *Stenops gracilis.*

The *triceps extensor antibrachii* presents the same complexity as in most *Quadrumana.*

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[1] Recherches d'Anatomie Comparée sur le Genre *Stenops*, &c., 4to, 1843, p. 45.

[2] Burmeister, *op. cit.*

The 'long portion' or 'head' (Pl. XXIII. fig. 2, 22 *a*) arises from the rough facet behind the glenoid cavity; the fleshy part is broad, thin, and short, ending in a broad tendon covering the lower half of the back part of the humeral muscles, and receiving the accessory head (*ib.* fig. 1, 22 *d*) from the latissimus dorsi; it is inserted into the olecranon. The 'external portion' (*ib.* fig. 2, 22 *b*) arises below the lesser tuberosity and contiguous part of the humeral shaft, and continues fleshy to near its insertion by a broad tendon into the outer border of the olecranon. The internal portion (*ib.* fig. 1, 22 *c*) arises from the inner and back part of the shaft of the humerus, beginning below the insertion of the teres major: it is thick and fleshy; the fibres, converging to a very short but broad tendon, are inserted, with the preceding, into the olecranon, and are attached to the outer part of the capsule of the elbow-joint. The lower portion of this muscle is noted by Burmeister[1] as an '*anconeus sextus*' in the *Tarsius*, and appears to be almost as distinct a part in the Aye-aye (Pl. XXIII. fig. 1, 22 *e*). Its fibres come from above the entocondyloid ridge to near its lower end, and are inserted into the inner part of the olecranon. Vrolik[2] speaks of an auxiliary fascicle to the triceps from the back part of the humerus in *Stenops*.

The *supinator longus* (Pl. XXIII. figs. 1 & 2, 23) has its long fleshy origin extended from the middle of the humerus to near the end of the ectocondyloid ridge, where it is partly covered by the origin of the *extensor carpi radialis longus*: its fibres converge as they pass along the upper and fore part of the forearm, below the middle of which the tendon commences whereby it is inserted into the outer part of the carpal tuberosity of the radius.

The *extensor carpi radialis longus* (Pl. XXIII. fig. 2, 24) arises from the lower part of the ectocondyloid ridge; it is less broad than the supinator, from which it is divided by the radial nerve; its tendon begins about the middle of the forearm, is crossed by the *abductor longus pollicis* (*ib.* 25), passes, with the tendon of the *extensor carpi radialis brevis* (*ib.* 26), through a synovial sheath in the dorso-carpal ligament, gives off a strong aponeurosis to the scaphoid and trapezium, and is finally inserted into the back part of the base of the metacarpal of the index finger.

The *extensor carpi radialis brevis* (*ib.* 26) arises from the outer and lower part of the ectocondyloid tubercle, in common with the *extensor digitorum* (*ib.* 27): its tendon begins lower down than that of the long carpal extensor, but has a similar course until it has passed through the dorso-carpal ligament (*x*), when it diverges to be inserted into the base of the metacarpal of the digitus medius.

The *extensor carpi ulnaris* (Pl. XXIII. fig. 2, 28) arises from the lowest part of the ectocondyloid protuberance: its tendon begins about the lower third of the ulna, near the end of which it passes through a pulley of the dorso-carpal ligament, and inclines outward to be inserted into the back and outer part of the base of the fifth metacarpal.

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[1] *Op. cit.* p. 32.

[2] *Op. cit.* p. 44.

The *extensor digitorum communis* (Pl. XXIII. fig. 2, 27), arising, in common with the *extensor carpi radialis*, from the ectocondyloid tubercle, accompanies that muscle in close attachment therewith down half the forearm, then separates therefrom to allow the abductor longus pollicis (*ib.* 25) to glide between them, and at about the same part of the forearm itself divides into two fasciculi terminating in the extensor tendons. These pass beneath the dorso-carpal ligament, beyond which they are connected together by strong fasciæ, forming, apparently, a broad band upon the metacarpus where the separate tendons diverge to the second, third, fourth, and fifth digits. They expand as they pass over the proximal joints, where they are connected with the divisions of the shorter extensor tendons. A deep-seated extensor, forming almost a separate muscle, sends subsidiary tendons (27 *a*) to the fourth and fifth digits, expanding upon the capsules of the proximo-digital joints. In this respect *Chiromys* resembles *Tarsius*[1], and differs from *Stenops*, in which, according to Vrolik[2], the deep extensor of the fourth and fifth fingers is wanting.

The *abductor longus pollicis* (Pl. XXIII. fig. 2, 25) arises from the lower part of the ectocondyloid tuberosity, descends on the radial side of the *extensor longus pollicis* as far as the middle of the antibrachium, then diverges obliquely radiad, decreasing in breadth as it passes over the tendons of the two radio-carpal extensors, passes with them through the dorso-carpal ligament, and goes to be inserted into the radial side of the metacarpal of the pollex.

The *extensor longus pollicis* (Pl. XXIII. fig. 2, 37) arises from the upper third of the ulna, passes down the back part of the interosseous space, becomes tendinous at the lower third of the forearm, bends radiad beneath the index and medius tendons of the common extensor, and, after passing through the dorso-carpal ligament, proceeds to its insertion into the back part of the proximal phalanx of the thumb.

Beneath the foregoing, arising from the middle of the ulna and interosseous ligament, is a small muscle, answering to the ‘indicator,’ but dividing into two slender tendons, which, after connexion with those of the superficial extensors, go respectively to the index and medius digits, dividing upon the proximal phalanx, and uniting to be inserted into the base of the distal phalanx.

Some of the smaller muscles of the digits are indicated in the description of the Plates.

The forearm of the Aye-aye appears to be incapable of being naturally brought into a straight line with the humerus, but freely bends within the limits of the obtuse angle to which it can, with moderate force, be stretched.

The *pronator teres* (Pls. XXII. & XXIII. fig. 1, 32) arises, in close connexion with the *palmaris longus*, from the lower and fore part of the entocondyloid ridge, and is inserted by a broad flat tendon into the radius at and above its middle part. The carneous fibres continue on the outer part of the muscle to near its insertion.

The *flexor carpi radialis* (*ib.* 31), with a similar but deeper origin, continues fleshy

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[1] Burmeister, *op. cit.*

[2] *Op. cit.* p. 45.

to the middle of the forearm: its long tendon passes under the vola-carpal ligament to be inserted into the base of the index metacarpal.

The *palmaris longus* (*ib.* fig. 1, 30), with a similar but superficial origin, is a more slender muscle, becomes tendinous halfway down the forearm, and is inserted partly into the vola-carpal ligament, and partly expands into the volar fascia.

The *flexor carpi ulnaris* (*ib.* fig. 1, 29) is the largest of the superficial flexors of the forearm: it arises, fleshy, from the entocondyloid ridge, and by fascia from the ulnar ridge of the proximal part of the ulna; its fibres converge to a tendon at the lower third of the forearm, which is inserted into the outer part of the pisiform (*p*), and, by a strong fascia, thence continued to the base of the fifth metacarpal.

The *flexor digitorum sublimis* (Pl. XXIII. figs. 1 & 3, 33) arises from the entocondyloid prominence of the humerus and from the coronoid process of the ulna, being covered there by the *palmaris longus* and *flexor carpi ulnaris*; it divides below the middle of the forearm into two fasciculi, each of which again divides. The tendons of the radial divisions (fig. 3, *a*, *b*) pass near each other, through the vola-carpal ligament, and diverge at the palm to the index and medius digits—the latter being a very slender tendon in relation to the slenderness of that finger. The ulnar pair of tendons have a similar course, rather removed from the preceding, to the annulus (*c*) and minimus (*d*) digits. Each tendon splits, as usual, at the base of its digit, giving passage to the tendon of the deep flexor, and itself being inserted into the sides of the proximal phalanx. Besides these four tendons, a short and strong one (fig. 4, *e*) is sent off from the inner or back part of the ulnar division of the *flexor sublimis* to join chiefly the division of the *flexor profundus* which supplies the middle finger.

The deep flexors of the digits (Pl. XXIII. fig. 4, 33) are two in number. The one on the radial side arises by three heads, the longest (*a*), answering to the *flexor longus pollicis*, from the upper part of the radius; the second (*b*) is a distinct strip, from the radius and interosseous space; the third (*c*) arises from the middle of the ulna, and from the interosseous space: the two first heads unite, and afterwards join with the third head, forming a strong tendon which, at the carpus, divides into two, one going to the distal phalanx of the thumb, the other to that of the forefinger; but this is united at the wrist with the tendons of the ulnar division of the *flexor profundus.* This division (*d*) arises from the entocondyloid tubercle and the whole of the fore part of the upper two-thirds of the ulna: it receives an accessory fasciculus from the middle of the ulna: their common tendon unites as it passes under the carpal ligament with that of the radial division by the short strip of tendon (*f*), then proceeds independently, and divides into two strong tendons—one for the fourth, the other for the fifth finger. The slender tendon of the middle finger comes off very near the point of union of the radial with the ulnar division of the *flexor profundus*, and also near the connecting tendon (*e*) between the superficial and deep flexors; so that the action of all the flexor masses may be concentrated on that slender middle finger.

The tendon of the fasciculus representing the *flexor longus pollicis* has an adhesion to the supplementary carpal ossicle and attached part of the transverse fascia, beyond which adhesion (Pl. XXII. fig. 1, 34 a) it sends the more distinct tendon to the pollex; but the effect of this attachment is to oppose, not the pollex only, but the pad at its outer base, which is supported by the supplemental ossicle (Pl. XXI. fig. 17, *o*) in the grasping act, when the radial is opposed to the ulnar side of the hand. The fleshy part of both flexors, but especially of the deeper-seated muscles, continues far on towards the hand, as in other *Lemuridæ*, and also as in the climbing *Rodentia*, thus enabling the muscles to continue their action as finger-benders in the bent position of the hand itself[1]. The tendons of the deeper flexors are thicker than those of the superficial flexors; but both those of the middle digit are very slender.

The *pronator quadratus* rises from the fore part of the lower fourth of the ulna. Its fibres pass obliquely outwards and downwards, to be inserted into the corresponding fore part of the radius. Both the pollex and minimus have their abductor and adductor muscles and short flexors. The tendons of the deep flexors give attachment to four lumbricales. Some of these minor muscles of the digits are noticed in the description of the Plates.

Muscles of the lower limbs.—The *psoas magnus* (Pl. XXIV. fig. 1, 1) presents a character of unusual length, corresponding with that of the lumbar region, from which it chiefly arises, its highest or foremost origin being from the last dorsal vertebra. An inner and superficial portion (*a*) may be recognized as an ill-defined psoas parvus, but becomes distinct below where it is inserted into the ileo-pectineal ridge. An outer portion (*b*) more especially unites itself with the *iliacus internus*, and, with the main body of the psoas, passes on to be inserted into the lesser trochanter, the unusual prominence of which relates mainly to the power of this great flexor of the trunk on the thighs and reciprocally.

The *iliacus internus* (*ib.* 2) is a long and thin or flat muscle from the fore part of the ilium, behind and exterior to the psoas, with which, especially the outer fasciculus, it unites below, for a similar insertion in the lesser trochanter.

The *tensor vaginæ femoris* (Pls. XXIV. & XXV. fig. 1, 3) is represented by a small external fasciculus from the anterior superior spine of the ilium, which extends into the fascia covering the fore and outer part of the thigh.

The *sartorius* (Pls. XXIV. & XXV. 15) is a long, flat, rather broad muscle, arising fleshy between the iliacus internus and ecto-gluteus[2] from the anterior border of the ilium, passing obliquely across the inner side of the thigh, slightly expanding to be attached to about an inch of the upper part of the spine of the tibia (Pl. XXV. fig. 2, 15) and to a thin fascia covering the knee-joint (Pl. XXIV. *f*).

The *gracilis* (*ib.* 14) rises fleshy from the whole of the symphysis pubis, and is similar

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[1] Vrolik, *op. cit.* p. 45.

[2] *Gluteus maximus* of anthropotomy. (See 'Osteology of Chimpanzees,' &c., p. 15.)

in shape and size to the sartorius, but rather thicker and narrower: it is partly covered by the sartorius as it passes to its insertion, which is by a narrow tendon, into the spine, one inch below the head, of the tibia, the tendon at its insertion uniting with that of the semi-tendinosus (21), which is behind it.

The *ectogluteus*[1] (Pl. XXV. fig. 1, 4) is represented by a series of conjoined fasciculi having an origin extended from the anterior spine of the ilium to the sacral and first two caudal vertebræ. The fibres converge and pass over the great trochanter and subjacent part of the ischium to be inserted into the back and outer part of the femur, from half an inch below the great trochanter to the ectocondyloid ridge. A small tendon is developed from the anterior border, near its insertion, over which tendon the longer posterior fleshy fibres are, as it were, twisted in descending.

The *semitendinosus* (Pl. XXV. figs. 1, 2, & 3, 21) has a double origin: one slender (*a*) from the second caudal vertebra, adjoining the caudal origin of the gluteus; the other (*b*) thicker, in common with the long head of the 'biceps,' from the outer and back part of the tuber ischii. The muscle formed by their junction is a flat band, and becomes tendinous for about an inch in length, where it passes to the inner side of the tibial to be inserted into the spine, along with the tendon of the *gracilis* (fig. 2, 21 & 14).

The ischial origin of the *biceps* (Pl. XXV. fig. 1, 20) is by a slender fasciculus, partly tendinous, which, receiving an accession of carneous fibres from the femur, expands as it descends to be inserted into the fascia (*c*) covering the head of the tibia and the origin of the *peroneus longus*, and, finally (*d*), into the fore, upper, and outer part of the tibial spine.

The *semimembranosus* (Pl. XXV. figs. 2 & 3, 22) arises from the under and fore part of the tuber ischii, beneath the common origin of the biceps and semitendinosus: it is a strong, fleshy, subtrihedral muscle; becomes flattened, contracted, and tendinous where it passes over the inner head of the gastrocnemius, and then beneath the internal lateral ligament (*x*), to be inserted into the inner and fore part of the head of the tibia.

The *adductor longus femoris* (Pl. XXV. fig. 2, 12′) arises from the symphysis pubis, adjoining the pectinæus, and beneath the origin of the gracilis, fleshy, and is inserted into the inner side of the femur, from the lesser trochanter to the entocondyloid ridge, being conjoined in the lower half of its insertion with the *adductor magnus*.

The *adductor magnus* (Pl. XXV. fig. 3, 12) arises from the ramus and tuber ischii, and is inserted by a series of somewhat loose fasciculi into the inner side of the femur from below the small trochanter to the intercondyloid space.

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[1] The three muscles answering to *gluteus maximus, gluteus medius*, and *gluteus minimus*, in Man, do not present the proportions indicated by those names in any inferior animal. The property distinguishing them throughout the mammalian series is 'relative position,' conveniently indicated by the terms proposed in a former memoir, *ut supra*, p. 15.

Ectogluteus, syn. gluteus maximus.

Mesogluteus, syn. gluteus medius.

Entogluteus, syn. gluteus minimus.

The *mesogluteus* (Pl. XXV. fig. 3, 5) is a long and very thick muscle, arising from the outer side of the ilium and the fascia covering the sacrum, the fibres converging to be inserted into the upper part of the great trochanter.

The *entogluteus* arises from the lower part of the ilium and adjoining part of the ischium, to near the tuberosity, and is inserted into the great trochanter on the inner side of the *mesogluteus*. The great ischiatic nerve and artery lie between the posterior margins of these muscles. The *entogluteus* is attached to the underlying part of the capsule of the hip-joint.

The *vastus externus* (Pl. XXV. figs. 1 & 3, 17) arises from the fore and under part of the trochanter major, by a short tendon, visible on its outer side only. It rapidly swells into a large fleshy mass, forming the outer part of the thigh, and converges to a flattened tendon, which is closely blended with the capsule of the knee-joint as it passes to its insertion into the upper and outer part of the patella. It sends off no fleshy fasciculus to the *rectus femoris*, as observed by Vrolik in *Stenops*[1].

The *rectus femoris* (Pls. XXIV. & XXV. figs. 1–3, 16) rises by a strong round tendon from the upper part of the acetabulum, and by a shorter tendon (fig. 3, *b*) from the inferior spine of the ilium. The muscle becomes fleshy at the junction of these, is fusiform, the strong subdepressed tendon being inserted into the upper part of the patella.

The *vastus internus* (Pls. XXIV. & XXV. figs. 1 & 2, 18) arises from the fore part of the great trochanter, becomes attached by a fascia to the inner side of the rectus femoris, developes a slender tendon on that side, which goes to the ligamentum patellæ, and then spreads into a thin fascia attached to the inner side of the knee-joint and ligamentum patellæ.

The *cruræus* (Pl. XXV. figs. 2 & 3, 19) arises from the whole of the inner and fore part of the femur, quitting the bone only at the lower end to spread over the upper part of the capsule of the knee-joint prior to being inserted into the corresponding part of the patella. The outer division of the cruræus (fig. 3, 19') is rather a distinct muscle, which might be termed the deep-seated vastus externus: it arises from the fore and outer part of the femur to the condyloid expansion, and is inserted by a fascia into the outer part of the ligamentum patellæ and capsule of the knee-joint.

The *pectinæus* (Pl. XXV. fig. 2, 13) arises from the upper part of the pubis, near the symphysis, and is inserted below the lesser trochanter. Beneath it are strong and thick *gemelli*, converging from their origin on the anterior surface of the pubis and ischium to the interspace between the small and large trochanter.

The *gastrocnemius* (Pls. XXIV. & XXV. 27) arises by the usual outer (fig. 2, 27, *a*) and inner (fig. 2, 27, *b*) heads from the back part of the corresponding condyles, the tendons being strengthened each by a sesamoid ossification. The outer head principally receives the accession of fibres from the upper part of the fibula, called *soleus* (fig. 3, 28); after which they combine into a single mass, which becomes tendinous on the

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[1] *Op. cit.* p. 46.

outside, about halfway down the leg, but continues fleshy on the inside to near the insertion into the calcaneum. A small ‘ plantaris ’ fascicle sends its tendon by the side of the os calcis to the strong fascia covering the sole.

The *flexor digitorum longus pedis* (Pls. XXIV. & XXV. figs. 1 & 2, 32) arises from the back part of the head of the fibula and the interosseous space. It forms a flattened tendon behind the lower fourth of the tibia, which glides through a channel behind the inner malleolus, expands beneath the tarsus, gives origin to the short flexors (Pl. XXIV. fig. 1, 36), sends off a tendon (Pl. XXV. fig. 2, *m*), which is joined by a tendon (*ib. n*) from the *flexor hallucis*, to go to the second digit (*ii*); then proceeds a short way, receives a second smaller tendon (*ib. e*) from the *flexor hallucis*, and finally divides into the flexor tendons of the three outer toes. The first of the short flexor muscles (Pl. XXIV. fig. 1, 36) sends a long and slender tendon to the first phalanx of the fifth toe; the second (*ib.* 36'), to that of the fourth toe; whilst the third (*ib.* 36'') is inserted into the large and long flexor tendon continued from the muscle itself.

The *flexor longus hallucis* (Pl. XXIV. fig. 1, & Pl. XXV. fig. 2, 31) arises from the back part and inner ridge of the tibia, and from the interosseous space, halfway towards the lower end of the bone. The fleshy fibres are continued on the inner surface to the malleolar ligament; the fleshy fibres on the outer side of the muscle, much higher up. The tendon glides through the groove behind the inner malleolus, sends off a small tendon (*e*) to join the division of the general *flexor* moving the three outer digits, and then divides into the flexor tendon of the hallux (*h*) and a tendon (*n*) joining that part of the general flexor tendon from which the tendon of the second digit proceeds. Thus, the major part of this muscle expends itself upon the flexion of the ordinary toes. These junctions between the *flexores digitorum* and *hallucis* combine the two muscles in a common action of grasping; and the strength of the muscle, sending the long tendon to the hallux, gives it the requisite power of rotating the foot, through that member, in a convenient position for grasping.

The *tibialis anticus* (Pl. XXV. figs. 1 & 3, 24) arises from the upper half of the fore and outer surface of the tibia, becomes tendinous towards the lower third of the bone, glides through a pulley of the ligamentum transversum (*x*), and is inserted into the entocuneiforme.

The *peroneus longus* (Pl. XXV. figs. 1 & 3, 25) arises from the head and upper two-thirds of the outer part of the fibula and contiguous part of the interosseous fascia, becomes tendinous towards the lower fourth of the leg, passes, with the tendon of the *peroneus brevis*, in the same sheath behind the outer malleolus, diverges to the cuboid, winds round the outer part of that bone in a groove, and, crossing the bases of the three middle metatarsals, is implanted into the base of that of the hallux.

The *peroneus brevis* (Pl. XXV. fig. 3, 26) lies beneath the *peroneus longus* (*ib.* 25), arises from the lower two-thirds of the fibula, and from the aponeurotic septum between it and the *extensor digitorum* (37); its tendon passes through the same sheath, behind the outer malleolus, with that of the peroneus longus, and then through a distinct sheath on the calcaneum, above the tendon of the peroneus longus, whence it passes on to its insertion into the base of the fifth metatarsal.

The *extensor longus hallucis* (Pl. XXV. fig. 3, 39) lies behind and partly beneath the *tibialis anticus* (24), arises from the outer and fore surface of the tibia, from near the head, a short way down; converges to a tendon about the lower third of the leg, which passes through a sheath in the transverse ligament (*x*), is bound down on the tarsus by a small ligamentous sheath attached to the naviculare, and thence passes along the outer part of the phalanges of the hallux to the ungual one, into which its terminal expansion is inserted.

The *extensor communis digitorum* (Pl. XXV. figs. 1 & 3, 35) arises by a distinct head from near the head of the fibula, and by a stronger portion from the upper half of the fibula and the interosseous fascia. The tendon from the first portion divides, to be attached to the second and third toes; that from the second part of the muscle (35') passes through a distinct sheath, and divides to go to the fourth and fifth toes. Both primary tendons, before their division, are expanded upon the tarsus and partially united to each other.

The *extensor brevis hallucis* (Pl. XXV. fig. 3, 40) arises from the upper and tibial side of the calcaneum; its fleshy fibres converge as they pass beneath the tendons of the long extensor to a tendon which is attached to the metatarsal of the hallux.

There are similar but smaller short extensors (*ib.* 41) arising from the calcaneum, and inserted into the metatarsal of the second digit and that of the third digit, expanding in each upon the capsule of the joint of the first phalanx. There is a small abductor and an adductor (*ib.* fig. 2, 42) of the hallux. Interosseous muscles serve to extend and abduct the fourth and fifth digits.

§ 6. *The Brain.*

The brain of the Aye-aye, viewed from above (Pl. XXIV. fig. 3), presents an oval form, with the small and obtusely pointed end forwards; it measures 2 inches 2 lines in length, 1 inch 7 lines in greatest breadth, and 1 inch 3 lines in height. The cerebrum (*ib.* fig. 4, A) covers the olfactory lobes (*ib.* C) in front, and about one-third of the cerebellum (*ib.* B) behind. The length of the cerebrum is 1 inch 10½ lines; its breadth is 1 inch 6 lines, each hemisphere measuring 9 lines across its broadest part, which is at about the junction of the middle with the hinder third.

The hemispheres are simply and symmetrically convoluted; each shows the longitudinal fissure (2, 2), which slightly diverges from its fellow as it advances, and bifurcates,—one branch curving forward and inward, bounding anteriorly the medio-longitudinal convolution *a*; the other bending outward and downward to bound the suprasylvian convolution *b*. The length of the fissure *a*, to its bifurcation, is 1 inch; it is of moderate depth. External to it is the suprasylvian fissure (3, 3), in the form of an irregular arch:

the part of the hemisphere, viz. the 'sylvian' or 'temporal' convolution (*c*), which it defines, is indented by a short vertical fissure (6). A shallow vascular impression goes from the summit of the suprasylvian fissure towards the longitudinal one. A shallow indentation (5) divides the suprasylvian convolution (*b*, *b*) from the anterior lobe. These fissures or anfractuosities, which are very symmetrical in the two hemispheres, mark out the folds or convolutions called the longitudinal (*a*, *a*), the suprasylvian (*b*, *b*), and sylvian (*c*, *f*) convolutions, the latter terminating below in the 'natiform protuberance,' *n*. The continuation of *a* with *b* forms the hinder protuberance of the cerebrum: its inferior and internal surface is smooth and unfissured. The bifurcation of the fissure (2) marks out the anterior lobe, which is also divided by a shallow vascular groove, continued from the lower branch of fissure (2) from the fore part of the suprasylvian convolution (*b*). The anterior lobes are marked by a few feeble indentations, not symmetrically repeated, but of which one (1) seems to answer to the one so marked in the brain of the Cat. There is sufficient resemblance in the pattern of the markings of the cerebral surface of the *Chiromys* and Cat, to determine the homologous fissures and folds, and I use the same figures and letters to indicate these as in the 'Memoir on the Cheetah,' in the first volume of the 'Zoological Transactions'[1]. But, in the number and disposition of the primary convolutions and fissures, the brain of *Chiromys* most closely resembles that of *Lemur* proper[2].

The cerebellum has a large and prominent superior 'vermiform' lobe (Pl. XXIV. figs. 3 & 4, *m*), a pair of small lateral lobes (*ib.* *n*), and the 'flocculus' (*ib.* *o*). The inferior vermiform lobe (*ib.* *l*) extends beyond the superior, where it rests upon the back part of the fourth ventricle. Behind the flocculus (*o*) is the tract (*s*) where the white matter appears, and to which can be traced the 'crus cerebelli ad pontem.' The breadth of the cerebellum, including the 'flocculi,' exceeds, by about a line, that of the cerebrum: the length of the cerebellum is 9 lines; the uncovered extent is 6 lines, from the posterior border of the cerebrum.

The pons Varolii (Pl. XXIV. fig. 2, *v*) is but slightly prominent, defined anteriorly from the cerebral crura (*u*) by a feeble transverse interrupted linear groove and by the third pair of nerves (3), and posteriorly chiefly by the sixth pair (6). The basilar artery feebly impresses the middle line of the pons. The pyramidal bodies, *p*, are feebly defined, and slightly expand to their insertion into the pons, where they received the nerves of the sixth pair (6). The cerebral crura (*u*), short and thick, are divided by the infundibular fissure, in front of which is the single median mammillary body. The optic nerves (fig. 2, 2) form a chiasma of which the breadth is twice that of the length.

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[1] "Anatomy of the Cheetah," Zool. Trans. vol. i. p. 129, pl. 20. fig. 4. In this memoir, read September 1833, I published my first attempt at determining the homologous convolutions of the cerebrum, a subject which was extended in a subsequent Course of Hunterian Lectures at the Royal College of Surgeons, and illustrated by the preparations and coloured diagrams now in that Institution.

[2] See Prep. No. 9, Physiol. Series, Hunterian Museum, determined by dissection of the *Lemur mongoz* to belong to that species, in 1832, 'Physiological Catalogue,' vol. i. 4to, p. 3.

The olfactory nerves commence by a broad white tract (*e*) from the outer and under part of the sylvian fissure, from which it can be traced to the corpus striatum, and by a low grey protuberance (*i*) near the back and lower part of the hemispheric fissure. The nerve is closely connected with the under part of the anterior lobe to near its terminal expansion (c), which does not extend beyond the anterior lobes of the cerebrum.

The *corpus striatum* (Pl. XXIV. fig. 5, *s*) is 11 lines in length, and has its anterior larger rounded end closely fitting the fore part of the ventricle, which is not prolonged into a horn-shaped bend beyond it. A broad choroid plexus covered the tænia semicircularis dividing the corpus striatum from the thalamus (*t*), beyond the outer and back part of which the ventricle extended about a line backward, and then was continued with the great hippocampus downward. The posterior indent (fig. 5, *i*) is the beginning of that extension which forms the "*scrobiculus loco cornu posterioris*" of Tiedemann[1], in higher Quadrumana. There was no crenation on the convex border of the hippocampus, nor any digital eminence. In other particulars of cerebral structure and in the disposition of the cerebral nerves *Chiromys* closely agrees with *Stenops*.

There is a delicate tapetum at the back of the cavity of the eyeball. The axis of the lens is one-third its transverse diameter.

§ 7. *Digestive System.*

The Mouth.—The characters of this aperture, and of the lips, jaws, and teeth, have been already described. The symphysis of the jaw, united by ligament only, and for a limited extent, permits a slight divaricating movement of the rami with their large incisors; much less, however, than that in the Phalangers or Kangaroos. On the palate (Pl. XXIV. fig. 6), anteriorly, are three transverse ridges, slightly convex forward, progressively increasing in breadth, followed by four transverse pairs of ridges, curving more obliquely backward as they approach the pharynx. The tongue (Pl. XXIV. figs. 7, 8, 9) is rather narrow, deep, slightly expanding anteriorly, and rounded at the tip, without an intermolar rising. The free portion is short, thick, fleshy, obtuse; it projects, in the passive state, three lines beyond the apex (*ib.* figs. 8 & 9, *a*) of the sublingual plate (*b*). This body is flat, triangular or leaf-shaped, the free apex (*a*) very short: a filamentary longitudinal ridge, or *lytta*, of cartilaginous firmness, projects from the middle of the under surface. A narrow free fold of membrane (*c*) is continued backward from each side of the base of the sublingual plate to the corresponding side of the pharynx. On the dorsum of the tongue (fig. 7) the tactile papillæ are short, subobtuse, rather large for the size of the tongue, becoming larger near the fauces. About one inch and a half from the apex of the tongue are a pair of fossulate papillæ, about two lines apart.

The soft palate is a broad and deep fold overarching the root of the tongue in front of the epiglottis. The uvula is represented by a short and narrow median longitudinal

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[1] 'Icones Cerebri Simiarum, &c.' Folio. 1821.

fold, projecting from the back surface close to the margin. The tonsils (fig. 7, *c*) project as compressed processes, two lines in length, one on each side of the pharynx. The epiglottis (*ib. e*) appears as a thick, transverse, semilunar fold, slightly swollen and notched at the middle; when pressed backwards, it bridges over the anterior half of the glottis.

The back part of the beginning of the œsophagus appears to include a thick plexus of veins. The œsophagus, commencing opposite the middle cervical vertebra, passes along the middle line, immediately beneath the spine, inclining slightly to the left, where it enters the thorax; in which cavity it is continued, in the posterior mediastinum, where it lies more loosely than in Man.

§ 8. *Abdominal Viscera.*

Disposition of the Abdominal Viscera.—On exposing the abdominal cavity, the stomach (Pl. XXVI. fig. 1) was seen occupying the upper part, extending from the left to the right hypochondria. Below the left side of the stomach appeared part of the spleen (*ib. k*). Above the stomach, reaching to within half an inch of the lower margin of the ribs, was the liver, but confined to the epigastric and right hypochondriac regions. The convolutions of the intestines extended over the rest of the cavity, the large intestines occupying the lower third, and the urinary bladder, with the urachal duplicature, appearing at the lowest part.

The suspensory duplicature of peritoneum, having the remains of the umbilical vein at its free margin, enters between the fissure of the cystic lobe defining the umbilical lobule to its left, whither it is reflected from the middle line of the diaphragm. The great epiploon was packed in folds between the stomach and the mass of small intestines; it was continued from the great curvature of the stomach, and sent a process upward and forward which adhered to a notch in the border of the cystic lobe of the liver. The right kidney (Pl. XXIV. fig. 1, *k*)[1], resting on the transverse processes of the second and third lumbar vertebræ, was higher or more advanced by half its own length than the left kidney. The adrenal bodies (*ib. u*) lay upon the inner and upper ends of the kidneys.

Alimentary canal.—The œsophagus (Pl. XXVI. fig. 1, *a*), having perforated the diaphragm in the usual place and way, has a course of about a third of an inch in the abdomen before terminating at the cardiac orifice (*ib. b*) of the stomach. This orifice is situated nearer the pylorus (*p*) than to the cardiac end (*c*). The stomach (Pl. XXVI. fig. 1, *b*, *c*, *d*, *e*) is of a simple, full, subglobular form: it measures 3 inches 3 lines long, when moderately distended; 2 inches 6 lines from the cardia to the middle of the great curvature (*d*), both in a straight line; the pyloric end projects about half an inch beyond the pylorus (*p*). A narrow glistening tract of fine aponeurotic fibres (*f*) runs parallel with, and a little below, the short curvature (*g*) between the cardiac and pyloric

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[1] This figure was drawn on the stone, from the original drawing, without reversing.

orifices, and from this tract the fibres of the outer muscular layer radiate. A narrow but well-marked crescentic fold projects into the cavity from the lesser curvature, four lines to the right of the cardia, subsiding about an inch down the fore and hind walls: this fold appeared after the cavity had been fully distended, and it marks out internally the division between the cardiac and pyloric compartments. The pylorus is a subcircular aperture, above which projects a short thick longitudinal prominence.

Among the contents of the stomach were portions of a semitransparent colourless pulp, which, under the microscope, were seen to consist of hexagonal cells, combined with long fibres of a brown colour; and these, under pressure, exhibited a moniliform structure. In the cellular structure were traces of a spiral vessel. The whole was indicative of the remains of the pulp of some tropical fruit. No evidence of larvæ or other insects was observed.

The duodenum (Pl. XXVI. fig. 1, *h*), after its usual curve, crosses the spine below the root of the mesentery, then turns up the left side to commence the three principal folds of the small intestine (*i*), on the border of the mesentery, by which, with the cæcum, they are freely suspended. A duplicature of peritoneum is continued from the end of the duodenum, and from the lower part of the beginning of the colon, to the first lumbar vertebra, attaching them thereto. The colon, after a course of three or four inches, forms a long narrow fold (*ib.* fig. 2, *c*, *e*), five inches in length, then passes to the left, above and behind the root of the mesentery, and descends along the left lumbar and hypogastric regions to form the rectum.

The duodenum is about 4 lines in diameter. The length of the small intestines, when detached from the mesentery, is about 4 feet. Here and there they show slight constrictions, as at *i*, *i*, fig. 1. The length of the cæcum (Pl. XXVI. fig. 2, *f*), from the end of the ileum (*ib.* *b*), is 2 inches 7 lines. The first inch (*f*) of the cæcum is 10 lines in diameter; the rest (*g*), measuring 1 inch 9 lines in length, is 3 lines in diameter. The cæcum suddenly contracts to this dimension, and terminates rather obtusely here, resembling an appendix vermiformis; but this is not marked off by any valvular structure from the wider part of the cæcum, and it is continued, as in the human fœtus, directly from the end of the wider part, or cæcum proper.

The large intestines are about 1 foot 10 inches in length. The colon, moderately distended, is 1 inch 2 lines in diameter at its commencement, and gradually decreases in width. Beyond the first enlargements (*c*, *c*) it is not sacculated, but is slightly puckered on a longitudinal band (*x*), which may be traced a few inches from the beginning of the gut, where two or three pouch-like protrusions appear on inflation. The ileo-colic aperture is slit-shaped, bounded by two low ridges, that next the cæcum being most produced.

The contents of the colon were of a dark pultaceous character; nothing more definite could be distinguished in them than vegetable tissues like those in the stomach, but more sparing and in more minute aggregates. Both were evidences of the food supplied to the Aye-aye after its recapture.

The mesenteric gland forms a mass at the root of the mesentery, 2 inches 3 lines in length, and half an inch across its widest part.

Alimentary Glands.—The parotid gland, flattened and lobulated, has a subtriangular form, measuring 1 inch 3 lines by 1 inch, extending in front of the ear from a little above the meatus to beneath the mandible, where it comes in contact with the submaxillary gland. The parotid duct leaves the gland about three lines above the lower margin of the mandible, crosses the masseter, and penetrates the buccal membrane close to the *angulus oris*, nearer the upper than the lower molars.

The submaxillary gland is thicker, more globose in form, and more compact in texture than is the parotid; it is 10 lines in length by 5 in breadth. I neglected to trace its duct before removing the glands in dissecting the digastric and other muscles, which I much regret.

The liver, 3½ inches in breadth and 2 inches in length, consists of the usual three primary lobes, viz., the 'right,' 'cystic,' and 'left' lobes[1]. The 'right' is the smallest, and sends off a ridge-like process, representing the 'Spigelian lobule.' The 'cystic' lodges the gall-bladder in a fissure traversing a third of the length of the lobe from its free margin; and an 'umbilical lobule' is marked out on its left, by the suspensory peritoneal fold including the umbilical vein. The left lobe, which is the largest, is notched posteriorly, but otherwise is entire. The fundus of the gall-bladder makes no appearance upon the convex side of the liver. The cystic duct receives the hepatic half an inch from the neck of the bladder: the common duct, after a course of nine lines, enters the back part of the duodenum, about six lines from the pylorus.

The pancreas is a broad thin gland; it extends from the splenic vessels to the duodenum, continuing as the 'small pancreas,' a little way beyond the entry of the duct, which is close to that of the gall-duct, and here sending off numerous narrow processes into the fold of the mesentery.

The spleen is an elongated, trihedral body, bent at nearly a right angle on itself, the lower portion being nearly half the length of the upper one (*a*, *b*).

§ 9. *Respiratory and Circulating Organs.*

The glottis (Pl. XXIV. fig. 7, *g*), a slit of 6 lines in length, is bounded by slender, well-defined 'chordæ vocales' proceeding from the arytenoids (Pl. XXII. fig. 3, *t*) to the fore part of the thyroid (*ib. r*). Between these and the overlapping epiglottis (*e*) is included a large and deep pouch, from which a small median sacculus (*ib. s*) is produced between the beak of the thyroid and the thick basal attachment of the epiglottis. The thyroid cartilage (*ib. r*) is shaped like the keel-less prow of a boat, being

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[1] I adhere to the homology and nomenclature of the hepatic divisions in the Mammalia, used in my "Catalogue of the Physiological Series," Mus. Coll. Chir. 4to, vol. i. (1833) pp. 237, 238.

more than usually extended forwards and contracted. The cricoid (*ib. c*) is notched at the middle of its broad posterior part: the thyro-cricoideal space is small. Both cricoid and thyroid were partially ossified, and would probably become more so in older individuals. The thyroid gland is represented by two separate small flattened bodies, closely attached to the sides of the third to the seventh tracheal rings, inclusive. The tracheal tube (*ib. l*), about 3 inches in length, is rather flattened from before backward. The rings, about twenty-six in number, are unclosed behind; their free ends meet there, without overlapping, and, by the elasticity of the connecting tissue, can be drawn apart. The bronchial tubes are more flattened, and about 5 lines in length, before entering the lungs.

The right lung (Pl. XXII. fig. 3) is divided into three lobes (*ib. f, g, h*), with the lobulus impar (*ib. i*). The latter is grooved interiorly by the great post-caval vein, or inferior vena cava, and extends from the pleural space to the middle of that vein. The middle lobe is the smallest, and lies anterior to the interspace of the other two; it is trihedral, and, as it were, pendunculate, swelling out after its origin. The left lung is divided into two (*ib. m, n*) lobes, the lower being the largest, and notched near its lower end.

The heart is rounded, subdepressed, with an obtuse apex. The arteria innominata gives off both carotids and the right subclavian, then the left subclavian. The aorta, bending over the left bronchus, takes the usual course through the thorax into the abdomen. Here it gives off the gastric (Pl.XXIV. fig. 1, *g*), the mesenteric (*ib. m*), and the renal (*ib. r*) arteries, which ascend obliquely to the kidneys. About an inch below the renal are sent off the spermatic arteries (*ib. s*); below these is the inferior mesenteric (*ib. i*). One inch and a half below the renal arteries, the aorta divides into the common iliacs (*l*) and the caudal artery (*t*). The mesenteric artery, first describing one large arch, next gives off a series of smaller secondary arches, from which the branches proceed directly to the intestine. The artery to the mesocolon is a branch of the mesenteric. The mesocolic artery forms two small arches at the base of the fold of the colon, and gives off the vessels to the rest of that intestine, without any anastomotic arches. The axillary artery (Pl. XXII. fig. 2, & Pl. XXIII. fig. 1, *x*) is continuous, from the subclavian to the brachial (*ib. r*), as a single tube, not broken up into numerous small branches as in the slow Lemurs. This was the case in both the upper limbs of the Aye-aye, in which a variety was observed in the giving off of the ordinary branches. In the right arm, the brachial artery gave off the superior profunda (Pl. XXII. fig. 2, *o*), the inferior profunda (*u*), and the anastomotica magna (*s*), with the medullary nutrient artery and small muscular twigs. In the left arm, the brachial sent off the radial artery (Pl. XXIII. fig. 1, *d*) from about the middle of its course, which, after distributing a muscular branch to the biceps, passed over the bend of the elbow-joint to its usual position by the side of the supinator longus (23). In both arms the brachial artery was continued as an undivided trunk to the entocondyloid foramen, through which it passes along with the median nerve (*m*). The iliac artery (Pl. XXIV. fig. 1, *l*), in like manner, is continued into the femoral (*ib. f*) as a simple undivided tube: it sends off the internal iliac (*n*) at the usual place. The posterior tibial artery is the only one which shows any disposition to break up or quickly divide into a number of small branches; these are distributed chiefly to the muscles arising from the long tendons, or other parts, as flexors or adductors of the toes.

§ 10. *Renal Organs.*

The right kidney (Pl. XXIV. fig. 1, *k*), situated as before described, is higher by half its own length, than the left (*ib. m*)[1]. The right kidney is 12 lines, the left one is 11 lines in length, the latter being the broadest, viz. 9 lines, with proportionate thickness. The cortical part (Pl. XXIV. fig. 10, *e*) is about 2 lines in thickness: the tubuli of the 'medullary' part (*m*) converge to a single short obtuse papilla (*p*). The ureters (*ib.* fig. 11, *u*) have the usual course and termination in the urinary bladder (*ib. b*). The renal arteries ascend obliquely to reach the pelvis of the kidney. The adrenals (supra-renal bodies, Pl. XXIV. fig. 1, *u*, *u*), proportionally larger than in the larger Quadrumana, correspond in general shape with the kidneys; but the right is narrower in proportion to its length.

The urinary bladder (Pl XXIV. fig. 11, *b*) is of a longish oval form; when moderately distended, it measures about 1½ inch in length and an inch in diameter. The ureters terminate in the usual oblique manner in the neck of the bladder.

§ 11. *Generative Organs.*

The testes are lodged in a sessile scrotal prominence on each side, and a little below the base of the penis. Their vaginal tunic communicates by a contracted aperture with the peritoneal cavity, into which they cannot be returned, but are permanently external to it.

The vasa deferentia (Pl. XXIV. fig. 11, *v*) take the usual course to the neck of the bladder, and become slightly enlarged above their entry into the notch of a flattened heart-shaped prostate. There are no vesiculæ seminales. The prostate gland (*ib. p*) is 5 lines in length by 4 in breadth, slightly concave on the broader posterior surface which is applied to the rectum. The two anterior surfaces meet at an open angle, along the middle of the fore part. The muscular part of the urethra, beyond the prostate, is 7 lines in length: along each side of it is a flattened oval gland (*ib. w*) 6 lines by 4 lines, slightly concave behind and convex in front; these answer to 'Cowper's glands.' Their ducts penetrate the back part of the bulb. This part of the urethra is 6 lines long by 3 in breadth, surrounded by an 'accelerator muscle' of half a line in thickness: the spongy structure of the bulb is exposed at *l*. The corpus cavernosum has a distinct septum, with a thick ligamentous capsule, as is shown in the section of the penis (*ib.* fig. 12). The 'erectores' (*ib.* fig. 11, *e*, *e*) have the usual origin

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[1] The mirror was not used in engraving the drawing, and the right and left sides are reversed in the Plate.

and attachments. There is also a pair of strong ‘levatores penis,’ arising from the fascia crossing the vena dorsalis, and inserted by a common tendon into the ossiculum penis.

§ 12. *Comparison of the External Characters and Dentition.*

In deducing the natural affinities of *Chiromys* from the ordinary zoological or external characters, and commencing by a comparison of its general form and proportions, I find its nearest resemblance to be to the Malmags (*Otolicnus*, Illig., *Galago*, Geoffr.) amongst the *Lemuridæ*; especially to the species called ‘Great Galago’ (*Otolicnus crassicaudatus*) from the south-eastern part of Africa, and to the ‘Black Galago’ (*O. alleni*) from Fernando Po. There is the same general character of the pelage, with the long hairy tail, and the same degree of liberation of the limbs from the trunk; the same breadth of head and large naked ears; but, in the shortness of the muzzle, the *Tarsius*, perhaps, more resembles the *Chiromys*. The proportionate length of the digits of the hand is almost the same; but the third digit is much more slender in *Chiromys*. The hallux of the foot has the flat nail as in all the Lemurs, with the strength and opposable position of that member; but the four unguiculate toes are more nearly of the same length in *Chiromys*; and the tarsal segment is as short as in *Lichanotus* and *Lemur* proper. Although the muzzle is deeper and less pointed than in the *Lemuridæ*, conformably with the large bent incisors and their sockets, it is less deep and is much shorter than in any Rodent, in which order the eyes are placed further back, and are lateral, the premaxillaries being larger and longer, and the whole head being compressed in the Rodents. The nostrils are more terminal in *Chiromys*, and are but partially, instead of being wholly lateral as in Rodents. The upper lip is not bifid as in Squirrels, nor curved downward and backward to cover the lower scalpriform teeth as in most Rodents. Although the mouth is less cleft than in the Lemurs, it is more so than in any Rodent of the same size, and the hairs are not extended upon the inner surface of the angle of the mouth. In *Tarsius* there are fasciculi of few and long vibrissæ, from the exterior of the lips and eyebrows, almost as in *Chiromys*.

The trunk is broader, less arched, and larger in the chest than in most Rodents; and the pelage of the Aye-aye has not the uniform, close-set, shining character as in that order.

In all Squirrels, the under part of the tail presents an almost naked narrow mid-tract, from which the long hairs diverge: the Aye-aye resembles the Malmags in their growth uniformly from the whole circumference of the tail.

In proceeding to a comparison of the locomotive members of the Aye-aye, we obtain an instructive test of the relative value of digital and dental characters in determining the ordinal affinities of a Mammal. Had the limbs only of the Aye-aye first reached the zoologist, it can scarcely be doubted but that the same conclusion of their being those of a Lemur would have been arrived at, as was expressed by the name applied to the Aye-aye by the naturalists (Schreber, Illiger) who guided themselves by the characters of the locomotive organs in the ordinal grouping of the mammalian class. The fore limbs and hind limbs have the same difference of length, and the same general proportions to the trunk, in *Chiromys* as in *Galago*. The fingers of the hand—long, slender, sub-nude, freely divergent from their metacarpal articulations—have also nearly the same proportional length, one to the other, in *Chiromys* and *Galago*. The superior length of the fourth finger, which begins, in the descending order of Quadrumana, to be manifested in *Ateles*, is general in the *Lemuridæ*, *Tarsius* being an exception, and reaches its maximum in the Aye-aye. The inferior length of the index, slightly manifested in *Ateles*, is more marked in most *Lemuridæ*, as it is in *Chiromys*; but amongst the slow Lemurs it is carried to the extent of malformation, as, *e. g.*, in *Perodicticus*.

Although in many Rodents, and especially in the Squirrels, the fore toes have considerable mobility, they are but four in number, the thumb being a mere vestige: they are more parallel, in their usual position; they are shorter in proportion to the hand or limb, are thicker, and more hirsute. The pollex in *Chiromys* has the same degree of opposability as in other *Lemuridæ*: it is shorter, but thicker than the other fingers, especially at the last segment. The extent of the naked palm is another lemurine or quadrumanous character. The attenuated mid-digit is a curious speciality of the Aye-aye. Even in this, perhaps, may be discerned an affinity to the nocturnal *Lemuridæ*, in which the hand is the seat of other extreme varieties. In *Perodicticus*, for instance, the index is reduced to its metacarpal, first phalanx, and a vestige of its second phalanx, which forms an unarmed tubercle, as if the finger had been there amputated: in *Chiromys* the medius seems to be atrophied, though retaining its length and normal joints.

The hind feet of *Chiromys* are strictly 'pedimanous,' while their secondary modifications best accord with the lemurine pattern of the grasping foot. The extent of the naked sole, the long and narrow tarsus, the thick, terminally enlarged thumb, with its flat nail, all proclaim that affinity; the difference from other *Lemuridæ* being only shown by the more nearly equal length of the four unguiculate toes.

The Aye-aye has a pair of nipples situated one on each side the umbilicus, but on a rather lower level, as in the Tarsier; but there is no trace of a pectoral pair in addition to the ventral pair. The Rodents have three or more pairs of nipples.

Even in regard to the dentition, some very significant approximations to the Rodent-like type in *Chiromys* are offered by the *Lemuridæ* among the Quadrumana. Thus, in the Indris (*Lichanotus*) the lower incisors are reduced to a single pair; and, of the two pairs above, the anterior pair is the longest. In the Tarsiers, also, where a single pair of lower incisors is opposed to two pairs above, the foremost of them is conspicuously the longest, even longer than the canine. In *Propithecus diadema*, Bennett, the first incisor much exceeds the lateral one in size.

The well-marked division of the upper incisor of the Aye-aye into an anterior thicker enamelled portion and a posterior suddenly narrow portion, might suggest the idea of its being the homologue of two incisors blended together; but the larger anterior incisor in *Propithecus*, usurping nearly the whole of the premaxillary, gives the truer view of the nature of the scalpriform pair in *Chiromys*.

The single pair of large inferior incisors, associated, as they are, with the pollicate foot in the Aye-aye, reminds one of the mandibular dentition and feet of the Phalangers; and if such an approach to the Rodent type be made by these pedimanous marsupials without masking their true lyencephalous affinities, as little need it prevent a recognition of the Lemurine nature of the *Chiromys*, where a single pair of upper scalpriform incisors is also paralleled by the marsupial Wombat, which offers the same extreme modification of the dentition of its group,—a relation which Cuvier seems to intimate by associating the skulls of the two 'anomalous' quadrupeds on the same plate of the 'Règne Animal.'

The incisors, although by their size, curvature, depth of implantation, and structure they most closely resemble the scalpriform teeth of the Rodents, yet they are much narrower in proportion to their depth, or fore-and-aft diameter, than in any known Rodent. In this compressed character they more resemble the first upper incisors of *Propithecus*, Benn., and the canines of *Lemur* proper: the shape of the inserted part of the crown is much more laniariform than scalpriform. Nevertheless they are true incisors, like those in *Phascolomys*, but have less resemblance to those of Rodents than in that marsupial. In both the Wombat and the Aye-aye the exposed parts of both upper and lower incisors project more forward, and meet each other more obliquely, than in the true Rodents, in which their direction is more vertical. The molar teeth, on the other hand, oppose each other more vertically than in the Rodents, and show no inclination to the outward bend of the upper and the inward one of the lower molars, so common in that order. The molar teeth, by their simple coronal cap of enamel, depart still more from the complex Rodent type of these teeth, and manifest their essentially quadrumanous nature. Like *Stenops*, *Otolicnus*, and *Tarsius* amongst the *Lemuridæ*, they are more numerous above than below, in the adult Aye-aye—a difference which is rare and exceptional among the *Rodentia*. Their fewness and smallness is a speciality in *Chiromys* among the *Lemuridæ*. The soft, nutritious, readily masticable nature of the food of the *Chiromys* is indicated by their small size and simple obtuse crowns. A reference to the excellent account of the skull and dentition of *Chiromys*, given by De Blainville in his 'Ostéographie,' will show that I have reproduced most of the comparisons which were there first urged in support of its Lemurine affinities. The opportunity of examining a fœtal or very young Aye-aye is much needed to determine the fact of rudimental transitory teeth, between the retained incisors and molars[1].

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[1] The interesting observation by Prof. Gervais, cited at p. 57, had not come under my notice when the above passage was in type: it still leaves the uterine and milk stages of dental development to be determined.

§ 13. *Comparison of the Skeleton.*

The number of the 'true' vertebræ, and of each of their three kinds (*c* 7, *d* 13, *l* 6=26) in *Chiromys*, agrees with that in *Lemur*, *Tarsius*, and *Sciurus* (as exemplified by *Sc. bicolor*): this, indeed, is a common formula in ordinary quadrupeds. But both in the *Lemuridæ* and *Sciuridæ* there are great differences: in *Stenops tardigradus*, *e. g.*, the formula is *c* 7, *d* 16, *l* 8=31; and in a large flying Rodent (*Anomalurus pelii*) it is *c* 7, *d* 15, *l* 10=32.

The affinities of *Chiromys* are shown rather by the structure of the vertebræ. In the agile Squirrels, which, on the ground, progress by bounds with considerable flexure of the spine, such action is indicated by the much stronger inclination of the vertebral spines before and behind the eleventh dorsal, towards that centre of the spinal inflexions, than is seen in *Chiromys*. The diapophysis, moreover, is distinctly developed on the vertebra, *e. g.* the ninth dorsal in *Sciurus bicolor*, the tenth in *Anomalurus*, where the combined met- and an-apophyses form the ridge above it; and the diapophysis continues to be distinctly developed in the succeeding vertebræ, in which both the metapophysis and anapophysis have become distinct, as is the case in most, if not all Rodents: whereas in *Chiromys*, as in other Quadrumana, the diapophysis is suppressed, or nearly so, in the last two dorsal vertebræ in a degree which is misleading, and has misled, in the attempt to determine the homologies of the lumbar transverse processes. These processes in the *Sciuridæ* are longer and more inclined forward than in *Chiromys* and the *Lemuridæ*. The pleurapophysial parts of the cervical transverse processes are more developed in the 3–6 cervical vertebræ in *Sciuridæ*—the axis is longer in proportion to the atlas—than in *Chiromys*.

The chevron-bones (hæmapophyses) are two in number in the caudal region, and are confined to the interspaces between the third and fourth, and fourth and fifth vertebræ in *Chiromys*; they are similarly restricted in number and position in the long-tailed *Lemuridæ*: in the Squirrels and other long-tailed Rodents the hæmal arches may be traced along a much longer proportion of the caudal region.

In comparing the skull of the Aye-aye with that of a Squirrel or other Rodent of equal bulk of body, the first great distinction is shown by the superior size, both absolute and relative, of the brain-case; especially in the part due to the size and convexity of the parietal and frontal bones; making the region, which is low and flat in the *Sciuridæ*, an expanded convex dome in the Aye-aye. The foramen magnum is relatively larger to the cranial cavity in Rodents than in the Aye-aye; it is also vertical in position, looking directly backward; and the superoccipital does not bulge out beyond and behind it, as in *Chiromys*, in which the plane of the foramen is turned as much downward as in other *Lemuridæ*. The cranial vertebræ follow each other in a more straight line, in Rodents; which, with the position of the occipital condyles and aspect of the foramen magnum, causes the premaxillary end of the skull to be on nearly the same line as the cervical axis in the ordinary position of the head. The alisphenoids do not reach the parietals in *Rodentia*, but they rise to the height of the squamosals for that purpose in the Aye-aye, as in most Quadrumana. In the *Chiromys* the bony frame of the orbit is entire; in the Rodents it is widely incomplete behind; and, in the species where a postorbital process is present, it ends in a free point. In the complete circumscription of the rim of the bony orbit, *Chiromys* exemplifies its quadrumanous affinity; whilst it shows the special family to which in that order it belongs, by the deficiency of the wall partitioning the orbital from the temporal cavity. The Lemurs, in this defect, indicate the transition to the lower unguiculate Gyrencephala, the *Galeopithecus* offering the last step by the incompleteness of the orbital frame-ring behind. The outlook of the orbits, obliquely forward, upward, and outward, but least so in the last direction, differs significantly from the direct outward aspect of those cavities in most Rodents. The paroccipital projects freely in *Sciuridæ* and other Rodents; in some, as in the Capybaraand Coypu, to a great length. The zygomatic part of the squamosal begins in the Aye-aye at the lambdoidal ridge and extends forward; in Rodents it begins much in advance of that ridge, and inclines downward before bending forward. The malar bone by its width and depth, expanding the orbit by its outer convexity, and uniting behind with the frontal as well as with the squamosal, speaks for the Lemurine and against the Rodent affinities of *Chiromys*: but, as in other *Lemuridæ*, it does not join the alisphenoid, as it does in higher Quadrumana. The posterior plate of the squamosal is long and narrow in Rodents, clamping the tympanics and mastoids to the sides of the cranium; no approach to this character is seen in *Chiromys.* The facial plate of the maxillary in Rodents is either almost used up by a large antorbital vacuity (*Anomalurus*), or if entire, as in *Sciurus*, is scooped by a deep vertical channel. In *Sciurus bicolor* the maxillary as well as the premaxillary joins the broad frontal; in *Anomalurus pelii* a larger lacrymal is interposed, as in *Chiromys*; but no Rodent shows the lacrymal fossa and foramen on the facial plate, external to the rim of the orbit, as in *Chiromys*: this is a very significant mark of the close affinity of this genus with the *Lemuridæ*, in which the entry of the lacrymal canal is external to the orbit. The interposition of the premaxillary between the nasal and maxillary is one of the most marked differences in the skull between *Chiromys* and other Quadrumana; its agreement in this respect with Rodents depends upon the anomalous development of the incisors. The nasal septum is continued almost to the hinder opening of the nasal passages in *Chiromys* as in *Lemuridæ*, but is far from reaching that orifice in the *Sciuridæ*. The pterygoid processes of the alisphenoid show no trace, in *Chiromys*, of the canal for the ectocarotid, so general in *Sciuridæ* and other families of *Rodentia*.

Viewing the Aye-aye as among the lowest forms of Quadrumana, it is interesting to find a reappearance of the frontal sinuses which the highest of that order exhibit, but which are wanting, as a rule, in the intermediate series, from the Apes to the normal *Lemuridæ* inclusive. The maxillary series of sockets converge more or less anteriorly in all Rodents,—least so, perhaps, in *Sciurus*; but there is no such convergence in *Chiromys.* The diastema is chiefly in the maxillary, and is sharp, in *Chiromys*; it is chiefly in the premaxillary, and is smooth, broad, and convex, in *Rodentia.* In this order the squamosal is peculiar for its length, its straight upper border, and the detachment of the zygomatic process from the fore part of the outer side; it forms a deep longitudinal groove for the mandibular condyle, and does not anchylose with the petro-tympanic element. None of these characters are shown in the squamosal of the Aye-aye, which conforms with that in the *Lemuridæ*, and more especially departs from the Rodent type in the broad flat articular surface for the lower jaw; but this has no posterior ridge. A well-ossified palate is an exception in the *Rodentia*, and the *Sciuridæ* show best that exception; but in these the prepalatine or incisive vacuities are longer than in *Chiromys*, and the postpalatine notch is deeper: in the breadth of the bony palate the Squirrels come nearest to the Aye-aye.

The mandibular condyle in *Chiromys* approaches the form of that in *Rodentia* by the superiority of its fore-and-aft over its transverse diameter; but, in its oval convexity, it resembles more nearly the condyle in *Tarsius* than that of any Rodent. In all Rodents the condyle of the mandible is higher than the level of the grinders; the angle of the jaw is produced backwards beyond it; the long and narrow coronoid process curves back to nearly the same vertical line with the condyle. The symphysis reaches the lower border of the ramus, and the curved incisive socket projects more or less from the inner surface. All these Rodent characteristics of the mandible are wanting in *Chiromys.* In certain *Lemuridæ* (*Stenops*, *Lichanotus*, Illig., *Propithecus*, Bntt.) the angle of the jaw is rounded off; but it is nearly on a vertical line with the condyle: its advanced position in *Chiromys* is a speciality in the Quadrumanous series. It is one which leads it still further from the Carnivora; and the sessile condyle contrasts strongly with the pedunculate one, especially in the small extinct Ferines (*Plagiaulax* and *Triconodon*) of the Purbeck beds: a concomitant difference being shown in the dentition: trenchant teeth, grooved as in the lower carnassials of *Thylacoleo*, hold the place of the thick flat-crowned molars of *Chiromys.*

The scapula of *Chiromys* differs from that of Rodents, and resembles that of Lemurs, in the proportions of the supra- and infra-spinal fossæ. The subscapular surface does not show the intermuscular cristæ which are usually so well marked in Rodents. The lower border, though well everted, has less the character of a second spine than it shows in the Squirrels.

The perforation above the internal condyle of the humerus is the rule in the *Lemuridæ*; it is the exception in the *Rodentia.* The perforation between the condyles is common in the *Rodentia*[1]; it is not present in the *Lemuridæ.* In the foregoing comparison the humerus of *Chiromys* agrees with that in the *Lemuridæ.* In its relative length to the

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[1] The intercondyloid perforation, without the supracondyloid one, occurs in *Leporidæ, Capybara, Cavia, Dolichotis, Chinchilla, Lagotis, Myopotamus, Cœlogenys, Dasyprocta, Hystrix,* and *Arvicola.* The supracondyloid

thorax, for example, the humerus of *Chiromys* agrees with that shown by *Lemur* and *Nycticebus*: in *Sciurus* and most Rodents the humerus is relatively shorter; only in the volant *Pteromys* and *Anomalurus* the humerus differs as much, or more, by its greater length, as it does in *Galeopithecus*, from that in *Chiromys*. The straight outline of the deltoid ridge in the Aye-aye's humerus is a Lemurine feature: its lower part projects and forms an angle in *Sciurus*. The configuration of the elbow-joint is more Lemurine than Sciurine in *Chiromys*.

The Aye-aye resembles the *Lemuridæ* and Platyrhine Quadrumana in the complexity of its carpal structure,—the 'intermedium,' sometimes described as a dismemberment of the scaphoid, sometimes as that of the magnum, being present, together with the accessory scapho-trapezial sesamoid; but the scaphoid shows the proportion in respect of length whereby the *Lemuridæ* more resemble, than do other Quadrumana, the Carnivora. The Squirrels (*S. bicolor*, e. g.) have the intermedium and the accessory sesamoid; but the scaphoid and lunare are confluent: other Rodents depart further from the Lemurine type of carpus which *Chiromys* exemplifies.

The pelvis of the *Chiromys*, in the ilio-vertebral and ilio-pubic angles, in the degree of expansion of the fore part of the ilium, in the smoothness of its outer surface, and in the moderate development of the ischial tuberosities, closely accords with the Lemurine type. It strongly departs from the Rodent type in the ilio-pubic angle, which in the Squirrels is 145°, in the Aye-aye 110°. The iliac bones, moreover, in most Rodents are bent outwards at their summits, which are thickened and tuberous, and the outer surface is bisected by a longitudinal ridge. On the other hand, the ischial tuberosities do not bend out in Rodents, as in *Chiromys* and the Quadrumana. The obturator foramina are relatively larger in *Rodentia* than in *Lemuridæ* or in *Chiromys*.

The femur, equalling in length the last ten true vertebræ, offers, in *Chiromys*, a proportion to the trunk more common in *Lemuridæ* than in *Rodentia*. In the Squirrels, for example, the femur is relatively shorter to the trunk, and the ridge for the ecto-gluteus projects as a third trochanter. In most Rodents the lower extremity of the femur is less expanded, comparatively, with the shaft than in *Chiromys*, where the femur closely repeats the proportions and formal characters of that in *Lemur* proper.

The tibia, by its near equality of length with the femur, instructively proclaims the quadrumanous nature of *Chiromys*: in most Rodents, and especially those with long hind limbs, or when these have the same proportion to the trunk as in *Chiromys*, the leg is longer than the thigh, usually in a well-marked degree. The fibula is more slender in proportion to the tibia in the Squirrels and other Rodents, where it is a distinct bone, than in the Aye-aye and *Lemuridæ*; it is also situated more posteriorly: in most Rodents it anchyloses with the tibia.

Amongst the pentadactyle Rodents, the Squirrels most resemble the Aye-aye in the

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perforation, without the intercondyloid one, is found in *Sciurus, Pteromys, Myoxus, Anomalurus, Helamys*, and *Dipus*. Both perforations are wanting in *Castor* and *Arctomys*.

structure and proportions of the tarsus; but the inner part of the naviculare, which articulates with the backwardly produced angle of the ento-cuneiforme, is a distinct bone in *Sciurus* as in other pentadactyle Rodents: in *Castor* the dismembered part of the naviculare articulates with a larger proportion of the ento-cuneiforme, and there is a second accessory ossicle on the radial side of the tarsus. But the size, shape, and position of the articular surface for the hallux still further differentiate the ento-cuneiforme in *Chiromys* from that in any Rodent, relating as it does to the capital distinction of the opposable hinder thumb, which unites the Aye-aye with other Quadrumana. In the relative length of the tarsus to the leg and to the rest of the foot, the *Chiromys* most resembles *Lichanotus* and *Propithecus*: it is rather shorter than in *Lemur* proper, being less than one-third the length of the tibia, and only about one-fourth the length of the whole foot. The scaphoid and calcaneum are proportionally rather shorter than in *Lemur* proper or *Perodicticus*, Btt. The bones figured as tarsal ones of the Aye-aye in De Blainville's 'Ostéographie' (*Lemur*, pl. 5) do not belong to that animal: the calcaneum and naviculare exhibit the excessive length characteristic of *Tarsius* and *Otolicnus*[1], and agree in size, as do likewise the tibia and fibula of the same plate, with those bones in *Otolicnus crassicaudatus*, Wagn.[2] The sum of the osteological comparisons favours the affinity of *Chiromys* with the *Lemuridæ*, and with that section having the less elongate tarsus.

Comparison of Muscles.—Although, in a comparison of the Quadrumana with their conterminous Gyrencephalous order, the Carnivora, the size and distinctness of the clavicular portion of the *sterno-cleido-mastoideus*, in *Chiromys*, shows its resemblance to

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[1] *Otolicnus crassicaudatus*, Wagner, or 'Grand Galago,' of which Cuvier figures the skin in his 'Règne Animal,' ed. 1817, pl. 1. fig. 1, from which specimen the bones, supposed to belong to the Aye-aye, had probably been taken; and it might be from the examination of this very specimen that Cuvier was enabled, for the first time, to make known that, "Dans les Tarsiers et les Galagos, les os *scaphoïde* et *calcaneum* sont prolongés de manière à donner à leur tarse autant de longueur qu'à celui de certains oiseaux."—'Ossemens Fossiles,' 4to, tom. iii. p. 508 (1822.)

[2] [Prof. Gervais, of Montpellier, having visited the British Museum since the first sheets of the present memoir went to press, I communicated to him my suspicion as to the origin of the tarsal bones figured by De Blainville as those of the Aye-aye, in his 'Ostéographie des Lemurs,' pl. 5, and requested him to oblige me by inspecting the stuffed specimens of the Aye-aye and Galago on his return to Paris. The following is the reply with which I have been favoured by the accomplished Professor:—

"MON CHER CONFRÈRE,—C'est hier seulement que j'ai pu vérifier dans les galeries du Muséum de Paris le point relatif à l'Aye-aye que vous m'aviez indiqué. Je n'ai malheureusement pas pu retrouver le tarse figuré dans l'Ostéographie, et que M. Laurillard supposait provenir de l'Aye-aye; mais une patte postérieure de la même espèce, tirée du sujet donné à la collection par M. de Castelle, ne laisse aucun doute. Comparée à la figure publiée dans le Fascicule des Lémurs, elle montre des différences analogues à celles que vous m'avez vous-même fait remarqué. J'ai examiné ensuite, ainsi que nous en étions convenu, la peau bourrée de l'exemplaire de Sonnerat. Les deux pattes de derrière n'ont point été touchées, et leurs parties osseuses, les deux tarses compris, y sont encore en place. Il n'en est pas de même du *Galago crassicaudatus*; l'individu encore unique que l'on a conserva, et qui est celui décrit par G. Cuvier et E. Geoffroy, n'a plus son tarse gauche, quoique les phalanges et les métatarsiens du même côté soient restés dans la peau, et que la patte droite soit absolument the Quadrumana; yet, as the difference depends on the non-claviculate character of the Carnivora, a remnant only of the clavicular strip of the muscle being present in those with small free clavicular bones, as the *Felines*, and being wanting in those without clavicles, we cannot derive the same evidence of the ordinal relations of *Chiromys* when we extend the comparison to the myology of those of the Lissencephalous group which have complete collar-bones. In the Squirrels, *e. g.*, a clavicular strip exists, which differs from that of *Chiromys* only in its minor relative size to the sternal portion. The well-developed *digastricus*, with its distinct intermediate tendon, is a more decisive mark of the Lemurine affinity of *Chiromys*, as against the Rodents. In the muscles of the jaw of *Chiromys*, although the masseter has unusual thickness and strength, it retains the character of that muscle in the Quadrumana, and there is no trace of the peculiarly distinct oblique strip, described as an accessory masseter, in the *Rodentia*,—especially in those with the large antorbital vacuity. In the muscles of the limbs, especially in the tendinous strip uniting the flexor sublimis and flexor profundus muscles for a partially associated action, the Aye-aye resembles the *Tarsius* dissected by Burmeister, the *Stenops* dissected by Vrolik, and the *Perodicticus* dissected by Van der Hoeven.

Comparison of the Brain.—The brain of the Aye-aye, by the proportion and relative position of the cerebrum to the cerebellum, and by the fissures and folds of the cerebral surface, determines *Chiromys* to be a member of the wave-brained section of Mammalia, *Gyrencephala*; and in that section it most resembles, in the number and disposition of the primary convolutions of the cerebrum, as well as in general shape and proportions, the brain of *Lemur* proper. The brain of the little Tarsier (*C. tarsius*), whilst exhibiting the more constant and essential gyrencephalous character, as do other diminutive species, in the extension of the cerebrum over the cerebellum, shows an almost entire absence of superficial fissures. In that of the *Tarsius* figured by Burmeister [1], the fore part of the sylvian fissure and the short vertical fissure in the sylvian fold are all the traces of convolutions which are indicated. In the brain of the Javanese Slow Lemur (*Stenops javanicus*), described and figured by Schroeder Van der Kolk and Vrolik, the sylvian fissure extends to the upper surface of the cerebrum; the Aye-aye, in this respect, being intermediate between *Stenops* and *Tarsius*. The sylvian fold, in *Stenops*, is also indented by the vertical fissure, which is more wavy than in *Chiromys* or *Tarsius*; but the suprasylvian and medio-longitudinal fissures are wanting in *Stenops* as in *Tarsius*. *Stenops*, however, shows the bifurcate anterior ends of the medio-longitudinal fissure, and a transverse

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intacte. Il est évident qu'on en a retiré, après l'empaillage, le tarse aujourd'hui manquant, et tout fait supposer (je ne puis dire atteste, parceque la pièce n'est pas sous mes yeux, et qu'il ne subsiste aucune note au sujet de cette opération) que le tarse figuré comme étant celui de l'Aye-aye est bien, comme vous l'avez supposé, le tarse du *Galago crassicaudatus*.

"J'ai pensé que ces détails vous feraient plaisir, et je vous les communiquer immédiatement.

"Croyez à mon entière considération et à mon affectueux dévouement, votre très-empressé,

"Paris, 28 Octobre, 1862." "Paul Gervais."]

[1] *Op. cit.* p. 30, pl. 1. figs. 1–4.

curved fissure near the back part of each hemisphere, answering to that marked 7, in the brain of the Cat, in my memoir on the Cheetah[1], which is wanting in *Chiromys*. The side of the anterior lobe in *Stenops* appears to have a deeper and better-marked vertical fissure, curved with the convexity forward: a few shallow linear indentations mark the sides of the narrower anterior lobes in *Chiromys*. This animal, therefore, like the Mongoz Lemur, associates with its superiority of size over *Stenops* and *Tarsius* a more regular and complex folding of the cerebral superficies.

In the Squirrels the cerebral hemispheres are devoid of convolutions, and do not extend over the cerebellum; and in the few larger *Rodentia*, as, *e. g.*, *Agouti*[2], *Capybara*, in which any fissuring of the cerebral surface appears, it is as a feeble trace of the medio-longitudinal fissure, and is associated with the depressed form and small proportion of the cerebrum characteristic of the Lissencephalous group. By the brain alone *Chiromys* is proved to be no Rodent, but might be recognized as a true Gyrencephale, and, in that category, as having its nearest affinity with the *Lemuridæ*.

In the absence of the digital eminence and in the restricted development of the back part of the lateral ventricle, *Chiromys* resembles *Stenops*: its brain shows no indication of the linear fissure produced backward from the beginning of the descending horn, which Burmeister figures in the brain of *Tarsius*[3].

The 'flocculus cerebelli,' into which Foville traced the origin of the acoustic nerve, is present in most of the timid and sharp-eared Rodents; but it is likewise present in the *Stenops* and *Tarsius*[4], and is associated, as its presumed function might lead one to suspect, with the large external ears and well-developed auditory organ of *Chiromys*.

The rhinencephala, or olfactory bulbs, project in advance of the prosencephala in all Rodents; and this appears likewise to be the case with the *Tarsius*; but *Chiromys* agrees with the higher *Lemuridæ* and Quadrumana in the production of the anterior cerebral lobes above the olfactory lobes.

The Viscera.—In the following comparison of the internal abdominal and thoracic organs of the Aye-aye, I shall restrict myself to the Quadrumanous and Rodent orders, and herein to the Lemurine and Sciurine families respectively. In both these families the large obtuse blind end of the stomach projects far to the left of the cardia; this orifice and the pylorus are approximated; and the 'lesser curvature' is accordingly very short. But the stomach of the Aye-aye more resembles that of *Stenops* than of *Sciurus*; the œsophagus is less prolonged in the abdomen than in the Squirrels and most Rodents.

The cæcum presents a point of greater contrast between the Lemurs and the Squirrels. In the latter this gut is very long, is narrowest where the ileum enters, and increases to its blind end, which is thick and obtuse; most of the cæcum exceeding in width the rest of the large intestines. In the Lemurs the widest part of the cæcum is where the

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[1] *Op. cit.* pl. 20. fig. 4.

[2] Prep. No. 1323 G, Physiol. Series, Hunterian Collection; Physiol. Catalogue, vol. iii. p. 29.

[3] *Op. cit.* taf. 6. fig. 15.

[4] *Ib.* figs. 13, 16.

ileum enters, and it diminishes in diameter to the blind end, and, in most, rather suddenly about halfway thereto, which has led to the comparison of the cæcal half to the 'appendix cæci,' especially of the human fœtus[1]. In the characters of the cæcum, the Aye-aye strongly manifests its Lemurine affinities: this gut is scarcely one-fifth the length of the body from the muzzle to the tuber ischii, whilst in the Grey Squirrel the cæcum is half the length of the body. In this Rodent the large intestines are twice the length of the body, but they are only one-fourth longer than the body in the Aye-aye.

The small intestines are rather more than three times the length of the body in the Aye-aye, while in the young Squirrel they are seven times the length of the body.

The divisions of the liver are at, or nearly at, right angles to the surface of the gland in the Aye-aye, as in the Lemurs; in the Squirrel they are oblique and deeper, the left lobe covering almost all the others.

The tongue becomes a good test of affinity, owing to its well-marked characteristics in the Rodents and Lemurines respectively. The Squirrels, like other Rodents, have a short tongue, thick vertically, and especially between the molar teeth, where the dorsum rises above the tip, forming the 'intermolar lobe,' which commonly bears the impress of the palatal furrows.

In the Aye-aye there is no structure like this: the tongue is thickest transversely, has a longer portion free, and, above all, it is characterized by the sublingual firm plate, corresponding in general form and structure with that in other *Lemuridæ*[2].

The small median supra-thyroid laryngeal sacculus is an indication of the quadrumanous nature of *Chiromys*.

In the vascular system, the disposition of the great veins entering the heart affords a test of the affinities in question. In the *Sciuridæ*, as in most other Rodents, the left trunk of the jugular and subclavian veins passes down the back part of the auricle to enter close to the orifice of the post-caval vein: in the Aye-aye, as in the *Lemuridæ* and all Quadrumana, that venous trunk crosses the fore part of the arteries rising from the aortic arch to join the corresponding trunk on the right side and to form a true 'pre-caval' vein.

The organs of generation are important indications of natural affinity in the Mammalian class, more especially the male organs, of which the sex of the Aye-aye dissected

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[1] "The cæcum is long, and terminates almost in a point, and looks like the appendix cæci in the human, especially the appendix in the fœtus."—Hunter, 'Posthumous Essays and Observations on Natural History, Anatomy,' &c., 8vo, 1860, vol. ii. p. 33 (*Stenops gracilis*). Schroeder Van der Kolk and Vrolik have made the same comparison. "Mais il est bon d'observer que chez l'enfant en bas âge et chez les anthropomorphes l'appendice vermiforme ressemble assez au prolongement en pointe du cæcum chez le *Stenops*" ('Recherches d'Anatomie Comparée, sur le genre *Stenops*,' p. 50).

[2] Hunter, in *Lemur mongoz*, L.:—"The tongue has a part underneath in shape like a bird's tongue, so that it might be called double-tongued" (*op. cit.* vol. ii. p. 29). See Hunterian Preps. Physiol. Series, Mus. Coll. Chir., Nos. 1516, 1517, and 1518; Physiol. Catal. 4to, vol. iii. (1836) pp. 83 and 84; Burmeister, in *Tarsius*, *op. cit.* 1846, p. 104. pl. 6. fig. 2; Van der Kolk and Vrolik, in *Stenops*, *op. cit.* p. 52. pl. 1. fig. 5 *b*.

by me permits this application. In all Rodents the peritoneal opening of the serous sac of the testis is so wide, and the cremaster so large and so disposed, that the gland can be withdrawn into the abdomen, and it emerges into a temporary sessile scrotum only under the seasonal enlargement for procreation, which is considerable. Thus, the *Rodentia* are ‘temporary testiconda.’ The Aye-aye has not this organization: the testes are permanently ‘scrotal’ after their passage out of the abdomen.

The Squirrels, like other *Rodentia*, have distinct ‘vesiculæ seminales’ with thick glandular coats: in the *Leporidæ* the vesicula is single, but large. The absence of distinct vesicular bag or bags in the Aye-aye removes it from the *Rodentia*, whilst the size and shape of the prostate[1] and of Cowper's glands approximate it to the *Lemuridæ*.

More decisive testimony is given by the penis. The Squirrels and all *Rodentia* are ‘retromingents,’ the penis being bent back suddenly upon itself, with the ‘glans’ lying in a prepuce which opens close to the anus. In the Aye-aye, as in the *Lemuridæ* and other Quadrumana, the preputial sheath of the penis projects freely forward to the extent signified by the Linnean character ‘pendulous,’ applied to the ‘Primates’ generally in the ‘Systema Naturæ.’

§ 14. *Conclusion.*

The pressure of daily duties and engagements has prevented my further unravelling the structure of this little denizen of the woods of Madagascar. I should otherwise gladly have pursued the investigation to a degree of completeness more nearly approaching that of which Burmeister has left so admirable an example in his ‘Beiträge zur nähern Kenntniss der Gattung *Tarsius*,’ 4to, 1846. Believing, however, that the main points required for determining the moot relationship of *Chiromys* to the Mammalian orders had been looked to, I felt it due to zoologists to submit the results to their judgment, without further delay.

The first and, to my mind, most congenial reflection that arose on the survey of these structures was their adaptive relations to the known way of life and favourite kind of food of the Aye-aye.

This quadruped is stated to sleep during the heat and glare of the tropical day, and to move about chiefly by night.

The wide openings of the eyelids, the large cornea and expansile iris, the subglobular lens and tapetum, are arrangements for admitting to the retina, and absorbing, the utmost amount of the light which may pervade the forest at sunset, dawn, or moonlight. Thus the Aye-aye is able to guide itself among the branches in quest of its hidden food. To detect this, however, another sense had need to be developed to great perfection. The large ears are directed to catch and concentrate, and the large acoustic nerve and its ministering ‘flocculus’ seem designed to appreciate,

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[1] Hunter, in *Stenops gracilis*:—“The prostatic glands are two at the basis [or the gland is left there], like the heart on playing-cards.” (See Prep. Phys. Ser. Mus. Coll. Chir. No. 2564; Physiol. Catal. vol. iv. p. 101.)

any feeble vibration that might reach the tympanum from the recess in the hard timber through which the wood-boring larva may be tunnelling its way by repeated scoopings and scrapings of its hard mandibles. How safe from bills of birds or jaws of beasts might seem such a grub in its teak- or ebony-cased burrow! Here, however, is a quadrumanous quadruped in which the front teeth, by their number, size, shape, implantation, and provision for perpetual renovation of substance, are especially fitted to enable their possessor to gnaw down, with gouge-like scoops, to the very spot where the ear indicates the grub to be at work. The instincts of the insect, however, warn it to withdraw from the part of the burrow that may be thus exposed. Had the Aye-aye possessed no other instrument—were no other part of its frame specially modified to meet this exigency—it must have proceeded to apply the incisive scoops in order to lay bare the whole of the larval tunnel, to the extent at least which would leave no further room for the retracted grub's further retreat. Such labour, however, would have been too much for the reproductive power of even its strong-built, wide-based, deep-planted, pulp-retaining incisors: in most instances we may well conceive such labour of complete exposure of the burrow to be disproportionate to the morsel so obtained. Another part of the frame of the Aye-aye is, accordingly, modified in a singular and, as it seems, anomalous way, to meet this exigency. We may suppose that the larva retracts its head so far from the opening gnawed into its burrow as to be out of reach of the lips, teeth, or tongue of the Aye-aye. One finger, however, on each hand of that animal has been ordained to grow in length, but not in thickness, with the other digits: it remains slender as a probe, and is provided at the end with a small pad and a hook-like claw. By the doubtless rapid insertion and delicate application of this digit, the grub is felt, seized, and drawn out. But, for this delicate manœuvre the Aye-aye needs a free command of its upper or fore limbs; and, to give it that power, one of the digits of the hind foot is so modified and directed that it can be applied, thumb-wise, to the other toes, and the foot is made a prehensile hand. Hereby the body is steadied by the firm grasp of these hinder hands during all the operations of the head, jaws, teeth, and fore paws, required for the discovery and capture of the common and favourite food of the nocturnal animal.

Thus we have not only obvious, direct, and perfect adaptations of particular mechanical instruments to particular functions,—of feet to grasp, of teeth to erode, of a digit to feel and to extract,—but we discern a correlation of these several modifications with each other, and with modifications of the nervous system and sense-organs—of eyes to catch the least glimmer of light, and of ears to detect the feeblest grating of sound,—the whole determining a compound mechanism to the perfect performance of a particular kind of work[1].

[1] The Superintendent of the Zoological Gardens communicated to the Zoological Section of the British Association at Cambridge, October 3rd, the fact that the Aye-aye then living in the Zoological Gardens refused the mealworms, weevils, and other insects which had been offered to it for food. A repudiator of the principle

But all this must have a cause; and our sole guide to a conception of its nature is the analogical connexion of its effect with that of the exercise of faculties which energize in our own intellect. Such energy, by way of foresight, invention, and adaptation, has produced many machines for useful ends; and so, through study of analogous but more perfect results, we seem to discern the exercise of like faculties in a transcendently higher degree.

To conceive the direct formation and adjustment of such an organization as the Aye-aye's to its purpose accords best with, and comes most home to, the mode of our finite human adaptive operations. And here Paley and the pure teleologist would pause. But I would next remark that we further discern the higher marvel of such a correlated organic machine being capable of reproducing itself by the act of generation. That act premised, Aye-aye after Aye-aye becomes what it is, through progressive growth and development, from the condition of a minute pellucid monadiform cell. The whole of its exquisitely adjusted structure is built up according to law. Still more marvellous, and almost transcending our scope of thought or power of clear conception, is the possibility of such organic mechanism, with its faculty of reproduction, being the necessary, but not the less fore-ordained, result of the nature and adjustment of influences forming part of the general system of our planet, with its varied forces, acting and reacting under certain conditions so as to issue in such a result.

Some minds, indeed, lose their hold of the notion of design in passing beyond the conception of a direct act of the Designer in the formation of an organic and self-reproductive machine. Yet the idea of a forecasting, designing Power is not incompatible

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of final causes thereupon objected to the evidences of adaptation above cited, which I had previously communicated to the Section, "that they could have no such meaning, inasmuch as the Aye-aye would not feed on insects." I replied that the fact communicated by Mr. Bartlett received, and could only receive, its true explanation through teleology. The native habits and food of the Aye-aye exemplified its operation and purpose in the woods of Madagascar as a check upon the undue prevalence of tree-destroying Xylophagous larvæ. Had the Aye-aye possessed an indiscriminate appetite for insects, it would satisfy such appetite on much easier terms than by gnawing into hard wood for a particular kind of grub. But, as M. Liénard had testified, before Mr. Bartlett, "il ne voulait pas de larves de tous les arbres indistinctement; il les reconnaissait en les flairant." The restriction of its likings to the wood-boring kinds ensured, and was necessary to ensure, the application to their extraction of the efficient instruments with which the Aye-aye had been endowed for the purpose. Thus teleology renders the fact of the non-indiscriminate taste for insects intelligible: the negation of intention and design blinds the mind to the recognition of the significance of the fact, and leads to the more stupid blindness to any meaning in the coadjustment of special modifications which render the Aye-aye so effective an antagonist to the wood-boring larvæ of the forests it inhabits.

The great Anteater, when in captivity at the Zoological Gardens, refused to feed upon the ants which were offered in abundance to it. Their pungent formic acid seemed to disgust the animal. It was, in fact, adapted to keep in check insects of another order—the destructive *Termites*. And, in their dearth, it was kept alive, during its captivity, on milk, yolk of egg, and boiled liver chopped small. But it was not, therefore, concluded that the long tongue, huge salivary glands with their bladders, correlatively modified toothless jaws, gizzard, powerful claws, &c., were of no special use—were devoid of any explanation on the principle of design and adaptation.

with the conception of the constitution of an organized species by the operation of forces and influences which are part of the ordained system of things; and if the nature of such operation be not comprehended, it, at least, may be a legitimate subject of an endeavour at comprehension. The human intellect has power so to conceive the relations of numbers as to give expression to such conception, for example, by the terms of the 'Binomial Theorem'; and successive mathematicians concur in accepting and using the theorem as the true expression of such cognition. As the human intellect has been framed by its Author, it could not otherwise best express such numerical relations; and this impossibility of any other relation between the conception and expression of the theorem may be stated in terms not unusual with the old scholastic disputants, but jarring against later and better taste, viz. that "God himself could not abrogate such necessary result of the necessary relations of numbers."

And, nevertheless, that result may be, and by the healthy human mind, in careful thought, is felt to be, a high act of creative power; and the appreciation of its necessity is an endowment which engenders in such mind a spirit of grateful devotion.

So, also, conditions of existence have a creative cause, as well as the animals related to those conditions. Constructed as we find them, animals are necessarily so related, and must be affected by every change in such conditions.

But if we can conceive such conditions to change agreeably with the laws of their being,—the crust of the earth, *e. g.*, having been created to move up and down, affecting its relations to water, air, temperature, and other circumstances influencing living beings,—these beings and their dwelling-place having been created as they are, with such interdependencies, the changes are necessary, may be called fatalistic, and yet are not the less a preordained result of the Creator of the arrangements, foreseeing the consequences of a long-continued series of operations and influences, educing new adjustments and developments out of efforts and exercises of organs stimulated by surrounding changes, or out of slight departures from parental form; which change of organs by change of exercise, and which congenital deviations or varieties, were equally a fore-ordained property of the living species.

Whether such considerations be evidence of careless thinking, and whether, as some affirm, they blot God out of creation[1], may be left to the judgment of sound and unbiassed intellects.

The adaptation of the earth to our well-being, by its waters and lands, with localized coal, chalk, &c., through secondary causes which have developed the present varied condition of its surface by means of slow physical and organic operations through long

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[1] On the appearance of the work in which I first expressed the opinion that the "orderly succession and progression of organic phenomena were the result of natural laws or secondary causes," whilst admitting ignorance of their nature or mode of operation ('Nature of Limbs,' 8vo, 1849, p. 86), I was assailed as follows:—"But it is not German Naturalists alone who are contributing to diffuse scientific Pantheism. We have in England an anatomist and physiologist, Richard Owen, who, in a lecture on the 'Nature of Limbs,'

ages, is not the less clearly recognizable as the act of all-adaptive Mind, because we have abandoned the old error of supposing it to be the result of a primary, direct, and sudden act of creational construction.

So neither would the phenomena of the long succession of organized species justify the notion, nor do I believe they would suggest, that they were the result of blind chance, if it should be demonstrated that they, too, are the result of secondary influences operating through long ages. It may be true that many of the aims of derivative tendencies miss their end: but myriads of germs never reach perfection; and the proportion of such short-coming is much greater in the phenomena of human life. These serve to exemplify abundantly in how small a degree the doings of the highest created agent here square with the ideal of the aim and end of his existence: yet he is not, therefore, argued to be a thing of chance. The succession of species by continuously operating law is not necessarily a "blind operation." Such law, however dimly discerned in the properties and successions of natural objects, intimates, nevertheless, a preconceived progress. Organisms may be evolved in orderly succession stage after stage, towards a foreseen goal; and the broad features of the course may still show the unmistakeable impress of divine volition.

But the conception of the origin of species by a continuously operative secondary cause or law is one thing; the knowledge of the nature and mode of operation of that cause is another thing.

One physiologist may accept, another refute or reject, a transmutational or natural-selective hypothesis; and both may equally hold the idea of the successive coming-in of species by law[1].

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which was delivered at the Royal Institution in February last, and has since been published, brings all his profound scientific knowledge and demonstrative skill in support of what is called the 'Theory of Development.' This theory, as our readers may know, assumes that God did not interpose to create one class of creatures after another, as a consequence of each geological revolution; but that, through long course of ages, one class of creatures was developed from another." The writer then quotes from the lecture to show that its author "concludes that God has not peopled the globe by successive creations, but by the operation of general laws." ('Little Lectures on Great Topics,' *Manchester Spectator*, December 8, 1849.)

The true state of the case is simply this: my assailant has his own notions of the exterminating character "of each geological revolution," and of the way in which "God, thereupon, interposed to create one class of creatures after another." But there are phenomena which God, in His unsearchable ways, permits to be known by His observant instruments; and these phenomena, faithfully interpreted, plainly indicate that He has been pleased to operate differently from what some prefer to believe. Thereupon the interpreter is charged with "blotting God out of creation." But in such charge truly lies the impiety. Could the pride of the heart be reached whence such imputation came, there would be found, unuttered,—"Unless every living thing has come to be in the way required by my system of theology, Deity shall have no share in its creation."

[1] No relaxation is more agreeable to the inductively drudging mind than an occasional release from the trammels of fact, to soar in the regions of conjecture, and indulge in easily feigned creative ways and means. Those who yield least to this enjoyment respect most the workers who refrain; whilst he who most hastily and clamorously welcomes each new phase of the hypothesis-inventing faculty is apt to be least charitable

What I have termed the 'derivative hypothesis' of organisms, for example, holds that these are coming into being, by aggregation of organic atoms, at all times and in all places, under their simplest unicellular condition; with differences of character as many as are the various circumstances, conditions, and combinations of the causes educing them,—one form appearing in mud at the bottom of the ocean, another in the pond on the heath, a third in the sawdust of the cellar, a fourth on the surface of the mountain rock, &c., but all by combination and arrangement of organic atoms through forces and conditions acting according to predetermined law. The disposition to vary in form and structure, according to variation of surrounding conditions, is greatest in these first-formed beings; and from them, or such as them, are and have been derived all other and higher forms of organisms on this planet. And thus it is that we now find energizing in fair proportions every grade of organization from Man to the Monad. Each organism, as such, also propagates its own form for a time under such similitude as to be called its kind.

Specific characters are those that have been recognized in individuals of successive generations, propagating similar individuals, as far back as observation has reached; and which characters, not being artificially produced, are ascribed to nature. Instead of referring such characters to an originally distinct creation, the derivative hypothesis, whilst admitting their transmissibility and their maintenance for an unknown period through generative powers obstructive of departure from such characters, holds that observation has not yet reached the actual beginning of such species, nor the point at which variation stops.

Now, the foregoing hypothesis is at present based on so narrow and, as respects the origin of life, so uncertain a foundation of ascertained facts[1], that it can be regarded only as a kind of vantage-ground artificially raised to expand the view of the outlooker for the road to truth, and perhaps as supporting sign-posts directing where that road may most likely be fallen in with.

In the meantime different hypotheses, guesses, and beliefs have been propounded in explanation of the way of the origin of species. And the Aye-aye lends itself with advantage as a test of some of these.

Buffon assumes the direct or immediate primitive creation of a certain number of organic forms, which may truly and intelligibly be called 'types.' These, left to the

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to his more cautious or reticent fellow-labourers. But I would offer this consolation to those whom Professor Grant stigmatizes as "species-mongers" ('Tabular View of the Primary Divisions of the Animal Kingdom, &c.,' 8vo, 1861, p. vi.):—for all the intents and purposes of the descriptive and recording naturalist, species are constant; they will last our time. When the existing binomial units of botanical and zoological specific lists cease to show their present distinctive characters, the *Homo sapiens* of Linnæus will have merged into another, probably a higher, specific form.

[1] Annales des Sciences Naturelles, 1861, p. 33 (Pasteur); *ib.* 1862, p. 277 (Pouchet; able in refutation of objectors to Heterogeny, and full of resource in its support).

operation of secondary laws in a 'world accursed,' have had degenerate successors; and the departures from type, varying according to the diversity of deteriorating influences, are represented by the majority of the naturalist's species of the present day. Applying his principle to those he had treated of in his great 'Histoire Naturelle[1],' Buffon believed that he was able to reduce them to fifteen primitive stocks. The theory of 'degeneration' assumes a course of change inversely to that of 'derivation'; which, moreover, rigidly excludes the operation of any cause, not in the actual category of powers, of the origin of the parent forms of organic beings. I will not occupy time in attempting to show how the 'degeneration-hypothesis' could have operated in producing the various remarkable correlated structures in the organization of the Aye-aye: it might have been regarded by Buffon as a primitive type, or an 'isolated form.'

According to the modifying influences suggested by Lamarck, a Lemurine quadruped, attracted by the noise of a boring caterpillar in the bough on which it happened to be perched, instinctively applied its incisors to the bark, and, by frequent repetition of such efforts, increased the mass of the gnawing muscles; which, stimulating the growth of the bone, led to concomitant modifications in the size and proportion of the jaws. The incisors, by repeated pressure, either became welded into a single pair above and below; or, the stimulus to excessive growth being concentrated on one incisor, the neighbouring teeth became atrophied by disuse, and by derivation of their nutrient fluid to the contiguous pulp; hence the preponderating size of the pair of front teeth, and the extent of edentulous space behind them. Concomitantly with the efforts excited by the particular larvivorous tendency of a certain Madagascar Lemur to expose the canal in which its favourite morsel lay hidden, were repeated endeavours to poke the longest finger into the burrow so laid open. The repeated squeezing of the soft skin, with the compression of the nerves and vessels, permanently affected the growth of such digit, and kept it reduced to the blighted state, whereby it happens to be suited to the work of extracting the larva. Lamarck supposes all these changes to be gradual, and effected only through long succession of generations; he assumes that changes of structure, due to habitual efforts and actions, are transmissible to offspring; and he finally invokes, like his successors, the requisite lapse of time and long course of generations. It is to be supposed that, until the modifications of dental and digital structures were brought about, the grub-hunting Lemur subsisted on the necessary proportion of fruits and other food more readily obtainable under the ordinary Lemurine conditions of existence.

That the same finger should be the seat of the wasting influences on both hands, and in all Aye-ayes, strikes one as a result hardly to be looked for on the hypothesis of the cause of such specific structures propounded by Lamarck: that there should be a modification of the muscles of the forearm, whereby both *flexor sublimus* and *flexor profundus* combine their action upon the same tendon, pulling the probe-

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[1] Tome xiv. p. 311.

like digit, is left unaccounted for. The physiologist finds still more difficulty in accepting the explanation of the way in which the peculiar conditions of the incisors could be brought about. The action of muscles pressing upon the bony sockets might affect the growth of teeth filling such sockets, but could not change a tooth of limited growth, like the incisors of an ordinary Lemur, into a tooth of uninterrupted growth. Besides, the crowns of both the scalpriform incisors of the *Chiromys* and the ordinary small incisors of other Lemurines are formed according to their specific shape and size before they protrude from the gum. They acquire so much development while the animal still derives its sustenance from the mother's milk. In the Aye-aye the chisel or gouge is prepared prior to the action of the forces by which it is to be worked. The great scalpriform front teeth thus appear to be structures fore-ordained—to be predetermined characters of the grub-extracting Lemur; and one can as little conceive the development of these teeth to be the result of external stimulus or effort, as the development of the tail, or as the atrophy of the *digitus medius* of both hands. I have, on a former occasion, tested the Lamarckian hypothesis of transmutation by the phenomena of the dentition of the male Gorilla[1], and have not yet seen a refutation of my argument. A strong superorbital ridge may project, as an occasional variety, in Man; and may be supposed to exemplify the way in which, on the degeneration-hypothesis, Man might sink into the Ape. But such a fact in no way affects the physiological conclusions against the Lamarckian doctrine of transmutation.

There remains, then, to be seen whether the subsequently propounded hypothesis of 'natural selection' will afford us a better or more intelligible view of the origin of the species called *Chiromys madagascariensis*.

I may remark, on the outset, that this hypothesis differs from Lamarck's in invoking a supernatural commencement of organisms which are held to have been "descended from some one primordial form, into which life was first breathed"[2]. And herein is one main distinction between it and the 'derivative hypothesis,' which maintains that single-celled organisms, so diversified as to be relegated to distinct orders and classes of *Protozoa*, are now, as heretofore, in course of creation, or formation, by the ordained potentiality of second causes; with innate capacities of variation and development, giving rise, in long course of generations, to such differentiated beings as may be distinguished by the terms 'plant' and 'animal;' from which all higher animals and plants have, through like influences, ascended, and are being ascensively derived. This, as the naturalist knows, is mere hypothesis, at present destitute of proof. But it is more consistent with the phenomena of life about us, with the ever-recurring appearance of mould and monads, and with the coexistence, at the present time, of all grades of life rising therefrom up to Man, than is the notion of the origin of life which is propounded in Mr. Darwin's book 'On the Origin of Species by Natural Selection.'

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[1] Trans. Zool. Soc. vol. iii. p. 381, and vol. iv. p. 175. See also 'Classification of the Mammalia,' 8vo, 1859, p. 101.

[2] Darwin, 'On the Origin of Species,' p. 414.

Applying to the Aye-aye the illustration of his hypothesis, as submitted by Mr. Darwin to the Linnean Society[1], it may be admitted that the organization of a Lemur, feeding chiefly on fruits or birds, but sometimes on grubs, is, or might become, slightly plastic, in the sense of being subject to slight congenital variations of structure. We may, also, suppose changes to be in progress in the woods of Madagascar, causing the number of birds to decrease, and the number of insects to increase, especially of those the larvæ of which are xylophagous. The effect of this might be that the Lemur would be driven to try to catch more grubs. His organization being slightly plastic, those individuals with the best hearing, the largest front incisors, and the slenderest middle digit, let the difference be ever so small, would be to that extent favoured, would tend to live longer, and to survive during that time of the year when birds or fruits were scarcest; they would also rear more young, which would tend to inherit these slight peculiarities. Were the Lemurs to be reduced to this insect-food, those individuals less plastic than the incipient Aye-aye, or not varying in the same way, would become extinct.

The varieties of condition of the human mind are manifold, and may be exemplified by the fact that there are some with modes and habits of thought which lead them to entertain no more doubt that such causes, in a thousand generations, would produce a marked effect upon the Lemurine dentition and limbs, adapting the form and structure of the Quadrumane to the catching of wood-boring grubs instead of birds, than that any domesticated quadruped can be improved by selection and careful breeding; whilst to other minds the propounding of such plastic possibilities leaves no sense of any knowledge worth holding as to the origin of the species called *Chiromys madagascariensis*, no help to the conception of such origin which is at all equivalent to so wide a departure from actual experience of facts. We know of no changes in progress in the Island of Madagascar, necessitating a special quest of wood-boring larvæ by small quadrupeds of the Lemurine or Sciurine types of organization. Birds, fruits, and insects abound there in the ordinary proportions; and the different forms of *Lemuridæ* coexist, with their several minor modifications, zoologically expressed by the generic terms *Lichanotus*, *Propithecus*, *Chirogaleus*, *Lemur*, and, we may now confidently add, *Chiromys*.

That organic species are the result of still operating powers and influences is probable, from the great palæontological fact of the succession of such so-called species from their first appearance in the oldest-known fossiliferous strata: it is the more probable, from the kind and degree of similitude between the species that succeeds and the species that disappears, never to return as such; the similitude being, in the main, of a nature expressed by the terms of "progressive departure from a general to a special type." Creation by law is suggested by the many instances of retention of structures in palæozoic species which are embryonal and transitory in later species of the same order or class; and the suggestion acquires force by considering the analogies which the transitory embryonal stages in a higher species bear to the mature forms of lower

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[1] Proc. Linn. Soc. August 1858, p. 49.

species. Every new instance of structures which do not obviously, and without straining, receive a teleological explanation, especially the great series of anatomical facts expressed by the "law of vegetative or irrelative repetition,"—all congenital varieties, deformities, monstrosities,—oppose themselves to the hypothesis of the origin of a species by a primary or immediate and never-repeated act of adaptive construction.

Such series of facts, with those treated of in my works 'On the Homologies of the Vertebrate Skeleton' and 'On the Nature of Limbs,' appear to me to be the chief grounds in zoological science for the hypothesis of a continuously operative secondary creational law. That this law works by derivation of one species from a previous species, of a new from an old species, is made probable by the demonstrated unity of plan in the Articulate and Vertebrate types of organization, and by the approximations to such unity of type in the molluscous and some lower forms of organized beings. The phenomena of parthenogenesis have made known unexpected and strange instances of great degrees of difference of form between the self-subsistent independent generative product and the producing organism. But the "derivative hypothesis" is, at present, as I have already admitted, little more than an indication of a route of research by which the mode and way of derivation may be ultimately better understood.

The terms in which the zoologist would express the sum of the observations above recorded on the Aye-aye would be, "that it was related by affinity to the *Quadrumana*, and by analogy to the *Rodentia*."

And such terms become intelligible if they mean that the Aye-aye has been derived, in common with other existing *Lemuridæ*, from some pre-existent animal of a more generalized Lemurine type of organization, in departing from which it has gained a character, *e.g.* the dental one, very like that which prevails in the *Rodentia*, without losing the more numerous and essential characters of its inherited Lemurine organization.

The terms in which the anatomist would express the sum of his observations on the structural resemblances traceable from the Aye-aye throughout the *Lemuridæ* would be, that the principle of 'unity of organization' prevailed through such group.

And such term would have a more intelligible meaning on the hypothesis that these singularly diversified Lemurs were genetically related by descent from a common ancestral form.

Whilst admitting the general evidence, therefore, in favour of 'creation by law,' I am compelled to acknowledge ignorance of how such secondary causes may have operated in the origin of the *Chiromys*. Darwin seems to be as far from giving a satisfactory explanation of them as Lamarck.

One discerns in the *Lemuridæ*, if we therein include the *Galeopitheci*, such a range of variety in their dentition as suggests the idea of instability of character, or of unusual plasticity, in that part of their organization.

The varieties of the limbs, also, as manifested by the long ankle-bones of *Otolicnus* and *Tarsius*, by the reduction of the index to a stump in *Perodicticus*, and by the atrophy of the medius in *Chiromys*, in like manner indicate a tendency to deviate from type in the hands and feet of this Quadrumanous family.

Why the forefinger in both fore limbs should have been, as it were, amputated—reduced to a short stump—in one kind of *Stenops*, and why it should be much shorter than usual in others, is not intelligible in reference to any known use or peculiar application of the upper hand in that kind of Slow Lemur.

The purpose of the probe-like middle finger is more readily discerned in the Aye-aye. The function of the large comb-like lower incisors in *Galeopithecus*, and that of the gouge-like strong incisors of *Chiromys*, have received explanation. Some might discern, in the greater length of the middle upper incisor of *Propithecus* and *Tarsius* as compared with that of the lateral incisor, and the reduction of the lower incisors to a single pair, a step in the transition from the Lemurine type of dentition to the extreme modification of that type in *Chiromys*. But all the surmises and guesses as to the conditions of such changes, all the attempts to explain how they were brought about—if they have been brought about—by still operative causes, are inadequate and unsatisfactory.

The real knowledge which we possess of the *Chiromys* is limited to certain particulars of form, structure, habits, relations of structure thereto, likeness and unlikeness to other creatures, and geographical limitation. Far be it from me to imply that zoology may never know more than the nature and relations of the animal as it now exists.

Although one of the greatest intellects has warned us of the futility of our finite endeavours to penetrate the mystery of the beginning of things, the attempts to dissipate that which still enshrouds the origin of species cannot but be fraught with collateral advantages to zoological science.

DESCRIPTION OF THE PLATES.

PLATE XIV.

Female Aye-aye (*Chiromys madagascariensis*, Cuv.), half the natural size: from the animal living in the Gardens of the Zoological Society, October 1862.

PLATE XV.

Male Aye-aye, from the specimen transmitted, in spirits, by Dr. Sandwith, C.B., in the attitude of exposing the burrow of its favourite larval food : half the natural size.

PLATE XVI.

Front view of the same specimen : half the natural size.

PLATE XVII.

Back view of the same specimen: half the natural size.

PLATE XVIII.

View of the head in profile, and of the fore limbs, of the male Aye-aye: natural size.

PLATE XIX.

Skeleton of the male Aye-aye: natural size. The letters and numbers are explained in the text.

PLATE XX.

Skull, Teeth, and Hyoid Arch of the Male Aye-aye.

Fig. 1. Upper surface of skull.
Fig. 2. Under surface or base of cranium.
Fig. 3. Upper view of mandible.
Fig. 4. Front view of skull.
Fig. 5. Upper view of cranial cavity.
Fig. 6. Side view of cranial and nasal cavities.
Fig. 7. Inner side of mandibular ramus.
Fig. 8. Teeth of left maxilla (upper jaw), *in situ*, with roots exposed.
Fig. 9. Outer side of mandibular ramus, with the base of incisor exposed, and the three molars added above, with the roots exposed.
Fig. 10. Grinding surface of upper and lower molars of the right side: magnified.

In the figures showing the teeth,—*i*, incisor; *e*, enamel; *d*, dentine; *p*, pulp; *p* 4, last premolar, fourth of the typical series, retained in the upper jaw; *m* 1, first molar; *m* 2, second molar; *m* 3, third molar.

Fig. 11. Malleus: natural size.
Fig. 12. Incus: natural size. Figures of these 'ossicula auditus,' magnified, are given below.
Fig. 13. Side view of hyoid arch: 41, basihyal; 40, epihyal; 33, ceratohyal; 38, stylohyal; 46, thyrohyal.

The following are the parts indicated by letters in the figures of the skull:—

a. Precondyloid foramen.
b. Jugular foramen.
c. Internal auditory foramen.

d. Tympanic cavity, exposing co-articulated parts of malleus and incus.
e. Appendicular fossa.
f. Foramen ovale.
g. Foramen rotundum.
h. Foramen opticum.
i. Olfactory fossa, with cribriform plates.
j. Sinus frontalis.
k. Pituitary fossa.
l. External auditory foramen.
m. Entocarotid foramen.
n. Pterygo-palatine foramen.
o. Incisive foramen.
p. Vomerine fissure.
q. Sinus sphenoidalis.
s. Naso-maxillary foramen.
t. Dental foramen.
u. Mental foramen.
v. Antorbital foramen.
x. Condyloid process
y. Angular process } of mandible or lower jaw.
z. Coronoid process

PLATE XXI.

Fig. 1. Atlas vertebra, front view.
Fig. 2. Atlas vertebra, back view.
Fig. 3. Atlas vertebra, side view.
Fig. 4. Axis vertebra, front view.
Fig. 5. Axis vertebra, side view.
Fig. 6. Cervical vertebræ, side view.
Fig. 7. Fourth lumbar vertebra, upper view.
Fig. 8. Fourth and fifth lumbar vertebræ, side view.
Fig. 9. Sacrum, upper view.
Fig. 10. Five first caudal vertebræ, upper view.
Fig. 11. Sternum and clavicles, front view.

In the foregoing figures:—*a x*, hypapophysis of atlas; *c a*, centrum of atlas, anchylosed as the 'odontoid process' with—*c x*, centrum of axis; *n*, neural arch; *n s*, neural spine; *d*, diapophysis; *pl*, pleurapophysis; *m*, metapophysis; *a*, anapophysis; *z*, zygapophysis; *h*, hæmapophyses.

Fig. 12. Right scapula, coracoid, and clavicle; front view.

Fig. 13. Right scapula, inner view.
Fig. 14. Left humerus, front view.
Fig. 15. Left humerus, back view, with lower articular surface beneath.
Fig. 16. Upper ends of right radius and ulna, side view.
Fig. 17. Lower ends of right radius and ulna, with bones of hand.
Fig. 18. Carpal bones.
s, scaphoid ; *i*, intermedium ; *l*, lunare ; *c*, cuneiforme ; *p*, pisiforme ; *t*, trapezium ; *z*, trapezoïdes ; *m*, magnum ; *u*, unciforme.
Fig. 19. Right os innominatum, side view.
Fig. 20. Ossa innominata, front view.
Fig. 21. Upper end of left femur, front view.
Fig. 22. Bones of the right foot.
Fig. 23. Portion of tarsus of *Otolicnus crassicaudatus* ; from De Blainville, 'Ostéographie des Primates' (*Lemur*, pl. 5).
s, naviculare ; *a*, astragalus ; *d*, calcaneum ; *i*, entocuneiforme ; *m*, mesocuneiforme ; *e*, ectocuneiforme ; *b*, cuboïdes.

(All the figures are of the natural size.)

PLATE XXII.

Fig. 1. Superficial muscles of neck and fore limb.
Fig. 2. Axillary and brachial artery *in situ*.
Fig. 3. Larynx, trachea, and lungs.

(Natural size: the letters and figures are explained in the text.)

PLATE XXIII.

Fig. 1. Deep-seated muscles of arm, with the axillo-brachial artery, and origins of muscles of the forearm.
Fig. 2. Superficial muscles of the fore limb, outer and back view.
Fig. 3. Flexor sublimis perforatus.
Fig. 4. Flexor profundus perforans.

PLATE XXIV.

Fig. 1. Renal and adrenal organs *in situ* ; abdominal aorta and its primary branches ; superficial muscles of the hind limb, inner and plantar view (the drawing has been engraved without the use of the mirror).
Fig. 2. Brain, base view.
Fig. 3. Brain, upper view.

Fig. 4. Brain, side view.
Fig. 5. Brain, with prosencephalic or 'lateral' ventricle exposed.
A, cerebrum; B, cerebellum; C, rhinencephalon; *a*, longitudinal convolution; *b*, suprasylvian convolution; *c*, sylvian convolution; *m*, upper vermiform lobe of cerebellum; *n*, lateral lobe; *q*, appendicle; *o*, flocculus; *p*, pyramidal tracts: *n*, fig. 2, natiform protuberance; *u*, crus cerebri; *v*, pons Varolii.
Fig. 6. Palatal ridges and grinding surface of the upper teeth.
Fig. 7. Tongue, fauces, pharynx, and glottis.
Fig. 8. Under surface of the tongue, showing the 'lytta' or sublingual plate, *a*, *b*.
Fig. 9. Side view of the tongue and sublingual plate.
Fig. 10. Longitudinal section of a kidney.
Fig. 11. Back view of the urinary bladder, muscular and bulbous parts of urethra, and accessory genital glands.
Fig. 12. Transverse section of penis.

(All the foregoing parts of the male Aye-aye are represented of the natural size.)

PLATE XXV.

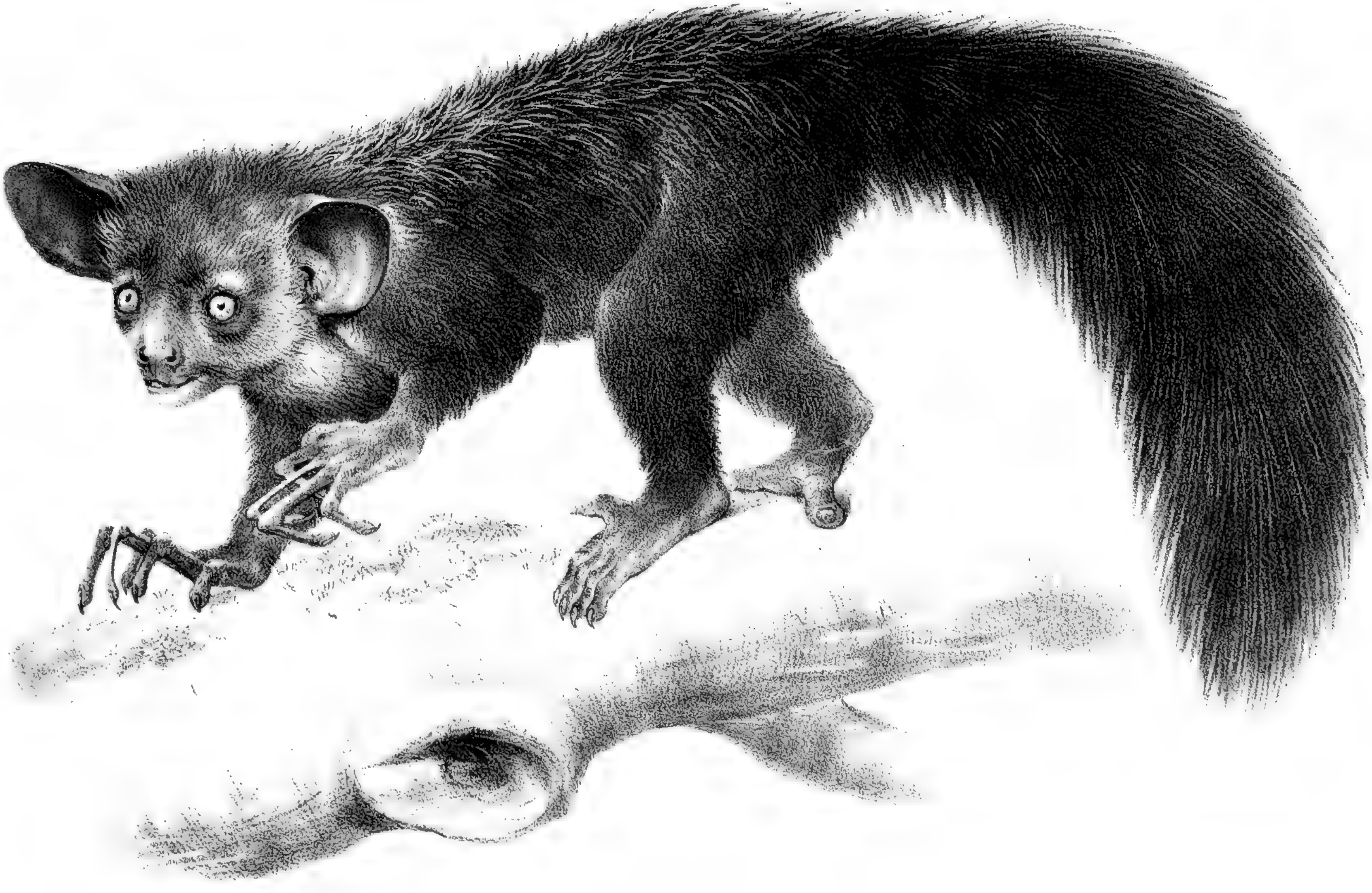
Fig. 1. Superficial-seated muscles of the hind limb, outer and plantar view.
Fig. 2. Deeper-seated muscles of the hind limb, inner and plantar view.
Fig. 3. Deeper-seated muscles of the hind limb; outer and rotular view, or on the 'dorsum' of the foot: half the natural size.

(The numerals are explained in the text.)

PLATE XXVI.

Fig. 1. The stomach, duodenum, and spleen.
Fig. 2. The cæcum, with the termination of the ileum and commencement of the colon.

(These parts of the male Aye-aye are of the natural size.)



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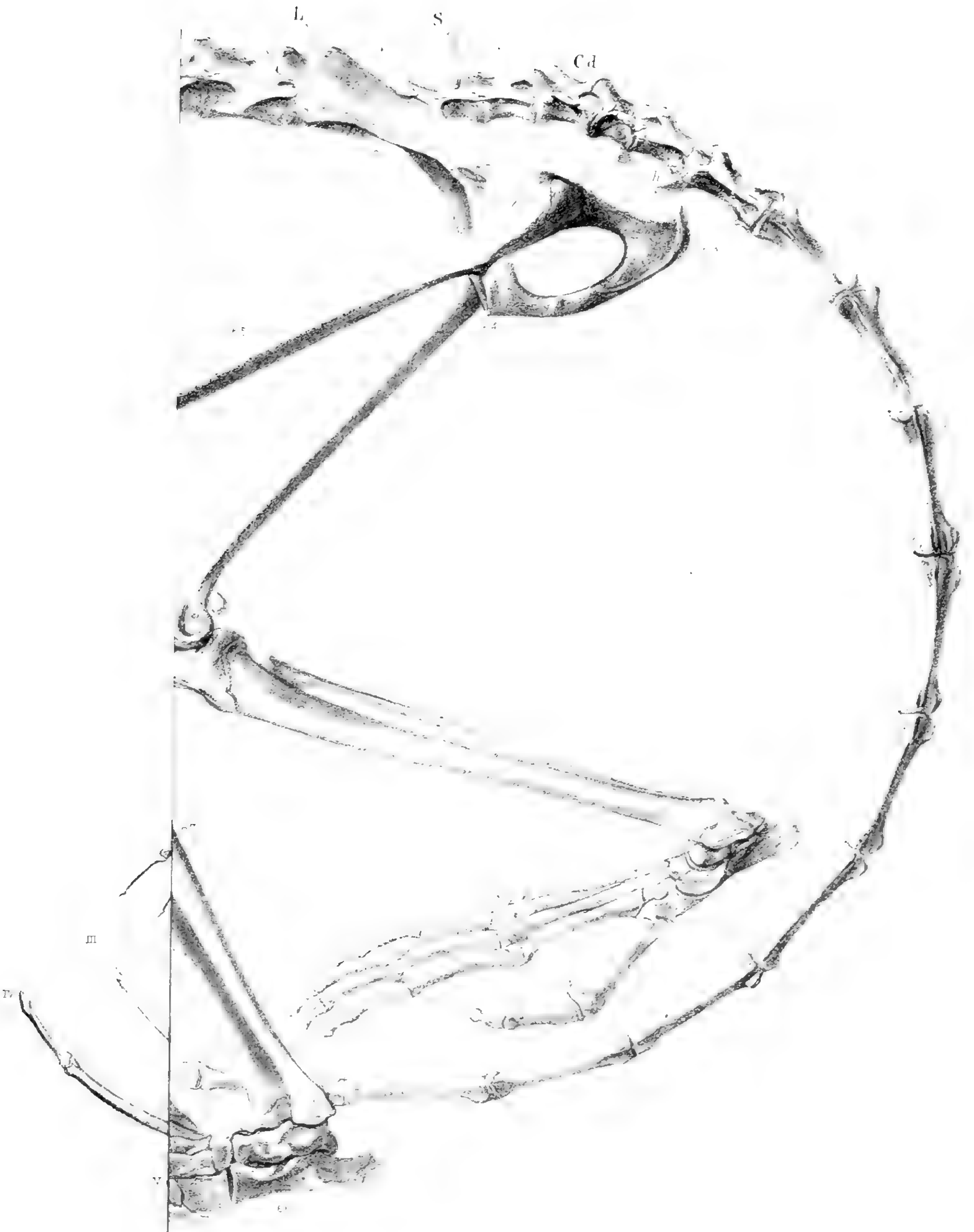

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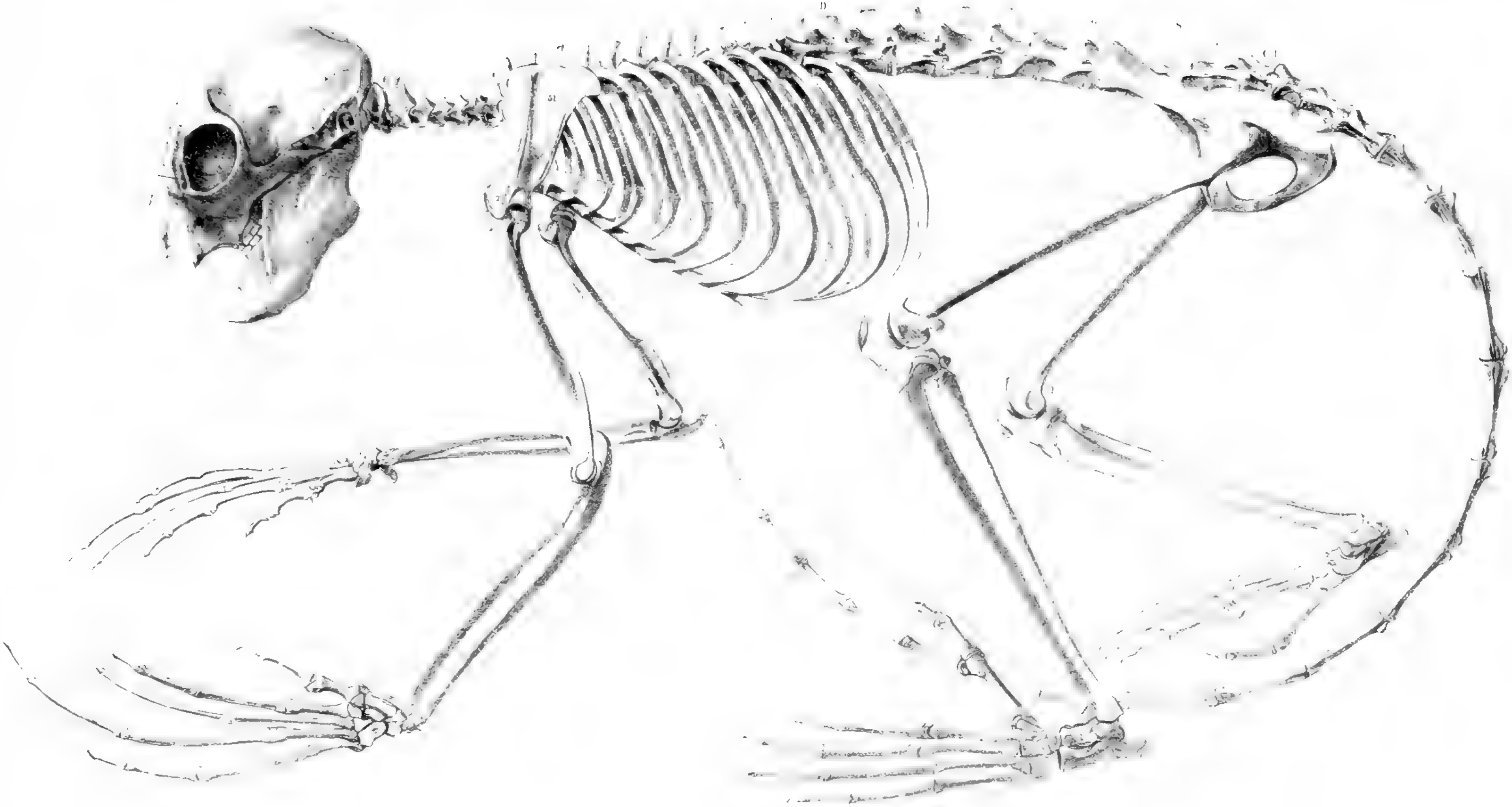

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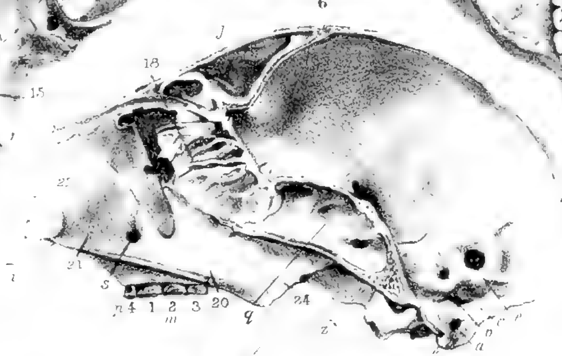

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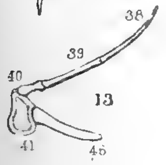

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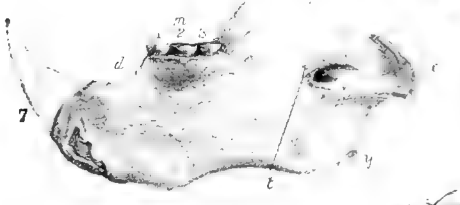

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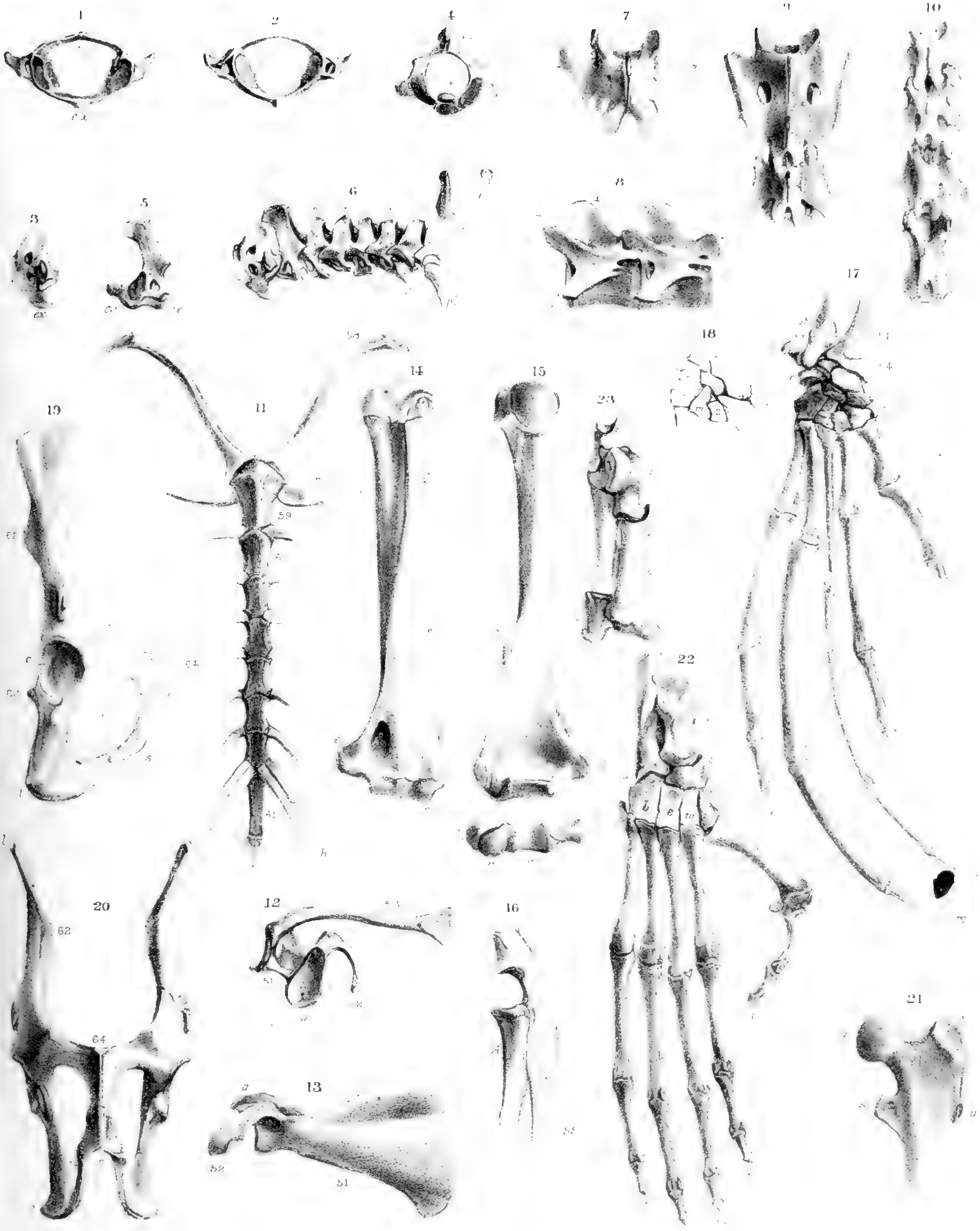

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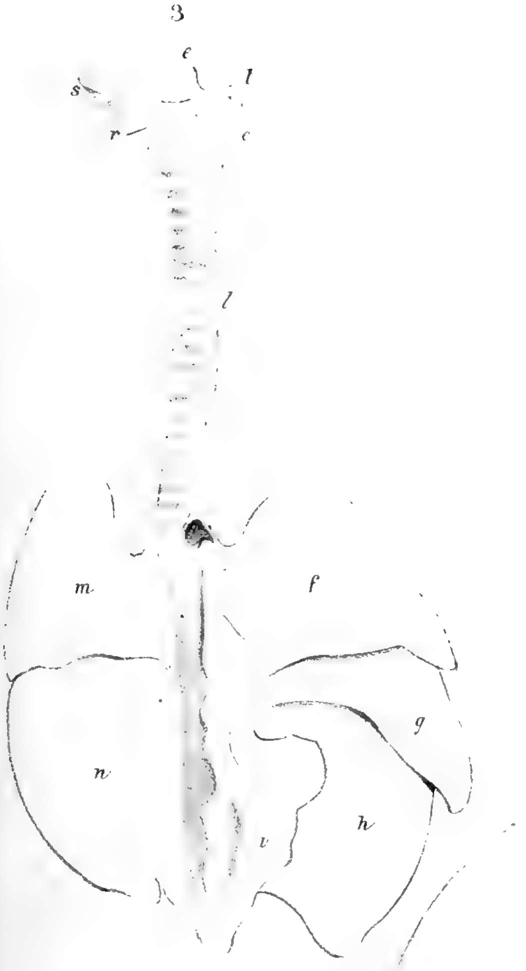

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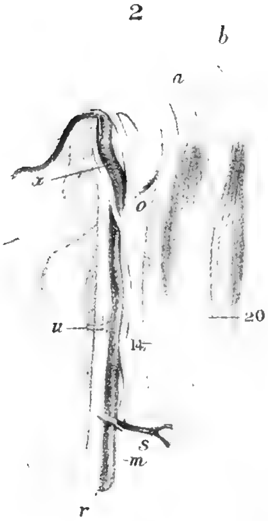

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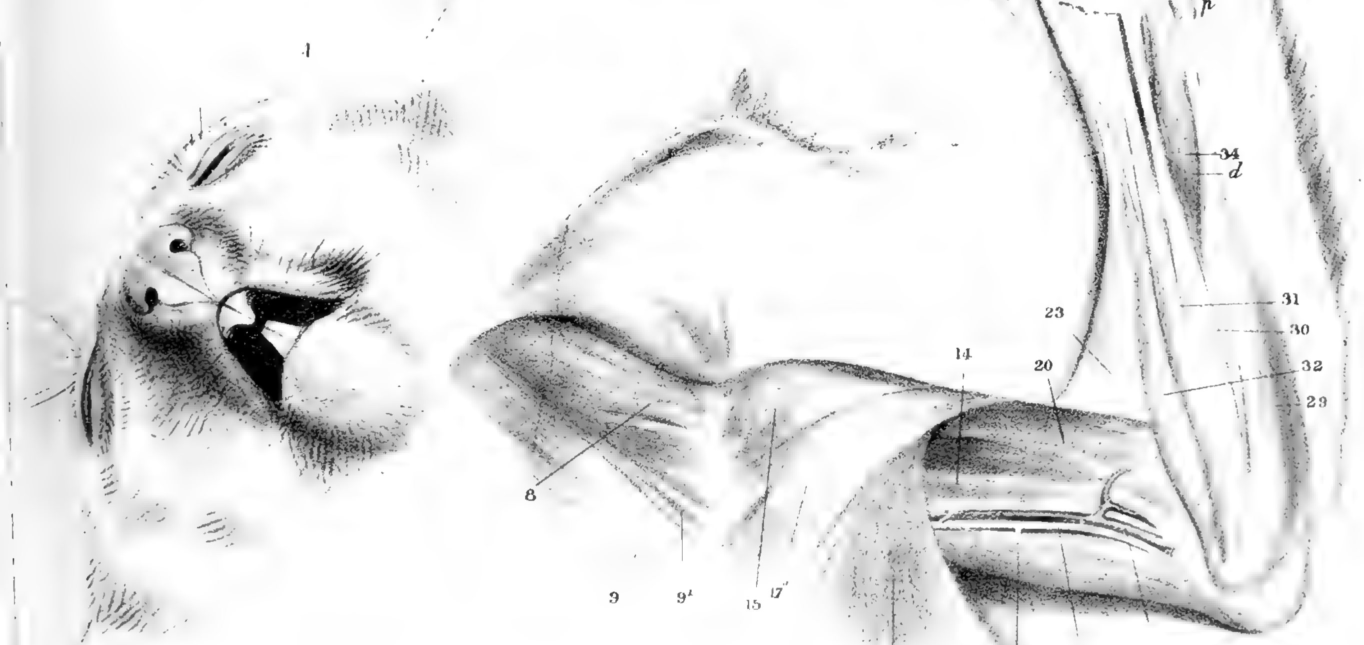

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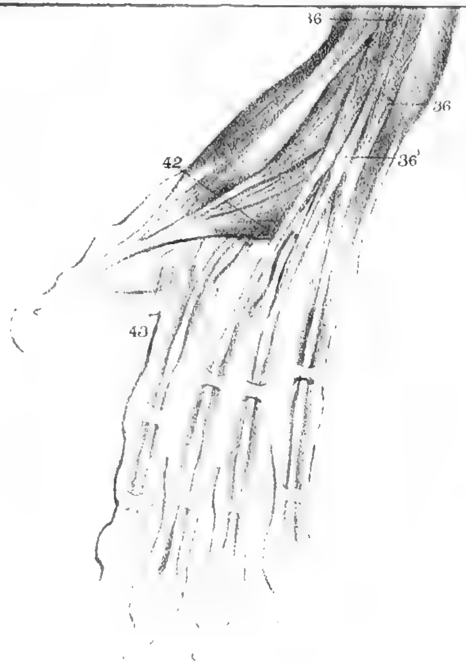

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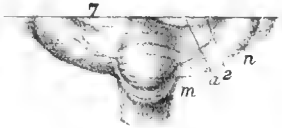

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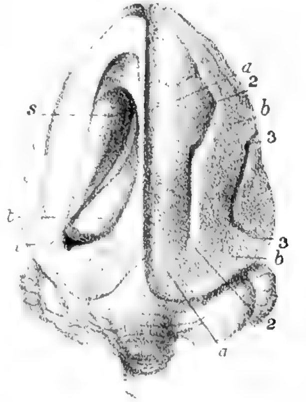

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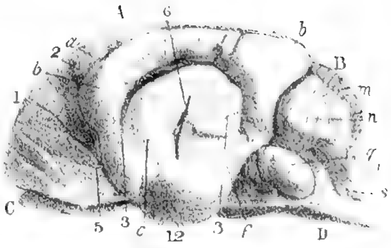

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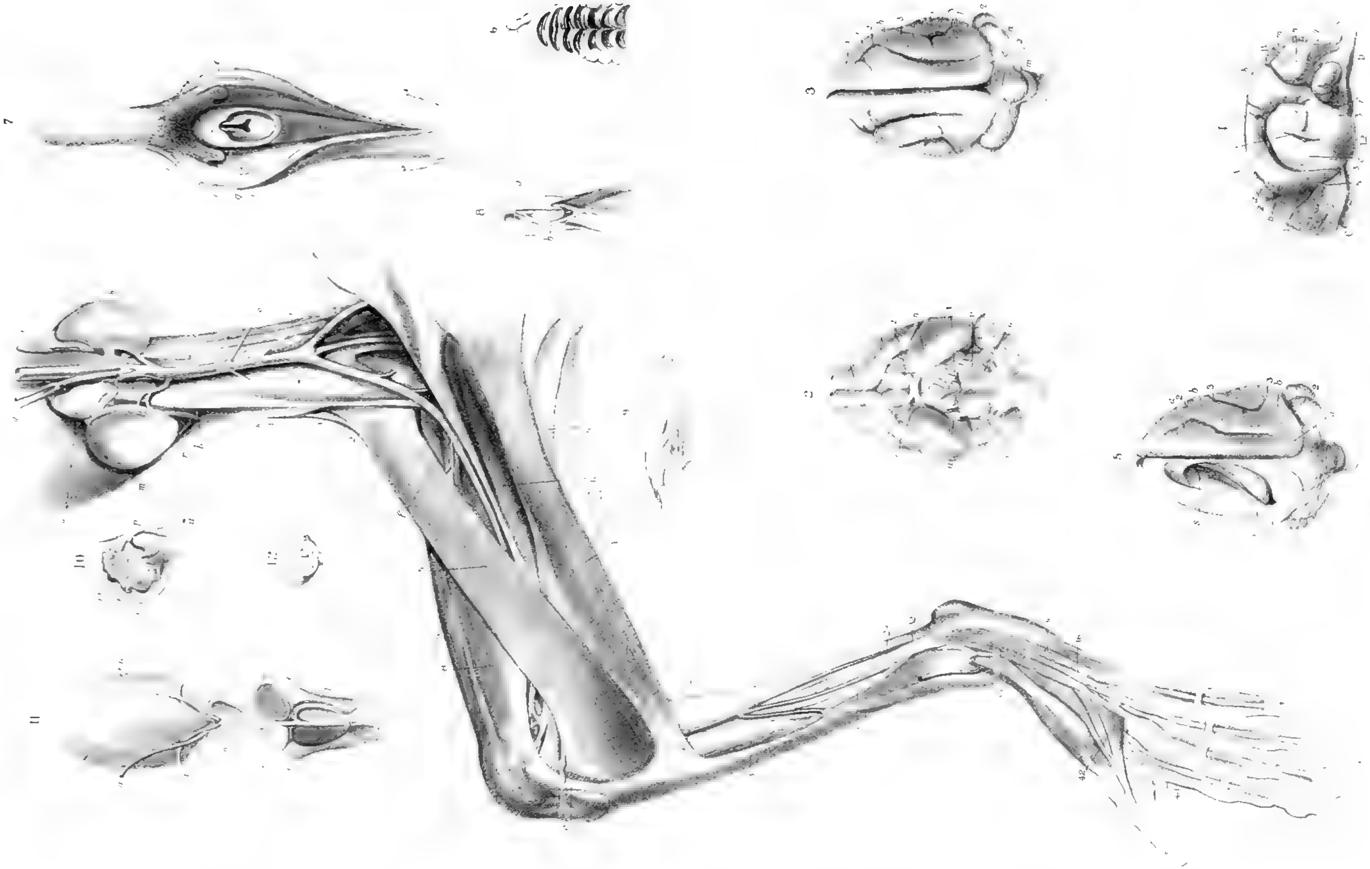

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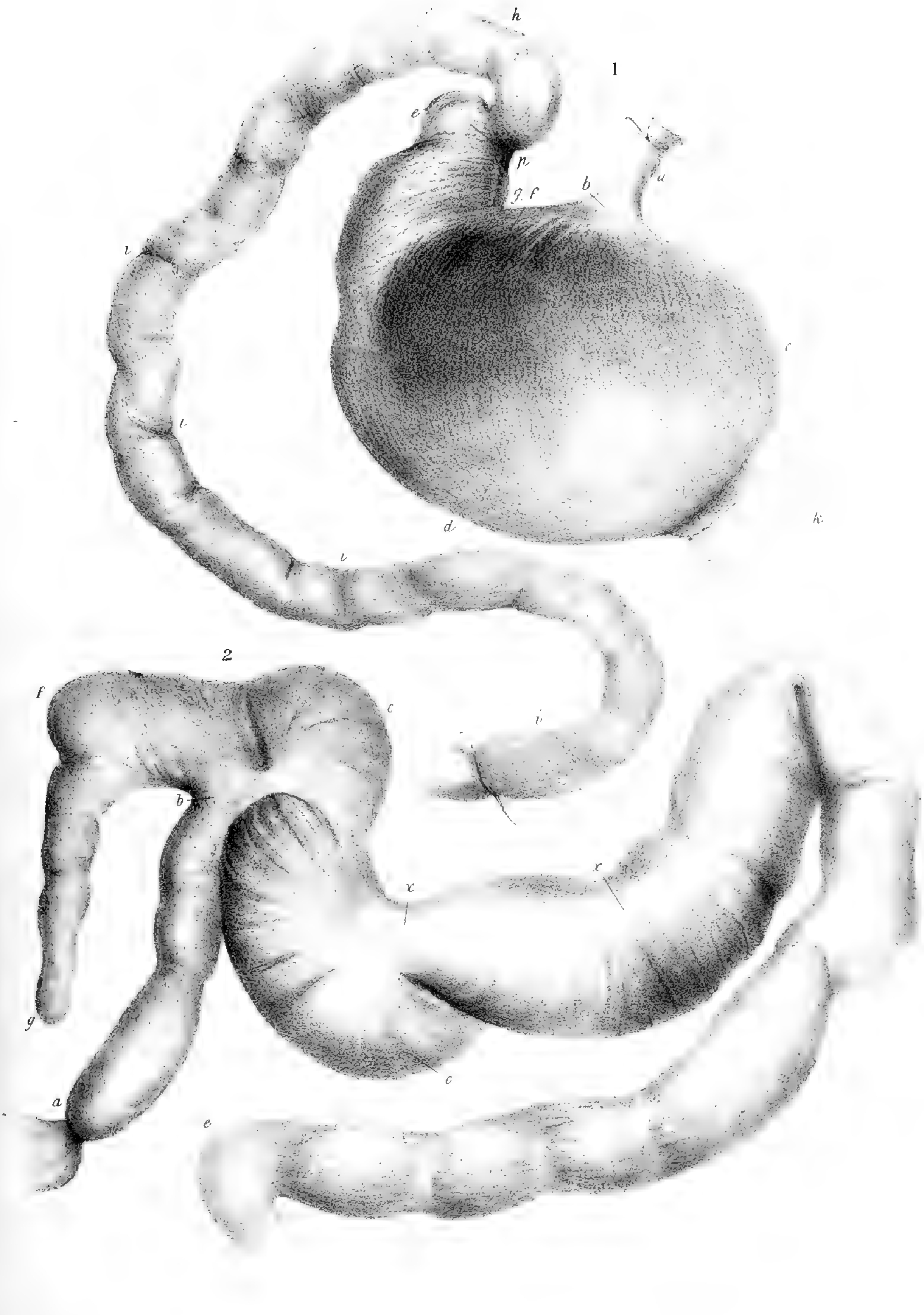

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III. *On the Brain of the Javan Loris* (Stenops javanicus, *Illig.*). *By* WILLIAM HENRY FLOWER, *F.R.C.S., F.L.S., F.Z.S., Conservator of the Museum of the Royal College of Surgeons.*

Read March 11, 1862.

[PLATE XXVII.]

ALTHOUGH the brain of *Stenops* has been described by such eminent anatomists as Van der Hoeven[1], Schroeder van der Kolk[2], and Vrolik[3], both the description and figures given by these authors appear to me insufficient for the requirements of modern zoological science, partly because, at the period at which they were made, attention enough was not paid to those precautions now known to be necessary for preserving the essential characters of the organ during its examination, and partly because the knowledge of the arrangement of the cerebral convolutions of the higher Quadrumana had not then attained to that state of precision to which the researches of Gratiolet[4], and others who have followed in his path, have since brought it. It is proposed, therefore, in the present communication, to put on record a new description of the brain of an animal of this genus, dwelling especially upon the form and surface-markings of the cerebral hemispheres, and to add a few observations suggested by a comparison of this brain with that of some of the most nearly allied forms.

The individual which furnished the subject of this memoir was an adult female, which died in the Society's Gardens in January 1862. In the examination of the brain every care was taken to preserve the natural configuration of the different portions of the organ; the drawing of the upper surface was made before its removal from the cranial cavity, and the other drawings, descriptions, and measurements have been checked by a comparison with a cast of the interior of the skull.

Description of the Brain.

When seen *in situ* (fig. 1), the two hemispheres present together an oval figure, 1·3 inch in length, and 1·05 inch across the broadest part, which is at the junction of the middle and posterior third of the long axis. From this point the oval gradually narrows to rather a sharp apex in front, formed by the closely approximated anterior terminations of the two hemispheres. The more rounded posterior end of the oval is inter-

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[1] Tijdschr. voor natuurl. Geschied. d. 8, 1841, p. 337.

[2] Bijdrage tot de Anatomie van den *Stenops kukang*. Leiden, 1841.

[3] Nieuwe Verhand. der 1e Klasse v. h. kon. Nederlandsche Inst., 1843.

[4] Mémoire sur les Plis cérébraux de l'Homme et des Primatès. Paris, 1854.

rupted in the middle line by a slight divergence from each other of the occipital extremities of the hemispheres, distinct even before removal from the cranial cavity. The sulci, though few, are well marked and tolerably symmetrical. The general surface of the brain is very uneven, being raised into strongly pronounced, sinuous gyri, the impression of which is very distinct on the inner surface of the calvarium. There is no appearance of that want of symmetry both of size and form, in the two hemispheres, described and figured by Vrolik. Projecting anteriorly to the extent of one-fifth of an inch beyond the cerebral hemispheres, are the olfactory lobes, of considerable vertical depth, but compressed laterally and pointed in front. Projecting posteriorly is a very narrow edge of the cerebellum, most visible in the middle line, both on account of its own greater prominence at this part, and because the widening out of the termination of the great longitudinal fissure of the cerebrum allows more of its upper surface to be seen.

When seen from one side, the upper contour of the brain forms a low flattened arch, the greatest point of elevation being a little way behind the centre (fig. 3). The anterior or frontal lobe is much depressed, and excavated below to make room for the orbital plates of the frontal bone. The temporal lobes, distinctly marked off from the last by the Sylvian fissure, are moderately full, and make a well-marked projection downwards and forwards. The occipital lobes are short and of little vertical depth, being hollowed below for the cerebellum, the greater part of which they cover.

The sulci of the cerebral hemispheres are[1] :—A. On the outer face (figs. 1 & 3). 1. The fissure of Sylvius (*e*, *e*), distinctly marked, directed obliquely upwards and backwards to the middle of the upper surface of the hemisphere, where it makes a slight change in direction, continuing to extend backwards, but almost parallel to the great longitudinal fissure. In the first portion of its course, it is as nearly as possible parallel to the inferior margin of the temporal lobe. It divides the whole hemisphere into two tolerably equal parts, the anterior containing the frontal and parietal, the posterior the temporal and occipital lobes. On separating its lips, no distinct median lobe, or *insula*, could be traced. 2. A distinctly marked sulcus (*f*) on the temporal lobe, posterior and parallel to the last, corresponding to the "antero-temporal" of the higher Quadrumana ("*scissure parallèle*" of Gratiolet). 3. A small sulcus running in a transverse direction on the upper surface of the hemisphere, at the junction of the parietal and occipital lobes, recalling the "temporo-occipital" (*scissure perpendiculaire externe*) of the Quadrumana, which fissure is, however, wanting in the smaller American Apes, as in *Lemur*. Anterior to the fissure of Sylvius are three small and straight sulci, all placed longitudinally, at different levels, the first on the upper, the second on the outer, the third on the lower (orbital) surface of the hemisphere. The two former may be called "supero-frontal" and "infero-frontal." There is no appearance either

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[1] The nomenclature proposed by Mr. Huxley (Proc. Zool. Soc. 1861, p. 259), founded on that of M. Gratiolet, is used throughout, when speaking of the cerebral sulci and gyri of the Quadrumana.

of the "postero-parietal" (*scissure de Rolando*) or of the "angular" sulcus[1], both so well marked in all the larger Apes. The sulci being mostly short, or only, as it were, partially developed, the boundaries of distinct gyri or convolutions are not very clearly marked out; indications of most of those that are present in the ordinary Quadrumana may, however, be traced, except perhaps those of the parietal region, which is altogether much reduced.

B. Sulci of the inner face of the hemisphere (fig. 4). The inner face of the hemisphere is generally smooth, but has several deeply cut and well-defined sulci, without any secondary indentations. 1. The "calloso-marginal" sulcus (*i*) is quite simple, except at its anterior end, where it is slightly bifurcated. It rather exceeds the corpus callosum in length, and is placed about midway between this and the upper margin of the hemisphere. 2. The "calcarine" sulcus (*l*) extends from below the hinder end of the corpus callosum backwards almost to the apex of the hemisphere, is slightly curved, with the concavity downwards, and joined about midway by (3) a perpendicular fissure (*k*) resembling the "occipito-parietal" (*scissure perpendiculaire interne*), and which does not extend quite so far upwards as the margin of the hemisphere. 4. The "dentate" sulcus (*m*) offers nothing remarkable; the calcarine appears to run into it, but becomes so shallow at the point of junction as scarcely to intercept the union of the callosal with the uncinate gyrus. The dentate gyrus (20) is broad and, as usual, becomes continuous with the uncinate (19) at the lower end of the sulcus. The corpus fimbriatum, as seen in this view, is very broad at the upper part; and below, it joins with the two gyri last named. There is no indication of the "collateral" sulcus. Fig. 3 exhibits well the proportionate length of the corpus callosum to the other parts of the cerebrum. The total length is 1·3 inch, of which the corpus callosum is ·65, the portion anterior to it is ·2, and that behind it ·45.

The under surface of the brain (fig. 2) presents the following characters:—The olfactory lobes in their anterior half are compressed, and of equal width almost to their termination; posteriorly they become flat, and widen out backwards to their attachment to the under surface of the anterior lobe. The fissure of Sylvius divides them from the temporal lobe. This fissure is at this spot less deep than it is higher up on the side of the hemisphere, but it is not actually intercepted by the base of the olfactory lobe, as it is in the Carnivora, Ruminantia, and other inferior mammals. The orbital surface of the hemisphere, as seen on each side of the olfactory lobes, is hollowed out, and presents the simple longitudinal sulcus before mentioned. The optic nerves are small for the size of the brain; behind their commissure is a prominent, round, whitish mass, filling up the greater part of the interpeduncular space, in which the corpora albicantia are not clearly distinguished from the tuber cinereum. The pituitary body is flat, of roundish outline, but broader in front than behind, attached by a narrow

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[1] As the arched sulcus which bounds the upper margin of the "angular gyrus" (*pli courbe*) does not appear to have received a name heretofore, I have called it as above.

pedicle springing from the middle of its anterior margin to the infundibulum, and divided by a transverse groove into two lobes, of which the posterior is much the smaller. The crura cerebri are of moderate size. The pons Varolii is not much elevated; it is distinctly marked off in front, but very indefinitely separated from the medulla behind. The medulla oblongata is broad and flat anteriorly, the median groove distinct, its other divisions but faintly indicated. A slight longitudinal groove marks the outer boundary of the pyramidal bodies; but the olivary bodies make no projection on the surface, and the corpora trapezoidea are not well defined. The nerves appear all to rise in the usual situations.

On separating the hemispheres above, while still *in situ*, the corpus callosum was seen to cover half of the anterior pair of the corpora quadrigemina. Of these bodies the anterior are the largest; they are flat and rounded in outline, narrower before than behind; the posterior are small, but very prominent. The corpora geniculata are well marked; the pineal gland small. On dividing the corpus callosum, the posterior part of the fornix was seen to be extremely broad, covering the optic thalami, and forming a broad, wide lamina (corpus fimbriatum) descending into each middle cornu of the ventricle. The hippocampus major is of moderate size. Although every care was taken to ascertain the extent to which the ventricular cavity extended into the posterior lobe, I was not able to do so satisfactorily: so readily do the layers of brain-substance separate in this direction, following exactly the curve of the bottom of the calcarine fissure, that it is difficult to distinguish an artificially formed from a natural cavity; but, as I have elsewhere shown, the extent to which the walls of this portion of the ventricular cavity are adherent is of no anatomical or physiological importance, and varies even in the same species; while, on the other hand, it is of consequence that, if the homologies of the calcarine sulcus as traced from Man through the Quadrumanous series to *Stenops*, *Lemur*, and *Galago* are true, the portion of cerebral grey matter answering to that forming the so-termed "hippocampus minor" of the human subject, only of proportions corresponding to the greater relative depth of the calcarine sulcus, must exist in the brains of all these animals[1].

When a horizontal section had been made of the hemisphere, the length of the antero-median portion, measured to the posterior edge of the hippocampus major, was 0·9 inch, and that of the posterior portion 0·4 inch, giving a proportion of 100 to 44,—being a shorter posterior lobe than in any of the true Apes that I have measured [*Hylobates* excepted], and longer than in any of the inferior Mammalia.

The cerebellum is 0·7 inch in breadth, and 0·4 inch in length. The upper surface is flat, rising but slightly in the median line, the superior vermiform process being much less distinctly marked than in *Lemur*, but forming a projection instead of a notch (as in the human subject) in the posterior border when seen from above. The lateral lobes are of moderate size, and more resemble those of the higher Quadrumana than those of

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[1] "On the Posterior Lobes of the Cerebrum of the Quadrumana," Phil. Trans. 1862, pt. 1, p. 185.

the Carnivora in structure. The flocculus consists of four lamellæ, attached by a very narrow pedicle, and lodged in a fossa in the temporal bone, as in the other Quadrumana.

Comparison of the Brain of Stenops *with that of* Lemur.

The brain at present under consideration presents the same general characters, both of form and disposition of the surface-markings, as that of *Lemur nigrifrons* (figs. 5, 6, and 7). The principal differences that may be observed between them are:—In *Lemur* the hemispheres are rather rounder and fuller, though the anterior lobes are more compressed. The temporal lobe is rather more developed. In the sulci of the outer face, in *Lemur*, the Sylvian fissure is deeper, especially at its anterior or lower part, and conceals a small but distinctly marked *insula* or median lobe; it does not extend so far upwards and backwards; and there is a sulcus ("angular") running lengthwise on the hemisphere between the upper end of the Sylvian fissure and the great longitudinal fissure, no trace of which exists in *Stenops*. In the arrangement of the sulci of the inner face the two brains closely resemble each other.

Comparison of the Brains of Stenops *and* Lemur *with those of the higher Quadrumana.*

As has been so clearly demonstrated by M. Gratiolet in his beautifully illustrated memoir before referred to, a certain type, both of general conformation and of surface-markings, pervades the brain of all the Primates, from Man to the Marmoset. From this type M. Gratiolet excludes the Strepsirhine Quadrumana, associating them with the Insectivora, in a division of Mammalia whose cerebral organization he considers to be quite distinct; but as his promised work upon this group has not yet seen the light, we are but imperfectly informed of the grounds upon which this conclusion is based.

In general form the Lemurine brain certainly departs considerably from the form of what may be called the Primatial type of brain, and approaches more nearly to that of the Carnivora. This is particularly apparent in the shortness of the posterior lobes of the cerebrum, which in the two higher families of Quadrumana (I believe, without exception) completely cover, and in most cases project beyond, the cerebellum[1]. But it must be observed that there is a considerable difference in this respect among the members of those families, and that this difference follows no regular gradation, and appears not to be correlated with any other structural characteristics. And it is especially remarkable that, in the development of the posterior lobes, there is no approximation to the Lemurine short-hemisphered brain in those Monkeys which are commonly supposed to approach this family in other respects, viz. the lower members of the Platyrhine group.

[1] Since this was written, an exception has been described in the genus *Hylobates*. See Natural History Review, April 1863, p. 279.

A second character by which the Lemurs are distinguished from the Monkeys is the large size of the olfactory lobes: but in these portions of the encephalic mass a gradual increase may be perceived from the higher to the lower Quadrumana; and they project in front of the cerebral hemispheres in all the Platyrhini, and even in the greater number of the Old World Apes. In the large majority of Mammals the base of these lobes extends backwards to the under surface of the temporal lobe, obliterating the lower part of the fissure of Sylvius; whereas in the true Apes, and in Man, their connexion with the cerebral hemisphere is chiefly with the anterior lobe and the bottom of the fissure itself. In this respect, as well as in the size of the lobes, *Stenops* and *Lemur* hold an intermediate position between the two groups, more nearly approaching the higher than the lower type.

Another most distinctive characteristic of the primatial brain is the possession of a complete Sylvian fissure. Although the presence of this important sulcus is not recognized by some anatomists in the Mammalia generally, it exists almost throughout the series, but in a rudimentary condition, the part which remains corresponding to the middle portion of the fissure when completely developed. Concealed by the lips of the Sylvian fissure is the median lobe—so well marked and even complex in Man, simpler and smaller, but still distinct, throughout the greater part of the Monkey series, but lost in the diminutive Marmoset, recognizable, however, in the *Lemur*, not distinctly traceable in *Stenops*, absent in all other Mammalia. Next to the fissure of Sylvius, the most characteristic Simian sulcus on the outer surface of the hemisphere is the one placed behind and parallel to it—the antero-temporal, the last that disappears as the size of the brain, and attendant amount of surface-involution, decreases. In the presence of this sulcus both *Stenops* and *Lemur* perfectly agree with the type. After this the most persistent fissure on the outer face appears to be the one bounding the upper border of the angular gyrus; this also exists in *Lemur*, but is not seen on the smaller hemisphere of *Stenops*.

But it is perhaps the sulci of the inner face of the hemisphere that are most characteristic of the Primates, and offer the most striking differential features from the other Mammalia. Here, too, the Lemuridæ follow strictly the higher type. That essentially primatial sulcus, the calcarine, which persists deeply marked in the little *Hapale iacchus*, when every other trace of fissure, except the Sylvian, is gone, is equally well developed in both *Lemur* and *Stenops*. The calloso-marginal is also well marked, but a fissure somewhat corresponding to this is found throughout the Mammalia.

In order to make a comparison of the brain of the Lemuridæ with those of the higher Quadrumana more perfect, brains of somewhat similar size in the two groups should be selected; and in reference to such a comparison, as well as on other grounds, it is to be regretted that we are not yet sufficiently acquainted with the cerebral organization of many of the Platyrhine Apes; but among those that are known there are two which, in general arrangement of sulci, present great resemblance to *Lemur* and *Stenops* respectively. *Callithrix moloch*, as figured by Gratiolet (fig. 11), has a moderately extended Sylvian fissure, a well-marked antero-temporal and a distinct angular sulcus, as in *Lemur*, while in the Douroucouli (*Nyctipithecus trivirgatus*) there is a Sylvian fissure much prolonged upwards and backwards, an antero-temporal, but no angular sulcus, all of which characters are reproduced in *Stenops*. Thus the most marked differences between the brains of *Lemur* and *Stenops* find their parallel in those of two very nearly allied genera of another family.

The cerebellum of *Lemur nigrifrons* appears to me to present marked characters of inferiority as compared with the same part in the true Apes, especially in the large relative proportion of the *vermes*, both median and lateral, as compared with the bodies of the three divisions of this organ; but, as before stated, *Stenops* does not present this character in so marked a degree; indeed I could perceive little essential difference between the cerebellum of this animal and that of *Hapale* and the other small Monkeys; but my observations on this point do not agree with those of Vrolik, and may require verification.

Comparison of the Brains of Lemur *and* Stenops *with those of the lower Mammalia.*

Having placed side by side with the brains of the animals now under review those of some of the smaller Carnivora, as the Cat and the Kinkajou (*Cercoleptes caudivolvulus*), it becomes evident that these latter present a common family likeness to each other in the character of their convolutions, and belong to a different type from that on which the Lemurs and Monkeys are formed. In general shape they certainly are approached by the Lemuridæ, but in the arrangement of the sulci it is difficult to trace any resemblance; the nomenclature of the superficial parts of the hemisphere of the one utterly fails us when we attempt to apply it to the other. In the Carnivora the convolution surrounding the rudimentary Sylvian fissure is followed by two or three more, one encircling the other, the upper one bounded by the margin of the hemisphere. On the inner face the dissimilarity is equally striking, especially in the absence of anything resembling the calcarine fissure (see fig. 12, inner face of the right hemisphere of a cat's brain). Whether more critical researches, aided by a careful study of the development of the convolutions, will hereafter enable us to trace the homology between the parts marked off by such dissimilar patterns I cannot say; but no satisfactory solution of the problem has yet been offered.

To turn to another group of animals with which the Lemurs are supposed to have affinities, viz. the Cheiroptera, our difficulty is here greatly increased by the want of any member of the order with a brain of sufficient size to possess sulci on its surface. In a species of *Pteropus* I could trace none distinctly, and indeed it could scarcely be expected when such markings are almost absent in the brain of a true Primate of even larger size (*Hapale*). In general form the Bat's brain is far removed from that of the

Apes: the cerebrum is so short as to leave almost the whole of the cerebellum uncovered, and the Sylvian fissure is almost obliterated. On these grounds alone we might be induced to place these orders far away from each other, in a system of classification founded mainly on cerebral organization, if the fact of the persistence of the primatial type of convolution upon a degraded configuration of brain in the Lemurs did not warn us that it is possible that the Cheiroptera, and perhaps the Insectivora also, may form a group presenting a still lower degree of development (characterized by still shorter hemispheres) of the same high type, and that therefore, in the absence of any knowledge of what the surface-markings of the hemispheres of the Cheiroptera would be if developed, there scarcely seems sufficient justification for removing them, on the score of their cerebral organization alone, from the position assigned to them on other grounds by Linnæus, Cuvier, and a large majority of systematic zoologists. It may be, perhaps, that we shall find in the simpler brains of this lower group a common form by means of which the more completely developed and specialized cerebral organs of the Carnivora and the Quadrumana are united, and through which, instead of through any direct link, their affinities are to be read. At all events, it cannot be doubted that more searching comparisons of the form and the convolutions of the brains of different groups of Mammalia, conducted on such a system as that so successfully pursued in one group by M. Gratiolet, will throw much light upon the mutual relation of different members of the class, and I trust that these few observations upon a very interesting form may be accepted by the Society as a small contribution towards this desirable end.

Note.—May 1862. The recent examination of the brain of a specimen belonging to the genus *Pithecia* (Proceedings of the Zoological Society, Dec. 9, 1862) has led to a different determination of the sulci of the posterior part of the inner face of the hemisphere to that given above and in the author's paper "On the Posterior Lobes of the Quadrumana" (Phil. Trans. 1852). The sulcus marked *k*, in figs. 4, 7, & 10 (*Stenops*, *Lemur*, and *Nyctipithecus*), which was supposed to represent the occipito-parietal of the higher Quadrumana, is more probably the upper branch of the posteriorly bifurcating calcarine, because (in *Nyctipithecus*, without doubt) it is homologous to a small sulcus which in *Pithecia* coexists with a true occipito-parietal descending from the upper margin of the internal face of the hemisphere and, as in all except the highest Quadrumana, not extending so low as to join the calcarine (*loc. cit.* fig. 4). All trace of this sulcus is absent in the smaller Platyrhine Monkeys and Lemurs.

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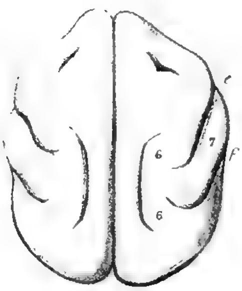

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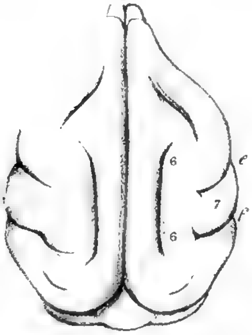

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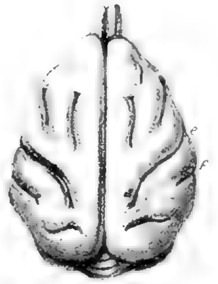

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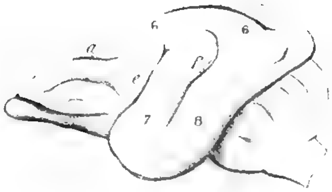

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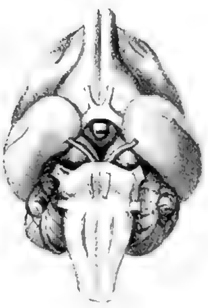

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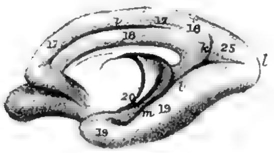

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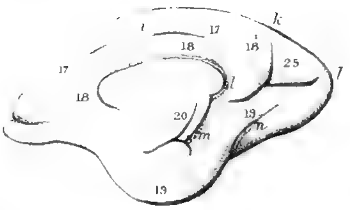

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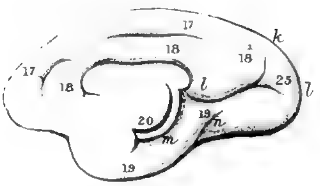

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M & N. Hanhart, Impᵗ.

DESCRIPTION OF THE PLATE.

The figures are all of life-size, and, with the exception of fig. 11, drawn from nature.

Fig. 1. Upper surface of the brain of *Stenops Javanicus.*
Fig. 2. Under surface of the same.
Fig. 3. Side view of the same.
Fig. 4. Inner face of the right hemisphere of the same.
Fig. 5. Upper surface of the brain of *Lemur nigrifrons.*
Fig. 6. Side view of the same.
Fig. 7. Inner face of the right hemisphere of the same.
Fig. 8. Upper surface of the brain of *Nyctipithecus trivirgatus.*
Fig. 9. Side view of the same.
Fig. 10. Inner face of the right hemisphere of the same.
Fig. 11. Upper view of the brain of *Callithrix moloch* (from Gratiolet).
Fig. 12. Inner face of the right hemisphere of the brain of a cat (*Felis domestica*).

Sulci in all the figures:—

a. Infero-frontal.
e. Fissure of Sylvius.
f. Antero-temporal.
i. Calloso-marginal.
k. Occipito-parietal (see note, p. 110).
l. Calcarine.
m. Dentate.
n. Collateral.

Gyri in all the figures:—

6. Angular.
7. Antero-temporal.
8. Medio-temporal.
17. Marginal.
18. Callosal.
18′. Quadrate lobule.
19. Uncinate.
20. Dentate.
25. Internal occipital lobule.

ERRATA.

Page 110, line 12 from bottom, *for* May 1862 *read* May 1863.
„ „ 8 „ „ *for* 1852 *read* 1862.

IV. *Notice of a Collection of Nudibranchiate Mollusca made in India by* WALTER ELLIOT, Esq., *with Descriptions of several New Genera and Species. By* JOSHUA ALDER *and* ALBANY HANCOCK, *F.L.S.*

Read May 12, 1863.

[PLATES XXVIII.—XXXIII.]

THE Nudibranchiate Mollusca which form the subject of the present paper were collected, chiefly during the years 1853 and 1854, at Waltair, in the Presidency of Madras, by Walter Elliot, Esq., of Wolfelee, Roxburghshire, while Commissioner of the Northern Circars in that Presidency. They supply a most interesting addition to our knowledge of the molluscan fauna of the Indian Seas, the more especially as Mr. Elliot has not only preserved the animals themselves for examination, but has caused beautiful and accurate drawings of each species to be made in the living state. These drawings, from which the accompanying plates are engraved, were made by native Hindoo artists. Besides the species here described, Mr. Elliot's collection contains specimens and drawings of many other interesting Mollusca, in the allied families of *Diphyllidiadæ*, *Pleurobranchidæ*, *Bullidæ*, and *Aplysiadæ*, which may possibly afford materials for some future memoir. Mr. Elliot has favoured us with the following account of the locality where most of the specimens were procured :—" Waltair is a suburb of the town of Vizagapatam, the capital of a province of the same name, one of the Northern Circars. The coast south of Vizagapatam is flat and sandy, with a heavy surf, which is unfavourable to the existence of naked Mollusks ; but the whole of the coast of Vizagapatam is rocky, and sometimes precipitous, abounding in bays filled with rock and shingle, amongst which the delicate forms of the creatures you have been describing find shelter. Immediately to the north of Waltair is one of these bays, called Lawson's Bay, in which a large proportion of the specimens were found ; but I employed men to search along a more extended line, both north and south of the bay. Most of the species were taken between tide-marks, and only one or two in deep water."

In addition to this fine collection, so kindly placed in our hands by Mr. Elliot, we were favoured by the late Dr. Kelaart with a large collection of drawings, representing the species described by him in the Ceylon branch of the 'Journal of the Royal Asiatic Society,' together with many of the specimens preserved in spirit. These have afforded us additional facilities for understanding the species here described, and with such materials at our command we hope to give a more full and accurate account of these animals than has yet appeared.

Until very lately little was known of the *Nudibranchiata* of the Indian Seas. Our previous knowledge had been derived principally from the naturalists of the exploring expeditions sent out by the French government, and especially from the splendid work of MM. Quoy and Gaimard, forming the zoological portion of the 'Voyage of the Astrolabe,' where many species of Nudibranchs are described and figured; but, from these naturalists not being familiar with the characters on which the distinctions in this order are founded, their descriptions are often deficient in those points which are now relied upon for the division of genera and species. Few of this tribe of animals have been noticed by English voyagers. Mr. Arthur Adams, however, has described some interesting species collected by him, in the 'Voyage of the Samarang;' but in all these instances the animals described were procured either on the high sea or among the islands of the Indian Ocean only: no exploration of the shores of continental India had been undertaken. About the same time, however, as Mr. Elliot was making this valuable collection on the coast of Madras, Dr. Kelaart, stimulated by a knowledge of what European naturalists were doing in this department of natural history, acquired on a recent visit to England, set himself diligently to work, on his return as medical officer to the garrison of Ceylon, to examine the naked Mollusca of the shores of that island. The result was the discovery of more than fifty species that he considered to be new. These, along with many new species of *Actinia*, *Planaria*, &c., he published in the 'Journal of the Royal Asiatic Society' in 1858, and subsequently in the 'Annals of Natural History' for 1859. Coloured drawings of all the species had been made, which are now before us: though fully equal to most of the figures of South Sea Nudibranchs previously given, these drawings have not been thought sufficiently accurate to justify the expense of publication.

Considering the proximity of the coasts of Ceylon and Madras, it was to be expected that several of the species described by Kelaart would be found on the shores of the adjoining continent; we are glad to find, however, that many additional new species have been discovered by Mr. Elliot, and remain now to be described.

In comparing the Indian Nudibranchs with those of our northern seas, we are at once struck with the great proportion of *Dorides* among the former, their great size, the variety of their sculpture, and the beauty of their colours. A more remarkable fact, however, is that, among the mollusks that have hitherto passed under the name of *Doris*, there is a group of species which differ so much from that genus in a physiological point of view as to require the establishment not only of a new genus, but even of a new family for their reception. These animals have a mouth formed for suction, without any trace of tongue, teeth, or jaws. They are also distinguished by the absence of calcareous spicula[1], a characteristic hitherto supposed to have been universal in the *Acanthobranchiata* (those animals, namely, that have the branchiæ surrounding the vent on the central line of the back). This new genus, which we have named *Doridopsis*, cannot be distinguished from *Doris* by any external characters, if we except the small size of the head and mouth, and a remarkable difference in the position of the latter. The structure of their buccal apparatus, however, indicates as great a difference in the economy of the animals as exists between the *Haustellata* and *Mandibulata* (suckers and masticators) among insects, though we have not in this case considered the divisions entitled to so high a rank.

The *Goniodoris* of Forbes has hitherto been considered a northern form—the southern species which some authors have referred to it belonging almost without exception to the allied genus *Chromodoris*, which, on the other hand, has not been found further north than the Mediterranean. In this collection, however, three species of the true *Goniodoris* appear, while only one of the *Chromodoris* is present. Most of the genera belonging to other families are distinct from those of Europe. A few *Eolides* are found; but their numbers are proportionally small, compared with those of northern latitudes. Three only occur in this collection; and seven others are described by Kelaart. As these collections have been made with care, they probably represent pretty fairly the predominant characters of the Indian Nudibranchiate fauna.

In all, there are four new genera in the collection[2], which comprises forty-two species, thirty being undescribed.

Order NUDIBRANCHIATA, *Cuvier.*

Suborder ACANTHOBRANCHIATA, *Férussac.*

Family DORIDIDÆ, *Alder & Hancock.*

Cloak large, spiculose, without marginal appendages. Dorsal tentacles retractile within cavities. Oral tentacles various or wanting. Mouth with a denticulated prehensile tongue, and occasionally with a spinous collar.

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[1] Mr. Elliot's specimens had unfortunately been preserved in some saline fluid, which, in most cases, had injured the spicula to such an extent that they could not be made out satisfactorily; moreover it had rendered many of the specimens hard and brittle, so that they were quite unfit for anatomical examination. This must account for the imperfect descriptions of the spicula, and some other deficiencies, that will be found in the following pages. We can, however, speak pretty confidently to the absence of spicula in *Doridopsis*, as Kelaart's collection, which is preserved in spirit, contains several species of this new form; and we have in our possession an individual of this genus from Madeira, also in spirit, which, like all the other specimens, is without spicula.

[2] Another apparently new genus is figured in the plates, but sufficient materials have not been preserved for its description.

Genus Doris, *Linnæus.*

Body depressed; cloak covering the head and foot. Dorsal tentacles laminated, retractile. Oral tentacles variable. Branchiæ plumose, surrounding the vent in the medio-dorsal line, and retractile within a common cavity. Tongue broad, with numerous spines in each row.

Doris formosa, n. sp. (Pl. XXIX. figs. 1, 2, 3.)

Body oval, much depressed. Cloak coriaceous, very ample and with the edges deeply sinuated; yellowish-olive-coloured, beautifully marbled and blotched with scarlet, and minutely freckled with dark brown; under side white, with large scarlet-orange spots and blotches, with a minute dark freckling near the foot, and pale minute transverse lines, indicating probably the presence of muscles. Dorsal tentacles clavate, yellowish; the margins of the orifices a little raised and whitish, spotted with brown. Oral tentacles linear, rather stout, with the dorsal surface grooved, giving them a folded or ear-like appearance; freckled with brown. Branchial plumes six, tripinnate; the margin of the cavity produced into six lobes or leaf-like processes, which fold down over the branchiæ when retracted; they are white, with conspicuous brown spots. Foot rather narrow, dilated in front, where it is laminated and deeply notched, and rounded posteriorly; it is white, with minute brown freckles over the surface. Length $3\frac{1}{2}$ inches.

Some individuals have the markings much fainter, with the spots on the under side yellow.

The tongue (as in most of the species here described) is similar to that of the common *Doris tuberculata* of Cuvier: the lateral spines in each transverse row are very numerous, smooth, stout, and strongly hooked, diminishing in size towards the centre, and without a central spine.

This handsome *Doris* may be taken as the type of a group of *Dorides*, common in the Indian Ocean, that have the cloak largely developed and generally coriaceous; and the branchial plumes, six in number, retractile within a cavity with six lobes closing over them when withdrawn. This latter character has been employed by Ehrenberg to raise them to the rank of a genus, which he calls *Actinocyclus*. As, however, these species agree in all other respects with the characters of *Doris*, we consider the lobes of the branchial aperture not sufficient for generic distinction. The *Doris solea* of Cuvier belongs to this section.

Doris ellioti, n. sp. (Pl. XXVIII. figs. 1, 2.)

Body oval, depressed. Cloak large, with the upper surface granulated or minutely tuberculated, and the edges a little undulated; of a yellowish colour, inclining to orange, thickly spotted with umber-brown, the spots larger towards the sides, and the margin surrounded by thick-set purplish-brown blotches; the extreme edge pale: under side yellowish orange, with large dark brown circular spots, intermingled with a few smaller and lighter ones; the margin blotched with brown. Dorsal tentacles clavate, with brown laminæ, and retractile within slight sheaths. Oral tentacles short, linear. Branchial plumes six, retractile within a cavity, the margin of which is produced into six lobes, as in *D. formosa*; anal tube long and narrow. Foot orange-coloured, narrowish, rounded at both ends, and slightly laminated and notched in front. Length from 2½ to 3 inches.

A variety has the cloak of a dark brown above, obscurely blotched and spotted: the under side of a deep orange, with very large deep-brown spots.

Tongue as in *D. tuberculata*.

This fine species is common on the Coromandel coast. Two specimens are preserved in the collection.

DORIS PARDALIS, n. sp. (Pl. XXVIII. fig. 3.)

Body oval, slightly elongated. Cloak covered with very small, pointed tubercles; the surface yellowish, pretty regularly covered with rufous spots, inclining to orange, largest towards the centre of the back. Under surface pale yellowish white, with faint reddish spots. Dorsal tentacles clavate, rather slender, reddish. Oral tentacles small, linear. Branchial plumes six, rather large, slender, tripinnate; anal nipple prominent, the margin six-cleft. Foot oblong, rounded at both ends, whitish, without markings, excepting a few scattered dark freckles; the front laminated, but not notched. Length about 2 inches.

Tongue as in the last species, with the addition of a prehensile collar. *Doris pardalis* bears great resemblance to *D. concinna* (described below), but differs in having the tubercles smaller, and the markings of the cloak more regular and of a different colour. The branchial aperture, too, is lobed in this species, which is not the case in *D. concinna*.

Rare. One specimen is preserved in the collection.

DORIS STRIATA, *Kelaart*. (Pl. XXIX. fig. 4.)

Body depressed, elliptic-oblong, yellowish brown. Cloak ample, firm, coriaceous, minutely granular or tuberculated, of a yellowish or rusty-brown colour, paler or whitish towards the margin, a little marbled on the back, and everywhere covered with fine waved brown lines for the most part arranged in a radiated manner. Under surface white, with waved and branching brown lines near the foot. Dorsal tentacles stout, clavate, and pointed, with purplish laminæ; the apex white; margins of the orifices a little produced, and whitish with brown streaks. Oral tentacles linear, white, and grooved on the upper surface. Branchial plumes six, imperfectly quadripinnate, beautifully streaked with dark brown, the streaks following the lines of the stem and branches: they are retractile within a cavity, the margins of which are divided into six angular lobes: the plumes correspond to the spaces between the lobes. Foot oblong, rounded at both ends, with a shallow notched lamina in front; white, the upper side beautifully lineated with brown; the under surface plain, with a few faint lines towards the centre. Length upwards of 4 inches.

Tongue as in *D. tuberculata*: no collar.

Doris striata, Kelaart in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 302.

Doris striata comes very near to the *D. cruenta* of Quoy and Gaimard, but wants the large red blotches which distinguish that species. Kelaart's specimen measured only an inch and a half long. Our animal, however, agrees so well with his drawing and description that we have no hesitation in considering it the same.

There are two specimens of this species in the collection. It is not very common.

DORIS CONCINNA, n. sp. (Pl. XXVIII. figs. 4, 5, 6.)

Body oval, rather convex, brownish. Cloak with smallish, conical, finely pointed tubercles, rather soft and much attenuated towards the margin, placed a little apart with small ones interspersed; it is yellowish or reddish brown, sometimes inclining to grey, with large dark blotches (often rather obscure) on the sides of the back, and spotted with brown over the whole surface. Under side pale yellowish brown, irregularly spotted with dark brown, and minutely reticulated with white. Dorsal tentacles clavate, brown. Oral tentacles pointed. Branchial plumes six, quadripinnate, yellowish brown, with darker brown freckles; the margin of the cavity slightly raised. Foot broad, grooved and notched in front, of a yellowish or reddish brown, freckled with a darker shade of the same colour; the upper surface paler, with dark brown spots. Length from 2½ to 3 inches.

The young is paler and more minutely spotted.

Spicula small, pointed, a little bent, arranged in a reticulated manner, and in bundles at the base of the tubercles.

The tongue is similar to that of *D. tuberculata*; but the mouth is also supplied with a prehensile collar. The spawn is riband-formed, with the free margin sinuous, forming one or two irregular coils.

This is a common species.

DORIS FRAGILIS, n. sp. (Pl. XXVIII. figs. 7, 8.)

Body broadly oval, depressed, brownish. Cloak ample, firm, covered with minute, somewhat scattered, spiculose, blunt tubercles, of unequal sizes, rather paler than the ground—which is yellowish brown, beautifully marbled with darker brown and white, and covered with minute dark freckles; under surface strongly blotched with reddish brown, the blotches becoming confluent near the foot and fewer towards the margin, which is pale. Dorsal tentacles conical, finely laminated on the upper part; the laminæ meeting in front, dark yellowish, much and minutely freckled, especially below; retractile within short sheaths. Oral tentacles linear, pointed. Branchial plumes six, large, quadripinnate, minutely speckled with dark brown: the circle open behind: anus large and tubular. Foot broad, ovate, reddish brown, with darker blotches, and pale towards the margin: it is deeply grooved in front, but not notched; the posterior end short and rounded. Length 5 or 6 inches.

Tongue as in *D. tuberculata*, with a prehensile collar.

Spicula very numerous, small, and rather irregular in form; but usually bent in the centre, with the extremities obtuse, sometimes a little enlarged.

Mr. Elliot informs us that this species is so brittle that it breaks to pieces even when alive. The two specimens preserved are much mutilated. It is not uncommon, and bears some resemblance to the *D. bellicosa* of Kelaart, from which it differs in size and colour, as well as in the obtuse form of the tubercles. The spawn is white, and in the form of a single irregular coil, with the free margin much contorted.

DORIS AREOLATA, n. sp. (Pl. XXX. figs. 1, 2, 3.)

Body oval, convex, gelatinous. Cloak ample, very rugose and warty, covered with irregularly rounded, minutely tuberculated nodules of a yellowish or reddish-brown colour. Two or three irregular rows of deeply depressed smooth areas run down each side of the back, each depression having a large circular black spot in the centre, with a light margin, and the rest of the area greenish. The spots of the intermediate row on each side are largest: a slightly elevated nodulous ridge runs along the centre of the back, generally rising into a conical protuberance in front of the branchiæ, most conspicuous in young individuals. Under side of the cloak dark-purplish brown. Dorsal tentacles clavate, and a little bent backwards; the laminæ alternately large and small, nearly continuous in front; they are retractile within cylindrical sheaths of the same rugose character as the cloak, sinuated at the margins. Oral tentacles small, linear. Branchial plumes five, large, quadripinnate, brown, with a strong midrib and branches of a paler colour; the circle is incomplete behind. Foot rather broad, with a large strongly notched lamina in front. Length 6 inches.

Tongue as in *D. tuberculata*; no collar. The minute pallial tubercles are spiculose.

Rather rare. Three or four specimens are preserved in the collection.

This fine *Doris* is remarkable from its size and the sculpture and markings of its cloak. It is extremely soft and gelatinous, contracting very much in spirit. In several of its characters it comes near to the *D. spongiosa* of Kelaart.

DORIS VILLOSA, n. sp. (Pl. XXXIII. fig. 1.)

Body broadly oval, a little convex. Cloak ample, slightly sinuated at the margin, covered with irregular tubercles, the smaller ones clavate, the larger papillose, and frequently bearing one or two delicate filaments. Along the centre of the back there are three or four tubercular processes with filaments on the tubercles; there are a few similar processes on the sides; and smaller ones are scattered over the surface; the ground-colour of the cloak is ochre-yellow, inclining to orange towards the back, the centre of which is dark chocolate-brown, and large blotches of the same colour surround the margin, with a few various-sized spots between: under side freckled with brown, the marginal blotches also appearing through. Dorsal tentacles conical, bending backwards, finely laminated, with a shallow depressed line dividing the laminæ in front. Oral tentacles linear. Branchial plumes six, tripinnate, brown, forming an incomplete circle. Foot moderate-sized, laminated in front, but not notched; pale; with a few scattered freckles, most numerous at the margin. Length from 1½ to 2 inches.

Tongue as in *D. tuberculata*; no collar.

A variety of this species is much more soberly coloured, being of a stone-colour, with obscure bluish-black markings.

Rare. Two specimens are in the collection.

The tubercles are not represented sufficiently distinct in the figure, nor is their character well given.

Doris rusticata, n. sp. (Pl. XXX. figs. 4, 5.)

Body oblong oval, moderately depressed. Cloak firm, covered with large, flat-topped, distant, spiculose tubercles, interspersed with a few smaller ones; of a yellowish or rusty-brown colour. Dorsal tentacles clavate, with numerous chestnut-brown laminæ nearly meeting in front; when withdrawn, two large tubercles close over the orifice like lateral valves. No oral tentacles (?). The head with lateral angles. Branchial plumes five, pretty regularly bipinnate, freckled with brown. Foot pale and broad, slightly notched in front. Length nearly an inch.

Tongue as in *D. tuberculata*; no collar.

This species is tolerably common.

Doris castanea, Kelaart. (Pl. XXVIII. fig. 9.)

Body ovate, not much elevated. Cloak large, of a dark chestnut-brown colour, covered with stout, blunt tubercles. Dorsal tentacles stout, brown, with white tips. Oral tentacles short, linear, pointed. Branchial plumes six (?), short, bipinnate, of a dark purplish-brown colour. Under parts deep vermilion-red, speckled with dark red. Foot short, red. Length nearly 2 inches.

Doris castanea, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 303.

Of this *Doris*, which we refer to the *D. castanea* of Kelaart, no specimen is preserved in the collection; we can therefore only judge from the single drawing, some parts of which are rather imperfectly defined. The description of the under side is supplied from Kelaart.

Doris osseosa, Kelaart. (Pl. XXVIII. figs. 10, 11.)

Body elliptic-oblong. Cloak ample, firm, granular, greenish drab, with minute dark spots: an elevated rounded ridge runs down the centre of the back, rising to a large elevation a little in advance of the branchiæ; and an irregular network of small ridges, uniting with the central one, covers the sides: the ridges are paler than the spaces between them, and are covered with minute, obtuse, spiculose tubercles; there are also a few scattered tubercles in the spaces. Under side of the cloak pale, reticulated with paler lines, giving it a sponge-like appearance. Dorsal tentacles rather small, clavate, finely laminated, the laminæ divided in front by a depressed line; retractile within distinct tuberculated sheaths. Oral tentacles small, pointed. Branchial plumes five (?), tripinnate, spreading, retractile within a cup, the margin of which is scalloped and produced into a large lobe in front. Foot rather narrow, truncated in front, without markings. Length from 2 to 2½ inches.

Tongue like that of *D. tuberculata*; no collar.

Doris osseosa, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 298.

Not uncommon.

Doris tristis, n. sp. (Pl. XXX. figs. 6, 7.)

Body ovate-oblong, slightly raised. Cloak firm, coriaceous, with angular ridges and swellings on each side of the back, and a few tubercular elevations at the sides; the surface is also covered with minute tubercles, particularly on the ridges and swellings, and the hollow spaces between the latter are minutely reticulated with pale lines, the interstices being dark or black: a deep depression occupies the centre of the back in front, behind which is a large conical protuberance: the ground-colour of the cloak is dusky olive, with a few scattered dark brown freckles on the sides and along the margin; under side of the same colour as the upper, minutely reticulated, and with a few small black freckles. Dorsal tentacles retractile within elevated and minutely tuberculated sheaths, of a dark olive-colour, with the margins pale and denticulated; the tentacles are rather small, with minute laminæ divided in front by a depression; they are dark, with the tips white and pointed. Oral tentacles small, linear. Branchial plumes four, tripinnate, spreading laterally, rather paler than the cloak; the margin of the orifice much elevated and undulated, and produced in front into a large erect lobe. Foot ample, with a large deeply notched lamina in front, rounded behind, and extending a little beyond the cloak in progression: the upper surface freckled with black. Length 2 inches and upwards.

Tongue as in D. *tuberculata*; no collar. The cloak appears to be well supplied with spicula.

Not common. Only one specimen is in the collection.

This curious *Doris*, from its sheathed tentacles and dorsal protuberances, shows some affinity with *D. spongiosa*; but it differs from that species in the peculiar arrangement of the dorsal area, as well as in its very sombre and unattractive appearance.

Doris carinata, n. sp. (Pl. XXIX. figs. 5, 6.)

Body oval, rather raised at the sides, and flattish on the back. Cloak greenish olive-coloured, darker towards the back, regularly covered with small fulvous tubercular spots: an area on the centre of the back, extending from the tentacles to the branchiæ, is pale, and covered with whitish tubercles; this area is broad between the tentacles, linear down the back, and expands into a circle in front of the branchiæ. Dorsal tentacles clavate, brownish, without sheaths, the cavities with pale margins. Branchial plumes numerous, stout, greenish olive, forming a complete circle. Length ½ inch.

There is no specimen in the collection.

Doris apiculata, n. sp. (Pl. XXX. fig. 8.)

Body broadly oval, rather convex. Cloak firm, raised into reticulated ridges frequently radiating from elevated conical centres, each of which bears a delicate style or filament; the ridges and centres are crowded with minute, pale, spiculose tubercles, the interspaces being comparatively smooth and of a dark brown colour approaching to black; the colour of the elevated ridges and apices of the cones (which do not extend to the margin of the cloak) is yellowish, as are also the sides of the cloak, the latter being rather paler and obscurely blotched with brown; a row of minute dark spots runs along the extreme pallial margin. Under side minutely reticulated with pale lines, giving it a sponge-like appearance; there are also a few scattered pale brown spots. Dorsal tentacles clavate, rather slender, pale, with the laminated portion dark; retractile within short sheaths, the margins of which are beset with numerous minute points. Head small, with short lateral linear processes or oral tentacles. Branchial plumes five, tripinnate, freckled with blackish brown; the margin of the cavity minutely and irregularly denticulated. Foot narrow, plain below, spotted with brown above; the anterior lamina rather ample and notched. Length about an inch.

Tongue as in *D. tuberculata*; no collar.

This curious species comes very near to the *Doris incii*, figured in Mrs. Gray's 'Figures of Molluscous Animals.' It is not uncommon; only a single individual was preserved.

Doris funebris, Kelaart. (Pl. XXX. figs. 9, 10.)

Body oblong, white, with black spots. Cloak covered with minute, pointed, spiculose tubercles; white, with a few ocellated black spots on the back, the centres of which are granulated with black within a jet-black ring: the spots become smaller towards the margin of the cloak, where they are uniformly black. Dorsal tentacles clavate, white, with black laminæ and tips. Oral tentacles slender, linear, tipped with black or chocolate-brown; the head rounded. Branchial plumes six, large, quadripinnate, with black stems; retractile within an ample cup, the margin of which is considerable produced. Foot large, with a deep, strongly notched frontal lamina, spotted with black; produced a little beyond the cloak behind, and ending in a blunt point: white, with a row of black spots on the upper margin, shining through below, as do also the spots on the margin of the cloak. Length 2½ inches.

Spicula small, linear, and pointed, occasionally a little bent in the centre.

Tongue as in *D. tuberculata*; the spines large, and occasionally of a bright grass-green; no collar.

Doris funebris, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 293.

This beautiful *Doris* is not unfrequent on the Coromandel coast—though rare on that of Ceylon, according to Dr. Kelaart, from whom we have three fine examples. Only one specimen is preserved in Mr. Elliot's collection.

Genus CHROMODORIS, *Alder & Hancock*.

Body elongate, subquadrate. Cloak narrow, covering the head, but exposing the foot, smooth (?), generally marked with bright colours in stripes or spots. Dorsal tentacles laminated, retractile. Oral tentacles conical or tubercular. Branchiæ linear, simply pinnate, surrounding the vent on the medio-dorsal line, retractile. Tongue broad, with numerous close-set plates, arranged in many transverse rows, and each bearing two large spines, one set in advance of the other; the posterior one with three or four denticulations. No central spine or plate. A buccal collar formed of a pair of broad plates, with closely arranged, minute, bifid spines.

CHROMODORIS ZEBRINA, n. sp. (Pl. XXIX. fig. 7.)

Body elongated, slender, rounded in front, and tapering to a point behind; white, with red and yellow markings. Cloak broadly rounded, and produced considerably beyond the head in front; nearly parallel at the sides, narrow and rounded posteriorly; it is white, with a waved crimson stripe down the centre of the back, and transverse stripes of the same colour (of unequal lengths) at the sides and round the ends; there are largish yellow spots down each side of the central stripe and between the transverse ones near the margin: a crimson stripe also runs from the cloak along a ridge to the tail. Dorsal tentacles longish, clavate, with the laminated part crimson, the margin of the orifices a little raised. No oral tentacles: the head rounded in front and indistinctly angulated at the sides. Branchial plumes nine, small, simply pinnate, crimson, forming nearly a complete cup; the two posterior plumes smaller than the rest. Foot large, broadly truncated in front, and extended to a blunt point behind. Length $\frac{2}{10}$ths of an inch.

One specimen only is preserved, which, from its diminutive size, may probably have been young.

Family DORIDOPSIDÆ, *Alder & Hancock.*

Cloak large, without spicula or marginal appendages. Dorsal tentacles retractile within cavities; no oral tentacles. Mouth suctorial, opening on the front margin of the foot, without tongue, jaws, or collar; with a retractile proboscis.

Genus Doridopsis, nov. gen.

Body more or less depressed, ovate or elliptical. Cloak covering the head and foot, smooth or with soft tubercles. Dorsal tentacles laminated. Head minute, generally produced into small lateral lobes, without oral tentacles. Branchiæ plumose, wholely or partially surrounding the vent on the medio-dorsal line, retractile within a common cavity.

The chief peculiarities in the anatomy of *Doridopsis* are found in connexion with the alimentary system. In this genus there is no large rounded buccal organ, so constant in the *Nudibranchiata*. On the contrary, we see here, in the place of that powerful muscular apparatus, an attenuated suctorial tube or proboscis, which is capable of being protruded through a small circular orifice situated in the anterior margin of the foot. There is neither tongue, spinous collar, nor jaws, nor is there any armature whatever in connexion with this proboscidiform mouth. It is furnished, however, with two large folliculated glands, which pour their secretion through a slender duct into the anterior extremity of the proboscis. The secretion thus supplied may perhaps be a solvent, to enable the animal to penetrate the calcareous covering of its prey, and thus to reach its food, or it may be a poisonous fluid to benumb its victims. From the position of these organs, they might be supposed to be salivary glands; but the true salivary glands are present, situated as usual at the commencement of the œsophagus, though they are so small as to be almost rudimentary. They are in the form of irregular masses placed one at each side of the alimentary tube, just where it joins the posterior extremity of the proboscis. At this point the œsophagus is somewhat constricted, but it almost immediately enlarges into an elongated anterior stomach or crop. On reaching the anterior border of the liver it is again contracted a little, and, penetrating that viscus, it opens into the true stomach, which is of considerable extent. The liver itself is bulky, rounded a little, hollowed in front, and bifid behind. There are no distinct hepatic ducts, the stomach apparently being formed in a great measure by the expansion of their trunks. The walls of the cavity, however, have a peculiar honeycombed appearance, caused perhaps by a rudimentary condition of those conduits.

The intestine passes from the upper wall of the stomach, at some little distance behind the œsophagus, and penetrates the liver as a tube of no great size or length; it turns almost immediately backwards, and terminates in a large anal nipple in the usual position amidst the branchial plumes.

The reproductive organs do not present any very striking peculiarity. The male intromittent organ is extremely small, and the glandular tube in connexion with it is divided into two portions; that next the penis, or outer portion, is small and convoluted; while the inner portion is much wider, and has an extremely minute convoluted tube within it. The ovary is spread over the anterior portion of the liver, and, in addition to the large mucous gland, there is a small folliculated gland attached to the female outlet.

The vascular system appears to be as complete as it is in the *Dorididæ*,—arteries conveying the nourishing fluid to all the various organs, which fluid is returned to the auricle through the skin and branchiæ. That which passes through the aërating organs is derived entirely from the great hepatic vein, which drains the liver, stomach, and ovary. All these organs combine to form one single mass, within which the circulation appears to be complete. The hepatic vein passes backwards from the liver on the median line, and opens into the inner or afferent branchial channel, which is of a crescentic form, arched forwards, with the limbs passing close round each side of the anus. The branchial arteries open into this channel, and, passing up the inner surface of the gill-plumes, communicate through the leaflets with the branchial veins, which run down the opposite or outer side of the plumes. These veins debouch, on the other hand, into an outer, crescentic, efferent branchial channel, which opens into the posterior lateral angles of the auricle by two large orifices, one a little on either side of the median line. The blood returned through the skin is drawn from the general lacunary system. It is conveyed by a lateral pallial channel on either side of the back, and enters the anterior lateral angles of the auricle.

The nervous centres are characterized by extreme concentration—the cerebroid, branchial, and pedal ganglions forming a fused mass around the base of the proboscis. They exhibit also in a notable manner the globular structure so frequently observed in the Mollusca. The buccal ganglions are placed on the under side of the œsophagus, close to the true salivary glands; they are connected with the cerebroids by extremely long commissures, so as to allow the necessary action to the proboscis.

The above account of the anatomy of this genus has been drawn up entirely from *Doridopsis gemmacea*: the other species examined show no remarkable divergence in their structure, with the exception of *D. miniata*, in which there is no anterior stomach or crop, the gullet being continued backwards almost to the posterior extremity of the body as a constricted tube; and the intestine is considerably enlarged as it leaves the stomach.

DORIDOPSIS RUBRA, *Kelaart*, sp. (Pl. XXXI. figs. 1, 2.)

Body oblong-oval, rather depressed. Cloak well developed, smooth, and soft, of a rose-colour with brown blotches: under side pale, without markings. Dorsal tentacles placed well forward and near to each other; the laminæ rose-coloured, and divided in front by an elevated line; the cavities a little marginated. Head very indistinct, slightly lobed at the sides. Branchial plumes six, quadripinnate, rose-coloured, luxuriantly developed, forming a complete circle. Foot pale rose-coloured, broad, having the mouth, which is small and circular, opening further back than usual on the anterior margin. Length from 1½ to 3 inches.

Doris rubra, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 298.

A beautiful variety occurs, with the markings of a dark rose-colour. This is a common species, of which several good specimens are preserved in the collection.

DORIDOPSIS FUSCA, n. sp. (Pl. XXXI. fig. 3.)

Body oval, rather depressed. Cloak smooth and soft, undulating a little at the margin, of an olive-brown colour with darker blotches, and becoming paler towards the margin. Dorsal tentacles rather small, with brown laminæ and pale tips; the cavities slightly marginated. Branchial plumes six, large, quadripinnate, reddish brown. Foot broad, with the mouth situated as in *D. rubra*. Length from 2 to 2½ inches.

There may be some doubt whether this is distinct from the last.

DORIDOPSIS GEMMACEA, n. sp. (Pl. XXXI. figs. 4, 5, 6, 7.)

Body elongated, with the sides nearly parallel, and rounded at both ends. Cloak soft but tough, the dorsal portion with three longitudinal rows (one central and two lateral) of depressed, smooth, lozenge-shaped areas, of a rich brown colour, with a few brilliant blue spots in each; there are also two irregularly formed areas of similar character in front of the tentacles, and a few smaller ones down the sides. Between those on the back are two rows of elevated lozenge-shaped areas confluent with the rest of the cloak, and united in front behind the tentacles; these are of a pale brownish colour, with paler concentric lines, and have a large soft tubercle in the centre of each, with a dark bluish spot at the apex, and are surrounded by smaller tubercles at the base. These elevated areas are united at the angles, where there is usually a tubercle similar to those of the areas; other small tubercles and irregular dark areas are dispersed on the sides of the cloak, which in that portion is pale yellowish white, and marked at the extreme margin with sublinear blotches of blue or lilac, arranged in pairs in a radiating manner. Under side of the cloak pale, without markings, but with the blue or lilac blotches appearing through. Dorsal tentacles rather long and tapering, brown, with pale tips; the laminæ divided in front by a fine ridge: they are retractile within very short sheaths with pale margins. Branchial plumes five, large and spreading, quadripinnate; the circle open behind; of a yellowish-brown colour, beautifully lineated externally with dark brown, following the ramifications to the extreme pinnæ: the inner surface darker: margin of the cavity slightly tuberculated. Head small, with the lateral angles a little produced; mouth opening on the anterior margin of the foot. Foot ample, pale, without markings, produced a little behind the cloak in progression. The upper surface yellowish brown, with a pale margin, within which is an obscure dark line. Length from 2 to 4 inches.

Spawn yellowish white, in the form of a narrow band in two or three open coils.

This elegant species varies a little in colour and markings. It is not uncommon. Two or three specimens are preserved, in good condition.

Doridopsis clavulata, n. sp. (Pl. XXXI. figs. 10, 11, 12.)

Body elongated, depressed, and equally rounded at both ends. Cloak firm, but soft, of a brick-red colour, covered with large, rounded, soft tubercles paler than the cloak, tipped with yellow, and encircled at their base with dark red lines: a row of tubercles larger than the rest runs along each side of the back, exterior to which is a row of five or six nearly circular dark areas, with a few blue spots in each. The margin of the cloak is sinuous, and marked with dark yellowish-brown blotches: under side yellowish white, with corresponding blotches. Dorsal tentacles rather small, dark brown, with white tips; the laminated portion long and tapering: they are retractile within short sheaths with tuberculated margins. Branchial plumes five, large and spreading, quadripinnate, of a rich golden-brown colour, changing to violet at the edges; the stem and branches lineated with dark brown on both surfaces. Head small, with narrow auricular prolongations. Foot oblong-ovate, of a dark chocolate-brown colour above and below; margined with pale ochreous yellow. Length $2\frac{1}{2}$ inches and upwards.

A beautiful species, of which three well-preserved individuals are in the collection; it is nearly allied to the last, though evidently distinct from it. The spawn is whitish, forming a narrow, tortuous riband of no great length.

Doridopsis tuberculosa, *Quoy & Gaimard* (sp.). (Pl. XXIX. figs. 8, 9, 10.)

Body oblong-oval, rather depressed, semigelatinous. Cloak ample, yellowish brown inclining to olive, areolated and tuberculated; studded with large, warty, conical nodules, each surrounded by a circle of tubercles at the base. Under side smooth, of an olive-colour more or less deep, and covered with large, circular, white spots, generally circumscribed by a narrow ring of black. Dorsal tentacles stout, broadly laminated, generally turned a little backwards, dark chocolate-brown on the stem and laminæ, below which latter is a ring of white, with a streak from it running up between the laminæ to the apex; retractile within small sheaths. Oral tentacles linear.

Branchial plumes five, large, tripinnate, of the same colour as the cloak. Foot oblong, equally rounded at both ends, pale olive or pinkish, without markings. Length from 4 to 5 inches.

Doris tuberculosa, Quoy & Gaimard, Voy. Astr. vol. ii. p. 266, t. 19. f. 12, 13; Lam. Anim. s. Vert. 2nd ed. vol. vii. p. 469; Gray, Fig. Moll. Anim. t. 65. f. 4.

Doris carbunculosa, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858?; idem in Ann. Nat. Hist. 3rd ser. vol. iii. p. 301?

There can be little doubt that this is the *D. tuberculosa* of Quoy & Gaimard, and perhaps it may also be the *D. carbunculosa* of Kelaart, though, as the conspicuous white spots on the under side of the cloak are not described by the latter naturalist, nor represented in his drawing, some doubt may remain respecting it. The large cones that stud the upper surface of the cloak give this species a very peculiar appearance. It is not unfrequent on the Coromandel coast; two specimens were brought home.

DORIDOPSIS PUSTULOSA, n. sp. (Pl. XXXI. figs. 8, 9.)

Body oval, rather depressed. Cloak with large conical pustules irregularly disposed over the back, of a dull ochreous-yellow colour, concentrically ridged or lineated, with a largish tubercle on the apex of each, and occasionally a few smaller ones at the sides; the pustules nearly touch each other at the base, the interspaces being narrow and of a dark brown colour; margin of the cloak pale yellowish white, with ochreous-yellow stripes running in pairs towards the edge. Dorsal tentacles rather small, bent a little backwards, brown, with a white ring below the laminæ, a spot of the same in front, and a white apex. Branchial plumes five, moderate-sized, yellowish, with brown lines along the ramifications. Length 1¾ inch.

As the specimen of this species was lost, the character of the under side cannot be given. It has some resemblance to the last, of which it may possibly be the young.

DORIDOPSIS NIGRA, *Stimpson*, sp. (Pl. XXXI. figs. 13, 14, 15, 16.)

Body elliptical, rather convex. Cloak smooth and soft, black with a bluish tinge, rather paler towards the margin, freckled with minute, well-defined, white spots, larger and more numerous towards the margin; on the back they become clustered, generally round a larger spot; under side black, without markings. Dorsal tentacles clavate, black, with pure-white tips; the upper portion bent backwards; laminæ eighteen or nineteen, well developed, and divided in front by a narrow ridge; retractile within simple cavities. Branchial plumes eight, forming a circle incomplete behind, tripinnate, uniformly black, soft, and plumose. Head indistinct, indicated by a slightly arched elevation in front of the foot, produced into points at the sides: mouth situated in a depression dividing the anterior edge of the foot, behind which is a small area. Foot of a smoky colour. Length from 1½ to 3 inches.

Var. *a*. Cloak with larger white spots on the sides, and compound ones on the back; an obscure red line surrounding the cloak at a little distance from the margin, best seen from the under side. Branchial plumes bluish black. Foot dark smoky brown, with a pale reddish margin.

Var. *b*. Cloak black, with simple white tubercular spots; margin blue, with a rose-coloured or crimson line within it, surrounding the cloak. Branchial plumes brown. Foot dark brown, with a paler red edge (*Doris atroviridis*, Kel.).

Var. *c*. Cloak dark yellowish brown on the back, becoming paler towards the sides, with a faint blue margin: spots as in the typical form. Branchial plumes brown.

Doris nigra, Stimp. in Proc. Philad. Acad. Nat. Sc. 1855.

Doris atrata and *D. atroviridis*, Kel. in Journ. Asiatic Soc. 1858; idem in Ann. Nat. Hist. 3rd ser. vol. iii. pp. 299, 300.

This species appears to be plentiful and widely distributed; the specimens described by Professor Stimpson having been obtained at the Loo Choo Islands. The *Doris atrata* and *D. atroviridis* of Kelaart were considered by him to be distinct species; but the varieties enumerated above show that they pass into each other by imperceptible gradations.

Several specimens were preserved.

Doridopsis atromaculata, n. sp. (Pl. XXXI. figs. 20, 21, 22, 23, 24.)

Body ovate, rather convex. Cloak soft and thick, pale buff-coloured, with various-sized scattered papillæ: the largest of these are black, and give the cloak a spotted appearance; they are slightly branched or serrated, with pointed white tips; the smaller papillæ are slender, less branched, pointed, and of the same colour as the cloak. Dorsal tentacles yellowish, with numerous laminæ, tapering towards the apex and separated by a ridge in front. Branchial plumes three, tripinnate, snuff-brown-coloured: two are lateral and one posterior, with a rudimentary plume in front: anal tube large, nearly central, on the left side of the posterior plume. Head not visible externally; oral aperture minute, situated immediately in front of the thickened margin of the foot. Foot oblong-oval, of a deeper buff colour than the cloak, with a dark blotch in front. Length 2 inches.

Rare; one specimen only preserved.

Doridopsis punctata, n. sp. (Pl. XXXI. fig. 17.)

Body ovate, rather convex, broad behind and subtruncate in front. Cloak yellowish, soft, with a few opake white tubercular freckles, and scattered, sharp, black, minute spots or points: there are also along the margins and near the tentacles and branchiæ numerous blurred spots and blotches of a dusky violet colour, with generally a black point in the centre and a few clustered about it: under side pale, with scattered black freckles. Dorsal tentacles small, clavate, placed near to each other. Branchial plumes three, tripinnate, two placed forward and one behind, the anus opening at the right side of the posterior plume: the stems are stout and dark, with a few freckles; the pinnæ yellowish. Head small; the mouth minute, opening on the anterior margin of the foot. Foot pale yellowish, freckled with black both above and below. Length about an inch.

Not uncommon. A single specimen is in the collection.

Doridopsis miniata, n. sp. (Pl. XXXI. figs. 18, 19.)

Body oval, much depressed. Cloak vermilion-coloured, paler at the edges, and covered with rather distant, rounded tubercles of nearly equal size, becoming smaller towards the margin. Dorsal tentacles conical; with numerous dark laminæ, only divided in front by a delicate ridge; apex rather blunt; margin of the cavity slightly raised. Branchial plumes five, tripinnate, scarlet, two in front and three behind; the anus is excentric, terminating on the left side close to the root of the left anterior plume. Head very indistinct, indicated by an arched ridge immediately in front of the foot; the mouth is very minute, opening in a cleft on the anterior margin of the latter. Foot scarlet, nearly equally and sharply rounded at both ends: the smooth anterior area very limited. Length 1½ inch.

A variety is of a much paler colour, with the centre of the back nearly black.

Spawn scarlet, forming an irregularly convoluted riband.

Doridopsis miniata is remarkable on account of the excentric position of the anus, at the side of the branchial plumes. This character is observed, in some degree, in the two preceding species, where the presence of a central posterior plume occasions a slight displacement of the anal opening.

Common: four or five specimens are in the collection.

Family POLYCERIDÆ, *Alder & Hancock.*

Cloak small or obsolete, spiculose, generally with marginal appendages. Dorsal tentacles variable. Oral tentacles frequently wanting. Mouth provided with a spinous prehensile tongue, and generally with a spinous collar or horny jaws.

Genus Goniodoris, *Forbes.*

Body elongate, prismatic or subquadrate. Cloak small, short, with a scalloped margin, exposing the head and foot. Dorsal tentacles laminated, non-retractile. Oral tentacles flattened. Branchiæ plumose, surrounding the vent on the medio-dorsal line, non-retractile. Tongue narrow, with four spines in breadth; the two next to median line large: no central plate: a spinous buccal collar.

GONIODORIS ASPERSA, n. sp. (Pl. XXXIII. fig. 2.)

Body elongated, densely and minutely freckled with dark chocolate-brown. Cloak oblong or subquadrate, with the margin slightly sinuated and turned up at the sides, and also in front, where it is bent back in a rounded lobe; the posterior end bending inwards behind the branchiæ: the cloak is densely freckled like the rest of the body, having an irregular pale line running down each side: the margin is also pale, with a few black and yellow spots; and an irregular line of light spots runs along each side of the body below the pallial margin. An obtuse carinated ridge reaches from the mantle to the tail. Dorsal tentacles clavate and laminated, freckled with the same dark colour as the body. Branchial plumes five, small, twice or thrice pinnated, and placed a little apart from each other and from the anal nipple; they are darkly freckled above, with yellow tips; the under surface pale. Head squared in front and produced considerably beyond the cloak, the sides forming two moderate-sized tentacular processes held laterally. Foot yellowish, without markings, truncated in front, and rather narrow, with the sides almost parallel, extending beyond the cloak for about one-fourth of the whole length of the body, and terminating in a blunt point. Length nearly $\frac{1}{2}$ an inch.

Tongue minute and like that of *G. nodosa*, but the sides of the spines are smooth; there is a buccal collar with rudimentary jaws, as in *Doris pilosa.*

Rather rare: two specimens are in the collection.

GONIODORIS CITRINA, n. sp. (Pl. XXXII. figs. 1, 2, 3.)

Body oblong-ovate, broad in front and tapering to a point behind, lemon-coloured, with the processes tipped with purple-brown. Cloak largely developed, and produced at the sides into about seven rounded lobes reflected upwards and densely freckled with purple-brown; posteriorly the pallial margin appears to terminate in a well-produced point on each side, but an indistinct ridge converges from thence to a fringed keel tipped with purple-brown, which runs down to the tail: the rest of the cloak is pale lemon-yellow, darker towards the centre, where there is a slightly elevated ridge bearing obtuse points. Dorsal tentacles clavate and strongly laminated; the laminæ and tips of a purple-brown colour. Head not much produced, very broad, with two shortish, flattened tentacular processes, somewhat pointed, and tipped with purple-brown. Branchial plumes five, large, tripinnate, yellow, marked on the under surface with purple-brown, closely surrounding the anus, the two posterior plumes rising from the roots of the lateral pair. Foot broad and ample, of an ovate form, truncated in front, and produced into a point behind. Length upwards of an inch.

Tongue as in *G. nodosa,* very minute; the sides of the spines are extremely minutely denticulated: no spinous collar was observed.

Tolerably frequent. Only one specimen preserved.

Goniodoris modesta, n. sp. (Pl. XXVIII. fig. 12.)

Body oblong, with parallel sides, and tapering to a very slender tail; of a chestnut-brown colour. Cloak with a pale margin spotted with black and yellow, irregularly sinuated and turned up all round, forming two lobes before the dorsal tentacles, and expanded a good deal at the sides anteriorly, meeting in a point behind the branchiæ, and thence forming a slight crest to the tail. Dorsal tentacles fusiform, largely laminated, and very slender below, brown like the body. Head very little extended beyond the cloak, produced into two clavate oral tentacles at the sides. Branchial plumes five, large, set rather widely apart round the anus; bi- or tri-pinnate, brown, the edges rather pale. Foot linear, tapering behind into a long slender tail. Length $1\frac{1}{4}$ inch.

No specimen of this very distinct species was in the collection.

Genus Trevelyana, *Kelaart*[1].

Body limaciform, without cloak or appendages. Dorsal tentacles laminated, retractile: no oral tentacles. Branchiæ plumose, surrounding the vent on the centre of the back, non-retractile. Tongue broad, with simple spines: no collar nor jaws.

Trevelyana, Kel. Journ. Asiatic Soc., and Ann. Nat. Hist. 3rd ser. vol. i. p. 257.

Trevelyana bicolor, n. sp. (Pl. XXIX. figs. 11, 12.)

Body elliptic-oblong, nearly linear, tapering to a blunt point behind, white on the head and sides, with an oval dorsal area of a blackish colour, the whole spotted with golden yellow. Tentacles clavate and laminated, white, with the apex and anterior portion yellow; retractile within cavities. Branchial plumes twelve or thirteen, pinnate, forming a circle on the centre of the back; white, with a yellow midrib externally, and yellow tips. Foot linear, white. Length $\frac{1}{2}$ an inch.

No specimen of this interesting genus is preserved in the collection.

Genus Plocamophorus, *Rüppell.*

Body limaciform. Cloak obsolete, forming an expanded veil with branched appendages on the head, and two or three tubercular processes on the sides of the back. Dorsal tentacles laminated, retractile. Oral tentacles flat. Branchiæ plumose, non-retractile, surrounding the vent on the centre of the back; a wide fin-like carinated ridge running down the posterior part of the back to the tail.

Tongue broad, with twelve or thirteen plates on each side, the three next the centre bicuspid: no central plate. An incomplete buccal collar.

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[1] This genus may possibly be synonymous with the *Gymnodoris* of Stimpson, Proceed. Philad. Acad. Nat. Sc. 1855.

The anatomy of *Plocamophorus* corresponds very nearly with that of *Polycera*. The buccal organ is large. The tongue (in *P. ceylonicus*) has eighteen rows of plates, twenty-four to twenty-six in each row; the central space is bare, without any plate; the three plates on each side next the centre bear two large broad spines; beyond these on either hand there are nine or ten elongated and squared plates with elevated centres. The buccal lip is supplied with an incomplete collar, open above and wide below; it is stiff and almost horny, and has the surface covered with rather long, stout, bristle-like processes.

The œsophagus as it leaves the posterior extremity of the buccal organ is much contracted, and has on either side, opening into the mouth, a long tubular salivary gland. The alimentary tube almost immediately expands into an elongated anterior stomach or crop. This becomes constricted again as it approaches the anterior extremity of the liver; and penetrating that organ, it is enlarged once more, and assumes the character of a second stomach of rather limited dimensions. The intestine is a moderately long tube; it passes from the anterior wall of this stomach, and issuing through a cleft on the left side of the liver, turns backwards to terminate in an anal nipple within the branchial circle. The liver is an ovate mass, rounded behind and truncated in front; it throws the hepatic fluid into the second stomach by two ducts which open in the floor of the organ, one on each side of the pyloric orifice.

The reproductive organs resemble, in their general features, those of *Polycera quadrilineata*; but in the place of the large laminated organ in connexion with the glandular tube leading to the penis, there is a beautiful dendritic gland, composed of several distinct systems of ramuscules, which are spread over the large spermatheca, forming for it a sort of open capsule, as the mace does for the nutmeg. The ramuscules are connected by their trunks to the inner extremity of the tube attached to the penis; and at the point of junction the usual connexion of the oviduct with the male apparatus is effected by a short, slender duct. The vascular system does not appear to differ from that of *Polycera*; and the nervous centres closely resemble those of *P. quadrilineata*, all the principal ganglions being distinct and lying above the œsophagus.

PLOCAMOPHORUS CEYLONICUS, *Kelaart*, sp. (Pl. XXXII. figs. 4, 5, 6.)

Body oblong, tapering behind, of a yellowish fawn-colour, spotted and blotched with warm brown: the blotches largest on the back, where they assume some degree of symmetry, there being usually a large, elongated, branched blotch between the tentacles, and another between the first pair of pallial processes, with smaller ones behind. The surface is covered with delicate, pale, branched papillæ. Mantle obsolete on the sides of the body, where its position is indicated by three pairs of branched processes, the two posterior pairs having their extremities enlarged and rounded: in front the mantle is produced into an ample arched veil, the margin bearing a fringe of numerous branched processes of various sizes: the veil is marked and coloured like the body.

Dorsal tentacles set wide apart, stout, clavate, freckled with brown; produced above into a white mucro; sheaths short, with the margins minutely papillated. Oral tentacles forming broad lamelliform lobes. Branchial plumes five, tripinnate, large and spreading, situated on an elevated portion of the centre of the back, and rising from a slightly pedunculated base; they are freckled like the body, with a pale line running up the stem and branches. The dorsal ridge of the tail is produced into a large fin-like expansion, the margin of which bears a few minute processes. Foot rather narrow, pale yellowish white, pointed behind, and truncated in front, where there is a shallow groove forming an indistinct frontal lamina: the upper surface is spotted with yellow or orange. Length 1½ inch.

A variety is of a deep orange-colour, darkest on the centre of the back, and without markings: the branchiæ and other processes are pale and nearly white: the upper surface of the foot is also paler and spotted with orange.

Polycera (?) *ceylonica*, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858.

This interesting mollusk is rather common on the Coromandel coast. According to Dr. Kelaart, it is very rare in Ceylon. He remarks that "The transparent membranous expansion is fully extended when the animal swims, which it does more freely than any known species. For ten or fifteen minutes it will keep floating and moving its body like an eel in the water."

There are five or six specimens preserved in the collection.

Genus KALINGA[1], nov. gen.

Body oval, subprismatic, rounded behind. Cloak not much produced, the margin most developed in front, where there is a row of close-set papillated processes covering the head; a few similar processes are on the sides of the back. Dorsal tentacles laminated, retractile within sheaths. Oral tentacles flattened. Branchiæ plumose, non-retractile, surrounding the vent, but placed separately at a little distance from it on the posterior part of the back. Tongue broad, with numerous rather distant rows of tricuspid spines: no jaws nor collar.

This genus is somewhat intermediate between *Euplocamus* and *Plocamophorus*, but differs from both in the obtusely rounded form of the body, and in the separate position of the branchial plumes, in this respect approaching to *Hexabranchus*. It also differs from *Plocamophorus* in the absence of an expanded veil, as well as of the peculiar fin-like tail. The oral armature is likewise different from that of the two former.

Of the three specimens in the collection, two were much mutilated, and the third was quite in an immature state. The anatomy of all the organs, therefore, could not be determined.

The buccal organ is extremely large and muscular: it is of a rounded form, somewhat

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[1] An old Indian name for Telinguna.

produced behind; there are no jaws nor collar, but it is provided with a large fleshy tongue, which sustains the spinous membrane described above. The spines are minute in comparison with the great size of the tongue.

The salivary glands open rather far forward into the buccal organ. They are tubular, a little folliculated at the base, and placed on each side of the median line. The œsophagus passes from the upper surface of the buccal organ: it is rather wide and long, and tapers slightly as it penetrates the anterior surface of the liver, which is small and conical, with the base forwards, and hollowed a little. The intestine issues from a cleft in the left side of the liver, and, passing across almost to the opposite side, arches backwards, and terminates in a nipple-formed anus in the centre of the branchial circle.

The cerebroid, branchial, and pedal ganglions are fused into one mass, which is placed on the dorsal aspect of the buccal organ. The commissure has consequently to pass round this organ to complete the nervous collar, and is therefore extremely long. The ganglionic mass is made up of a multitude of strongly defined globules, varying in size, and giving to the organ a very striking appearance. The eyes are almost sessile on the anterior portion of the mass.

KALINGA ORNATA, n. sp. (Pl. XXXII. figs. 7, 8, 9, 10.)

Body broadly oval, rather enlarged and rounded behind, not produced into a tail; skin coriaceous, but rather soft, covered on all the upper surface with distant, soft, papillated tubercles, of various sizes, having the appearance of little tufts. Cloak rather broad, forming a ridge along the side, and produced over the head into twelve or fourteen close-set, linear or subclavate, fimbriated or papillated processes; six or seven larger but similarly branched processes run down each side on the ridge of the cloak, the ridge itself terminating at each side behind the branchiæ in one of these processes. The colour of the surface is white or yellowish, varied with tints of green and rose-colour on the anterior portion; the tubercles white, with frequently a rose-coloured or crimson spot in the centre: the frontal processes are white; those down the sides crimson, with yellow tips. Dorsal tentacles rather small, clavate, or subfusiform, tapering to a point above; the laminæ divided by a narrow groove in front: the base of the tentacles and upper part of the laminated portion are crimson; the intermediate space and tips white: the sheaths are subglobose, surrounded near the margin with crimson tufts. The sides of the head are expanded into large oval discs, which are adherent to the under surface of the mantle; the oral tentacles, which are small and flattened oval processes, spring from the anterior margin of these discs. Branchial plumes generally five, large and spreading, placed at some little distance from the anus and from each other; three or four times pinnate, white, with the pinnæ veined with crimson. Foot very broad, rounded behind, and laminated but not notched in front. Length varying from 3 to 8 inches.

Occasionally found along the Coromandel coast. When alive, the tinting of the mantle is exceedingly delicate and beautiful.

Suborder Polybranchiata, *Férussac.*

Family SCYLLÆIDÆ, *Alder & Hancock.*

Genus Scyllæa, *Linnæus.*

Body compressed. Cloak produced into lateral lobes, with plumose or tufted branchiæ scattered over the inner surface. Tentacles two, laminated, with large, compressed sheaths. Veil rudimentary. Anus lateral. Foot linear, grooved.

Tongue broad, with numerous rows of denticulated spines.

Scyllæa marmorata, n. sp. (Pl. XXXIII. fig. 3.)

Body rather stout, nearly linear, tapering to a blunt point at the tail; marbled with dark and pale brown, with a few scattered ill-defined spots of a dusky hue: a pale line runs down the back of the tentacular sheath and along the pallial ridge, following the branchial lobes, and uniting behind in a single line which passes along the margin of the caudal crest: a row of distant yellow tubercles runs along each side of the body, with a few indistinct scattered ones on the same part. Tentacles small, finely laminated, rising out of large wide sheaths, the posterior surface of which is expanded into an arched wing or crest. Branchial lobes two pairs, placed rather close together, pretty regularly rounded or ovate, marked with a darker belt of marbling externally, within the pale line already mentioned. Branchial tufts luxuriant, covering nearly the whole of the inner surface of the lobes, and extending a short way on each side of the caudal crest, which is not very large, commencing abruptly, and arching pretty regularly backwards. Foot narrow, truncated in front, and pointed behind. Length 1½ inch.

This species differs from *S. pelagica* in colour and markings, in its smaller size, more rounded lobes, and less produced caudal crest; but the species of this genus have been so imperfectly described that it is not easy to decide upon their specific differences.

Three specimens have been preserved in good order. The species is stated to be common.

Scyllæa viridis, n. sp. (Pl. XXXIII. figs. 4, 5.)

Body rather slender, linear, produced into a slender pointed tail, of a uniform greenish colour, with a few pale tubercles. Tentacles stoutish, rising from short sheaths, with the margins and crest much expanded. The head a little produced and truncated. Branchial lobes, two pairs, placed rather further back than in the preceding species, ovate, rather thin and flexible. Branchial tufts finely fimbriated, scattered over the inner sides of the lobes and on the back; caudal crest nearly obsolete, the posterior extremity much compressed and extending into a fine point. Length about an inch.

Rare: only a single individual was taken.

Family TETHIDÆ, *Alder & Hancock.*

Body elongate or ovate. Cloak indistinct or wanting. Veil large, funnel-shaped. Tentacles two, dorsal, retractile within sheaths. Branchiæ plumose, clavate, or muricated, set in single series on the sides of the back. Anus latero-dorsal. Mouth without tongue or jaws.

Genus MELIBE, *Rang.*

Body elongate, compressed, without cloak. Head with a large hood-like veil fringed at the internal margin. Tentacles two, small, with long pedunculated sheaths. Branchiæ large, clavate or wedge-shaped, set in single series on each side of the back. Foot linear, grooved.

Our specimens were too much injured to enable us to determine the anatomy with anything like minute accuracy. We succeeded, however, in ascertaining sufficient to prove that *Melibe* is very closely related to *Tethys.* This is obvious enough from an examination of the digestive and reproductive organs.

In *Melibe* the buccal organ is provided with neither tongue, jaws, nor collar; it is not by any means very distinctly marked, formed as it were by a mere enlargement of the œsophagus, and having little or no increase of muscular power. It opens in front through fleshy lips, situated towards the lower margin of the veil; and the œsophagus passes from behind as a very short, somewhat constricted tube. The stomach is a rather large pyriform pouch, with its small extremity placed backwards. It lies diagonally across the anterior portion of the visceral cavity, and is divided into an anterior and posterior chamber by a slight constriction near the centre. The interior of the lower portion of the posterior chamber is encircled transversely by an almost complete belt of horny, compressed, lancet-shaped processes, similar to those in the gizzard of *Scyllæa*; so that this division of the stomach should perhaps be looked upon as a gizzard. A little behind this belt is situated the pyloric orifice. The intestine is short and wide; it passes from the posterior extremity of the stomach, and turns immediately backwards; it then bends to the right, and terminates in a nipple-formed anus on the side of the back. At the point where the intestine joins the stomach, there is a rather large, rounded organ, with the interior laminated. This is apparently the same as the pancreatic origin in the Dorides.

The central portion or tube of the gastro-hepatic apparatus is large and folliculated: it opens into the left side of the stomach, a little in advance of the belt of horny processes. From this point, and from the corresponding point on the opposite side, folliculated branches are sent to the anterior branchial processes; and similar branches from the central tube penetrate the posterior processes. The hepatic glands within the processes are very slender, and are delicately branched. All these characters of the digestive system are alike common to *Tethys*, with the exception of the belt of horny processes encircling the stomach, and the branching of the hepatic gland within the branchial processes, which two features seem to distinguish *Melibe*.

The reproductive organs also closely resemble those of *Tethys*: there is the same peculiar form of the mucous gland in connexion with the female channel, the same single, almost sessile, spermatheca, and the same rounded compact gland interposed between the glandular tube of the penis and the oviduct.

In the nervous system this relationship is likewise seen. The principal ganglions are, as in *Tethys*, fused into a single mass; and, as in that genus, they exhibit in the same conspicuous manner the globular structure well known in the Mollusca, the whole mass being composed of distinct globules of various sizes. The eyes are sessile on the anterior portion of the cerebral mass.

MELIBE FIMBRIATA, n. sp. (Pl. XXXIII. figs. 6, 7.)

Body elongated and elevated, nearly linear, much compressed at the sides, and tapering to a narrow tail; skin rather thick, soft, and covered throughout with slender fimbriated filaments; colour ochre-yellow, deepening to fulvous on the back, spotted and blotched with darker shades of the same colour. Veil large, convex, covering the head like a hood; the margins fringed with numerous linear filaments. Tentacles with nine or ten laminæ, sharply angulated at the sides, and divided in front by a strong midrib; they are placed within cup-like sheaths, supported on long, narrow, linear footstalks, situated on the posterior part of the veil. Branchial processes very large, wedge-shaped, thin, and coming to an edge at the upper margin, which is widened a little and truncated; much thickened below, where they are attached by a slight peduncle: the surface is fimbriated like the body. They are set in a row of six or seven on each side of the back, extending nearly to the tail, the posterior ones smallest; they are flexible, and often bent over at the ends. Foot very narrow and grooved. Length 7 or 8 inches.

The *Melibœa viridis* of Kelaart is probably a variety of this extraordinary-looking animal in a young state; but as the name of *viridis* is quite inappropriate to our species, and would lead to an erroneous impression of its colour, we have not thought it desirable to adopt it, especially as this name has not got a footing in science. A small, white, hyaline variety is represented among Mr. Elliot's drawings, which seems to be Kelaart's species, but is assuredly the young of *M. fimbriata.*

This species is tolerably frequent, but is difficult to preserve entire on account of the deciduous nature of the processes. It has a delicate and gelatinous appearance when alive.

Two or three mutilated specimens are in the collection.

M. fimbriata differs from the *M. rosea* of Rang in the form of the branchiæ, which in the latter are claviform, with rounded tops, and beset with stout tubercles. The body of *M. rosea* likewise appears to be smooth.

Family DENDRONOTIDÆ, *Alder & Hancock.*

Genus Bornella, *Gray.*

Body compressed, without cloak. Tentacles two, retractile within branched sheaths. Head with two branched or fimbriated appendages. Branchiæ plumose and papillose, arranged on foot-stalks, in single series on each side of the back. Anus lateral. Tongue narrow, with a large, broad, denticulated, central spine, and several smooth lateral spines on each side.

The anatomy of this genus confirms the opinion (that might be inferred from its external characters alone) of its close relation with *Dendronotus.* The organic structure in the two forms agrees throughout in almost every particular.

The buccal organ is rather large, and is armed with corneous jaws and a spiny prehensile tongue, which is supported on the ridge of a wedge-shaped muscle that rises from the floor of the mouth. The armed membrane is supplied with from thirty-eight to forty transverse rows of spines, a large broad central spine with the margins denticulated, and on each side of it nine smooth comparatively slender ones. Two dendritic or folliculated salivary glands pour their secretion through delicate ducts into the posterior extremity of the buccal organ, one on each side of the œsophagus.

The œsophagus is rather long and slender: it opens into the anterior extremity of the stomach, which is well defined, rather large, and of an oval form. The latter has in the interior a broad transverse belt of soft, recurved, pointed papillæ, arranged in close-set longitudinal rows. The hepatic duct enters just in front of this belt; and a large fold of the mucous membrane, which passes from the intestine, advances to its posterior margin. It is difficult to say what is the function of this peculiar papillose structure, though, from its position, it may possibly be a modification of the supposed pancreatic organ in *Melibe.*

The intestine is extremely short: it issues from the posterior extremity of the stomach, and goes to the right side of the animal, where it terminates in an anal nipple between the first and second branchial tufts.

The liver is, in a great measure, retained within the visceral cavity, as an elongated, folliculated mass, the anterior extremity of which, extending up the left side of the stomach, is attached to that viscus, and opens into it a little behind the œsophagus. Folliculated branches pass from this biliary organ to the branchial tufts, and penetrate to the papillæ, within which they terminate in slightly branched or folliculated prolongations. The anterior pair of tufts, however, receive their branches from folliculated masses attached to the dorsal wall of the stomach in front, which masses open into the anterior portion of the stomach.

The reproductive organs, as far as they could be determined, resemble those of *Dendronotus*; and, as in it, the ovary lies above the liver or central folliculated trunk of the gastro-hepatic system.

The vascular system is also similar to that of *Dendronotus.* The heart occupies a distinct pericardium, on opening which it is easy to see that the blood is returned from the branchiæ by four lateral vessels, two in front and two behind. The gills are very peculiar: they are in the form of pedunculated tufts, each tuft being composed of simple papillæ and laminated plumes; and it is evident that the blood takes a definite course through both structures. It finds its way through the cellular tissue of the peduncle into all the divisions of the tufts; it then passes over the aërating surfaces, and reaches the efferent branchial channels which run down the outer margins of the papillæ and plumes, and unite at the base to form one common trunk, which descends at the posterior margin of the peduncle. Arrived at this point, the blood falls into the great lateral channels that lead to the auricle. From these facts there can be little doubt that the papillæ, as well as the plumes, are gills, only the latter are a little more differentiated or somewhat more highly organized. That the one is only the other modified, we have a proof in an abnormally developed plume which one of the specimens exhibited: this plume retained to a considerable extent the appearance of a papilla.

The cerebral ganglions are arranged as in *Dendronotus.* The cerebroid and branchial are fused into two oblong masses, which are united across the median line; and the pedal lie beneath the œsophagus: the commissural cord has disappeared, these latter ganglions being united by their inner margins below the œsophagus.

BORNELLA DIGITATA, *Adams.* (Pl. XXXIII. figs. 8, 9.)

Body nearly linear, rounded above, flesh-coloured, covered with crimson reticulated lines. Sides of the head produced in front into two star-like, rounded lobes, with six or seven radiating filaments on the margin and others beneath. Tentacles clavate or fusiform, obliquely laminated, retractile within long cylindrical sheaths, the upper margin of which bears four linear papillæ, one of which is much larger than the rest and clavate, banded near the top with crimson, and tipped with yellow. Branchial processes six on each side of the back, in single series, diminishing posteriorly: they are pedunculated, branching above into two or three stout papillæ, each with a band of crimson, above which is yellow, with the extreme apex white: at the inner base of these papillæ arise three delicate bipinnate plumes of a white or pale-yellow colour. Foot linear, spreading a little at the sides. Length 1¾ inch.

Bornella digitata, Adams & Reeve, in Voy. Samar. p. 67. t. xix. f. 1.

Rather rare. Two or three specimens were brought home.

Family PROCTONOTIDÆ, *Alder & Hancock.*

Body depressed. Cloak more or less distinct. Dorsal tentacles non-retractile. Oral tentacles small or wanting. Branchiæ fusiform or linear, arranged round the cloak on each side of the back and above the head in front. Anus dorsal or lateral. Mouth with corneous jaws.

Genus MADRELLA, nov. gen.

Body depressed, ovate, with a distinct cloak. Dorsal tentacles with the upper portion papillated; no oral tentacles. Head broad, with a semilunar veil. Branchiæ papillose or linear, placed in several rows round the margin of the cloak. Anus lateral. Tongue narrow, with three pectinated plates in each row.

The anatomy of this genus proves its close relationship to *Antiopa*. The buccal organ is extremely large and muscular, and the jaws are very large and strong; but their cutting edges are devoid of the denticulations that characterize these organs in that genus. In this respect *Madrella* agrees with *Proctonotus*. The narrow tongue, however, is peculiar, that of the other members of the family being generally broad, with numerous smooth spines. In our species it is strap-formed, with fifty-seven or fifty-eight rows of pectinated plates, three in each row; the central one has eight or nine denticulations on each side, and a large spine in the centre; the lateral plates have a large spine at the outer margin, and twelve or thirteen smaller ones or denticulations on the inner margin. The œsophagus is short: it leaves the dorsal wall of the buccal organ further forward than usual. There are apparently no salivary glands. The stomach is wide and irregularly rounded. The intestine is a widish tube of moderate length; it passes to the right, and then dips below the ovary, and, bending backwards, ascends a little to terminate in a nipple-formed anus, situated about two-thirds down the right side, directly below the overhanging pallial margin.

The gastro-hepatic system is arranged much in the same manner as it is in *Antiopa*. A dark brown folliculated glandular substance extends all round the animal, within the expanded pallial border. This substance, which, in the living state, would probably assume a branched appearance, is connected with the stomach by three wide tubes, two of which, the anterior, pass from the upper wall of the stomach at its junction with the œsophagus, and go, one on each side, to the folliculated substance in front; the third or posterior tube passes from the under side of the stomach immediately behind the œsophagus, and runs backwards, passing below the ovary, to the posterior portion of this substance on either side. The papillary glands are simple, or perhaps a little folliculated; they originate in this glandular matter, and are very short, extending only into the base of the papillæ.

The reproductive organs agree, as far as they were examined, with those of *Antiopa*; and the nervous centres appear to be similar to those of that form.

This genus evidently belongs to the family Proctonotidæ; but it has become necessary to extend the previous characters of the family to include it, as it differs from the other members of the group in the lateral position of the anus, and the absence of oral tentacles, unless the veil-like expansion of the head be so considered.

MADRELLA FERRUGINOSA, n. sp. (Pl. XXXIII. figs. 10, 11, 12.)

Body elongate wedge-shaped, or sharply ovate, depressed, broad in front, and tapering to a point behind; of a deep rusty-brown colour. Cloak much produced at the sides and in front, nearly covering the head and foot, excepting posteriorly, where the latter extends into a pointed tail, carinated above. Branchial papillæ linear, tapering to a fine point, placed three or four deep round the margin of the cloak, extending round the head in front of the tentacles and meeting behind, so as to form a continuous belt, leaving a bare space in the centre of the back, where there are a few scattered tubercles: the papillæ are of moderate size, becoming small towards the margin of the cloak; they are hyaline, minutely freckled with brown, and with opake tips, the gland, which is simple and of a brown colour, passing a short way up. Dorsal tentacles placed near together, and rather backward in position: they are clavate and bent backwards above; the footstalk longer than the clavate portion, which consists of a belt of numerous simple papillæ surrounding a well-developed obtuse mucro. Head expanded into a large broadly arched veil, the lateral angles of which are free. Foot large, broad, and slightly arched in front, without laminæ, extending to a point behind. Length nearly 1½ inch.

Tolerably frequent. Several specimens in good order were in the collection.

Family GLAUCIDÆ, *Alder & Hancock.*

Genus GLAUCUS, *Forster.*

Body elongate, without cloak. Tentacles four, linear, non-retractile. Branchiæ linear, flattened, and tapering, arranged in fan-like pedunculated tufts on the sides of the back. Anus lateral. Foot narrow. Tongue a single longitudinal series of arched plates, with a central spine and lateral denticles.

Glaucus forsteri, *Lamarck.* (Pl. XXXIII. fig. 13.)

Body nearly linear, rather broad in front, and tapering to a fine point behind; of a delicate blue colour, fading into pale grey or violet, with a metallic lustre at the sides. Dorsal tentacles very minute, linear, placed laterally, and rather far back. Head small, rounded, with minute linear oral tentacles. Branchial lobes three pairs, pedunculate, and terminating in a flattened disc set with stout, linear, tapering branchial papillæ round the margin, those in the centre long, and diminishing gradually towards the sides; these, with the disc, are of a deep blue, much darker than the body: the first pair are a good deal produced, the posterior pairs shorter, the last nearly sessile. Foot linear, dark blue, rather paler in the centre, a little dilated and rounded in front, tapering to a slender tail behind. Length nearly 1½ inch.

Glaucus forsteri, Lam. Anim. s. Vert. 2nd ed. vol. vii. p. 448.

Two or three specimens were brought home.

This well-known ocean-wanderer, under the names of *G. atlanticus* and *G. forsteri*, is generally diffused in the seas of warm climates. As in the present instance, the figures usually represent it in an inverted position, which has given rise to some mistakes in its description.

Family EOLIDIDÆ, *Alder & Hancock.*

Genus Eolis, *Cuvier.*

Body elongate, limaciform, without cloak. Dorsal and oral tentacles linear, non-retractile. Branchiæ ovate-oblong or linear, arranged in tufts or transverse rows on the sides of the back. Anus lateral. Mouth with corneous jaws. Tongue narrow, generally with a single longitudinal series of denticulated plates.

Eolis unilineata, n. sp. (Pl. XXXIII. fig. 14.)

Body rather slender, buff-coloured. Dorsal tentacles moderate-sized, flesh-coloured, annulated with six rather distant rings. Oral tentacles long, tapering from a broad base, the outline uniting with the line of the head, flesh-coloured below, with yellowish-white tips. There is a scarlet line from the centre of the head in front, running backwards between the dorsal tentacles, where it is slightly interrupted, and thence to the commencement of the branchiæ. Branchial papillæ rather short and stout, of a purplish-brown colour, set in five or six indistinct rows or clusters, nearly meeting on the back, and terminating a short way from the end of the tail. Foot narrow, rounded in front, without lateral angles. Length ½ an inch.

Tongue a single series of spines, each with six or seven lateral denticles. Jaws narrow, with denticulated cutting-blades.

The collection contains six specimens.

EOLIS MILITARIS, n. sp. (Pl. XXXIII. fig. 15.)

Body rather stout, tapering to a fine point behind, of a pale flesh-colour or nearly white. Dorsal tentacles rather long, smooth, swelling a little in the centre, and tapering to a point above, with a broad belt of scarlet near the centre, gradually fading into flesh-colour below; bright yellow on the upper half, excepting the extreme tips, which are white. Oral tentacles large, stout, and tapering, coloured as the dorsal, excepting that the scarlet central belt is extended down each tentacle in a narrow line, the two uniting in a bulb on the centre of the head, and continued thence backwards to the commencement of the branchial papillæ: a scarlet line also runs along each side of the body from the anterior angles of the foot. Branchial papillæ numerous, moderately stout, of a reddish-brown colour, with bright yellow tips, forming six clusters on each side, and nearly meeting on the back. Foot with the anterior angles much produced and stout, terminating behind in a slender tail considerably behind the branchiæ. Length 1 inch.

Tongue with a single series of fifteen or sixteen denticulated spines: there are seven denticles on each side. The jaws are broad, with the cutting edge denticulated.

This handsome species bears considerable resemblance to the last in colour and markings; but differs in the absence of rings on the dorsal tentacles, and in the produced anterior angles of the foot. The colours are also more brilliant. The remains of a single specimen only were in the collection.

EOLIS OCELLATA, n. sp. (Pl. XXXIII. figs. 16, 17.)

Body linear, white, spotted and blotched with yellow. Dorsal tentacles long and slender, smooth, tapering to a fine point; yellowish brown in the centre, and white above and below, with a few yellowish spots near the base. Oral tentacles about half the length of the dorsal pair, white, confluent with the line of the head. Branchial papillæ rather inflated for about two-thirds up, where they become suddenly contracted, and linear towards the apex, which is encircled with brown; five or six brown rings form a chain-like circle round the upper part of the inflated portion, the rest of the surface is white, spotted with yellow, and there is a narrow brown central gland: the papillæ are set in four clusters, the front ones much the largest. Foot with the angles produced into long tentacular processes in front, rather broad and fin-like towards the tail. Length about $\frac{3}{4}$ths of an inch.

The spawn forms a narrow white riband, loosely coiled in one or two volutions.

This species is rare. No specimen was preserved.

Family HERMÆIDÆ, *Alder & Hancock.*

Genus PHYLLOBRANCHUS, nov. gen.

Body elongate, flattened on the back, and angulated at the sides, without distinct cloak. Tentacles two, dorsal, longitudinally folded, bifurcate above, non-retractile. Head produced at the sides into angulated and folded expansions. Branchiæ leaf-like, with distinct footstalks, arranged in several rows along the sides of the back and round the head in front. Anus lateral.

The tongue of this genus resembles that of *Hermæa*. In our species there are thirty-seven or thirty-eight short stout spines, in single longitudinal series, with seventeen or eighteen truncated denticles on each side. The spines diminish rapidly in size in front, where the tongue is convoluted.

PHYLLOBRANCHUS ORIENTALIS, *Kelaart*, sp. (Pl. XXXIII. figs. 18, 19.)

Body elongated, but capable of great contraction, flattened on the back, and angulated at the sides, of an olive-green colour. Dorsal tentacles placed much forward, long, cylindrical, longitudinally folded through their entire length, and bifid above for about one-third down: the slit is posterior; the external surface has a few minute tubercles. Branchiæ large, ovate, leaf-like, with long footstalks, arranged in crowded ill-defined rows along the sides of the back and round the head, extending backwards nearly to the tail: the peduncles are cylindrical, the foliaceous portion flattened into ovate laminæ, with a minutely denticulated margin; the upper surface is slightly concave, and a little hollowed below, where the margin of the leaflet is raised at the top of the peduncle; its surface has four stout branched lines, radiating from the footstalk: more minute radiating lines are seen on the under side: the hepatic gland forms a beautiful dendritic expansion of a dark green colour, the stalk passing down the peduncle. Head flat above, inclined downwards, and rounded in front; produced at the sides into foliaceous expansions, which are angulated behind, and extended into folded tentacular points. Foot dark olive, broad and ample, slightly arched and produced into blunt points in front, where it is laminated but not notched; behind, it tapers to a blunt point. There is a white spot on the back, with a slight swelling indicating the region of the heart. Length 2½ inches.

Proctonotus orientalis, Kel. in Journ. Asiatic Soc. (Ceylon Branch) 1858; idem, in Ann. Nat. Hist. 3rd ser. vol. iii. p. 492.

This curious animal is not uncommon. There are six or seven specimens in the collection, but they are all too hard and brittle for anatomical examination. Mr. Elliot informs us that the branchial papillæ are very liable to fall off, and that their loss does not seem to inconvenience the animal. It is occasionally found of a very pale green, without any tinge of olive. The native name for it is *Aku-purugu* (leaf-animal).

EXPLANATION OF THE PLATES.

PLATE XXVIII.

Figs. 1, 2. *Doris ellioti.*
Fig. 3. *Doris pardalis.*
Figs. 4, 5. *Doris concinna.*
Fig. 6. A few of the tubercles of the same.
Figs. 7, 8. *Doris fragilis.*
Fig. 9. *Doris castanea.*
Figs. 10, 11. *Doris osseosa.*
Fig. 12. *Goniodoris modesta.*

PLATE XXIX.

Figs. 1, 2. *Doris formosa.*
Fig. 3. Branchial opening of the same, showing the marginal folds.
Fig. 4. *Doris striata.*
Figs. 5, 6. *Doris carinata.*
Fig. 7. *Chromodoris zebrina.*
Figs. 8, 9. *Doridopsis tuberculosa.*
Fig. 10. Dorsal tentacle of the same.
Figs. 11, 12. *Trevelyana bicolor.*

PLATE XXX.

Figs. 1, 2. *Doris areolata.*
Fig. 3. A dorsal tentacle of the same.
Fig. 4. *Doris rusticata.*
Fig. 5. A dorsal tentacle of the same.
Figs. 6, 7. *Doris tristis.*
Fig. 8. *Doris apiculata.*
Figs. 9, 10. *Doris funebris.*

PLATE XXXI.

Figs. 1, 2. *Doridopsis rubra.*
Fig. 3. *Doridopsis fusca.*
Figs. 4, 5. *Doridopsis gemmacea.*
Fig. 6. A dorsal tentacle of the same.
Fig. 7. Spawn of the same.
Figs. 8, 9. *Doridopsis pustulosa.*

Figs. 10, 11, 12. *Doridopsis clavulata.*
Fig. 13. *Doridopsis nigra.*
Fig. 14. The same, var. *b.*
Figs. 15, 16. The same, var. *a.*
Fig. 17. *Doridopsis punctata.*
Fig. 18. *Doridopsis miniata.*
Fig. 19. Spawn of the same.
Figs. 20, 21. *Doridopsis atromaculata.*
Fig. 22. A dorsal tentacle of the same.
Figs. 23, 24. Tubercles of the same.

PLATE XXXII.

Figs. 1, 2. *Goniodoris citrina.*
Fig. 3. A dorsal tentacle of the same.
Figs. 4, 5. *Plocamophorus ceylonicus.*
Fig. 6. Under view of the head of the same.
Figs. 7, 8. *Kalinga ornata*, two varieties, natural size.
Fig. 9. Under view of the head of the same.
Fig. 10. A dorsal tentacle of the same.

PLATE XXXIII.

Fig. 1. *Doris villosa.*
Fig. 2. *Goniodoris aspersa.*
Fig. 3. *Scyllæa marmorata.*
Fig. 4. *Scyllæa viridis.*
Fig. 5. A tentacle of the same.
Fig. 6. *Melibe fimbriata.*
Fig. 7. The same in a young state (*Melibæa viridis,* Kel. ?).
Fig. 8. *Bornella digitata.*
Fig. 9. A tentacle of the same.
Figs. 10, 11. *Madrella ferruginosa.*
Fig. 12. A tentacle of the same.
Fig. 13. *Glaucus forsteri.*
Fig. 14. *Eolis unilineata.*
Fig. 15. *Eolis militaris.*
Fig. 16. *Eolis ocellata.*
Fig. 17. A dorsal papilla of the same.
Fig. 18. *Phyllobranchus orientalis.*
Fig. 19. A branchial papilla of the same.
Fig. 20. Undescribed species, apparently of a new genus related to *Goniodoris.*

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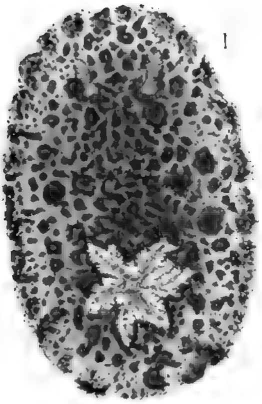

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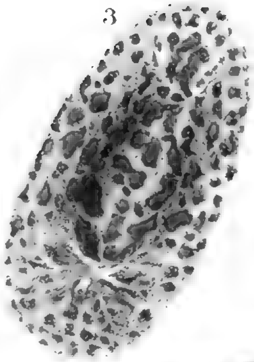

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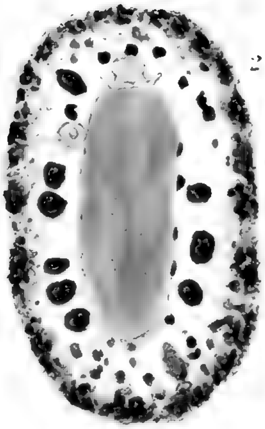

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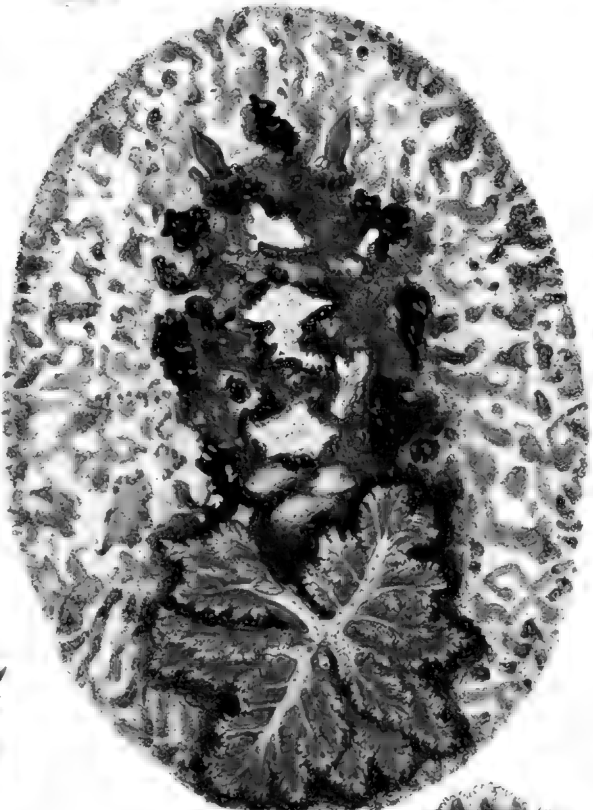

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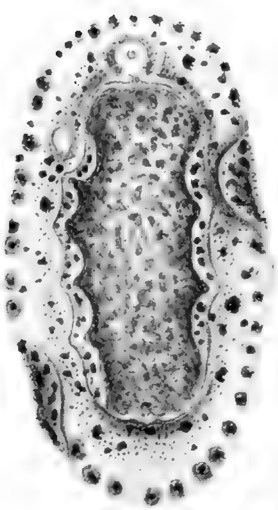

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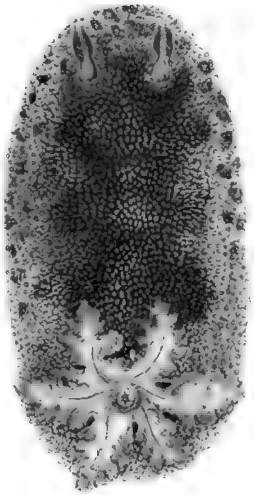

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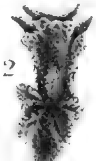

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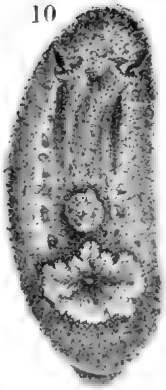

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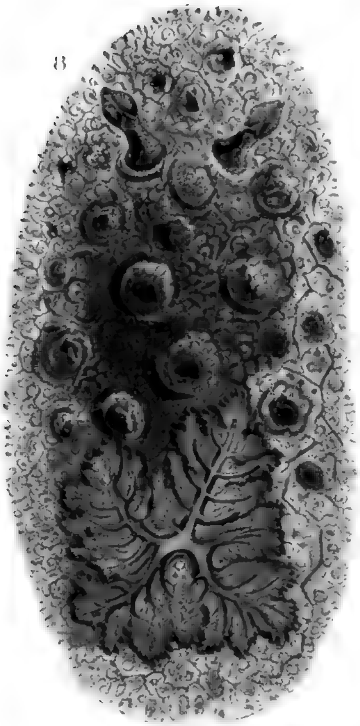
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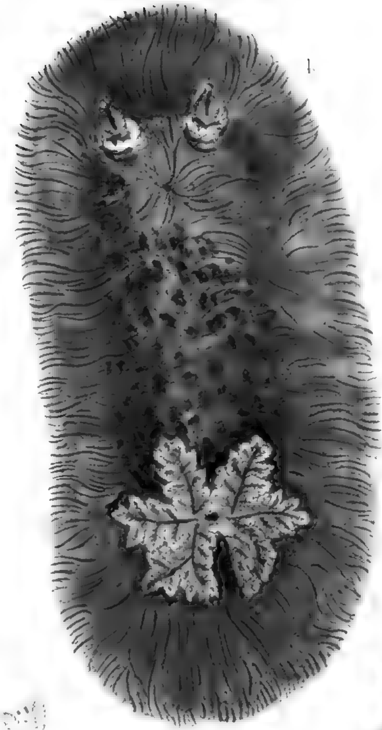
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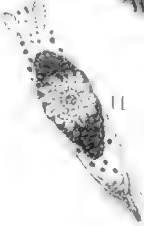
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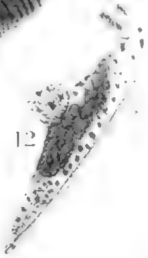
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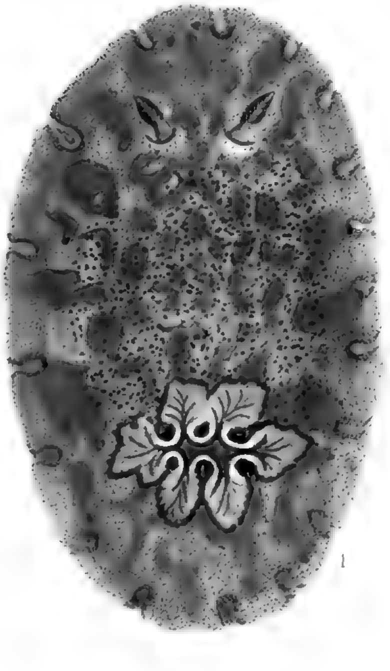
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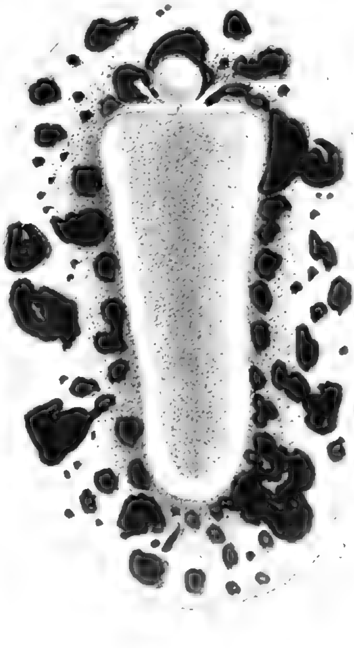


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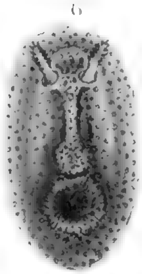
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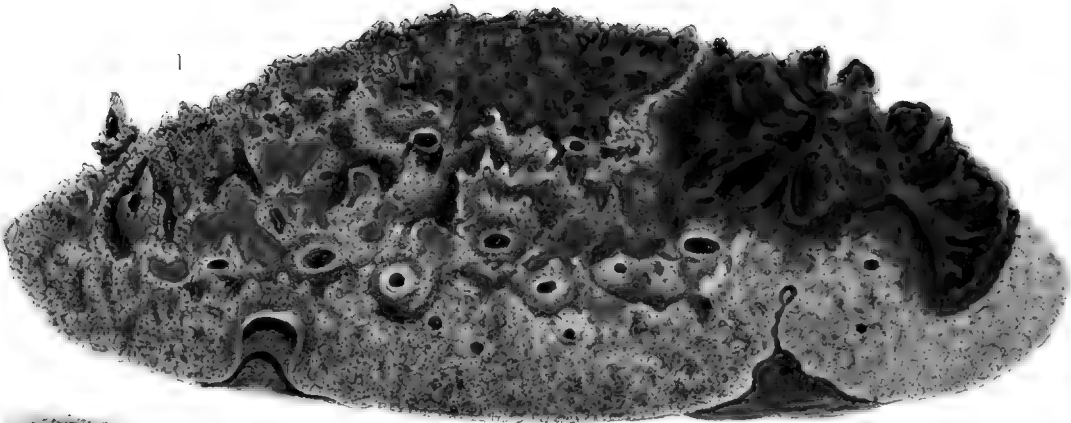
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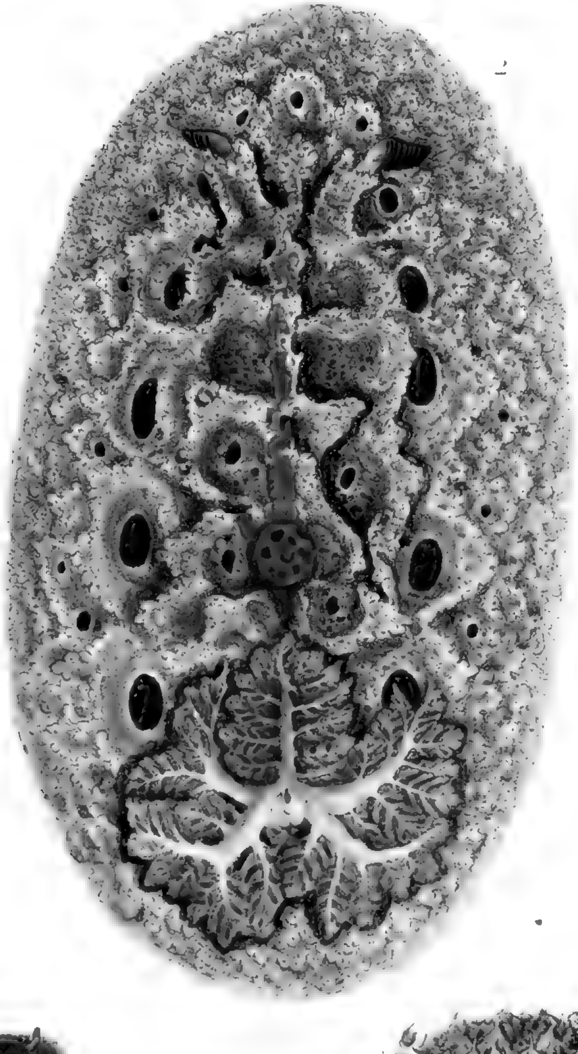
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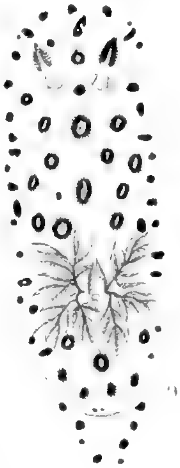
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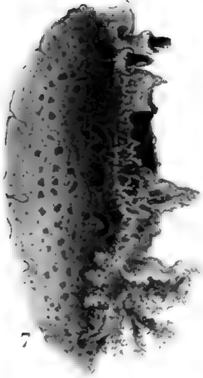
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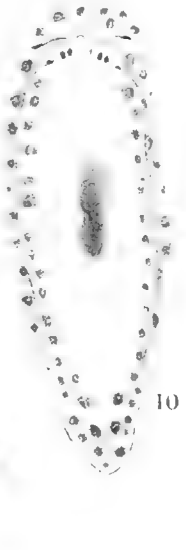
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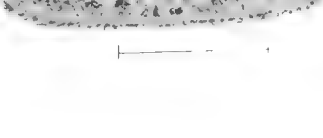
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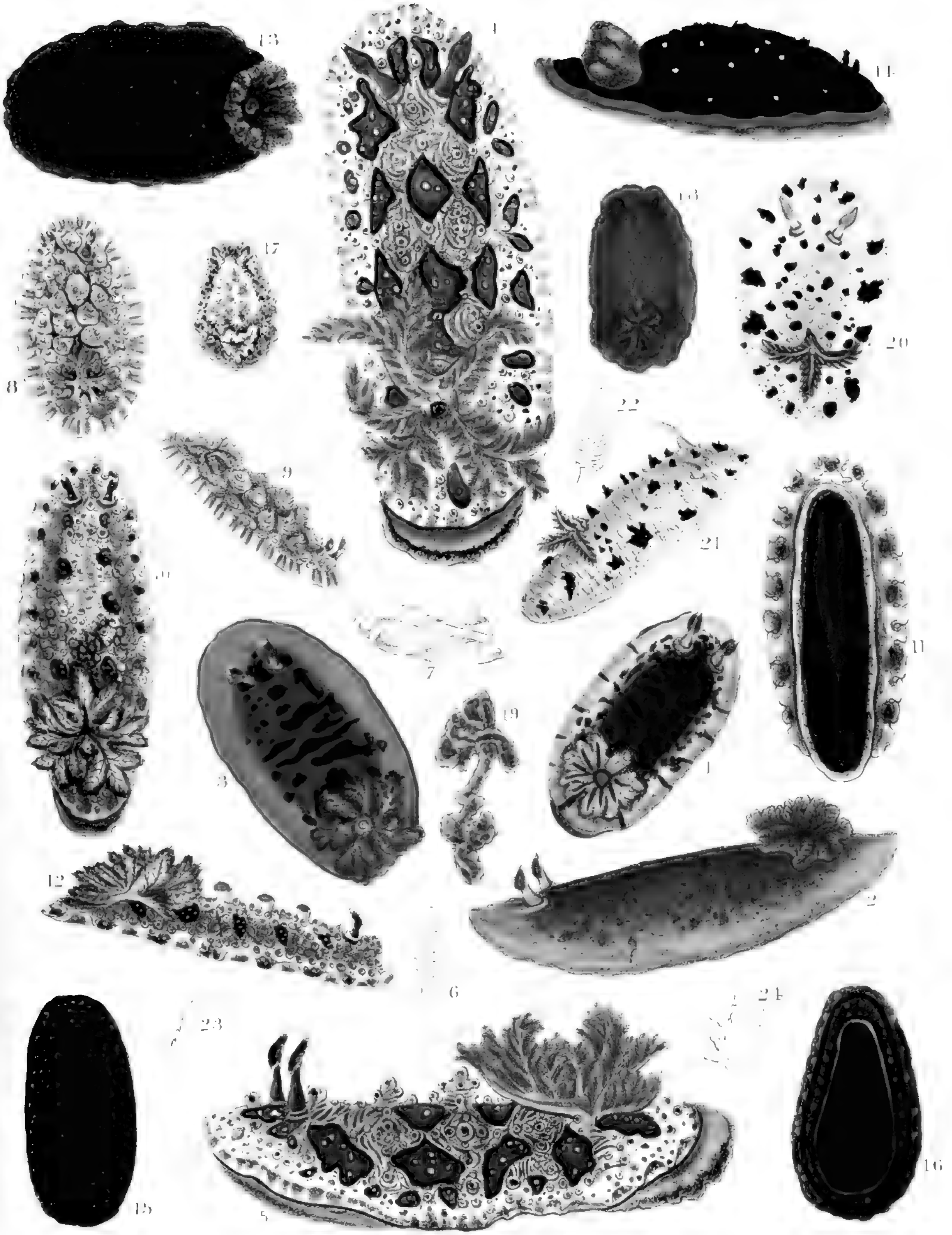
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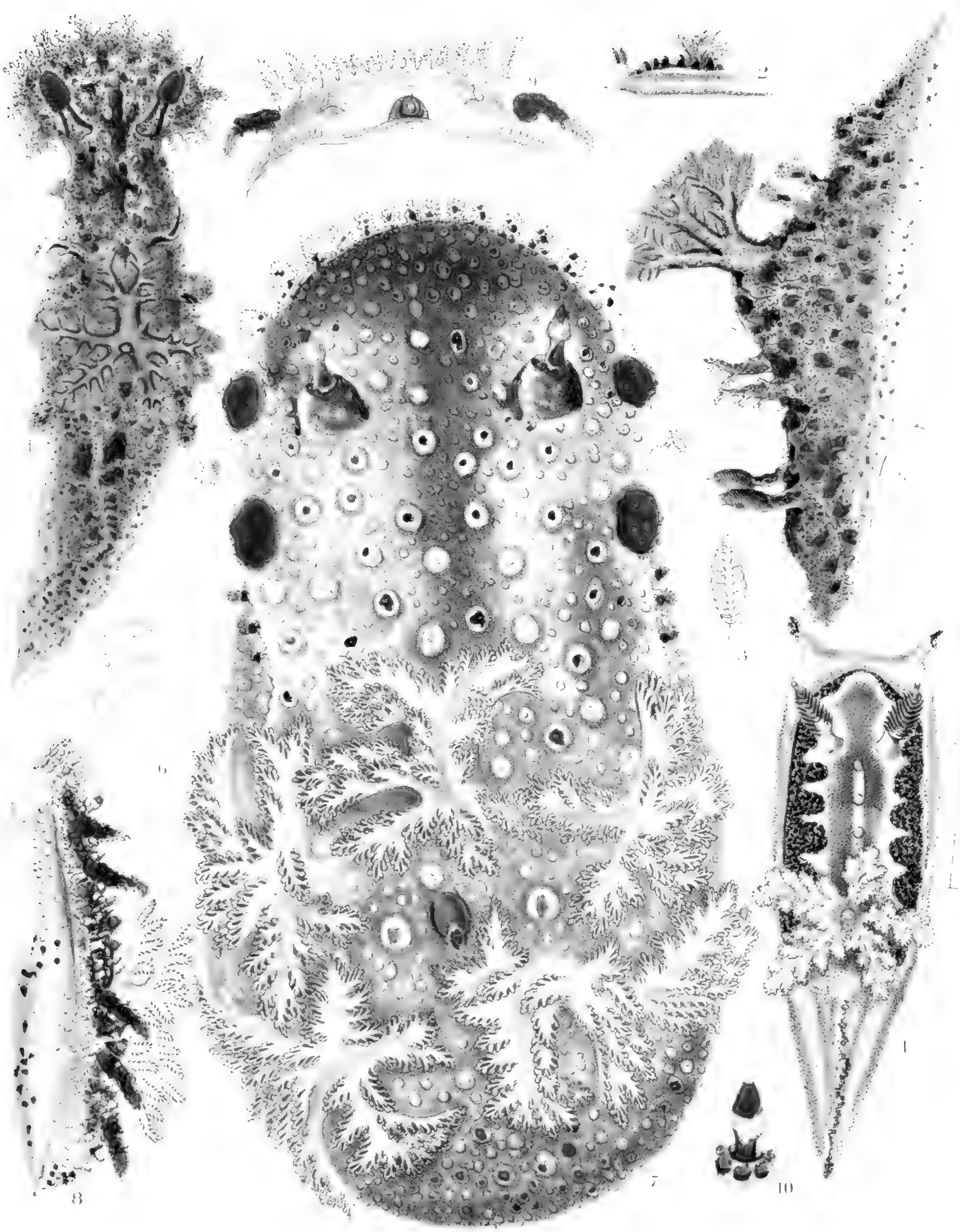
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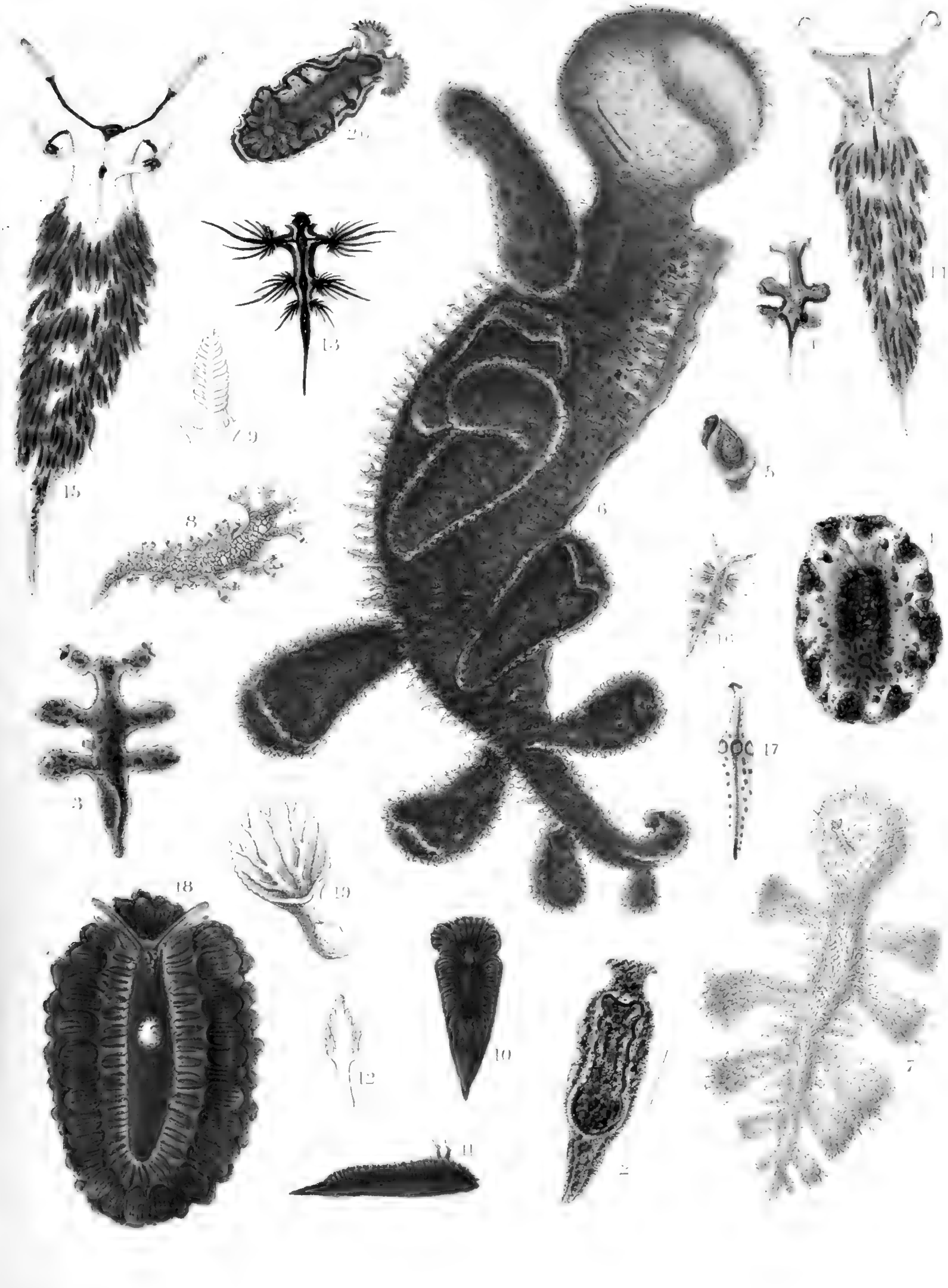

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V. *On the Osteology of Gallinaceous Birds and Tinamous.* By W. K. Parker.

Read November 25, 1862.

[Plates XXXIV.–XLII.]

Introduction.

In the present paper my proper work is to throw some light upon the affinities of the Gallinaceous birds, both among themselves and in relation to the surrounding groups. The main part of the difficulty of my task lies, however, in the determination of the relationships of certain border-groups, viz. the Sand-Grouse, the Hemipodes, and the Tinamous. This cannot be done without an intimate acquaintance with the structure of the grallatorial tribes, whether low and unspecialized, as the Ostriches, or more defined, special, and typical, as the Plovers, Cranes, and Bustards. Then the position of all these families of birds in the great class itself can only be known by a familiarity with the conditions of structure to be seen in the highest and most specialized types; and these are not to be found on the side of the running, wading, swimming, or diving birds, but on that side of the class which, as it were, rises upwards from the walking, hopping, and perching birds, viz. Fowls, Pigeons, Crows, and Finches[1].

If the whole class could be worked out anatomically and embryologically, family by family, genus by genus, and species by species, then a perfect classification might be made: until then all our attempts will be mere approximations. Undoubtedly much has been done by the zeal and talent of the numerous cultivators of this most fascinating branch of zoology; yet at present the structure of birds is rather a neglected than a well-cultivated part of *anatomical* science. Whilst demanding a more perfect acquaintance with the morphology of birds, I am not in the least inclined to undervalue the study of their dermal structure and general outward characters, still less to underrate the importance of a most minute acquaintance with their habits. All these things work together for the good of ornithology; the mind, however, will not rest in these outward things, and a knowledge of the skeleton, the nervous system, the digestive, respiratory, and vocal organs becomes a great desideratum. A knowledge of the latter structure—the vocal apparatus—is of the utmost importance to those who would appreciate the Bird as compared with the Mammal, the Reptile, and the Fish. Perfection of these structures is a correlate of the highest condition of the great nervous masses; and the whole life of the upper bird-groups answers to their high endowments of struc-

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[1] Although the true arboreal birds are all "altrices," yet the water-birds are not all "præcoces"; the "Cultrirostres" and "Totipalmatæ" have their young feeble at the time of hatching, and very rapid in their growth.

ture. Such birds also yield to man the greatest delight; they always have been, and always will be cherished by us, whatever be our age or our degree of general culture; and one of the saddest descriptions of a waste and deserted country has its gloominess and desolateness wrought to the deepest degree of shade by this one short sentence—

> "And all the birds of the heavens were fled."

Macgillivray[1] was perfectly right in laying great stress upon the structure of the digestive and vocal organs,—the former relating to the food and therefore the habits and instincts of the bird, the latter forming a correct measure and index of the higher ornithic qualifications and accomplishments. For as that speaking, singing, mocking animal, Man, is the culmination of the Mammalian series, so that bird in which the gifts of speech, song, and mockery are combined must be considered as the top and crown of the bird-class. But the digestive organs failed me just where I wanted them to be most oracular, viz. in the case of the *Syrrhaptes*. If I had sat down contented with what the digestive organs of that bird revealed, I should have said, it is simply a Grouse. But its vocal organs do not coincide with those of the "Tetraonidæ"; they agree with those of Pigeons and Plovers. The study of its osseous construction reveals much more than this, as I shall show hereafter. Yet nothing could be more puzzling than a mere acquaintance with the condition of the adult condition of the bones of birds, especially those of the skull proper: an acquaintance with, not one, but many stages of the beautiful framework is necessary. I will give an instance to show the bearing of these remarks.

I had long been in the habit of watching the marvellous gracefulness and ease of the flight of the pure-breasted Sea-Gulls, and of comparing them with the Lapwing,—when one day it rushed back to my recollection that many years ago I had found their skeletons to have much in common. Having procured a series of young Gulls (*Larus argentatus* and *L. ridibundus*), I found, upon careful dissection, that the skull and the bones of the face in these *pulli* corresponded, not only with those of the young, but also of the full-grown Lapwing and Golden Plover. The skull of the adult Gull, or even of one but two months old, would not have revealed this; for these birds have scarcely acquired the power of flight before the most marked pluvialine characters have been effaced. The acquisition of a more *vulturine* cast of face, the longer jaws, the hooked bill, and the absorption of certain parts of the outer table of the bones of the spine to admit air is in perfect harmony with the obliteration of the anterior pterygoid processes[2] and their corresponding peduncles on the pterygoids, and with the filling-in by bone of the lateral occipital fontanelles, which are so large and open in the embryonic Gull and in the adult Lapwing. (Pl. XXXVII. figs. 1, 2, & 4.)

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[1] History of British Birds, vol. i. p. 52, and in many other parts of that excellent work.

[2] It is very curious to find that the atlas and axis of the Gulls are medullary bones; this may be seen i *Larus ridibundus*, *L. canus*, and *L. maximus*.

In the simple structure of the bones of the face, and in the condition, permanently, of certain structures arising from the great *skull-balk*, the Lapwing (*Vanellus*) and its immediate allies the Plovers, Sandpipers, and others are not so much specialized and modified from the low, fundamental, struthious type amongst the land-birds, and the equally *generalized* condition of the Penguins amongst the water-birds, as the Gulls on one hand and the Thick-knees (*Œdicnemus*), the Bustards (*Otis*), and the Cranes (*Grus*) on the other. Still the elevation of a bird in the ornithic scale does not "go on all fours;" it oscillates, as it were, in a sort of see-saw manner. For instance, the Pigeons are almost as typical ornithically as the Passerine birds and the Crows; yet, in the normal genera of the "Columbinæ," the base of the skull and the pterygoids are scarcely more removed from the struthious type than they are in the Fowl and the Plover. In the Dodo, in the Didunculus, and in the *Goura* the pedicles of the embryonic skull-base become arrested in the course of their growth; whilst the wings of these birds are far inferior to those of the typical Pigeons. The "Rallinæ," again, are inferior to the Fowl-tribe in general intelligence, and far below the Pigeons; and yet, in them the skull passes through a more perfect metamorphosis[1]. This is the more remarkable when we consider, not only the struthious folly of this low-brained group, but also the abortive condition of the wings and sternum in *Brachypteryx* and in *Notornis*. So low are these latter birds in this respect, that our great naturalist, Professor Owen, forgetting the salient characters of the struthious skull, has unaccountably confused the two groups—the Notornis and the Cassowary becoming almost amalgamated in his inward vision. And this leads me to speak of *isomorphism*, or imitative resemblance independent of *near* affinity.

In tracing out the almost infinite varieties of the modifications of any one specific type of shelled Rhizopod, my friend Professor Rupert Jones and I found that *like varieties of distinct species were much nearer in shape and appearance than unlike varieties of the same essential species*. This had caused the most pitiable ravelling of the forms in systematic works,—the "isomorphs" being put together, and the varied conditions of one and the same specific type (from overgrowth or from arrest, from happy or from inimical habitats) being placed at, in some cases, the very opposite poles of the order to which they belonged.

Now, in venturing to work out ornithic affinities, I find it necessary to beware of being misled by mere *isomorphism*, and of mistaking it for immediate or pure affinity. The two are, however, often intimately blended; and this makes the task the more difficult. Such an instance of "isomorphism," I think, we have in the likeness of the Porphyriine Rails to the Cassowaries.

We cannot say that there is no affinity; there is such an affinity as must of necessity

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[1] One great difficulty in the *derivative* study of birds arises from the fact that in the Ostriches we have a blending of reptilian with mammalian characters: in the Penguin and the Cormorant the want of typical purity seems to arise from reptilian qualities merely.

exist between birds no further removed from the Reptilian groups than the Ostriches and the Rails; but I do contend that the possession of a compressed face and large inferior extremities by species in both these groups is not a sufficient reason for our marrying the two families into one. Do that, and all the family landmarks may with equal reason be obliterated,—a course which would, if followed out by some consistent painstaking ornithologist, result in the reduction of the great bird-class into one opulent family, possessed of a thousand genera and of ten thousand species.

I shall speak hereafter of the typical (sylviine, or perhaps corvine) characters of *Hemipodius*, and of the strange build of certain Australian Sylviines (e. g. *Petroica*), birds with so mixed a constitution that the term *Struthious Warblers* would scarcely be inapplicable to them. I hope at some future time to take up this intricate part of ornithology, and, if possible, do something towards unravelling what appears, at first blush, to be so extremely confusing. It has for some time appeared to me that our so-called " circles of affinity " should be made with *toothed edges* ; for the groups of birds do not merely impinge upon one another; they do more, they interdigitate. This dovetailing, as we all know well, occurs between class and class, as well as between order and order and between family and family.

Thus the Batrachians are, as it were, only just lifting themselves up out of the Fish-class, and striving after the higher dignity of the crawling Reptile. The *Ornithorhynchus* and the *Echidna* have not quite freed themselves from the Reptilian group; whilst, in the structure of the face and the palate, the Crocodilians overlap the lower border of the Mammiferous circle, passing, in these respects, beyond what the Bird ever attains to, so that the Crocodilian skull is a *prolepsis* of that of the Mammal. At this sinuous border-line we fall in with the " lot " of the Ostrich-tribe; and from it we may pass in all directions through many a substruthious and many a subtypical group, until we come to birds with merry notes and perfect social economy. Wandering at will amongst these groups, it would appear that our only way of coming to some understanding about their proper arrangement will be to seize upon some well-known form as the convenient centre and type of each particular family. This *practical type* should stand fairly in the centre of several genera, the most unlike of which should impinge upon the outlying genera of the contiguous families. Our very best efforts at naturalness will often fail to make our family-groups of equal value; and the larger families will often have to be divided into a typical and one, two, or more subtypical families. The manner in which the families cluster round and overlap each other is extremely interesting; this, however, is often masked by the teleological modifications of certain important organs, especially the face and the pelvic extremities.

Cuvier was wont, in his classification of birds, to lay hold on the modifications of the beak and the feet; but he seems to have been careless even of these organs in his nomenclature; for he often named a group after some especial bird, as, for instance, his Orders " Accipitres," " Passerinæ," and " Gallinaceæ," which are his first, second, and fourth. His fifth Order, "Grallatoriæ," and his sixth, or "Palmipides," are named after a different principle. Cuvier's "Families" are named in the first class from the habits of the birds—"Accipitres Diurnæ" and "Accipitres Nocturnæ;" the third "Order," the "Scansoriæ," is also named on the same principle, or from the habits of the birds. He has no "Families" in the scansorial and gallinaceous "Orders;" and the Families of the "Passerinæ" are all named from the beak, viz. "Dentirostres," "Fissirostres," "Conirostres," and "Tenuirostres:" this last "Family" is a curious assemblage of genera; it contains *Sitta*, *Certhia*, *Trochilus*, *Upupa*, *Merops*, *Prionites*, *Alcedo*, *Todus*, and *Buceros*. After this, let no modest young ornithologist be afraid of thinking for himself, when this great zoological chief has left us such a jumble.

The "syndactyle" division of Cuvier's "Tenuirostres," the "Fissirostres," and the Scansorial birds ought to be placed in very close contiguity; and I have been more struck with the dovetailing of these very interesting groups than with that of any others in the class. One of the first things to be done in the study of these three conterminous families is, for the time, to forget the peculiar modifications of the bill and the feet, and to look a little more deeply into the matter. Take the sternum alone in these three groups, and how large an amount of modification do we have! and yet the study of its development shows how slight and how gentle are the changes—how much is due to *arrest* in one, to *overgrowth* in another. The breast-bones of *Caprimulgus* and of *Cuculus* are almost identical in shape: the same part in *Buceros* is like that of the fledgeling Cuckoo,—the inner portion of the hyposternal piece not being lost along the margin of the entosternum. The sternums of the Toucan, the Woodpecker, the Plantain-eater, and of the Kingfishers (*Dacelo*, *Alcedo*) are very nearly alike; that of *Podargus* belongs to the same style, but is especially like the sternum of some of the more delicate-billed Kingfishers. All these latter species have the hyposternal element forked. But the pelvis and the skull show just the same kind of facts, and prove the close relationship of these groups; and it would require the space of a goodly volume to give the matter in its fulness.

The "Fissirostres" are not a little heterogeneous. The Swift (*Cypselus*) seems to have barely escaped being a Swallow; and the abortion of the inferior laryngeal muscles and of the symmetrical cæca coli is rather startling to one who has just been studying the true sylviine *Hirundines*. Must we set down to "teleology" alone the sudden overgrowth in the Swift of the sternum and the wing-bones, and the abortive development of its legs and feet? Without leaving the family of the Warblers, the Swallows and Martins have taken on the gaping mouth, the long wing, the forked tail, and the tiny feet of the Swift, but not to the same degree. Whilst they retain all the true sylviine structures, they overlap the "Fissirostres" on their cypseline border, and might receive the title "Swift-like Flycatchers" (*Muscicapæ cypseliformes*).

A very large amount of work has to be done for the "Scansores" and their ornithic neighbours, not merely in tracing the development of the skeleton, and especially the skull, in each of the smaller groups of genera, but even in the structure of the adult.

An equally large field awaits the labourer lower down among the feathered tribes. Who will trace for us the relationships of the border-groups of the "Grallatores" and "Palmipeds," and tell us how much of isomorphism and how much of affinity there is between the Phalarope, the Coot, and the Grebe? It is worth while to notice that the Coot (*Fulica atra*) is thicker in body and has a much softer and fuller plumage than its inland relatives; it is also *more marine* in its habits. A Coot with a still thicker body and shorter sternum would make a very apt connecting link between *Fulica atra* and the small short-bodied Grebe (*Podiceps* (*Sylbeocyclus*) *europæus*)[1].

The nearness of the Gulls to the Plovers is indicated by the Pratincole, which connects the Plovers and Oystercatchers with the smaller species of the family "Larinæ." The Grebes (*Podiceps*), the Divers (*Colymbus*), and the "Alcinæ" (*Alca*, *Uria*) are all nearly related to each other and to the Penguins. The Gulls, Mews, and Terns (*Larus*, *Gavia*, *Sterna*), and the Albatroses (*Diomedea*), are all more highly specialized forms than their relatives the Plovers. The most highly modified birds amongst the web-footed tribes, however, are the "Totipalmatæ," viz. the Cormorant, Gannet, and Pelican. This small group is of the greatest interest to the student, because, although there are but few genera, yet the relationships of these genera are numerous. The Tropic-bird (*Phaëton*) is evidently a modified Tern (*Sterna*); the Frigate-bird (*Fregata*, Ray; *Tachypetes*, Vieillot) a near congener of the Petrels; and the Cormorant is related both to the Grebes on one hand, and to the outlying "Anatinæ" (*Merganser, Mergus*) on the other; whilst the Booby and Gannet (*Sula*) are evidently more related to *Colymbus*, *Uria*, and *Alca*. The Anhingas or Darters (*Plotus*) are, most likely, modifications of the Gannet, and might be thought, by no great stretch of fancy, to be the *imagos* of the Plesiosaurus. The culmination of the group takes place in the Pelicans, just as the Herons terminate in the Adjutant, the Plovers in the Great Bustard, and the Fowl-tribe in the Turkey.

I cannot, in this place, enter into the relations of the Bird with the other class-groups; but the use of the term *imago* brings to mind that marvellous metamorphosis of the vertebrate form which the anatomist has seen to take place who has passed carefully upwards from the lowest fish to the highest bird. Every embryologist knows that this metamorphosis, which in the Vertebrata can only be fully seen by passing from class to class upwards, is not really greater than that which, in most insects, takes place in the life-history of a single individual. Analogically, the fish is the vertebrate *larva*, the reptile the more developed but slow *pupa*, whilst the bird is the lovely *imago*.

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[1] Mr. Bartlett informs me that the little Finfoot of South America is the identical link wanting to connect the Coot with the Grebe.

On the Gallinaceous Group.

The Pigeons must be excluded from the great Gallinaceous family, and be made to stand by themselves. They have intimate relations with the "Cracidæ," the Hemipodii, the "Pteroclinæ," and even with the "Megapodiinæ;" but they seem to me to be worthy of a place to themselves: they are "Altrices," not "Præcoces" like the Fowls.

I shall be able to show a considerable preponderance of struthious characters in the Tinamous, as well as the existence of no very nascent Plover qualities; they may therefore, notwithstanding their large sternum, be eliminated from the Gallinaceæ. We have then left to us—

a. The typical "Gallinæ," or "Phasianinæ."

b. The subtypical or "Tetraoninæ."

c. Another subtypical group, the "Megapodiinæ," in which the *Rasorial* qualifications reach their highest point: this might be called the *ultratypical* group.

d. The aberrant "Cracinæ."

e. The first inosculant group, the "Hemipodiinæ."

f. The second inosculant subfamily, the "Pteroclinæ."

a. "*Gallinæ*" *proper, or* "*Phasianinæ.*"

The Common Fowl may be taken as a convenient and good type of this central group of Gallinaceous birds; both in size and structure it is intermediate between the gigantic Turkeys on one hand, and the diminutive Quails on the other. The exact border of this group, as it impinges upon the somewhat modified "Tetraoninæ," runs right through the genus *Perdix*, leaving the Red-legged Guernsey Partridge (*P. rubra*) on the typical side, and the Common Grey Partridge (*P. cinerea*) on the side of the Ptarmigans. I shall speak of the differences between the bony structure of this group and the next in treating of the subtypical forms.

b. *The Subtypical* "*Gallinæ,*" *or* "*Tetraoninæ.*"

As a rule, the Grouse are more Pigeon-like in form than the Fowl and its nearest congeners—the body being very large in proportion to the legs and feet, whilst the latter are sprawling or *reptilian*. The hallux is still high, as in the typical genera; but there is no rudiment of the sharp inner toe, or first of the foot-digits. The structure of the whole skeleton is more lathy or fibrous, and tends sensibly towards that of the typical Plovers. The skull, so thick even in the little Quail (*Coturnix dactylisonans*), is, as a rule, more thin-walled, less ivory-like, and poor in diploë. The nearness of the brain to the outer surface of the skull causes its form to be more exactly a model, even on the outside, of the cerebral contents. Plate XXXVI. (figs. 6–10) represents the skull of the Red Grouse (*Lagopus scoticus*), magnified two diameters; and it can at once be seen how closely every part corresponds essentially with the like part in the skull of the Common Hen, whilst yet there is much greater delicacy of structure. The occipital plane lies nearly at a right angle with the basi-cranial axis, as in the typical bird: indeed this valuable character is caricatured in the abnormally thick skull of *Tetrao urogallus*; in that bird an acute angle is formed between the occiput and skull-base, as in the Pelican. The Cock of the Woods also differs from its congeners, the smaller "Tetraoninæ," in having a more ornithically typical vomer and stronger legs. Leaving out this giant of the Grouse-tribe, the rest are very uniform in their structure. The occipital condyle, as in the types, has the form of a deeply dimpled human chin, and is broadest from side to side. Both the occipital and basi-temporal regions are very broad, as in the type, so in the subtype; and this arises from the most unusual size of the basi-temporal bones below, and of the two superoccipitals above. The only birds approaching the "Gallinæ" in the expanse of the skull-base are the "Anatinæ;" the birds that rival them in the size of the upper occipital region are the "Struthionidæ." The lateral occipitals combine with the basi-temporals to form, in the "Tetraoninæ," a very fine, large tympanic bulla, from which, as in the type, the os quadratum is altogether excluded. This total exclusion of the "os quadratum," or developed "incus," arises from the collapse, as it were, of the two incudal crura into one, as in Reptiles, and that one having the relations of the anterior crus, which articulates primarily with the prootic by a small facet, and secondarily with the squamosal by a large reniform condyle. The typical and subtypical Gallinæ are peculiar among birds in possessing this most important feature. The orbital process of the "os quadratum" is longer and more delicate in the Grouse than in the Fowl: this process, so well developed in birds, is almost entirely peculiar to them, although a rudiment exists in the larger Ophidians; nothing of the sort exists on the human "incus;" and below birds the "os quadratum" ceases to have distinct crura. The tympanic ring is not unfrequently strengthened by distinct bony points, as may be seen in *Tetrao urogallus*. In some typical forms the external meatus is supported behind by some bony matter; in *Pavo cristatus* there is a goodly-sized ossicle in this region. Like the basi-temporal, the "posterior pterygoid processes" of the basi-sphenoid are enormously developed in the Gallinæ; more so, however, in the subtype than in the type.

The "anterior pterygoid processes" of the basi-sphenoid are in both groups, as in *Crax*, *Talegalla*, and the "Anatinæ," low and very long, and, as in them, articulate with a corresponding facet on the anterior third of the pterygoid. The basi-sphenoidal "rostrum" is always moderate, much shorter than in the "Struthionidæ." In both Fowls and Grouse, as in the Ostrich-tribe, the membranous space between the eyes is small, and becomes filled up with periosteal layers of bone. In both type and subtype the whole of the facial axis in front of the ethmoid continues unossified; and in the typical species the alæ of the ethmoid and the antorbital plates continue soft throughout life: thus the whole of the nasal labyrinth is lost by prolonged maceration.

In the "Tetraoninæ' the antorbitals, however, are multiplied, and ossify. In *Tetrao cupido* there are three, and in *T. urogallus* four cartilaginous pieces behind the middle turbinal, instead of a continuous *pars plana*, as in the Mammals and Ostriches; these antorbitals are ossified. The middle ethmoid becomes very thick in *Tetrao urogallus*. The orbito-sphenoidal region is but little indebted to the true orbital alæ in Gallinæ; and these alæ are ossified continuously from the presphenoid, which is sometimes composed of two pieces, as in *Pavo*. The orbital plates of the frontal wall-in the membranous skull at this part, and supply the deficiencies of the true orbito-sphenoids. *Tetrao urogallus* has small free orbito-sphenoids when examined during the first summer. In neither the Fowl nor the Grouse is there any very definite outgrowth of the ali-sphenoid answering to the "external pterygoid plate." In both these groups the lachrymal has a strong superorbital plate; but the descending process is very feeble and styloid, most so in *Lagopus* and *Tetrao*. The nasals in both type and subtype are lath-like, broad, ascend only a moderate way up the frontal region, and have rather short anterior processes; the outline between these processes, an upper and a lower, is gently concave, more so than in the "Anatinæ." The premaxillary is strong and arched, and descending; the dentary margin very sharp, and the palatine process a mere splint. There is no maxillary; and the prevomerine bones are very small in the type, still smaller in the subtype. They are composed each of a flat scale-like body, a slight ascending process (the rudiment of the shell-like outer portion of the bone in the Ophidian and Lacertian), an inner process (feeble and flat in the Fowl, still feebler in the Grouse), and a posterior or zygomatic process.

This latter process is vicarious of the zygomatic process of the lost maxillary (which exists as a mere rudiment in a few birds, as the Emeu, Night-Heron, Egret, and Swift[1]); and it overlaps the feeble malar style, which in its turn overlaps the equally feeble quadrato-jugal. The vomer is in both groups a feeble style, bifurcate at the posterior end; it is double in *Numida meleagris*, one of the types, and broad in the subtypical *Tetrao urogallus*. The feeble palatines are just a step above those of the "Struthionidæ;" they have the long anterior, very *ornithic* splint. The pterygoids are thick, and in both kinds articulate by a double head with the os quadratum. In a chick nearly a week old I have found a small distinct "meso-pterygoid" between the head of the pterygoid and the rostrum of the basi-sphenoid. The mandible in both kinds is very strong: in the type the membranous space becomes filled up; it is very large and oval in the "Tetraonidæ." The external and internal angular processes (the latter the homologue of the Mammalian *manubrium mallei*) are long in the type, the internal being strong, the external sickle-shaped and flat. These parts have a similar

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[1] There is a rudiment also of this bone in the small Egyptian Glede (*Elanus melanopterus*); and in the Great Penguin (*Aptenodytes antarctica*) (Osteol. Catal. Mus. Coll. Surg. vol. i. p. 216, no. 1118) there is a splint-like, delicate maxillary, 3 inches in length.

development in the "Tetraonidæ," and are enormous in the Cock of the Woods (*Tetrao urogallus*). These angular processes are similarly developed in the "Anatinæ."

I have not been able to find a "coronoid" element as a distinct piece in the chick, although we see it in the Ostriches, and indeed in most birds. The os hyoides is very elegant in all these "Gallinæ;" the true hyoid cornua are delicate and lie in the tongue, their tips being cartilaginous; there is also a basi-hyal, a uro-hyal, and the two double thyro-hyals: all delicate and rather feebly ossified (Pl. XXXVI. fig. 10).

Lastly, the great anterior semicircular canals are a considerable distance from each other over the sides of the foramen magnum; and yet the posterior crus of each canal is imbedded in the side of the corresponding superoccipital. There is no distinct "epiotic" in the chick; but on about the eighteenth day of incubation a small "opisthotic" may be seen: it soon coalesces with the exoccipital. In *Lagopus* the columella is extremely delicate, the rod being fine, and the basal plate large and thin; the rod thickens before it trifurcates, but the branches do not ossify. I have never seen in these, nor indeed in any other birds, any bone answering to the os orbiculare of Man and the superquadrate ossicle of the Lizard; nor does there appear to be any bone in birds answering to that small osseous segment of the periotic capsule of the Mammal which becomes converted into the "pyramid," and which appears to be a rudiment of that huge proximal piece of the hyoid arch of the fish, which, breaking away from the postfrontal, ali-temporal, and prootic regions, becomes developed into the hyo-mandibular. With regard to the structure of the rest of the skeleton of the type and subtype, it may be remarked that the differences are similar to what is seen in the skull. On one hand, we have coarseness of texture, with a considerable amount of diploë; on the other, there is a lathy and rather tough than strong condition of the bones. In treating of the other groups of Gallinæ, I shall have to speak of the skeleton both of the Fowl and of the Grouse. It may be said, however, that the sternum of the typical Fowl and Pheasant is exactly intermediate between that of the gigantic Turkey and Peacock, on one hand, and that of the Quail and Partridge (Pl. XLI. figs. 9 & 10) on the other, and that in the gigantic forms the shortness of the hyposternal processes and the general characters of the entire bone closely approximate to the conditions we find in the Brush-Turkey (*Talegalla*), and the Curassow (*Crax*). There is, however, one of the typical species, a dwarfish form, of which I must speak before passing on to the Megapods: this is the Guatemala Tree-Partridge (*Dendrortyx*). Larger than the true "Quails," yet possessing the same general osteological characters, the *Dendrortyx* may be said to have in its skull and face the Quail-characters highly exaggerated. The occipital plane is vertical and flat, the condyle bifid, the tympanic cavity shallow, the skull-walls thick and having a rather coarse diploë, the interorbital septum somewhat deficient, the bird being rather small; the temporal space is bridged over, as usual. The antorbitals and the rest of the lateral ethmoidal and pre-ethmoidal structures continue cartilaginous as in the type. The vomer and the palatines are as feeble as usual, the former being unusually long. The posterior half of the frontal and the whole of the parietal region is curiously sinuous and uneven; yet the oval eminences answering to the highest part of the cerebral hemispheres are well shown. The whole of the anterior frontal region is much elevated, and the superorbital still more so, the general surface being at this part almost scabrous with risings and depressions; whilst the entire superorbital ridge is broken up into rough bosses that send their bony matter into the very thick, wide superorbital membrane, which, stretching from the lachrymal to the postfrontal process, gives the anterior part of the top of the head a width equal to what obtains in the Parrots.

The lachrymal, which reminds one of that of the *Talegalla* in the abortion of its descending process, is also thick and knobbed, and is incurved at its edge: the size of the superorbital plate makes up for the abortion of the descending portion. The knobs along the edge of the lachrymals and frontals of *Dendrortyx* may, some of them, have been at one time separate pieces; but, whether or no, they are undoubtedly the true homologues of the orbito-frontal denticles of the young Dotterel (*Charadrius hiaticula*), and the dying-out of that curious lacertine (*Scincoid*) character which I have to describe in the Tinamou, where the superorbital region is roofed in with a tile-like series of bones. At the fronto-maxillary hinge the coalesced nasal and frontal mass dips suddenly and deeply down; and there is a deep transverse sulcus above the hinge. As in the Quail, but still more pronounced, the premaxillary is exceedingly stout, highly arched, and short, the nasal aperture very large and almost circular, and the angles of the premaxillary stop suddenly behind the descending crus of the nasal.

The feeble prevomerine bones, malars, and quadrato-jugals are perfectly typical; and the facets formed by the squamosal and prootic for the single head of the os quadratum lie in a perfect acetabulum. The mandible, answering to the premaxilla, is very strong, is typical, and has the membranous space wholly obliterated. Now, in the marvellously strong lower jaw of the Cock of the Woods (*Tetrao urogallus*) this space is 14 lines long by 4 lines broad—the external angular process in the same jaw being full an inch long, and the thicker internal process half an inch; so that the size of that oval space in the mandible—arising from the curious manner in which the dentary breaks into two long crura at its middle, and to the abortive development of the "splenial" piece—is a very good and safe tetraonine character. The whole of the sternal apparatus of *Dendrortyx* is extremely elegant and delicate: the furculum, coracoids, and scapulæ are all long, narrow, and light. The epi-, hyo-, and hyposternals all have the like delicacy of build, the latter being relatively shorter than in the Grey Partridge (Pl. XLI. figs. 9, 10). The inner hyposternal piece, instead of being bowed out as in the Partridge (answering to the thicker body), is quite straight; and the horizontal part of the great entoxiphisternal portion of the bone is relatively as much pared away, as it were, as in the Tinamou (Pl. XLI. fig. 1).

The large perforated episternum is perfectly typical. The pelvis of *Dendrortyx* reminds the observer of that of *Hemipodius*; but it is wider in the postfemoral part, and really keeps close to the structure of the Quail's pelvis. The long and arched os femoris answers well to its counterpart in the Quail. The four coalesced bones, followed by the one separate vertebra in front of the sacrum, is perfectly typical; and the rest of the vertebræ, and the ribs with their appendages, all speak the same language[1].

The long "military" spur dies out in the dwarfs of the typical group; not so the furious pugnacity of the jealous males: the female *Hemipodius*, notwithstanding her relationship to the Turtledove on the one hand and to the gentle Plover on the other, yet possesses this "cursedness" of the Gamecock and the Quail, and that in an undiminished degree[2].

c. *The ultratypical "Rasores" or "Megapodiinæ."*

Example: The Brush-Turkey (*Talegalla lathami*).

There are many reasons why the phasianine Gallinaceous birds should be considered typical; they are furthest in both outward and inward structure from all other groups; whilst the other subfamilies have one or more decided leanings towards outlying types. The voice, so simple and yet so peculiar, and proceeding from a very simple apparatus, (the inferior larynx having no special muscles), the plumage of many members of the group attaining the highest degree of gorgeousness—a gorgeousness only rivalled, not surpassed, by the Birds of Paradise and the insect-like Humming-birds,—and, lastly, the peculiar armature of the legs, render these birds very peculiar, and quite distinct from all others. In the subfamilies all these things fall off: the spurs are gone, the plumage has become sombre, and, in the Sandgrouse and Megapods, the inferior speech-organ has attained a pair of special muscles. In the typical species the most direct structural relationship is, leaving out the other Gallinaceous subfamilies, with the aberrantly struthious Tinamous[3]; and the typical Fowl is a midway stepping-stone from the least ornithic birds, the Ostriches, to the most ornithic birds, the Crows and Songsters. Perhaps the most inherent affinity, the one that keeps breaking out in the most unexpected ways in the subfamilies, is with the Grallatorial groups. We shall come to see that the Struthious bird does not, as it were, pass at once into the Gallinaceous form, but seems to hesitate and look *ploverward*,—the first breaking-up of the mass being compound, and requiring fresh and fresh specialization before the true and proper

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[1] I shall speak of the digestive organs of *Dendrortyx* when I come to describe those of *Talegalla*.

[2] Mr. Blyth informs me that the female *Hemipodius* is better-coloured, larger, and far more pugnacious than her mate. The large size of this *shrew* is a very important fact; for in the Plover tribes it is very common: and the osteology of the *Hemipodius* is in some respects decidedly pluvialine.

[3] The relationship existing between the whole Gallinaceous tribe with the "Anatinæ," of which latter group *Palamedea* is the most "rasorial" form, will be spoken of at the end of this paper.

bird-types are perfected: and, hypothetically, the "Struthionidæ" may be said to form one of the *ancestral* groups.

The group under consideration—the Megapods—have a sort of tincture or stain of this grallatorial nature; yet this time it is not pluvialine, but ralline. Structurally, there is not much of this; but, just as a few drops of crimson fluid suffice to make rosy a goodly vessel of pure water, so a slight dash of the Rail in the Mound-makers has wrought a wonderful amount of isomorphism with that group of birds of whose nature they possess so little. I need only refer to what follows to make good my assertion that, except in the head, the Ralline *taint* is slight; but that the *resemblance* of the two groups—the large Land Rails and the Megapods—is most striking is at once shown by the fact that, looking upon them from without, the eyes of an Owen have not detected their distinctness. Yet the Megapods are, in some respects, more typically Gallinaceous than the Curassows and Guans, and to a superficial observer both the skull and the skeleton generally would seem to differ very little from that of the Common Fowl. The differences, subtle and delicate as they are, yet are nevertheless of great importance to the systematist.

A first view of the *Talegalla's* skull would, however, easily beguile a hasty observer into the belief that it was most intimately related to the *Palapteryx* and the *Notornis*[1]: but much of this depends upon the great strength of the head and the great height of the bill. Careful comparison shows that both the *Notornis* and the *Palapteryx* have their nearest relatives in *Brachypteryx australis*, *Tribonyx mortieri*, and *Ocydromus australis*. I have carefully studied the structure of these three species, and I shall compare the *Talegalla* with them; then, its relations to these three being determined, they will also be known with regard to the extinct and subextinct Rails.

The occipital region of the *Talegalla* is really almost exactly intermediate between that of *Gallus* and *Ocydromus*; it is more vertical and less rounded than in the Rail, less vertical and more rounded than in the Fowl. The occipital condyle is less dimpled than in the Fowl; more so than in the Rail, where the pit on its surface is extremely small. Just so as to size: it is less than that of the Fowl, larger than that of the Rail. The tympanic cavity is more shallow than in the Fowl; it is, however, deeper than in *Ocydromus*. The os quadratum has its head bifid, but not so much so as in *Ocydromus*; yet the posterior head of this "incus" lies in the tympanic cavity: we have seen that it is nearly obsolete in the Fowl. As to the upper surface of the head, there is a more even general convexity than in the Fowl; but there is none of the smoothness and almost polish of this part such as we see in the Rail. Above the orbits Rail-characters cease, and the great breadth of this part (so narrow in the Rail) is altogether far beyond what occurs in the Fowl: it is more like what is seen in the Curassow and in the Wood-Pigeon (*Columba palumbus*), and still more in the Dodo. The lachrymal is in a *special* condition, and there is no counterpart of this in the other groups—only a slight approach to it in *Dendrortyx*. In front, at the edge of the "hinges," a trace of the

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[1] See Mantell's 'Fossils of the British Museum' (pp. 117–128, and figs. 28–31).

fronto-lachrymal suture can be seen; but, for the rest, all is fused, and the lachrymal finishes in front the beautiful sharp-edged superorbital semicircle. In front of the semicircle the lower edge of the lachrymal is incurved; but there is no trace of the styloid descending process of the Fowl, the thicker rod of the Rail, or the thick cellular mass in which the bone terminates below in the Curassow, Pigeon, *Syrrhaptes*, and *Hemipodius*. The basi-temporal region is truly Gallinaceous; yet there can be detected a manifest lessening of the mass, both centrally and laterally, and a decided approach to what is seen in the Great Rails. The basi-sphenoidal "rostrum" is more smooth and Pigeon-like than in the Fowl; and the anterior pterygoid processes are more decidedly raised, and a little nearer the pituitary space. So also the counterpart processes on the pterygoid; they are a little further back, and smaller than in the Fowls, and thus are a step nearer the condition of the like parts in the Pigeon and the Hemipod. But the interorbital septum, rising above the "rostrum," is as smooth, strong, and complete a partition as that of an aged Fowl—far unlike that of the Pigeon, and still further from the great open interorbital space of the Rail. In this latter bird, let it be remarked that the lachrymals are excessively like those of the Safeguard Lizards (*Monitor*).

But for the ossification of the great vertical ethmoid, the "Phasianinæ" and "Tetraoninæ" would come close to the Chelonians in the totally unossified condition of all the "rhinal" structures. The same thing occurs in the Hemipods and Pigeons, save that in them the upper and lower elements of the lateral ethmoids ossify. But in *Crax*, *Talegalla*, *Pterocles*, and *Syrrhaptes*, we have bone in the inferior turbinal and septal regions. Yet in these parts the *Talegalla* comes nearer the Weka-Rails (*Ocydromus*) than to its own relatives; indeed it is, in this respect, one of the most instructive birds in the whole class. It is a remarkable fact that, whilst the ossification and the complexity of the turbinal outgrowths of the nasal sacs are so much simpler and so much less ossified than in mammals, yet the actual continuation of the cranio-facial axis is, in many birds, highly specialized and curiously segmented—so totally unlike the slow osseous degeneration, as it were, to which the middle ethmoid and nasal septum is subjected in the Mammalia. These segments have, however, just as much affinity with vertebræ as the successive pieces that form the digits of the air-breathing Vertebrata and the fin-rays of the Fish. The structure I am speaking of can best be seen in the Guillemot (*Uria*), the Auk (*Alca*), the Gull (*Larus*), and the *Ocydromus*. The middle ethmoid is, as usual, a large bone, and in its alar region directly ossifies about four-fifths of the upper turbinal, which, as in the Rail, is osseous for some distance at its root. The other fifth is formed by a distinct bone, a true prefrontal, and representing the upper half of the Fish's prefrontal, and the delicate band of cartilage which in the Lacertians passes inwards and downwards across the antorbital region. The antorbital, or back of the middle turbinal, is ossified, all but its lower external angle; this is somewhat in excess of what exists in *Ocydromus*.

The middle ethmoid is relatively twice as broad below the hinge as in *Crax*, more so than in *Gallus*; it ends in a transversely straight line. In front of this line there is a delicate upper septal piece, of small extent; and the roots of the inferior (the so-called middle) turbinals have in them a small grain of bone. In front of this there is another piece, ossifying all the rest of the septum; its continuousosseous alæ diminish anteriorly, and it has two pairs of bony outgrowths on its sides: the lowest and most anterior of these are the homologues of those bony crura which in Hawks, Owls, and many other arboreal birds project from the septum, and divide the nasal canal from the external nostril. These processes have been erroneously considered to be the inferior turbinals: they are continuous ossifications of that expanded anterior part of the base of the septum which can be so well seen in the embryo Ox, which has been described by Rathke in the Frog, and which exists in all air-breathing Vertebrata. *Talegalla* and *Ocydromus* greatly approximate in these structures, save that in the latter its inferior turbinal ossicles are larger, and the septum has an additional short piece, in front of which the rest of the septum is only developed above in a flat tongue of bone; it is a question also whether the upper prefrontal is autogenous in *Ocydromus*: it has also an additional ossicle behind the vertical ethmoid; an ethmo-septal piece between the eyes.

The premaxillaries form a very strong bone, high, arcuate, trenchant, and helping the nasals to form, in the dry skull, large short-pyriform nostrils,—not *long-pyriform* as in the Fowl, still less *oblong* as in the Rail. Yet there is a Ralline character peeping out even here; for in the Fowl, owing to the gently concave line between the crura of the nasal, the large end of the pyriform space is behind; in the *Talegalla* it is in front—the crura of the nasal diverging at an acute angle, as in the Rail, the "Grallæ" generally, and in water-birds (excluding the "Anatidæ"). The angles of the premaxillaries are more abrupt in the Fowl; and their nasal processes, which, in the Gallinæ generally, *e. g. Gallus*, *Crax*, *Tetrao urogallus*, continue separate along nearly all their length, are completely fused into a bony tongue as in *Ocydromus*, but which does not coalesce with the ethmoid as in that bird. The prevomerine bones are as feeble as in the rest of the Gallinæ; but the inner process of each bone is not continuous with the body in the same scarcely constricted manner as in the Fowl and the Ostrich. Yet it is broadest at its root, and each process converges towards the other in a somewhat sigmoid manner, the upper surface of each of these flat spaces being convex, and the lower concave; they appear in the dry skull as blunt retral hooks. These parts, in the *Talegalla*, are nearer their typical condition, as seen in Crows, Finches, and Warblers, than they are in the "Phasianinæ" and "Tetraoninæ:" they are quite unlike what is seen in the Rail and in water-birds. The zygomatic process of the prevomer is very long, reaching more than two-thirds of the distance to the os quadratum. The palatines seem at first sight to be only as much developed as in the Fowl; a second look at them shows that they have the anterior portion better developed and broader, as in the Goose, whilst there is a rudiment of that second ridge which in higher birds grows downwards from the process that embraces the skull-base. The vomer is altogether better developed than in the "Gallinæ," and is indeed exactly intermediate between that of the Fowl and the Rail.

The mandibles of *Talegalla* are strictly Gallinaceous, and yet the internal angular process is thicker and more clubbed; the posterior or external angular process is shorter, broader, and less falcate: here again we see a falling-off from the type. The os hyoides—the greater part of the skeleton of the last poststomal, and the first postcephalic arch—is strictly typical. The arrested hyoid cornua are cartilaginous for the anterior third and a little behind; they lie in the tongue: the *basi-*, *uro-*, and double *thyro-*hyals have their tips cartilaginous, as in the Fowl. In the Rail, as in most Grallæ and many Palmipeds, the "cornua minora" do not ossify, and are not so divergent; for the rest, the bones are feebler and less ossified even than in the *Talegalla* and the Fowl.

I shall not go so much into detail in describing the osteology of the body of *Talegalla*; for, in the first place, those modifications of structure which indicate the curious affinities of outlying and aberrant groups of birds often cluster most within the cephalic structures; and secondly, I wish to do something to extend the knowledge of this most important branch of animal morphology the structure of the skull: at present the *unknown* is a forest, the *known* a very inconsiderable clearing.

The skeleton of the *Talegalla* has only one rival as to massive strength and the coarseness of its bony tissue, viz. the *Apteryx*. It is the *Mylodon robustus* of the bird-class; and on examining it for the fiftieth time it strikes the observer with fresh surprise. The bones of one hinder extremity of a female, very dry and nearly free from oil, weigh as much as the entire skull and jaws together of both the Flamingo and the Sacred Ibis, viz. 5 drachms, 15 grains. The bones of one hinder extremity of the Great Toucan weigh 1 drachm, 4 grains, or one-fifth of the weight of those of the *Talegalla*. The entire skull and jaws of *Ramphastos toco* weigh 2 drachms, 55 grains; those of *Buceros ruficollis* (fœm.) weigh 3 drachms, the rest of its skeleton 11 drs. 1 scruple,—the total skeleton of this large bird only weighing 14 drs. 1 scr., or less than two "troy" ounces, and less than three times the weight of the bones of one leg of the *Talegalla*.

Mr. Bartlett informs me that the huge eggs of the *Talegalla* are, as in the Crocodile, a long while incubating, and that the young bird is fully fledged before it is hatched. This is in striking conformity with the fact that the massive limb-bones are practically solid; for I find it impossible to insert even very fine wire along the shaft of the bones. The humerus and the os femoris, thick as they are, contain air, the pneumatic passages being merely like pin-holes. The bones of the legs and wings are perfectly Gallinaceous in character, with all the unshapeliness of a Fowl's bones exaggerated and as it were in caricature. The toe-bones correspond with the rest, and the terminal joints are covered with mighty claws, averaging an inch in length. The length of these claws made Swainson think that he had found a most absurd kind of bird, a "Rasorial Vulture"!

whilst the length of the toes and the physiognomy of the bird deceived Professor Owen, and made him call the bird a Rail. All the toes are on the same level in *Talegalla*. There are sixteen strong, short cervical vertebræ, the last two bearing rather long ribs, those of the last being stout, and having each an appendage. The last is anchylosed to the first dorsal, and it to the next two, whilst the last dorsal is free. Only the two first dorsal ribs have appendages, and these very stunted[1]. The first sacral (of which series there are about seventeen) has ribs that meet a large double hæmapophysis, the latter half of which belongs to the second sacral rib. The second sacral rib is small and styloid, and has coalesced with the sacrum; and a small flap, articulated with the hinder half of the double hæmapophysis, belongs to the third sacral. The last sacral vertebra has not coalesced with the rest, and, like the six strong caudal bones, is nearly solid; all the rest of the sacrum, all the dorsal and cervical vertebræ, the ribs and the hæmapophyses are pneumatic, but the numerous air-passages are small. This is similar to what we meet with in the Fowl, only in it the ribs are solid, and all the other back and trunk-bones are very devoid of diploë. The *Talegalla* agrees best, in the very cellular condition of its trunk-bones, with the large culminating forms of the typical "Gallinæ," and with the great arboreal Curassows, rather than with the medium-sized Pheasants and Fowls. The scapula and furculum are solid in *Talegalla*; but the coracoids contain air. We have the same thing in the Fowl; but in *Crax globicera* the thick spongy scapulæ are pneumatic.

Of the shoulder-bones, only the furculum has diverged from the type: its angular process is smaller and turns up more than in the Fowl and the Curassow; the whole bone is more U-shaped than is usual in the Fowl tribe; but little change either way would convert such a furculum into that either of a Plover or a Crow. The sternum is pneumatic, but the passages are few and small. It is excessively strong; but differs little from that of a Curassow or of a Peafowl, very much from that of a Fowl, Pheasant, Quail, or Grouse. In the latter birds the processes are all very long, narrow, elegant, and thin; but the *Talegalla*, a medium-sized bird, rivals the gigantic forms in the coarse strength of its sternum.

Hence the spaces between the forks of the hyposternum and between the hypo- and xiphisternums are relatively much smaller, and the external process of the hyposternum is twice as broad as in the common Cock. As in the Curassow, the sternal keel is deeper than in the type, and is very thick. Altogether, the sternum comes very near that of *Crax globicera*, the hyosternal processes being thick and short. The episternum is perforated, but it is feebly carinate below, whilst in the Curassow the carination is much developed. The "ossa innominata" are essentially Gallinaceous; but the prefemoral parts of the ilia, with the anterior third of the sacral crest, are very much more

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[1] These appendages are very abortive in the Cariama (*Dicholophus*), and are totally absent in the Screamer (*Chauna chavaria*). In the Apteryx and Penguin they are very large, and fix the chest-bones almost as completely as the rib-sutures do in the Chelonia.

arched and elevated than is usual, and even than in the Curassow[1]. With this latter bird the *Talegalla*, however, agrees very closely in the structure of its whole pelvis, the bones being in both very spongy and thick. In the *Talegalla* the "acetabulum" is more in the middle than in *Crax*; and the prefemoral part of the ilium is longer, narrower, and steeper: the os pubis is also thicker. Moreover the "ossa innominata" are wholly coalesced with the sacrum in *Crax*, only in the anterior half in *Gallus*, whilst they are wholly separate in *Talegalla*. Also in *Talegalla* and *Crax* the curious preacetabular spur is much shorter than in the type. In the *Apteryx* the bones are still more reptilian than in the *Talegalla*: in the former the cervical vertebræ are much the strongest; and the ribs and pelvic bones are coarse and *flat*, while in the *Talegalla* they are coarse and *thick*.

Remarks on the Viscera of Talegalla lathami.

The digestive organs of *Talegalla* are extremely capacious; the crop is very large, and shaped like a simple mammalian stomach, such as that of Man or the Bat. The proventriculus is long; the gizzard strong, as in *Gallus*; the duodenal fold very long, and the intestines and cæca both long and very capacious. The whole length from the pharynx to the end of the cloaca is 68⅓ inches, the length from the pharynx to the gizzard being 12 inches.

Measurements of parts, in inches and lines:—

	inches.	lines.
From pharynx to crop	4	0
Average width of this part	0	8
Length of crop	2	8
Average width	1	3
Length of a rather wide part, below the crop . .	0	8
Width of the same	0	5
Length of a narrow part, reaching to the infundibulum	1	6
Width of ditto	0	3
Length of infundibulum	2	2
Width of infundibulum	0	8
Longest axis of gizzard	2	0
Shortest axis of gizzard	1	6
Width of duodenum	0	5
Width of ileum	0	4
Length of one cæcum	4	5
Length of the other	4	2
Average width of cæca	0	8

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[1] The arching of this part is just similar to what is seen so markedly in *Brachypteryx*, *Psophia*, and *Rhinochetus*; and in other respects the pelvis approaches to what we see in those genera.

	inches.	lines.
Length of colo-rectum and cloaca	5	0
Width of former	0	7
Width of latter	1	0

The proventricular glands are small, simple, and ovoidal as in the Rails, and not racemose as in the Fowls and Grouse. The belt of glands is complete. The lining of the gizzard is precisely like that of the Fowl; and the mucous membrane of the cæca coli is simple, and not raised into strong longitudinal folds as in *Lagopus* and *Syrrhaptes.* The gall-bladder is large.

The trachea is 4 lines wide, flat, and rather feebly ossified; but the rings are complete bone, save at the top, where the bone is in patches, as in the Fowl. There is one pair of inferior laryngeal muscles, as in Pigeons, the *Syrrhaptes,* Rails, Plovers, and many other birds. These muscles are absent in Ostriches, Fowls, Grouse, and Geese.

There are no inferior laryngeal muscles in *Dendrortyx*; and its cæca coli, which are nearly 5 inches long by one-third of an inch wide, are plicated within, the folds being *inosculated* as in the typical Fowls, and not *continuous* as in the Grouse and Sand-grouse. The structure of the viscera of *Talegalla* conform, on the whole, to those of typical gallinaceous birds; yet there is a falling-away from the type in the simplicity of the proventricular glands, and an ascent, as it were, from the type in the possession of a more complicated inferior larynx. It is evident that the *Talegalla,* like the mower and the ploughman, has to labour hard, and yet to content himself with very coarse fare: his digestive organs are evidently competent to deal with almost anything the vegetable kingdom can supply.

d. *The aberrant " Cracinæ."*

Example 1: The Globose Curassow; *Crax globicera,* Linn.

These noble birds come much nearer to the highest kinds of the arboreal groups than do the typical " Gallinæ," and the skeleton is as perfectly pneumatic as in the Diurnal rapacious birds. The only bones not admitting air are those which lie distad of the elbow- and knee-joints, and also the flat and feeble furculum. There is but little to add to what I have said of the skeleton generally of this bird in the foregoing description of the *Talegalla.* Leaving out the head, the rest of the bird's structure is principally separated from that of the gigantic Turkey and Peafowl by the absence of the spurs and the low position of the heel. The habits of these " Cracinæ " show a nearer approach to the typical ornithic groups. There is also nothing in their digestive organs, nor in the structure of their organs of speech, to distinguish them from the giants of the typical subfamily. Outwardly they differ considerably, having lost the typical gaudiness; yet their dress is, in many cases so *rich,* even in its neatness, that the absence of bright colouring is scarcely to be considered a loss. Wattles appear again in the Guans (*Penelope*), as they do in some of the Pigeons; and beautiful crests, often crisped and curled in the most exquisite manner, are the rule in this group. The *bones* sometimes take more or less part in the ornamentation of the head; the *face* is enormously expanded into a bony tumulus in *Ourax pauxi*; the "cere" is more or less strengthened by an elevation of the subjacent bone in *Crax*; and the anterior frontal region is elevated to a great height, to form the "horn" of *Oreophasis*. The skull in these birds, as in many others, is the great problem to the morphologist; and on it we must be willing to bestow the most care and labour.

On the whole, the degree of divergence from the Gallinaceous type in the structure of the Curassow's skull is somewhat greater than what is seen in the *Talegalla*. The skull of *Crax globicera* reminds one more strongly of that of *Tetrao urogallus* than that of the Turkey; it is also manifestly *columbine* in many respects, but it does not strike me as being at all more related to the skull of a medium-sized Pigeon (e. g. *Columba palumbus*) than to that of one of the "Musophagidæ" or Plantain-eaters, *e. g.* the Touraco (*Corythaix buffoni*). There is but little difference as to thickness in the skulls of the Turkey, Cock-of-the-Woods, and Curassow; but that of the first is dense and hard, like a Mammalian skull; that of the second is very coarsely spongy; whilst the Curassow's skull, although thick and heavy, is more ivory-like, and altogether comes nearer to the skull of a typical bird. The occipital plane forms a more obtuse angle with the basicranial axis than in the Fowl, whilst in the Turkey it forms a right angle, and in *Tetrao urogallus* an acute. The occipital plane is more rounded and smooth than in the Fowl, whilst in the Fowl it is much more so than in the gigantic Turkey. The condyle is perfectly typical.

There is a falling-off in the breadth of the basitemporal region; but the ear-drum is as hollow as in the Fowl. The great "incus" has got a second head, not, however, very separate from the first. The temporal fossa is bridged over as in the Fowl tribe generally, but the orbit is better formed; it is evenly round for about three-fifths of a circle, and the massive frontals grow outwards into the supraorbital region, as in the larger Pigeons, so as to be flush at the edge with the lachrymal. There is a shallow fossa between each convex frontal. The lachrymal, which is a flat, fatty bone in the Fowl, the Turkey, and the Grouse, is in the Curassow spongy and pneumatic; and the descending process is also thick and expanded, coming close to the condition of the bone in the Screamers, Pigeons, and Plantain-eaters. The interorbital septum is perfect, but rather thin: in this it differs from *Columba* and *Corythaix*, and agrees with the large *Gallinæ* proper; that partly depends, however, upon the large size of the bird. The antorbital and the ali-ethmoidal laminæ are ossified at their roots; but the alæ of the septal and ali-nasal regions are, with all the upper part of the "septum nasi," wholly cartilaginous. The lower, outspread portion of the septum—that part which in all air-breathing Vertebrata tends in the embryo to enclose the air-tubes, and to make them into complete cartilaginous pipes—this broad base of the ethmo-vomerine cartilage is ossified in the Curassow, and is coalesced with its "prevomers," the *splints* of this same region.

This is extremely interesting to the embryologist, and is a great step upwards towards the most instructive condition of these parts in the Syndactyle, Zygodactyle, and Raptorial groups on the one hand, and the "Cultrirostes," "Lamellirostres," and "Totipalmatæ" on the other. As in *Corythaix*, there is either no vomer or but a rudiment, as in Fowls. I have not been able to find one in this tribe; yet it may have been lost, each time, in preparing the skull. The mass of bone forming the ossified preseptal cartilage and the prevomerine splints is very thick and spongy, only a degree below what is seen in *Corythaix*. In the Pigeons the prevomers are cellular, but the septum does not ossify. The nasals are typical in *Crax*: they are high and splint-like; but their broad frontal ends are spongy, and rise a little where they coalesce with the frontals; in front of this thick portion they are extremely elastic, and admit of free bending at the hinge. A good part of the nasal processes of the premaxillaries continues distinct; just where they coalesce they rise into scabrous masses, which lie within the "cere." The rest of the premaxilla is typical; it is high, arcuate, and trenchant at the edges, and the angles are, as in *Tetrao urogallus*, very free of, and considerably below, the flat, feeble zygomatic processes of the "prevomers." The jugals and quadrato-jugals are, as usual, splint-like and rather weak. As in the *Talegalla*, the palatines show a somewhat higher degree of development than in the types; for there is a trace of the external palatine groove—that which forms such a strong channel in many birds.

There is but little to be remarked about the thick pterygoid, save that the facets for articulation with the basi-sphenoid are very long, as in *Tetrao urogallus*. This bone embraces the skull-balk more perfectly than in either the type or the subtype, and thus comes nearer the higher birds. Compared with those of the Turkey, the mandibles of the Curassow are more arched (in the side view), are deeper, and have the splint-pieces equally well developed, thus filling in all the membrane which is so open in the "Tetraonidæ:" the condyles and angular processes are quite typical. The structure of the os hyoides is quite the counterpart of that of the Fowl.

There are sixteen cervical vertebræ in *Crax globicera*, all perfectly typical; the last two bear free ribs. There are four dorsal vertebræ, the last free, and the others forming one piece with the last cervical. There are about sixteen sacral vertebræ, the first of which bears ribs that articulate with the expanded top of the last hæmapophysis. The six caudal vertebræ are very strong; the last, or compound bone, is nearly an inch and a half in length, and has large, forked, coalesced hypophyses. The penult and antepenult have hypophyses; but they only articulate with the centrums.

In *Crax globicera* I found nothing essentially different in the structure of the digestive and vocal organs from those of the typical Fowl, Peafowl, and Turkey.

Example 2. *Oreophasis derbyanus.*

This is an extremely interesting form of Gallinaceous bird, and serves to connect the typical subfamily with the Guans and Curassows, through the African genus *Numida*. It might be supposed that the two genera *Oreophasis* and *Numida* were merely isomorphs: but that is not the whole of the matter; they come very close together in structure. This bird is about one-fourth larger than the Guineafowl and Gamecock, and its bones are relatively, as well as really, less spongy and thick than those of *Crax globicera*. In the trunk, the last or compound caudal vertebra contains fat, and so does the furculum and all the limb-bones save the humeri; the other bones contain air. The *Oreophasis* is therefore intermediate between *Gallus* and *Crax* in this respect; for in the former the scapula contains fat, in the latter the thigh-bones contain air. Both *Oreophasis* and *Numida* agree with *Crax* in having the occipital condyle typical, but the occipital plane less vertical and more rounded than in the large typical forms; they both agree in the nearly typical condition of the basitemporal region and the tympanic cavities. There is a beautiful gradational series, in the Fowl-tribe, of the degrees in which the incudal crura (heads of the " os quadratum ") are collapsed or fused together.

In the Common Fowl the single head of the great incus has a kidney-shaped articular surface for the squamosal, and a small oval facet for the prootic; and in front of this is a trochanter-like tubercle, which might easily be mistaken for the missing head, but which is either abortive or missing in typical birds, where the heads are very distinct. In the Turkey, the Cock of the Woods, and the Red Grouse, the prootic facet is also very small, and in the latter bird is apt to become fused with the outer facet; but the concavities in the side of the skull are very distinct. In *Numida meleagris* the inner facet is still small, but is more distinct from the outer; whilst in *Oreophasis*, as in *Crax* and *Talegalla*, the inner or posterior head reaches the opisthotic region: in typical birds it goes still further back, and articulates at times with the exoccipital. The head of *Oreophasis* is in advance, histologically, of the typical *Gallus* and *Numida*; its texture is more like that of the skull in the higher sorts of birds. The frontals, instead of being outspread as in *Crax*, are mysteriously drawn upwards into a large bony horn-core, which has a slightly backward turn, but which is much more vertical than the horn-core of *Numida*: it is also nearly circular in outline, and not pinched from side to side as in the Guineahen. More than the upper half of the suture exists in this process, and in front below the suture there is a shallow fossa, gradually widening into the concave anterior frontal region: this sulcus is divided into two by a ridge, and on each side there are two more sulci, which become one opposite the suture. These subparallel grooves and ridges, gently converging upwards in the front of the horn-core, make it a very elegant structure. In section, the internal coadapted walls of the halves of the process are seen to be perfect; and they are each filled with moderately fine diploë. Another large pair of sulci exist close to the posterior face of the process:

below, the sulci notch the frontal margin; and their function is to carry vessels for the nourishment of the core and the "horn." The thick narrow anterior part of the frontals extends for a third of an inch before we reach the lachrymals, which are truly cracine, being but little expanded laterally, having a thick descending process, and containing air, and not fat, as in *Numida.* In the latter bird the broad frontal roof is short, and is nearly flush at the margin with the very large, flat superorbital plate of the lachrymal; so that there is no narrow intervening portion; the descending plate of the lachrymal is *aberrantly* strong in *Oreophasis.* Behind and mesiad of the lachrymals, there is on each frontal of *Oreophasis* a short ovoidal sulcus, going inwards and backwards, evidently a bed for the posterior end of the nasal gland: this is a very unlooked-for character; in *Tinamus* these glands are altogether pluvialine, and do not lie at all within the orbit. The horn-core is 16 lines high and 6 wide at the middle. The extreme coarseness of the upper part of the Guineafowl's skull is in great contrast with the typically ornithic character of the skull of *Oreophasis.* They both agree in a curious departure from the structure of Fowls generally; for the process of the squamosal is aborted, and therefore does not bridge over the temporal fossa. In this bird the orbital septum is rather imperfect; but an older individual would have shown a perfect plate. The ali-ethmoid and the antorbital are ossified to some considerable extent, as in *Crax*; but in front of the middle ethmoid there is only cartilage above, as usual; whether, like *Crax,* the inferior septal bone existed and formed the prevomers, I cannot say: these parts are lost in the skull under examination; so also is the vomer. The palatines are less perfect than in *Crax*; the pterygoids are like those of that bird; so are the jugals and and quadrato-jugals. The upper and lower jaws (premaxillæ and mandibles) agree well with those of the Fowl and Pheasant, not being so high and strong as in *Crax* and *Numida*: the posterior angular process is not so much curved upwards as in the Fowl. There are sixteen cervical vertebræ: the penult with styloid ribs more than an inch and a half long; the last with large free ribs, having each a broad appendage: this last cervical vertebra forms one piece by anchylosis with three of the dorsal, the last being free: there is one pair of sacral ribs; and these have large floating hæmapophyses. There are about sixteen sacral vertebræ, and six caudal, the last or compound bone being very large (1½ inch long); the last three have anchylosed, forked hypophyses. The two last ribs have no appendages. The three first pairs of dorsal ribs are exceedingly broad, 3½ lines at the widest part, something like those of the *Apteryx.* The sternum is precisely like that of the Brush-Turkey (*Talegalla*), but differs from the Curassow's in the deficient episternal plate or keel; the angular process of the furculum is better developed than either that of *Crax* or of *Talegalla*, but it is less than in the Fowl. There is nothing to remark in the structure of the wing-bones: as in *Dendrortyx*, the thigh-bones are very long. The tibia has its ridges strong; the fibula is only 2 inches long; the tarso-metatarsi rather delicate; the toes are moderately long and strong; the heel, on the same level with the rest of the toes, is more than half the length of the middle toe. There is no spur, as in the other "Cracinæ."

The pelvis is like both that of the *Talegalla* and of the Curassow, being smoother than in the Fowl; but the preacetabular spur is longer than in *Crax*. Anteriorly the ilia are more expanded than in *Talegalla* and *Gallus*; but this is a Cracine character: posteriorly the ilia are suddenly truncate and flat, very different from the same part in *Gallus*, and more so than in *Crax* and *Talegalla*. The postacetabular part of the ilium is still shorter and broader than even in *Talegalla*; the posterior outline of the ischium is convex as in *Crax*, and not concave as in *Talegalla*. The "ossa pubis" are slender as in *Crax*, and not strong as in *Talegalla*. Therefore, although there are leanings in *Oreophasis* on the one hand to the type-form through *Numida*, and on the other to *Talegalla*, yet on the whole the characters belong, in principle, really to the subfamily "Cracinæ."

e. *The First Inosculant Group of "Gallinæ," viz. the "Hemipodiinæ."*

Examples: *Hemipodius varius* and *Hemipodius* —— ?

It is impossible to determine anything with regard to the skull of the Hemipodius without the most careful examination of the skulls of related species. But these allies are very numerous; and it is hard to say which of them should be placed nearest this, one of the most "mixed" forms in the whole range of ornithology.

As instances of the numerous candidates for relationship with the Hemipodius, I may mention the Quail, the Ptarmigan, the little Ground-Pigeon (*Chamæopelia*), the Didunculus, the Dodo, the Syrrhaptes, the Tinamou and the Plover. Which of all these has the strongest claim upon or is nearest of kin to the Hemipodius we shall only learn by going through a mass of minute detail.

In speaking upon this subject, I shall have to anticipate certain results of study; for a considerable amount of minute observation upon the structure and development of the ornithic skull, which at present only exists in drawings and manuscript, will be imperatively called for to clear up difficult points. As I can find but little of what is needed in the published literature upon the anatomy of birds, it is necessary that a large amount of collateral investigation should be made, not only in the class of birds, but also in the other great vertebrate groups.

Some good will arise out of this apparent evil; for a more perfect unity will be thus attained, and the extreme difficulty of the task assigned me by the Council of the Zoological Society will act as a stimulus to the prosecution of fresh embryological research, by which alone, and not by splendid *à priori* theories, can the *meaning* of a structure be determined.

It will be well to examine the skull by a "region" at a time, as this for the most part falls in with what is natural, and will harmonize best with the study of those transient but most important metamorphoses through which the skull passes, and passes so rapidly, before it attains to its adult condition.

The first thing to be noticed is, that *Hemipodius* does not agree with the Quail or the Ptarmigan in having the occipital plane nearly at right angles with the base of the skull; but with the Pigeons, Sand-Grouse, and Plovers, in which the occipital plane tends to become almost coincident with that of the basis cranii (Pls. XXXIV.–XXXVII.).

It agrees with these last-mentioned birds, moreover, and differs from the former, the true *Gallinaceæ*, in a certain smooth, rounded, graduating occipital region, the *Gallinæ* having this part abrupt and flat (Pl. XXXVI. fig. 8).

The cartilaginous scaffolding of the occiput is freely developed in the Fowl-tribe. both in its typical, subtypical, and aberrant genera; but in this *osculant* form there is, as in the Pigeons, a deficiency of this substance, and a retention of the primordial membranous brain-sac as the only covering of the cerebellum for a certain space directly over the "foramen magnum."

This space exists in typical Pigeons, in the Goura, and in the Dodo, even in the adult skull, as a neat, round hole, like a pin-hole: in very aged individuals of the Wood-Pigeon (*Columba palumbus*) it becomes at times walled in with bone; but this small central tract never went through the cartilaginous stage.

This "middle occipital fontanelle" (Pl. XXXVII. fig. 6) is not insulated in some embryos of the Common Pigeon (*Columba livia*) at the time of hatching; indeed there is great variety in this bird as to the degree in which the occipital cartilage developes the insulating process on each side, to close in above the spinal marrow.

Very soon, however, the fontanelle is completed by bone, if not by cartilage. But in the little Passerine Ground-Dove (*Chamæopelia passerina*) the lower part of the mid-occipital region exists as a triangular membranous space formed by the *dura mater* within, and by an extension of the periosteum without. This is also the case in the smaller "Grallæ," *e. g. Tringa cinclus* and *Charadrius hiaticula*; but these have, like their proper congeners, a pair of lateral occipital fontanelles, to be spoken of hereafter.

This imperfectly insulated space exists in *Hemipodius*. In *H. varius* I find it as open below as in *Chamæopelia passerina*, but partly filled up on one side, and bridged across beneath in *H.* —— ? (Pl. XXXIV. fig. 2), the specimen from the Gardens of the Society[1]. There is in birds a very elegant, deep, semicircular fossa which follows the curve of the great anterior semicircular canal, being indeed formed by the projection of that canal inwards, thus leaving between it and the skull-wall above a deep rounded space. A large lateral "sinus" is lodged in this groove, the bone growing round it for two-thirds of its diameter, and, in the case of some birds, viz. the Pigeon, bridging it over

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[1] This specimen is now in the British Museum; the bird died too soon after its arrival at the Gardens for specific determination.

for some distance at its highest part. This sinus becomes entirely enclosed in bone just at the centre of each superoccipital piece, and emerges as a vein, to join the veins of the neck, close above the junction of the superoccipital with the lateral element. There is a great variety, however, in the manner in which this vein is enclosed; for in the feeble skull of the Ground-Pigeon (*Chamæopelia passerina*) (Pl. XXXIV. fig. 7) it soon finds the surface, but in *Columba palumbus* it burrows much further downwards in the skull-wall before it escapes.

This vein is very small in *Hemipodius*, and is much enclosed in bone; in the Grouse (*Lagopus*) (Pl. XXXVI. fig. 8) and in the Lapwing (*Vanellus*) (Pl. XXXVII. fig. 2) it is as large as in the Pigeon—the degree of its concealment in the bone, as in the latter bird, depending upon the age of the individual. The condition of the bone itself is very instructive; for whilst the "Gallinæ" have opake, thick-walled skulls (especially the typical species; for they are still opake, but thinner, in the "Tetraonidæ"), in the Pigeons, as in other arboreal birds, the walls are thin and translucent, and the diploë very delicate.

In the Plovers and their allies the bone is much less opake than in the Gallinaceous birds; but the diploë, instead of being extremely thick, as in them and in the "Struthionidæ," is very deficient. This latter condition of the bone coexists with an increasing fattiness of the bone as we pass from the Plovers, through intermediate forms, to the plunging and diving "Palmipeds."

In *Hemipodius* the skull-wall, in its transparency and in the delicacy of its diploë, as well as in the smooth, polished condition of the surface, agrees with the "Columbidæ." Looking at the skull of the Hemipodius from above (Pl. XXXIV. fig. 3, Pl. XXXV. fig. 3), and seeing how the frontals are narrowed between the orbits, one might be beguiled into the opinion that it was but little modified from that of *Coturnix*.

In *Chamæopelia*, however, this region is not much wider across than in the Quail and the Hemipodius; yet as we pass to the Ringdove (*C. palumbus*), and especially to the Dodo, we see to what a width this part may grow.

What the Dodo is to the *Chamæopelia* in this respect, that the Adjutant is to the Bittern; and the same remark holds good with regard to the interorbital septum also. It is well to be aware of the great amount of modification due merely to the necessities of a gigantic organism, and in no way affecting our conclusions concerning matters of affinity (see 'Ibis,' July 1862).

There is a shallow sagittal fossa in the Hemipodii; that is to say, the frontals incline gently towards each other, as is very common in small birds (Pls. XXXIV. & XXXV. fig. 3). In *H. varius* the long-oval elevations on each side the sagittal line, on the main part of the frontals, are very distinct and large; they are very indistinct in the smaller species (Pl. XXXIV. fig. 3). They exist in many birds, especially small forms, where the convexities of the prosencephalon affect the outer table through the inner.

The rim of the orbit, although projecting but little, is perfect for nearly three-fourths of its circumference: all the upper portion is formed by the frontal, which is somewhat bevelled, especially in *H. varius.* I am not certain whether there was any portion of the nasal gland occupying a superorbital position. The general form of the skull in this smaller Hemipodius (*H* —— ?) (Pl. XXXIV.) is much more like that of the common Quail than that of *H. varius* (Pl. XXXV.), which is more Pigeon-like and, indeed, has its occipital plane much more *basal* than it is in the small kind. The whole aspect of the skull and face of the Hemipodii is, to my eye, very much like that of the nearest living relative of the Dodo, viz. *Didunculus strigirostris.* In both of these Hemipodii the parietal region is evenly convex; but whilst in the small kind the parietals and frontals pass insensibly into one another in the adult bird, as in the Quail, they retain their separate convexities in *H. varius* (Pl. XXXV. figs. 3 & 4). This condition agrees with what is found in the Pigeon, the Lapwing, and the Grouse (Pls. XXXVI. & XXXVII.). In *H. varius* the temporal fossa (Pl. XXXV. fig. 4, *sq.*) is composed of three parts, as in the Dodo; indeed, considering the small size of the bird, these structures are singularly like what we see in that large extinct form. These parts are less distinct in the small *Hemipodius* —— ?, and are more in the condition of the temporal fossa of the Quail. In both kinds the postfrontal process of the alisphenoid and the zygomatic process of the squamosal are very rudimentary. In the Quail and its large congeners, the "Gallinæ" generally and the "Cracidæ," they are long and splintery, and in full age become fused together where they meet over the somewhat strong temporal muscle. Here again the *Hemipodius* favours its columbine and pluvialine relations (Pl. XXXVII. figs. 4 & 9, *sq.*). The degree in which the lateral and basal elements of the occipital sclerotome assist in the formation of the single condyle is very different in the various families of birds. In the highest ornithic type, the Crow (*Corvus*), the basioccipital takes the greatest share, the condyle being an evenly convex oval, its long diameter lying in the antero-posterior direction. In the "Gallinæ" the condyle is nearly bifid, being much more indebted to the lateral elements than that of the Crow, and having its largest diameter transverse. In the Pigeons (Pl. XXXVII. fig. 6, *o.c.*) this takes place in a less degree; whilst in the "Struthionidæ" and in *Syrrhaptes* the condyle is only obscurely dimpled (Pl. XXXVI. figs. 1 & 3). The shape of the condyle is predetermined in the primordial cartilaginous skull, as may be seen in embryo birds before ossification takes place, and whilst the notochord lies in its axis.

In the Lapwing (*Vanellus cristatus*) the single occipital condyle (Pl. XXXVII. fig. 1, *o.c.*) is a very neat hemisphere; whilst in the *Hemipodius* (Pls. XXXIV. & XXXV.) its shape is almost entirely like that of the Crow. Here we are strongly reminded of that marvellous little isomorph of the small Gallinaceæ, the *Petroica bicolor* (see Osteol. Catal. Mus. Coll. Surg. vol. i. p. 299, no. 1584). Certainly this latter bird is the most aberrant of the soft-billed songsters; but whether it can claim any more than a general ornithic relationship to the *Hemipodius* it is impossible to say. We shall see, as we proceed, that the *vomer* of *Hemipodius* is the exact counterpart of the same bone in the recently hatched Corvinæ, Turdinæ, and Sylviinæ, and is extremely unlike that of the Gallinæ, Columbinæ, Pluvialinæ, or Struthioninæ.

The fossa in front of the condyle is well defined in the *Hemipodius*; but the anterior and posterior condyloid foramina, and the passage for the "vagus," are very small (Pls. XXXIV. & XXXV. figs. 1, 8, 9). The "basitemporal" region (*b.t.*) is in size and shape intermediate between that of the Pigeon (Pl. XXXVII. fig. 6) and Lapwing (Pl. XXXVII. fig. 1); and its anterior lip, below the common opening of the Eustachian tubes, is less pronounced than in the latter, but more than in the former. In the Lapwing it is really a well-defined process, whilst in certain of the Anatinæ it is a sharp style.

Where the large external ala of the basitemporal[1] meets the most anterior spur of the lateral occipital, it bridges over an empty space a little external to the foramen for the "vagus." In this the *Hemipodius* agrees with the majority of birds. A line or so in front, and mesiad of this space, is the opening of the elegant bony canal for the internal carotid (Pl. XXXIV. fig. 1, *i.c.*), which canal, principally formed by the basitemporal on each side, yet owes some of its substance above to the basisphenoid, and internally (as in the mammals) to the petrosal (*prootic*). Rathke erroneously terms the symmetrical bones, which in the Snake, Lizard, and Bird invest the internal carotid artery, basisphenoid; whilst the true basisphenoid, formed originally by ossification of the cartilaginous pituitary floor, he calls "presphenoid" (see Mem. on *Balæniceps*, p. 280). In my former paper (p. 316) I spoke of having found the rudiment of a true tympanic bone in the Peahen. Since that time I have dissected a large number of the skulls of *growing* birds, and find that in one form or another it is a very constant element in the class of birds, oftener, however, existing as a series of ossicles than as one distinct ring[2]. The bird-class is indeed remarkable for a free development of bony centres, every available structure being in some species converted into bone. We shall see a remarkable instance of this in the case of the Tinamou; but even in such highly organized birds as the *Falconinæ*, where the growth is so rapid, and the coalescence of bony elements so complete, there is a profusion of separate pieces, even where their distinctness is most transitory. Let the mere "teleologist," the anatomist of the Sir Charles Bell school, look well to this![3]

[1] The basitemporal of birds, being very large, ossifies the "lower tympanic lip" of the periotic capsule.

[2] Müller (Physiology of Man, Baly's transl. 1843, vol. ii. p. 1616) says:—"In young mammiferous animals two other parts" (besides the os quadratum and os zygomaticum) "can be distinguished in connexion with the temporal bone, namely the annulus tympanicus and the bulla tympani, which Hagenbach could distinguish as separate parts in some mammals." Platner saw "an annulus tympanicus in several birds; and frogs have also a rudiment of the same part." The ossification of the true internal "bulla tympani" is continuous with that of the prootic in most mammals; this lower lip of the primary cartilaginous tympanic wall is often absorbed. It is well developed in the Hyrax and Sloth.

[3] I shall not pass by this part of our subject without giving an instance of the prejudices of our anatomical fathers against the results of embryology.

The great man just mentioned, whose writings have been the joy of every lover of biology, takes occasion, in

To return to the tympanic ossicles of the *Hemipodius* (Pl. XXXIV. fig. 1, *t.* 1 & *t.* 2). They are relatively amongst the largest in the whole class, the bird that comes next them being the little Ring-Dotterel (*Charadrius hiaticula*). In the latter bird the largest bone is club-shaped and curved, and although forming not much more than a quadrant, yet shows itself to be the unmistakeable homologue of the more than semicircular "annulus" which is attached to the additional "pterapophyses" of the sphenoid in the Hedgehog's skull. The deficiency of the ornithic bone is, however, supplemented by a small ossicle which underlies the commencement of the Eustachian tube: the larger bone runs along the outer margin of the "basitemporal." In *Hemipodius* —— ? the lateral tympanic is larger and broader than in the Ring-Dotterel; the anterior bone is also larger, and is distinctly kidney-shaped: this latter piece is not so apparent in the skull of *H. varius*. The remainder of the floor of the large Eustachian tube in *Hemipodius* is formed by the junction of the basitemporal with the basisphenoid, the former element becoming more and more distinct from the latter anteriorly. In the "Gallinæ" proper (Pl. XXXVI. fig. 6) the basitemporal region is relatively larger than in any other birds, not excepting the "Anatinæ;" and these two groups agree also in the large, anteriorly placed, and but little elevated anterior pterygoid processes of the basisphenoid. A comparison of the base of the skull of *Hemipodius* with that of the Quail shows how far the former bird is from being truly "Rasorial."

It would be well to compare together the structure of the whole range of species in this group, if they could be obtained; for, even in the two under notice, there is a marked distinction, the smaller kind coming sensibly nearer to the Quail than *H. varius*. This may be well seen in the structure of the basisphenoid; for in *H. varius* the anterior pterygoid process (Pl. XXXV. fig. 1, *b. s.*) is further backwards than in its ally (Pl. XXXIV.), being, as in the Pigeon, practically, if not absolutely, opposite the middle of the pterygoid bone, the facet of which is a somewhat shorter oval than in the small kind, as well as being nearer the os quadratum. This is in the highest degree interesting and instructive; for in Pigeons and Plovers (Pl. XXXVII. figs. 1 & 6, *pg.*) the pterygoid gives off its short, flat-faced peduncle at the middle of its inner side, in both cases having the articular facet oval, but, whilst small in the former, it is much smaller in the latter. Then in all true Gallinaceæ, viz. "Gallinæ" proper, "Tetraoninæ," "Cracidæ," and "Megapodiinæ," the large, long, slightly elevated facet occupies the inner side of the anterior third of the pterygoid, this being joined with a similar forward, long, feebly pronounced anterior

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his work on 'The Human Hand' (p. 170), to criticise the views of those who, not finding the chain of little ear-bones perfect in birds, "choose," as he says, "to say that it is the incus, one of the four bones of the chain, which is wanting in the bird: and Where is it to be found? they ask. Here, in the apparatus of the jaw or mandible, in that bone which is called *os quadratum*." "I believe," says he, "that the slight and accidental resemblance which this bone in the bird has to the incus in man is the real origin of this fancy." But the passage is too long to transcribe, and I have no doubt that my readers are well acquainted with it, and with its sneering remarks upon the *materialistic* tendencies of anatomy when studied positively, and without constant reference to final causes.

pterygoid process of the basisphenoid. The "Struthionidæ," as we shall see, offer the very opposite of this condition, this anterior pterygoid process being in them placed so far backwards as to receive only the end of the pterygoid, which is jammed in between that *long peduncle* and the os quadratum (Pl. XLII. fig. 1, *pg.*). We shall soon see how this bears upon the affinities of the *Syrrhaptes* and the Tinamou.

The large, inflated, shell-like posterior pterygoid processes of the *Hemipodius* (Pls. XXXIV. & XXXV.) are more like those of *Vanellus* even than of *Columba*; least of all are they like the same parts in the Quail. So wide a "trumpet" do they form, with the help of the basitemporals and anterior tympanics below, that the Eustachian tubes are direct continuations of the cavity of the ear-drum. Their anterior termination, however, is very small, as they contract somewhat rapidly, and then open into one common vestibule, above the lip of the coalesced basitemporals, and beneath the scooped proximal portion of the rostrum of the basisphenoid (Pls. XXXIV. & XXXV. fig. 1).

The rostrum of the *Hemipodius* (*b.s.*) is short, thick, and cellular; anteriorly it is sheathed by the broad, short vomer; then three-fifths more of it is embraced by the ascending plates of the palatines and pterygoids. It is then free for some distance —two-fifths, or nearly, of the posterior part. No trace is left of its suture with the base of the ethmoid. The presphenoid is high up out of the way of the basisphenoid (*p.s.* & *b.s.*). The "sella turcica" is very neat and very deep; and the carotid foramina, at its narrow, backwardly placed fundus, large. The anterior clinoid processes are wide apart and sharp: the posterior pair have coalesced (as is usual), and form a thick, forwardly inclining wall, against which the base of the brain leans. Two bosses, near together, show, in the adult, that the posterior clinoids were ossified from each side, and that they thickened before they met. The alisphenoids of the *Hemipodius* (*a.s.*) are well ossified: they, with the imperfect orbital plates of the frontals and the exogenous orbital alæ of the presphenoid, wall-in the brain *antero-inferiorly.* There are two distinct eminences for muscular attachment on each alisphenoid; these represent the external pterygoid plate of Mammals. The alæ of the presphenoidal ossification have coalesced with the frontals and alisphenoids at their point of junction. A small, flat, narrow process descends from the presphenoid *towards* the junction-line of the high part of the base of the rostrum with the postero-inferior portion of the ethmoid. The presphenoid, however, interdigitates by sharp sutural teeth with the postero-superior process of the ethmoid (*p.e.*). This latter process is longer than the one that runs forwards to meet it. Not half the interorbital septum is ossified; for, although the ethmoid fills up some space below, it is cut away in a concave manner between its two backward processes—a large, oval, membranous space having been left by the feeble growth of what was, in an early state of the embryo, a perfect cartilaginous septum.

Between the postero-superior process of the ethmoid of *Hemipodius*, and the anterior part of the conjoined frontals, there is a distinct, oblong, membranous space, communicating freely behind with the antero-inferior fontanelle, caused by the deficient growth of the orbital plates of the frontal and the orbital processes of the presphenoid (*f.*, *p.s.*). A certain part, therefore, of the hemispheres and the olfactory lobes are merely protected by membrane, as in the early condition of the embryo. The olfactory crura in their posterior half are separated only by the "falx cerebri," where it is attached to the small "crista galli." Between the antorbital plates, the middle ethmoid thickens suddenly; but anchylosis has produced an apparent confusion in this region. On careful examination, however, the different parts may be made out.

The narrowest part of the coalesced frontals, between and above the eyes, is underpropped by the pointed end of the top of the ethmoid, which, further forwards, sends outwards a transverse ala on each side, these alæ gradually increasing in width until they reach the region of the antorbitals. In the early embryo these alæ are continuous along the top of all the remainder of the soft, chondrifying cranio-facial axis.

As the skull increases in size considerable differentiation takes place; so that the posterior part of each thin, outstanding, and down-turned "wing" may not inappropriately be called the *aliethmoid*, the middle the *aliseptal*, and the anterior the *alinasal*; this last being the rudiment of the alæ nasi of the adult bird. The middle portion or "aliseptal" turns downwards and inwards to form the "inferior turbinal;" whilst the "aliethmoid" turns down to form the upper turbinal or prefrontal. Looking at the antorbital plate of the *Hemipodius* from behind (Pl. XXXIV. fig. 6), we can see it to be composed of three portions connected by a faint, triradiate suture. The external portion of this relatively large cellular mass of bone is formed by the lachrymal (*l.*), which is like that of the Pigeon, but still more like that of the Dodo. The supero-internal portion is the upper prefrontal (*pr.f.*); the infero-internal is autogenous in its cartilaginous state, as well as in its ossified condition. This is the lower prefrontal, the so-called "antorbital" (*a.o.*) of the bird, and the homologue of the "pars plana," or "lamina papyracea," of the Mammal. This *perirhinal* element is partly coiled upon itself, in many birds, to form the middle turbinal.

In *Hemipodius* these coalesced structures are the tiny counterparts of what we see in the Dodo's skull. The "antorbital" mass towards the eyeball is concave; it is the inner third, separated from the outer portion by a gentle vertical ridge. Seen from the front (Pl. XXXIV. fig. 5), the ethmoid, prefrontals, and lachrymals of *Hemipodius* form a beautiful cellular structure. The great middle ethmoid (*p.e.*) is of moderate thickness, and is carinate anteriorly; it is separated on each side from the oval, swollen base of the upper turbinal (*t.*) by a very distinct space, through which the passage for the olfactory crura can be seen. In front of and somewhat external to these smooth, egg-like masses, the "aliethmoid" (*a.et.*) passes forwards, downwards, and inwards, as a thin osseous lamina, with its free internal edge dentate. Externally this lamina articulates with the front of the tumid lachrymal (*l.*) down its (vertical) mid line. At its base, this lamina is pedate, the foot-like process turning outwards. Between the aliethmoid (which is convex in front and hollow within) and the oval turbinal, there is a free space separating the two; the large end of the olfactory crus lies in this space. All these osseous developments of the nasal labyrinth of the *Hemipodius* impinge upon the space required by the Schneiderian membrane, instead of assisting to any extent to form surface-room. This condition, so unlike the rhinal outgrowths of the Mammal, is very much like the simplicity of these parts in Lizards; whilst the solid prefrontals almost rival, in rudimentary simplicity, those of Fishes. All the middle of the anterior part of the frontal region is formed in Pigeons and in the *Hemipodius* by the broad cellular posterior portion of the nasals (Pls. XXXIV. & XXXV. *n.*), the frontals (*f.*) being mere strips of bone on each side. The nasals bifurcate just where the frontals end, one process running forwards close to the nasal process of the premaxillary, whilst the other passes downwards and forwards to the so-called maxillary. This latter process is in some degree a measure of the height of the bird in the zoological scale; for it is abortive in the typical Struthionidæ (Pl. XLII. fig. 4 *n.*), extremely small and delicate in Tinamous and *Syrrhaptes*, a little stronger in *Hemipodius*, and stronger still in the Fowls, Pigeons, and Plovers. In the latter groups it is a highly characteristic process; for it is flat and lath-like in Fowls, thicker and cellular below in Pigeons, narrow and oval in section in Plovers. Between the forks of the nasal bone the aliethmoid can be freely seen in Pigeons, Sandgrouse, and the *Hemipodii* as a convex cellular plate (Pls. XXXIV. & XXXV. fig. 3); only a small portion can be seen in *Vanellus*, and that thin and fibrous like the rest of that bird's skull. The extreme thickness of the cellular descending process of the nasal in the Dodo hides the view of the aliethmoid in this aspect. This is but an exaggeration of a Pigeon-character in that massive bird. In the Fowl-tribe the aliethmoids are feebly ossified, but their cartilaginous margins are roofed-in above by the broad prefrontal portion of the nasals,—these bones in the "Gallinaceæ" not forking abruptly and at a sharp angle, but having, as it were, their anterior margin so scooped out as to leave an upper and an under sharply-pointed process.

Like the *Syrrhaptes* and the *Pterocles*, the *Hemipodii* are quite columbaceous in this part of their skull; what falling-off there is from that type is a leaning towards the Plovers, and not towards the Fowls. Curious to relate, the premaxillaries, as well as the mandibles, are very Gallinaceous in aspect; and the open nasal fossa in the dry skull is as wide as in the Quail (Pls. XXXIV. & XXXV. fig. 4).

The *Hemipodius varius* is more "pressirostral," has a more *compressed* beak than the smaller species, and it especially reminds one of the *Didunculus*. There is, however, in both the absence of that pinching-in of the whole upper jaw behind the solid part of the premaxillaries which is seen so markedly in the Dodo and the *Syrrhaptes* (Pl. XXXVI. figs. 1 & 2), and to a less degree in the Common Pigeon (*Columba livia*) (Pl. XXXVII. figs. 6 & 8). But in that sudden concavity of the outline below of the upper beak, which gives the *vulturine* cast to the Dodo's face, and which makes the *Didunculus* worthy of the trivial name *strigirostris*, that curve of the " neb " is much better seen in the *Hemipodii* than in *Syrrhaptes*.

It would be a great satisfaction to the anatomist to know the habits of all these curious birds, whether they are monogamous, as the Pigeons, or polygamous, as the Fowls.

Returning to the *Hemipodius* we find that the *dentary* margin of the premaxillary is, as in Pigeons and Plovers, more completely fused with the corresponding portion of the so-called maxillary or prevomerine bone than in the Gallinaceæ; but these parts, with the addition of the anterior end of the palatine, do not floor-in the nasal structures: except at the sides, more than the middle third is open. Towards the end of this space the prevomerine turbinal processes may be seen (Pls. XXXIV. & XXXV. fig. 1, *pv.*). They pass from the body of the bone just where it gives off the retral zygomatic style. These processes are smaller relatively in the *Hemipodii* than in any other bird,—the "Tetraonidæ" (Pl. XXXVI. fig. 6) and the Syrrhaptes (Pl. XXXVI. fig. 1) coming next, and then the Tinamous (Pl. XL. fig. 1), the Quail, and the larger Gallinaceous birds. The jugal and quadrato-jugal (*j.*, *q.j.*) are nearly as slender as the zygomatic process of the prevomer. These parts are very slender in all the relatives of the *Hemipodius*. The prevomerine processes pass inwards, and curve backwards, nearly reaching the little broad vomer (Pl. XXXIV. figs. 1 & 4, *v.*), which is convex anteriorly, with a short horn at each angle, and ending behind in a slight style on each side for attachment to the palatines. The tip of the "rostrum" rests on the upper concave face of the vomer. This bone is not to be seen in the skeleton of *Hemipodius varius* in the museum of the College of Surgeons; it may have been lost. The posterior part of the palatines is well developed (*pa.*), having, as in the Pigeon (Pl. XXXVII. fig. 6), Plover (Pl. XXXVII. fig. 1), and most typical birds, a pair of keels to each bone. They are most like those of the Plover. In the Fowls (Pl. XXXVI. fig. 6) the inner keel is aborted, in the Struthionidæ (including the Tinamous) both the keels are aborted,—the palatine of these birds being a mere semicylindrical shell of bone, with the middle part often mere membrane. All the anterior two-thirds of the palatine of *Hemipodius* is a delicate style of bone. The chief parts of this palatine (as in typical birds) are the narrow anterior portion, the wide posterior part with its two keels, the orbital process, embracing the basisphenoidal rostrum, the vomerine processes, which often coalesce with the vomer, and the narrow vertical articular surface for articulation with the pterygoid.

This latter bone, the pterygoid (*pg.*), has been partly described in treating of the basis cranii; anteriorly it presents a subtriangular vertical surface for articulation with the palatine; and above this facet is the orbital lamina, which embraces the rostrum more perfectly than the similar part of the palatine does. This bone is broader than that of the Lapwing (Pl. XXXVII. fig. 1), less cellular than that of the Pigeon (Pl. XXXVII. fig. 6) or the *Syrrhaptes* (Pl. XXXVI. fig. 1), and less thick and clumsy than it is in the Fowl-tribe (Pl. XXXVI. fig. 6). It is most like that of the Lapwing; but its sphenoidal or middle facet is relatively larger, and the whole bone is broader, although it has the same thin, sharp-edged character. Posteriorly the pterygoid articulates by a double condyle with the os quadratum; this articular surface is concave beneath, whilst above, at the end of its upper process, the facet is slightly concave across and convex vertically. This double articulation of the pterygoid with the os quadratum is found also in the congeners of *Hemipodius*, viz. the "Gallinæ," "Columbinæ," and "Pluvialinæ."

The os quadratum (*q.*) is intermediate between that of the Pigeons (Pl. XXXVI. fig. 6) and Plovers (Pl. XXXVII. fig. 1). The double upper articular head is perfectly normal, and not single, as in the "Gallinaceæ," where the homologue of the posterior crus of the "incus" is aborted. The orbital process is intermediate in breadth between the Plover, where it is broad, and the Pigeon, in which it is narrow—not so narrow, however, as in the Fowls. There is no such process on the incus of Mammals. In the breadth of the internal, convex articular surface for the lower jaw the os quadratum of the *Hemipodius* is also halfway between that of the Plover and Pigeon, it being broader than in the latter and narrower than in the former; the external facet is similar in all three (Pls. XXXIV. XXXV. & XXXVII.). The deep pit for the incurved end of the quadrato-jugal (*q.j.*) is strictly pluvialine, this articulation being shallow and oblique in the Fowl-tribe and Pigeons. The lower jaw of *Hemipodius* —— ? is an almost exact counterpart of that of the Ptarmigan (*Lagopus*), being much stronger than that of the Quail, Pigeon (Pl. XXXVII. fig. 9), or Plover (Pl. XXXVII. fig. 4). Perhaps the angle at which the rami meet is a little more acute than in the Ptarmigan, and the angular processes, especially the internal, are shorter and thicker relatively. The large membranous space of the ramus is quite equal to what is found in *Lagopus* (Pl. XXXVI. fig. 9); in the Pigeon it is almost obsolete, and in the Lapwing small and oval. The coronoid process of the surangular is very strong—as strong as in the Grouse. The articular facets are also more like those of the "Tetraonidæ" than those of the Pigeons or Plovers. The dentary elements are short in Pigeons, longer in Plovers, very long in the Tetraonidæ (Pl. XXXVI. fig. 9). The posterior part of the ramus in Pigeons (the *articulare*, with its investing splints, the *angulare*, and *surangulare*) is very thick and cellular—very different from the condition of this part in *Lagopus*, *Hemipodius*, and *Vanellus*. In the *Syrrhaptes* this part is intermediate between that of Pigeons and Grouse.

The "os hyoides" has not been preserved in either of the skeletons of *Hemipodius* under inspection.

In *Hemipodius varius* (Pl. XXXV. fig. 5) I find nineteen vertebræ between the skull and the sacrum (Professor Owen gives eighteen; see 'Cat.,' p. 274), and in the smaller species there are twenty. In the latter kind the last sacral vertebra is (in this specimen) still separate from the rest. The vertebral column in the two species has the numbers in each region as follows:—

	Cervical.	Dorsal.	Sacral.	Caudal.	Total.
Hemipodius varius	15	4	13	6	38
Hemipodius ——?	15	5	13	6	39

As usual, the last *vertebra* is an anchylosed *series*, so that the real number is perhaps about forty-five in all.

Perhaps the *atlas*, from its relation to the basis cranii, is the most interesting vertebra in the entire column; at any rate it is a good measure of the height of a bird in the ornithic scale. The perfectly typical character of the occipital condyle of *Hemipodius* (so unexpectedly combined with a typical but somewhat arrested vomer) is repeated in the articular "cup" of the *atlas*. A few remarks, however, upon the modifications of this part in relation to the more or less *reptilian* character of the occipital condyle—that is, whether its longest diameter is crosswise, and its shape bifid, as in the Fowls, or whether its longest diameter is lengthwise, and its surface entire, as in the Crows—will be useful. Most of the "Zygodactyli" agree with the Crows (*Corvus*, *Gymnorhina*), with the Finches (*Fringilla*, *Pyrrhula*), and with the soft-billed Songsters (*Budytes*, *Pratinola*, *Motacilla*) in the typically ornithic character of the occipital condyle and of the atlantal "cup." But the "Musophagidæ" (e. g. *Corythaix buffoni*) agree with the "Cracidæ," and therefore with the other Gallinæ in the possession of a very imperfect cup to the atlas.

The arboreal Pigeons, the Plovers, the Ostriches, the Tinamous, the Sandgrouse, the Psophiæ, the Ardeinæ, and most of the Palmipeds agree in this non-typical character of the cup of the atlas. Amongst the Palmipeds having this character, I may mention *Querquedula* and the other Anatinæ, the Larinæ (e. g. *Larus*, *Gavia*), the Divers (e. g. *Colymbus* and *Uria*); yet in *Alca torda* the odontoid ligament is bridged over, but still more so in the Cormorant (*Phalacrocorax carbo*). On the other hand, the Owls and Hawks are almost as far from the typical birds as the Fowl-tribe; this, however, agrees perfectly with many other non-typical characters in these "Raptores." I do not consider them to be much higher in the bird-scale than those other "unclean" birds the Storks and the Cormorants. Occasionally the cup, although very incomplete, is slightly bridged over by bone; this occurs in the Lapwing (*Vanellus cristatus*).

As to the other cervical vertebræ of *Hemipodius*, there are no carotid "bridges" (Pl. XXXV. fig. 5, *c*.) perfect, as is also the case in Fowls, Pigeons, and Plovers; and there are no especial characters to distinguish them from the smaller Gallinaceous birds. The last two bear ribs—the small one a mere style, and that on the last two-thirds the size of the dorsal ribs. This rib bears a considerable "appendage." The tenth to the fourteenth cervicals (inclusive) have distinct, flat, sharp "hypo-parapophyses;" in the fifteenth there are three such processes. These processes are long on the first two dorsals; the first of these strongly bifurcate, the rest feebly so. None of the dorsals are anchylosed (*d.*), but they are strengthened by osseous tendons as in *Vanellus.* The bodies of the cervicals are strong, but subcarinate as in Fowls and Plovers; not broad below, as in the Pigeons. The costal appendages are very large and overlapping, that of the last dorsal small; but there is none on the sacral rib, the hæmapophysis of which is *floating.* The hæmapophyses (*hm.*) are all very slender.

The sternum of *Hemipodius* (Pl. XXXV. fig. 5) is a step nearer that of the Gallinaceous birds than that of the Tinamou. It might be thought to be related to that of the Rallinæ; but it is not. In them the internal hyposternal process is aborted; in *Hemipodius* the external spur, so peculiarly sharp, distinct, large, and diverging in Pigeons and Fowls, is not developed (*hys.*), and the space mesiad of this long internal hyposternal piece is as large as in the feeblest Gallinaceous sternum. In the Tinamou all this is caricatured (Pl. XLI. fig. 1). The keel of the sternum is relatively as large in *Hemipodius* (*e. s.*) as it is in the typical "Gallinæ"—its inferior outline being, as in them, unusually straight, whereas in Pigeons and in Plovers it is very arcuate. The anterior margin of the keel is, as is usual in the congeners of this bird, sharply carinate; it has also a projection just where the great pectoral muscle sets on in front of the divisional line between the outer and middle muscle which passes from this process to the base of the xiphoid end of the body of the sternum. Much more room exists here for the *depressors* of the wings than in the more struthious Tinamou.

I must dilate a little upon the characters of the episternum. In Plovers and their allies there is a moderate-sized episternal process, broad and bifid above, carinate below, and imperforate at its base. In "Gallinæ" (proper), "Cracinæ," "Megapodiinæ," and "Tetraoninæ" (Pl. XLI. figs. 9 & 10, *ep.*), this process is similarly shaped; but it is much larger, and is perforated at its base, so that the internal angles of the articular bases of the coracoids touch, or may touch, each other *through* the episternum. In *Hemipodius* these corners of the coracoids dint the episternum on each side, but do not pass through. In *Vanellus* the coracoids nearly meet *over* the top of the episternum; in *Tinamus* they glide *beneath* it; for in that bird only the broad upper portion of the process exists. Again, in Pigeons the hole of the Gallinaceous episternum is a wide open cleft; the coracoids can touch each other (for the facets of synovial cartilage on the sternum are only the fiftieth of an inch apart in the common *Columba livia*) *between* the two episternal processes. The upper process in Pigeons is like that of *Tinamus*, but shorter; and it is not so *pared away* beneath; the lower process, not present in the Tinamou, is small and carinate below. This lower process of the episternum in Pigeons is much aborted in *Pterocles* and *Syrrhaptes*; and in these latter birds the upper process is quite absent. This abortive development of the episternum, which is a strong struthious character, takes place more completely in the ralline *Brachypteryx*; in that bird the episternal region is cut away in a semicircular manner as in the *Apteryx*, but not to the same degree. In the native Hen (*Tribonyx mortieri*) a small inferior process exists; in the Weka-Rail (*Ocydromus australis*) it is somewhat larger. The hyosternal processes (*hs.*) are smaller in *Hemipodius* than in the Fowls; narrow, however, as in them, and not broad as in the Plovers: they do not stand upwards as in *Tinamus*, nor lean forwards as in the Fowls, but are slightly recurved, with a retral process at the tip. The single (internal) hyposternum (*hys.*) bows out from the entosternum, and then makes an elegant curve towards it. A bony strap in typical Pigeons (not in *Goura*) connects this internal hyposternal process with the xiphisternum.

The wings of *Hemipodius* (Pl. XXXV. fig. 5) are relatively larger and more elegantly constructed than in the Quail; they have somewhat of the pluvialine structure in them, but the long, gently arcuate, blunt-ended scapula (*sca.*) is much like that of the common Fowl. The coracoids (*cr.*) are long, as in the Fowl and Quail, and the process outside the base of the bone is scarcely more developed. In *Vanellus* it is very long, outstanding, and recurved; in the Pigeon it is less marked.

The furculum (*fr.*) is as much V-shaped, and its rami nearly as straight, as in the Fowl, the Quail, and Partridge; but the process at the angle, which is clean gone in the Pigeons, and which is very small and recurved in the Lapwing, is, in *Hemipodius*, larger, but still recurved. In the "Gallinaceæ" it is almost in a line with the rami; still in them there is more of this large, flat plate above and behind than in front and below the branches.

The following table shows the length of the wing and shoulder-bones in these birds, and their relatives, the figures indicating inches and lines or *twelfths*.

	Clavicle.		Coracoid.		Scapula.		Humerus.		Forearm.		Hand.	
	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.
Hemipodius varius	1	3	1	1	1	6	1	4	1	5½	1	5½
Hemipodius ——?	1	1	0	11	1	3	1	1½	1	0	1	2
Vanellus cristatus	1	5	1	0½	1	7	2	7	3	0	2	7½
Coturnix dactylisonans ..	1	3	1	2	1	8	1	4	1	4	1	3
Columba livia	1	4	1	4	1	7½	1	8	2	0	2	7½

The *Hemipodius* agrees with the Pigeons and Fowls in having all the skeleton pneumatic, save the caudal vertebræ, the forearm, the carpo-metacarpus, the hinder extremities entirely, and perhaps also the bones of the shoulder.

Age makes a great difference in this respect; nevertheless in adult Pigeons (*Columba palumbus* and *livia*) I find that the coracoids receive air, whilst the clavicles and scapulæ are medullary. The openings that communicate with the thoracic air-cells in the Pigeon pierce the coracoids close above the basal articular surface.

Much has been said and written upon the degree in which air enters the bones of birds; part of the discrepancy in authors arises undoubtedly from the different conditions of the individual specimens examined. Many years ago I prepared the skeleton of a Cuckoo (*Cuculus canorus*), in which all the bones of the limbs, except the humeri, contained marrow. A few years afterwards I obtained an adult Cuckoo, which had died of starvation; and there was positively no oil in its bones. This specimen is, I believe, in the possession of Dr. Clarke, of Cambridge. Again, it would be interesting to know whether the wild Pelican has any non-pneumatic bones; also the Horn-bill. I should suppose not, however. The economy of osseous substance in the skeleton of *Pelecanus onocrotalus* is so great that Dr. Fritsch of Prague declared to me, with great fervour, of a specimen in his collection, that "you lay it on your hand, and it actually weighs nothing." Now, in the "Pluvialinæ" (e. g. *Vanellus cristatus, Charadrius hiaticula*, &c., only the cranium proper contains air. Their long-billed, probing relatives (e. g. *Numenius arquatus, Tringa cinclus, Limosa rufa, Totanus calidris*) have a similar state of the skeleton. The Gulls (e. g. *Larus canus, Gavia ridibunda*) and the Mergansers (e. g. *Mergus albellus*) have the head and the vertebræ, as far as to the thick part of the sacrum, pneumatic: in these birds the ribs, the sternum, and all other parts are fatty. In the typical "Anatinæ" (e. g. *Querquedula caudacuta, Cygnus olor*) the sternum and humerus also receive air. In that near relative of the Pelican the Cormorant, the bones seem to be entirely medullary. Many other Palmipeds have very fatty skeletons, especially the Divers, from the little Dabchick (*Podiceps europæus*) to the huge Penguins. In the Pluvialine and Tringine birds the thick branches of the trigeminal nerve are imbedded in fat-cells; so that the *facial* part of the skull is oily. In the larger "Waders" there are more pneumatic bones. In the Herons the tail-bones, the scapulæ, clavicles, and coracoids, and all the limb-bones contain marrow, except the humeri. The furculum contains air, however, in the Adjutant and the *Balæniceps*, as also do the caudal vertebræ. The Trumpeter (*Psophia*) agrees with the Heron, save that in it the broad coracoids are pneumatic. In the Hawks (Falconinæ) even the os femoris contains air, but not, as a rule, the caudal vertebræ. In the Owl the thigh-bones are oily, as they are in most of the arboreal "Perchers," "Creepers," and "Climbers," although in them the cranial, facial, and trunk-bones are pneumatic.

In birds that "do business in great [salt] waters" we find the most oily skeletons; and yet we all well know that some of the most graceful aërial birds belong to this class, both among the "Waders," "Swimmers," and "Plungers." But the plunging Gulls and the wading Plovers are better fliers than many of the beautiful "Anatinæ" that

> "Row their state, with oary feet."

Yet there is no very definite rule with regard to the connexion between pneumaticity of the bones and power of flight. All the salt-water birds have large nasal or supraorbital glands, for the sake, undoubtedly, of the delicate Schneiderian membrane. The isomorphs of the Cetacea (the Penguins) might be expected to have a coarse, fatty, non-ornithic skeleton, and they have such a framework; yet its *teleology* is as consummate as that of the Humming-bird or the Swift. The axillary air-cell pushes itself into the head of the humerus internally and below the deep expanded portion, in many birds, especially the "Anatinæ"; even where the humerus is medullary, as in *Mergus*, this large pit still exists, although the air-cell does not enter the bone-cavity. In the Pigeon this fossa is large and cup-like, and, as is always the case when this bone is pneumatic, the concavity is pierced at its fundus with inlets for the air. In Fowls all this structure is feeble. In the Lapwing, the Loon (*Colymbus septentrionalis*), and the Cormorant the fossa is almost obsolete, and no piercings for air are wanted, the cavity of the bone being filled with marrow. In the Toucan (*Ramphastos toco*) the fossa is large, and so are its basal passages. In the Hawk (*Falco æsalon*) the bone is still more scooped; but in the Owls (*Asio otus*, *Ulula aluco*, *Strix flammea*) the air-passage is large, but it is not imbedded, it is flush with the inner face of the bone.

The *Hemipodii* outdo all other birds, as far as I have seen, in the scooping away of the head of the humerus from within (Pl. XXXV. fig. 7). The bone, indeed, seems like a subcylindrical tube which, whilst in a plastic state, had collapsed at one end; and all the proximal portion of the humerus is a mere shell, the lower edge of this broad part curling inwards like the aperture of a *Univalve*.

Two or three pneumatic holes are punched through the floor of this wide fossa. I see nothing to remark upon specially in the forearm-, wrist-, and "hand"-bones (Pl. XXXV. fig. 5) of these birds, save that their texture is less coarse than in the Gallinæ. And here it will be well to remark that there is a very notable difference between the Galline and Pluvialine group as to the texture of the skeleton. In the skull especially is this seen; for its walls in the Fowls and Ostriches are relatively several times as thick as in the Plovers, Tringine birds, and Gulls. In the arboreal birds the skull, and indeed the bones generally, are more delicately cellular, but less thick, than in the great land-birds. In the thin-boned Pluvialinæ the bones are, in texture, something between horn and ivory. In the Geese, Swans, and Ducks the skeleton is in many respects like that of the Fowls in its texture, but more elastic and fibrous, and not so thick.

In the fast-flying Pigeon the humerus is only two-thirds the length of the carpometacarpus and phalanges. In the Lapwing (which flies in a dreamy, desultory manner, like a butterfly) the humerus is only slightly shorter than the "hand." In the Swift (*Cypselus apus*) the humerus measures $6\frac{1}{2}$ lines; the hand 21 lines. This bird, which dashes through the air like the Giant Dragon-fly (*Æshna grandis*), we see, has its "hand" three times the length of its "arm."

In the Quail the humerus is a line longer than the hand; in the Curassow (*Crax globicera*) it is three-quarters of an inch longer.

In *Hemipodius varius* the humerus (*h.*) is $1\frac{1}{2}$ line shorter than the hand; and in *Hemipodius* —— ? half a line. So we see that these birds, even in their wings come near to both Fowl, Pigeon, and Plover, especially to the last. There are, as usual, two phalanges to the middle digit, proximally, and one distal joint (*d.g.*); also a small joint to the "index." The quill-impressions on the ulna (*u.*) are scarcely visible, as in Fowls; and this bone is about thrice the thickness of the radius. The two carpal bones (*c.p.*) are of the usual size and shape. Lastly, to return to the humerus, the crest for the great pectoral is not so pronounced as in the Lapwing and Pigeon, but slightly more so than in the Gallinaceæ.

As in the other parts of its skeleton, so in the pelvis (Pl. XXXV. fig. 5), the *Hemipodius* seems to have attained to a higher condition of structure than the Gallinæ, between which birds and the Ostriches there is but a step. The outline of the pelvis of these little birds is sharper and more angular, and its texture is less coarsely cellular, than in their nearest gallinaceous relative the Quail. Starting aside from these congeners, they come near to the Plovers even in the "ossa innominata." The relative width of the pelvis is not greater than in the Quail; they are both flat-bodied birds, and in this respect differ much from the larger species of the typical Fowls, but more especially from the lesser kinds of the Grouse-tribe, from the Pigeons, and from the Sandgrouse. The lateral view of the pelvis of *Hemipodius* (fig. 5) shows best its characteristics. The postfemoral moiety of the ilium (*il.*) is stunted, the ischium (*is.*) is much developed—not, as in the Lapwing, by gradual attenuation, but, after leaving a large angle between itself and the ilium behind, passes to its extremity a broad and notched flap of bone, not unlike in its rudeness of outline to the same part in the *Apteryx*. Besides the three or four notches in the upper part of the ischium behind, there are some less-pronounced irregularities below, bordering the "obturator" notch. This "notch" is more open in *Hemipodius varius* than in the smaller kind, in which also the pubis scarcely passes beyond the ischium. In *H. varius* there is an evident projection of the former bone of about the ninth of an inch. The "preacetabular spur," so strong and evident in the "Gallinæ" proper and in the "Cracidæ," is as faint in *Hemipodius* as in *Lagopus*. This spur is nearly aborted in the Lapwing, quite so in the Pigeons and Sandgrouse. The ischiadic *foramen* (fig. 5) is smaller than it is in the immediate congener of *Hemipodius*. There is nothing specially noteworthy in the indications of *composition* in the sacrum (fig. 8, *sc.*)—save that it is not like a Plover's, nor is the neatly turned prefemoral part of the ilium; the latter part of the pelvis, however, in its sharpness is manifestly pluvialine[1]. The upper surface of the pelvis of *Hemipodius* (Pl. XXXV. fig. 8) is evenly convex posteriorly, more so perhaps (more gallinaceous) in *H.* ——? than in *H. varius*. The feeble caudal vertebræ (*cd.*) bring us close to *Tinamus*; but between *Coturnix* and *Gallus* there is a great range of size, the former coming close to *Hemipodius* in the stunted condition of its tail. Below the *Tinamus* come the Ostriches, scarcely more favoured than our own species as to the development of this part of the spine.

The measurements of the hinder extremity of the *Hemipodius* and its allies are subjoined:—

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[1] In the smaller "pressirostral" and "longirostral" *Grallæ* the pelvis is elegantly *open* in its structure, the hinder two-thirds being so slightly ossified that there is on each side a double row of large *fenestræ* filled up by membrane alone. This is seen also in small "insessorial" and "fissirostral" species. The filling up of these spaces is a good Gallinaceous character in *Hemipodius*.

	Os femoris.		Tibia.		Tarso-metatarse.		Mid toe.	
	in.	lin.	in.	lin.	in.	lin.	in.	lin.
Hemipodius varius	1	4	1	9	0	10	0	11
Hemipodius ——?	1	1	1	6	0	9	0	8
Vanellus cristatus	1	7	2	10	2	0	1	2
Coturnix dactylisonans	1	8	2	1	1	2	1	2
Columba livia	1	6½	2	2	1	1	1	3

I have purposely omitted the Sandgrouse and Tinamou from the list, as they must be spoken of hereafter.

The proportions of the bones in the hinder limbs of the two species of *Hemipodius* (Pl. XXXV. fig. 5) are pretty much the same; but in *H. varius* the toes are longer relatively by nearly 2 lines. The Pluvialine type has a shorter thigh-bone by far than the Galline, Columbine, or Hemipodiine types. Indeed all the bones of the hind limb in the true "Grallæ" are exquisitely constructed for running, stalking, or wading. Where the limbs are very long, the motions are solemnly measured and slow; if hurried, they become odd and grotesque—the sublime soon passing into the ridiculous, as may be seen in the Storks, Herons, Cranes, and Flamingos. When, however, the parts are not over-long, as in the Plovers, Tattlers, Curlews, &c., the movements of the bird in running, walking, or wading are very elegant. "Some on the ground walk firm, the "Crested Cock," for instance; and these birds differ as much in their manner, both of walking and running, from the Long- and Short-billed Pluvialines, as a dray-horse does from a racer. The heavy-bodied Pigeon might almost be accused of waddling; and the gait of the *Syrrhaptes* is something between waddling and sliding. The *Hemipodius* is intermediate between *Pterocles arenarius* and *Syrrhaptes paradoxus* in the structure of its tarso-metatarse and toes (*t.ms.* 3, 4, 5); but the relative length of the main divisions of the whole limb are much the same as in the Quail. The *Hemipodii* are evidently good walkers and tolerable runners. The muscular crests on the hind limbs of *Hemipodius* are very moderately developed; far inferior to the Lapwing in this respect, especially in the epi-, ecto-, and entocnemial ridges (*tb.*) on the head of the tibia. That very characteristic cavity at the base of the tibia in front, with its corresponding knob on the head of the tarso-metatarse, which is so beautiful a feature in most Grallatorial legs, is aborted, as is the knob also, in these *Hemipodii.*

The same state of things occurs in the Gallinaceæ. There is a distinct rudiment of this structure in *Syrrhaptes.* I see a large osseous "patella" (fig. 5) in *Hemipodius varius,* and also in the small kind; but no calcaneal sesamoid, as in *Pterocles arenarius.* The *fibula* is scarcely a third the length of the *tibia* (*fb.*, *tb.*). In the absence of the heel or hallux, the *Hemipodii* seem to be separated widely from the Gallinaceæ; but the heel disappears in the genus *Pterocles,* and is absent from the little abortive foot of *Syrrhaptes,* reminding one of the still weaker foot of the Swift. The nails of the toes (3, 4, 5) are, as in *Syrrhaptes,* large and thick in *Hemipodius*; they remind one in both these genera of the toes of the Hyrax, and seem fitted for rocky desert places, and for dry sandy plateaux. There is a feeble, half-grown, unfinished look about the tarsus of both the *Syrrhaptes* and the *Hemipodius* (Pl. XXXV. fig. 5) that reminds me strongly of the tiny shank-bone of the Swift (*Cypselus apus*). The sprawling outturned toes (a condition not absent from *Lagopus*) are very interesting to the philosophical zoologist, as it is the retention of a strong "reptilian" character.

f. *The Second Inosculant Subfamily of the "Gallinæ," viz. the "Pteroclinæ."*

Example 1: Pallas's Sandgrouse (*Syrrhaptes paradoxus*).

The trivial name *paradoxus* is certainly the best that could have been given to Pallas's Sandgrouse, a most unlooked-for kind of creature, full of apparent contradictions, and having in itself the essence, so to speak, of several types of birds. If I felt myself free to adopt the views of Mr. Darwin, no difficulty would exist, and no surprise be occasioned in my mind, by the revelations contained in this one chapter of zoology. Not being convinced at present of the truth of these well-known views, I am under the necessity of working on at these problems with a mind full rather of childish wonder than of philosophical calmness and satisfaction, and more in the state of one who is feeling after a great principle, if haply he may find it, than in that of some clear thinker who looks abroad from the great stand-point of an assured and established law. In the present paper I am constrained to work somewhat descensively at the study of ornithic types, and, as it were, to grope my way downwards from birds full of fine qualities and accomplishments, to the huge cyclopean Ostrich, of which a most sublime ancient naturalist says, with great truth and beauty,

> "God hath deprived her of wisdom, neither hath He imparted to her understanding."

When I first examined the skull of the *Syrrhaptes*, it appeared certain to me that I was passing *downwards* from the "Gallinæ" to the "Struthionidæ;" and although I have for three years more worked continually at the study of type-characters, I have not been led to change my opinion in the least. Nevertheless the *Syrrhaptes* is most intimately related to the true gallinaceous Grouse; but it is related in such a way and manner as to have its gallinaceous characters blended with those of the Ground-pigeons (*Didus*, *Goura*, *Chamæopelia*), of the *Hemipodii*, and of the substruthious Tinamous. To assist my own imagination in grouping the members of the bird-class, I compare it as a whole to a low spreading tree "with a shadowing shroud," and having "his top among the thick boughs." Such a tree will have his "little plants" (its *phytons*) very small and extremely numerous amongst the closely interwoven mass of its twigs; but where the twigs culminate in open space and end upwards and outwards, there will be a much fuller expansion of the spreading leaf-form. Yet down amongst the grass, at the very roots of our imaginary tree, we shall find the most inordinate growth of leafy individuals. Essentially, the base of the trunk contains all the rest; and, essentially, at each bi- or trifurcation we have all that is above that particular forking: at the extremities of the twigs we cease tracing, and if we would run up another branch we must return to the forks and begin our work from an old point.

The exuberant life at the base of the *bird-tree* yields us the inordinately large Ostriches; just at the first fork of the main axis we have the Tinamous; the tree branches, and we have the Sandplover and the Hemipodius; then its repeated forkings and trifurcations yield us the Pigeon, the Plover, and the Fowl. Each true typical group has its culminating forms, "and there an end." These may culminate near the base as side-branches, or at the top, and there we have the fullest exhibition of bird-qualities combined with large size. In the very heart of this tree are the countless typical groups of birds that, as it were, fork and refork, overlap and intertwine themselves. Where the Plover-type has separated from the Tinamous, Sandgrouse, and Hemipodii, there we have a great division made, as is now and then seen in the Silver-fir, a great branch taking the character of a second but smaller leader, and the tree is in a sense double; so the bird-tree becomes double from that point. The land-birds proper, or walking birds, as they run up into the perchers and climbers, form the great *true axis*; the "Grallæ," melting into "Palmipeds," form the secondary trunk[1].

In the Syrrhaptes the occipital plane (Pl. XXXVI. figs. 1, 3, & 4) is not quite so low as in the Pigeon, but it forms a more obtuse angle with the basicranial axis than in the Lapwing (*Vanellus*): this is at once a strongly differentiating character from the Grouse, where that angle is a right angle. Yet it is in the *Hemipodii* that we have the nearest approximation to the Pigeons in respect of the middle fontanelle: this may be transient in the Syrrhaptes; but there is no trace of it in the adult bird, which agrees in this with the Grouse and the Ostriches. But the occipital plane, save for this character, is exceedingly like that of the smaller Pigeons; and the texture of the entire skull and face agrees much more closely with the Pigeon than with any other bird. The foramen magnum (fig. 1) is large, and is intermediate between that of the Lapwing and the Pigeon: in the latter bird and in the Ptarmigan the upper outline is a very perfect semicircle, but in the Lapwing it is a slightly rounded right angle; in the Syrrhaptes it is exactly intermediate. Again, the occipital condyle is a beautiful hemispherical knob in the Lapwing, only a faint dimple existing at its posterior edge; in the Grouse it is kidney-shaped, the dimple forming the large concave "hilum;" in the Pigeon the "hilum" is shallow; whilst, finally, in the Syrrhaptes it is nearly as faint as in the Lapwing. In the Grouse the condyle is transverse; in the other three the axial diameter is slightly the longest. The tympanic wings of the lateral occipital are scarcely more outspread in the Syrrhaptes and the Pigeon than in the Ostrich and the Plover; in the true Grouse their extraordinary development yields an excellent character by which to distinguish them as a subtype from the typical Fowls.

The skull of the *Syrrhaptes*, seen endwise (fig. 3), shows in its narrowness upwards a

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[1] This fanciful comparison has rather a mnemonic than a scientific value. If the higher birds have descended from *generalized* forefathers, such as the Ostriches, yet there must have been several such ancestral groups.

considerable inferiority to that of the Pigeon (Pl. XXXVII. fig. 7) in the matter of brain-room, the hemispheres being drawn up into a cone instead of swelling out, as they do in the Pigeon, under the latter half of the tumid frontals. Nor is this all; for, like the "Struthionidæ," the entire head of the *Syrrhaptes* is very small. I have not weighed it; but it is evident the whole head and face of the *Syrrhaptes* would only weigh about three-fifths as much as that of a Common Pigeon, whose entire weight should be the same as that of the *Syrrhaptes*. Notwithstanding the likeness in the tissue of the *Syrrhaptes* skull to that of the Pigeon, there is a great falling-off at the superorbital regions, as in the Grouse (Pl. XXXVI. figs. 2 & 7). The extremes of the Pigeon-family in this respect are the Dodo and the Passerine Pigeon (*Chamæopelia passerina*); but the latter has a much more bold and rounded front than the *Syrrhaptes*. Every one who has an eye for bird-forms must have noticed this beautiful and distinguishing feature in the Pigeon's face, especially in our own native Ring-Pigeon (*Columba palumbus*); in this bird, especially, the egg-like roundness of the skull proper is continued undiminished along the fronto-nasal region down to the hinge. The superorbital feebleness of the *Syrrhaptes* skull coexists with a less protected condition of the eyeball in the postfrontal region. Close behind the narrowest part of the frontals, the vessels of the scalp communicate freely with those of the orbit. An extremely small postfrontal splint bridges over the smallest "temporal fossa" (fig. 4); and this is in harmony with the extremely feeble condition of the face, feebler even than in the small Pigeons. The Grouse peeps out here, as it were, in the side of the *Syrrhaptes* skull; for in Pigeons the squamosal has a much less rudiment of the mammalian zygomatic process, and there is in them no bridge over the temporal fossa. The os quadratum (Pl. XXXVI. fig. 4) is as far from that of the Grouse as it well can be, and it comes close to that of the Pluvialine birds; but it contains more diploë, as in the Pigeons. The homologues of the incudal crura of the mammals, the heads of the os quadratum, are only short; they have not in the least lost their distinctness; and, as in the Plovers, the peculiarly ornithic orbital process is very wide and rather short: in the Pigeon it is much more pointed, and in the Grouse and the Fowl it is long and styliform. The lower articular condyles of the os quadratum are quite distinct (fig. 1), as in the Plover (Pl. XXXVII. fig. 1 *q.*), and not one transverse cartilage-coated surface as in the Grouse (Pl. XXXVI. fig. 6): the Pigeons generally—e. g. *Columba livia* (Pl. XXXVII. fig. 6, *q.*) and *C. palumbus*—approach the Fowl and the Grouse; but the *Chamæopelia* has the cartilage interrupted: the Dodo agrees with the typical Pigeons in this respect; and this is very interesting, as the specialization of certain structures in the Dodo's skull show it to have been the outermost *leaf* in the Pigeon-branch of our great bird-tree.

On its basioccipital and basitemporal aspect, the skull of the *Syrrhaptes* is like the Grouse as to breadth (Pl. XXXVI. figs. 1 & 6); but this breadth is much exaggerated, and still the double cranial floor is not nearly so thick and spongy as in the Fowl-tribe. Also the tympanic wings of the basitemporals are very thick, terminate in an angle, and are bent downwards outside the canal for the internal carotid artery. The basitemporal plane is relatively twice as wide as in the Pigeon and Plover (Pl. XXXVII. figs. 1 & 6, *b.t.*); and although only the outer half of each moiety is anchylosed anteriorly to the true basisphenoid, yet the whole anterior margin of the coalesced basitemporals sends forward a free and slightly everted lip. In the Grouse these parts are only free where the Eustachian tubes meet below the pituitary space. Externally the basisphenoid and basitemporals are anchylosed, and the line of union is bevelled over and smooth: a similar state of things is seen in the Pigeon and the Plover. Moreover the region mesiad of this line of junction on each side is open in the *Syrrhaptes* to a much wider extent than in the skulls of its congeners; and the Eustachian tubes do not open close upon each other as in typical birds. This divergence of the bony Eustachian trumpets is combined in the *Syrrhaptes* with several other most unmistakeable struthious characters.

As in the Ostrich-group, the true basisphenoid is of great breadth where the anterior pterygoid processes grow out; and, as in them, the "rostral process" (Pl. XXXVI. fig. 1) is enormous, as it is in all the Struthionidæ; and in this little bird it is for some extent as thick as in the huge Curassow (*Crax globicera*). But histologically these parts are very Pigeon-like in the *Syrrhaptes*. The strong pedicles (anterior pterygoid processes) are in *Syrrhaptes* much larger than in the Lapwing (Pl. XXXVII. fig. 1, *b.s.*), and even than in the Common Pigeon (Pl. XXXVII. fig. 6, *b.s.*); they are nearly as large actually as in *Columba palumbus*: in the "Struthiones" they grow to their utmost size. They always grow out on each side the pituitary space, as thickenings of the roots of the *trabeculæ cranii*, and are externad of, and just anterior to, the openings of the Eustachian tubes. They are closest to these openings in the Struthionidæ, and somewhat freer from these passages in typical birds. The small, neat, forwardly placed pterygoids of birds are in great contrast to the long rambling osseous pieces which answer to them in reptiles. In the *Syrrhaptes*, the Tinamou, and the Ostriches, the pterygoids have a strongly reptilian character; but the gradation is complete from the Fowl and the Pigeon, through the *Syrrhaptes* and then through the Tinamou, to the Ostriches. In the Emeu the posterior end of the pterygoid is wedged between the anterior pterygoid processes and the os quadratum: in the true "Gallinæ," typical, subtypical, and aberrant, the anterior third of the pterygoid articulates on its inner side by a somewhat raised and margined facet with the long and low anterior pterygoid process. In *Hemipodius* this facet on the pterygoid has crept further back, and is shorter; in the Pigeon (Pl. XXXVII. fig. 6, *p.g.*) it is on the middle of the bone, and is much smaller; it is smaller still, and also in the middle of the pterygoid, in the Lapwing (Pl. XXXVII. fig. 1, *p.g.*). In the bird now under consideration, the *Syrrhaptes*, the facet is again large, and is placed at the junction of the middle with the posterior third of the bone; then in the Tinamou it has crept nearer the os quadratum; in the Rhea (Pl. XLII. fig. 1 *a.pt.* & *p.g.*) nearer still: and so we get a perfect series from the Fowl to the Emeu[1]. In about three-fifths of the genera of birds this articulation of the side of the pterygoid with the outstanding anterior pterygoid process only exists in the embryo, or at any rate only in the fledgeling. The articular processes are very feebly marked as thickenings of the cartilages in the Old-world Crows, and vanish after the middle of incubation; traces of them can be generally seen up to the time of hatching at least; and in many birds they exist throughout life on the basisphenoid, generally as recurved prickles, e. g. in *Gymnorhina*, *Ortygometra*, &c.; and a large prickle of this nature is well shown in Strickland and Melville's beautiful plates of the Dodo: this is on one side; on the other the arrested process is a mere elevation.

The palatines of the *Syrrhaptes* (Pl. XXXVI. fig. 1) are but a step in advance of those of the ordinary "Struthionidæ" (Pl. XLII. fig. 1, *pa.*); but they have, as in *Tinamus* (Pl. XL. fig. 1), the peculiarly ornithic premaxillary portion of the palatine present, as a mere thread of bone, however. Still, on the outer edge of the *Syrrhaptes* palatine there is a faint groove answering to the well-made, highly ornithic groove of the palatine in the Pigeon and Plover (Pl. XXXVI. figs. 1 & 6, *pa.*)—a groove formed by the development of two keels or crests on the posterior third (or essential part) of each palatine[2]. There is no vomer in the *Syrrhaptes* to tie the two palatines together; and this is a sudden assumption of a *columbaceous* character. Yet, in spite of this, the extremely wide separation of the palatines, and the consequent width—extreme width—of the middle nares shows how close this bird is, not only to the Ostrich, but also to the Reptiles.

In the "Struthionidæ" the mucous membrane of the palate has three large slits, one mesial and behind, for the two Eustachian trumpets to open into; and two somewhat further forwards, which converge considerably towards their anterior end: these are the middle nares, separated by the mucous membrane covering the large thick vomer. In typical birds these three form one large vestibular slit, as is well shown in Macgillivray's figure of the Buzzard's head (Brit. Birds, vol. iii. pl. 17. fig. 1).

In *Syrrhaptes* the middle nares are as wide as in the Ostriches; but in the dry skull they are only separated by the huge basisphenoidal rostrum, and by the laminæ of the palatines that embrace it (Pl. XXXVI. fig. 1). The interorbital septum of the *Syrrhaptes* (fig. 4) is intermediate between that of the Grouse and the Pigeon; better than in the latter, but with more membrane than in the former. As in the Pigeon, Plover, and *Hemipodius* (Pls. XXXIV. XXXV. & XXXVII.), the posterior part of the middle ethmoid above, and the body of the presphenoid which articulates and ultimately coalesces

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[1] In the Humming-bird the anterior pterygoid processes abut against the palatine ends of the pterygoids; so that they present the most perfect contrast to what is seen in the Ostriches.

[2] In some pluvialine birds there is a retral process to the palatine, the rudiment of the "os transversum" of the Passerine, Alcedine, Psittacine, and Caprimulgine groups. This important reptilian bone is, in these birds, distinct, first as cartilage, and then as bone: it coalesces with the palatine.

with it, are quite free of the frontals, which do not reach this vertical bar of the cranio-facial axis. Combined with this peculiarity there is mostly a feeble growth of the orbital plates of the frontal, and a very minute development of the orbito-sphenoidal laminæ: this gives rise to the curious openness in the dry skull at this part. These upper orbital fontanelles are seen in many adult birds. In the old Grouse only the anterior part of this space is open, as the superethmoidal fontanelle (Pl. XXXVI. fig. 9); in younger birds the upper orbital fontanelles are also seen, but periosteal layers of bone fill up the space in the course of time. This pyriform fontanelle of the Pigeon, Plover, and *Hemipodius* opens into the skull at its hinder broad part, and into both orbits anteriorly (Pls. XXXIV. XXXV. & XXXVII. In all these things the *Syrrhaptes* is intermediate between the Pigeon and the Grouse. The descending plate of the presphenoid of the *Syrrhaptes* (Pl. XXXVI. fig. 4) is very thin, but forms a more perfect junction with the great bony bar below than in the Pigeon and the *Hemipodius*. The subtypical Grouse, e. g. *Tetrao tetrix*, *T. urogallus*, and *T. cupido*, *Lagopus scoticus* and *L. cinereus*, and *Bonasia europæa*, all show an advance of the typical group in the ossification of the antorbitals; but the *Talegalla* is in advance of them. In the Pigeons, the *Hemipodii*, and the *Syrrhaptes* (Pl. XXXVI. fig. 4) we have a very perfect state of the ossification here—fusion of these parts taking place least in the Pigeon, and that bird having the descending plate of the lachrymal largest in proportion to the antorbital. In all these birds there is more or less obliteration of the suture between the upper and lower prefrontal plate ("antorbital" and "aliethmoid"), and with the lachrymal. All this thick mass of bone in front of the eye, and over which the nasal nerve and olfactory lobes pass, is in these three groups extremely thick and spongy, and not thin and fibrous as in the Grouse. In them all, but least in the Pigeons, these curious bony air-cells take up much of the room which should be occupied by the olfactory labyrinth; and in all of them the angle between the crura of the nasal is partly filled up with the cellular ala of the great central ethmoid. In the Plovers these alæ are less ossified and altogether less pneumatic than in the Pigeon and its allies. In the adult skull of these latter birds the cellular, broad frontal portion of the nasals melts insensibly into the frontal bones (Pl. XXXVII. fig. 8), and on each side of the tumid top of the aliethmoid there is a slender fibrous crus; the inner crus runs alongside the nasal process of each premaxillary; the outer runs downwards and forwards to join the prevomer and the angle of the premaxillary. The latter bone is not only thoroughly Pigeon-like in *Syrrhaptes*, but it is indeed somewhat of a caricature of what we see in the Common Pigeon (*Columba livia*). In the latter bird the true "neb" or solid part of the premaxillary is very small and feeble; and then the lateral rami are pinched inwards; so that the whole face is not only feeble, but also compressed (Pl. XXXVII. fig. 8, *px.*). In the *Syrrhaptes* and in the Dodo this takes place to a much greater extent, and the narrowing is sharp and sudden; it is a very elegant structure, however, as may be seen by referring to Strickland and Melville's Plates of the Dodo, and to Plate XXXVI. fig. 2, showing the *Syrrhaptes* skull. This remarkable *prolepsis* of the Pigeon's face is combined, however, with two characters which help to make this bird such a paradox. The first character is, that the prevomers (Pl. XXXVI. fig. 1) are not at all like those of the Pigeon (Pl. XXXVII. fig. 6, *pv.*), where they are, especially in the Dodo, extremely thick and spongy; but, instead of this, they are no more developed than in the Grouse (Pl. XXXVI. fig. 6), where they are feebler than in almost any other bird. The second character is neither *struthious* nor *columbaceous*; nor is it like what is found in any other kind of bird: this is the nasal septum, which is formed into one large bone in the Sandgrouse (Pl. XXXVI. fig. 4). Many birds have this part ossified, but not as one piece, such as this bony plate appears to be.

Corresponding to the Pigeon-like enfeeblement of the face, the zygoma of the *Syrrhaptes* (figs. 1, 2, & 4) is reduced to the last degree of weakness: the posterior process of the prevomer, and the whole of the jugal and quadrato-jugal, together form a bar of bone only like the ossification of a very delicate tendon.

Feeble as is the mandible (fig. 4), it is nevertheless more that of a Grouse than of a Pigeon; and, in accordance with the gallinaceous lower jaw, the bend at the mouth-angle is gentle, and not angular and sudden as in the Pigeon (Pl. XXXVII. fig. 9, *d.*) Moreover there is not that disparity, as in the Pigeon, between the lath-like anterior and the spongy posterior moieties of the jaw. The lateral space is wide open also, as in the "Tetraoninæ" (Pl. XXXVI. fig. 9)—that space which depends upon the tenuity of the dentary forks and the comparative arrest of the "splenial" piece. The angular processes, although arrested, are far in advance of those in the Pigeon (Pl. XXXVII. fig. 9, *ag.*). In conformity with the pinched face, the tongue of the *Syrrhaptes* is very narrow, as in the Pigeon; but, true to its Tetraonine relationship, the posterior half of each "cornu minus" is ossified (Pl. XXXVI. fig. 5), and these ossicles are united by a bony bridge in front of the hinge with the basihyal; yet there is a falling-off even here, for they do not unite again close behind their cartilaginous free ends as in the Grouse (Pl. XXXVI. fig. 10). In the Pigeons these "cornua" do not ossify (Pl. XXXVII. fig. 10, *c.h.*); in the Lapwing they unite at the mid line, and then there is an azygous bone lying in the tongue, as though it were a true mesial "glosso-hyal" piece (Pl. XXXVII. fig. 5, *c.h.*); in reality it is the cerato-hyals in a connate condition. The *Syrrhaptes* does not agree with the Grouse, *Talegalla*, Curassow, and Pigeon in having a distinct "uro-hyal"; but it agrees with the *Vanellus* in having the basi- and uro-hyal in one piece (Pl. XXXVII. fig. 5, *b.h. u.h.*): yet the tip of the uro-hyal in the Lapwing is, as in Fowls and Pigeons, a sharp styloid piece; but in the *Syrrhaptes* this cartilage (Pl. XXXVI. fig. 5) is a mere margin to the *spatulate* uro-hyal, as in the most typical of birds the Rook. Here we see, then, that the feeblest part of the Sandgrouse's skeleton—this delicate bony skeleton of the arrested second and third poststomal visceral arches of the embryo—yields us all that we could desire with regard to the determination of this bird's affinities. This os hyoides says plainly, that the *Syrrhaptes* is not a differentiated *type*, but that it is a basal or general form; that it is below the Fowls and even the Grouse—birds so little elevated, on the whole, above the Ostriches. It also teaches that much of its divergence from the "Tetraonidæ" is towards the "Columbidæ;" but not entirely, for the Plover comes in for its share of affinity. But the os hyoides teaches that the Grouse, the Pigeon, and the Plover do not exhaust the affinities of this paradoxical bird; it also shows that, whilst the bird is related to and yet below all these types, it also has within it a scarcely latent kinship to birds belonging to the most fully and best developed types.

Putting together this *corvine* condition of the uro-hyal in the *Syrrhaptes*, of the prevomers in the *Talegalla*, and of the vomer in the *Hemipodius*, and considering that all these three groups are groups of a more *general* and non-typical character than the Fowls proper—all these things, and many more which might be mentioned, indicate where the zoologist is to look for the radical forms from which the great central branches of the *bird-tree* have sprung. Establish that point, and then we shall find our way to the syndactile and zygodactyle groups; for we have already under our eye corvine genera with no faint indications of relationship to those families. Such a bird is the Piping-Crow (*Gymnorhina tibicen*): the *Coronica* and the *Vanga* also both lead in the same direction. All these genera are from Australia, a country rich in generalized forms.

Already the writer has seen the true *general* or fundamental form of the "Raptores:" it is the *Dicholophus*, and must have a certain *grallatorial* nature in it; for such men as Geoffroy[1] and Burmeister[2] have been wholly misled by its striking isomorphism with the terrestrial "Grallatores." I shall willingly spend and be spent in working out the details of facts of this kind; for let us once have a thorough knowledge of what is the positive truth in Nature, and then we shall be in a condition to appreciate the law underlying all these orderly and closely interwoven facts.

To return to the *Syrrhaptes*, we find that, whilst the skull is as exquisitely polished and cellular as in the Pigeons, even the os quadratum and pterygoid being mere labyrinthic air-cells, the skeleton generally is inferior to the Pigeons in this respect, and the *degree* of ossification is not so great. In the true Grouse, such as *Lagopus*, the whole shape and structure of the bird is very much after the fashion of the Pigeon, whilst the firm, majestic step of the typical walking-birds—the Cock, the Peacock, and the Turkey—is the result of an altogether stronger skeleton, with massive hinder limbs and pelvis; but the steps are short, and the manner hurried, as in short, fat people, in the Grey Partridge and the Ptarmigan. In the *Syrrhaptes* this is all intensified, as all who have seen the living bird know. As a biped, it reminds me most of the quadrupedal Armadillo in its movements, which are so quick, and yet have a rolling feebleness about them, whilst the large body hides the stunted legs by which it is carried.

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[1] Ann. d. Mus. d'H. N. xiii. p. 362.

[2] Abh. d. naturf. Gesellsch. z. Halle, vol. i. p. 1 (1853), et Syst. Ueb. d. Th. Bras. iii. p. 400.

The *Syrrhaptes* does not "stalk up and down like a Peacock, a stride and a stand;" it rather may be said to move like an automaton, the action being quick enough, but the cause of that action being invisible. Up "the hill of difficulty" the *Syrrhaptes* cannot go; a sudden elevation of an inch or two causes it to make, in its low, reptilian, uninventive way, a number of ineffectual pushes *against* the unlooked-for obstacle. The details of the structure of the *Syrrhaptes* skeleton will speak for themselves concerning the reason of these peculiarities; and the structure of this gentle bird is to the "teleologist" a distinct chapter—almost a special revelation.

Table showing the number of vertebræ in the Syrrhaptes, *Grouse, Fowl, and Pigeon.*

	Cervical.	Dorsal.	Sacral.	Caudal.
Syrrhaptes paradoxus	16	4	15	6
Lagopus scoticus	16	4	?	7
Gallus domesticus	16	4	15	6
Columba livia....................	14	4	14	7
Pterocles arenarius	15	5	15	7

I do not set much value on the number of caudal vertebræ, as the last is a series, and the tail is very apt to vary in the number of those which shall be swallowed up in this terminal piece. The sacral are easily distinguished from the caudal in these birds, as even in the Pigeons the caudals are no longer pneumatic; that is a better character even than coalescence of a vertebra with those that precede it. We see that the Pigeon fails of two vertebræ in the neck, and two more in the sacrum: the last cervical also keeps distinct from the coalesced dorsal piece, which has only three vertebræ in it. Reference to the foregoing descriptions will show how uniform the Gallinaceous birds are, in their subfamilies, as to the number of vertebræ: there is this difference, that in *Crax globicera* there are sixteen sacral and six caudal vertebræ, whilst in *Talegalla lathami* there are fifteen sacral and seven caudal. This may be accounted for by the fact that the bone which answers to the sixteenth sacral in *Crax* is distinct in *Talegalla*; in *Crax* the caudal vertebræ are *pneumatic*, as in certain of the highest types of birds.

The *Syrrhaptes* keeps close to the Fowls in respect to its vertebral characters; whilst *Hemipodius varius* has one cervical less than the Fowls and one more than the Pigeons, and has the pluvialine character of keeping the dorsals distinct. The cervical vertebræ of the *Syrrhaptes* (Pl. XXXVIII. *c.*) are as feeble as in *Lagopus* and *Columba*; but the little styliform coalesced ribs agree rather with those of the latter than of the former. The floating cervical ribs are feebler than in either, and the large one (*c.r.*) even has no appendage such as exists in Pigeons and Grouse. The rest of the ribs (*d.r.*) are equal to those of the Grouse, but feeble and less cellular than in the Pigeon: the sacral rib (*s.r.*), as is constant, has no appendage; and its hæmapophysis reaches the sternum, which it does not in Pigeons and Grouse. This last hæmapophysis has a rudiment attached to it which belongs to the second sacral rib. The keels depending from the vertebræ in the dorsal region (*d.*) answer to those of the two families with which I am comparing the *Syrrhaptes.* Both in *Lagopus* and *Syrrhaptes* the pelvis has greatly fallen off from its typical strength, to say nothing of its ultratypical condition in the *Talegalla* and the Peacock; but, as compared with that of the Pigeons, the pelvis of the *Syrrhaptes* and Grouse is in both cases truly Gallinaceous.

That which at once strikes the eye in the pelvis of the Pigeon is its almost square contour, the shortness, breadth, and horizontality of the anterior part of the iliac bones, the great size and evenly tumid condition of the posterior part, the ultimately complete obliteration of the ilio-sacral sutures, combined with a very perfect filling-up of all the interspaces, and, lastly, the exquisite polish and delicately cellular condition of the whole sheet of bone. There is much that is Pigeon-like in the pelvis of the Grouse and the *Syrrhaptes* (Pl. XXXVIII. *il.*, *isc.*, & Pl. XLI. fig. 5)—more in the latter than in the former; but the anterior part of the ilium (*il.*) is longer and narrower, and the posterior part relatively shorter, and its surface sinking more suddenly near the posterior margin. Then, in both, the ilio-sacral suture is not so apt to be lost; and, especially in the *Syrrhaptes*, the interspaces are badly filled up, particularly between the acetabula. The preacetabular spur is obsolete in *Columba*; it is present, but enfeebled, in *Lagopus* and *Syrrhaptes* (Pl. XLI. fig. 5, *ac.*). The ischiadic *foramen* is larger in these birds than in the Pigeon; and in both, especially *Syrrhaptes*, the pubis is a feebler bar of bone than in the Pigeon. The Pigeon and the Grouse agree in having the ischium continued backwards in a long triangular piece; in *Syrrhaptes* it is obliquely and rather suddenly truncated (Pl. XXXVIII. *isc.*). In both the Grouse and the *Syrrhaptes* the caudal vertebræ are considerably weaker than in the Pigeon; but they have much in common.

The sudden sinking-in of the ilium near the end, and the deficient sacral roof, are both manifestly Plover-characters; and I have no doubt that if some one would follow the osteologist and give us a perfect comparison of the muscular system in these groups, then we should see that all these pits, and hills, and jutting crags of bone are full of meaning, and answer precisely to the life of the bird.

The sword-shaped scapula of birds, simple as it is in form, is yet subject to endless modifications. In Fowls generally, e. g. *Gallus, Crax, Talegalla,* it is very roughly ensiform, thick at the beginning, broad at the middle, and then tapering gradually to an obliquely truncated point. In the Grouse (*Lagopus*) it is feebler and more truncated at the end. In the *Syrrhaptes* (Pl. XXXVIII. *sc.*) the truncation of the end is at its greatest degree, and the upper margin of the bone is longer than the lower; so that the bone looks like the *radix præmorsa* (*morsus diaboli*) of botanists, where, according to the fanciful notion of the old ecclesiastical herbalists, the great enemy has enviously bitten off much of the precious root. This *premorse* scapula tapers gently towards the end, as in *Vanellus*, but in that bird the "sword" is well shaped. In the Pigeon the bone becomes very broad in its last third, but ends in a somewhat hooked point. The scapula of *Syrrhaptes* is not typical, but mixed[1]; its most marked character also is

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[1] The scapula of *Syrrhaptes* is a very close counterpart of that of the Argus-like *Archeopteryx* (Professor

exaggerated. The "coracoid" of the true "Gallinaceæ," e. g. *Gallus*, *Lagopus*, *Crax*, *Talegalla*, is a clumsy bone, especially in the strong species; it is also of great relative length: in the Pigeons it is long, but its processes and faces and ridges are exquisitely cut and turned; so they are also in the Plovers, but in them the bone is relatively short. In the *Syrrhaptes* (Pl. XLI. fig. 4, *cr.*) it agrees in the condition of its processes with both Pigeons and Plovers; but it is as short as in the Lapwing, relatively to the size of the sternum. It is pneumatic, as in the Pigeon- and the Fowl-tribes, not oily as in the Plovers. The same confusion, as it were, of conditions is seen in the furculum (Pl. XXXVIII. *fr.* & Pl. XLI. fig. 4, *fr.*); and this is of great importance, for it may be said to be an extremely *mobile* bone as to form. True to the marvellous uniformity of structure in almost half the known birds, viz. the "Corvinæ," "Fringillinæ," "Sylviinæ," and the sundry families that lie around and among them, such as the "Tyranninæ," "Laniinæ,' "Muscicapinæ," and the Hirundine groups, in all these there is scarcely the least oscillation of form in the furculum, nor, indeed, of the whole sternal apparatus. This is true also of those outliers of the Corvine group that are found in Australia, viz. the Piping Crow (*Gymnorhina*), the *Coronica*, and the *Anthochæra*. But both the furculum and the sternum begin to lose their characters in such genera as *Petroica* and *Dasyornis*. Noting all this, I think we may take the furculum as a sort of delicate instrument to indicate and to measure the rise and the fall of types.

What change there is in the furculum of the *Talegalla* and the *Hemipodius* (Pl. XXXV. figs. 5 & 6, *fr.*) looks at first sight to be passerine, but it is more likely to be pluvialine or ralline; the change from the V- to the U-shape is greatest in the *Talegalla*; the enfeeblement of the angular process, and the loss of its straightness of direction, are an approach to the U-shaped furculum of the Plover, which has a small flat process at right angles with the crura of the bone. But one of the most important conditions of the typical Gallinaceous "merry-thought" is the straightness of the crura themselves. Now this character is wanting in *Crax*, *Talegalla*, *Hemipodius*, and *Syrrhaptes*, although it is preserved in *Columba*, where the process at the angle is quite lost, and where one crus passes below into the other smoothly and insensibly. But all these, except *Syrrhaptes*, have retained the *length* of the crura, in harmony with the length of the coracoids: this character is gone in *Syrrhaptes* (Pl. XXXVIII. *fr.* & Pl. XLI. fig. 4, *fr.*). The upper ends of the crura have retained their gallinaceous breadth in *Syrrhaptes*, and they diverge upwards more than in *Vanellus*; the whole bone is also weaker and smaller, both actually as well as relatively. There is also a mere bud of a process at the angle; but it does not go back as in the Lapwing. In the side-view the crura are nearly as arched as in *Vanellus*; whilst this arching increases greatly in many water-birds, even amongst the "Grallæ," e. g. in *Numenius*. The great osseous sternal breastplate increases in *bony* perfection in the following order, viz. *Apteryx*, *Struthio*,

Owen's Mem. pl. 1. figs. 1, 51, pl. 2. figs. 1, 51). Amongst the "Altrices," the Woodpeckers (*Picus*) have a blunt scapula, but in them it is almost crosier-shaped.

Rhea, *Tinamus*, *Hemipodius*, *Dendrortyx*, *Perdix*, *Phasianus*, *Gallus*, *Pavo*, *Meleagris*, *Oreophasis*, *Crax*, *Talegalla*, *Goura*, *Syrrhaptes*, *Columba*, *Pterocles*. Here we see that the *Syrrhaptes* (Pl. XXXVIII. & Pl. XLI. fig. 4) stands high in this respect, standing between *Goura* and *Columba*. That, however, must be qualified by showing that whilst there is, as it were, a sudden rise towards perfection of *growth*, yet nevertheless there are deficiencies in *detail* that modify this anomalous sternal completeness in so low a bird. I am not more surprised at finding such long-wingedness in the almost struthious *Syrrhaptes*, than in seeing birds related to the Thrush and the Sparrow with scarcely the power to fly: sudden arrest or over-development of some particular organ is not at all uncommon in nature. Zoologically, the Stilt-Plover is but a somewhat absurd Dotterel; and the shanks of the Flamingo only serve him to stalk about between the stilted Cranes and the clacking Geese. Were not the graduation of the sternum from the Gallinaceous to the Pigeon-group very gentle, that of the *Syrrhaptes* might cause surprise; but the change is easily made, and the clinging of the inner hyposternal process (Pl. XLI. fig. 4) to the entosternum for most of its length, and then its rejoining the mesial piece at the end, is all soon done in actual nature by allowing the bony matter to creep further and further along the membranous spaces between the cartilaginous bands. The great distance of the external fork of the hyposternum from the end of the bone is very extraordinary in the Gallinæ (Pl. XLI. figs. 9 & 10) and the Pigeons. In many water-birds, in Owls, Giant Goat-suckers (*Podargus*), in Woodpeckers, Toucans, Kingfishers, Rollers, where the hyposternum is double, the outer piece comes very nearly to the same transverse line as the xiphisternum. This is not always the case in water-birds, as may be well seen in *Numenius arquatus*; so that the hiatus between *Syrrhaptes* and the Pluvialines is somewhat filled up even as to this character.

In the individual now under description the inner hyposternal fork of the right side is as free from the body of the sternum as in *Goura*; on the left side there is an ossified tendinous band, which, as in the growing Pigeon, converts the notch into a *fenestra* (Pl. XLI. fig. 4, *hys. xs.*). That which strikes the eye at once is that neither of the hyposternal forks diverge nearly so much as in the Pigeons: there is a much greater tendency to that parallelism which is so marked in the Lapwing's sternum, and which, having a certain amount of filling up, is tending towards the curious, oblong, complete sternum of the "Gruinæ." As in the Plovers, these processes of the sternum of *Syrrhaptes* are not nearly so *pedate* as in the Fowls and Pigeons. The great entosternal keel (Pl. XXXVIII, *es.*) is quite equal to that of the Pigeon; but it does not stand forward so well as in that bird or the Plover, but falls back in a very gallinaceous manner (Pl. XLI. fig. 10, *es.*), although not so much as in the purer types. Its anterior margin is very thick, and it suddenly thickens, as in the Plover and Curlew (*Numenius*), not gradually as in the Pigeons and Fowls. The broadest part of the space on the keel for the "pectoralis major" is scarcely 3 lines; in the sternum of *Columba livia* it is 4½ lines,—the two sterna being nearly of the same size, and the greatest depth of the entire keel in both specimens being the same, viz. 10½ lines. We shall see, when we turn to the *Tinamus*, how the thinness of the great pectoral, and over-thickness of the middle muscle, bear upon the affinities of these birds. It is right to state, however, that the sternum of this *Syrrhaptes* is somewhat diseased at the keel-edge (Pl. XLI. fig. 4), and perhaps more room ought to be allowed for the great pectoral.

In the various Fowls and in the *Syrrhaptes*, the air only enters the body of the sternum at its anterior end, above; in Pigeons the mesial groove is riddled with holes. The hyosternal processes (Pl. XXXVIII. *hs.*) are not long and forthstanding as in the Fowl (Pl. XLI. figs. 9 & 10, *hs.*) and the Grouse, not short and *retral* as in the Pigeon and *Talegalla*; they are small, triangular, and upright, as in the Plovers. In the *Syrrhaptes*, as in the Pluvialines and many other birds, the lower episternal piece (Pl. XL. fig. 4, *ep.*) alone is present. In this point we again see how the *Syrrhaptes*, which has this process very small, keeps below the typical Fowls.

Length of wing-bones in the Syrrhaptes, *Pigeon, and Ptarmigan.*

	Arm.		Forearm.		Hand.	
	in.	lin.	in.	lin.	in.	lin.
Syrrhaptes paradoxus	1	7	1	10½	2	1
Columba livia	1	9	2	1	2	5½
Lagopus scoticus	2	6	2	6	2	5

This Table shows how near the *Syrrhaptes* comes to the Pigeon in the comparative shortness of the humerus, and in the length of the carpo-metacarpus and mid digit (Pl. XXXVIII. *h, dg.*); in both, the hand is considerably longer than even the forearm. In the feeble-winged Ptarmigan, the arm and forearm are of one length; whilst the hand, on which is inserted the primaries, is a line shorter. I only see two things to distinguish the wing-bones of the *Syrrhaptes* from those of the Pigeon: the first is that the recess inside the head of the os humeri for the extension of the axillary air-cell, and in the bottom of which the bone is pierced for the admission of air, is larger than in the Pigeon, and approaches what we have seen in the *Hemipodius*; the second point (and this may be partly due to captivity) is that the quill-knobs on the ulna (*u.*) are very faint indeed, whereas in Pigeons they are strong. The humeri alone admit air, as in most of the walking, running, hopping, and perching birds.

Length of the leg-bones in Syrrhaptes, *&c.*

	Femur.		Tibia.		Tarsus.		Mid toe.	
	in.	lin.	in.	lin.	in.	lin.	in.	lin.
Lagopus scoticus	2	8	3	5	1	7½	1	7
Columba livia	1	6	2	2	1	2	1	2½
Syrrhaptes paradoxus	1	6	1	11	0	10	0	7½
Himantopus melanopterus ..	1	4	5	1	4	7½	1	6

The body of the Stilt-Plover is only about half the bulk and weight of that of *Syrrhaptes*, and yet the tibia is as five to two in length, whilst the tarso-metatarse is 55½ lines long, that of *Syrrhaptes* being only 10 lines—more than five and a half times the length.

Even with the Pigeon the comparison shows how rapidly the more distal segments have shortened; for, the thigh-bones being in both cases 1½ inch in length, the tibia is 3 lines shorter in the *Syrrhaptes*, the tarsus 4 lines; and the mid toe is only half the length of that of the Pigeon (Pl. XXXVIII. *f.*, *dg.*). In the Ptarmigan, as in the Gallinæ generally, the thigh-bone is relatively longer. In the Guatemala Tree-Partridge (*Dendrortyx*), a bird intermediate in size and bulk between the Grey Partridge and the Quail, the os femoris is 2 inches 3 lines long, or three-quarters of an inch longer than that of the Syrrhaptes. In the Plovers generally the thigh-bone is relatively short; in *Vanellus cristatus* it is exactly the same length as that of the Common Pigeon and Pallas's Sand-grouse (*Syrrhaptes*). The os femoris, like the rest of the leg-bones, is non-pneumatic in the *Syrrhaptes*, and is slightly more arched than that of the Pigeon and Lapwing, but not so much so as in the Fowls: the arching of the femur of *Dendrortyx* is as perfect and as elegant as in the human thigh-bone. The splint-like fibula (*fb.*) runs along three-fifths of the tibia (*tb.*), and the latter bone does not send so strong a crest out laterally for its attachment as in the Pigeons. The muscular crests on the head of the tibia are in an arrested state, and are curiously contrasted with those of the tibiæ of its congeners, even of the Pigeon.

There is, however, a bony bridge in front of the inferior condyle, and the whole bone has about the same amount of arcuation as that of the Pigeon. The whole posterior surface of that condyle rolls on a two-faced, very large calcaneal ossicle (Pl. XXXVIII. *cl.*), which has a smaller one perched on it. The tooth on the middle of the astragular portion of the tarso-metatarse in front (Pl. XLI. fig. 6) is smaller than in the Pigeon; and the head of the posterior or middle metatarsal does not project so much behind (XLI. fig. 7), and altogether this curious little bone is free from those ridges and fossæ which mark a well-developed tarsus. The three hinges (Pl. XLI. figs. 6 & 7) (there is no trace of that for the hallux) have, like the lower head of the tibia, each its strong sesamoid, and there are smaller sesamoids at the base of the ungual phalanges, one for each. The toe-bones (Pl. XXXVIII. *dg.*) remind me of those of the Mole; they are very short and stout, and there is one joint wanting in each outer toe. There is, as Plate XXXVIII. *dg.* & Plate XLI. fig. 8 show, a curiously sprawling condition of the toes, the outer two being turned outwards, whilst the inner is turned inwards. The last phalanx is always deeply grooved on both sides, and it is covered by a very strong nail, whilst the under surface of the foot—the only part not buried in feathers—is paved with very strong projecting tubercles (Pl. XLI. fig. 8.). The toes are so close together that the sole of the foot forms one slightly trilobate mass, with the tubercles somewhat obsolete below the setting-in of the toes. The sprawling condition of the toes is thoroughly *reptilian*, and is seen to a less extent in the Ptarmigan (*Lagopus*).

The foot of the *Syrrhaptes* reminds me of that of the *Hyrax*; but the latter creature, having two pairs of limbs, takes advantage (not being able to burrow) of ready-made houses in the clefts of the rocks; the home of the *Syrrhaptes* is on the vast sandy plateaux of Central Asia. For a description of these "Steppes," see Humboldt's 'Views of Nature,' Bohn's edit. pp. 3, 28, 57. This gentle desert-bird has great charms for me, and it would be much more appropriate to write a sonnet in its praise than to spend all this time and labour in a dry and positive description of its osteology.

The viscera of the *Syrrhaptes* are *tetraonine* to a great extent; the trachea is cartilaginous, and it has at its bifurcation what the Grouse is bereft of, viz. a pair of laryngeal muscles, as in the Pigeon, *Talegalla*, and Plover.

The crop, gizzard, gall-bladder, and small intestines are much the same as in ordinary Gallinaceous birds; but, as in *Lagopus*, the cæca coli are very voluminous, they have, however, *twelve* longitudinal continuous folds in their mucous membrane, not *seven* as in the Ptarmigan. The proventricular glands are ovoidal and simple, as in the Pigeon and Plover, not botyroidal as in the Grouse and Fowls. In the latter, e. g. *Pavo*, *Meleagris*, *Numida*, *Phasianus*, *Dendrortyx*, the cæca coli are not so long, and have inosculating folds.

Example 2: The Common Sandgrouse (*Pterocles arenarius*).

The difference between the skull of *Pterocles arenarius* and *Syrrhaptes paradoxus* are not great, but they are important. The head and face of the former are altogether stronger, more gallinaceous, and less pigeon-like than in the latter. The skull-base has, in the *Pterocles*, that peculiar breadth which arises from the *struthiousness* of its structure. The upper frontal region is broader between the eyes, and the alæ of the ethmoid swell up to a greater extent between the crura of the nasal. The postorbital and squamosal processes are much stronger, and make a thicker bridge over the temporal fossa. The crossing of the posterior and horizontal semicircular canals project in the same hemispherical manner as in *Syrrhaptes*, and the tympanic ala of the lateral occipital is equally arrested. The malar arch is stronger, and the central interorbital space is filled up; so also are the orbito-frontal fontanelles; the common optic foramen is more closely and neatly circumscribed. There is still an oval slit, opening into both orbits, between the ethmoid bar and the lower edge of the frontals at their coalescence. The antorbito-lachrymal mass is equally large, and the septum nasi as well developed and as completely ossified. The bones of the face generally are quite as strong as in ordinary Pigeons, and therefore a degree beyond what is seen in *Syrrhaptes*. The double head of the "os quadratum" agrees with the same structure in *Syrrhaptes*; and there is nothing special to remark upon in the bones of the palatine region. The lower jaw is altogether stronger and deeper, its bend is more marked and further back, than in that of *Syrrhaptes*; the membranous space is of about the same size, as are also the angular processes.

There is one more vertebra in the caudal region of *Pterocles arenarius* than in that of *Syrrhaptes*, and that which is the last cervical of the latter is the first dorsal of the former, because of the fact that in *Pterocles* it meets the sternum through the intervention of a hæmapophysis; and this particular vertebra keeps distinct in *Pterocles*. The styliform ribs and the last, or sacral, have no appendage as in *Syrrhaptes*; this last hæmapophysis has a rudiment attached to it which really belongs to the arrested second sacral pleurapophysis. The same thing occurs in both genera. The strength of the vertebræ of *Pterocles* agrees pretty well with that of the Pigeons, especially the cervical; the caudal are, however, feebler. The pneumaticity of the skeleton of *Pterocles* agrees with what we find in *Syrrhaptes*. There is no appreciable difference in the wing-bones; but those of the leg are altogether stronger, and relatively of greater length as well. The great calcaneal sesamoid is also present. The middle metatarsal projects from between the other two, backwards, as in *Syrrhaptes*; but the rudimentary hallux-bones have not been preserved in the specimen under description. Professor Owen (Osteol. Catal. Mus. Coll. Surg. vol. i. pp. 273, 274, Nos. 1421 & 1422) speaks of "the long and slender tridactyle feet," and also that "there is no trace of a back toe." Now assuredly there is a rudiment of this toe in *Pterocles arenarius*, *P. setarius*, and *P. gutturalis*, or else all the figures that I have at hand to refer to are wrong: it appears to be smallest in *P. arenarius*. The separation of the sacrum from the ossa innominata is kept up in *Pterocles*, as in *Syrrhaptes*; but the filling-in of the sacral roof is more perfect, so that there is only a double row of small foramina, instead of the large fenestræ that are seen in the pelvis of *Syrrhaptes*. For the rest, there is only additional strength to be remarked upon.

The scapulæ are much more like those of the Grouse, and the tip of the bone is not nearly so *premorse*. There is no real difference between the furcula and the coracoids of the two genera of Sandgrouse; but the sternum is stronger, and the keel seems to project somewhat further at its apex. The episternum and hyosternal processes are exactly as in *Syrrhaptes*; but the external hyposternal processes are shorter, and the internal spurs are much more strongly bridged over to the xiphisternum. For the rest, the form of the hinder half of the sternum has the same *pluvialine* narrowness as in *Syrrhaptes*.

On the Osteology of the Struthious congeners of the "Gallinaceæ." Family "Tinaminæ."

Example: *Tinamus robustus*.

I approach this, by far the most arduous part of my task, with a feeling rather of intense caution than of actual diffidence. The linking-on of the great wingless birds with forms in which the organs of flight increase in relative size and actual perfection *pari passu* with a steady decrease in the bulk and dimensions of the individual creature has always been to me a matter of the greatest interest. Nevertheless my first impressions were that the short-winged Rails would yield us the best inosculants; and I still vividly remember the joy and satisfaction I felt at the first sight of the skeleton of *Brachypteryx.* It is now twenty years since a comparison of the structure of both the old and young Emu with that of the Gallinule showed me a correspondence in many points of structure between the *skulking*, foolish birds of the struthious type and the beautiful Waterhen—a bird so soon at its wits' end, and so easily intercepted and caught. At present, however, I have not found that very close correspondence between the Ostriches and Rails which, in my youthful days, I confidently expected. I have not yet studied the *Notornis* and the *Palapteryx* carefully—only the living types, e. g. *Brachypteryx*, *Tribonyx*, and *Ocydromus.* The Rail, however, only wants to be arrested at a certain embryonic stage, and then we should have the missing link.

Mere arrest of a Ralline bird, however, would not yield us anything nearly so struthious as the bird we have to consider in this part of our paper: with that arrest there must also be a *retention* of some of the nature of the reptile, and an *anticipation* of some of the characters of the mammal: moreover the Rails are more nearly related to the Penguins than to the Ostriches.

At the dawn of the very day on which I received from Dr. Sclater the priceless skeleton of the Tinamou, I was ruminating upon the possibility of the existence of a bird in which the gallinaceous and struthious natures should be blended. The unmistakeable evidence of a certain struthious tincture (such as I had seen in no other bird) in the skull of the *Syrrhaptes*, combined with the mingling of the blood of various types in that *mixed* bird and in the Hemipods—these things put together caused me to have a day-dream of the existence of some Cock-and-Ostrich mule. On that day my dream came true. I foresee that there will be opposition in the minds of some; for there are cultivators of zoology, as well as of theology, who have the greatest powers of disbelief; but shall their unbelief make the truth of none effect?

My work, let it be understood, is simply positive; I deal neither in matters that relate to efficient causes, nor have I any immediate business with the doctrine of final causes: the *pure* anatomist, for the time being, does not ask how nor why these things came about.

The horny sheaths of the mandible of *Tinamus robustus* correspond exactly with those of the typical Ostriches; there is a curious invagination of the culmen of the bill into the base. In the Tinamou the base is large in proportion to the produced and ensheathed part, and the alinasal cartilages project more than in the large species; this fulness of the "wings of the nose" is a gallinaceous character. The whole culmen and "neb" is separated from the sides of the upper jaw by a well-marked groove, which is repeated in the lower jaw: the upper grooves lead backwards into the nostrils. This is so exactly like what is seen in the Ostriches, that the ensheathed part has only to be produced into a longer beak, and the face of the *Apteryx* is seen at once. There are certain curious, thoroughly *marine* Plovers (*Chionis*), in which the sheathing of the upper jaw is very perfect; they thus retain a struthious character, but have it in an exaggerated condition. There is a somewhat faint condition of this in the Albatroses (*Diomedea exulans* and others), but it is more perfectly developed in the Petrels (e. g. *Procellaria glacialis*). In the Petrels the strong and highly arcuate "neb" is marked off from the sides by a deep groove, as in the "Struthionidæ." The breaking-out again, as it were, of these characters in the *pluvialine* and *larine* oceanic birds does not at all affect their value as indicating the affinities of the Tinamou; for many very high and noble birds amongst the typical groups betray, by their dress, gait, speech, and behaviour, a certain kinship to the low, soil-stained Ostriches—just as a Horse, with much good blood in him, may unfortunately possess the back-stripe which brands him as germane to the Ass. The plumage of the Tinamou comes very near to that of the subtypical "Gallinæ;" but in *wisdom* the bird is very far inferior to the Grouse and Partridge; and the easy manner in which it is caught with the "lasso" shows that it has no right to sit in the same zoological seat as the running "Gallinaceæ." As far as posture is concerned, they often assume that peculiar mode of sitting upright which the Ostriches so frequently adopt, and which is imitated also by some of the great clownish "Grallæ" of higher types. I suppose that the Carrion-Crow (*Corvus corone*) is about the same weight as *Tinamus robustus*; its cranium, however, is twice the breadth, and will hold 110 grains of powdered nitre; whereas that of the Tinamou will only hold 35 grains—less than one-third. Here we see that in these two birds, of almost equal bulk, the typically ornithic bird has more than thrice as much brain as the low aberrant kind. Any one who has watched the Tinamou must have noticed its peculiar, forlorn, wandering manner—like a half-witted person whose mind is not easily made up, and whose actions are feeble and indefinite.

The occipital plane of the Tinamou (Pl. XXXIV. fig. 8, & Pl. XL. figs. 1 & 3) is not, on the whole, less vertical than in the Common Fowl, and this latter bird agrees very much with the genera *Rhea* and *Dromæus* in this respect; but in the Tinamou the "foramen magnum" looks more downwards, and is really more basal than in the larger forms; it thus approaches in some degree to that of the *Syrrhaptes* and the Peewit (*Vanellus*). The whole plane is evidently an ossification of a thick mass of preexisting cartilage, as in the Fowls and typical Ostriches,—there being not the least trace of the middle fontanelle, nor more than a large, vertical, descending channel (Pl. XXXIV. fig. 8, and Pl. XL. fig. 1) on each side for the veins that carry the blood from the sinuses. These veins glide through the primary chink between the periotic capsule and the superoccipital cartilage; the canal for them is relatively very large, and becomes a mere rough-edged channel for the lower half of its course. Between these channels the superoccipital is gently convex; but the upper half is produced into a thick, low keel (Pl. XXXIV. fig. 8, *so.*). On the outer side of each channel is the periotic eminence, bulbous and cellular, and holding within itself, posteriorly, the crossing of the horizontal with the posterior semicircular canals. Above the venous canals the bone is somewhat depressed, and it is here that the epiotic (mastoid) and opisthotic have combined; on the outer edge of the more than semicircular occipital plane, we have the tympanic wings of the lateral occipitals—low, thick, slightly everted externally, evenly bevelled in front, and thoroughly struthious (Pl. XXXIV. fig. 8, *eo.*, and Pl. XL. figs. 1 & 3).

In harmony with what is found in other parts of the skull, the occipital condyle (Pl. XL. fig. 1) is neither struthious nor gallinaceous; for in Ostriches the condyle is generally broadest from side to side, and dimpled behind; in the Fowls it has become reniform. But in the Tinamou, although the dimple is retained in the knob itself, it is longest from fore to aft—an exaggeration of what we find in the Plovers, and, but for the dimple, precisely like what exists in the most typical birds, the Crows. I have before remarked upon this forestalling of typical characters in birds just breaking out from the Ostrich fence. The basitemporal region (Pl. XL. fig. 1) reveals the Ostrich at once; for the tympanic lateral alæ are aborted, and this, taken in connexion with the blunted margins of the lateral occipitals, shows a low and generalized condition of the tympanic cavity, which, save in its Eustachian elongation forwards, is very shallow, and is principally formed by the scooping-out of the outer face of the periotic capsule, neither the *tegmen* nor the *inferior lip* of which were ever much developed (Pl. XL. fig. 3). As far as I have at present seen, there is no ossification of the fibro-cartilaginous rim of the membrana tympani in the Ostriches and the Tinamou; yet this ossification is singularly constant, although very diverse in condition, in all the more typical families of birds. This again is obviously *general* and *reptilian.* The basitemporals are not nearly so defined in the adult Tinamou as in the *Rhea* (Pl. XLII. fig. 1, *bt.*); their anterior margins meet in front at the mid line, and form rather more than a right angle; yet this margin only forms a smooth ridge, in front of which the bone (basisphenoid) is somewhat scooped; whereas in the *Rhea* there is a free lip behind and external to the Eustachian openings (*eu.*). These openings are relatively much further apart in the Tinamou (Pl. XL. fig. 1) than in the *Rhea*; and in the latter the external half of the Eustachian tube is floored beneath by the coalescence of the basitemporal with its corresponding posterior pterygoid process (Pl. XLII. fig. 1, *bt.* & *p.pt.*): in the Tinamou, only a third of this duct is thus protected. In this respect the *Rhea* comes nearer the Fowl than the Tinamou. In the Fowl-tribe the internal carotid artery (Pl. XXXVI. fig. 6) is protected twice as far backwards as in the Tinamou; and the whole width of the combined basitemporals is only half as great in the latter as in the former. Yet, as far as thickness is concerned, there is but little difference between the Fowl and the Tinamou; and this thickness is in both cases dependent upon the fact that the bony *copy* is like the cartilaginous *pattern*; for the "investing mass" is very solid in this region in both groups, the great difference being that in the Fowls a more complete floor is formed to the periotic capsules by the lateral extension of the cartilage surrounding the pointed end of the notochord. The foramina for the vagus, ninth nerve, and condyloid vein are of moderate size, and are well shown by the artist (Pl. XL. fig. 1). The basitemporal region of the Tinamou reminds me of that of the Rails. In front of the basitemporals, at the mid line, the basisphenoid is ridged; this ridge passes along the rostrum, making it subcultrate: near the end of this elevation there is a small vascular foramen—the only remnant of the pituitary space (fig. 1). In typical birds this space is more or less scooped below, and is to some extent often wholly floored by the confluent angles of the basitemporals. This thick pituitary floor, and this subsidiary condition of the basitemporals, is thoroughly struthious); and there are Mammals, e. g. the *Echidna* and the Mole, in which these elements (in them called the "lingulæ sphenoidales") bear as great a proportion to the basisphenoid as in the Ostriches. In the Emu, *Rhea* (Pl. XLII. fig. 1, *bs.*), and Ostrich the basisphenoid shows its junction with the basioccipital on the lower face of the skull; if hidden at all at the mid line in the Tinamou, it is only very slightly; whilst in all birds above the "Struthionidæ" this is impossible, on account of the secondary floor formed by the basitemporals. A few Mammals, e. g. *Myrmecophaga jubata*, have retained this secondary skull-floor; but I am not able to say to what degree the lingulæ have contributed to its formation[1].

The great posterior pterygoid processes of the basisphenoid are as well developed as in the Ostriches and birds generally; they are quite rudimentary, although pretty constant, in Mammals, and often have the "lingulæ" anchylosed to them. They culminate in that most overgrown and extraordinary of all bony centres, the basisphenoid of the bird—a bone the counterpart of which in the Reptilia, e. g. *Centropyx*, *Mocoa*, *Monitor*, *Anolis*, *Anguis*, &c., is such a delicate splint, altogether in front of the massive basitemporals; in the typical Ophidians, however, it is large.

I mention these things, not for the sake of tediousness, and not by mistake, as wandering away from the subject of the affinities of the Tinamou, but simply because this bird has been placed by nature in the great highway of the vertebrate kingdoms, and not in the highway merely, but as it were on the very verge of the "debateable land" where a mixed language is spoken, and where the burning life of the Mammal has lowered down and verges on the half-frozen life of the Reptile. Stretching far away to the right and left of these hot and cold regions of air-breathing vertebrate life is that goodly land, the land of the feathered tribes, where nature sports her virgin fancies, and where neither the Wren, the Nightingale, nor the Turtle want their mate. The Tinamou belongs to the most plebeian tribe of this lovely people, and it has in it also a share of the nature of both those above and those below the class to which it belongs. As in the *Rhea* (Pl. XLII. fig. 1, *r.bs.*), the "rostrum" of the Tinamou (Pl. XL. fig. 1) is extremely large and long—twice the relative length that it attains in the Fowl and in many aërial birds, and a third longer than in the Rails and Plovers (Pl. XXXVII. fig. 1, *bs.*).

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[1] In the scarcely half-grown Hedgehog (*Erinaceus*) the "lingulæ" are distinct: they are very small, and the large descending plates that form the inner wall of the drum-cavities are exogenous: they are the "posterior pterygoid processes."

It is originally developed as the ossification of an extension forwards of the cartilaginous pituitary floor, which extension becomes a grooved style underlying the true and more or less coalesced *trabeculæ cranii.* The bird comes nearest the Ophidians as to the size of this rostrum ; but in those creatures the basitemporals lie on nearly the same plane as the " rostrum," and intervene *between* it and the basioccipital. Nearly the posterior fourth of the rostrum is bare beneath ; it is then for almost the rest of its extent sheathed by the overgrown vomer (Pl. XL. fig. 1), just as originally it sheathed the lower edge of the ethmo-vomerine cartilage : with that it coalesces early, with the vomer not at all. Where the " rostrum " is expanding behind into the thick portion of the basisphenoid the skull-base expands on each side and forms the " anterior pterygoid processes." Behind the root of these is, on each side, the Eustachian opening, and behind and above these directly outstanding pedicles there are the " posterior pterygoid processes." The former processes do not lean forward as in the Emu and *Rhea*, are not so long, and are much flatter ; they are *depressed.* Their development is altogether above and beyond what is seen in any typical birds, and the nearest approach made to their condition is in the *Syrrhaptes.* The oval articular facet on the pterygoid, answering to the facet on the end of this transverse sphenoidal spur, has crept a little further forwards than in the *Rhea,* which, again, is intermediate between the Tinamou and the Emu.

All we have described hitherto is truly and essentially struthious. Still there is an advance, and the typical *leaven* has begun to work in the generalized Ostrich-form. The anterior clinoid processes are small prickles ; the posterior form one, continuous, strong wall of bone ; the " sella " is, as in the Ostriches, only moderately deep, as compared with that of typical birds ; nor is it so neatly circular. The alisphenoid of the Tinamou (Pl. XL. fig. 3) is much like that of the Crocodile on the one hand, and of typical birds on the other. The external pterygoid process is a mere tubercle ; and, what is quite unusual and fish-like, the foramen ovale, at its infero-posterior angle, is divided into two by a bridge of bone. As in the Emu, *Rhea,* and Sparrow-Hawk (*Accipiter nisus*), the supero-posterior angle is developed separately into a " postfrontal " (Pl. XL. fig. 3, *po.*) *homologous* with that of the fish, because developed in cartilage, and only *analogous* with that of the Reptilia, which is a mere membrane-bone. Reptile-like, the suture between the alisphenoid and the orbital plate of the frontal is very long before it is obliterated, but it is also long separate from the anterior sphenoid (Pl. XL. fig. 3, *p.s.*). As each eyeball is about equal in bulk to the entire brain, the septum of the orbits is very large, and, as in birds generally, owes more to the ethmoid than to the anterior sphenoid. The upper edge of the alisphenoid is 6 lines in extent : the orbital alæ are scarcely half a line across ; they must be looked for inside the skull ; and they retain their distinctness for a most unusual time—when the bird is quite adult. These small orbito-sphenoids are wedged between the orbital plates of the frontals and the supero-internal angle of the alisphenoid ; between them is seen the upper surface of the presphenoid, which is in this case, as in most birds, quite vertical. Half of the cranial surface of the presphenoid is between the frontal plates, and half between the inner edges of the alisphenoids. This bone is here about a line thick; but it becomes thin as it grows forwards to join the upper process of the ethmoid (that part of the ethmoid which in Man sends back the "crista galli"), and thinner still where it descends as a narrow plate to articulate, and then coalesce, with the thick *presellar* part of the basisphenoid. At its middle this plate is only half a line broad; and it has in front of it a membranous space, 3 lines across and nearly 4 lines high. The descending part of the presphenoid is evidently formed from a separate centre, distinct from the upper part; it does not meet the basisphenoid until old age in *Vanellus* and *Columba*, and is represented by a very minute point in most Rails, e. g. the Weka-Rail (*Ocydromus australis*). It is, however, with this latter bird and its allies that the presphenoid of the Tinamou is to be compared, as also the membranous space—although the Rail exceeds somewhat in this, the middle ethmoidal plate ending in the Rail more abruptly. In Pigeons and Plovers the orbital plate of the frontal is deficient, as is also to some degree the alisphenoid at its inner edge, so that in them these bones combine to send inwards to the presphenoid a mere belt of bone; the presphenoid also in them projects out into the interorbital space. In the Tinamou and in the *Ocydromus* the upper or posterior edge of the presphenoid is buried in the well-developed plates of the frontal and alisphenoid—these plates being more *lateral*, as in Mammals, and not so *transverse* as in most birds. The postfrontal is 3 lines from the rudimentary zygomatic process of the squamosal (fig. 3); and, as in Ostriches generally, in Rails, Plovers, and in Pigeons these processes are wide apart, and leave the temporal fossa unbridged; so that here there is no approach to the Fowl. The fossa is an almost semicylindrical groove, and ascends relatively no higher than in the Ostriches, and the process of the squamosal which bounds it behind, and which overlaps the os quadratum, is thick, cellular, and so perfectly struthious that it cannot be mistaken for that of any other type of bird. The moderately convex fronto-parietal surface (Pl. XL. fig. 2) is composed of very thick and spongy bone, and the parietal is but slightly scooped below for the temporal muscle. The upper face of the parietals, and so much of the frontals as goes to roof-in the brain, form together a pretty regular pentagon. The edges of the frontals round the orbits (fig. 3) are tolerably well developed—much as in the Ostriches, and more than in the Rails; for in the latter birds the margins are bevelled away. In the Tinamou the narrow anterior portion of the frontals (fig. 2) equals that of the Rails and Ostriches in relative width; but its edge is not simply sharp as in the Emu, nor bevelled off as in *Ocydromus*, but is scooped above to receive the inner edge of each nasal gland. These supraorbital or nasal glands in the typical Ostriches have crept almost wholly into the front of the orbit; but in the Tinamou (fig. 2) each gland lies above the forehead, and is 7 lines long, and more than a line broad—a little larger than in the Lapwing (*Vanellus*) (Pl. XXXVII. fig. 3, *f.g.d.*).

In the latter bird, in its relative the Dotterel (*Charadrius hiaticula*), and in not a few of the "Grallæ," the frontal in the young bird sends out square denticles of bony substance under and beyond the gland; they form beyond the gland a smooth *eave* to the large eyeball; this eave extends forwards to coalesce with the large orbital plate of the lachrymal, and backwards to join the postfrontal process. In many Grallæ and Palmipeds this part is not developed, and the gland forms a thick edge to the eyebrow. In the Lapwing and others that have the secondary frontal margin, the gland is often but little protected beneath—the denticles not melting together, as a rule, until they meet beyond the gland. Anteriorly it is better floored, and close inside the lachrymal is the round passage for the efferent duct (Pl. XXXVII. fig. 3, *g.d.*). In the Tinamou we have not *denticles*, but *ossicles*—a whole row of superorbital bones, the like of which must be sought for, not amongst birds, but in a group of creatures a long way down in the scale (Pl. XL. fig. 2, *sr.o.*). My surprise at finding a perfect chain of bones in this region (see Zool. Proc. 1862, pt. iii. p. 259) arose from my failing to identify it with the row of dermal bones long familiar to me in the skull of the Blindworm (*Anguis fragilis*). I mentioned the three superorbitals over each eye of the Trigonal Cayman; but this instance does not satisfy the comparative anatomist nearly so well as the Blindworm, or better still the Skink Lizard, e. g. *Mocoa*. The largest of these square pieces is about 3 lines across, and is past the middle; the anterior ones are somewhat smaller, and the posterior, which run down to the postfrontal ossicle, are very small (Pl. XL. fig. 3). There are six main pieces on the right, and seven on the left side, besides four or five additional grains behind. On their inner edge these superorbitals are, like the frontal, scooped to receive the nasal gland; but they do not underlie all of it, and an open space (fig. 2) exists under the anterior half of the gland: thus the same results are arrived at as in the Dotterel and Lapwing, but by different means. The lachrymal (Pl. XL. fig. 3, *l.*) of the Tinamou is like that of the Lapwing, its superorbital plate projecting even less than in that bird, and the descending plate being relatively of the same size, and wanting the oval foramen of the struthious lachrymal. What there is of the lachrymal in the *Apteryx* is still more closely compressed, and is only flush with the rest of the face; in the other "Struthionidæ" the superorbital process projects far backwards and outwards, like that of the Falcons on one hand and the Safeguard Lizards (*Monitor*) on the other. This bony fence to the opercular flaps of the great optic space is curiously like the skeleton of the sense-organs themselves—the eyeballs; it looks at first sight as though a half-circle of the sclerotics had been falsely placed along the upper orbital eave.

In typical birds, before they have attained their full size, the tympanics have often a chain of five, and even, in the Carrion-Crow (*Corvus corone*), of six tympanics,—besides an occasional development of a posterior meatus-bone attached to the tympanic wing of the lateral occipital, as occurs at times in this same Crow, and constantly in the Peafowl (*Pavo cristatus*). So that this superorbital series is, morphologically, quite normal; only it is rarely developed. In osseous fish generally, the "preorbital" or lachrymal communicates with the true postfrontal by means of a chain of these dermal or at least *subcutaneous* bones. In Lizards generally, e. g. *Monitor, Chamæleo,* var. spec., *Anolis, Mocoa, Trachydosaurus, Centropyx,* and also in the subophidian *Anguis fragilis* the preorbital or lachrymal has beneath it the first of the suborbital series. This *ichthyic* bone, which the Lizard has retained, is however coexistent with another *subcutaneous* bone—the "postorbital." I boldly adopt this term for the so-called postfrontal of all the Reptilia; for I have not as yet found any instance in which this bone is developed in that class from anything but subcutaneous connective tissue: the cartilaginous skull in the Reptilia is in most cases a mere floor, and in the Ophidians the alisphenoids soon coalesce with the sides of the basitemporals. Some of the large Pythons show the bearing of these bones well: there is no prefrontal and no postfrontal; but the eyeball is most safely protected above by the superorbital, behind by the *postorbital,* in front by the preorbital or lachrymal, and below by the maxillary: all these are splint-bones, and have no existence in the primordial cartilaginous skull.

We never, at one time, have the roots of the eyelids completely set in bone; yet the thing is possible, and if the Parrot and Tinamou were added together in one bird, that condition would exist in such a bird. I am not unaware that the superorbital ossicles of the bird do not ossify quite so much of the dermal fibres as in the Lizard: yet they are fairly the true homologues of each other. Even the "squamosal" itself in the Ophidian is rather developed from the connective tissue lying between the membranous skull-wall and the skin, than from the deeper layer *on* which the frontals and parietals are developed. The occurrence of "scincoid" characters in a bird of so remarkably *general* a nature as the Tinamou is of scarcely less importance than would be the presence of *feathers* in some generalized member of the Reptile-class: that is my apology for the above detail.

As far as I can see, the "middle ethmoid" (Pl. XL. fig. 3, *eth.*) has ossified all the remainder of the cranio-facial axis left untouched by the small anterior sphenoid; the least fore-and-aft extent of the latter bone is half a line; of the former, the ethmoid, nine lines; whilst the entire extent of this bony plate, from the exit of the olfactory crura to the end of the nasal septum, is sixteen lines. In the first place, the great size of the vertical ethmoid, as compared with the presphenoid, is quite *ornithic*; and in the second place, the growth forwards of bony matter from that plate into the septum shows the arrested *general* Ostrich-type of structure. In the *Rhea* I have found a small *upper septal* bone (Pl. XLII. fig. 4, *s.n.*), three lines long; but none in the Tinamou—the answering part, and that only, remaining cartilaginous. I suppose that in the Tinamou, as in other Ostriches, the broad top of the ethmoid is separately developed by a long piece growing from above downwards between the anterior ends of the frontals. No suture remains to tell me that; but if it be so, all is perfectly *struthious*;

for those birds differ in this from all others examined by me. The finest instance of this curious *connation* of the upper part of the lateral ethmoids or prefrontals is in the Cassowaries, where this part forms primarily the whole of the huge helmet. Between the upper or *crista-galli* bar of the ethmoid and the lower face of the frontals there is a space (Pl. XL. fig. 3. 1), large and clavate, common to both orbits, and containing the olfactory crura in the fresh state. A thick bony wall stands between these crura in front, the sides of which they groove: above this groove is the broad "aliethmoidal" part, which I suppose to be separately developed (fig. 3). Mesiad of the lachrymal, this bony disk sends from its outer edge a papery lamina a line and a half broad; this plate, which is often separately developed as a small upper prefrontal in typical birds, passes inwards and backwards, and then suddenly downwards, where it is continuous with the "pars plana ossis ethmoidei." Where it joins that plate it sends another bony plate forwards, parallel with the middle ethmoid. The "pars plana," or *continuous* homologue of the *separate* antorbital of typical birds, is confluent externally with another bony plate which articulates with the inner edge of the descending lachrymal. This *outer antorbital plate* is the base and back of the largely developed "inferior turbinal"—so complex in the Ostriches and Mammals, and so simple in typical birds. In the latter, however, it is often more or less ossified, either at its root above or at its termination in front of the orbit. The upper oblique plate protects the olfactory lobe at its termination, and is the bony root of the mostly cartilaginous "superior turbinal." This must be very small in the Tinamou, for its posterior face is pressed forwards against the skull-axis, leaving it a mere slit-like chamber; moreover in this bird the middle ethmoid is merely scooped gently between the superior turbinals, and not reduced to membrane as in the Emu and certain typical birds, as the Wild Duck (*Anas boschas*).

The middle turbinal (fig. 3), which has at its back the "pars plana" or "lamina papyracea," is but feebly developed also in this as in other Struthionidæ; and it is also badly differentiated from the postero-internal folds of the more complex inferior turbinal. In typical birds there is a falling-off of the chondrifying process in the rhinal capsules, and the antorbital portion of the cartilage is laid on in distinct patches; so that the antorbital plate of birds, although answering to the "pars plana" of the continuous lateral ethmoid of Mammals and Ostriches, is really *autogenous* in both its cartilaginous and bony stages: it only answers to the lower part of the massive lateral ethmoid or prefrontal of the fish. The antorbital of the Tinamou has not joined the middle ethmoid; it is quite a separate bone; but the cartilage of the whole lateral ethmoid was, I have no doubt, continuous with the alæ at the top of the ethmoid. The posterior part of the great outer fold of the inferior turbinal of the Tinamou is ossified, and an elegant secondary plait within that; also some threads of bone higher up and further forwards, where the outer wall of this turbinal lies inside the lachrymal; and the descending crus of the nasal. Evidently this is all in advance, looking *mammal-ward*, of what is seen in typical birds;

but, although partly ossified, the inferior turbinals of the Tinamou are not so complicately folded as in the Emu and the Cassowary. There is a rudiment of the fissure which, in typical birds, grows upwards and separates the septum from the vertical ethmoid to form the hinge; it is two lines long, oval, with its longest axis from fore to aft; is divided behind by a thread of bone; it allows the lower part of the turbinal folds to touch each other at the axis of the skull, and it is converted into a foramen by having the great basisphenoidal "rostrum" running beneath it. In many typical birds this rostrum ends as a free style beneath the cranio-facial fissure—that fissure which allows the formation of the hinge of the face on the skull. The remarkably strong separate septum of the Sandgrouse thus agrees with that of the Tinamou in the *degree*, but not in the *source*, of its ossification: it is *ornithically* separate; whilst the cranio-facial axis of the Tinamou is arrested at an early stage, and is continuously ossified from the great ethmoidal plate as in the typical "Struthionidæ."

The nasals of the typical bird do not end at the hinge, as might be supposed by a cursory observer of the adult skull; their broadest and thickest portion is behind the hinge, and they force the pointed anterior ends of the frontals to the side. Where they are more feebly developed posteriorly, as in the Fowls and still more in the Ostriches (Pl. XLII. fig. 2, *n.eth.*), the ethmoid is apt to appear, as in fishes, on the top of the head.

Notwithstanding the separate condition of some of the lateral cranial elements in the skull of the Tinamou, the posterior part of the nasals, the anterior part of the frontals, and the upper part of the lachrymals all form one continuous bony mass (Pl. XL. figs. 2 & 3). The anterior part of each nasal, viz. the upper and lower crura, by their feebleness show the bone to be but small; and there is a touch of the Plover in the appearance of the bony part of the ali-ethmoid between the crura of the nasals. In the Pigeon, Sandgrouse, and Hemipod this condition is still better developed, and in them the part of the prefrontal which is there exposed is thick and spongy, and not thin and papery as in the Tinamou and Plover. The upper crus of the nasal, which runs external to and below the nasal process of the premaxillary, does not reach the end of the nasal fossa; it nearly reaches that point both in the Plover and the *Rhea*, but is much shorter in the Emu. The lower crus, which is absent in the *Rhea* (Pl. XLII. figs. 2 & 4, *n.*), and a mere style in the Ostrich and Emu, does reach the lateral edge of the upper jaw in the Tinamou (Pl. XL. fig. 3): it articulates with the ascending process of the prevomer. It is a very feeble, rounded rod of bone above, is bowed outwards at first, and is there, as it were, squeezed under the anterior edge of the lachrymal. This process then slowly thickens, descends with a slight lean forwards, and becomes broader and somewhat pedate where it articulates with the prevomerine spur below. In the dry skull, after the large alinasal and anterior part of the external wall of the inferior turbinal cartilage have been removed, the bony nasal fossa is very large indeed. It is more like that of the Plover (Pl. XXXVII. fig. 4, *n.*) than that of the *Ocydromus*, and very unlike that of the Fowl (Pl. XXXVI. fig. 9), and is quite in advance of the nasal fossa of the typical

Ostriches, seeing that in them it is not more than partially differentiated from the orbit; for in them the lachrymal does not reach to the zygoma, nor the posterior crus of the nasal to the ascending spur of the prevomer. In many birds, especially Plovers and Fowls, the nasal processes of the premaxillaries are very unapt to anchylose with each other (Pl. XXXVI. fig. 7, & Pl. XXXVII. fig. 3, *px.*): in the "Struthionidæ" this is the first thing to take place (Pl. XLII. fig. 2, *px.*); and in *Struthio camelus* I have found that in an embryo with the head only an inch and a half long these processes had coalesced, whilst the beak-part of the bone had not its two sides fused, and the cartilaginous scaffolding (the prevomerine, evanescent rostrum) still showed itself between the two bones on the upper aspect. The Tinamou (Pl. XL. fig. 2) answers to the Ostriches in this respect; for the nasal processes of the premaxillaries are quite fused, and are, relatively, broad as well as long: in the *Ocydromus* there is a considerable approach to the Ostriches in this respect. In the Tinamou (Pl. XL.) the beak-part of the premaxillary is only 4½ lines long, whilst the nasal part is 13 lines; but it is altogether struthious, with its well-defined lateral groove on each side, and its large vascular puncta so close and with such small interspaces as to convert this part of the bone into something like the stony tissue of a madrepore (Pls. XL. & XLII.). The palatine processes of the premaxillaries reach backwards more than 13 lines from the tip of the bone; they are separated from the "dentary" margins by the prevomers, and are, like all the subnasal portion of the bone, extremely thin, fibrous, and translucent (Pl. XL. fig. 1). The dentary portion of the bone, after it has become distinct by the inwedging of the prevomer, is a very delicate rod (figs. 2 & 3), and ends at the foot of the inferior crus of the nasal: in the *Rhea* this process does not go so far backwards. I have no maxillary bone to describe in this bird, nor should have in by far the greater number of birds; at present I have only found it in the Emu a week before hatching; in the fledgeling Swift (*Cypselus apus*) it seems to exist as an upper mouth-angle scale of bone; and it is certainly present in *Nycticorax ardeola* and in *Herodias garzetta*, even in old birds, and in a few others.

It is, however, when present, a very minute piece, *outside* the other face-bones, and close behind the dentary angle of the premaxillæ. But the bones (Pl. XLII. figs. 1, 2, & 4, *pv.*) which have hitherto been mistaken for the superior maxillaries in birds, and which have long been a puzzle to both Professor Huxley and myself, are, I am thoroughly satisfied, nothing more than the homologues of the bones which, in the Python, were called by Cuvier "cornets inférieurs." They exist in the Amphibians, Lacertians, and Ophidians, but not in the Crocodiles and Chelonians, nor in the Mammalia. If they were present in those animals, we should see them filling up the "anterior palatine foramina," underlying the outspread anterior part of the septum nasi, and articulating with the outer edge of the anterior part of the vomer. In this place I can only *assert* the truth; it must be *proved* fully in another kind of paper. It was necessary, however, to make a clearance of this particular stumbling-block before proceeding with the palate of the Tinamou. This bone, the prevomer, is not a *rhinal* element—a true turbinal, nor the homologue of the prefrontal of the fish (see Owen, Report on Archetype, p. 220), but a splint applied to the cartilaginous floor of the anterior nostril, and only existing in birds and certain groups of Reptiles, and in the Amphibia. In the Tinamou the prevomer runs forwards as a sharp wedge between the palatine process and the dentary margin of the premaxilla, to within 7 lines of the end of the beak: it is made of just the same delicate fibrous bone (Pl. XL. fig. 1). It gradually becomes 2 lines in width, and then divides into a long zygomatic and a short palatine process: close behind this bifurcation the zygomatic process thickens and gives off two secondary processes, one upwards, which articulates, as we have seen, with the descending crus of the nasal, and one inwards, a flat zigzag band of bone (Pl. XL. figs. 1 & 2), which becomes pedate and then articulates with the anterior part of the palatine, by curving downwards and applying itself to the inner edge of that bone. On the whole, the bone of the Tinamou agrees closely with its counterpart in the Ostriches; yet the *inner* process is some approach to the same part in the Grouse and the Sandgrouse; but in them the body of the bone is reduced to the smallest dimensions, and the inner process passes far more mesiad of the palatine bar, and is free and straight, although pedate. In the Ostriches the inner process is scarcely differentiated from the rest, and the body of the bone in them is of most unusual size. The ascending process of the prevomer is the homologue of that curling outward part of the bone in the Python which seemed to Professor Owen to have "a neurapophysial relation with the olfactory nerves" (*ibid.*).

Our author atones for this mistake, at the top of the next page, by satisfactorily determining the great preorbital bones of the Python to be merely the lachrymals, and not the "anterior frontals" as Cuvier supposed.

Across the mid region of the palate of the Tinamou there has been an unusual amount of anchylosis even for a bird (fig. 2); and here we impinge upon the *Apteryx* in a manner not to be misunderstood. This is the more interesting, as this bird is four-toed; and if any one will also compare the leg and foot of the two birds, they will see how very gentle a change is required to convert either the leg or the beak of an Apteryx into that of a Tinamou.

The zygomatic process of the prevomer has coalesced with the slender jugal (Pl. XL. figs. 1, 2, 3), and this latter bone reaches, as in other "Struthionidæ," nearly to the os quadratum, the quadrato-jugal being a small piece of bone passing somewhat within the jugal; it is, however, separate in the adult. These bones vary greatly in different birds, and in the Fowl-tribe the quadrato-jugal reaches nearly to the angle of the premaxilla. Where the maxillary exists at all, it is quite external to the prevomer, which is always placed *mesiad* of the dentary part of the premaxilla, of the maxilla itself, and of the quadrato-jugal. The absence, for the most part, of the maxillary gives rise to an extraordinary and somewhat *vicarious* development of the prevomer in birds. In the fledgeling Heron (*Ardea cinerea*), the palatine part of the prevomer reaches to within an inch of the end of the beak, and the zygomatic part to within a quarter of an inch of the os quadratum,—its whole length being nearly 4 inches, the entire head at that time not being more than 5 inches 8 lines: compare this with the prevomer of the Amphibians! The " vomer " of the Tinamou (Pl. XL. fig. 1) is full an inch long, and a line wide at the narrowest part; in the *Rhea* (Pl. XL. fig. 1, *v.*) it is more than 2½ inches long and 3 lines broad at the middle; the form is the same in both, and the relative size the same, but it is slenderest in the Tinamou. It forks in front in both, and these forks are underlain on each side by the palatine processes of the premaxillaries (Pl. XL. fig. 1, & Pl. XLII. fig. 1, *v.px.*): in both cases it forms a splint-like sheath to the great basisphenoidal rostrum, which appears in front between and above the forks (Pl. XL. fig. 1, & Pl. XLII. fig. 1, *r.bs.*). How far this is from the structure of any gallinaceous bird I need not say, where the vomer is extremely delicate and small, and the " rostrum " short (Pl. XXXVI. fig. 6.).

In the Weka-Rail (*Ocydromus*) and in the Lapwing (*Vanellus*), the shorter " rostrum " lies in the vomerine groove (Pl. XXXVII. fig. 1, *v.bs.*); but it does not in either case reach the middle: still these birds have vomers and " rostra " more in harmony with those of the struthious birds than the Fowls have. On one hand, the large, single, semicylindrical vomer of struthious birds comes near that of the mammals; on the other hand, it is unmistakeably like the single vomer of the Chelonians—having, like them, a broad anterior part on a lower plane than the rest and articulating with the premaxillæ, a middle constricted part separating the middle nares from each other, and a posterior expanded part sheathing the cranio-facial axis, and articulating with the posterior end of the palatines and the anterior end of the pterygoids[1] (Pl. XLII. fig. 1, *v.*). The posterior broad end of the Tinamou's vomer does not keep free as in the Great Ostriches, but agrees with that of the *Apteryx* in coalescing with the pterygoids and palatines. It is very common for the vomer to keep distinct from the palatines in the Rails, Plovers, and in many both wading, swimming, and diving birds; but in a large number of the other great groups the posterior forks of the bone rapidly coalesce with the *interior* edge of each palatine, where they are sheathing the " rostrum." But it is only, as a rule, in certain birds of a high and noble kind that we meet with a coalescence of the palatine elements to such a degree as to involve the pterygoids also. The Tinamou has this character; the *Apteryx* has it; and then we must pass to the three main divisions of the great typical group to find this state of things again. I have found this coalescence in the following birds:—

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[1] Amongst the typical birds, the Falcons (*Falco*), the *Dicholophus*, the Sacred Ibis (*Threskiornis æthiopicus*), some of the " Meropidæ," the Wild Duck (*Anas boschas*), and especially the Albatros (*Diomedea exulans*) come near the Chelonians in the condition of the vomer; in all these, however, the vomer is separated more or less from the palatines by the intervention of an additional segment on each side, viz. the " mesopterygoids."

"Corvinæ"	Piping Crow, *Gymnorhina tibicen.*
"Passerinæ"	Canary-bird, *Fringilla canaria.*
	Crimson Finch, *Estrelda phaëton.*
	Brown Linnet, *Linaria cannabina.*
	Bullfinch, *Pyrrhula vulgaris.*
"Sylviinæ"	Pied Wagtail, *Motacilla Yarrellii.*

In these birds, however, a pair of additional bones have also been melted into the common mass, viz. the "mesopterygoids," the homologues of Professor Owen's "entopterygoids" in the fish, bones which are additional to the homologues of the internal pterygoid plate of the human skull, and therefore not conveniently receiving a name which would confound them with those plates. I have not at present discovered these parts in the Struthionidæ; but they are present in most other birds at an early period. The extreme state of *prognathism* in the bird causes the palatines to be drawn out anteriorly into a very long splint of bone (Pl. XXXVII. fig. 1, *pa.*), the *periosteal* growths proceeding far beyond the original cartilaginous rod *in which* the palatine ossification first commenced[1]. In the generalized face of the Ostrich this is not so much needed, and consequently their palatines are but little prolonged anteriorly (Pl. XLII. fig. 1, *pa.*). Nothing can be simpler than the skeleton formed in the maxillary rudiment of the embryo Ostrich; this part (the anterior crus of the palato-quadrate arch) is shaped like a piece of knee-timber; its thick hinder end is applied to the os quadratum; its narrow front end reaches the inner edge of the prevomerine splint, and the middle broad part turns inwards and upwards to apply itself to the skull-beam some distance in front of the pituitary space. The hinder part is ossified, and is the pterygoid; the front piece becomes bony, and is the palatine: they largely overlap each other, the palatine applying its pedate base to the outer edge of the pterygoid, whilst that bone runs forwards as a splintery pointed piece, and lies *on* the corresponding posterior fork of the vomer (Pl. XLII. fig. 1, *pg.v.*). The palatines are broadest in the *Rhea*, narrowest in the Tinamou (Pl. XL. fig. 1), where there is a considerable extension forwards of the bone: in all cases the outer edge of the palatine is thick, the inner thin; the upper surface convex, and the lower concave. In the *Rhea* the bone is but little perforated, but in the Emu all its centre becomes mere membrane; in the Tinamou each bone has two or three fenestra—a state of things by no means uncommon in the Grallatorial tribes. The palatines of the Fowl-tribe (Pl. XXXVI. fig. 6) are but little in advance of those of the Ostriches; yet in them the long premaxillary process of the bone is certainly an ornithic advance, and at times there is a faint rudiment of that mesopalatine keel which gives such finish and beauty to this bone in the Plover (Pl. XXXVII. fig. 1, *pa.*), Heron, Rail, &c. In the Tinamou, as in the Ostriches, the

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[1] The palatines and pterygoids have commenced to ossify in the embryo bird whilst the tissues of the skull are in a very nascent condition, before the cells of the hyaline cartilage have become cemented together by intercellular substance.

palatines and the pterygoids could scarcely have been simpler; they bound the large middle nares behind, and laterally for some distance, and through the intervention of the overgrown prevomers they connect the palate with the zygoma.

We must look to another group to yield us anything like that curious *prolepsis* of the mammalian posterior nares which is seen in the Crocodiles. The Finches just mentioned, especially *Estrelda*, have a condition of the palatines and pterygoids not far from those of the great reptiles, as it respects the posterior nasal canal; the tube is, however, imperfect for its lower third. The sphenoidal facet on the Tinamou's pterygoid has been mentioned already; that which hinges on to the os quadratum is a miniature of the concavity on the ulna of the mammal for the reception of the condyles of the humerus. As in the other "Struthionidæ," the lower edge of the Tinamou's pterygoid is thick, the upper thin and sharp. The only real difference between the bones of the subtype and the type is the slenderness of those of the former, combined with a somewhat more elegantly ornithic form—a more delicately moulded condition (Pls. XL. & XLII. fig. 1).

If we look to escape from the struthious type in the "os quadratum" of the Tinamou, we shall be mistaken; and not only is it struthious in character, but, like its counterpart in the great Ostriches, it is only barely ornithic (figs. 1 & 3); the superadded orbital process (which is lost again in the "incus" of the mammal) and the characters of the hinge for the mandible are its saving qualities, and connect it with its typical condition in the higher classes of birds. The facets on the base of the os quadratum are like those of the larger "Struthionidæ," the outer having somewhat the shape of a kidney, with the hilum looking inwards and forwards; the inner convexity is irregularly ovoidal, the broad end being outwards, and the narrow end passing inwards and a little forwards. Above the inner end of this facet is a trochlea, on which the concave end of the pterygoid is hinged. These condyles are very unlike those of the "Gallinæ" (Pl. XXXVI. fig. 6), but they are nearer those of the Rail and Plover (Pl. XXXVII. fig. 1, *q.*): in them the inner facet somewhat resembles the condyle on the anterior end of the cervical vertebræ of birds, being convex across and concave from side to side; they are still more like the upper articular face of the astragalus of the Sheep and Ox, as the scooping is oblique, and not square with the ends of the trochlea as in the bird's vertebra. The orbital process is almost as elegantly formed as in the Plover; it is, however, narrower than in that bird, or the great Rails, or its own congeners. That narrowing is important, as it is one more very faint gallinaceous character in the head of the Tinamou. But the head of the bone is the most important character, and from it alone the anatomical expert might have determined the struthious nature of the bird owning it. There is but one facet, a very long oval in shape (Pl. XL. fig. 3), with the outer side scooped[1] somewhat, as in the Rhea; this convex facet is a better oval in the Emu. Its long axis is not parallel with the axis of the

[1] Precisely as in the *Lacertilia*.

head, but oblique; and its corresponding facet on the skull is extended along the side of the prootic, over the opisthotic and the fenestra ovalis, to be finished by the lateral occipital.

In all birds, save the Gallinæ, the head of the os quadratum leans backwards considerably, and the lateral occipital generally contributes something towards the articular concavity. In the typical birds the posterior part of the head is also *the inner* part, the "os quadratum" standing nearly at a right angle to the axis of the skull: to some extent this is the case in the Ostriches also. In the transverse position of the os quadratum the typical bird comes nearest the Lizard, but not in another and more essential point. The upper condyle of the os quadratum of the Tinamou, like that of the Ostriches, although oblong and greatly turned backwards by the curving of the neck of the bone, yet is quite simple; there is no division into an external or anterior head and an internal or posterior. Once above the Ostriches and Tinamous, and we have the articular condyle divided into two facets, even where the head of the bone is so little changed from the hemispherical shape as in the Fowls and Parrots. The more this head is divided, the nearer do we come to the "incus" of the mammal with its anterior or outer crus, and its posterior or inner—the former in the embryo having its own "acetabulum" on the side of the cartilaginous prootic region, the latter maintaining its separateness from the skull-wall, and soon contracting an articulation with the "stapes."

But there is a little bone which intervenes between the incus and stapes in the mammal; has it any separate existence in the bird? I believe not; but Professor Huxley, in his late 'Hunterian Lectures' (see 'Lancet,' April 18th, 1863, p. 435), has suggested that it may possibly have its homologue in that bone of the fish which Cuvier called "tympanal," but which he calls "metapterygoid." This fish-bone is merely a large *superquadrate epiphysis*, and is never separated by an articulation from the os quadratum; only it starts from its own osseous centre, and a large clear tract of unaltered cartilage always separates it from the os quadratum. This is nothing more than the ossified end of the palato-quadrate arch of the embryo; and in Fishes the posterior crus of this arch runs upwards to the skull, and is of considerable length and breadth. Now, in the *Lacertilia* generally, and in the Blindworms (*Anguis*), the posterior crus of this arch is also of great relative length, and only its thick lower part and the crown of the arch is used up in the formation of the os quadratum: the upper pointed part of the crus becomes detached, is ossified slowly and imperfectly, and gets firmly wedged between the lower end of the squamosal, the tip of the long parietal horn, and the end of the lateral occipital process. In some Lizards, e. g. *Trachydosaurus rugosus*, a flat, cake-shaped epiphysis is formed on the end of this lateral occipital pedicle, and it intervenes between the superquadrate epiphysis and the occipital spur. In the Chamæleon the parietal does not come down to this point. I have not seen this bone—the superquadrate or metapterygoid—in the Ophidians, Chelonians, Crocodilians, nor in Birds.

Let us look at this a little more closely If ossification were to take place in the substance of the largely developed palato-quadrate cartilage of the Shark, it is very probable that no metapterygoid would be formed; for in that fish the posterior crus is extremely short. The shortness of the hinder limb of this cartilage is then repeated in those *ossified* vertebrate skulls in which the os quadratum terminates the series of bones posteriorly. Just below the articular head of the Tinamou's os quadratum, and on its outside, there are some large air-passages (Pl. XL. fig. 3); these may also be seen in Ostriches and other Birds. There is a very large passage of this kind in the Lapwing (Pl. XXXVII. fig. 1, *q.*). The air enters from the tympanic cavity, and the os quadratum thus becomes an extension of that cavity. In the smaller Turtles and Tortoises the os quadratum *is* the ear-drum; the foramen just mentioned in the Lapwing is still larger in them, and has the membrana tympani attached to its margin; the whole bone is hollowed out completely, whilst external and posterior to the upper articular surface it is developed, with the help of the hollow squamosal, into a very beautiful "bulla tympani."

I have purposely trespassed in the matter of the Tinamou's os quadratum, but the interest of its bearings and meaning is not at all exhausted by what is written above.

The mandibles of the Tinamou (Pl. XL. figs. 3, 6, & 7) are struthious throughout: a comparison of the figures given will show how remotely they are akin to those of the Pigeon, Plover, Grouse, Hemipod, or Sandgrouse (Pls. XXXIV.–XXXVII.). The membranous space in the thick part of the ramus is filled up, and the sutures have vanished from that part of each jaw which underlies the most coalesced portion of the palate and the zygoma; it is as though some special influence had passed through the middle of the Tinamou's head, causing all the central part to become solid, whilst the fore and hind part of the head was left but little affected. This increased solidity and the narrowness and comparative delicacy of the jaws make us again to remember what exists in the *Apteryx*. In old Rheas the dentary part of the jaw (Pl. XLII. fig. 4, *d.*) is only retained to the articular (*malleal*) part, with its splints, by membrane, and the membranous space is persistent; it vanishes in the Emu and *Apteryx*. Each dentary (Pl. XL. fig. 3) elegantly repeats the lateral grooves and the vascular honeycombing of the premaxilla. This rich perforateness is seen both above and below; and a fragment of this part would determine the struthiousness of the bird, and prove it not to be gallinaceous, as much as a very small piece of foolscap paper would suffice to show that it had not been torn from a scroll of parchment. The extent of the symphysis is 3 lines—relatively rather less than in the *Rhea* and Emu; it has become thoroughly anchylosed. The internal or anterior facet on the "os articulare" (Pl. XL. fig. 6) is roughly oval in outline, and is deeply scooped for the very convex condyle on the os quadratum. The posterior or outer facet runs up to the edge of the surangular inside, and is narrow kidney-shaped. Between the two facets there is a large pear-shaped hollow, lined with periosteum only; on the top of the angular and abrupt internal angular process is a small air-hole. The posterior or external angular process (fig. 7) is a very small tubercle: this is all there is to represent the long horn curling upwards here in the "Gallinæ" (Pl. XXXVI. fig. 9), an inch in length in the Cock of the Woods. Altogether the mandibles are struthious, and the articular end of the jaw, with its deeply scooped, obliquely oval posterior face, is as much like that of the *Rhea* (Pl. XLII. figs. 4, 5, 6) as can be, and as perfectly diagnostic of the affinities of the bird.

I have no os hyoides to work from, and thus, unfortunately, lose an important part of my demonstration. The viscera also must be left for some future paper.

In what follows I hope to be able to show that the remoter parts of an organism are less to be depended upon for the demonstration of special affinities than the central, and that any very slight hint given by the *head* may be acted upon to a very unexpected extent by the *hands and feet.* Still there is "no schism in the body," however great the amount of "adaptive modification" to which it has been subjected; and the "kingly crowned head" is always in beautiful harmony with

> "Our steed the leg, the tongue our trumpeter,
> With other muniments and petty helps
> In this our fabric."

I have to keep to the parts that immediately surround the pituitary space for the organic centre of the skull, and, in a certain sense, of the whole skeleton—the spine being viewed as a sort of extended and secondary point, or rather series of points, of departure.

We shall always find the outlying parts the most modified, even in the head; in the body, not only "the muniments and petty helps," but even "our steed the leg" is ready to undergo very sudden changes as we pass from species to species.

The whole skeleton of the Tinamou (Pl. XXXIX.) is very light and spongy, and is pretty accurately intermediate in this respect between the Guatemalan Tree-Partridge (*Dendrortyx*) and the Curassow (*Crax*). With the exception of the caudal vertebræ, the furcula, the wing-bones from the elbow, and all the leg-bones, the skeleton is delicately pneumatic and spongy; the bones that contain marrow, however, are not much heavier in build than those of the *Dendrortyx*, and very much more typical in this respect than those of the Fowl. That seems something sudden; yet any one well acquainted with the structure of the bones of the great "Struthionidæ" will remember what exquisitely light diploë they possess. It is the *Apteryx* that stands so low down in this matter, the Brush-Turkey (*Talegalla*) being a step or two above it.

There are twenty-two vertebræ between the skull and the sacrum: the last of these is free; in front of that there are four which are coalesced into one piece (*d.*). The first of these has a large floating rib (*cr.*), and the rib of the last, or separate dorsal, has a half-sized floating hæmapophysis; so that only three of the dorsals have perfect sternal ribs (*dr.*). The penultimate cervical has a large floating rib, an inch long; the antepenult a small, distinct rib-head; in front of that, the small pleurapophyses are all welded to their vertebræ (*c.*); none of them are very long, the longest being at the middle of the neck. The "procœlian" facet of the atlas is only a half-moon, whilst in the *Rhea* small styles nearly enclose the odontoid process. The cervical vertebræ, generally, are merely like an enfeeblement of the neck-bones of the Great Ostriches. The carotid canals are as imperfect as in Fowls, Pigeons, and their congeners; and the relative length and thickness of each bone is much like what is seen in ordinary members of those types, and also in the Ostriches themselves. The fusion of the last cervical with those of the dorsals (*c.d.*) shows the introduction of some *leaven* or other; this is certainly not a *struthious* character: and yet we, *regal vertebrates*, cannot tell whence that zymotic influence comes, nor whither it goes. The ribs are scarcely longer than the hæmapophyses; they are moderately spongy: the second dorsal has a small appendage, and the next a trace, whereas in the *Rhea* the first four dorsal ribs have large appendages; the corresponding four ribs in the *Apteryx* have them very large. The Tinamou comes nearest the Emu in this respect, whilst the Ostrich is intermediate between the *Rhea* and the Emu. I only find eighteen sacral vertebræ (Pl. XXXIX. fig. 3, *sm.*, & Pl. XLI. *sm.*), whereas the Emu has twenty-two, as may be seen in the young bird[1]. In the *Rhea* the middle of the sacrum is abortively developed, and only the embryo would give us the number. The Tinamou's sacral vertebræ are not so stout as those of the Fowl, but they are much like them, the width of the pelvis allowing a much freer development of the transverse processes and stunted ribs than in any of the large Ostriches. Indeed the sacrum, together with the hinder part of the ilium on each side (Pl. XLI. fig. 3, *il. sm.*), gives us a gently convex, smooth surface, more Pigeon-like than even in the Curassow itself, and the spaces between the sacral diapophyses are merely indicated on the upper surface by two symmetrical rows of small foramina. Between the anterior parts of the ilia, however, the spaces are larger, and there is something of the feebleness of the pelvis of the *Syrrhaptes* (Pl. XLI. fig. 5) in that part. The caudal vertebræ have been shorn of their strength; the spinous and transverse processes are very short and feeble, and there is the slightest attempt at inferior processes (Pls. XXXIX. & XLI. *cd.*). They are six in number, and the last is evidently three in one; only four mere *centra* project beyond the ischium in the *Rhea*, but I find nine in the chick of the Emu; indeed the number is very variable in the "Struthionidæ." The two or three fused and compressed bones at the end of the Tinamou's coccyx must be contrasted with the ten fused coccygeal bones of the Common Duck. The *ralline* compression of the pelvis, caused by an almost vertical position of the ossa innominata, has been lost in this aberrant little Ostrich.

The shape of the iliac bone (*il.*) is very much like that of the Tree-Partridge and the Curassow, not only in the anterior, but also in the posterior moieties; it is nearest

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[1] The extraordinary *ornithic* fore-and-aft growth of the pelvis is the cause why so many vertebræ should be thus married together, bones which are quite *free* in the Reptilia.

that of the latter, but there is no coalescence (in this specimen) with the side of the sacrum. The prefemoral part of the ilium is flat in front and gently scooped behind; the hinder part of the bone is gently convex, has a slightly arcuate external outline, and is truncated obliquely behind, the internal angle going furthest back. The bone is very thick at its outer edge, behind the acetabulum, looking precisely as if it had been evenly pared away by a knife (Pl. XXXIX. *il. isc.*); the thick edge is quite flat. *Morphologically*, a large piece has been cut away—all that somewhat incurved plate of bone which should reach to, and coalesce with, the posterior two-thirds of the upper edge of the ischium: here we have not the enclosed ischiadic *foramen* of the ordinary bird, but the great gaping "ischiadic *notch*" of the Cassowary, *Apteryx*, and Emu. In the African Ostrich this cleft is enormous; but the ischium unites with the pubis, and the pubis with its fellow of the opposite side. In the *Rhea* a broad band of tendon ossifies and binds the stunted hinder part of the ilium to the ischium below; and the same bond exists between the ischium and pubis: the latter is a very rare condition, yet it is seen also in the Hornbills (*Buceros*).

Notwithstanding this curious anticipation in the *Rhea* of the Hornbill's pelvis, the ilium of the former bird is not better developed behind (this postfemoral part is an ornithic stronghold) than in the *Apteryx*. The ischium and pubis of the Tinamou (Pl. XXXIX., *isc. pb.*) are very little removed from those of the *Apteryx*, and in both the Tinamou and the *Apteryx* the preacetabular projection of the bone (Pl. XLI. fig. 3, *ac.*) at the junction of the pubis with the ischium is as strongly developed as in the Fowl. The acetabulum is only half the size of that of the Common Cock, and is not so neatly scooped; it is equally imperfect internally. That which gives a certain gallinaceous character to the ischium and pubis is, that they are elegantly bowed, first outwards and then inwards (Pls. XXXIX. & XLI. fig. 3); the space between the bones, however, is large, and this long obturator notch is partially divided into two by the descending process near the head of the ischium; behind this process there is another notch (Pl. XXXIX. *isc.*), as in the *Apteryx*. In the Fowl the gap in front of the notch becomes developed into a true obturator foramen, whilst the descending process of the ischium is more than seven lines in extent, and anchyloses with the pubis. In the *Syrrhaptes* and *Hemipodius* this whole tract keeps open; and in *Lagopus* the pubis adheres closely to the ischium, but for a long while keeps distinct.

Subjoined are a few measurements of the sternal apparatus of a Common Fowl of medium size, in which the whole length of the sternum equalled that of the Tinamou; and of the same parts in the latter bird.

		inches.	lines.
Length of scapula	Fowl	3	1
	Tinamou	2	7
Greatest width of scapula	Fowl	0	3½
	Tinamou	0	3½

		inches.	lines.
Length of coracoid	Fowl	2	5
	Tinamou	1	10
Straight line from tip of ramus to angle of furculum	Fowl	2	1½
	Tinamou	1	0
Length of each furcular ramus along the curve	Fowl	2	2
	Tinamou	1	6
Length of sternal keel along its root	Fowl	3	10
	Tinamou	4	7
Length of sternal keel along the lower edge	Fowl	3	10
	Tinamou	4	10
Extent of ridge separating the middle from the great pectoral muscle	Fowl	3	0
	Tinamou	1	6
Greatest depth of space for great pectoral muscle	Fowl	0	5½
	Tinamou	0	2½
Length of sternum, from episternum to xiphisternum	Fowl	5	1½
	Tinamou	5	1½
Length of episternum	Fowl	0	4
	Tinamou	0	4
Length of hyosternum	Fowl	0	10
	Tinamou	0	6
Whole length of internal hyposternal bar along its curve	Fowl	2	9
	Tinamou	4	1
Average breadth of internal hyposternum	Fowl	0	1½
	Tinamou	0	1
Narrowest part of entosternum	Fowl	0	3½
	Tinamou	0	2½

The scapula of the Tinamou (Pl. XXXIX. *sc.*) is blunt, or rather suddenly pointed at the end, near which is its broadest part, and not at the middle as in the Fowl: it agrees rather with that of the *Syrrhaptes*, being thick and narrow just beyond the glenoid facet, and then becoming gradually thinner and more outspread. It is pneumatic, and its size is in proportion to the sudden development of the wings.

There are a few typical birds among the zygodactylous division, in which the furcular rami do not coalesce, as the Toucan (*Ramphastos toco*) and the Touraco (*Corythaix buffoni*); but here the rami are long. In some of the "Psittacinæ," however, the rami are very minute and abortive; these continue distinct, as in the Emu, in the Love-bird (*Agapornis pullaria*), but they coalesce with the coracoid in the Many-coloured Parakeet (*Psephotus multicolor*): this process has evidently taken place in the Ostrich, Cassowary, *Rhea*, and *Apteryx*.

The Tinamou has a form of furculum (*fr.*) very common among birds, being U-shaped, and having short curved rami; it has, however, no angular process: there is a slight trace of this process in the *Syrrhaptes*, and it has become still more evident in the Plovers (*Vanellus* and *Charadrius*) and in the Gambet (*Totanus fuscus*) and its allies. Yet the feebler sort of pluvialines have this same kind of furculum, which is but little altered in the typical Ibises: it takes on great changes in the forms that grow, as it were, out of the Ibis-type, and that have become specialized into Herons and Storks.

The curve of the furcular rami in the Tinamou is shown by the fact that they are one-third longer actually than a line drawn from the tip to the angle. The flattened tip of the bone is as blunt as in *Syrrhaptes*, and blunter than in the Lapwing: in the feeble "Longirostres," e. g. *Totanus*, *Limosa*, and also in *Numenius*, the extremity is greatly lengthened. I mention this to show that the furculum of the Tinamou comes nearest to that of the simple pluvialine type. In the "Gallinæ and Rallinæ" we have a V-shaped furculum, in the former with an angular plate, in the latter without it: in the *Hemipodius* we get much nearer the Fowls in this part of the skeleton. The coracoids (Pls. XXXIX. & XLI. *cr.*) are very gallinaceous in character, being roughly formed, having none of the sharpness and neatness of the bone in the higher tribes; they are much shorter than in the Fowl, as may be seen from the table; their pneumatic hole is close behind the head.

The sternum of the Tinamou was described and figured by M. F. J. l'Herminier in 1827. He describes it at p. 66 of his 'Recherches sur l'Appareil sternal des Oiseaux;' and in pl. 3. fig. 24, *a*, *b*, an upper and an oblique side-view are figured of this remarkable structure. At p. 67 he remarks, "Cette pièce existe seule au Muséum, et manque de son complément par l'absence des trois os de l'épaule; elle m'a suffi cependant pour séparer les Tinamous des Gallinacés, auxquels on les réunit d'ordinaire, et pour en former une famille tout-à-fait distincte."

We shall see, even from the structure of the sternum only (Pls. XXXIX. & XLI. fig. 1), how distinct the Tinamou is from the Fowls; and this bone also throws some light upon this extremely variable part of the skeleton—the worst part for the systematist to hold by, and yet extremely valuable if properly *checked* by the structure of the skeleton as a whole. The sternum of the Tinamou is a good *halfway* in passing from that of the *Apteryx* to that of the Fowl; and although the Tinamou has not escaped from the struthious group, yet, in brief, it may be said to be a natural intermedium between those forms. The only process in the Tinamou's sternum which is wanting in that of the *Apteryx* is the keel; but there is a marvellous contrast in this respect: that of the Tinamou is large, long, and rather deep; the whole body of the sternum in the *Apteryx* is like a strip of parchment. We have convexity in the breastplates of the Emu, Cassowary, and Ostrich, the mesial part being as it were collected into an ovoidal *tumulus*: in the *Rhea* the entosternum is really subcultrate. The episternum of the Tinamou (Pl. XLI. fig. 1, *ep.*) has all the appearance of that of a Fowl from which has been smoothly pared the whole of the middle bridge and lower keel; or it may be compared to the upper episternal piece of a Pigeon, thinned away from below upwards. The episternum exists as a rudiment in *Apteryx*, at the centre of the huge *fault* in the anterior part of the sternum; and it gives this retiring anterior margin, between the widely separated coracoid grooves, an elegant bilunate shape. This episternal deficiency appears in the "wingless" Rails, e. g. *Brachypteryx*; it is also really present in the Tinamou as a wide fossa, having a pneumatic hole at its base, below which passage the anterior edge of the keel begins. The episternum of the Tinamou is but the rudiment of that of the Fowl, which bird has it large and conspicuous, standing right forward like the figure-head of a ship (Pl. XLI. figs. 9 & 10). There is the same feebleness of expression in the "hyosternal" crests of the Tinamou (Pls. XXXIX. & XLI. fig. 1, *hs.*): in the Fowl (Pl. XLI. figs. 9 & 10, *hs.*) they stand boldly forthright, like the episternum; but here they are almost upright, save that they bend outwards; they are also only about half the size of those of the Fowl: behind them is the groove on each side for the three sternal ribs: the whole *articular* surface of the upper (hyosternal) edge of the sternum is 4 lines in extent—one-sixteenth of the entire length of the sternum. The *Rhea* has only three pairs of hæmapophyses articulating with the sternum; and, among the higher "Grallæ," the Tiger Bittern (*Tigrosoma leucolophum*) has no more; the Common Cassowary has an additional rudimentary pair in front, the *Apteryx* and the Emu four perfect pairs, and the Great Ostrich (*Struthio camelus*) five pairs. The hyosternal crests are nearly as well developed in the *Apteryx* as in the Tinamou, and the hyposternals are marked off; they are very different from those of the Tinamou, but not more simple; in the latter (Pls. XXXIX. & XLI. fig. 1, *hys.*) each bone is an elegantly bowed style, 4 inches long by a line in average breadth: in the *Apteryx* each process is a flap of thin bone, 9 lines by 3, but *bowed* also in the same style as in the Tinamou. The best figures fail to show the elegance of these processes and the extreme beauty of the whole sternum in the latter bird; beauty, however, seems scarcely to have been aimed at in the construction of the *Apteryx's* breast-bone. As in the Fowls, the middle bony piece of the Tinamou's sternum (the entosternum) is principally composed of keel; indeed the keel is merely broadened into a gently convexo-concave side-plate on each side (Pl. XLI. fig. 1, *es.*), the margin of these up- and out-standing crests of bone is sharp, and the whole outline has the same elegant bend as the hyposternum, the concavities of these outlines being opposed so as to leave a membranous interspace nearly ten lines across at the middle. The body of the sternum thickens abruptly at the end; all is ossified; and the xiphisternal termination (*xs.*) is truncate, and is 3½ lines across. The hyposternals are well marked and *tinamoid* in the Great Ostrich (*Struthio*); and there is a *pluvialine* notch on each side the xiphisternal end: all the sternum is ossified. These small notches exist in the Cassowary before the adult age; but the end of the sternum is a bluntly pointed cartilage. The long, subcultrate sternum of the *Rhea* continues soft after its posterior third; but the bone ends in an emarginate manner. In the shorter sternum of the Emu, the xiphoid end is pointed, yet a broad margin is left soft in the old bird; but the bone has its outline parallel with that of the cartilage. In the *Apteryx* the xiphisternal end is all ossified; but it is a mere pointed flap, scarcely larger than the hyposternal, and yet, curious enough, has its margins notched near the end—a curious *promise* this of what the anatomist so frequently finds as he ascends in the scale of bird-life. I have no doubt that the hyposternum of the Tinamou is that of the Fowl, *minus* the elegant pedate outer crus; if so, it is the inner hyposternal process alone, and not, like that of the Rail, the outer *minus* the inner. Yet this view must not be carried too far; for we see that even in the *Apteryx*, as well as in the Ostrich and Cassowary, the inner or submesial notch appears, whilst in them the outer part of the sternum behind must of necessity answer to the long, delicate hyposternum of the Tinamou.

The wings of the Tinamou (Pl. XXXIX.) are of the size of those of a medium Domestic Fowl: at first sight they are not to be distinguished from them; but upon closer inspection it may be seen that they are lighter, not so thick in proportion to their length, and that the *muscular* prominences are not so pronounced. In the humerus (*h.*) the pneumatic passage is of the same shape and nearly of the same size, and lies in a similar recess; the crest, however, for the insertion of the pectoralis major is not turned over as in the Fowl: this answers to the extreme (*struthious*) thinness of that muscle in the Tinamou, this bird having but little power to *depress* his wings. He can *elevate* them, however, and the middle pectoral muscles are as large as in most birds, the surface on the *keel* for their origin being 8 lines deep in front; whilst that for the *pectoralis major* is only 2½ lines: the knob for the insertion of the middle pectoral is as large in the Tinamou as in the Fowl. It is highly interesting to see the Tinamou *lift* his wings, just in the same manner as the Ostrich elevates hers; so that that same very ancient zoologist was most true to nature when he spoke of the Ostrich in this way—

> "What time she *lifteth* up herself on high, she scorneth the horse and his rider."

The bird does not merely raise her head, and elevate her body; she *lifts* her wings, and expands her whole person.

The Tinamou's "organs of flight" are still much more rudimentary than those of the Fowl, seeing that they are constructed far more for *elevation* than for *depression*, the latter movement being the one so necessary to flight. The *quill-buttons* on the ulna (*u.*) are, as in the Fowl, nearly obsolete; and the ulna and radius (*r.*) are both much alike in both birds, save that in the Tinamou they are altogether lighter and more elegant. The two carpals (*cp.*), the three metacarpals (*mcp.*), the three proximal digits (*dg.*), and the one subdistal joint may all be dismissed in the same manner. The humerus of both Fowl and Tinamou is relatively longer than in the *Syrrhaptes* and Pigeon, being only 2 lines shorter than the ulna; and whilst in those better fliers the hand is much the longest part, in the Tinamou the ulna is more than 4 lines longer than the "hand:" the measurements of this bird's wing-bones are—humerus 2 in. 11½ lin., ulna 3 in. 1½ lin., hand (metacarpus and phalanges) 2 in. 9 lin.

I have already spoken of the affinities of the *Hemipodius*, and of the nearness of that type to the Tinamou: I do not despair of finding some connecting link between the two. It is of importance to note that not only is the *Hemipodius* related to the Quails and Colins (*Coturnix* and *Ortyx*), but the *Dendrortyx* or Tree-Partridge seems to lie on the Tinamou-side of the typical Gallinaceæ: the comparative slenderness of the Tinamou's bones, as compared with those of the Fowl (when, if it were a direct intermedium between the *Apteryx* and that bird, they ought to be very heavy), is a fact quite in favour of the relationship of the Tinamou to the *Dendrortyx*.

The bones of the Tinamou's legs are also in favour of a relationship, or at least a leaning towards the same group of typical Gallinæ as those with which the *Turnix* or *Hemipodius* is most closely connected. These are the Quails and Colins; and I have been peculiarly fortunate in receiving from the Gardens of the Society the body of the *Dendrortyx*—one of the best of the unspurred dwarf Fowls for comparison with the Tinamou. We have seen how in the *Dendrortyx* the superorbital chain was, as it were, just dying out,—and also the peculiar lightness and delicacy of its bones generally, especially the sternum.

The bones of the leg, when due allowance is made for the inferior size of the bird, come very near to those of the Tinamou (Pl. XXXIX.), this latter bird not having such massive limbs as our typical walking bird the Fowl. This lightness or slenderness of the bones of the Tinamou's leg is a correlate of the *cursorial* character of the bird; but its running-powers are not backed by intelligence, such as is found in the birds belonging to the more specialized groups above it. The os femoris (*f.*) is a very elegant bone, although in nowise departing from the form common to Struthious and Gallinaceous birds; the trochanteric part of the upper articular surface is very large and highly scooped, the curve of the shaft is very considerable, and the patellar groove narrow: the patella itself does not ossify, but is a fibro-cartilaginous pad. The tibia (*tb.*) has its muscular ridges small and blunted, its shaft rather long, the inferior head of moderate size and well formed: there is a great difference in the character of this lower articulation from what is seen in the Fowl, in which there is in front a very large tendon-bridge stretching obliquely across above the trochlear ridges, and below this bridge a small articular fossa for the mid knob in front of the head of the tarso-metatarse.

Now, that is the tibio-calcaneal joint of the best of the walkers; but in cursorial birds there is another structure. In the Tinamou, as in the Adjutant (*Leptoptilus*), the tendon-bridge is small, oblique, and pushed to the inner side; whilst below, between the widely separated trochlear eminences, the tibia has a large, suboval, shallow articular cup for the corresponding cartilage-capped eminence in the front of the head of the compound shank-bone. This structure permits the tibia and metatarse to be flexed to the utmost on each other, besides giving the utmost safety and accuracy to the marvellous gymnastic movements of these peculiar and, as it respects the pelvic movements, highly gifted birds, the "Grallæ." Still this structure is not carried to that pitch in the Tinamou to which it arrives in that apparently ungainly but really very clever bird the Adjutant. The slender fibula (*fb.*) reaches to within 8 lines of the lower end of the tibia. The tarso-metatarse (*tmt.*) is a slender, moderately long bone, with well-scooped concavities for the elegant trochlear convexities of the tibia, and with a well-marked median knob in front. The calcaneal ridges and grooves are feebly developed, and there is no bony bridge, as in the Fowl, for the tendons that flex the toes; the fossa leading to the interspaces between the metatarsal heads is of moderate size, and the shaft has none of that angularity which is seen in the *Apteryx* and the Fowl; there is no bony calcaneal sesamoid. The small inner metatarsal (*h*) is not so high up nor so large as in the *Apteryx*; it is as high up, but is much smaller than in the Fowl. The toes (*dg.*) agree in strength and size rather with the Red Grouse than with the typical bird; they do not differ much in length, as may be seen by what follows:—heel, excluding small metatarsal, Tinamou 4½ lines; Grouse 4½ lines: inner toe, Tinamou 13 lines; Grouse 13 lines: mid toe, Tinamou 17 lines; Grouse 19 lines: outer toe, Tinamou 13 lines; Grouse 14 lines. The toes of the Tinamou are only half the size, and scarcely half the strength, of those of *Apteryx australis*.

Notwithstanding this tenuity, the shank and foot of the Tinamou, when considered in all its bearings, and with the skin upon it, is much more like what is seen in the *Apteryx* than in the Fowl. The horny scutes are strong, and the tubercles under the toes well developed; the *nails* are not in anywise gallinaceous, but are the true and exact miniature of those of the great Ostriches—*Struthio*, *Dromæus*, *Rhea*. These nails are curved as follows:—that of the heel looks outwards, and so does that of the outer toe; the middle "unguis" is turned suddenly inwards, and the inner toe is bent in the same way, but in a less degree; in the *Syrrhaptes* the whole middle toe turns very much *outwards*, in the same direction as the outer toe. Still the sprawling of the toes, although varied in manner in the two birds, has the same *reptilian* significance in both. The coarsely developed horny sheathing of the tarsus and foot is most exaggerated on the back of the shank, and some of these plates are two lines across; they are exceedingly thick, are *inversely* imbricated, and of a polygonal shape. These very strong plates get small both below and also behind the tibial hinge; they are of a whitish colour, and reach round two-thirds of the circumference of the shank, impinging upon the front scutes, which are broad, deep, and black.

This bird, like its proper congeners, is quite innocent of the thought of *perching*; it *squats*, and that in the very manner of the Emu, Ostrich, *Rhea*, and *Apteryx*. It sits up like a Kangaroo—a position at times assumed by the Adjutant and other large "Grallæ," but which is very characteristic of the Ostrich-tribe. Speaking teleologically, the armature of the shanks of this bird (its most strong and serviceable buskins) shows that it was made to sit in that peculiar way—a posture very much unlike that of the Hen when she squats, as in dusting herself or as when sitting on her nest. Finally, it may be remarked that, notwithstanding the upsprouting of higher characters in the Tinamou, from head to foot this foolish, lizard-like bird of the dust has only pushed against, but has not been able to break from, the outer Ostrich-barrier.

APPENDIX.

A.—*Notes and Criticisms on the Memoir "On the Osteology of* Balæniceps rex" (Zool. Trans. 1861).

From the very nature of my work, which is that of determining the affinities of birds by means of their skeletal structures, a large amount of morphological detail has to be given. In my former large paper this detail was very much in excess; and in the present it rather preponderates over that which is purely zoological. This arises from the fact that the actual development of the skeleton generally, and especially of the skull, is only beginning to open itself up to me. I may state that in the working-out of the present paper I have stumbled upon many curious embryological facts, both in the Bird-class and amongst Fishes, Reptiles, and Mammals, which were not known to me heretofore.

Moreover, during this time, the privilege of frequent discussions with men of less embarrassed and clearer thought has imparted to me not merely fresh impulse and valuable hints, but also facts of the greatest importance. The invaluable course of lectures, delivered during the past year by Professor Huxley, at the College of Surgeons, have been of the greatest value to me; and his lucid determinations of the meaning of the periotic bones, and of the large splint bone at the base of the skull, in Fishes and Amphibia form most excellent stand-points from which to begin future researches in the morphology of the skull.

The highly composite nature of the pterygo-palatine apparatus, and of the rhinal structures,—the great variety in the development of the tympanic chain of bones,—the absence, as a rule, or extremely abortive condition of the maxillary in birds,—and the determination of the so-called maxillaries to be the homologues of the *miscalled* inferior turbinals of the Lacertian and Ophidian,—these and many other points, which in their opening up have gladdened me in my labours, must be treated of elsewhere.

In both zoology and botany the discovery of new species is ever disturbing the old order of things: it is just so in morphology; and the nomenclature must be as mobile as the science which it subserves.

Many of the statements in my former paper with regard to the general morphology of the vertebrate skull are very open to criticism; I am now engaged in such researches as will either prove or disprove them: there is not space to deal with them here.

In the present paper I have endeavoured to make the nomenclature of the parts of the skull simpler and more accurate, and especially to keep safe by the old familiar terms used in descriptions of the human skull. For Professor Owen's term "entopterygoid" (in Fish and, as I find very constant, in Birds) I substitute "mesopterygoid," as it is not the homologue of the internal pterygoid plate of Man and the Mammalia generally, but occurs in the Fox and some others in addition to the internal or true pterygoid. Again, the term "ectopterygoid" would seem to infer that it was the homologue of the external pterygoid plate, which it is not; it only occurs in the "Sauropsida:" Cuvier's term "os transversum" must be retained for the present. The small membrane-bones which, in the "Lamellirostral" birds and in the Tiger Bittern, pass inwards and forwards from the inner edge of the palatines at their middle, may be called "interpalatines:" they occur *exogenously* in the palatines of many arboreal birds. Instead of using the heavy terms "ecto-" and "ento-pterapophysis" for the processes which, often in the Mammalia and constantly in birds, arise from the basisphenoid, and which have no anthropotomical name, these had better be called posterior and anterior pterygoid processes. In Man these have no existence; for the "lingulæ sphenoidales" (the rudiments, as Professor Huxley suggested to me, of my "basitemporals" in the "Sauropsida") apply themselves closely to the body of the sphenoid behind. In many Mammals these ossicles are thrust outwards to some distance from the axis of the skull by a pair of small posterior pterygoid processes; in the Hedgehog these parts are very large. In most Mammals the internal pterygoid plate abuts against the body of the sphenoid; but in the Guineapig (*Cavia aperea*) a pair of pedicles keep them off, and to them they are eventually anchylosed: these are a retention of the ornithic "anterior pterygoid processes"—the "entopterapophyses" of my former paper.

These processes attain their largest size in the "Struthionidæ" (Pl. XLII. fig. 1, *apt.*), are aborted in many genera, and do not exist in the Reptilia; for in them the pterygoids are attached to the skull-base still further backwards than in the Ostriches, through the medium of the pterygoid processes of the basitemporals; these latter processes are well seen in the King-Vulture (*Sarcorhamphus papa*), but in it they are only used for muscular attachment.

I have in this paper used the term "prevomer" for the splint bone which is vicarious of the maxillary in the Bird-class: it is not (as Cuvier supposed) the homologue of the "inferior turbinal" of Man.

At p. 285 of my former paper, the Oyster-catcher (*Hæmatopus*) is placed in "Group 3," instead of in "Group 5," as though it had its anterior pterygoid processes aborted: this is not the case. The "turbinals or ethmoidal pterapophyses," spoken of at p. 297, are really the inner parts of the prevomer and the "maxillaries;" at p. 301, the outer margins of these bones.

At p. 317, in a note, the tympanic is spoken of as being absent from the skulls of most "Gallinaceæ:" this only refers to the meatus-bone, so large in the Peacock. I had not then discovered the proper tympanic chain of ossicles.

At p. 317 I failed to mention that the small tongue of the *Balæniceps* showed its near relationship to the *Ibis*. When the whole of the ardeine "Altrices" have been worked out, I will return to the affinities of the *Balæniceps*, which still seems to me to have the Heron-characters in preponderance, and to stand really between the truly ardeine *Cancroma* and the ciconiine *Scopus*.

In speaking of the gaps between living genera of birds (p. 346), I mentioned the isolation of the Flamingos (*Phœnicopterus*); I am now satisfied that they were not always so much alone in the class. Through the kindness of Dr. Falconer, I have recently had my attention called to an excellent paper on fossil birds by the younger Milne-Edwards[1], in which he describes three species of an extinct genus of birds closely allied to the Flamingos, on one hand, and to true water-birds on the other. This new genus is named by him *Palælodus*. These important fossils have been found in the tertiary deposits of Mayence and Auvergne.

B.—*Concluding Remarks.*

In the foregoing descriptions of the truly gallinaceous birds, frequent allusion has been made to the conformity of many parts of their skulls with the like parts of those of the Goose-tribe. Prior to my acquaintance with the osteology of the *Palamedea*, there was to me no solution of this puzzling fact; practically this difficulty is cleared, and any bird which should be intermediate between the *Palamedea*, on one hand, and either the Curassows or the Megapods on the other, would perfectly link together all the birds that lie fairly between the Peacock and the *Merganser*. This, at first sight, looks unlikely enough; and yet, taking the skull only—the noblest part, and the great centre of the organism—the correspondence between the members of this great bipolar group is, embryologically, exceedingly intimate.

But, to say nothing of the body of the bird, the superadded splint bones which go to form the outworks of the skull and face, and which are subject to endless adaptive modifications—these parts differ as extremely as in any of the most divergent bird-groups.

The skull of the *Palamedea* is a perfect key to all the intricacies of this matter—that is, if it be studied in the light of the embryology of the Fowl and of the Duck or Goose. The only great and important difference between the primordial cartilaginous skull and its facial rods in the one group and in the other is this—that in the gosling the second poststomal rods are unusually large, whilst in the chick the confluence of the occipital and periotic cartilages is nearly complete: thus the tongue of the Goose becomes large and flat, and the occipital plane of the Fowl wants those large fenestræ (the lateral occipital fontanelles) which are seen in all the Goose-tribe, save in the *Palamedea*.

But the occipital condyle, the basitemporal floor, the anterior and posterior sphe-

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[1] Mémoire sur la distribution géologique des Oiseaux fossiles, et description de quelques espèces nouvelles, par M. Alphonse Milne-Edwards (Ann. Sc. Nat. Zool. ser. iv. vol. xx. p. 133).

noids, the pterygoids, palatines, os quadratum, and os articulare, all these agree in everything essential, even in the adult bird.

But, more than this, the wrappings of the mandibular rod, much as they differ anteriorly in the two groups, yet agree behind in the peculiar sickle-like process to the "angular" splint bone.

An extended embryology will largely influence the systematic arrangement of birds; for it will open our eyes to the essential unity often underlying the uttermost degree of *polymorphism*, whilst the veil will be torn from those mimetic *isomorphs* which have so long deceived those ornithologists who look mainly at outward appearances, but do not penetrate to the heart of the matter.

As the relationships of the Gallinaceous subfamilies are very intricate, I shall append a few schemes, showing the comparative nearness of certain main genera; these will, of necessity, be the merest *diagrams*, and will represent the fulness of the subject just as the first sketch of an artist, when he has thrown in the outline of the trunk and of a few of the main branches, represents the fulness of a noble tree.

I will first show, in two parallel columns, how both the Fowls and the Rails run insensibly through certain leading genera into the lowest (reptilian) types of diving-birds.

Notornis.
Brachypteryx.
Ocydromus.
Tribonyx.
Crex.
Rallus.
Gallinula.
Porphyrio.
Fulica.
Podilymbus.
Podiceps.
Podica.
Aptenodytes. *Phalacrocorax.*

Gallus.
Crax.
Talegalla.
Palamedea.
Anseranas.
Plectropterus.
Anser.
Anas.
Fuligula.
Harelda.
Biziura.
Merganser.
Colymbus. *Alca.*

But the Plovers (*Charadrius*, *Pluvialis*) stand in the centre of large groups of genera, many of which are nobler (more ornithic) than themselves, and not a few of which are, notwithstanding their elevation above the simple and very reptilian Plovers, quite true to that type. These latter are the Ibises on one hand, and the Gulls on the other: these latter birds, be it remarked, *ascend* in the bird-scale, in spite of their *marine* habits and although they never become quite fissiped. In the following list the central birds are the lowest in type:—

Eurypyga.		*Ciconia.*
Scolopax.		*Ibis.*
Himantopus.		*Numenius.*
	Limosa.	
	Tringa.	
	Calidris.	
	Pluvialis.	
	Hæmatopus.	
Chionis.		*Glareola.*
Procellaria.		*Sterna.*
Diomedea.		*Larus.*

The Plovers and the Rails do not stand far apart in Nature, and the two types are for ever blending to form secondary types, e. g. *Parra*, *Botaurus*, *Grus*, *Psophia*; but the Plover is at once more nearly related both to the Ostrich and to the Lizard than the Rail, and yet it is a more intelligent bird.

The "Struthionidæ" are hemmed in on all sides, except the Mammalian, with the genera that have taken up so much of our attention in the present paper; yet are they the most unconformable of all the living feathered tribes, and I much question whether the *Archæopteryx* itself did not agree better with ordinary birds, it having no such contiguity to the Mammals as we see in the Ostrich-tribe.

The relationships of the *Talegalla* may be faintly shown by the appended scheme.

	Gallus.	
	Crax.	
Brachypteryx.	Talegalla.	*Rhinochetus.*
	Palamedea.	

Those of *Hemipodius* by the next.

	Coturnix.	
	Dendrortyx.	
Didunculus.	Hemipodius.	*Charadrius.*
	Tinamus.	

The affinities of *Syrrhaptes* appear to me to be as follows, viz.:—

	Gallus.	
	Lagopus.	
Chamæopelia.	*Pterocles.*	
Hemipodius.	Syrrhaptes.	*Charadrius.*
	Tinamus.	

The relationships of *Tinamus* may be put in such a form as the following, viz.:—

Gallus.
Charadrius. *Dendrortyx.* *Ocydromus.*
Syrrhaptes. *Hemipodius.*
Tinamus.
Apteryx. *Rhea.*
Casuarius.
Mammalia : Reptilia.

In summing up the affinities of the birds described in this paper, it may be said that the "Tetraoninæ" differ from the "Phasianinæ," just as the Ducks differ from the Geese—the legs are shorter, and the ear-drum is far more perfectly developed; whilst, as the Grouse lean towards the Sandgrouse, so the Ducks—the marine genera—lean towards the Grebes and the Cormorants.

The Curassows are evidently true and normal connecting links between the Fowls and the Palamedeas.

The *Talegalla* and its allies are not only related to the Curassows and Palamedeas, but also to the wingless Rails, and through them to the Kagu (*Rhinochetus*).

The *Hemipodii* have the Quails above them, the Tinamous below, the smaller Plovers on one side, and the Ground-Pigeons on the other.

The Sandgrouse are borderers, and although lower than the Grouse in many respects, being but little removed from the struthious type, yet are related, and that intimately, to the Plovers and the Pigeons.

The Tinamous are perhaps the most instructive of all these mixed forms; for although essentially struthious, yet they are structurally closely related to the *Dendrortyx* (and through it to the Fowl), to the *Hemipodius*, the *Syrrhaptes*, the Rails, and the Plovers. Finally, it has reappearing in its skull structural characters only found again in such Reptilia as the Blindworms and the Skinks[1]. That most important bone, the "os quadratum," is thoroughly Reptilian in the Tinamou (as in the Ostriches), almost single-headed in the Fowls and Grouse, and well-nigh typically ornithic in the Mound-makers, Curassows, Hemipods, and Sandgrouse[2].

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[1] The superorbital chain of bones occurs, as I find by a recent dissection, in the *Psophia*: this bird is a member of a very *mixed* group, yet it is one of the most intelligent of all the "Aves præcoces."

[2] At the last moment, I have received from the Gardens of the Society a fresh Variegated Tinamou (*Tinamus variegatus*) for dissection. It differs from *T. robustus* in having four sternal hæmapophyses on the left side, and five on the right; for the rest, its soft structures will yield us all that we need. The tongue is small, triangular, and soft, as in the "Struthionidæ;" but its skeletal parts are of precisely the same form as in the "Gallinæ;" yet the ceratohyals and the basihyal are not ossified, as in them, but cartilaginous, as in the Ostriches. The urohyal is feebly ossified proximally; and the thyrohyals, which are extremely delicate and long, are as much ossified as in the Fowls. As in the Ostriches, the trachea is wholly cartilaginous; in the Fowls the rings are patched with osseous centres; they are also feebler altogether than in the Fowls. Another extremely good non-

EXPLANATION OF THE PLATES.

PLATE XXXIV.

Hemipodius —— ?

Fig. 1.	Basal view of skull.
so.	Superoccipital.
m.o.f.	Middle occipital fontanelle.
eo.	Exoccipital.
o.c.	Occipital condyle.
bo.	Basioccipital.
9.	Anterior and posterior condyloid foramina.
8.	Foramen for vagus nerve.
i.c.	Opening for internal carotid artery.
*t.*1.	Anterior tympanic.
*t.*2.	Lateral tympanic.
bt.	Basitemporal.
sd.	Sesamoid at angle of jaw.
q.	Os quadratum.
qj.	Quadrato-jugal.
j.	Jugal.
bs.	Basisphenoid.
pg.	Pterygoid.
pa.	Palatine.
ao.	Antorbital.
v.	Vomer.
pv.	Prevomer.
n.	Nasal.
px.	Premaxillary.
Fig. 2.	End view of skull.
ar.	Articular.

ornithic character is, that the cartilaginous rings fail of perfection in two ways: firstly, in a few places they form a short spiral with free ends; and secondly, the lowest six are open behind, as in the Mammalia. I do not find this character in the Emus, the Mooruk (*Casuarius Bennetii*), the *Rhea*, or the Ostrich (*Struthio camelus*). In the Emu, at the lower third the trachea is enlarged, and the rings are open in front at that part. In the Tinamou the trachea is enlarged above the middle; but the rings are complete in the dilated region.

The *Rhea* has, unexpectedly, a pair of thick inferior laryngeal muscles; I find none in the Mooruk, Ostrich, Emu, or Tinamou: in this these birds agree with the typical and subtypical Fowls and the Geese.

The Tinamou has the pharynx, crop, and gizzard exactly as in the true Gallinæ; but the proventricular glands are not racemose as in the Fowl, the Grouse, the *Rhea*, and the Ostrich, but simple, as in the Pigeon, Sand-grouse, *Talegalla*, Emu, and Cassowary. In these latter huge birds (*Dromæus* and *Casuarius*) the glandules are long and cylindrical; in the Tinamou they are short and ovoidal, as in *Syrrhaptes*.

The cæca coli of the Tinamou are inferior to those of the Fowls, and relatively shorter than in the *Rhea*; the largest of the two is $3\frac{1}{2}$ inches long by $\frac{1}{2}$ an inch in width at the widest part. These organs are not sacculated as in the *Rhea*, and they have neither the delicate reticulated plicæ of the Fowl nor the large longitudinal folds of the Grouse and Sandgrouse; in the Mooruk and the Emu they are short; in the latter bird they are not an inch in length six weeks after hatching. In this Tinamou the œsophagus is $7\frac{1}{2}$ inches in length; but the crop projects from it 2 inches 8 lines, and is 1 inch 8 lines across. The proventriculus is 10 lines in length; the gizzard $1\frac{2}{3}$ inch across, $1\frac{1}{3}$ inch deep, and $\frac{3}{4}$ of an inch thick. The duodenal fold is 3 inches long, and the intestine, from the gizzard to the cæca, 31 inches; the colo-rectum is 5 inches long. The whole length of the intestinal canal is 54 inches. The three slits in the soft palate (the two anterior being the median nares, and the posterior slit receiving the Eustachian tubes) are in the Tinamou perfectly struthious.

sq. Squamosal.
p. Parietal.
f. Frontal.
Fig. 3. Upper view of skull.
po. Postfrontal.
l. Lachrymal.
Fig. 4. Side view of skull.
as. Alisphenoid.
ps. Presphenoid.
p.e. Perpendicular ethmoid.
1. Olfactory groove.
2. Optic foramen.
ag. Angular.
sag. Surangular.
d. Dentary.
Fig. 5. Front view of nasal region.
prf. Upper prefrontal.
aet. Ali-ethmoid lamina.
t. Turbinal mass.
Fig. 6. Posterior view of nasal region.
r.bs. Section of rostrum of basisphenoid.

End view of skulls.

Fig. 7. *Chamæopelia passerina.*
sob. Superorbital ridge.
Fig. 8. *Tinamus robustus.*
sob. Superorbital ridge.

Figs. 1, 2, 3, 4, & 7 are magnified three diameters; figs. 5 & 6, six diameters; and fig. 8, two diameters.

N.B. The letters correspond in all the plates; when any additional letter occurs, it is explained.

PLATE XXXV.

Hemipodius varius.
(Figs. 1–4 magnified two diameters.)
Fig. 1. Basal view of skull.
Fig. 2. End view of skull.
Fig. 3. Upper view of skull.
Fig. 4. Side view of skull.
Fig. 5. Skeleton, side view: nat. size.
m. Maxillary region.
mn. Mandible.
cr. Cranium.
io.s. Interorbital space.
c. Cervical vertebræ.
d. Dorsal vertebræ.
sc. Sacral vertebræ.
cd. Caudal vertebræ.
sca. Scapula.
cr. Coracoid.
fr. Furculum.
h. Humerus.
r. Radius.
u. Ulna.
cp. Carpus.
mc. Metacarpus.
dg. Digits.
hs. Hyosternal process.
es. Entosternal process.
hys. Hyposternal process.
xs. Xiphisternal process.
f. Os femoris.
tb. Tibia.
fb. Fibula.
tms. Tarso-metatarsus.
3,4,5. 3rd, 4th, and 5th digits.
il. Ilium.
is. Ischium.
pb. Pubis.
Fig. 6. Sternum, lower view: nat. size.
es. Episternal process.
Fig. 7. Humerus, back view: nat. size.
ax. Axillary cavity.
Fig. 8. *sc.* Sacrum.
ac. Acetabulum.

PLATE XXXVI.

Syrrhaptes paradoxus.

(Figs. 1–10 magnified two diameters.)

Fig. 1. Basal view of skull.
Fig. 2. Upper view of skull.
Fig. 3. End view of skull.
Fig. 4. Side view of skull.
Fig. 5. Upper view of os hyoides.

Lagopus scoticus.

Fig. 6. Basal view of skull.
Fig. 7. Upper view of skull.
Fig. 8. End view of skull.
Fig. 9. Side view of skull.
Fig. 10. Upper view of os hyoides.

PLATE XXXVII.

Vanellus cristatus.

(Figs. 1–10 magnified two diameters.)

Fig. 1. Basal view of skull.
pt. Posterior pterygoid process.
l.o.f. Lateral occipital fontanelle.
Fig. 2. End view of skull.
Fig. 3. Upper view of skull.
g.d. Passage for duct of nasal gland.
Fig. 4. Side view of skull.
c.g. Crista galli.
5. Foramen ovale.
5*a*. Foramen rotundum.
Fig. 5. Upper view of os hyoides.
ch. Connate ceratohyal.
bh. Basihyal.
uh. Urohyal.
*th.*1. Distal thyrohyal.
*th.*2. Proximal thyrohyal.

Columba livia.

Fig. 6. Basal view of skull.
p.p. Posterior pterygoid process.
Fig. 7. End view of skull.
Fig. 8. Upper view of skull.
Fig. 9. Side view of skull.
Fig. 10. Upper view of os hyoides.

PLATE XXXVIII.

Syrrhaptes paradoxus.

Side view of skeleton: nat. size.

c.r. Rib of last cervical.
d.r. 1st dorsal rib.
s.r. 1st sacral rib.
sc. Scapula.
sm. Sacrum.
isc. ischium.
mcp. Metacarpus.
tmt. Tarso-metatarse.
dg. Digits.
cl. Calcaneal sesamoids.

PLATE XXXIX.

Tinamus robustus.

($\frac{4}{5}$ths nat. size.)

sc. Scapula.
sm. Sacrum.
isc. Ischium.
l.p. Space for large pectoral muscle.
h. The so-called hallux or 2nd toe.
dg. Digits (3rd, 4th, & 5th).

PLATE XL.

Tinamus robustus.
(Figs. 1–3 magnified 2 diameters.)

Fig. 1. Basal view of skull.
Fig. 2. Upper view of skull.
sro. Superorbital chain of ossicles.
Fig. 3. Side view of skull.
eth. Vertical ethmoid.
io.s. Interorbital space.
p.o. Post-frontal bone.
Fig. 4. Front view of tarso-metatarse: nat. size.
Fig. 5. Posterior view of tarso-metatarse: nat. size.
Fig. 6. Articular surface of mandible: 2 diam.
Fig. 7. End view of mandibular rami: 2 diam.

PLATE XLI.

Tinamus robustus. Nat. size.

Fig. 1. Lower view of sternal apparatus.
Fig. 2. Coracoid and furculum (side view).
Fig. 3. Pelvis and caudal vertebræ (upper view).

Syrrhaptes paradoxus. Nat. size.

Fig. 4. Sternal apparatus (lower view).
Fig. 5. Pelvis, and dorsal and caudal vertebræ (upper view).
Fig. 6. Tarsometatarse (front view).
Fig. 7. Tarsometatarse (posterior view).
Fig. 8. Foot (lower view): 2 diam.

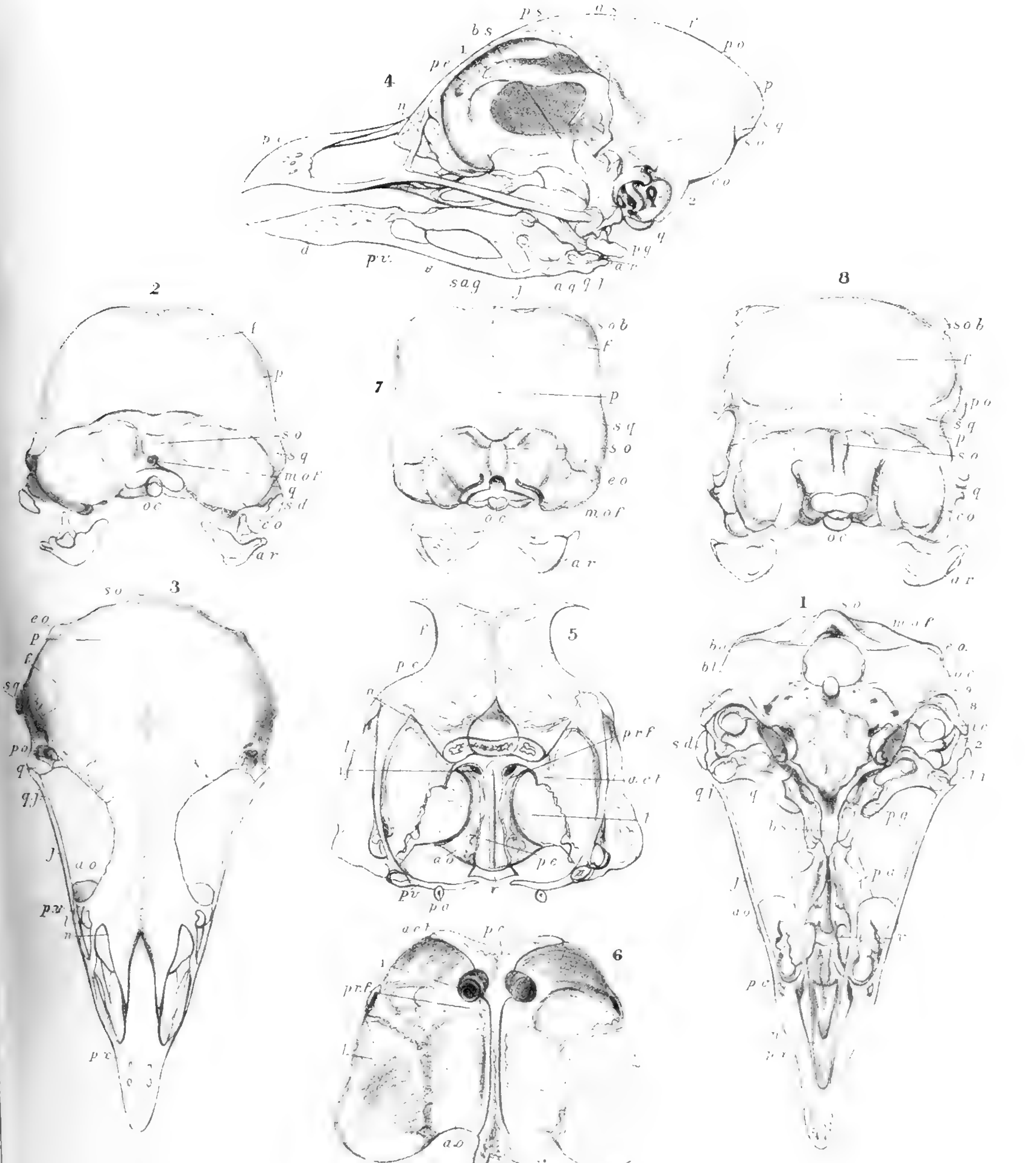
Perdix cinerea. Nat. size.

Fig. 9. Sternum (lower view).
Fig. 10. Sternum (side view).

PLATE XLII.

Rhea americana. Nat. size.

Fig. 1. Basal view of skull.
f.m. Foramen magnum.
p.pt. Posterior pterygoid process.
a.pt. Anterior pterygoid process.
eu. Eustachian tube.
r.bs. Rostrum of basisphenoid.
Fig. 2. Upper view of skull.
n.px. Nasal process of premaxillary.
Fig. 3. End view of skull.
ep. Epiotic (Huxley).
op. Opisthotic (Huxley).
Fig. 4. Side view of skull.
os. Orbito-sphenoid.
m.s. Membranous space between upper turbinals.
ao. 1. Upper antorbital.
ao. 2. Lower antorbital.
s.n. Septum nasi.
Fig. 5. Articular surface of mandible.
Fig. 6. End view of mandible.

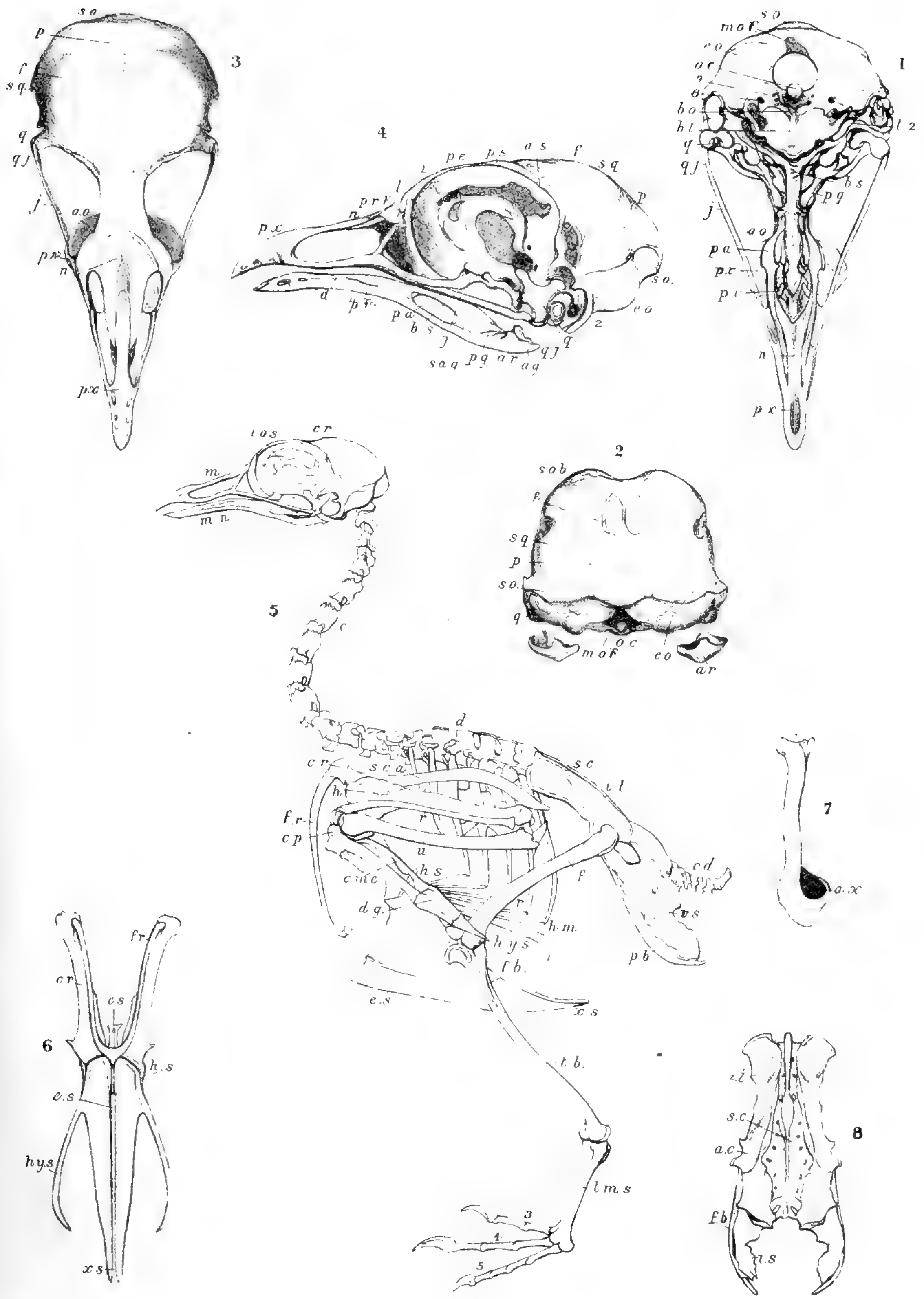


E Parker del^t J Erxleben lith

M & N Hanhart imp^t

-6. HEMIPODIUS _ ? 3 & 6 Diam 7 CHAMÆPELIA PASSERINA 3 Diam 8 TINAMUS ROBUSTUS 2 Diam

BRITISH MUSEUM
NATURAL HISTORY

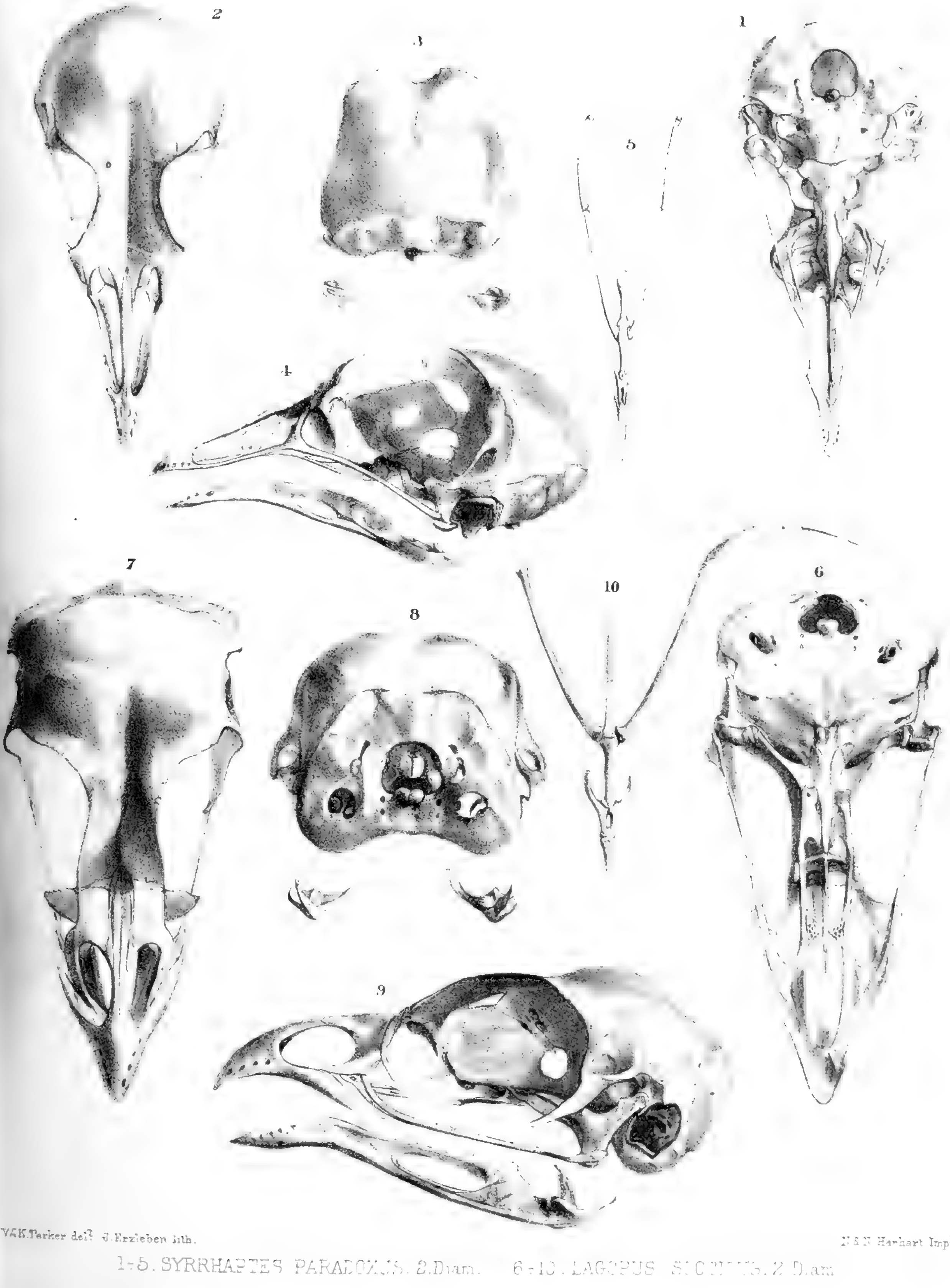


W.K.Parker del^t J.Erxleben Lith.

M & N. Hanhart Imp^t

HEMIPODIUS VARIUS Nat Size. & 2, Diam.

BRITISH MUSEUM
Z D
NATURAL HISTORY

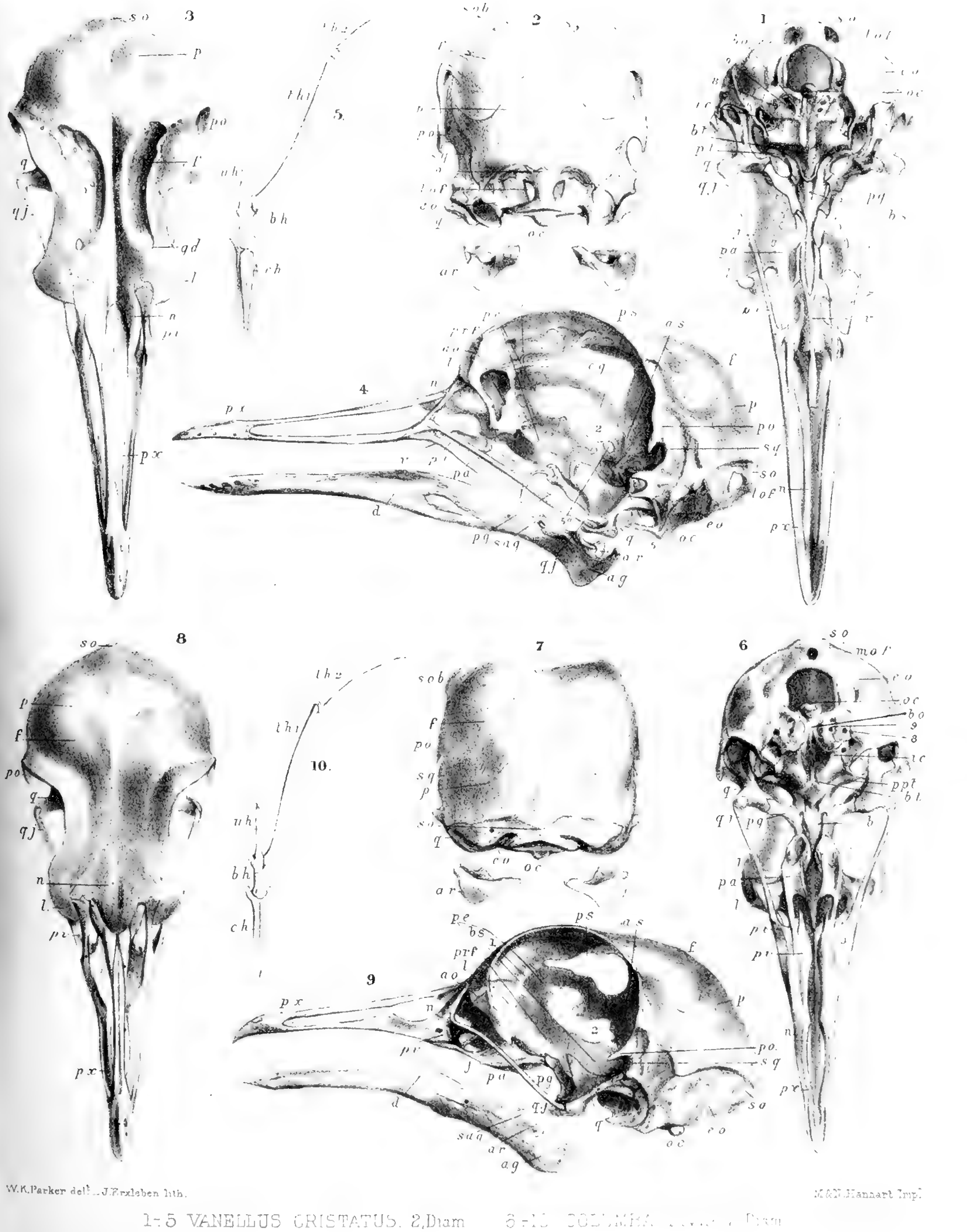


W.K. Parker del.t J. Erxleben lith.

M & N Hanhart Imp.t

1–5. SYRRHAPTES PARADOXUS. 2 Diam. 6–10. LAGOPUS SCOTICUS. 2 Diam.

BRITISH MUSEUM
Z S D
NATURAL HISTORY



W.K.Parker delt. J.Erxleben lith.

M&N.Hanhart Imp.

1-5 VANELLUS CRISTATUS. 2,Diam 6-10 COLUMBA [illegible] Diam

BRITISH MUSEUM
Z D
NATURAL HISTORY

From Na. on Stone by J. Erxleben.

M & N Hanhart Imp.

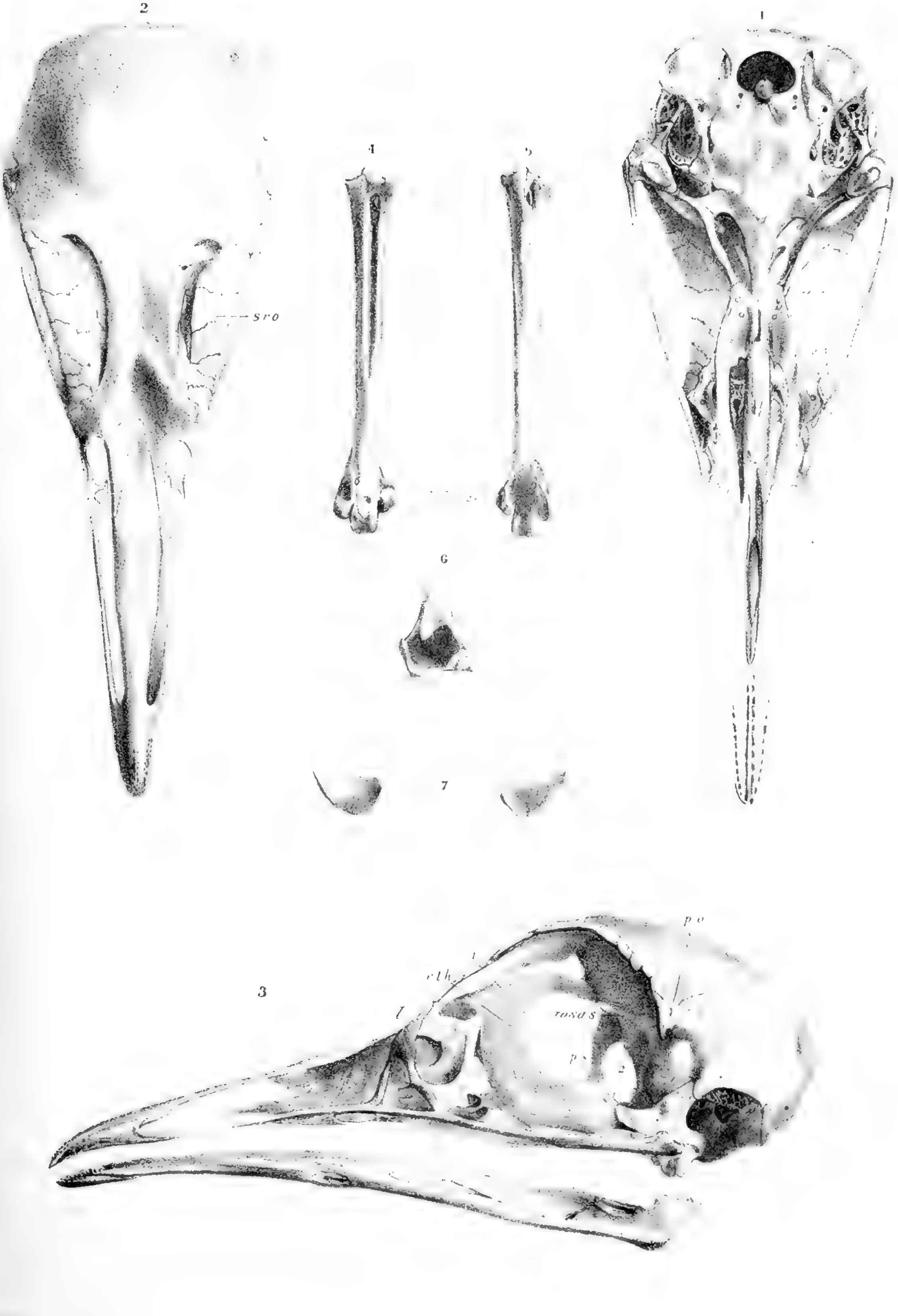
SYRRHAPTES PARADOXUS, Nat Size.

BRITISH MUSEUM
Z D
NATURAL HISTORY

[illegible] Stone by J. Erxleben.

M & N Hanhart Imp.

BRITISH MUSEUM
Z D
NATURAL HISTORY



Del. Stone by J. Erxleben.

M & N Hanhart Imp.

1–7. TINAMUS ROBUSTUS 1¾ Diam.

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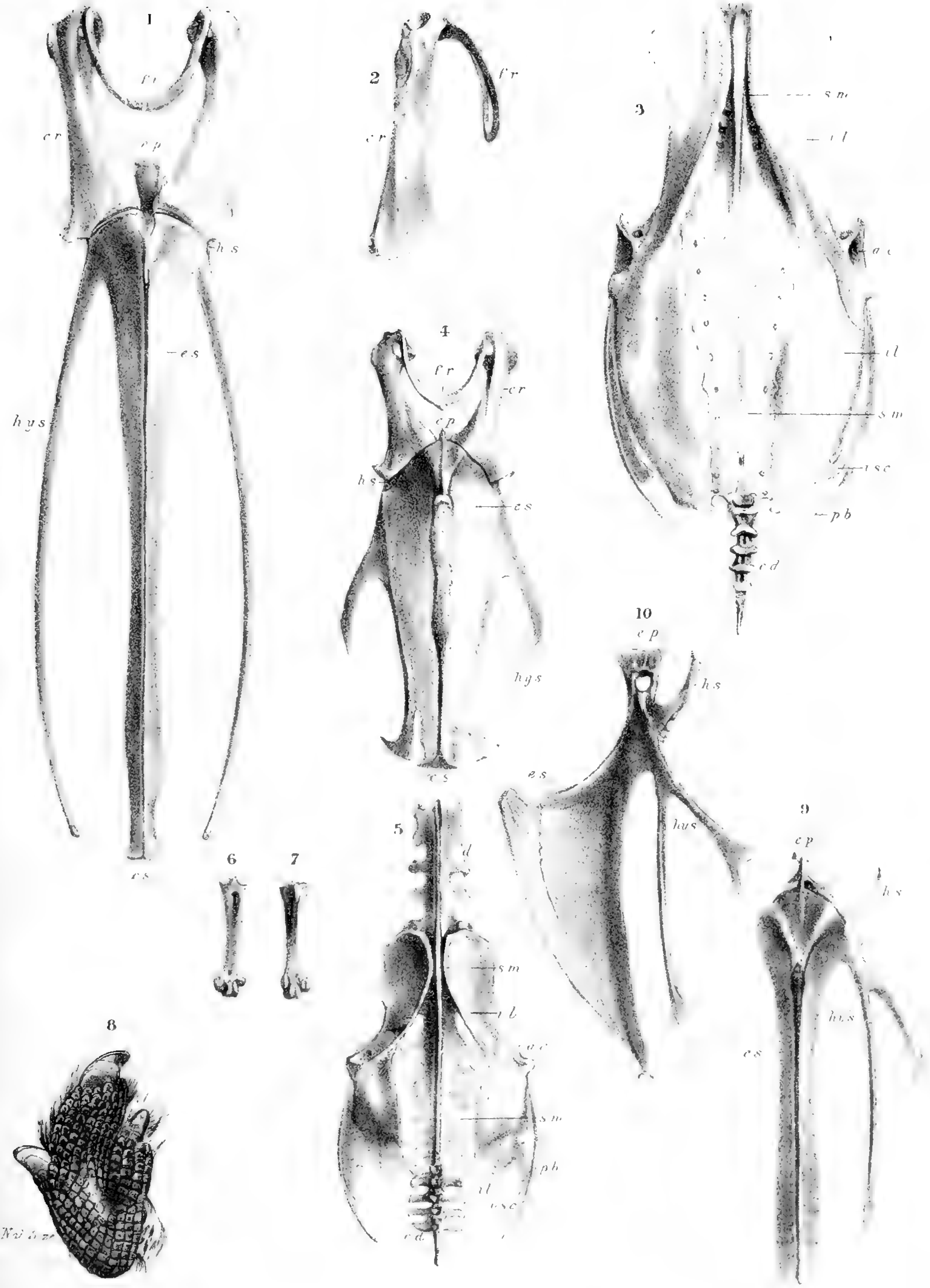
NATURAL HISTORY



From Nat. on Stone by J. Erxleben.

1-3 TINAMUS ROBUSTUS

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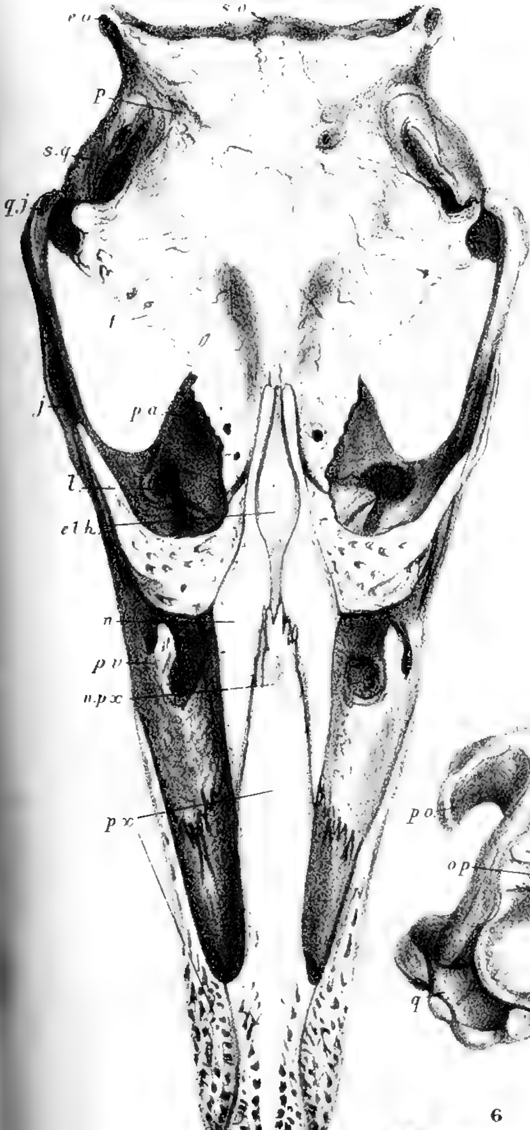
2



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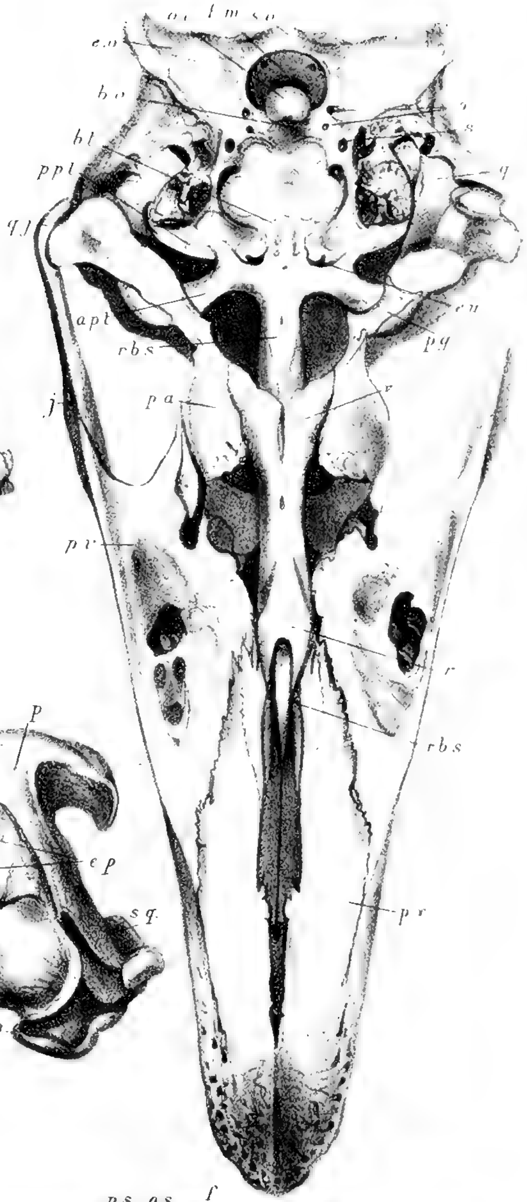

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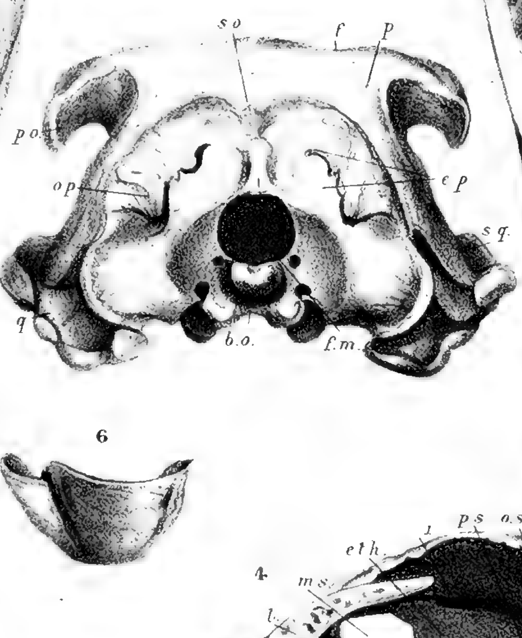
3



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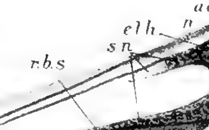

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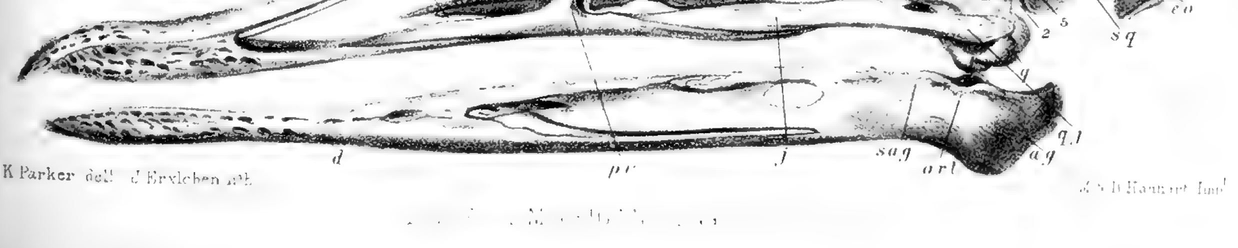

W.K Parker del. J Erxleben lith.

M & N Hanhart imp.

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VI. *Contributions to the Natural History of the Anthropoid Apes.* No. VIII. *On the External Characters of the Gorilla* (Troglodytes Gorilla, *Sav.*). *By* Professor OWEN, *F.R.S.*, *F.Z.S.*, *&c.*

Read January 11th, 1859.

[PLATES XLIII.—XLIX.]

AFTER ten years' correspondence, appeals, and instructions, carried on with a view to obtaining from the Gaboon the desired materials for completing our knowledge of the external characters of the Gorilla, I am enabled to submit to the Society so much of the desired information as can be had from the study of a young but nearly full-grown male specimen (Pls. XLV. & XLVI.), which reached the British Museum, preserved in spirits, on the 10th of September, 1858.

Before, however, proceeding to the description of this specimen, I may be permitted briefly to recapitulate the steps which have led to the determination of the great anthropoid Ape of Africa, called *Troglodytes Gorilla*, of which but vague and uncertain indications had previously reached the scientific world.

The first authentic information which I received of its existence was by a letter from Dr. Savage, dated 'Gaboon River, West Africa,' April 24, 1847, enclosing a sketch of the cranium, and requesting that the results of my comparison might be communicated to him, which was done.

In December 1847 I received from Bristol two skulls of the full-grown male, and one of a female, descriptions of which, with the previous evidence which had reached me, were communicated to the Zoological Society, February 22, 1848[1].

The skulls obtained by Dr. Savage at the Gaboon were taken by him to Boston, U. S., and were described by the Doctor and Prof. Wyman in the 'Journal of the Natural History Society of Boston' (vol. v. 1847), and the name *Troglodytes Gorilla* was proposed for the species.

Translations of Dr. Wyman's and my papers being published in the 'Annales des Sciences Naturelles,' the attention of Continental naturalists was strongly excited toward this unexpected addition to the Mammalian class; and the inducements held out for the collection of specimens have led to the acquisition of additional materials for completing the zoographical history of the animal which it seems now agreed to call "Gorilla." Those which reached London previous to the present date enabled me to communicate to the Zoological Society[2] a description of the entire skeleton of the *Troglodytes Gorilla*, since published, with illustrations, in the 'Transactions' of the Society[3], the main facts being previously recorded in my 'Descriptive Catalogue of the 'Osteological Collection in the Museum of the Royal College of Surgeons,' 4to, 1853,

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[1] Trans. Zool. Soc. vol. iii. p. 381, pls. 58–63.

[2] Proc. Zool. Soc. Nov. 11, 1851.

[3] Vol. iv. pt. iii. p. 75. pls. 26–30, pt. iv. p. 89. pls. 31–36, and vol. v. pt. i. p. 1. pls. 1 to 13.

pp. 782–804. Entire skeletons of the full-grown *Troglodytes Gorilla* are now set up in the Museum of the College and in the British Museum.

All the foregoing specimens were obtained from a part of the west coast of tropical Africa traversed by the rivers "Fernandes Vas," "Danger," and "Gaboon," in latitudes 1° to 10° N. and 1° to 15° S.

A corresponding series of illustrations—first crania, then the skeleton, finally an entire specimen of the *Troglodytes Gorilla*—have successively reached the Museum of the Garden of Plants, Paris, and have afforded materials for interesting and instructive memoirs from the accomplished Professors in that noble establishment for extending and diffusing the science of natural history.

Prof. de Blainville had caused a lithograph to be prepared of the skeleton of the Gorilla, shortly before his demise. His successor, Prof. Duvernoy, communicated a description of this skeleton to the Academy of Sciences in 1853, which is published, with some interesting particulars of the anatomy of the soft parts, in the 'Archives du Muséum d'Histoire Naturelle,' tome vii. (1855). The Memoirs and Observations by the accomplished Professor of Mammalogy and Ornithology, Isidore Geoffroy St.-Hilaire, on the Gorilla will be found in the 'Comptes Rendus de l'Académie des Sciences,' January 19, 1852, and subsequent numbers; in the 'Revue de Zoologie,' No. ii. 1853; the whole being summed up in the part of his excellent 'Description des Mammifères nouveaux,' &c., 4to, which appeared in vol. x. of the 'Archives du Muséum,' 1858.

The differences in the results of the observations by the American, French, and English authors relate chiefly to the interpretation of the facts observed. Dr. Wyman agrees with me in referring the Gorilla to the same genus as the Chimpanzee, but he differs in regarding the latter as being more nearly allied to the Human kind. Professors I. Geoffroy St.-Hilaire and Duvernoy consider the differences in the osteology, dentition, and external characters of the Gorilla to be of generic importance[1], and enter it in the Zoological Catalogue as *Gorilla Gina*, the *nomen triviale* being taken from 'Weggeena,' 'Ngina' and 'Djina,' as the name of the beast in the Gaboon tongue has been diversely written by voyagers. The French naturalists also concur with the American in placing the Gorilla below the Chimpanzee in the scale. I propose to discuss these questions at the conclusion of the present paper, and to test the notion current in some works that the long-armed Apes (*Hylobates*), and not the Orangs or Chimpanzees, are the most anthropoid of Quadrumana.

The young male Gorilla, here described, was killed by natives in the interior of the Gaboon, and brought down to the port entire: it was at once immersed in a cask of

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[1] The main discrepancy, in regard to matter of fact, is that the arms of the Gorilla are stated by Isid. Geoffroy to be much longer, whilst I found them to be relatively shorter, than those of the Chimpanzee.

"Bras { de proportions presque humaines............ Genre I. Troglodytes.
beaucoup plus longs que chez l'homme ...... Genre II. Gorilla." (Isid. Geoff. p. 15.)

Compare, however, plate 48. vol. i. Trans. Zool. Soc. (*Troglodytes niger*) with plate 13. vol. v. ib. (*Troglodytes Gorilla*).

spirits; but as no antiseptic had been applied to the skin when fresh, decomposition had made some advance; and when the cask was opened on its arrival in London, a great part of the cuticle with the hair had become detached from the specimen. It had, however, come off in large patches; and, as the texture had acquired a certain hardness through the action of the alcohol, their replacement was practicable, and the characteristic shades of colour of the different parts of the body and limbs could be determined.

Before availing ourselves of this condition of the cuticle for taxidermal purposes, I proceeded to secure the features, proportions, and position of the body and limbs, as presented to view on removing the animal from the preserving liquor, by means of photography, and four of the views so taken are given in Plate XLV.

As the parts which were stripped of their natural covering were in a condition to afford an instructive comparison with the naked body of Man, I was glad to receive the aid of the graphic skill of Mr. Joseph Wolf in securing the characteristic outline-views given in Plate XLVI.

The length and strength of the upper limbs, the large proportional size of the head, hands, and feet to the trunk, and the shortness and thickness of the neck first attract attention. Owing to the backward articulation of the skull and the great length of the spines of the neck-vertebræ[1], the contour from the occiput to the back is in almost a straight line (Pl. XLV. fig. 4), and the cervical construction is shown only at the sides and fore part of the neck. Here the prominence of the muzzle is such that, although the chin recedes, it descends, in the ordinary *pose* of the head, before and below the manubrium sterni; and owing to the great size of the blade-bones, with the oblique course taken by the clavicles to reach the acromion processes, these, with the shoulder-joints, rise to above the level of the angles of the lower jaw.

From the strong superorbital ridge the forehead recedes at first with a slight concavity, and then passes with a gentle convexity to the vertex. As the sagittal crest rises to give due attachment to the growing crotaphyte muscles in the older male, the contour from the superorbital ridge to the upper part of the occiput becomes almost a straight line. The superorbital prominence is a marked feature in the skeleton, which is exaggerated in the living animal by a thick superciliary roll of integument, which, with the thick epiderm and the hair continued thereon, forms a scowling pent-house over the small, deep-set eyes (Pl. XLIII.).

The nose is indicated by a slight median longitudinal convexity extending from the interorbital space and subsiding to midway towards the mouth, when it is again more prominently marked by broad cartilaginous alæ, arching from a slight median prominence, each over its own nostril, and increasing in thickness outward and downward, and then inward to the upper lip (Pl. XLV. figs. 2 & 3). There is a slight median furrow on the upper part of the alar or cartilaginous portion of the nose: a deeper indent divides the nasal ala from the cheek, becoming shallower as it bends upward, inward, and

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[1] Zool. Trans. vol. iv. pl. 33. fig. 1, vol. v. pl. 13. fig. 2.

downward to the median furrow. The aspect of the nostrils is forward and a little outward. The cartilaginous 'septum narium' extends to the tip of the interalar prominence, its margin being slightly concave: the median point of confluence of the alæ projects a little beyond the fore part of the 'septum.' Thus the nose is more prominent than in the Chimpanzee and Orang-utan, and offers a nearer resemblance to that feature in the West-African negro.

The upper eyelid is largest and most moveable, and its eyelashes are longer than those of the lower lid. The wrinkles exterior to the eyelids were strongly marked in this young animal. The interspace between the inner canthi is longer than the extent of the opening of the eyelids (Pl. XLV. fig. 3).

The mouth is of great width; the lips large, of uniform thickness, the upper one terminating in a straight, almost as if incised, margin. The upper lip is, however, relatively shorter than in the Chimpanzee, and this is an important comparative character with Man; it is coincident with the shorter premaxillaries pointed out in a former memoir[1]. The dark pigment is continued from the base of the lip to this margin, and no part of the thin and smooth inner lining would be visible when the lips were naturally closed: a little of this lining, which forms what is commonly understood by "lip" in Man, might be shown by the under lip of the Gorilla, but it is obscured by added pigment, as in most Negro races. The chin is short and receding; but the whole face is prominent. The circumference of a front view of the head (Pl. XLV. fig. 3) presents an oval, with the great end downward: in the old male the upper end is very narrow, owing to the development of the parietal ridge. The superorbital or cranial part is confined to the upper fifth in this view, and the bestial aspect of the visage is much increased when the huge prominent tusks are exposed in the full-grown male by opening the lips (Pl. XLIII.). In a direct front view the ears are rather above the level of the eyes; they are as much smaller in proportion to the head, as in the Chimpanzee they are larger, in comparison with Man; but in structure they resemble the human auricle more than does the ear of any other Ape.

The tragus and anti-tragus, the helix and anti-helix, the concha, the fossa of the anti-helix and the lobulus are distinctly defined: the chief difference is the large size of the concha compared with the fossa of the anti-helix and the lobulus; but though the lobulus is small, it is distinctly marked and pendulous, while it is sessile in the Chimpanzee and Orang. Both tragus and anti-tragus are nearly as prominent as in Man. The helix is reflected or folded centrally from its origin to opposite the anti-tragus, as in Man, whereas in the Chimpanzee the fold subsides opposite the fossa of the anti-helix, and the rest of the margin of the auricle is simple, not folded. The upper part of the helix is more produced in the Gorilla than in Man, and the greatest

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[1] Zool. Trans. vol. iii. p. 392:—"The extent of the premaxillary bones below the nostril is not only relatively but absolutely less in *T. Gorilla*; and the profile of the skull is less concave at this part, or less 'prognathic,' than in *T. niger*."

breadth of the ear is above the concha, in which the 'incisura intertragica' is less deep than in Man.

The hairy part of the scalp is continued to the superorbital prominence, the hairs becoming gradually shorter to that part; thence the hair-clad skin is continued outward and downward upon the sides of the deep cheeks, where the hair is long: it becomes rapidly shorter upon the upper lip and as it approaches the margin of the lower lip: but there is no excessive development of hair in the positions of the Human whiskers and beard [nor are these more marked in the old male Gorilla][1]. The naked parts of the skin of the face are much wrinkled, and these are deep where related to the action of the well-developed cutaneous muscles corrugating the eyebrows and moving the eyelids and the alæ nasi.

The chest is of great proportional capacity, and the shoulders are very wide across. The profile of the trunk behind describes a slight convexity from the nape, which projects beyond the occiput, downward to the sacrum: the blade-bones slightly project; but there is no inbending at the loins, which seem wanting. The abdomen is prominent both before and at the sides. The pectoral regions are slightly marked, and show the pair of nipples placed as in the Chimpanzee and Man. In the male the penis (Pl. XLVI. fig. 2) is short and subconical; the prepuce is devoid of frænum; the scrotum is broader and more sessile than in Man; the perineum is longer, the anus being placed further back than in Man (*ib.*). There is no trace of ischial callosities. The glutei are better developed and give more of the appearance of nates (Pl. XLVI. fig. 1) than in any other anthropoid Ape, but they do not project so as to meet beyond the anus and conceal it.

The chief deviations from the Human structure are seen in the limbs, which are of great power, the upper ones prodigiously strong, making by comparison the legs, through the want of "calves," look feeble.

The first characteristic is the almost uniform thickness of each segment of the limb: this is seen in the arm, from below the short deltoid prominence to the condyles, neither biceps nor triceps making any definite swelling: a like uniform thickness is seen in the antibrachium from below the olecranon to the wrist: the leg increases a little in thickness from the knee to the ankle (Pl. XLVI. fig. 1): the short thigh shows some decrease as it descends; but there is a general absence of those partial muscular enlargements which impart the graceful, varying curves to the outlines of the limbs in Man. Yet this, upon dissection, is found to depend rather on excess than defect of development of the carneous as compared with the tendinous parts of the limb-muscles, which thus continue of almost the same size from their origin to their insertion, with a proportionate gain of strength to the beast.

The difference in the length of the upper limbs between the Gorilla and Man is but

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[1] The passages within brackets, relating to the full-grown male Gorilla, have been added to the original paper from observations of the well-preserved skins purchased by the British Museum of Mr. du Chaillu, in 1861.

little in comparison with the trunk ; it appears greater through the arrest of development of the lower limbs. Very significant of the closer anthropoid affinities of the Gorilla is the superior length of the arm (humerus) to the fore-arm, as compared with the proportions of those parts in the Chimpanzee. The hair of the arm inclines downward, that of the fore-arm upward, as in the Chimpanzee. The thumb extends a little beyond the base of the proximal phalanx of the fore-finger ; it does not reach to the end of the metacarpal bone of that finger in the Chimpanzee or any other Ape : the thumb of the Siamang (*Hylobates syndactyla*) is still shorter in proportion to the length of the fingers of the same hand. The philosophical zoologist will appreciate the significance of this fact. In Man the thumb extends to, or beyond, the middle of the first phalanx of the fore-finger.

The fore-arm in the Gorilla passes into the hand with very slight evidence, by constriction, of the wrist (Pl. XLVI. fig. 3), the circumference of which, without the hair, was fourteen inches, that of a strong Man averaging eight inches. The hand (Pl. XLVII. figs. 2 & 3) is remarkable for its breadth and thickness, and for the length of the palm, occasioned both by that of the metacarpus and by the greater extent of undivided integument between the digits than in Man ; these only begin to be free opposite the middle of the proximal or first phalanges, and nearer the second phalanx between the third and fourth fingers. The digits are thus short, and appear as if swollen and gouty, chiefly through the callous pads of cuticle on the back of the middle and distal phalanges (*ib.* fig. 3): they are also more or less conical in shape after the first joint, by tapering to nails, which, being not larger or longer than those of Man, are relatively to the fingers much smaller. The circumference of the middle digit at the first joint in the Gorilla is $5\frac{1}{2}$ inches ; in Man, at the same part, it averages $2\frac{3}{4}$ inches. The thick and callous skin on the back of the fingers leaves little outward appearance of the second joint. The habit of the animal to apply those parts to the ground, in occasional progression (Pl. XLIV. fig. 1), is manifested by these callosities. The back of the hand (Pl. XLVII. fig. 3) is hairy as far as the divisions of the fingers ; the palm (*ib.* fig. 2) is naked and callous. The thumb, besides its shortness according to the standard of the human hand, is scarcely half so thick as the fore-finger. The nail of the thumb did not extend to the end of that digit ; in the fingers the nail projected a little beyond the end, but with a slightly convex worn margin, resembling the human nails in shape, but relatively less.

In the hind limbs was chiefly noticeable that first appearance in the Quadrumanous series of a muscular development of the gluteus, causing a small buttock to project over each tuber ischii (Pl. XLVII. fig. 1). This structure, with the peculiar expanse, as compared with other Quadrumana, of the iliac bones[1], leads to an inference that the

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[1] The intrepid and much-enduring explorer and observer of living nature at the Gaboon, to whom science is indebted for the best and most abundant materials for enlarging our knowledge of the anthropoid Apes, remarks :—"The common walk of the Gorilla is not on his hind legs, but on all-fours." When advancing as a biped to

Gorilla must naturally and with more ease resort occasionally to station and progression on the lower limbs than any other Ape[1].

The same cause as in the arm, viz. a continuance of a large proportion of fleshy fibres to the lower end of the muscles, coextensive with the thigh, gives a great circumference to that segment of the limb above the knee-joint, and a more uniform size to it than in Man. The relative shortness of the thigh, its bone being only eight-ninths the length of the humerus (in Man the humerus averages five-sixths the length of the femur[2]), adds to the appearance of its superior relative thickness. Absolutely the thigh is not of greater circumference at its middle than is the same part in Man.

The chief difference in the leg, after its relative shortness, is the absence of a "calf," due to the non-existence of the partial accumulation of carneous fibres in the upper half of the gastrocnemii muscles, causing that prominence in the type-races of Mankind. In the Gorilla the tendo Achillis not only continues to receive the "penniform" fibres to the heel, but the fleshy parts of the muscles of the foot receive accessions of fibres at the lower third of the leg, to which the greater thickness of that part is due, the proportions in this respect being the reverse of those in Man. The leg expands at once into the foot, which has a peculiar and characteristic form (Pl. XLVII. figs. 4 & 5), owing to the modifications favouring bipedal motion being superinduced upon an essentially prehensile quadrumanous type. The heel makes a more decided backward projection (Pl. XLVI. fig. 1) than in the Chimpanzee; the heel-bone is relatively thicker, deeper, more expanded vertically at its hind end, besides being fully as long, relatively to the size of the animal, as in the Chimpanzee[3]. This bone, so characteristic of anthropoid affinities, is shaped and proportioned more like the Human calcaneum than in any other Ape, but with differences far greater than those which any two genera of Quadrumana present in serial comparison. The malleoli do not make such well-marked projections as in Man; they are marked more by the thickness of the fleshy and tendinous parts of the muscles that pass near them, on their way to be inserted into parts of the foot. Although the foot be articulated to the leg with a slight inversion of the sole, it is more nearly plantigrade than in the Chimpanzee or any other Ape. The hairy integument is continued along the dorsum of the foot to the clefts of the toes, and upon the first phalanx of the hallux (Pl. XLVII. fig. 5): the whole sole is bare (ib. fig. 4).

The hallux (great toe, thumb of the foot, Pl. XLVII. figs. 4 & 5 *i*), though not relatively longer than in the Chimpanzee, is stronger; the bones are thicker in proportion to their length, especially the last phalanx, which in shape and breadth more resembles

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attack, "his walk is a waddle from side to side, his hind legs, which are very short, being evidently somewhat inadequate to the proper support of the huge superincumbent body. He balances himself by swinging his arms, somewhat as sailors walk on shipboard." "My own observations led me to the concluson that the Gorilla walks more often in the erect posture than the Chimpanzee; and in this I agree with the conclusion of Prof. Owen." (Du Chaillu, 'Explorations and Adventures in Equatorial Africa.')

[1] Memoir, No. VII. p. 12. pl. 6.

[2] Ib. p. 14: compare pl. 3 with pl. 7.

[3] Ib. p. 22. pl. 11.

that in the Human foot[1]. The hallux in its natural position diverges from the other toes at an angle of 60 degrees from the axis of the foot; its base is large, swelling into a kind of ball below, upon which the thick callous epiderm of the sole is continued. The transverse indents and wrinkles show the frequency and freedom of the flexile movements of the two joints of the hallux (Pl. XLVI. fig. 6): the nail is small, broad, and short. The sole of the foot gradually expands from the heel forward to the divergence of the hallux, and seems to be here cleft, and almost equally, between the base of the hallux and the common base of the other four digits. These are small and slender in proportion, and are enveloped in a common tegumentary sheath as far as the base of the second phalanx. A longitudinal indent at the middle of the sole, bifurcating—one channel defining the ball of the hallux, the other running towards the interspace between the second and third digit—indicates the action of opposing the whole thumb (which seems rather like an inner lobe or division of the sole) to the outer division terminated by the four short toes (ibid.). What is termed the " instep " in Man is very high in the Gorilla, owing to the thickness of the carneo-tendinous parts of the muscles as they pass from the leg to the foot over this region. The mid-toe (Pl. XLVII. figs. 4 & 5 *iii*) is a little longer than the second (ib. *ii*) and fourth (ib. *iv*); the fifth (ib. *v*), as in Man, is proportionally shorter than the fourth, and is divided from it by a somewhat deeper cleft. The whole sole is wider than in Man—relatively to its length much wider, and in that respect, as well as by the offset of the hallux, and the definition of its basal ball, becomes a " hand," and one of huge dimensions and of portentous power of grasp.

In regard to the outward coloration of the Gorilla, only from the examination of the living animal could the precise shades of colour of the naked parts of the skin be truly described. The parts of the epiderm remaining upon the face of the subject of the present description indicated the skin there to be chiefly of a deep leaden hue; it is everywhere finely wrinkled, and was somewhat less dark at the prominent parts of the supraciliary roll and the prominent margins of the nasal "alæ:" the soles and palms were also of a lighter colour.

Although the general colour of the hair appears at first sight, and when moist, to be dark, it is rather of a dusky grey: it is very different from that of the Chimpanzee (*T. niger*), being lighter and more varied in different parts of the animal: this is due to an admixture of a few reddish, and of more greyish, hairs with the parti-coloured fuscous and grey ones which chiefly constitute the " pelage;" and the above admixture varies at different parts of the body. The reddish hairs are so numerous on the scalp, especially along the upper middle region, as to make their tint rather predominate there; they blend in a less degree with the long hairs upon the sides of the face. The greyish hairs are found mixed with the dusky upon the dorsal, deltoidal, and anterior femoral regions; but, on the limbs, not in such proportion as to affect the impression of the general dark colour, at first view. The hairs are wavy, approach-

[1] See, however, the difference between *Homo* and *Gorilla* in this respect (Memoir, No. VII. pl. 11. *i, i*).

ing to a woolly character. Near the margin of the vent are a few short whitish hairs, as in the Chimpanzee. The epiderm of the back showed the effects of habitual resting with that part against the trunk or branch of a tree, occasioning the hair to be more or less rubbed off: the epiderm was here very thick and tough[1].

It is most probable, from the degree of admixture of different-coloured hairs above described, that a living Gorilla, seen in bright sunlight, would in some positions reflect from its surface a colour much more different from that of the Chimpanzee than appears by a comparison of the skin of a dead specimen sent home in spirits. It can hardly be doubted, also, that age will make an appreciable difference in the general coloration of the *Troglodytes Gorilla.*

[The adult male Gorilla brought to London by Mr. du Chaillu, and purchased for the British Museum, measures 5 feet 6 inches from the sole to the top of the head: the breadth across the shoulders is nearly 3 feet: the length of the upper limb is 3 feet 6 inches; that of the lower limb, from trochanter to sole, is 2 feet 7 inches, but, carried out to the end of the mid-toe, it is 3 feet 5 inches: the length of the head and trunk is 3 feet 6 inches, whilst the same dimension in Man does not average, indeed seldom reaches, 3 feet.

The skin of this adult male (Pl. XLIII.), and those of the female and of the young (Pl. XLIV. fig. 2) of the *Troglodytes Gorilla*, also brought by Mr. du Chaillu from the Gaboon, afford ample evidence of the true coloration of the species. In the male, the rufo-griseous hair extends over the scalp and nape, terminating in a point upon the back (Pl. XLIV. fig. 1). The prevalent grey colour, produced by alternate fuscous and light-grey tracts of each hair, extends over the back, the hair becoming longer upon the nates and upon the thighs. The dark-fuscous colour gradually prevails as the hair extends down the leg to the ankle. The long hair of the arm and fore-arm presents the dark-fuscous colour; the same tint extends from below the axilla downwards and forwards upon the abdomen, where the darker tint contrasts with the lighter grey upon the back. The scanty hair of the cheeks and chin is dark. The breast is almost naked, and the hair is worn short or partially rubbed off across the back, over the upper border of the iliac bones, in consequence of the habit ascribed by Mr. du Chaillu to the great male Gorilla of keeping at the foot of a tree, resting its back against the trunk. The female Gorilla presents a darker and more rufous tint than the male; but this may be due to difference of age. In one female the rufous colour so prevailed as to induce Mr. du Chaillu to note it as a "red-rumped variety."

In the young male Gorilla, 2 feet 6 inches in height, 1 foot 7 inches in the length of the head and trunk, and 11 inches across the shoulder, the calvarium is covered with a well-defined "skull-cap" of reddish-coloured hair (Pl. XLIV. fig. 3). The back part of the head behind the ears, the temples, and chin are clothed with that mixture

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[1] ["I have come upon fresh traces of a Gorilla's bed on several occasions, and could see that the male had seated himself with his back against a tree-trunk." (Du Chaillu, *op. cit.*)]

of fuscous-brown and grey hair which covers with a varying depth of tint the trunk, arms, and thighs. The naked part of the skin of the face appears to have been black, or of a very dark lead-colour; a few scattered straight hairs, mostly black, represent the eyebrows. A narrow moustache borders the upper lip: the whole of the lower lip and sides of the head are covered with hair of the prevailing grey-fuscous colour.

In Pl. XLIV. the male Gorilla (fig. 1) is drawn by Mr. Wolf walking off in the distance, in the attitude suggested by the callosities on the back of the fingers of the fore-hand[1].]

The foregoing pages include the results of direct observations made on the first and only entire specimen of the Gorilla which has reached England. At the period when they were made, no other description of its external characters had reached me; and if the majority of them be found to agree with previously recorded observations by naturalists enjoying earlier opportunities of studying similarly preserved specimens, the rarity and importance of the species may excuse, if it does not justify, a second description from direct scrutiny of a new specimen by an old observer of the anthropoid Quadrumana.

A more important labour, however, remains. The accurate record of facts in natural history is the first duty of the observer; the true deduction of their consequences is his next aim. I proceed, therefore, to reconsider the conclusions in which my experienced French and American fellow-labourers in natural history differ from me, and in which I seem to stand alone.

The first question in regard to the Gorilla is its place in the scale of nature, and its true and precise affinities.

Is it, or is it not, the nearest of kin to Human kind? Does it form, like the Chimpanzee and Orang, a distinct genus in the anthropoid or knuckle-walking group of Apes? Are these Apes, or are the long-armed Gibbons, more nearly related to the genus *Homo*? Of the broad-breast-boned Quadrumana, are the knuckle-walkers or the brachiators, *i. e.* the long-armed Gibbons, most nearly and essentially related to the Human subject? I proceed to discuss the first as the most important question.

At the first aspect, whether of the entire animal or of the skeleton, it may be freely admitted that the Gorilla strikes the observer as being a much more bestial and brutish animal than the Chimpanzee. All the features that relate to the wielding of the strong jaws and large canines are exaggerated; the evidence of brain is less—its chamber is more masked by the outgrowth of the strong occipital and other cranial ridges. But the impression so made—that the Gorilla is less like Man—is the same which is derived from comparing a young with an adult Chimpanzee, or some small tailless Monkey with a full-grown male Orang or Chimpanzee. Taking the characters that cause that impression at a first inspection of the Gorilla, most of the small South-American

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[1] This inference has been confirmed by Mr. du Chaillu's observations on the living Gorilla and its foot-marks.

Monkeys are more anthropoid than it; they have a proportionally larger and more human-shaped cranium, much less prominent jaws, with more equable teeth.

In the skeletons of the adult males of the Gorilla, Chimpanzee, Orang, and Gibbon, it may be remarked that the globular cranium of the last, and its superior size compared with the jaws and teeth, seem to show the Gibbons to be more nearly akin to Man than are the larger tailless Apes; and this conclusion has been adopted by a distinguished French palæontologist, M. Lartet, and accepted by a geological authority at home[1]. They cite the experienced Professor of Human Anatomy at Amsterdam as supporting this view; but I have failed to find any statement of the grounds upon which it was sustained. In the article "Quadrumana" of Todd's 'Cyclopædia of Anatomy,' cited by Lartet[2], Prof. Vrolik briefly treats of the osteology of the Quadrumana according to their natural families. In "a first genus, *Simia* proper, or Ape," he includes the Chimpanzee or Orang, noticing some of the chief points by which these Apes approach the nearest to Man. He next goes to "the second genus, the Gibbons" (*Hylobates*); he notices their ischial callosities, and the nearer approach of their molars, in their rounded form, to the teeth of Carnivora than the molars of the genus *Simia*. Then, comparing the Siamang with other species of *Hylobates*, Vrolik says, "its skeleton approaches most to that of Man"—which may be true in comparison with other Gibbons, but certainly is not so as respects the higher *Simiæ*. No details are given to illustrate the proposition even in its more limited application; but the minor length of the arms in the Siamang, as compared with *Hylobates lar*, was probably the character in point.

The appearance of superior cerebral development in the Siamang and other long-armed Apes is due to their small size and the concomitant feeble development of their jaws and teeth. The same appearance makes the small platyrrhine Monkeys of South America equally anthropoid in their facial physiognomy, and much more human-like than are the great Orangs and Chimpanzees. It is an appearance which depends upon the precocious growth of the brain as dependent on the law of its development. In all Quadrumana the brain has reached its full size before the second set of teeth is acquired —almost before the first set is shed. If, however, a young Gorilla, Chimpanzee, or Orang be compared with a young Siamang of corresponding age, the absolutely larger size and better shape of the brain, the deeper and more numerous convolutions of the cerebrum, and the more completely covered cerebellum in the former, unequivocally demonstrate the higher organization of the shorter-armed Apes. "In the structure of the brain," writes Vrolik[3], in accordance with all other comparative anatomists, "they" (Chimpanzee and Orang-utan) "approach the nearest to Man." The degree to which the Chimpanzee and Orang so resemble the Human type seemed much closer to Cuvier,

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[1] Sir C. Lyell, 'Supplement to the Fifth Edition of a Manual of Elementary Geology,' 1859, p. 15.

[2] Comptes Rendus de l'Académie des Sciences, Juillet 28, 1856.

[3] Art. *Quadrumana*, 'Cyclopædia of Anatomy,' vol. iv. p. 195.

who knew those great Apes only in their immaturity, with their small milk-teeth and precociously developed brain. Accordingly, the anthropoid characters of the *Simia Satyrus* and *Simia Troglodytes*, as deduced from the facial angle and dentition, are proportionally exaggerated in the 'Règne Animal'[1]. As growth proceeds, the milk-teeth are shed, the jaws expand, the great canines succeed their diminutive representatives, the temporal muscles gain a proportional increase of carneous fibres, their bony fulcra respond to the call for increased surface of attachment, the sagittal and occipital crests begin to rise: but the brain grows no more; its cranial box retains the size it showed in immaturity; it finally becomes masked by the superinduced osseous developments in those Apes which attain the largest stature and wield the most formidably armed jaws. Yet, under this show of physical force, the brain of both Orang and Chimpanzee is still the better and the larger than is that of the little long-armed Ape, which retains throughout life so much more of the characters of immaturity, especially in the structure of the skull.

The Siamang and other Gibbons have smaller but longer upper canines, relatively, than in the Orangs and Chimpanzees; the permanent ones more quickly attain their full size, and are sooner in their place in the jaws; consequently the last molar teeth (*m* 3) come last into place, as they do in the Human species. But, if this be interpreted as of importance in determining the relative affinity of the longer-armed and shorter-armed Apes to Man, it is a character in which, as in their seeming superior cerebral development, the *Hylobates* agree with some much lower Quadrumana with still smaller canines.

The systematic zoologist, pursuing this most interesting comparison with clear knowledge of the true conditions and significance of a globular cranium and small jaws within the Quadrumanous order, first determines, and takes as his compass or guide-point, the really distinctive characters of the Human organization.

In respect to the cerebral test, he looks not so much for the relative size of the brain to the body, as for its relative size in the species compared one with another in the same natural group. He inquires what quadrumanous animal shows absolutely the biggest brain? what species shows the deepest and most numerous and winding convolutions? in which is the cerebrum largest as compared with the cerebellum? If he finds all these characters highest in the Gorilla, he does not permit himself to be diverted from the just inference because the great size and surpassing physical power attained in that species mask the true data from obvious view.

The comparative anatomist would look to the cæcum and the ischial integument: if he found in one subject of his comparisons (*Troglodytes*) a long "appendix vermiformis cæci," as in Man, but no "callosities,"—in another subject (*Hylobates*) the ischial callosities, but only a short rudiment of the cæcal appendix,—he would know which of the two tailless Apes was to be placed next "the Monkeys with ischial callosities and no vermiform appendix," and which of the two formed the closer link toward Man. He would find

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[1] Ed. 1829, pp. 87, 89.

that the anthropoid intestinal and dermal characters were associated with the absolutely larger and better-developed brain in the Gorilla, Chimpanzee, and Orang; whilst the lower quadrumanous characters exhibited by the cæcum and nates were exhibited by the smaller-brained and longer-armed but rounder-skulled and shorter-jawed Gibbons.

Pursuing the comparison through the complexities of the bony framework, he might first glance at the more obvious proportions, and such, indeed, as would be given by the entire animal. The characteristics of the limbs in Man are their near equality of length, but the lower limbs are the longest. The arms in Man hang down to below the middle of the thigh; in the Gorilla they attain the knee; in the Chimpanzee they reach below the knee; in the Orang they touch the ankle; in the Siamang they reach the sole; in most Gibbons the whole palm can be applied to the ground without the trunk being bent forward beyond its naturally inclined position on the legs. These gradational differences coincide with other characters determining the relative proximity to Man of the Apes compared. In no Quadrumana does the humerus so much exceed the ulna in length as in Man; only in the most anthropoid, viz. the Gorilla and Chimpanzee, does it at all exceed the ulna in length; in the rest, as in the lower quadrupeds, the fore-arm is longer than the arm.

The humerus, in the Gorilla, though less long, compared with the ulna, than in Man, is longer than in the Chimpanzee; in the Orang it is shorter than the ulna; in the Siamang and other Gibbons it is much shorter: the peculiar reach of grasp in those "long-armed" Apes is chiefly due to the excessive length of the antibrachial bones.

The difference in the length of the upper limbs, as compared with the trunk, is but little between Man and the Gorilla. The elbow-joint, in the Gorilla, as the arm hangs down, is opposite the "labrum ilii," the wrist opposite the "tuber ischii"[1]; it is rather lower down in the Chimpanzee; it is opposite the knee-joint in the Orang; it is opposite the ankle-joint in the Siamang.

Man's perfect hand is one of his peculiar physical characters: that perfection is mainly due to the extreme differentiation of the first from the other four digits, and its concomitant power of opposing them as a perfect thumb. A partially opposable thumb is present in the hand of most Quadrumana, but it is usually a small appendage compared with that of Man. Small as it is in the Gorilla, it is relatively largest in that species. In this Ape the thumb reaches to a little beyond the base of the first phalanx of the fore-finger; it does not reach to the end of the metacarpal bone of the fore-finger in the Chimpanzee, Orang, or Gibbon; it is relatively smallest in the last tailless Ape. In Man the thumb extends to or beyond the middle of the first phalanx of the fore-finger. The philosophical zoologist will see great significance in the results of this comparison. Only in the Gorilla and Chimpanzee are the carpal bones eight in number, as in Man; in the Orangs and Gibbons they are nine in number, as in the tailed Monkeys.

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[1] Memoir, No. VII. pl. 13. fig. 2.

The scapulæ are broader in the Gorilla than in the Chimpanzee, Orang, or long-armed Apes; they come nearer to the proportions of that bone in Man[1]. But a more decisive resemblance to the Human structure is presented by the iliac bones[2]. In the Gorilla they bend forward, so as to produce a pelvic concavity; and in no other Ape are they so broad in proportion to their length as in the Gorilla. In *Troglodytes niger* and *Pithecus Satyrus*[3] the iliac bones are flat, or present a concavity rather at the back than at the fore part. In the Siamang they are not only flat, but are narrower and longer, resembling the iliac bones of tailed Monkeys and ordinary quadrupeds.

The lower limbs, though characteristically short in the Gorilla, are longer in proportion to the upper limbs than in the Chimpanzee; they are much longer in that proportion and more robust than in the Orangs or Gibbons. But the guiding-points of comparisons here are the heel and the hallux.

The heel in the Gorilla makes a more decided backward projection than in the Chimpanzee[4]; the heel-bone is relatively thicker, deeper, more expanded vertically at its hind end, besides being fully as long, relatively, as in the Chimpanzee. Among all the tailless Apes the calcaneum in the Siamang and other Gibbons least resembles in its shape or proportional size that of Man.

Although the foot be articulated to the leg with a slight inversion of the sole in the Gorilla, it is more nearly plantigrade than in the Chimpanzee. The Orang departs far, and the Gibbons farther, from the Human type in the inverted position of the foot.

The great toe, which forms the fulcrum in standing or walking, is, perhaps, the most characteristic peculiarity in the Human structure; it is that modification which differentiates the foot from the hand, and gives the character to the order *Bimana*. In the degree of its approach to this development of the hallux the quadrumanous animal makes a true step in affinity to Man.

The Orang-utan and the Siamang, tried by this test, descend far and abruptly below the Chimpanzee and Gorilla in the scale. In the Orang the hallux does not reach to the end of the metacarpal of the second toe; in the Chimpanzee and Gorilla it reaches to the end of the first phalanx of the second toe; but in the Gorilla the hallux is thicker and stronger than in the Chimpanzee. In both, however, it is a true thumb, by position, diverging from the other toes, in the Gorilla, at an angle of 60 degrees from the axis of the foot[5].

Man has twelve pairs of ribs; the Gorilla and Chimpanzee have thirteen pairs; the Orangs have twelve pairs; the Gibbons have thirteen pairs. Were the naturalist to trust to this single character, as some have trusted to the cranio-facial one, and in equal ignorance of the real condition and value of both, he might think that the Orangs (*Pithecus*) were nearer akin to Man than the Chimpanzees (*Troglodytes*) are.

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[1] Memoir, No. VII. pl. 1. [2] Ib. pl. 6. [3] Memoir, No. I. Trans. Zool. Soc. vol. i. pl. 50.

[4] Compare Memoir, No. I. pl. 49, with Memoir, No. VII. pl. 13. fig. 2.

[5] Memoir, No. VII. pl. 11. fig. 2.

But Man has sometimes a thirteenth pair of ribs; and what we term "ribs" are but vertebral elements or appendages common to nearly all the true vertebræ in Man, and only so called when they become long and free. The genera *Homo*, *Troglodytes*, and *Pithecus* have precisely the same number of vertebræ: if *Troglodytes*, by the development and mobility of the pleurapophyses of the twentieth vertebra from the occiput, seem to have an additional thoracic vertebra, it has one vertebra less in the lumbar region. So, if there be, as has been observed, a difference in the number of sacral vertebræ, it is merely due to a last lumbar having coalesced with what we reckon as the first sacral vertebra in Man.

The thirteen pairs of ribs, therefore, in the Gorilla and Chimpanzee are of no weight as against the really important characters significative of affinity with the Human type. But, supposing the fact of any value, how do the advocates of the superior resemblance of the Siamang's or Gibbon's skeleton to that of Man dispose of the thirteenth pair of ribs in the long-armed Apes?

In applying the characters of the skull to the determination of the important question at issue, those must first be ascertained by which the genus *Homo* trenchantly differs from the genus *Simia* of Linnæus. To determine these osteal distinctions, I have compared the skulls of many individuals of different varieties of the Human race, together with those of the male, female, and young of species of *Troglodytes*, *Pithecus*, and *Hylobates*; and I refer to the 'Catalogue of the Osteological Series in the Museum of the Royal College of Surgeons,' 4to, 1853, for the detailed results of these comparisons. On the present occasion I restrict myself to a few of these results.

The first and most obvious differential character is the globular form of the brain-case, and its superior relative size to the face, especially the jaws, in Man. But this, for the reasons already assigned, is not an instructive or decisive character, when comparing quadrumanous species, in reference to the question at issue. It is exaggerated in the human child, owing to the acquisition of its full or nearly full size by the brain, before the jaws have expanded to lodge the second set of teeth. It is an anthropoid character in which the Quadrumana resemble Man, in proportion to the diminution of their general bulk. If a Gorilla with milk-teeth (Pl. XLIX. figs. 3 & 4) have a somewhat larger brain and brain-case than a Chimpanzee at the same immature age (*ib.* figs. 1 & 2), the acquisition of greater bulk by the Gorilla, and of a more formidable physical development of the skull, in reference to the great canines in the male, will give to the Chimpanzee the appearance of a more anthropoid character which really does not belong to it—which could be as little depended upon in a question of precise affinity as the like more anthropoid characters of the female as compared with the male Gorilla or Chimpanzee.

Much more important and significant are the following characters of the Human skull:—the position and plane of the occipital foramen; the proportional size of the condyloid and petrous processes; the mastoid processes, which relate to balancing the head upon the trunk in the erect attitude; the small premaxillaries and concomitant small size of the incisor teeth as compared with the molar teeth. The latter character relates to the superiority of the psychical over the physical powers in Man: it governs the feature in which Man recedes from the brute; as does also the prominence of the nasal bones in most, and in all the typical, races of Man. The somewhat angular form of the bony orbits, tending to a square, with the corners rounded off, is a good Human character of the skull, which is difficult to comprehend as an adaptive one, and therefore the better in the present inquiry. The same may be said of the production of the floor of the tympanic or auditory tube into the plate called "vaginal."

Believing the foregoing to be sufficient to test the respective degrees of affinity to Man within the limited group of Quadrumana to which it is proposed, in the present Memoir, to apply them, the argument need not be diluted by citing minor characters. The question at issue is the respective degrees of affinity as between the anthropoid Apes and Man. Cuvier deemed the Orang (*Pithecus*) to be nearer akin to Man than the Chimpanzee (*Troglodytes*) is. That belief has long ceased to be entertained. I proceed, therefore, to compare the Gorilla, Chimpanzee, and Gibbon, in reference to their Human affinities.

Most naturalists entering upon this question would first look to the premaxillary bones, or, owing to the early confluence of those bones with the maxillaries in the Gorilla and Chimpanzee, to the part of the upper jaw containing the incisive teeth, on the size and direction of which depends the prognathic or brutish character of a skull. Now the extent of the premaxillaries below the nostril is not only relatively but absolutely less in the Gorilla, and consequently the profile of the skull is less convex at this part, or less "prognathic," than in the Chimpanzee. Notwithstanding the degree in which the skull of the Gorilla surpasses in size that of the Chimpanzee, especially when the two are compared on a front view, the breadth of the premaxillaries and of the four incisive teeth is the same in both. In the relative degree, therefore, in which these bones are smaller than in the Chimpanzee, the Gorilla, in this most important character, comes nearer to Man. In the Gibbons the incisors are relatively smaller than in the Gorilla, but the premaxillaries bear the same proportional size in the adult male Siamang.

Next, as regards the nasal bones. In the Chimpanzee, as in the Orangs and Gibbons, they are as flat to the face as in any of the lower *Simiæ*. In the Gorilla the median coalesced margins of the upper half of the nasal bones are produced forward, in a slight degree it is true, but affording a most significant evidence of nearer resemblance to Man. In the same degree they impress that anthropoid feature upon the face of the living Gorilla. In some pig-faced Baboons there are ridges and prominences in the naso-facial part of the skull, but they do not really affect the question as between the Gorilla and Chimpanzee. All naturalists know that the Semnopitheques of Borneo have long noses; but the proboscidiform appendage which gives so ludicrous a mask to those Monkeys is unaccompanied by any such modification of the nose-bones as gives the true anthropoid character to the Human skull, and to which only the Gorilla, in the Ape-tribe, makes any approximation.

No Orang, Chimpanzee, or Gibbon shows any rudiment of mastoid processes; but they are present in the Gorilla, smaller indeed than in Man, but unmistakeable; they are, as in Man, cellular, pneumatic, and with a thin outer plate of bone. This fact led me, in a former memoir, to express, when, in respect to the Gorilla, I only knew the skull, the following inference, viz.—"from the nearer approach which the Gorilla makes to Man, in comparison with the Chimpanzee or Orang, in regard to the mastoid processes, that it assumed more nearly and more habitually the upright attitude than those inferior anthropoid Apes do[1]." This inference has been fully borne out by the rest of the skeleton of the Gorilla, subsequently acquired.

In the Chimpanzee, as in the Orangs, Gibbons, and inferior *Simiæ*, the lower surface of the long tympanic or auditory process is more or less flat and smooth, developing in the Chimpanzee only a slight tubercle, anterior to the stylohyal pit. In the Gorilla the auditory process is more or less convex below, and developes a ridge, answering to the vaginal process, on the outer side of the carotid canal. The processes posterior and internal to the glenoid articular surface are better developed, especially the internal one, in the Gorilla than in the Chimpanzee; the ridge which extends from the ectopterygoid along the inner border of the foramen ovale terminates in the Gorilla by an angle or process answering to that called "styliform" or "spinous" in Man, but of which there is no trace in the Chimpanzee, Orang, or Gibbon.

The orbits have a full oval form in the Orang; they are almost circular in the Chimpanzee and Siamang, more nearly circular and with a more prominent rim in the smaller Gibbons; in the Gorilla alone do they present the form which used to be deemed peculiar to Man. There is not much physiological significance in some of the latter characters, but, on that very account, I deem them more instructive and guiding in the actual comparison.

The occipital foramen is nearer the back part of the cranium, and its plane is more sloping, less horizontal, in the Siamang, than in the Chimpanzee and Gorilla. Considering the less relative prominence of the fore part of the jaws in the Siamang as compared with the Chimpanzee, the occipital character of that Gibbon and of other species of *Hylobates* marks well their inferior position in the quadrumanous scale.

In the greater relative size of the molars, compared with the incisors, the Gorilla makes an important closer step towards Man than does the Chimpanzee. The molar teeth are relatively so small in the Siamang, that, notwithstanding the small size of the incisors, the proportion of those teeth to the molars is only the same as in the Gorilla: in other Gibbons (*Hylobates lar*), the four lower incisors occupy an extent equal to that of the first four molars, in the Chimpanzee equal to that of the first three molars, in the Siamang equal to that of the first two molars and rather more than half of the

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[1] Trans. Zool. Soc. vol. iii. p. 409.

third, in Man equal to the first two molars and half of the third: in this comparison the term ‘molar’ is extended to the bicuspids.

The proportion of the ascending ramus to the length of the lower jaw tests the relative affinity of the tailless Apes to Man.

In a profile of the lower jaw, I compare the line drawn vertically from the top of the coronoid process to the horizontal length along the alveoli; in Man and the Gorilla it is about $\frac{7}{10}$ths, in the Chimpanzee $\frac{6}{10}$ths, in the Siamang it is only $\frac{4}{10}$ths of the length of the jaw. The Siamang further differs in the shape and production of the angle of the jaw, and in the shape of the coronoid process, approaching the lower *Simiæ* in both these characters. In the size of the post-glenoid process, in the shape of the glenoid cavity, which is almost flat, in the proportional size of the petrous bone, and in the position of the foramen caroticum, the Siamang departs further from the Human type, and approaches nearer that of the tailed *Simiæ*, than the Gorilla does, and in a marked degree.

Every legitimate deduction from a comparison of cranial characters makes the tailless Quadrumana recede from the Human type in the following order:—Gorilla, Chimpanzee, Orang, Gibbons; and the last-named in a greater and more decided degree.

These comparisons have of late been invested with additional interest from the discoveries of remains of quadrumanous species in different members of the tertiary formations.

The first quadrumanous fossil, the discovery of which by Lieuts. Baker and Durand is recorded in the ‘Journal of the Asiatic Society of Bengal’ for November 1836, has proved to belong, like subsequently discovered quadrumanous fossils in the Sewalik (probably miocene) tertiaries, to the Indian genus *Semnopithecus*. The Monkey's molar tooth from the pliocene beds of Essex is most closely allied to the *Macacus sinicus*[1]. The remains of the large Monkey, 4 feet in height, discovered in 1839 by Dr. Lund in a limestone-cavern in Brazil was shown by its molar dentition ($p.\frac{3-3}{3-3}$, $m.\frac{3-3}{3-3}$) to belong to the platyrrhine family now peculiar to South America. The lower jaw and teeth of the small quadrumane discovered by M. Lartet in a miocene bed of the South of France, and described by him and De Blainville[2], are so closely allied to the Gibbons, as scarcely to justify the generic separation which has been made for it under the name *Pliopithecus*.

The fossil femur from the miocene of Eppelsheim, recognized as quadrumanous by Professor Kaup, proves, upon comparison, to be most like the femur in the Gibbons[3].

The quadrumanous fossils from the miocene beds of Pikermi are referred by Wagner to a genus *Mesopithecus*, more allied to *Semnopithecus* than to *Hylobates*[4].

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[1] Owen's ‘British Fossil Mammals and Birds,’ p. xlvi. figs. 1–4.

[2] ‘Ostéographie,’ fasc. iv., “Primates Fossiles,” p. 54.

[3] Trans. Zool. Soc. vol. v. pt. i. p. 18.

[4] ‘Die fossilen Knochen-Ueberreste von Pikermi,” 4to, 1854.

The lower molar teeth from the eocene sand at Kyson, Suffolk, which at the time of their discovery most

Finally, a portion of a lower jaw with teeth and the shaft of a humerus of a quadrumanous animal (*Dryopithecus*), equalling the size of those bones in Man, have been discovered by M. Fontan, of Saint-Gaudens, in a marly bed of upper miocene age, forming the base of the plateau on which that town is built. The molar teeth present the type of grinding surface of those of the Gibbons (*Hylobates*), and, as in that genus, the second true molar is larger than the first, not of equal size, as in the Human subject and Chimpanzee. The premolars have a greater antero-posterior extent, relatively, than in the Chimpanzee, and in this respect agree more with those in the Siamang. The first premolar has the outer cusp raised to double the height of that of the second; its inner lobe is less developed than in the Gorilla, certainly less than in the Chimpanzee. The posterior talon of the second premolar is more developed, and consequently the fore-and-aft extent of the tooth is greater, than in the Chimpanzee; thereby the second premolar of *Dryopithecus* more resembles that in *Hylobates*, and departs further from the Human type.

The canine, judging from the figures published by M. Lartet[1], seems to be less developed than in the male Chimpanzee, Gorilla, or Orang, in which character the fossil, if it belonged to a male, makes a nearer approach to the Human type; but it is one which many of the inferior Monkeys also exhibit, and is by no means to be trusted as significant of true affinity, supposing even the sex of the fossil to be known as being male.

The shaft of the humerus, found with the jaw, is peculiarly rounded, as it is in the Gibbons and Sloths, and offers none of those angularities and ridges which make the same bone in the Chimpanzee and Orang come so much nearer in shape to the humerus of the Human subject. The fore part of the jaw, as in the Siamang, is more nearly vertical than in the Gorilla or Chimpanzee; but whether the back part of the jaw may not have departed in a greater degree from the Human type than the fore part approaches it, as is the case in the Siamang, the state of the fossil does not allow of determining. One significant character is, however, present—the shape of the fore part of the coronoid process. It is slightly convex forwards, which causes the angle it forms with the alveolar border to be less open. The same character is present in the Gibbons. The front margin of the lower half of the coronoid process in Man is concave, as it is likewise in the Gorilla and Chimpanzee. I am, however, acquainted with this interesting fossil, referred to a genus called *Dryopithecus*, only by the figures published in the 43rd volume of the 'Comptes Rendus de l'Académie des Sciences.' From these it appears that the canine, two premolars, and first and second true molars are in place; the socket of the third molar is empty, but widely open above; from which it

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closely resembled those of a small Macacus (September 1839, Magazine of Nat. Hist. p. 446), have since been matched by the lower molars of the extinct genus *Hyracotherium*, subsequently discovered, and determined by the dentition of both upper and lower jaws. (Annals of Nat. Hist. 1841 & 1862.)

[1] Comptes Rendus de l'Académie des Sciences, Paris, vol. xliii.

may be concluded that the third molar had also cut the gum, the crown being completed, but not the fangs. If the last molar had existed as a mere germ, it would more probably have been preserved in the substance of the jaw.

In a young Siamang, with the points of the permanent canines just protruding from the socket, the crown of the last molar is complete, and on a level with the base of that of the penultimate molar; whence I infer that the last molar would have cut the gum as soon as, if not before, the crown of the canine had been completely extricated. This dental character, the conformation and relative size of the grinding teeth, especially the fore-and-aft extent of the premolars, all indicate the close affinity of the *Dryopithecus* with the *Pliopithecus* and existing Gibbons; and this, the sole legitimate deduction from the maxillary and dental fossils, is corroborated by the fossil humerus, fig. 9, in the above-cited Memoir.

There is no law of correlation by which, from the portion of jaw with teeth of the *Dryopithecus*, can be deduced the shape of the nasal bones and orbits, the position and plane of the occipital foramen, the presence of mastoid and vaginal processes, or other cranial characters determinative of affinity to Man; much less any ground for inferring the proportions of the upper to the lower limbs, of the humerus to the ulna, of the pollex to the manus, or the shape and development of the iliac bones. All those characters which do determine the closer resemblance and affinity of the genus *Troglodytes* to Man, and of the genus *Hylobates* to the tailed Monkeys, are at present unknown in respect of the *Dryopithecus*. A glance at fig. 5 (*Gorilla*) and fig. 7 (*Dryopithecus*) of the plate of M. Lartet's memoir would suffice to teach their difference of bulk, the Gorilla being fully one-third larger. The statement that the parts of the skeleton of the *Dryopithecus* as yet known, viz. the two branches of the lower jaw and the humerus, " are sufficient to show that in anatomical structure, as well as stature, it came nearer to Man than any quadrumanous species, living or fossil, before known to zoologists[1]," is without the support of any adequate fact, and in contravention of most of those to be deduced from M. Lartet's figures of the fossils. Those parts of the *Dryopithecus* merely show—and the humerus in a striking manner—its nearer approach to the Gibbons; the most probable conjecture being that it bore to them, in regard to size, the like relations which Dr. Lund's *Protopithecus* bore to the existing *Mycetes*. Whether, therefore, strata of such high antiquity as the miocene may reveal to us " forms in any degree intermediate between the Chimpanzee and Man " awaits an answer from discoveries yet to be made; and the anticipation that the fossil world " may hereafter supply new osteological links between Man and the highest known Quadrumana[2]" must be kept in abeyance until that world has furnished us with the proofs that a species did formerly exist which came as near to Man as does the Orang, the Chimpanzee, or the Gorilla.

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[1] Sir Charles Lyell, 'Supplement to the Fifth Edition of Manual of Elementary Geology,' 8vo, 1859, p. 14.

[2] Ibid.

Of the nature and habits of the last-named species, which offers the nearest approach to Man of any known Ape, recent or fossil, but with an interval far exceeding that between any two members of the quadrumanous series, I have received many statements from individuals resident at or visitors to the Gaboon, and have given careful consideration to those in print, from which I should select the following as most probable or least questionable.

Gorilla Land is, for the most part, a richly or densely wooded extent of the western part of Africa, traversed by the tributaries of the rivers Gaboon, Muni or Danger, and Fernandes Vas, extending from the equator to from 10° to 15° northward and southward. The port from which the first and most of the subsequent specimens of *Troglodytes Gorilla* have been shipped is the Gaboon.

The animal is most likely to be met with in the loneliest and darkest parts of the forest; it prefers the densely wooded valleys, but also is found or heard upon the high plains and rugged heights at the fruiting of certain shrubs or trees there growing; it is usually near, seldom far from, a plentiful supply of water.

Among the trees which afford sustenance to the Gorillas have been specified the Palm-nut (*Elæis guineensis*), of which the fruit and upper part of the stipe, called the "cabbage," are eaten by them, the Papaw-tree (*Carica papaya*), the Banana (*Musa sapientum*), and another new species (*Musa paradisiaca*), the *Amomum Afzelii*, and *Amomum grandiflorum*.

The wild sugar-canes (*Arundo saccharifera*), growing near deserted huts or villages of the natives, attract the Gorillas. The succulent white parts of pine-apple leaves,—various wild forest berries, especially the kinds that grow on low bushes,—a pulpy pear-shaped subacid fruit, growing close to the ground, called the 'Tondo' by the natives,—the pith of some trees,—a kind of nut with a very hard shell, to break which requires the strength of jaw and teeth which is found in both sexes,—such fruits and other productions of the vegetable kingdom constitute the staple food of the Gorilla. The molar teeth, which alone truly indicate the diet of an animal, accord with the statements as to the frugivorous character of this great Ape; but they also sufficiently answer to an omnivorous habit to suggest that a certain proportion of animal matter, such as the eggs and callow brood of birds, might not be unacceptable.

Mr. du Chaillu, however, states that he examined the stomachs of the Gorillas killed by himself and his hunters, and "never found traces there of aught but berries, pine-apple leaves, and other vegetable matter[1]." The Gorilla is a huge feeder, as its vast paunch, protruding when it stands upright, shows; "and indeed," as Mr. du Chaillu well remarks, "its great frame and enormous muscular development could not be supported on little food[2]." The same traveller refers to this necessity for abundance of the appropriate vegetable food the restless and nomadic habits of the Gorilla, "wandering from place to place, and scarce ever found for two days together in the same neighbourhood[3]."

The young and the females sleep in trees; the heavier and more bulky males are

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[1] 'Explorations and Adventures in Equatorial Africa,' 8vo, 1861, p. 348. [2] Ibid. [3] Ibid.

mostly on the ground; and Mr. du Chaillu, in accordance with my inference from the state of the hair in the specimens which I had examined in 1859[1], testifies that the male "sleeps seated with his back against the tree-trunk."

The voice of the male Gorilla is a very loud "barking roar:" "it begins with a sharp bark, like an angry dog, then glides into a deep-bass *roll* like distant thunder along the sky, for which I have sometimes mistaken it when I did not see the animal. So deep is it, that it seems to proceed less from the mouth and throat than from the deep chest and vast paunch[2]."

The capacity of chest, girdled by an extra pair of ribs, gives countenance to this testimony of the power and quality of voice.

The female and young scream when alarmed, and the mother utters also a low kind of cluck to call or warn her young one. The Gorilla is not gregarious: it is monogamous: but one female is found with the male, and he is often companionless. "Young Gorillas I found sometimes in companies of five or less, but never more[3]." "The young always run off, on all-fours, shrieking with fear. They are difficult to approach, as their hearing is acute." "The adult animal is also shy. When the mother runs off from the hunter, the young one grasps her about the neck and hangs beneath her breasts with its little legs about her body[4]."

The absence of the Lion in the Gorilla-forests leaves this powerful Ape the mastery of his habitat, if, indeed, his presence may not account for the absence of the so-called "king of beasts."

The tracks of the Gorillas observed by Mr. du Chaillu showed that they went on all-fours, with evidence of occasional rest, as when tempted by wild sugar-cane or other favourite food; and he describes it as the usual mode of progression. The body is carried half erect, the hind legs moved with a swing between the arms, as on crutches, and those somewhat bowed outward[5] (Pl. XLIV. fig. 1). The hind feet leave no traces of any of the toes, except the great inner one or 'hallux.' The broad impressions of the digital callosities of the fore-hand leave slight marks of their distinctness. When alarmed, the hind limbs take a greater share in flight; but the body is inclined forward, and no doubt the fore limbs assist in the more rapid movement. When progressing on the lower limbs only, the "walk is a waddle from side to side:" these being somewhat inadequate to the proper support of the huge superincumbent body, he balances himself by swinging his arms, or clasping them behind the head.

When so pursued as to be driven to stand at bay, the Gorilla, like the Bear, raises himself on his hind feet, with his powerful arms and hands free for the combat. In this predicament Mr. du Chaillu affirms that the creature "offers defiance by beating his breast with his huge fists, till it resounds like a bass-drum[6]." There is nothing in the struc-

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[1] Proc. Zool. Soc., January 1859, p. 19.

[2] Du Chaillu, 'Explorations and Adventures in Equatorial Africa,' p. 70.

[3] Ibid.

[4] Ib. p. 352.

[5] Ib. p. 352.

[6] Ib. p. 70.

ture of the Gorilla, save the size and depth of the chest, to suggest or accord with this peculiar action. Nor, were the dog as rare a beast, is there anything in its anatomy that would have suggested, to one who had never seen it alive, its occasional habit of running on three legs. In statements of this kind by a traveller, it is neither wise to discredit nor implicitly to believe; but one may acquiesce, and wait the report of succeeding observers whose attention has been directed to the original statement. Laceration of the abdomen and laying bare part of the intestines are described as the effects of a blow of the immense hand of the Gorilla[1]. In an instance where the Negro hunter had been so felled, the Ape vented its rage upon the musket[2]. This is a probable incident, and the power of the upper limb is equal to the alleged effect of its stroke. Mr. du Chaillu also adduces the testimony of the natives, that, when stealing through the gloomy shades of the tropical forest, they become sometimes aware of the proximity of one of these frightfully formidable Apes by the sudden disappearance of one of their companions, who is hoisted up into the tree, uttering, perhaps, a short choking cry. In a few minutes he falls to the ground a strangled corpse. The Gorilla, watching his opportunity, has let down his huge hind hand, seized the passing Negro by the neck with vice-like grip, has drawn him up to higher branches, and dropped him when his struggles had ceased. Describing the effect of contemplation of the recently killed male, he writes:—"There is no doubt the Gorilla *can* do this, but that he does it I do not believe. They are ferocious, mischievous, but not carnivorous[3]." The original report, however, does not assign any other purpose in the strangulation of a Negro pursuer or persecutor, except to kill him. In reference to the mode of attack described by Du Chaillu, viz. "to strike one or two blows, leaving the prostrate victim," Bowdich's brief hearsay testimony in the main accords with this direct one. In the 'Narrative of a Mission from Cape Coast Castle to Ashantee' (8vo, 1819), Bowdich writes, in reference to the vicinity of the Gaboon, "The favourite and most extraordinary subject of our conversation in natural history was the *Ingena*, an animal like the Orang Outang, but much exceeding it in size, being 5 feet high and 4 across the shoulders. Its paw was said to be even more disproportioned to its breadth, and one blow of it to be fatal. It is commonly seen by them, when they travel to Kaybe, lurking in the bush to destroy passengers," (not to eat them, for) "it feeds principally on wild honey, which abounds."

The name *Ngina* or *Gina*, in the Mpongwe dialect (pronounced *Nguyla* by some of the hunters in the interior of the Gaboon), together with the now known stature and strength of arm of the Gorilla, satisfactorily show the true species of Ape to which Bowdich's Negro gossips referred. Battel distinguishes the larger Ape (*Pongo*), of which he heard while prisoner to the Portuguese in Angola, or wandering amongst the Negroes of the interior, as being of a dunnish colour, from the smaller one (*Engeco*), which is black.

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[1] Du Chaillu, 'Explorations and Adventures in Equatorial Africa,' p. 287.

[2] Ibid.

[3] Ib. p. 277.

"The Pongos," he also writes, "are never taken alive, because they are so strong that ten men cannot hold one of them," which is true of the Gorilla; while the black *Engeco* (the *Enche-eko*, or *Nstiego*, of the Mpongwe and Camma tribes of the present day) would offer less resistance, through its smaller size and weaker structure. Very significant of the accuracy of the report of the old African wanderer is the indication of the difference of colour of the "Pongo" and "Engeco." In this narrative[1] is the first notice of the Gorilla under the name of "Pongo." 'Hanno's Voyage[2],' from which Dr. Savage borrowed the name, too vaguely refers to some large hairy Ape for identification of the species. But Cuvier acted in the true interests of science in excluding the hearsay evidences on record prior to the publication of the 'Règne Animal' from that trustworthy compendium of zoological facts.

From present knowledge of the characters of the Gorilla, its position in the zoological series may be deduced; but the conclusions will bear some tincture of the mind that so deals with such evidence, and consequently, as heretofore, those entitled to offer an opinion may, for some time to come, be found to differ.

I would first observe, although to most it may be superfluous, and to every competent and candid naturalist it ought to be so, that characters of homology are not to be confounded with those of zoology. For example, if, in the accepted zootomical text-books[3], every bone in the foot of Man is shown to be present in the hind hand of the Monkey and in the hind fin of the Seal, the tyro in zoology is not to believe that the

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[1] Battel's narrative is contained in the compilation by Purchas, entitled 'Pilgrimages, or Relations of the World,' &c., fol., 1625, pt. ii. p. 981.

[2] The 'Periplus, or Voyage of Hanno,' was translated by a learned and accomplished physician, Dr. Falconer (8vo, 1797). I am indebted to the venerable Bishop Maltby, eminent as a Greek scholar, for the following translation of the passage supposed to allude to the species in question:—"On the third day, having sailed from thence, passing the streams of fire, we came to a bay called the Horn of the South. In the recess there was an island like the first, having a lake, and in this there was another island full of wild men. But much the greater part of them were women, with hairy bodies, whom the interpreters called 'Gorillas.' But, pursuing them, we were not able to take the men; they all escaped, being able to climb the precipices, and defended themselves with pieces of rock. But three women (females), who bit and scratched those who led them, were not willing to follow. However, having killed them, we flayed them, and conveyed the skins to Carthage; for we did not sail any further, as provisions began to fail." This encounter indicates, therefore, the southernmost point on the west coast of Africa reached by the Carthaginian navigator.

To the inquiry by Bishop Maltby, how far the newly discovered great Ape of Africa bore upon the question of the authenticity of the 'Periplus,' I replied:—"The size and form of the great Ape, now called 'Gorilla,' would suggest to Hanno and his crew no other idea of its nature than that of a kind of human being; but the climbing-faculty, the hairy body, and skinning of the dead specimens strongly suggest that they were large anthropoid or tailless Apes. The fact that such Apes, having the closest observed resemblance to the Negro, being of human stature and with hairy bodies, do still exist on the west coast of Africa renders it highly probable that such were the creatures which Hanno saw, captured, and called 'Gorullai.'"

[3] Cuvier, 'Leçons d'Anatomie Comparée,' 8vo, 1805, tom. i. art. vii., "Des os du coude-pied, ou du tarse, dans l'Homme et dans les Mammifères"; 'Ossemens Fossiles,' 4to, 1825, tom. v. partie vii., "Squelettes des Phoques," p. 226, &c.

characters which the modifications of these several structures afford lose any of their value, in a classificatory science, through the fact of their being superinduced upon a common type. The Seal retains as strongly the peculiarity of the swimming-limb ; the Ape has its equally distinctive climbing-limb ; and, in like manner, Man stands alone in the possession of limbs for upright station and bipedal progression. Although the "astragalus," "hallux," &c., may be determinable in most Mammalia, a "foot," properly so called, is nevertheless peculiar and common to mankind.

So with the brain and most other organs, although the homologues of the parts in Man may not be traceable to the same extent down the mammalian series. Kuhl, e. g., in *Ateles Belzebuth*[1], Tiedemann in the Macaque[2] and Orang[3], Van der Kolk and Vrolik in the Chimpanzee[4], and myself in the Gorilla[5], have severally shown all the homologous parts of the Human cerebral organ to exist, under modified forms and grades of development, in Quadrumana. Nevertheless the distinctive characters of the Human brain, such as the manifold and complex convolutions of the cerebral hemispheres, their extension in advance of the olfactory lobes and further back than the cerebellum, thereby defining a posterior lobe, with the corresponding "horn of the lateral ventricle" and "hippocampus minor," are as available to the zoologist in classification as are the equally peculiar and distinctive characters of the calcaneum, hallux, and other structures of the foot.

With regard to the brain, the first element in the present problem which that organ yields the zoologist is its early arrest of growth in the Gorilla, as compared with Man. In this respect it obeys the same developmental law as the brain in the Chimpanzee and Orang[6]. All Quadrumana, indeed, agree together and differ from Man in this respect.

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[1] Beiträge zur Zoologie und vergleichenden Anatomie, 4to, 1820, zweite Abtheilung, p. 70, tab. vii.

[2] Icones cerebri Simiarum, fol. 1821, p. 14, fig. iii. 2.

[3] Treviranus, Zeitschrift für Physiologie, Bd. ii. s. 25, taf. iv.

[4] Nieuwe Verhandlingen der erste Klasse van het Koningl. Nederlandsche Instituut. Amsterdam, 1849.

[5] Fullerian Lectures, Royal Institution (March 18th, 1861); reported, with copies of diagrams, in 'Athenæum,' March 23rd, 1861, p. 395.

[6] Memoir, No. I., "Osteology of Chimpanzee and Orang-utan," 1835, Trans. Zool. Soc. vol. i. p. 355 :—"The brain does not continue to expand after the development of the deciduous teeth."

See also the remarks on this subject in the memoir by Professor Eudes-Deslongchamps, who obtained for the Museum of the Faculty of Sciences at Caen (of which he is Dean) the body of the first and sole specimen of a young Gorilla which reached a European port alive. This judicious naturalist records his impressions on this point, and gives the results of his comparisons, as follows :—"L'encéphale d'un jeune Gorille, Chimpansée, ou Ourang-Outang n'atteint point à beaucoup près les dimensions d'un encéphale humain d'un âge correspondant au leur ; il acquiert promptement le volume qu'il doit conserver pendant le reste de la vie ; ses enveloppes osseuses ont bientôt pris une solidité et une épaisseur qui ne permettent presque plus au cerveau de grandir, tandis que chez l'homme le cerveau continue de s'accroître et ses enveloppes de se prêter à ce développement pendant un temps bien plus long que celui qui est accordé au développement du cerveau des singes anthropoïdes. La tête de ces singes, arrivée à l'âge où toutes les dents de lait sont sorties et en exercice (pls. 3–6), The size which the brain of the Gorilla acquires in the full-grown male is illustrated by the capacity of the cranium, in the paper on that subject (No. IV.) communicated to the Zoological Society, November 11, 1851, and published, with illustrations of the vertical longitudinal sections, in the fourth volume of the 'Transactions' (Pl. XXVIII.)[1]. From these sections an observer, not anatomically acquainted with the disposition of the dura mater in relation to the "lateral sinuses," might infer that the cerebrum extended backward beyond the cerebellum: it is coextensive therewith in length, but not quite in breadth. The Gorilla shows the same degree of development of the "posterior cornu" and "hippocampus minor" as has been observed by Van der Kolk and Vrolik in the brain of the Chimpanzee. It is the beginning of those structures which are backwardly extended, with the parts of the hemispheres containing them, and fall short, in the same degree, of their extended and differently curved homologues, in Man. The term "rudiment," as applied to the totality of an undeveloped organ, such as the mammary organs in the male mammal, the hidden tusk in the female Narwhal, &c., cannot be applied in the same sense to the commencing extensions of homologous parts in a given direction of growth. The stunted tail of the Sloth, for example, is not the "rudiment" or undeveloped representative of the whole tail in the Megatherium; it answers only to two or three of the caudal vertebræ at the base of such tail, of which huge and complex vertebræ alone, in the Megatherium, the answerable vertebræ in the Sloth can truly be affirmed to be rudiments. The hinder thumb, in many Orangs (seven out of eight observed by Camper (Œuvres, tom. i. p. 54)), is not the homologue of the Human hallux, but only of its metatarsal and first phalangeal bones. The beginnings of the posterior cornua and their inflected eminences, in the Gorilla, are shown in Pl. XLVIII. fig. 3[2].

To supplement the information which the partial decomposition of the exterior surface of the Gorilla's brain left incomplete, a cast was prepared of the cranial cavity of an adult male. The brain of the Gorilla, as exemplified by such cast (Pl. XLVIII.), is of a narrow-ovate form, with the small end forward: the cerebrum does not extend beyond the cerebellum; viewed with the lower surface of the medulla oblongata horizontal, it does not extend so far back as the cerebellum does. The difference of size between it and a small-sized male Negro's brain is exemplified in the subjoined admeasurements:—

égale à peine celle d'un enfant qui vient de naître; et lorsque les dents de lait de celui-ci sont arrivées au point ou époque que je citais tout-à-l'heure pour les singes anthropoïdes, la tête de l'enfant, ou plutôt son cerveau, a acquis un volume double ou triple du cerveau des singes que je lui compare, et il doit accroître beaucoup encore." (Bulletin de la Société Linnéenne de Normandie, vol. vi. p. 53, 1861.)

[1] Reduced woodcuts of the figures were given in the report of the paper which appeared in the 'Literary Gazette,' November 15th, 1851, p. 777; that of the adult Gorilla is No. 3.

[2] Kuhl takes the correct view of the homologous part, which he shows in the brain of the *Ateles*, and calls it "Anfang" (commencement) "des hintern, dritten Horns des Seitenventrikels" (*op. cit.* p. 70).

	Gorilla.		Negro.	
	in.	lines.	in.	lines.
Length of cerebrum	4	10	6	3
Breadth of cerebrum	3	9	4	10
Depth (greatest vertical diameter)	2	6½	4	6
Breadth of cerebellum	3	4	3	7
Length of cerebellum	1	10	2	3
Depth of cerebellum	1	4	1	8

In these admeasurements some deduction from the Gorilla's brain must be made for the thickness of the dura mater and other membranes included in the cast: that of the Negro's brain showed it stripped of its membranes; and the admeasurements are from a subject corresponding with the smallest of those figured by Tiedemann in the 'Philosophical Transactions' for 1836, pl. 31, in which the posterior cerebral lobes extend half an inch beyond the cerebellum.

Although in most cases the Negro's brain is less than that of the European, I have observed individuals of the Negro race in whom the brain was as large as the average one of the Caucasian; and I concur with the great physiologist of Heidelberg, who has recorded similar observations, in connecting with such cerebral development the fact that there has been no province of intellectual activity in which individuals of the pure Negro race have not distinguished themselves. The contrast between the brains of the Negro and Gorilla, in regard to size, is still greater in respect of the proportional size of the brain to the body—the weight of a full-grown male Gorilla being one-third more than that of an average-sized Negro.

Passing from this contrast to a comparison of the Gorilla's brain with that of other Quadrumana, we discern the importance and significance of the much greater difference between the highest Ape and lowest Man, than exists between any two genera of Quadrumana in this respect: the brain of the Gorilla, in the contraction of the anterior lobes, in the non-development of posterior lobes extending beyond the cerebellum, and in the paucity, symmetry, and relative size of the cerebral convolutions, closely accords with the brain of the Chimpanzee. From these to the Lemurs the difference of cerebral development shown in any step of the descensive series is insignificant compared with the great and abrupt rise in cerebral development met with in comparing the brain of the Gorilla with that of the lowest of the Human races. This difference parallels that in the structure of the lower limbs, especially the foot, in the Gorilla and Man; on which difference, as exemplified in the Chimpanzee and lower Apes and Monkeys, Cuvier founded the ordinal grade to which he assigned the genus *Homo*, under the term *Bimana*. The disposition of the hallux as a hinder thumb, with the concomitant modifications of the tarsal bones, are as strongly marked in the Gorilla as in any lower Quadrumane, and the contrast between the foot-structures of the Gorilla and Negro is as great.

The long-continued growth and superior size of the Human brain, more especially the superior relative size of the cerebral hemispheres and their numerous deep and complex convolutions, are associated with psychical powers, compensating for and permitting the absence of natural weapons of offence and defence; they are corelated with those modifications of the lower limbs which free the upper ones from any call to serve the body in the way of moving or supporting it, and leave them at the command of the intellect, for such purposes, in the fabrication of clothing, weapons, &c., as it may energize upon according to its measure of activity in the individual.

In investigating and studying the value and application of the cerebral characters of Man in the classification of the Mammalia, I have been led to note the relations of equivalent modifications of cerebral structure to the extent of the groups of Mammals respectively characterized by such conditions of brain. The Monotremes and Marsupials, which offer numerous extreme modifications of the limbs, all agree in possessing a brain in which there is no connecting or commissural mass of fibres overarching the lateral ventricles of the cerebrum. The surface of this part shows, however, a few symmetrical convolutions in *Echidna*[1] and *Macropus*, especially the largest species[2]; but in the majority of Marsupials the hemispheres are smooth. The "corpus callosum," or great commissure, makes its appearance abruptly in the Rats, Shrews, Bats, and Sloths, which in general organization and powers are next the "loose-brained" Marsupials or *Lyencephala*; but this commissure is associated with a similarly smooth unconvolute cerebrum, and with so small a size of the cerebrum as leaves uncovered the cerebellum and, in most, the optic lobes. Only in the largest of the "smooth-brained" group (*Lissencephala*) are a few simple, symmetrical, cerebral fissures present. I refer to my paper in the 'Proceedings of the Linnean Society,' 1837, for the summary of the characters which associate in close contiguity the Cuvierian orders *Rodentia*, *Edentata*, *Insectivora*, and *Cheiroptera*, and indicate their position as next above the Marsupials and below the other orders in the 'Règne Animal.' In almost every system of organs, except the cerebral, they offer as many and great varieties as do the *Lyencephala*: the one organ that links them together by the uniformity of its developmental grade and structural condition is the brain; whence they may be collectively spoken of as "Lissencephala," or the smooth-brained subclass with connected hemispheres.

The inference as to the respective values of 'brain,' 'teeth,' 'limbs,' &c., as mammalogical characters is plain: the most constant organ bespeaks the widest group.

In the remaining and, as I infer, higher orders of Mammalia the cerebrum presents a sudden increase of size: if, as in the diminutive Lemurs and platyrrhine Marmosets, its surface is smooth, it not only covers the optic lobes, but also more or less of the cerebellum. But, as a rule, the grey superficies of the cerebrum is expanded by convolutions[3]. In the platyrrhine and catarrhine Quadrumana the cerebrum becomes

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[1] Cyclopædia of Anatomy and Physiology, art. "Monotremata," vol. iii. p. 383. fig. 182.

[2] Phil. Trans. 1837, pl. 5. fig. 4.

[3] Even in the Rodent-like Aye-aye.

coextensive backward with the cerebellum, and the beginning of the structures[1] characteristic of the posterior lobes in Man are determinable. But, for the present zoological application, the following accurate definition by Tiedemann of the Human condition of some of these structures may be relied upon:—"Pedes hippocampi minores vel ungues, vel calcaria avis, quæ a posteriore corporis callosi tanquam processus duo medullares proficiscuntur, inque fundo cornu posterioris plicas graciles et retroflexas formant, in cerebro Simiarum desunt; nec in cerebro aliorum a me examinatorum mammalium occurrunt; Homini ergo proprii sunt." ('Icones cerebri Simiarum,' p. 51.)

With regard to other characters, if the naturalist, seeking the true cerebral endowments of the genus *Homo*, were to abandon his proper guide, viz. the average condition of the brain in the male sex, and to take the brain of a female of the lowest Papuan or Ethiopian variety, he would nevertheless find that the primary cerebral convolutions characteristic of Man, and widely differentiating his brain, by their number, size, depth, and course, from the Ape's brain, are all present, though they may be marked by fewer secondary fissures[2]. The cerebrum not only overlaps, but extends beyond the cerebellum; and the difference in the proportion of the cerebrum to the cerebral nerves, to the pyramidal bodies, to the bigeminal bodies, to the myelon, is such as to manifest as abrupt a step in development as that which is met with between the Lyencephalous and Lissencephalous types, or between the *Lissencephala* and *Gyrencephala*. The extent of difference in the proportion of the cerebrum to the above-cited parts in the different varieties of mankind is small, and with such slight gradational steps as to mark the unity of the family in a striking manner. I therefore conclude that the Human characteristics of the brain afford a zoological character of higher degree and importance than do those of his limbs, and concur in the functional estimate with which Tiedemann terminates his paper on the brain of the Orang:—"The cerebral hemispheres are thus most clearly shown to be essentially the instruments by which, in life, the intellectual functions are performed, since through the large size, circumferential expanse, and elaboration of the cerebrum Man differs from all other animals[3]." It would seem, moreover, that the numbers of the *Archencephala*, under their manifold varieties, would

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[1] "Anfang des hintern, dritten Horns des Seitenventrikels" (Kuhl, in *Ateles, loc. cit.*). "Scrobiculus parvus loco cornu posterioris" (Tiedemann, in *Macacus*, 'Icones cerebri Simiarum,' fol. p. 14, fig. iii. 2). "Die grossen seitlichen Hirnhöhlen bestanden aus dreien Hörnern, einem vorderen, mittleren oder absteigenden, und einem hinteren Horn" (Tiedemann, on the Orang; who is, however, silent as to any "hippocampus minor"). It exists, however, in the condition described by Vrolik, as "une éminence que nous croyons avoir le droit de nommer un indice de pes hippocampi minor" ("Note sur l'encéphale de l'Orang," in Versl. en meded. afd. natuurk. Deel xiii., 1861).

[2] The "primary" and "secondary" convolutions and fissures are defined and distinguished in my paper on the Cheetah (Sept. 1833, Zool. Trans. vol. i. p. 134).

[3] "So wird dadurch auch evidenteste bewissen, dass die Hemisphären des grossen Hirns vorzüglich als die Werkstätte zu betrachten sind, durch welche im Leben die intellectuellen Verrichtungen vermittelt werden, dem eben durch Grösse, Umfang und Aussbildung des grossen Hirns unterscheidet sich der Mensch von allen übrigen Thieren" (*loc. cit.* p. 28). This remark antagonizes that of Buffon, who, in regard to the Orang and

soon surpass those of the kinds of *Gyrencephala*, *Lissencephala*, and *Lyencephala* now living upon the earth.

Agreeably, therefore, with the above estimate of the value of cerebral characters, the *Troglodytes Gorilla*, like the *T. niger* and the *Pithecus Satyrus*, remains with the Gibbons and lower Quadrumana, and stands apart in a distinct subclass from the genus *Homo*.

I next proceed to consider the value and application of the characters afforded by the limbs of the Gorilla.

In the terminal segment of the fore limb the pollex is stunted[1]; the other digits, lengthened and strengthened, with their proximal and especially their middle phalanges expanded for the support of the broad callosities on which the beast walks: the length of these digits enables them also to bend upon the palm and grasp or cling to a bough, and the hand is thus adapted for movement in trees, as well as for the quadrupedal progression on the ground: but, in the same degree, it is deprived of the faculty of delicate digital prehension or "manipulation." The hand of the Gorilla offers a slight advance upon the type of that in the Chimpanzee or Orang by its greater relative breadth: the entire fore or upper limb is also rather shorter in proportion to the body. Compared with the modifications of that limb in Man and the resultant powers of the member, the fore limb of Quadrumana appears to me to be inferior to that in Bimana in a greater degree than it is superior to the fore limb in the Squirrel or any pentadactyle Unguiculate: the difference between the Gorilla and Man in this particular I regard therefore as one of ordinal value. In the lower or hind limb the difference between the Gorilla and Man is still more manifest and important in its consequences. The deficiency of length in proportion to the trunk is greater than the excess of length of the upper limbs. The foot is made a true hand, or grasping organ, by the opposition of a thumb to the other digits, as well as by the length and flexibility of the toes[2]. Accordingly the innermost digit presents as well-marked modifications to act the part of a 'thumb' as affect it in Man in order to act the part of a 'great toe': in both cases the whole tarsus has been subject to coordinate modifications[3]. The other four digits in the Gorilla present a greater excess of length compared with Man than in the upper limb; they are also more approximated to each other, and are bound together in a common ligamentary sheath to nearer their extremities than in Man, and are collectively

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Chimpanzee, affirms:—"Le cerveau est absolument de la même forme et de la même proportion, et il ne pense pas: y a-t-il une preuve plus evidente que la matière seule, quoique parfaitement organisée, ne peut produire ni la pensée ni la parole qui en est la signe, à moins qu'elle ne soit animée par un principe superieur?" (Hist. Nat. xiv. p. 61.)

[1] In the Gorilla the length of the entire pollex only equals that of the metacarpal of the middle finger, and is rather more than three-eighths the length of that finger: in Man the pollex equals the metacarpal and nearly the whole of the first phalanx of the middle finger, and is almost two-thirds the entire length of that finger, including the metacarpals in both cases. (Memoir, No. VII., Trans. Zool. Soc. vol. iv. p. 11. pl. 10.)

[2] Memoir, No. VII., pl. 11. fig. 2.

[3] Ib. figs. 1 & 2.

applicable to the sole in the act of grasping[1]: by this "syndactylous" character the toes seem to be shorter, but are made stronger for this purpose; and their length is here adverted to as it is manifested by their bones. The result is a limb adapted to functions as distinct from those of the Human leg and foot as it is from those of the Bear or Dog. If zoology assigns an ordinal value to the limb-characters which distinguish *Carnivora* from *Quadrumana*, it must, in consistency, assign the same value to the limb-characters which distinguish *Quadrumana* from *Bimana*. These distinctions are as plain in the embryo as in the adult[2], and are in no way affected by the anatomical demonstrations of the homologies of the bones of the lower or hinder limb: on such ground, indeed, there could be no zoology as a classificatory science.

The Gorilla, by the legitimate application of such science, being relegated to the Quadrumanous order in the Gyrencephalous subclass of Mammalia, the question becomes narrowed to its status and affinities in such order. Before, however, entering upon this phase, I would premise a few words on the primary groups of the Quadrumana of Cuvier. In the second edition of the 'Règne Animal,' 1829, after remarking that the order had been divided for a long time into two groups, "les *Singes*" (*Simia*, Linn.) and "les *Makis*" (*Lemur*, Linn.), he proposes to distinguish the *Ouistitis* (*Hapale*, Illiger) as a group of equal value.

Having availed myself of the earliest opportunity to compare the brain of an Ouistiti (*Hapale midas*, Illig., *Midas rufimanus*, Geoffr.) with that of the *Makis*, on the one hand, and of the *Singes* on the other, I found it to agree with the latter in the backward coextension of the cerebrum with the cerebellum[3]. In all the *Makis* (Lemuridæ) about one-half or one-third of the cerebellum is left uncovered. The distinctive characters on which Cuvier relied for the separation of the *Ouistitis* were the number of the molars, nails only on the hinder thumbs, and those of the fore limbs not meriting the name of thumb[4]. The first of these characters as a mark of affinity to the Old-World *Simiæ* is deceptive: the number of "mâchelières" is, indeed, the same, but their kinds

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[1] Isidore Geoffroy St.-Hilaire, lamenting "the impediments to zoological science by the deplorable vagueness pervading the meaning of the terms applied to characteristic organs," defines a "hand" as having long and flexible digits opposable to the palm or sole, so as to be able to grasp or seize an object, which, if light and moveable, can thus be brought to the mouth; if heavy and fixed, can serve as a fulcrum for moving the animal's body: he thus evades the objection based on the inadequacy of the thumb to oppose the fingers, in many Quadrumana. ("Remarques sur la Classification et les Caractères des Mammifères, Première Mémoire, Famille des Singes, '*Définition zoologique du mot 'Main,'*" Archives du Muséum d'Histoire Naturelle, 4to, 1839, p. 17.)

[2] See Breschet, "Recherches sur la Gestation des Quadrumanes," Mém. de l'Académie des Sciences, tome xix. 1845, pl. 13. fig. 3 (Human embryo) and fig. 5 (embryo of *Simia sabæa*), at a period when the digital divisions and phalanges begin to be marked by bone, but before there is any trace of ossification in the tarsus.

[3] Phil. Trans. vol. cxxvii. (1837), pl. v. fig. 2 (copied in the "Classification of the Mammalia," Proc. Linn. Soc. 1857, fig. 3).

[4] "Ils n'ont que vingt mâchelières, comme les Singes de l'ancien continent:" "tous leurs ongles sont comprimés et pointus, excepté ceux des pouces de derrière; et leurs pouces de devant s'écartent si peu des autres doigts, qu'on ne leur donne qu'en hésitant le nom de quadrumanes" (*op. cit.* p. 105).

are different. The essential distinction in the New-World *Simiæ* is their having *three premolars*, instead of *two*, on each side of both jaws: and in this respect they show their lower grade and nearer approach to the unguiculate *Gyrencephala*. The *Ouistitis* differ in wanting a true molar on each side of both jaws: *m.* 3 is undeveloped in these small and short-jawed Marmosets. The homological characters of the "mâchelières" in Quadrumana are given in the subjoined formulæ:—

Old-Word *Simiæ*, "singes de l'ancien continent," Cuv. . $p. \frac{2-2}{2-2}, m. \frac{3-3}{3-3} = 20$;
New-World *Simiæ*, "singes du nouveau continent," Cuv. . $p. \frac{3-3}{3-3}, m. \frac{3-3}{3-3} = 24$;
Marmosets, "*Ouistitis*," Cuv. . . . . $p. \frac{3-3}{3-3}, m. \frac{2-2}{2-2} = 20$.

Thus it is seen that the *Ouistitis*, instead of resembling the Old-World Apes in dentition, differ from them in a greater degree than do the other New-World *Simiæ*: they have not only one premolar more, but one true molar less, in the dental formula. In their deciduous dentition the Marmosets correspond with the other American Quadrumana[1].

With regard to the character which Cuvier derived from the feeble and hardly opposable anterior thumb in the *Ouistitis*, that great naturalist had remarked, in the same section of his classical work, that one of the "Sapajous" (*Mikiri*) had a very short thumb; another (*Chamek*) had the thumb still shorter, wanting the ungual phalanx and nail; and a third (*Coaiti*[2]) had no thumb visible. About the same period Isidore Geoffroy St.-Hilaire had generalized the fact of the inferiority of the thumb of the anterior hand, in the Howlers (*Mycetes*), Capuchins (*Cebus*), and Caparos (*Lagothrix*, Geoffr.)[3].

The characters of the extremities, therefore, like those of the teeth, in the *Ouistitis*, are invalidated, and their separation as a primary group of Quadrumana cannot be maintained. In my 'Odontography' I adopted three primary groups of Quadrumana:—1. the Lemurids or Makis, including *Cheiromys*; 2. the New-World *Simiæ* of Cuvier,

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[1] 'Odontography,' p. 439 (1840). The system of notation is there explained. See also 'Phil. Trans.' 1850; and the article "Teeth," 'Cyclopædia of Anatomy.' Mr. Blyth remarks, "We cannot but think that Cuvier has, in this rare instance, attached undue importance to the *number* of molar teeth, in so decidedly separating the *Ouistitis* from the other small American Quadrumana" (Orr's edit. of the 'Animal Kingdom,' 8vo, 1840, p. 63). The determination of the kinds of teeth confirms the suspicion.

[2] "Absolument sans pouce visible" (Règne Animal, i. p. 101). The metacarpal is present, but concealed by the skin.

[3] "*Hurleurs* ou *Alouates*:—pouce antérieur de moitié moins long que le second doigt, très-peu libre dans ses mouvemens, et à peine opposable.

"*Sajous* ou *Sapajous* proprement dits:—les pouces antérieurs sont peu allongés, peu libres dans leurs movemens, et peu opposable aux autres doigts; absolument comme dans les Hurleurs et les Lagothriches" (Dictionnaire Classique d'Hist. Nat. t. xv. 1829). Mr. Ogilby, by independent observations, arrived at the same conclusion as to the inferiority of the anterior thumbs in the "New-World *Simiæ*" of Cuvier, and went so far, in his application of the character, as to sever them from the other Quadrumana of Cuvier, and associate them with the Opossums and *Cheiromys*, in an order called *Pedimana* (Proc. of the Zool. Soc. March 1836); "Observations on the Opposable Power of the Thumb in certain Mammals" (Mag. of Nat. Hist. vol. i. 1837, p. 449).

including the *Ouistitis*; and 3. the Old-World *Simiæ*. In these Buffon[1] had generalized the fact of the narrow septum of the nose, as he had also that of the broad nasal septum in the New-World Monkeys. Etienne Geoffroy St.-Hilaire[2] invented names for the two great groups expressive of these characters, e. g. *Catarrhini* and *Platyrrhini*. Observing also a peculiar twist of the nostril in certain Lemurids, he proposed for that group the term *Strepsirrhini*, to give uniformity of nomenclature to these three divisions of the Quadrumana. The Lemurine group, including *Chiromys* and *Galeopithecus*, offers, however, exceptions to the form and position of nostrils to a degree not known in the two higher groups. The dentition and other important parts of the organization present also more and greater modifications than in the Platyrrhines and Catarrhines. The difference in the relative size of the cerebrum between any known Lemurine and the lower Platyrrhine is such as to indicate a higher degree of value to the Strepsirrhine group, and that it is more distinct from the Platyrrhine[3] than this is from the Catarrhine group. Moreover, the Lemurines in their diversities of organization are a less natural or circumscribed group, and their wider geographical distribution accords with this conclusion. Of all the *Gyrencephala*, they have the closest affinities with the *Lissencephala*; yet the small smooth-brained Lemurines show a larger proportional cerebrum than the Rodents or Insectivores of corresponding size[4].

With these admissions, retaining the Lemurines or Strepsirrhines as a primary group and the lowest suborder of Quadrumana, I regard the Platyrrhines, or New-World *Simiæ*, and the Catarrhines, or Old-World *Simiæ*, as two other suborders, respectively more circumscribed and natural than the lower one, and more nearly allied to each other than to it.

Of the subdivisions of these suborders it is not in my present aim to say more than that I adopt as the highest group or "tribe" of Catarrhines, the *Pithecina* of Isidore Geoffroy St.-Hilaire[5]. To the characters of teeth (common to it with all Catarrhines)

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[1] Histoire Naturelle, tom. xiv. p. 13.

[2] Annales du Muséum, tom. xix. pp. 85 & 156.

[3] Mr. Blyth, in Orr's edition of the 'Règne Animal,' 8vo, 1840, remarks upon the *Ouistitis*, "Their brain is surprisingly low, almost without convolutions." But, in my Memoir of 1837, it was shown that the *Midas rufimanus* was superior to the smooth-brained Rodents and Marsupials in the greater relative size of the cerebrum, which is a more important character.

[4] See "Memoir on the Aye-aye (*Chiromys*)," Trans. Zool. Soc. vol. v. pp. 68 & 84, pl. 24. figs. 2–5.

[5] Archives du Muséum d'Hist. Nat., 1839, "Sur la classification et les caractères des Mammifères, Première Mémoire, Famille des Singes."

"Tribu I. PITHECIENS, *Pithecina*: Singes à cinq molaires (32 dents en tout), à ongles courts, à membres antérieurs plus longs que les postérieurs."

Van der Hoeven, excluding *Galeopithecus* from the order, divides the Quadrumana primarily into LEMURINA seu PROSIMII and SIMIÆ. The latter group he subdivides into—

"Phalanx I. Hemipitheci.
II. Hesperopitheci.
III. Heopitheci."

The first two answer to the Platyrrhines; the third to the Catarrhines. In this arrangement the genera and limbs which he assigns to the "tribe," may be added, as more important and distinctive, those of the skeleton, the brain, and the digestive organs. The most conspicuous of the osteological characters are the great relative breadth and flatness of the sternum, and the reduction of the caudal vertebræ to a non-projecting 'os coccygis;' the feeble met- and an-apophyses in the lumbar vertebræ contrast also with their interlocking development in lower Catarrhines. In the digestive system the absence of cheek-pouches, and presence of an 'appendix vermiformis cæci,' are characters of the *Pithecina*, Is. Geoffr. Their dental distinction is seen in the conformation of the grinding surface of the true molars, which in the lower jaw presents five low tubercles, two on the inner and three on the outer and back part, instead of their development in transverse pairs or ridges as in the lower Catarrhines. In the brain may be noticed the bipartition of the 'corpus mammillare,' and the absence of the 'trapezium' on the medulla oblongata.

Of the latisternal or broad breast-boned Apes (*Pithecina*), one section has ischial callosities, the other not. To the first belong the Gibbons or "Long-armed Apes" ('Arm-affe,' Kuhl), *Scleropyga, natibus callosis*; to the second, the true Apes ('Affe,' Kuhl)[1], *Dasypyga, natibus villosis.* In the Dasypygal division the Orangs (genus *Pithecus*, Geoffr.) manifest, agreeably with their geographical position, the nearest affinities with the *Scleropyga*, in the length of the upper limbs and the proportionally small size of the hallux: the Chimpanzees (genus *Troglodytes*, Geoffr.) show the higher position in the proportions of the upper limbs to the trunk, the large size of the hallux, and other characters set forth in the present and former memoirs on the Anthropoid or Dasypygal Apes.

The Gorilla is shown, by its osteology, to appertain to the latisternal section of ecaudate Catarrhines[1]; and therein, by the absence of ischial callosities ("natibus tectis"), to the *Dasypyga* or true Apes, as contradistinguished from the *Scleropyga* or Gibbons ("natibus nudis, callosis").

The *Dasypyga* have been divided, as we have seen, into two genera, *Pithecus*, Geoffr., and *Troglodytes*, Geoffr. To the first belong the *Simia Satyrus* of Linnæus, or Orang-utan, characterized by long arms (reaching to the ankles), a short thumb of the hind hand, sometimes wanting the ungual phalanx and nail, never reaching the end of the metatarsal of the second toe: the ligamentum teres of the hip-joint is absent; there are twelve pairs of ribs; the superorbital ridge is slightly produced; the premaxillaries become anchylosed during the second or permanent dentition; the tuberculate grinding surface of the molars is rugose. The second genus is represented by the Chimpanzee

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Jacchus, Geoffroy, and *Midas*, Geoffroy, form a group equivalent to the genera *Cynocephalus*, Cuv., *Innuus*, Cuv., *Cercopithecus*, Erxl., *Semnopithecus*, F. Cuv., *Hylobates*, Illig., and *Simia*, Illig. I have therefore given, in the text, a few remarks on the value of the group formed by the last two Illigerian genera, and on the grounds for a division of *Simia*, Illig., into two genera.

[1] *Op. cit.*, "Tabula Synoptica Simiarum," p. 4 (1820).

(*Simia Troglodytes*, Linn., *Troglodytes niger*, Geoffr.), characterized by less long arms (reaching to the knee), a long thumb of the hind hand, never without ungual phalanx and nail, reaching to the second joint of the second toe: the ligamentum teres is present; there are thirteen pairs of ribs; the superorbital ridge is strongly developed; the tuberculate grinding surface of the molars is smooth; the premaxillaries become anchylosed during the first or deciduous dentition. According to the above generic characters, the Gorilla belongs to the genus *Troglodytes*.

But equal value has been given to other characters, *e.g.* 1st, "to the much-elongated and much-depressed form of the head, and to the very prominent cranial crests, in the adult[1]."

These, however, are sexual rather than generic characters; they are present only in the adult males, and require a certain age of such adult to bear the terms in which they are expressed by Is. Geoffroy. As compared with aged adult male specimens of *Troglodytes niger*, they are differences, not of kind, but simply of degree. This degree of development of the cranial crests, with their concomitant influence on the shape of the head, moreover, accords with the difference in the size of the adult males of the Chimpanzee and Gorilla.

In every admitted natural genus of Carnivorous Unguiculates, the small species differ from the large species, just as the small kind of *Troglodytes* does from the large one, in the degree of development of the intermuscular plates of bone affording attachment to the temporal muscles.

2. "The external ear is small and of the human shape[2]." It is smaller in proportion to the head, and a little smaller absolutely, in the Gorilla than in the Chimpanzee: in both, the auricle is broader in proportion to its length than in Man: the space between the helix and anthelix at their upper part is much less than in Man; and the fossa of the anthelix is scarcely marked: the lobulus is rather better marked in the Gorilla (Pl. XLVII. fig. 6) than in the Chimpanzee; and this is the only notable difference in the conch or external ear of the two Apes, except size: it is a difference which, in my judgment, is of a specific, not generic value.

The third alleged generic distinction, viz. the greater relative length of the upper limbs[3], rests, as has been already shown[4], on an error of observation.

The small amount of difference may help the specific diagnosis: in the degree in which it is determinable, it places the Gorilla higher in the genus than the Chimpanzee.

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[1] "La Gorille n'appartient point au genre *Troglodytes*: il constitue un genre distinct. Les caractères principaux de ce genre peuvent être ainsi résumés:—

"1. Tête arrondie dans le jeune âge; tête très-allongée et très-déprimée à l'état adulte: les crêtes craniennes très-saillantes" (Isid. Geoffroy St.-Hilaire, *op. cit.* p. 38).

[2] "2. Conques auriculaires petites et de forme humaine" (ib., *op. cit.* p. 38).

[3] "3. Membres antérieurs longs; leur extrémité atteignant, l'animal étant debout, le milieu de la jambe" (ib., *op. cit.* p. 38).

[4] Compare Memoir, No. VII., pl. 13. fig. 2 (Gorilla), with Memoir, No. I., pl. 48 (Chimpanzee).

4. "The anterior hands large; the palm, especially, being as broad as long (almost exactly of the Human proportion); the fingers short, relatively to those of Man and the Chimpanzee[1]."

If the upper hands in the Gorilla and Chimpanzee are compared, as they are shown by the bony framework, they plainly, in the proportion of the thumb and the curvature and flattening of the proximal and middle digital phalanges, exhibit the same generic type; and the difference in regard to the breadth of the metacarpus is seen to relate to the greater strength of the larger species, and to be of no higher than specific value. I find, in the recent hands, that the digital clefts of the integument are checked in both at about the same relative distance from the bases of the proximal phalanges; the seeming shortness of the free part of the Gorilla's fingers is due to their greater thickness (Pl. XLVII. figs. 2 & 3). As to the digits ii. iii. iv. v. being really shorter than in Man, either absolutely or relatively to the breadth of the base of their metacarpus, I refer to my Seventh Memoir, plate 10. The ungual phalanges are relatively shorter; but the other phalanges are longer, as well as broader. In the degree in which the Chimpanzee shows a greater relative length of the digits, it manifests its specific distinction, and its further departure from the Human proportions of the hand.

5. "The posterior hands elongate: the three intermediate toes (in the male) united by the teguments as far as the second phalanx[2]."

In the degree in which the Gorilla appears more "syndactylous" than does the Chimpanzee, with respect to the three middle toes, I cannot discern more than a specific difference, if even it be of that value. The female Gorilla agrees with the male in the structure of the foot. Both the Gorilla and Chimpanzee show their generic relationship in the proportions of the hallux (Pl. XLVII. figs. 4 & 5, *i*): in this respect they differ generically from the Orang-utans, as in the direction, relative position, and functions of the hallux they alike differ ordinarily from Man.

6. The sixth character[3] seems to have been admitted inadvertently among those which are given as proving the generic distinction of the Gorilla from the Chimpanzee. I will only observe that the nails of both fingers and toes are thicker, shorter, narrower, and more convex in both kinds of Ape than in the Human species: those of the Gorilla are shown in the above-cited figures from photographs of the animal preserved in spirits.

Isidore Geoffroy's last generic character is derived from the dentition.

7. "The canines enormous; the incisors ranged in almost a straight line. The three lower molars elongated from before backwards, and with a 'talon.'[4]"

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[1] "4. *Mains antérieures larges*: la paume en particulier presque aussi large que longue (de proportion presque exactement humaine); les *doigts courts* (relativement à ceux de l'Homme et du Chimpanzée)" (ib., *op. cit.* p. 38).

[2] "5. Mains postérieures allongées; les trois doigts intermédiaires (chez le mâle) réunis par les téguments jusqu'à la seconde phalange" (ib. *op. cit.* p. 38).

"6 Ongles des quatre mains très-aplatis (comme chez l'Homme et le Chimpanzée)."

[4] "7. *Les canines énormes*; les incisives rangées presque en ligne droite. *Les trois mâchelières inférieures allongées d'avant en arrière, et à talon*" (ib., *op. cit.* p. 38). The italics throughout these quotations are as in the original.

In former memoirs I selected the best-preserved conditions of the dental series in adult males of *Troglodytes Gorilla* and *Troglodytes niger*, in expectation of demonstrating beyond cavil, by the important characters of dentition, the generic affinity of the Gorilla and Chimpanzee, and their relative position in such genus.

In Memoir III., for example[1], plates 61 and 68 show the large proportion of the canines to be no generic peculiarity of the Gorilla, but to characterize almost equally the adult males of both Gorilla and Chimpanzee: even a specific difference can hardly be predicated of the two Apes in this respect. Plates 60 and 63 show their correspondence in the almost transverse arrangement of the four incisors; and, also, the specific distinction of the Gorilla in the smaller relative size of those teeth, and its resultant higher grade in the genus. The diastema between the incisors and canines is greater in the Chimpanzee than in the Gorilla, in the two skulls of the males figured.

With respect to the lower molars, I would request a reference to my Memoir, No. V.[2] plate 32. In both Gorilla and Chimpanzee the outer half of each molar is divided into three tubercles, the third being situated towards the middle of the back part of the crown, but so as to show it to belong to the outer rather than to the inner moiety of the crown: it is superior in size and distinctness in the last molar of the Gorilla than in that of the Chimpanzee, making the fore-and-aft extent of the crown greater in proportion to the breadth. The portion of 'cingulum' at the back part of the crown is developed into a small accessory cusp, more distinctly in the Gorilla, and yet also present in the Chimpanzee. In neither, however, is it so large or so shaped as the true 'talon' in the last lower molar of *Macacus*: it does not form part of the grinding-surface of the tooth. Every zoologist may discern the essential similarity of structure, under the slight difference of proportion, in the last lower molar of the Chimpanzee and Gorilla; and I believe the majority will concur in my estimate of the value of the differences between the lower true molars in *Troglodytes Gorilla* and *Troglodytes niger*. The most important facts which the above-cited Memoir (V.) and plates elucidate are those which show the resemblance of the pattern of the grinding-surface of the true molars in the genus *Troglodytes* to that in *Homo*, at least as it is manifested in the large grinders of an Australian aboriginal (plate 31. fig. 3).

On the above-stated grounds, therefore, I refer the Gorilla to the genus *Troglodytes*, Geoffr., to a distinct species (*T. Gorilla*, Sav.) in that genus, which species in the serial order I place above the Chimpanzee (*T. niger*, Geoffr.). The genus *Troglodytes* belongs to the 'dasypygal' section of the 'latisternal' tribe of tailless, catarrhine Quadrumana, and, in that section, ranks above the genus *Pithecus*, Geoffr. The Quadrumana are 'gyrencephalous,' and have an 'ordinal' distinction in their subclass,

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[1] "Osteological Contributions to the Natural History of the Chimpanzees (*Troglodytes*, Geoffr.), including the description of the skull of a large species (*Troglodytes Gorilla*, Savage)," Trans. Zool. Soc. iii. 1848.

[2] "Osteological Contributions, &c., No. 5: Comparison of the Lower Jaw and Vertebral Column of the *Troglodytes Gorilla, Troglodytes niger, Pithecus Satyrus*, and different varieties of the Human Race," Trans. Zool. Soc. iv. 1851.

of which they form the head. *Troglodytes* differs generically, ordinally, and subclassically from *Homo*, which genus forms the sole order (Bimana) of the *Archencephala*.

In preparing the present communication for the Zoological Society, and with special reference to the primary aim of the Society—the extension of a knowledge of animals and of their place in the natural series, I have clothed the results of my observations and comparisons in the usual technical language of systematic zoology.

I am fully conscious, however, of the relative value in biological science of this department and aim of the naturalist's labours, and of the close resemblance of its language to the garb of thought characteristic of the mediæval scholastic mind.

The essential knowledge of which we are in quest rests on the determination of the form and structure of the newly acquired animal, the degree in which it resembles therein the previously known species, between any two of which it may thus be determined to stand, and the way in which it may have come to differ from them. In the zoological method of defining such results as may be attainable and have been attained, the differences are sought for, weighed, prominently set forth, and technically defined: in the homological quest the resemblances receive most attention; and the result of their appreciation is commonly, if not inevitably, some speculation, or tendency to speculate, on their cause and relations.

In the Gorilla, as in other latisternal Apes, the homologue of every organ and of almost every named part in Human anatomy is present.

To transmute a Gorilla into a Man the chief steps would be as follows:—In the alimentary canal, to develope the mucous membrane of the small intestines into the 'valvulæ conniventes,' and to alter the proportions as to length of the small and large intestines. To abrogate the sexual distinctions of the dental system: to reduce the size of the teeth, especially in relation to the head; to reduce in a greater degree the size of the incisors, and still more so that of the canines, especially in the males, so as to bring the crowns of all the teeth to the same level, admitting, and being followed by, their arrangement in a continuous unbroken series; to alter the shape of the canines and contiguous premolars, and to slightly modify that of the crowns of the other grinding teeth.

In the nervous system, the steps in transmutation would be to abrogate the law of the early arrest of the brain's growth, and to cause it to proceed, especially in the cerebral part, with the general growth and development of the frame, though in a slower ratio: to add to the number and depth of the cerebral convolutions, and to modify their disposition: to augment the size of the corpus callosum, both absolutely and relatively to the cerebellum and medulla oblongata: to expand the cerebrum in all directions, and especially backward beyond the cerebellum, so as to define a 'posterior' or 'post-cerebellar' lobe: to extend the chief cerebral cavity, or 'lateral ventricle,' forward beyond the corpus striatum into an 'anterior horn,' and backward beyond the hippocampus major into a 'posterior horn,' answerable to the cavity so called in anthropotomy, and with prominences corresponding with Tiedemann's and other anthropotomical definitions of the 'hippocampus minor;' the beginnings, or incipient homologues, of which cavity and part are alone present in the highest Apes.

Coextensively with this new and improved condition of cerebral growth will be the expansion of the cranial cavity, as, with the reduction of the size of the teeth, there would be contraction of the jaws; the general result being the change in the proportions of the face to the cranium, and transmutation of the shape of the head and skull from that shown in vol. iv. pl. 28. to that shown in vol. iv. pl. 30. of the 'Transactions of the Zoological Society.'

In the vertebral column the following changes must take place:—Reduction of the length of the cervical spines and of the ribs of the thirteenth dorsal, converting this vertebra, by their anchylosis, into a first lumbar vertebra: liberation of the pleurapophyses of the twenty-third and twenty-fourth vertebræ at their distal ends, reduction of their thickness, and consequent transformation of the first two sacral into the last two lumbar vertebræ. The curves and disposition of the different sets or kinds of 'true vertebræ' must be likewise modified. When the zoologist contrasts *Homo* with *Troglodytes* or *Pithecus*, by predicating five lumbar vertebræ as peculiar to and characteristic of Man, in the limits of such comparison, the tyro is not to suppose that the modified homologues of those vertebræ are wanting in the Apes; nor will the teacher gain other than a passing notoriety by vaunting their presence as a new and valuable discovery, with brazen charges of their absolute denial by the real demonstrator of their homological existence.

Finally, in regard to the geographical distribution of the higher Quadrumana, I would contrast the peculiarly limited range of the Orangs and Chimpanzees with the cosmopolitan character of Mankind. The two species of Orang (*Pithecus*) are confined to Borneo and Sumatra; the two species of Chimpanzee (*Troglodytes*) are limited to an intertropical tract of the western part of Africa. They appear to be inexorably bound by climatal influences regulating the assemblage of certain trees and the production of certain fruits. With all our care, in regard to choice of food, clothing, and contrivances for artificially maintaining the chief physical conditions of their existence, the healthiest specimens of Orang or Chimpanzee, brought over in the vigour of youth, perish within a period never exceeding three years, and usually much shorter, in our climate. By what metamorphoses, we may ask, has the alleged humanized Chimpanzee or Orang been brought to endure all climates? The advocates of "transmutation" have failed to explain them. Certain it is that those physical differences in cerebral, dental, and osteological structure which place, in my estimate of them, the genus *Homo* in a distinct group of the mammalian class, zoologically of higher value than the 'order,' are associated with equally contrasted powers of endurance of different climates, whereby Man has become a denizen of every part of the globe, from the torrid to the arctic zones.

DESCRIPTION OF THE PLATES.

PLATE XLIII.

Adult male Gorilla (from Mr. du Chaillu's collection, purchased by the Trustees of the British Museum).

PLATE XLIV.

Fig. 1. Adult male Gorilla, showing the ordinary quadrupedal mode of progression.
Fig. 2. Adult female Gorilla.
Fig. 3. Young male Gorilla.

(From Mr. du Chaillu's collection, purchased by the Trustees of the British Museum.)

The above figures were drawn by Mr. Joseph Wolf, for the illustration of the present Memoir, and lithographed, in 1861.

PLATE XLV.

Fig. 1. From a photograph of a half-grown male Gorilla, as the specimen appeared, with much loss of cuticle and hair, when recently removed from the cask of spirits in which it had been transmitted from the Gaboon to the British Museum.
Fig. 2. From a photograph of the head of the same specimen.
Fig. 3. *Ibid.* Front view of the head.
Fig. 4. *Ibid.* Right side of the head.

PLATE XLVI.

Fig. 1. From a sketch, by Mr. Joseph Wolf, of the same specimen, showing the nates and hind limbs.
Fig. 2. *Ibid.* Supine position.
Fig. 3. *Ibid.* Fore-arm and hand, as applied to the ground in progression.
Fig. 4. *Ibid.* Another view of the fore hand.
Fig. 5. *Ibid.* Fore hand grasping.
Fig. 6. *Ibid.* The hind hands.

PLATE XLVII.

Fig. 1. From a photograph of a male Gorilla, retaining cuticle and hair, as the specimen appeared when recently removed from the cask of spirits in which it had been transmitted to the 'Derby Museum' at Liverpool.

Fig. 2. *Ibid.* Palm of the fore hand.
Fig. 3. *Ibid.* Back of the fore hand.
Fig. 4. *Ibid.* Palm or sole of the hind hand.
Fig. 5. *Ibid.* Back of the hind hand.
Fig. 6. The pinna, auricle or external ear, of a young male Gorilla, photographed on a larger scale.
  h. Helix.
  a. Anthelix.
  s. Scaphoid fossa, or fossa of the helix.
  f. Fossa of the anthelix.
  c. Concha, partially divided by *h*, the commencement of the helix.
  t. Tragus.
  r. Antitragus.
  i. Incisura intertragica.
  l. Lobulus.

Fig. 7. The nose and part of the upper lip of the same animal, photographed on the same scale.

(For these photographs I am indebted to Mr. Moore, the able Curator of the Derby Museum.)

PLATE XLVIII.

Fig. 1. Upper view of the cast of the cranial cavity, representing the brain of a full-grown male Gorilla.
Fig. 2. Side view of the same cast.
  c. Cerebrum.
  b. Cerebellum.
Fig. 3. Dissection of the brain of a young male Gorilla, showing the beginning of the posterior cornu and pes hippocampi minor.
  a. Corpus striatum.
  b. Tænia hippocampi.
  c. Hippocampus major.
  e. Posterior cornu with beginning of pes hippocampi minor.

(The diagram of this dissection, used in my Fullerian Course of Lectures at the Royal Institution, February 1861, was copied in the Report of the Lecture in the 'Athenæum,' March 23, 1861.)

PLATE XLIX.

Outlines of skull of a young Chimpanzee (sex unknown), and of a young male Gorilla, with deciduous dentition, answering to the human phase of the third year: three-fourths the natural size.

Fig. 1. Upper view, *Troglodytes niger.*
Fig. 2. Side view, *Troglodytes niger.*
Fig. 3. Upper view, *Troglodytes Gorilla.*
Fig. 4. Side view, *Troglodytes Gorilla.*

The following symbols apply to each figure :—

d.i. 1. Deciduous mid-incisor, acquired in the human infant at about the seventh month.
d.i. 2. Deciduous side-incisor, acquired in the human infant at about the eighth to the tenth month.
d.c. Deciduous canine, acquired in the human infant at about the fourteenth to the twentieth month.
d.m. 3. Deciduous anterior molar, answering to the 'third' of the typical diphyodont dentition, acquired in the human infant at from the twelfth to the fourteenth month.
d.m. 4. Deciduous posterior molar, answering to the 'fourth' of the typical diphyodont dentition, acquired in the human child at from the eighteenth to the thirty-sixth month.
i. 1 (in figs. 1 & 2). Germ of permanent mid-incisor.

In regard to the question of the relative degree of approximation to Man, or to the position in the animal series, of the Gorilla and Chimpanzee, the above outlines, engraved from drawings made with great care in 1860, show the greater absolute size of the cranium in the Gorilla; its greater relative size to the face, more especially the greater convexity of the frontal bone; the smaller relative size of the premaxillary (*d.i.* 1 & 2), containing the deciduous incisors; the smaller relative size of those incisors, both to the entire skull and to the molars.

The greater relative size of the deciduous canines in the Gorilla may depend upon a difference of sex; the skull of the young Chimpanzee may have been that of a female: it was presented to the Royal College of Surgeons of England, by Earl Spencer, in the year 1816, and is described in my 'Catalogue of the Osteology' of that museum, 4to, vol. ii. p. 781, no. 5171[1].

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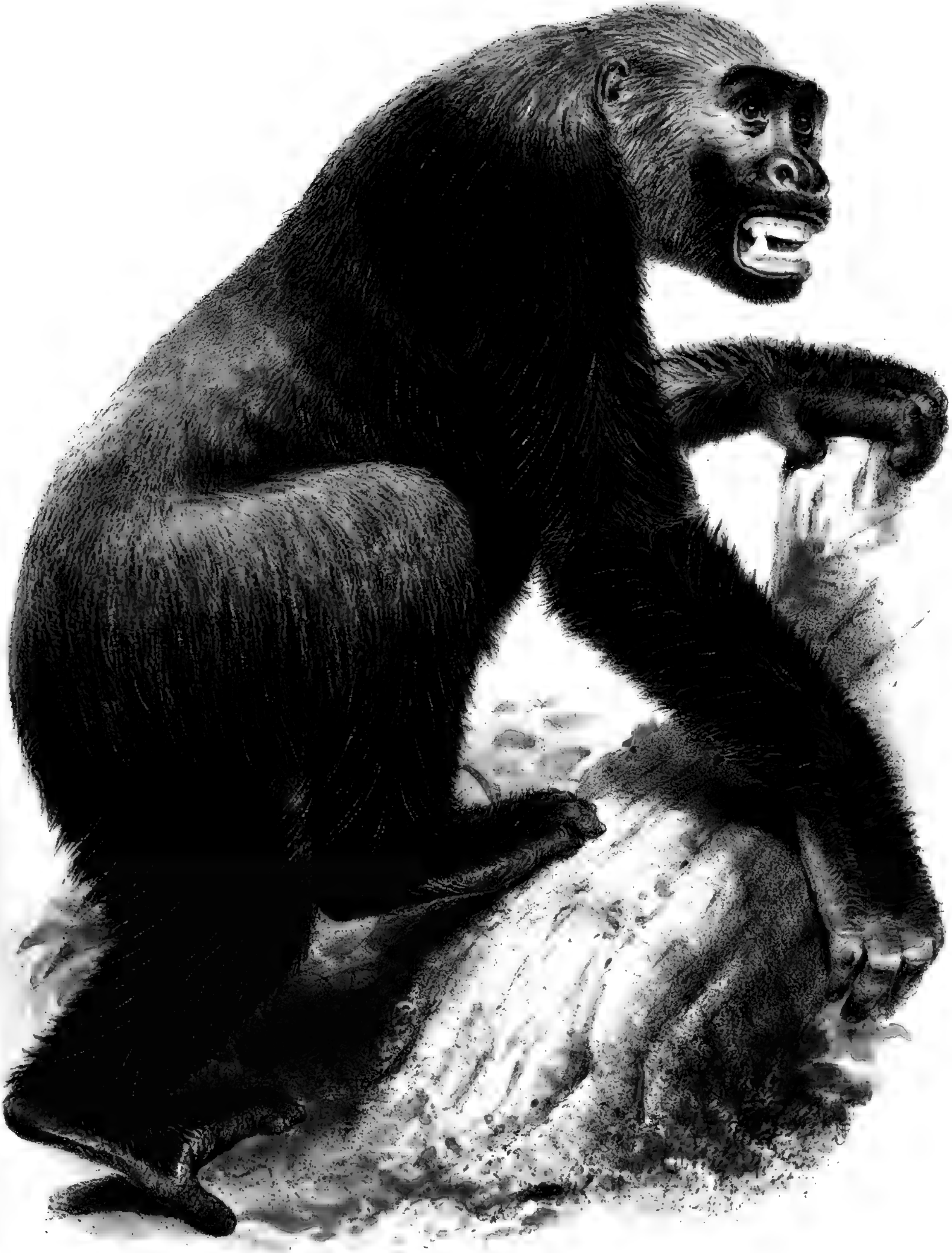
[1] See also the memoir, "Sur le Gorille," in the 'Bulletin de la Société Linnéenne de Normandie' (vol. vi. Caen, 1861), by the accomplished Professor and Dean of the Faculty of Sciences of Caen, M. Eudes-Deslongchamps, in which are given figures of the skulls of the young Orang, Chimpanzee, and Gorilla, and of their deciduous dentition, confirmatory of the conclusions to which I had arrived as to their order of precedence in the zoological scale.



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Troglodytes Gorilla.

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F Robinson lith

Troglodytes Gorilla

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C H Ford

Troglodytes Gorilla

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Troglodytes Gorilla

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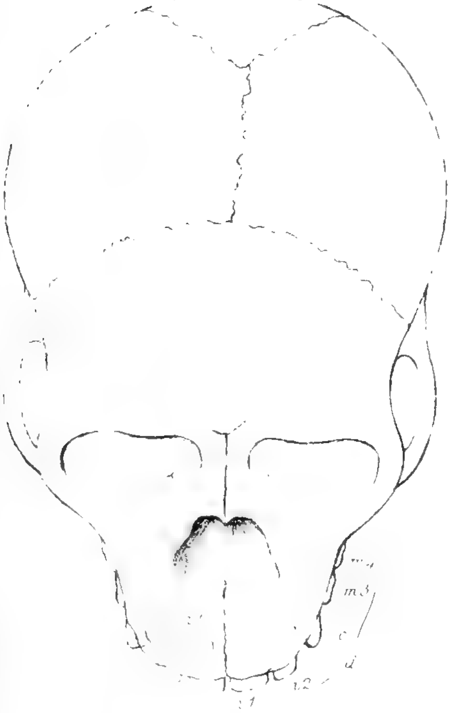

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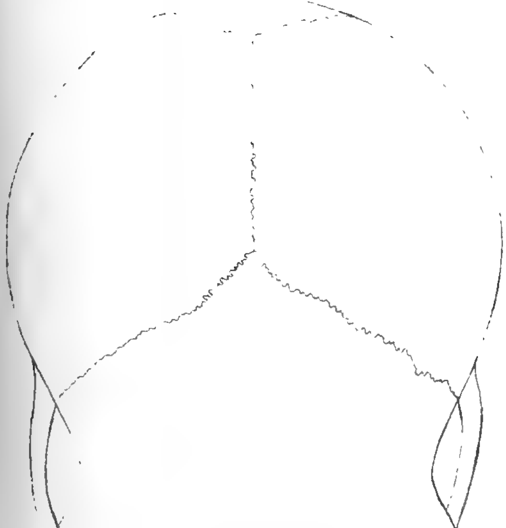

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VII. *On the Placental Structures of the Tenrec* (Centetes ecaudatus), *and those of certain other Mammalia; with Remarks on the Value of the Placental System of Classification.*

By Professor ROLLESTON, F.R.S., F.Z.S., &c.

Read June 23, 1863.

[PLATE L.]

HAVING, through the kindness of Alfred Newton, Esq., F.Z.S., come into possession of a female Tenrec (*Centetes ecaudatus*), I propose to lay before the Society a description of its generative organs, and of certain fœtal structures which were found in connexion with them. To this I shall append descriptions of the homologous structures in several other Mammalia, comparing them *inter se*, as well as with what I believe will prove to be the unique modifications of the placenta in the Tenrec; and throughout the paper I shall keep in view the bearing which the facts detailed may have upon the morphological value of differences in the structure of the placenta.

1. *Female Generative Organs.*

The urethro-sexual and anal outlets open within a single orifice, on either side of which there is a saucer-shaped depression, such as exists in the Rabbit, underlain by a cluster of all but sessile glands, with which racemose anal glands, possessing excretory ducts converging to one common pedicle, coexist. The urethro-sexual canal is seven eighths of an inch in length; its walls are smooth internally, and it receives on either side the duct of a Duvernoy's gland. The vagina is divisible into two portions, the lower part of the tube being smooth and patent internally, whilst the upper has its canal more or less perfectly obliterated by the interlocking of inwardly growing transverse processes of its walls. The lower part of the vagina is one inch in length; the upper is one inch and an eighth. The interlocking processes developed from the walls of the upper part leave a pervious passage from below upwards for about half the length of this part of the tube; the uppermost half, however, is entirely blocked up by the formation of complete transverse septa. Upon one of these, at a distance of three eighths of an inch from the commencement of the uterine cornua, an *os tincæ*-like projection, a quarter of an inch long, but ending blindly, is developed. Its presence may make it doubtful whether the portion of the sexual canal, with the interlocking processes developed upon it, does not correspond to parts both of vagina and of corpus uteri. Somewhat similar processes are figured by C. G. Carus[1] in the Kinkajou (*Cercoleptes caudivolvulus*) in the vagina alone, the corpus uteri having been left un-

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[1] C. G. Carus, 'Tabulæ Anatomiam Comparativam Illustrantes,' pars v. tab. viii. fig. 6, 1840.

dissected in the preparation there drawn; and Leuckart[1] speaks of similar outgrowths being developed in the vagina of the Banxring (*Cladobates*, sp.?) during pregnancy; whilst in the ordinary Ruminants and the Llama (*Auchenia glama*), figured by Carus (*l. c.* fig. 5), they are confined to the corpus uteri. In the common Pig (*Sus scrofa*) similar processes to those in the Tenrec are to be seen occupying a similar situation[2].

There is in the Tenrec a short corpus uteri above the closed portion of the sexual canal. Of the two cornua opening into it, the left one is three inches and a half long, and the right four inches. In the left cornu there were contained four fœtuses, and, in addition to the utero-placental areæ corresponding with them, there were two patches of tumid mucous membrane over and above, indicating apparently that two additional ova had been attached there and aborted. There was one similar patch in the right cornu, together with eight fœtuses. In all, therefore, as many as fifteen ova had been impregnated; three had aborted, and twelve might have been brought to the birth. As many as twenty-one young ones are said to have been brought forth by the Tenrec at one time: it has twenty-four mammæ; but the number of mammæ and the number of fœtuses are by no means always in exact correspondence in the class Mammalia.

From the neighbourhood of the ovary a stout fibrous band passes upwards to lose itself in the peritoneum, lying exteriorly to the kidney, and in relation with the diaphragm. This structure is to be seen in most female Mammalia; and a band, with homologous connexions, exists in many male Mammalia, both of "testicondous" and of other orders. It has been seen by me in the Tamandua (*Myrmecophaga tetradactyla*) and in the *Pteropus*, and also in the fœtus at full time of the Pigtailed Monkey (*Macacus nemestrinus*) and in the Human subject at the age of fifteen months, in each case attached to the caput majus epididymis. It is, no doubt, the remnant of the *ligamentum diaphragmaticum*, figured by Kölliker (fig. 215, Entwickelungsgeschichte, 1861) as connecting the Wolffian body and the generative gland of the early embryo with the structures in relation with the diaphragm.

There is no *ligamentum rotundum* in the Tenrec; and indeed we should not expect to find such a structure in a species the male members of which have the testes permanently lodged in the position in which they are primarily developed[3]. The rudiment, however, of the ligamentum diaphragmaticum is often found coexisting with the ligamentum rotundum, as, for example, in the Hedgehog (*Erinaceus europæus*), and consequently it cannot be, as has been asserted[4], the homologue of it.

In the Tenrec the ligamentum diaphragmaticum is continued onwards from the region of the ovary on to the uterine cornu, constituting thus a "ligamentum ovarii" of anthropotomy. Upon the compound cord thus constituted the ovary is not quite

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[1] Vergleichende Anatomie und Physiologie, von C. Bergmann und R. Leuckart, 1855, p. 627.

[2] The same condition obtains in the Rhinoceros and in the Elephant. (See 'Hunterian Catalogue,' iv. 2775, 2777 *a*.)

[3] C. G. Carus, *l. c.* tab. ix. fig. 2.

[4] Phil. Trans. 1850, p. 516.

sessile[1], but is connected with it by a short cord which meets it at right angles. The peritoneal capsule of the ovary is large and loose, opening by a small orifice into the general cavity of the peritoneum. The ovary itself has, from the small quantity of its stroma, the granulated appearance so well marked in the Shrew and Hedgehog.

2. *Maternal and Fœtal Structures developed* in utero *in connexion with the Embryos.*

Owing to the state of preservation in which the specimen was when it came into my hands, the maternal and fœtal structures in connexion with the chorion had, in every case but one, become self-analyzed into three parts. These parts were, first, an area of tissue continuous at its periphery with the non-placental uterine mucous membrane; (Pl. L. fig. 3); secondly, a lamina of membrane floating loosely, and, like the utero-placental area, perforated centrally by vascular orifices (fig. 2); and, thirdly, the placenta proper (fig. 1), of a diameter of about half an inch. One ovum only retains its natural connexion with the uterine wall; but in several cases the lamina of membrane (fig. 2) ordinarily found floating loosely remains attached to its utero-placental area. Of this area I will first speak. It is subcircular, and bounded by a slightly raised parapet of uterine mucous membrane (U P, fig. 3), with which an upgrowth of the chorion (CH′ fig. 1) was continuous in all the ova, and remains so in one instance at present. The diameter of each utero-placental space thus bounded being about half an inch, its area is divisible into two regions—one, the outer one, being quoit-shaped and surrounding a circular central inner region (P S, fig. 3). The depth of the outer ring is about half the length of the diameter of the entire area; it is clothed with a mucous membrane of pulpy appearance and corrugated more or less regularly. In being thicker, and in being corrugated, this portion of the utero-placental area contrasts with the mucous coating of non-placental portions of the uterus, the mechanical pressure and contact of the many fœtuses accounting, probably, for the smoother and thinner character of the mucous layer in the latter portions of the organ. The central circular portion of each utero-placental area is distinguished, by its irregularly perforated and discoloured appearance, both from the ring-shaped area immediately surrounding it and from the rest of the uterine mucous coat. The membrane covering both regions in each utero-placental area is single, and does not admit of being split up into laminæ; but in several cases, the lamina (fig. 2), more commonly found floating freely, is left adhering to the utero-placental area. This lamina, when free, presents many orifices of blood-vessels, centrally; and its general structure is loose and pulpy. When adherent to the utero-placental area, it is by its outer margin that it is attached along the line of demarcation between the outer and inner regions of each utero-placental area. In other words, the utero-placental mucous membrane seems to split at this line into two laminæ, between

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[1] The ovary of the Sow is somewhat similarly pedunculate (see 'Hunterian Catalogue,' iv. 2782), and so also is that of other animals, as the Rat.

which a watch-shaped cavity is included, and each of which is sieve-like centrally from vascular perforations.

The placenta (Pl. L. fig. 1) is thinnest at its centre; at its periphery the chorion is prolonged upwards in the shape of a circular rim (CH′) of a depth of a quarter of an inch. The umbilical vessels are very plainly seen to be prolonged into ramifications along this rim, and in it. The rim itself, or upgrowth, is continuous with the parapet, or downgrowth, of uterine mucous membrane (U P, Pl. L. fig. 3)—an arrangement which, so far as I have been able to find, is unique.

The umbilical cords of these fœtuses are long; the fœtuses being about an inch and a half long, the cord is in some instances of equal length with them; and the cavity of the amnios is large—sufficiently capacious, indeed, to admit of the introduction of a second fœtus. Resembling the Human fœtus more or less in these two points, the fœtal membranes of the Tenrec resemble those of the Ruminants in the possession of numerous corpuscles studding the interior surface of the amnios. These corpuscles are in some cases attached to the inner surface of the amnios, but in most cases they have fallen away from it; in some cases they are filiform or even club-shaped, in most they are boat-shaped, or, rather, of the shape of a single valve of an ordinary bivalve, and attached by the concave side to the amnios, whilst projecting with a smooth convex one into its cavity. And as to the naked eye, so under the microscope, they resemble *les plaques de l'amnios chez les Ruminants*, as described by Professor Claude Bernard[1]. The longer of these corpuscles were as much as two millimetres long by one broad—much the same size, in fact, as the similarly placed corpuscles of the Elephant described by Professor Owen[2]; many, however, were of smaller dimensions.

I could not discover any traces of yelk-sac, nor of allantois, nor of any membrane exterior to the amnios. Neither were any omphalo-mesenteric vessels detectable within the cavity of the abdomen. But the anastomosis between the veins of the abdominal wall and the umbilical vein, which is not rare in Mammalia[3], was very plainly demonstrable.

The placenta proper has assumed the "flocculent" appearance which prolonged maceration, whether in weak spirits or in any other such menstruum, will confer on any placenta, however "cellulo-vascular" or "spongy," in the normal condition. Still to the apices of its villus-bearing trees, shreds of the lamina (fig. 2) are in several instances left adhering, especially in the angle between the chorionic upgrowth, CH′, and the uterine aspect of the placenta. The layer of tissue adherent to the utero-placental area possessed histological characters quite distinct from those of the muscular coat it overlay. The circular muscular coat is easily separable from the longitudinal.

The lamina of tissue (fig. 2) intermediate between the placenta and the utero-placental area, I would propose (without any reference to the etymological meaning of the word

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[1] Brown-Séquard, 'Journal de Physiologie,' vol. ii. p. 34, 1859.

[2] Phil. Trans. 1857, p. 348.

[3] Rathke and Coste, cit. Kölliker, 'Entwickelungsgeschichte,' p. 420.

"*serotina*," or to the now exploded theory which the word was intended to bring before the mind) to call "*deciduous serotina*"; the utero-placental mucous area (fig. 2) I would call "*non-deciduous serotina*"; and the spongy structure (fig. 1) made up of villi and umbilical vessels, and, in all placental mammals (except Cetacea, Artiodactyles, and Perissodactyles, and possibly Bruta), of more or less maternal structure inextricably intermixed as well, I would call "placenta." The word "after-birth" includes "placenta" and "deciduous serotina," both usually, though not invariably, coming away together.

Owing to errors of observation, the name "decidua serotina" has been applied to the structure I would call "non-deciduous serotina," as well as to that to which Dr. Priestley[1], like myself, would limit it. It is called "parietal decidua" by Professor Goodsir[2], and "caduque intero-placentaire" by M. Robin[3]. And in an account of it given by Professor Kölliker, I find him speaking of it in the Human subject as "eine zusammenhangende Haut wenn er gut erhalten ist"[4]. It is sometimes called "placenta materna"; but this phrase is applied to the maternal element of the "placenta" also, and the adoption of it would consequently cause confusion. That the utero-placental area is, after parturition, covered by a layer of mucous tissue, and that the muscular coat is not laid bare at that period, but protected by a more or less consistent and coherent coating, to which I would affix the name of "non-deciduous serotina," was clearly shown, in the year 1853, by Dr. Matthews Duncan[5], and has been subsequently confirmed by Drs. Chisholm and Priestley[6] in Great Britain and by M. Robin in France.

This is not the place for histological and pathological details, such as will be found in the literature to which I have just referred; but, from a zoological point of view, it may be remarked that the fact of the non-regeneration of the uterine cotyledons of the Ruminant, after accidental separation of them from the uterine wall, lends the strongest confirmation to Dr. Matthews Duncan's views. It has been most satisfactorily shown[7] that, after such an occurrence, the place of the lost cotyledon is occupied not by fresh mucous membrane, but merely by a white cicatrix.

I will now proceed to contrast and compare the fœtal and maternal structures in connexion with the placenta of certain other mammals with their homologues already described in the Tenrec.

[1] On the Development of the Gravid Uterus, pp. 22 & 48, 1860.

[2] Anatomical and Pathological Observations, 1845, p. 60, pl. 3. fig. 6.

[3] Mém. Acad. Imp. Méd. Paris, 1861, tom. xxvi. pp. 131 & 141, where there is a disquisition on its histology. See also Cazeau, 'Traité des Accouchements,' 1856, pp. 192 & 202.

[4] *l. c.* pp. 145 & 158.

[5] Edinburgh Monthly Med. Journ. Sept. 1853. See also Medico-Chirurgical Review, Oct. 1853; Edinburgh Month. Med. Journ., Dec. 1857, Feb. 1858; Obstetrical Society's Trans. vol. iv. April 1859, May 1862.

[6] Edinburgh Monthly Med. Journal, Sept. 1854; *ibid.* Jan. 1857.

[7] M. Goubaux, cit. Colin, 'Physiologie Comparée,' vol. ii. p. 612.

Insectivora and Chiroptera.

In the Hedgehog (*Erinaceus europæus*), at a time when the fœtus is about one-third the size of that of the fœtal Tenrecs here described, and the yelk-sac is as large as the amniotic, the non-deciduous serotina is separable as a perfectly distinct and coherent coat from the circular muscular coat which it overlies; the deciduous serotina is a very thick mass, bell-shaped, with its convex end attached to the non-placental mucous membrane by a thin peripheral parapet, within which vessels and cellular tissue connect it with the utero-placental area. Exteriorly to the attachment of the delicate parapet of non-placental mucous membrane, the external surface of the deciduous serotina becomes smooth, and it may here take the name of "decidua reflexa," whilst its internal surface, in apposition with the ovum, remains rough and flocculent. The prolongation of decidua serotina, or, in other words, the decidua reflexa, does not entirely encapsulate the ovum, as we shall see that it does in certain Rodents, but falls short of doing so by an interval homologous with the non-vascular umbilicus-like spot observable in the decidua reflexa of the Human subject[1]. The entire structure inter-uteroplacentally and extra-ovularly placed is bell-shaped, as compared with its wafer-shaped homologue in the Tenrec, or its closed sac-like homologue in the early embryo of the Rat. The decidua reflexa is sometimes spoken of as being an outgrowth of the decidua serotina[2], sometimes as being continuous rather with the decidua vera in the Human subject[3]. What is of importance to bear in mind is, that the non-placental mucous membrane becomes continuous at the periphery of the placental area with both non-deciduous and deciduous serotina; and that from the point of its junction with this latter structure a more or less extensive envelope grows outwards over the chorion, to which the name "decidua reflexa" is given. The placenta at this period in the Hedgehog is a much smaller structure than the deciduous serotina it underlies; it is itself underlain by a purse-shaped allantois like that of the Rabbit, which moors the amniotic sac and the fœtus it contains to one pole, whilst the yelk-sac moors it to the other pole of the chorion. As in the early fœtus of the Dog, so in that of the Hedgehog at this period, it is possible by maceration to separate entirely, or nearly so, the fœtal villi growing on the allantoic area of the chorion from the maternal elements, which shortly after become inextricably interfused with them to form the "placenta."

In a Shrew (*Sorex*, sp. ?), the fœtus being at an early stage of development, and only three eighths of an inch long, the deciduous serotina was, as in the Hedgehog, about three times the size of the placenta proper. I did not satisfy myself that it was prolonged into a decidua reflexa: that it was so is rendered improbable by the fact that the other membranes were drawn out at either end into slender tubular processes of an eighth of an inch in length, beyond the subglobular space occupied in the uterine cornu by the fœtus. Its structure was coarsely columnar; that of the placenta presented a villous appearance. The placentæ were attached to the free border of the uterine cornu.

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[1] Kölliker, *l. c.* pp. 178, 181.

[2] Ibid. p. 142.

[3] Robin, *l. c.* p. 131.

Of the fœtus (now unfortunately lost) of a Vampire (*Phyllostoma hastatum*) I have the following note:—"The ovum was five eighths of an inch long. There was a considerable, if not complete, decidua reflexa. Next to the decidua reflexa came the chorion, to which, as in the Rodents, an omphalo-mesenteric artery went." In the uterus of this Bat (which I still possess) the non-deciduous serotina is, as in the Insectivora, separable from the circular, and this again from the muscular coat.

Neither in the Shrew nor in the Vampire have I any note of the umbilical vesicle. In the fœtus of the Mole, however, and *Pteropus* I have observed it to be present, and large.

Before passing on to a comparison of the Tenrec's placental structures with those of other orders of Mammalia, it may be well to enumerate the points in which they differ from those of the, perhaps, most nearly allied order, Chiroptera, as well as from those of other Insectivora. These points of difference, then, are the absence of a yelk-sac, of the allantois as a distinct sac, and of any membrane, either decidual or chorionic, on the exterior of the amnios. The upgrowth of the chorion in the Tenrec, its attachment to the periphery of the utero-placental area, and the division of this area into two regions are points peculiar to this creature. Aberrant thus in its placenta, it is aberrant from those nearest of kin to it in several other peculiarities pointing towards marsupial affinities. Of these it may suffice to mention the involution of its lower-jaw angle, and the reception of its lower canine into a fossa in the upper jaw.

Carnivora.

A Bull-bitch (*Canis familiaris*) which had been impregnated, it was believed, by a dog of much larger size, was delivered, with artificial help, of one of two fœtuses at full time. The other fœtus was retained in the left uterine cornu, the life of the mother, (the vagina having been ruptured) having come to an end after the birth of the first. The uterus and vagina were brought to me, together with their contents, by Dr. Tuckwell, and I am thus enabled to give the following account of the state of the afterbirth, and of the uterine walls of the Bitch after parturition. In the right cornu, whence the fœtus, which had been expelled, came, the mucous membrane was much corrugated transversely to the long axis of the tube. The zone to which the fœtus had been attached was recognizable by its pale colour, a red injection which had been thrown into the vessels having given a florid tinge to the non-placental mucous coat on either side of it, but having left it of a greyish hue, and by its roughened surface irregular with depending broken ends of vessels and with processes of membrane. It was bounded also on either side by an upstanding parapet, the homologue of the structure U P in the several figures appended. The same description will apply to the mucous coat of the other cornu, with the exception that in it, owing to the retention of the fœtus, no corrugation was observable. On examining the mucous coat of the uterus, it was found to be perfectly continuous over the placental area, to be thicker over that zone and more opake, and to resist disruption at the lines of junction with the non-placental portions of the coat with the greatest tenacity; and, as in the Hedgehog, and in the Vampire (*Phyllostoma hastatum*), the mucous coat of the placental area, or persistent serotina, was readily detachable, as a distinct and coherent layer, from the circular muscular coat, and this again from the longitudinal. Examined with the microscope, the utero-placental zone was found to contain abundance of tubular glands, as was also the homologous layer in the uterus of a Cat at full time. The membranes of the undischarged fœtus had been ruptured, and the placental zone broken across. Its uterine surface was rough and shreddy; but no distinct deciduous serotina could be raised from its surface (as there can be from that of the Cat at full time, in a continuous ring-like sheet). Of the absence of the decidua serotina in the fœtal membranes of the Dog at full time both Bojanus[1] and Von Baer[2] were aware, though neither of them states that it is present at the same time in the Cat. If we look, however, at the uterine surface of the placenta of the Dog at full time, we shall see upon it shreds of membrane, which, on floating the structure out under water, are observed to form a more or less regular polygonal reticulation. This network of upstanding laminæ is the remnant of what was a separable membrane at earlier periods. This will appear the more clearly from a description of the placenta, deciduous, and non-deciduous serotina of the fœtal Dog at about a month of intra-uterine life.

The non-deciduous serotina is then distinctly visible as a villous coating on the utero-placental zone. Bojanus (*l. c.* p. 143) speaks of it, in comparison with the non-placental mucous membrane, as "crassiorem, floccosam, leviter spongiosam, et cellulis distinctam hiantibus ubi primum fœtus suis velamentis ab utero distrahitur." Next to it we find a membrane separate alike from placenta below and non-deciduous serotina exteriorly, presenting the appearance of a circular honeycomb-work, the depth of the more or less regularly polygonal cells being from the fifth to the eighth of an inch in depth, and of about the same diameter. This membrane readily peels away from the placenta proper, at all events in a specimen which has been for some while in spirits; and the surface of this latter envelope is now seen to be also obscurely mapped out into polygonal spaces. These spaces, however, are not empty, as are the honeycomb membranes just described, but their periphery is filled up with cellular elements belonging to the maternal organism, whilst in the centre of each is to be seen the summit of the mushroom-shaped upgrowths from the chorion. These two elements may, as already remarked in the case of the Hedgehog, be separated from each other with some little trouble[3]; at a later period they not only become inextricably fused with each other, but, growing upward and into the honeycomb layer of decidua serotina, they cohere inextricably with it also, and bring it away with them at parturition, as already described. It is perhaps remarkable that the decidua serotina should retain its distinctness in the Cat; its alveolar character, however, is not of the same coarseness as that of the homologous membrane in the Dog,

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[1] Nova Acta, tom. x. p. 143, 1820.

[2] Entwickelungsgeschichte, ii. p. 242, 1837.

[3] Bischoff, 'Hunde Ei,' p. 114.

and the greater relative abundance of all the other elements, and the smaller consequent size of the honeycomb vacuoles, may account for the maintenance by it of an independent existence up to the period of parturition. It exists, however, in the Cat at full time rather as a separable than as a coherent layer. In the Dog it is neither coherent nor separable from the placenta[1].

It is difficult to see how, with the honeycomb-like decidua serotina of the fœtal Dog placed in relation with the mucous membrane of the unimpregnated and unenlarged uterus of the bitch as figured by Dr. Sharpey[2] before one, it is possible to cast the doubt upon that observer's views which M. Robin has done[3]. It is obvious that when glands or follicles are arranged as closely together as in the figure referred to, all increase of their calibre must take place by means of outgrowth of interfollicular or interglandular substance, and that, admitting the facts which are incontrovertible, the contradiction of of M. Robin amounts but to a dispute[4] as to the use of words. Bischoff's assertion[5], that the cotyledons of the Roe (*Cervus capreolus*) are devoid of utricular glands, amounts to more than a verbal question; but as Eschricht and Von Baer had noted their absence in the similar structures of ordinary Ruminants[6] many years previously, this observation has little claim to be quoted as novel.

The decidua reflexa can be scarcely said to be present even as a mere rudiment in Carnivora. The mucous secretion found exteriorly to the chorion may perhaps be considered as homologous with the distal part of what in other orders is a coherent, more or less perfectly encapsulating membrane.

I have not observed, nor do I know, that any observations have been made showing that any variations exist as to the relations or degree of development of the allantois, amnios, or umbilical vesicle within the class Carnivora.

Von Baer's words (*l. c.* p. 243), "Vielleicht weicht das Ei der Sohlengänger, das ich nicht kenne in einiger Hinsicht, ab; beim Iltis ist der Gürtel des Fruchtkuchens nicht vollständig," refer in all probability to the description given of the placenta of the *Ferret* by Daubenton, in the 'Histoire Naturelle,' tom. vii. 1758. "Iltis" is ordinarily used to denote the Polecat (*Mustela putorius*); but Von Baer may have thought himself justified in considering the Polecat and Ferret as of the same species, and using the term "Iltis" as an equivalent for *Mustela furo*. Breschet[7], however, is in no way justi-

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[1] It would seem from Barkow's description of the fœtal membranes of a Seal (*Phoca vitulina*), that the decidua serotina possesses both these characters in that animal (Zootomische Bemerkungen, 1851, p. 7).

[2] Müller's 'Physiology,' translated by Dr. Baly, p. 1575.

[3] Robin, *l. c.* p. 132, "Les villosités des cotyledons ou du chorion de l'homme et des autres mammifères tels que ruminants, rongeurs, carnassiers, solipèdes, et fissipèdes, n'enfoncent pas, comme on le dit, leurs subdivisions terminales dans les glandes tubuleuses de la muqueuse utérine."

[4] See also Goodsir, 'Anat. and Path. Observations,' 1845, p. 58; and Henle, 'Handbuch der Eingeweidelehre,' 1862, p. 462.

[5] 'Entwickelungsgeschichte des Rehes,' 1854, p. 22, fig. 43, cit. Kolliker, *l. c.* p. 170.

[6] Von Baer, 'Gefässverbindung,' p. 16. Eschricht, 'De Organis,' p. 36.

[7] 'Mémoires de l'Institut,' tom. xix. p. 457.

fied in substituting for "le Furet Putois" the words "*la belette Mustela*;" and Daubenton's words, which we append, will show that he is scarcely justified in speaking of this creature as furnishing an instance of a double placenta, such as that which we find in the Old-World Simiadæ (p. 220), "Chaque fœtus avoit deux placentas ronds, posés sur une zone circulaire qui embrassoit le fœtus sur le milieu du corps, comme les placentas du Chien et de la Fouine. Les placentas du Furet avoient chacun environ neuf à dix lignes de diamètre et une ligne d'épaisseur dans le milieu. Leur face extérieure étoit grisâtre, et l'intérieure avoit une couleur rougeâtre. Ils n'étoient éloignés l'un de l'autre que d'une ligne par l'un des côtés et d'un pouce par l'autre côté; *ce dernier intervalle étoit rempli par une sorte de placenta, car la substance qui s'y trouvoit étoit beaucoup plus épaisse que celle du chorion et celle de l'amnios.*"

Rodentia.

The following history will show that in the Rat, and probably in all other Rodents, the three structures which we have called placenta, deciduous serotina, and non-deciduous serotina are as distinct from each other as they are either in the Cat or in the Tenrec. A female Rat (*Mus decumanus*) was killed after giving birth to nine fœtuses. Of these, three had been partly devoured by the mother to the extent of one-third or so of their whole bodies, beginning in two cases from the head and in the third from the tail. The stomach of the mother was found to contain, besides the food furnished to her and the portions of the fœtuses just specified, the placentas or a great number of the placentas which had been in connexion with the nine fœtuses. Some of these placentas had upon the convex surface a cap of pulpy decidua serotina with a thickened border; in others this cap was removed, and the placenta, from exposure to the macerating action of the digestive juice, had its villi hanging free, and presenting an arborescent appearance. Portions of decidua serotina were found in the stomach lying loose by themselves. Some of the placentæ had cords of about an inch in length in connexion with them.

Along one uterine cornu there were found six, and along the other there were found three globular masses forming hernial protrusions either into, or by the side of the mesometrium, and marking the places of attachment of the nine fœtuses. A vertical section of one of these lateral dilatations, together with the uterine tube to which it is appended, is given in Pl. L. fig. 8. The cavity of the uterine tube is covered with a corrugated mucous membrane; at its mesometrial border a funnel-shaped depression, also covered with this corrugated mucous membrane, leads down to the hernial protrusion, or globular dilatation, which is formed by the non-deciduous serotina (P S) and the circular muscular coat (C M) with which the utero-placental mucous membrane is more intimately connected in the Rodents than in any of the three orders we have as yet spoken of, and in the interstices of which much mucous tissue is contained. A projecting process (U P) of corrugated non-placental membrane marks the line where a lamina of this tissue passed to be connected with the convex surface of the deciduous serotina, about an eighth of an inch from its free edge, *i. e.* the thickened peripheral rim already spoken of. The non-deciduous serotina (P S) resembles the homologous structure in the human uterus in histological characters, but, so far as the naked eye is concerned, it differs widely from it, inasmuch as the deciduous serotina in the contracted human uterus forms a more or less elevated mass projecting into the cavity of the uterus, and not a laterally appended diverticular mass as in the Rat. It is interesting to remark that the deciduous serotina in Man does form a mass of such size as to have caused it to be mistaken[1] for a morbidly adherent placenta—an error involving serious consequences, but not likely to be committed by persons who by actual inspections, such as the one here recorded, of the changes undergone by the homologous structures in lower animals have vividly present to their mind the fact, which is indeed enucleable *à priori*, that the non-deciduous serotina of an emptied and contracting uterus must have different positions, relations, and proportions from those which it occupied when spread over the utero-placental area of a gravid and yet distended organ[2].

A person who, like myself, is not always able to compare the specimens in the Hunterian Collection with the descriptions given of them in the catalogues which are accessible at a distance from London, would, from the description of Prep. 3466, vol. v. Physiological Series, be led to suppose, like myself, that the condition of parts there described is the same as that represented in my figure 8, and not that represented in fig. 1 tab. 8 of C. G. Carus's 'Tabulæ Anatomiam Comparativam Illustrantes.' I have, however, since the appearance in Professor Huxley's 'Elements of Comparative Anatomy' (p. 107) of a sketch of the principal points of this paper, satisfied myself, by an examination of the specimen no. 3466, Hunterian Museum, that I was wrong in supposing the preparation to have been wrongly described as a Rat's uterus "at an

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[1] Cazeau, 'Traité des Accouchements,' 1856, p. 500.

[2] The following words from M. Robin's Memoir (p. 137) are so important in themselves, and besides this they furnish such a valuable explanation of an appearance left unexplained in M. Coste's valuable 'Histoire du Développement des Corps Organisées,' that I herewith append them :—"Enfin, la portion *utéro-placentaire* de la muqueuse utérine qui n'est pas entraînée par le placenta lors de l'accouchement n'est jamais *caduque*, et c'est à tort qu'on lui donne ce nom, en ajoutant comme épithète les adjectifs *sérotine, interutéro-placentaire*, &c. Elle persiste toujours, et ne fait que diminuer peu-à-peu d'épaisseur jusqu'à ce que son niveau ait atteint celui de la muqueuse qui se régénère. Il est toutefois des femmes chez lesquelles la muqueuse reste, pendant plusieurs années après l'accouchement, plus épaisse et plus saillante dans cet endroit qu'ailleurs." M. Robin says, in a note of a previous paper of his, treating of this point, "J'admettais donc à tort, avec les autres, que la sérotine s'exfolie et s'élimine pendant la durée des lochies." The appearance faithfully reproduced, but left without explanation, by M. Coste, which these views enable us to understand, will be found pl. 1 *a*, fig. 3. In his description we read, "Tache rougeâtre que présentait la muqueuse utérine, tout le reste de son étendue étant exsangue." It is situated on the posterior wall, near the entrance of the left Fallopian tube of a uterus "d'une femme, mère de plusieurs enfants, morte empoisonnée quelques jours après la menstruation." There can be little doubt, I apprehend, that this vascular areola indicates the gradually diminishing non-deciduous serotina of, probably, the last pregnancy.

early stage of impregnation." Preparation no. 3466 is, beyond doubt, a preparation of an organ in much the same condition as the organ figured by C. G. Carus in the plate just referred to. But I submit that the words which follow those which I have just quoted from the Hunterian Catalogue, viz., "each of the embryos is contained in a special dilatation appended to the side of the uterine tube," do not apply to the structures in that preparation. For, firstly, what is spoken of as a "special dilatation appended to the side of the uterine tube" is in reality a conical projection with its wall curving continuously with those of the uterine tube, and not forming, as in my figure 8, segments of another circle. And, what is of more consequence, the embryos are contained in the uterine tube, and what is contained in the misnamed "special dilatation appended" to it is merely serotinæ and placenta. The embryo of the Rat, when only a line in length, is contained in the uterine tube, and, together with its envelopes, causes the calibre of that tube to bulge outwards on both sides between its mesometrial and its free border; and a reference to Reichert's plate 6, in his recently published and most valuable essay, 'Beiträge zur Entwickelungsgeschichte des Meerschweinchens,' will satisfy every one who may not have access to yet earlier specimens, that, in all probability, it never occupies any other position[1]. In a word, this developing uterus in the Rat is moniliform, and is correctly so represented, for the most part, in Carus's plate; it is the uterus retrocedent post partum, which has "special dilatations appended" to it, and thus presents in section a figure somewhat resembling a figure of 8 as ordinarily written, with its upper segment the larger of the two.

The fœtal membranes of the Rat at earlier stages are especially instructive, and without a study of them the homologies of the adult envelopes are scarcely to be unravelled. When the fœtus is five eighths of an inch long, there are two structures in connexion with it, the relations, and proportions, and even the existence of which are much masked in the more advanced stages of its development. These structures are, firstly, the decidua reflexa, which forms at this period a perfect capsule for the fœtus, but which near full time is usually represented by the thickened rim at the periphery of the deciduous serotina alone, though a few shreds may still remain, and in the Water-rat (*Arvicola amphibia*) often do remain, appended to this thickened rim, as if to indicate its real import. Kölliker's words (*l. c.* p. 154), "Gibt es eine Stelle wo man den Uebergang von Zellen in Bindgewebsfasern deutlich demonstriren kann, so ist es hier," apply most accurately to this thickened rim, the remnant of decidua reflexa. The second structure, seen plainly in the early, and obscured or lost in the more advanced Rat-embryo, is the primitive chorion. This membrane will be seen to pass from the point of attachment of the secondary chorion to the centre of the placenta outwards, to line the internal surface of the capsule of decidua reflexa. It is somewhat strange

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[1] Von Baer's remarks upon this subject are much to the point—"Alle Embryonen (mit Ausnahmen) der frühesten Zeit normal so liegen dass ihr Rücken in der grossen Curvatur des Fruchthalters und seiner Hörner liegt." Entwickelungsgeschichte, ii. p. 232. See also Reichert, *l. c.* pp. 130 & 131.

that Bischoff, who has figured what is nothing else than this primitive chorion (fig. 59, Meerschweinchen-Ei), should have yet fallen into the error relative[1] to it which he has done, and to which, as entailing yet another error, we shall have to revert.

In both early and advanced embryo, the non-placental uterine mucous membrane becomes continuous with the saucer-shaped deciduous serotina on its convex aspect, about the eighth of an inch within a line corresponding with the periphery of the after-birth, or, in other words, along a line concentric with, but an eighth of an inch within the thickened band of the late embryo. The circular parapet by which the persistent and deciduous uterine structures are connected is but a slight lamina, and gives way upon very little traction. The blood-vessels and cellular tissue within its periphery serve to keep the after-birth in continuity with the persistent non-deciduous serotina. Indeed, in the Agouti the blood-vessels form the only bond of union, and the after-birth becomes "pedunculate," at least if we may trust an observation put on record by Bischoff[2] as made by Dr. Franz Müller. On the other hand, the Guinea Pig's deciduous serotina is, as shown in our figure 5, connected with the uterine non-placental mucous surface by a series of tags (D S″) or fimbriæ, developed at its periphery, as well as with the non-deciduous serotina by an abundance of vessels. These peripheral tags are most distinctly continuous with the uterine walls, and are injectible from the uterine vessels, whence it is much to be wondered at that Bischoff (*l. c.* p. 42) should have spoken of them as the remnants of the perfect decidua reflexa of earlier days. Our figure 6, and the description appended to it, will show where the rudiment of that structure is really to be sought for. These tags are to be seen in a fœtal Rat, in Prep. 3467, Hunterian Museum, and they are described as follows:—"The folds or processes of the lining membrane of the uterus which converge to be attached to the maternal portion of the placenta, are here shown." Their office is described to be that of "supporters of the embryo and conductors of the vessels of the maternal placenta." With this description my own of the homologous growths in the Guinea Pig will be seen to agree; but I should be inclined to say that in the preparation in question there is, besides the system of radiating peripheral tags, also the uterine circular parapet, usually found alone in the Rat, coexisting with them, though I have not been able to satisfy myself of the coexistence of these two connecting media in any placenta, as that of the Guinea Pig, which I have been able to manipulate. Neither have I ever been so fortunate as to find this system of tags in the common Rat (*Mus decumanus*); and but that the homologous structures, two only in number, which are to be seen in the Rabbit (*Lepus cuniculus*), and are figured and described in Pl. L. figure 7, are far from being invariable in their appearance, I should suggest that the fœtal Rat in question was of the Black Rat (*Mus rattus*) species.

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[1] Kölliker, *l. c.* pp. 160, 161, 172.

[2] 'Meerschweinchen-Ei,' p. 6; Müller, 'Wiener Zeitschrift,' 1851; Schmidt, 'Jahrbücher,' Bd. lxi. p. 329.

The persistent or non-deciduous serotina in the Guinea Pig is inseparable, save to the eye aided by the microscope, from the circular muscular coat.

Bischoff says[1] of the decidua serotina, that it separates from the regenerating mucous coat immediately after the separation of the placenta, and is either discharged or, as he thinks, in many cases quickly absorbed; and Reichert[2] believes that certain structures found not rarely in the uteri of pregnant Guinea Pigs may be the remnants of the placenta uterina and decidua reflexa of previous pregnancies. I have no observations of my own with reference to what takes place in the natural order of things, but in the after-births of Guinea Pigs killed at full time I have found the deciduous serotina in some cases so firmly cohering with the placenta and with the upgrowth of it (PL′) as to make it difficult to believe that it does not occasionally come away with it in parturition, as by actual observation we know it does in the Rat. Variations may occur in the case of the former animal.

The Guinea Pig and Rat resemble each other in having, in early stages of development, a perfect decidua, in having their chorion attached to the centre of a unilobed placenta, and in having the sac of the allantois early obliterated; and in all these points they differ from the Leporidæ.

The circlet of vascular villi lying exteriorly to the placental area, and supplied exclusively by the omphalo-mesenteric system, is said by Bischoff[3] to spring up only in the latter part of fœtal life. In those Rodents in which, as in the Muridæ and in the Guinea Pig, the chorion is attached by an apex, as it were, to the centre point of the floor of the placenta, we see, on making a transverse section of a uterine dilatation containing an advanced fœtus, that a considerable interval exists on either side of the attachment of the chorion to the after-birth, along which any matter secreted by the uterine mucous coat can pass. And it is precisely over the part of the chorion which forms one side of this triangular space that these villi spring up, according to Bischoff, in the later stages of pregnancy—at a period, that is, in which the non-vascular non-secreting decidua reflexa is absorbed, and the secretion of the non-placental mucous membrane, whatever it may be, can be brought into relation with, and absorbed by, the fœtal vessels. This appears to be a very beautiful instance of natural economy. In the Leporidæ, it is true, the chorion is not attached to the centre of the placentulæ, and it therefore has not that partial protection from the pressure of the uterine walls for the omphalo-mesenteric circlet of villi which the placentæ of the Rodents we have been speaking of enjoy; but as their decidua reflexa is but a rudimentary fringe (fig 7, D R), whatever is secreted by the uterine walls can at all times come into immediate relation with the omphalo-mesenteric vessels, and be absorbed by, or interchange products with them.

In no Rodent that I have examined is the non-deciduous serotina separable as a distinct and coherent layer from the circular muscular coat; in all Rodents the placental

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[1] Meerschweinchen-Ei, p. 44.

[2] Beiträge, p. 131.

[3] Meerschweinchen-Ei, pp. 43 & 44.

site is on the mesometrial border, and in all also, and not merely in the Rabbit[1], does the chorion receive a vascular supply from the omphalo-mesenteric as well as from the umbilical arteries. In all Rodents that I have examined at the time of their birth the omphalo-mesenteric vessels were persistent. In this point they agree with the Carnivora; and in that of these vessels being supplied to the chorion, the Vampire resembles them.

Simiadæ.

A female Pig-tailed Monkey (*Macacus nemestrinus*) having died after giving birth to a fœtus, and having had one of its two morbidly adherent placentæ removed by artificial means before its death, the maternal vessels were injected with a red, and the fœtal with a chrome-yellow injection. One of the two placentæ was in its natural position; and from it a triangular slice was removed for microscopic and other examination. The deeper layers of mucous tissue which are exposed over the site of the placenta, artificially removed in the hope of saving the animal's life, are richly injected; the undisturbed superficial layer, the homologue of the human decidua vera, is of a uniform opaque white, the injection nowhere showing its colour through its smooth unbroken surface. This layer of mucous membrane abuts upon the remaining placenta a little way within its outer rim, and upon its uterine surface; whereas in the human subject it becomes continuous with it at its free edge, or even joins it a little within this on the fœtal aspect. In fig. 9 a representation of a vertical section of a part of the placenta, with portions of chorion and of other deciduous and non-deciduous membranes in connexion with it, is given. In the section of the placenta we see the arborescent upgrowths which carry the villi, and the downward processes of maternal tissue[2], more plainly than we see their homologues, at least with the naked eye, in the lower Mammals of which we have been speaking. The uterine surface of the placenta is clothed by a smooth continuous membrane, from which these "Decidua-Fortsätze" pass downwards into it. Above the placenta a thin but coherent lamina of membrane (D S) is seen, left partly in apposition with, partly divaricated from it, and joining the decidua vera at the point where it impinges upon the after-birth. In its distinctness, and ready separability, and coherence, it resembles the deciduous serotina of the Rodents; but there can be little doubt that it does not make up the whole of that layer in the Macaque, but that more or less of the tissue between it and the deeper strata clothing the muscular walls, viz. the persistent non-deciduous serotina, would in the natural order of events have been deciduous likewise. More than the thin lamina (D S) may be seen to have been deciduous in the natural labour of a *Macacus rhesus*, of which the after-birth is preserved

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[1] Kölliker, *l. c.* p. 164.

[2] These are the "Decidua-Fortsätze" of Ecker (Icones Physiologicæ, taf. 28. fig. 1, *df*). They are described by Kölliker (Entwickelungsgeschichte, p. 145), and well figured by Dr. Priestley (Lectures, p. 57. fig. 16), in the Human placenta at six months, after Van der Kolk. They are much less prominent in the Human placenta at full time. Cf. Kölliker, *l. c.* pp. 143, 177, 183.

in the College of Surgeons (Hunt. Mus. Phys. Series, 3584). It is not, however, easy to say what line will exactly define the limits of deciduous from those of non-deciduous serotina. For between the muscular coats (from which in the Simiadæ and Rodents, as in our own species, it is not easy to separate the mucous) and the deciduous utero-placental structures a very considerable interval exists, filled up with loose lamellæ of tissue, the deeper of which, consisting of cells with large nuclei and tapering ends, have a horizontal direction, and those more directly in connexion with the deciduous layer a vertical one. In this interval a considerable number of large blood-vessels is also to be seen; so that we easily understand how, had the animal's life been preserved and its uterus contracted, a lamellar cake, perforated and made irregular by vermiform vessels, would, as we know it does in our own species, have come to project for a while into the cavity of the organ at the placental site. The tissue, therefore, which would have been persistent or non-deciduous serotina, differs little from the homologous layers in the Human subject, except, perhaps, in being relatively somewhat more abundant. In this point (as remarked in the Hunterian Catalogue, prep. 3584, and as may be seen by comparing either what I suppose to be a drawing of the placenta whence that preparation was taken, viz. Sir Everard Home's plate 168, vol. iv. 'Comparative Anatomy,' or Breschet's fig. 2, pls. 1 & 2, and fig. 4, pls. 3 & 4, *l. c.*, or Rudolphi's figure of a Marmoset's placenta, Abhand. Berlin Akad. 1828, with the description given of the Human decidua serotina by Kölliker, *l. c.* p. 145 or p. 158, or by Priestley, *l. c.* p. 48) this Simious decidua serotina contrasts markedly with the Human. I must, however, add that I could not note any similar difference in the placenta of a Chimpanzee (*Troglodytes niger*) which I had an opportunity of seeing in the College of Surgeons.

The chorion having been nearly entirely removed when the preparation I have been describing came into my hands, I am unable to say whether the decidua reflexa retained the completeness which it and the decidua vera are figured and described by Breschet[1] as possessing. The lining membrane of the non-placental parts of the uterus was lowly vascular and smooth internally; and herein it resembles the decidua vera of the human subject. In a case where even the placentæ were morbidly adherent, it will not be expected that the non-placental uterine membrane should have exfoliated. It is difficult to see, however, how the double membranes just referred to as figured by Breschet can have been other than deciduous; so that Kölliker[2] and Funke[3] are scarcely justified in speaking of the decidua vera, as well as the reflexa, as being exclusively Human structures. Their statement and Weber's (Zusätze, p. 417) as to the exclusively anthropoid character of the decidua reflexa is, of course, also erroneous; but what we have already said is sufficient as to this envelope. I should add that Virchow[4] has shown that the

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[1] Pls. 1 & 2. fig. 2, pls. 3 & 4. fig. 2, p. 444 of the Mémoires de l'Institut, tom. xix. 1845.

[2] *L. c.* p. 169.

[3] Lehrbuch der Physiologie, 1858, ii. 929.

[4] Virchow, Gesamm. Abhandlungen, p. 782, 1856, cit. Dr. Duncan, Edin. Med. Journ., Dec. 1857.

decidua vera, which was supposed to be deciduous in the Human species and in no other, is occasionally not deciduous at all where its caducity has been laid such stress upon, whilst in the Chimpanzee the relations of the non-placental as of the placental deciduæ seemed to me to be those more ordinarily described as met with in the Human subject.

A third difference has been stated to exist between the Human and all other placentæ, namely, that the fœtal capillaries were in it, and in it alone, bathed in a sinus-system, not merely apposed to vessels of similar or somewhat similar calibre. This distinction was propounded by Weber in 1832, and indeed was known even earlier than that date[1]. The existence of this sinus-system was questioned by Eschricht[2], as previously by Von Baer[3], but without good reason. Since that time its existence has been nearly universally held to be distinctively anthropic[4]. Robin[5], however, after saying "la disposition de veines en forme de sinus ne se voit pas que chez la Femme," adds "et peutêtre chez ceux des Singes dont l'uterus a une paroi musculeuse épaisse et rigide non intestiniforme." I must also confess that I am unable, in a section of the placenta of the *Macacus nemestrinus*, to recognize any such apposition to the fœtal arborescent villi of maternal *vessels*, as contradistinguished from maternal *sinuses*, as the usually held views would demand. Though the injection thrown into the maternal vessels has penetrated down to the chorionic floor of the placenta, it does not seem, under the microscope, to have mapped out for itself those vascular trees which are so easily distinguishable in other placentæ in the like position, and, in this placenta, in the fœtal villi. It is right, however, to add that the Monkey-placenta which I have been describing was injected, skilfully and successfully it is true, but still a considerable number of years before it came into my hands for examination; so that possibly less weight may be assigned to the results of a microscopic inspection of the relation of its maternal and fœtal blood-vascular systems than would have been due to a similar investigation of it in the recent state. I am not, however, myself inclined to think that the lapse of time has made any difference of consequence in the appearances in question. Approximations, on the other hand, to the sinus arrangement of maternal intraplacental vessels have been noticed by Eschricht (*l. c.* p. 24) as existing in the Cat; and Kölliker (*l. c.* pp. 163, 170) speaks of the "*colossal capillaries*," $\frac{1}{6}'''$ wide, of the Dog's placenta, as forming, in contradistinction to the ordinary capillaries of the homologous parts in the Rabbit, the Ruminants, and the Pig, a transition towards the arrangement which, in the previous sentence, he characterizes as exclusively Human.

It is well to put on record the fact that upon yet a fourth point of supposed difference between the Simious and the Human placenta considerable weight has been laid, which close examination has shown it would not bear. This point was the per-

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[1] Froriep, 'Notizen,' p. 90, no. 996.

[2] De Organis, p. 28.

[3] Gefässverbindung, p. 25, 1828.

[4] Hunt. Cat. 3583; Kölliker, *l. c.* p. 170.

[5] Mém. Acad. Méd. Paris, 1861, p. 133.

sistence of the umbilical vesicle; and Rudolphi[1] speaks emphatically of its supposed disappearance at the third month in the Human fœtus as sharply differentiating its fœtal structures from those of *Mycetes*, which, in other points, it so closely coincides with. This statement looks strange by the side of such a title to a recent monograph[2] as the following:—'Das Nabelbläschen ein constantes Gebilde in der Nachgeburt des ausgetragenes Kindes' ('The umbilical Vesicle a constant Structure in the After-birth of the Child at full time'), or of a statement to the same effect as the heading of this paper of Dr. Schultze's, which is made by Breschet[3] in his already cited memoir.

Before leaving the subject of the Simious placenta, it may be well to state that the last-named author is inclined to suspect that further investigation will show that a naked-eye difference of arrangement distinguishes, as do so many other points of the like character, the Old-World from the New-World Monkeys. This point of difference is the possession by the New-World of a unilobed, and by the Old-World Monkeys of a bilobed placenta; and should Professor Breschet's anticipation prove to be correct, we should have an additional, though slight, confirmation of the law which teaches us to expect to find considerable differences in structure and in habits between Old-World animals and their South-American representatives, and an additional, though slight, confirmation of the general value of the placental system from a classificatory point of view. I call the confirmation it would lend to these great principles but slight, firstly, because the anthropomorphous Apes, if we may judge, at least, from one of them, viz. the Chimpanzee (*Troglodytes niger*), resemble the New-World Monkeys, and differ from the Old-World species, so much nearer to them in other structures and in place, in possessing a unilobed placenta; and, secondly, because such a point as the divarication of such an organ as a placenta, which is usually a single mass, into two or more naked-eye masses, seems to me but of small morphological importance. Such an example as that of the Ferret (*Mustela furo*), already detailed from Daubenton, deters one from assigning any very great value to the continuity or discontinuity of the cellulo-vascular mass, which it is not pretended has changed its relations either to allantois, to amnios, or to umbilical vesicle. The placenta of the Leporidæ will not, I anticipate, be found to be uniformly bilobular or multilobular; and a reference to any work on midwifery[4] will show that very great varieties of the like nature may exist in the placenta of our own species.

It would, however; be highly interesting to have further observations made as to the placentæ of the Long-nosed Monkey (*Semnopithecus nasicus*) amongst the lower Old-World Simiadæ, and of the *Callithrix sciureus* amongst the New-World Monkeys, as in

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[1] Abhandlungen Berlin Akad. Phys. Klass. 1828. "Bis hierher Alles also menschlich: aber nun die grösste Abweichung zwar nicht der absoluten aber der relativen Zeit nach wem man das Nabelbläschen betrachtet."

[2] Von Dr. Bernhard Sigismund Schultze, Professor der Geburtshülfe in Jena. Leipsic, 1861.

[3] *L. c.* p. 470.

[4] Cazeau, *l. c.* p. 191, where a figure of a cotyledonary Human placenta is given.

specimens of their placental structures (*which were, however, in both cases alike in a bad state of preservation*) Professor Breschet[1] was unable to satisfy himself that his rule held good.

The figure of the placenta of the Sloth, which is given by Professor C. G. Carus in his 'Tabulæ Anatomiam Comparativam Illustrantes,' pars 3, does not seem to me to be so decidedly different from even the Human placenta, in its naked-eye bossy outlines, as Dr. Sharpey's account[2] of the placenta of the *Manis* shows it to be from the placenta of all the Carnivora, Rodentia, Insectivora, Chiroptera, and Simiadæ which have been as yet examined. A well-injected or even a well-preserved pregnant uterus of a Sloth would be most valuable, and would enable us to speak more confidently as to the extent of intimacy with which the maternal and fœtal blood-vessels are connected than the figures alluded to from Professor Carus's work can do. Should the placenta of the Sloth be found to bring away with it (as we know placentæ to the full as cotyledonary in general outline do[3]) maternal elements inextricably intermingled with its mass, the structure of the placenta of the *Manis* might perhaps be explained as being an instance of "correlation of growth" between aberrant tegumentary and reproductive organs This, however, is but conjecture. It is of more consequence to observe that, by Professor Huxley's examination of the placentæ of the Elephant and the *Hyrax*, we are enabled to make one general description of the placentæ of all the Unguiculata of Linnæus, deducting from them, provisionally, the Edentata, and definitely *Rhinoceros* and *Didelphys*. This general proposition we cannot give better than in the words of Weber, addressed, now nearly thirty years ago, to an Association of German Naturalists and Physicians at Bonn[4]. "Die gefassreichen Zellen oder Falten oder anders gestalteten zur Verbindung vom Mutter und Frucht dienende Organe des Uterus mit den gefassreichen Zotten und Falten des Eitheils so verwachsen sind dass sie bei der Geburt vom Uterus abgerissen werden." "The vascular cells or folds or otherwise shaped organs of the uterus for the connexion of the mother and the fœtus are so interblended with the vascular villi and folds of the fœtal parts of the membrane, that in parturition they are

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[1] Professor Breschet's words are (*l. c.* p. 461), "S'il ne s'est glissé aucune erreur dans l'histoire de la fait anatomique, il faut avouer que la loi que j'établissais de l'existence d'un double placenta dans l'œuf des Singes de l'ancien continent, et d'un seul placenta dans celui des Singes d'Amérique, n'est pas exacte ou qu'elle souffre des exceptions. Le mieux serait peut-être d'attendre que de nouvelles observations vinssent éclaircir la question et lever tous les doutes sur la pointe." The following account, therefore, which may apply, perhaps, to Professor Breschet's labours, will nevertheless, I apprehend, give an incorrect impression of what his opinions are:—"Professor Breschet has described and figured the two separate discoid placentæ in the small South-American Squirrel-Monkey (*Callithrix sciureus*, Kuhl), in the Green Monkey (*Cercopithecus sabæus*, Desm.), and in the Long-nosed Monkey (*Semnopithecus nasicus*)." (Linn. Soc. Proc. 1857, p. 17, note.)

[2] Cited by Professor Huxley, 'Lectures,' p. 112.

[3] Cazeau, *l. c.* p. 191.

[4] Froriep, 'Notizen,' *l. c.*, October 1835. Weber refers here to a memoir of his own published in 1832 in Hildebrandt's 'Anatomie'; but he appears to have had no knowledge of V. Baer's now well known paper on the same subject and to the same purpose, bearing date 1828. See Professor Huxley's 'Lectures,' p. 92.

torn away from the uterus." There are, however, it must be confessed, but few propositions which can be made of all unguiculate, or of all deciduate Mammalia beyond those which the two names connote. These, however, by themselves are sufficient to justify us in retaining the binary division of Professor Weber, coinciding as it does so nearly with the class founded by Linnæus on the peculiarities of a system so far removed from the reproductive as is the tegumentary. And to them we may add the defenceless condition in which the young of nearly all deciduate Mammalia, except the Elephant (and *Hyrax*?), are brought into the world, and the general, though not universal, coexistence in them of multifid livers and multifid lungs with simple stomachs. The value of the placentary system of classification is much better seen when we come to the subdivisions of Weber's great class, when we see that of each of the well-established orders, Simiadæ, Insectivora, Rodentia, and Carnivora, a well-established and distinct aggregation of placental characters can be predicated. Of the Chiroptera I do not speak, as I have only been able to examine a single example from this order, and that but for a short time and at a comparatively early period of development. Of the placentæ of the four other orders we may say, as perhaps of the entire sets of characters belonging to each of the orders themselves, that those of the Carnivora are more distinctly marked off from each and all of the other three than is any one of the other three from any other of the three; and of these three the Insectivora possess, on the whole, a nearer affinity to the Simiadæ than do the Rodents. In each case the characters are those of the placenta at or near full time.

In the *Simiadæ* we find the ultimate ramifications of the umbilical vessels confined to the placenta; and in it the fœtal capillaries are probably not merely apposed to simliar maternal vessels, but plunged within a maternal sinus-system. The presence in them of structures known as decidua reflexa and decidua vera show that all the aëration and all the nourishment which the fœtus receives comes from the single or double placenta, and not at all from the extraplacental uterine mucous membrane. The deciduous serotina is ordinarily separable from the uterine surface of the placenta in a coherent sheet, whilst in the substance of the placenta, besides other maternal elements, there are the processes known as "Decidua-Fortsätze" mixed up inextricably like them, but, unlike them, distinguishable by the naked eye.

The *Insectivora* have the umbilical vessels confined to the placenta, but their ultimate capillaries are apposed to similar maternal vessels not immersed in maternal sinuses. Their decidua reflexa is more or less incomplete. The placental site may be anywhere in the circumference of the uterine tube. The Tenrec's maternal and fœtal structures are exceedingly aberrant. The upgrowth of the chorion, the absence of any envelope exteriorly to the amnios, and the distinction of the utero-placental region into two areæ, clothed with distinct kinds of mucous tissue, are unique points in this animal. By its amniotic corpuscles it resembles the Elephant among deciduate, and several orders amongst the non-deciduate mammals.

In the *Rodent* placenta the ramifications of the umbilical vessels have the same relations as in the Insectivora; but the chorion is supplied with blood-vessels from the omphalo-mesenteric system in its non-placental parts, which consequently take a share in the nourishment and respiration of the fœtus. The decidua reflexa is, when not rudimentary from the beginning, fragmentary at the end of gestation. The deciduous serotina is always distinct from the placenta, and separable from it (even when not separated) at parturition. The placentæ are always attached to the mesometrial border of the uterine cornu.

In the *Carnivora* the umbilical ramifications spread over the entire chorion, not merely in its placental zone, absorbing nutriment consequently from, and interchanging products with, the secretions of the non-placental uterine mucous membrane. The allantois is here always a perfect sac, separating the exterior of the amnios from the interior surface of the chorion. They have no decidua reflexa properly so called. The omphalo-mesenteric vessels are to be found persistent within the cavity of the abdomen, as in the Rodents, for some time after birth; but they never reach the chorion, as in that class. There is an approximation made, by the colossal maternal capillaries of certain of this class, to the sinus-system of the Simiadæ.

In therefore the deciduate Mammalia, or, in other words, in those Mammalia in which the fœtal placenta brings away with it always certain maternal elements inextricably interfused with its mass, and very commonly certain other maternal elements also in the form of a superposed layer of deciduous serotina, we find that, by looking to the three following points—firstly, to the extent of vascularity which the chorion possesses, secondly, to the sources whence this vascular supply comes, and, thirdly, to the relation which the ultimate capillary ramifications of the umbilical vessels hold to the maternal blood-vascular system—we can make four classes corresponding to the four classes well established and acknowledged upon quite other principles of division, viz. the Simiadæ, the Insectivora, the Rodentia, and the Carnivora.

The persistence of the allantois as a sac seems to be a variable character within the limits of single classes; but its relations to the amnios within and to the secondary chorion without appear, in this as well as in the non-deciduate division of Mammals, to furnish good classificatory indications.

The development of a decidua reflexa is probably constant in the Simiadæ; it is variable in extent in the Rodents and probably also in the Insectivora, and it is virtually absent in the Carnivora.

In the Rodents alone does the yelk-sac assume any physiological importance, and this it does by virtue of the omphalo-mesenteric vessels it carries, and at the cost of its sac-character. In the other classes it is found, at the end of the period of gestation, to retain this character, the structure being in a more or less atrophied condition.

The second division in Professor Weber's binary classification of Mammals corresponds, if we exclude the Edentata provisionally, and include, with perhaps more confidence, the Sirenia, exactly with the Ungulata and Mutica of Linnæus, and with the Artiodactyla, Perissodactyla, and Mutilata of Professor Owen's classification in the Linnean Society's 'Proceedings.' Of all these animals alike it may be predicated that at parturition the villi of the chorion separate themselves from the maternal structures, in which previously they were ensheathed, without bringing away any of these structures, either interfused with, or superposed upon them; and for the entire class the term "non-deciduate" is proposed by Professor Huxley. The first question which arises is, What number of general propositions can we make as to the entirety of this class, to a certain similarity existing between the least mutually resembling members of which, testimony is borne by the trivial names of "Sea-Cow" and "Sea-Camel" as applied to certain of the herbivorous, and "Meerschwein" to certain of the carnivorous Cetacea? There is a considerable number of such propositions; but it is not always easy to say whether certain of them are not correlated, either in the way of nutrition with the large size which distinguishes this division of placentals as a whole, or in the way of function with their peculiar modes of life, and are therefore of little classificatory value. It is as functional correlations, perhaps, that we should note the absence of clavicles and the faculty of self-help which the young of all non-deciduate Mammals possess from their first entrance into the world; and I should incline to consider as a correlation of growth the possession of complexly convoluted brains by these animals, since, in the class to which they and their deciduate allies both belong, the complexity of the convolutions varies very commonly in a direct ratio with the increase of bulk. Neither of these explanations, however, will account for the fact that in all the non-deciduate Mammalia we find one superior cava, and one only, and that in the whole class, so few of the members of which are multiparous, the uterus still retains a bifid character, its cornua greatly predominating over the corpus uteri. In antithesis to the deciduate Mammals, we find in the non-deciduate a general, though not a universal, coexistence of comparatively simple livers and simple lungs with complex stomachs. I am not aware that anal glands have been observed in any non-deciduate Mammal. It is well known that the generative organs of both sexes in the Artiodactyles and the Cetacea proper are "almost exactly similar[1], only that the testicles are not external and there are no external parts in the females" of the latter order.

The great abundance of blood and the great relative abundance of blood-cells are points common to the Pig and to the Porpoise; and it may be remarked that the halitus evolved on opening the great cavities of each of these animals possesses a very similar odour. Upon the first of these two points, perhaps, little stress should be laid, as it may be either a result or a necessity of the mode of life of either creature; and the latter, depending entirely upon the evidence of the sense of smell, has consequently but a subjective cogency. Much greater importance should be assigned to the state-

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[1] Hunter's 'Essays and Observations,' ed. Owen, vol. ii. p. 105; and Hunterian Catalogue, vol. iv. 2527.

ment, now ordinarily[1] made, to the effect that the Cetacea have no azygos veins at all, as this peculiarity would, if it really did exist, differentiate them from all other mammals whatever. But on looking at the words of Von Baer[2], upon whose authority this statement is made, and at the facts with which Von Baer's words are usually in accordance, it will be found that the vena-azygos system not only does exist in Cetacea, but actually furnishes us with an additional point of affinity between them and the large ungulate Mammalia. Von Baer's words, in the 'Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg,' *l. c.*, are, "la veine dite impaire qui manque *excepté le bout antérieur*, et dont les sinus de la colonne vertébrale tiennent lieu." This anterior end, however, is a very considerable vessel; and in the 'Nova Acta' (*l. c.*) I find that Von Baer describes it as having a trunk as large as that of the vena cava superior, which it joins; and he goes on to state that its large size is not to be accounted for by its intercostal factors, but by the junction to it of a trunk from within the vertebral canal, of large size and connected by its constituent factors, as the vena azygos is, with those of the lower cava as also with the lower intercostal veins. If we examine a Pig, we shall find it to possess a large azygos vein on the left side; and this the Cetacean, it is true, does not; but it will be seen to have on the right side a short vena azygos, just as the Porpoise has, with four or five affluents from the upper intercostal spaces, as well as very considerable tributaries from the muscles of the back and scapulæ. The vena azygos system is well known to be intimately connected with venous ramifications situated about, around, between, and within the spinal column; and the greater development of any one of these vascular connexions does not destroy the specific and distinctive character of that peculiar system. Its perirrhachidian or dorsispinal anastomosis is chiefly developed in the right side in the Pig, which has a left azygos also; its endorhachidian or intravertebral factors have absorbed its lower intercostal tributaries in the Porpoise; and in this animal there is no vena azygos on the left. These points of difference are, however, but slight as compared with the difference which the statements ordinarily made on this point would lead us to expect. The Cetacea, we may add, have been observed to resemble the Sheep and Pig and Horse, in the deficiency of the rudimentary structure known as the Eustachian valve, which, however, is by no means invariably present in deciduate Mammals.

A few points of resemblance between the placentæ of the Ungulata and the Mutica have escaped notice. First, in Cetacea and in certain Ungulata we find the membranes of what is often a solitary embryo prolonged from one cornu round into the other, and projecting by a cæcal extremity into the short corpus uteri. Such a condition of the structures is figured from the Mare by Colin (*l. c.*), and has been seen by myself in the membranes of a small Cetacean, sp.?; and in the Cow and other Ruminants

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[1] 'Phil. Trans.' for 1849, p. 152. Milne-Edwards, 'Physiologie Comp.' vol. iii. pl. 2. p. 593.

[2] Nova Acta, vol. xvii. pt. 1. p. 408, 1834; Bull. Acad. St. Pétersbourg, tom. i. 1835; Froriep, 'Notizen,' 50, p. 38. 1836.

a similar extension of the membranes of a fœtus lodged in one cornu round into the other is not rarely seen, but without any cæcal diverticulum markedly developed in their short corpora uteri. The multiparous Sow does not, of course, resemble its less fertile congeners in this particular; but the membranes of the deciduate and ordinarily uniparous Seal (*Phoca vitulina*) have been observed to be confined to the uterine cornu which contained its single fœtus[1].

Secondly, we find on the umbilical cord of the fœtal Cetacean, filiform outgrowths of the amnios which are undoubtedly homologous with the similarly placed growths in the early Ruminant, and in the soliped embryo, as well as with those on the amnios of the Tenrec, as already described. In the amnios of the Pig no such growths are observable, but certain dilated microscopic vesicles[2] have been supposed to take their place and function. On the other hand, numbers of rough granulations exist between the layers of the chorion, and project into the sac of the allantois, of this animal at full time; and these structures must find their homologues in the similarly placed outgrowths described by Professor Owen in the membranes of the Elephant, and possibly also in the "hippomanes" of Solipeds[3]. I have observed these growths in the membranes of an embryonic Pig of 5 inches in length; and also in the *appendices allantoidis* of the Ruminants. From an examination of the membranes of an embryonic Cetacean of 7 inches in length, I am inclined to say they exist there also. But a fresh or well-preserved specimen is necessary to decide this point[4]. Finally, the cornual ends of the Cetacean membranes just alluded to are bare and glabrous as compared with the villous character of the rest of the chorion. It is possible that this appearance may have been produced by the treatment to which the membranes were subjected before they came into my hands; but it is also possible that it may be another point of resemblance between the placenta of the Cetacean and of the Artiodactyla as described and figured by Von Baer[5].

The condition of the Cetacean membranes which I have been able to examine has not been such as to enable me to make out the relations of the allantois either to the circumference of the amnios within, or to that of the villous membrane exteriorly. It would be highly interesting and important to have as accurate records of the relations of these parts in the Mutica as we have already of those of the same structures in the Ungulates. In the meanwhile it may be anticipated that no such differences will be discovered as the very great ones which distinguish the Carnivorous membranes from those of the other three classes of deciduate mammals of which we have been speaking.

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[1] Barkow, 'Zootomische Bemerkungen,' p. 7.

[2] Birnbaum, 'Untersuchungen über den Bau der Eihäute,' Berlin, 1863, pp. 18 & 67.

[3] Hunterian Catalogue, vol. v. 3558, A.

[4] Such a specimen would be further valuable, as it would enable one to discover whether the Cetacea possess that peculiar vascular arrangement which Von Baer and Eschricht have described in the membranes of the Artiodactyles, and which we may call a "placental portal circulation."

[5] Entwickelungsgeschichte, 252, 254, tab. v. fig. 5. Gefässverbindung, p. 14. fig. 1.

Professor Kölliker (*l. c.* p. 169), whilst adopting Weber's class of deciduate Mammalia, has divided his non-deciduate class into two, the first of which is represented by the Pachyderms, and the second by the Ruminants. Of the first of these he says, "The placenta is wholly wanting, the connexion of the ovum with the uterus is quite loose, the chorion carries well nigh over its entire surface small villuli (Zöttchen), which insert themselves into slight (leichte ? *s*eichte) depressions of the uterine mucous membrane (type of the Pachyderms, or of the Pig)." Of the second we read, "There is an intimate union of maternal and fœtal structures; yet maternal and fœtal placentæ are separable without any tearing of tissues." It is true that the cotyledon and the caruncle of the Ruminant are visible to the naked eye, and the villus and shallow pit of the Pachyderm are best seen with the help of a lens; but this seems scarcely a sufficient ground for such a bifurcation as that made by Professor Kölliker. And when we consider, further, that an undoubted Ruminant, the Camel, possesses a diffuse placenta and no cotyledons, and that, according to Professor Owen's suggestion[1], the pigmy Musk-Deer (*Tragulus*) will probably be found to be similarly organized, whilst the undoubtedly Suine Peccary (*Dicotyles torquatus*) approximates markedly to the Ruminants[2] not only by the increase of the stomachal cavities, but also by the decrease of the number of its offspring, this secondary division of the non-deciduate Mammalia will appear to be even less justifiable morphologically.

Leaving now the consideration of the points in which the non-deciduate Mammalia resemble or differ from each other, I will pass in review certain statements which have been made as to the relation of their placental structures to those of the Rodents. In the excellent 'Vergleichende Anatomie und Physiologie' of Bergmann and Leuckart I find, at p. 632, the following comparison:—"To these cotyledons (of the Ruminant) the single disk-shaped placenta of the Rodents has a strong resemblance, inasmuch as in their case also the maternal part usually projects notably out from the surface of the uterus in the shape of a button." ("Mit diesen Cotyledonen hat die eine scheibenförmige Placenta der Nager viel Aehnlichkeit, indem auch hier der mütterliche Antheil bedeutend knopfförmig aus der Fläche der Uterus hervorzuragen pflegt.") This comparison may seem to be amply borne out by a reference to my figure 5, which might serve, though but roughly, for a representation of a vertical section of a single cotyledon of a Ewe. But though the appearance of the parts may be much alike, their history and physiology is very unlike. The structure lettered D S″ gives way in the Rodent and allows the cup-like mass which it attaches to the uterine wall to drop freely into the uterine cavity; if it gives way in the Ruminant, as it sometimes does, it is a pathological process which entails, *pro tanto*, sterility upon the animal in which it occurs, and has its occurrence marked by the production of a cicatrix. In other words, the fibro-plastic cells which may be found on the utero-placental area of a Ruminant, from which the structure D S of figure 5 is accidentally separated, are not sufficient for the regeneration of the mucous

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[1] Hunter's 'Essays and Observations,' p. 135. note 3.

[2] Ibid. p. 124. note 3, and p. 125.

structures over that area, which perfect regeneration, however, we do find to take place in the whole class of deciduate mammals. Nor is this all. For though the structures lettered PL and PL′ in fig. 4 might be taken to represent, though roughly, the cotyledons on the discharged placenta of a Ruminant, the structures which they were drawn from in the Rodent differ essentially from the placentulæ of the Ruminants, in that they contain inextricably mixed up in their mass, as a well-injected specimen will always show, maternal elements which the apparently similar Ruminant structures do not[1]. In its early attainment of the faculty of self-help, however, in the inguinal position, and in the small number of its mammæ, the Guinea Pig presents points of real resemblance to the Ruminants and also to most other non-deciduate mammals.

Secondly, Professor Owen, in the Linnean Society's 'Proceedings,'[2] says of the deciduous portion of the Rat's placenta, that it "consists of fœtal parts exclusively;" and that the "structure of the discoid placenta in the *Pteropus*, like that of the Rat, more resembles that of the fœtal portion of the cotyledon in the Cow than that of the cellulo-vascular, spongy placenta of the Quadrumana." To this it must be replied that specimens, such as most museums possess, of uteri containing fœtuses in which both fœtal and maternal vessels have been injected show distinctly that this resemblance does not exist. It is impossible to inject the uterine vessels of any deciduate mammal, at any but the very earliest stages of pregnancy, without leaving much of the injection inextricably interfused with the fœtal villi, whereas it is perfectly possible to do this with the Ruminant placentulæ at any period. The fœtal villi of a placenta may be "long, delicate, and branched, giving a flocculent appearance to the small portion of the centre of the disk by which the fœtal placenta is attached to the womb"[3]; but it is difficult to see how by this peculiarity they come to resemble "the fœtal portion of the colytedon in the Cow," unless it could be shown that the uterine vessels when injected in a fresh specimen left none of their own substance or of the tissue supporting them interblended organically with the fœtal upgrowths. This can be shown in the Ruminants. The delicate arborescent appearance which is described in the placenta of *Pteropus* is due, in all likelihood, to the prolonged maceration in spirit to which a pregnant uterus of an animal of its geographical distribution would, in all likelihood, be subjected, and it may be paralleled by the appearance which the human placenta, when similarly treated for the purpose of showing its villous structure, may, in most museums, be seen to wear. So far, therefore, from approximating a Chiropterous animal to the Pecora of Linnæus, this placental peculiarity brings them, as Linnæus did bring them, into the same class as the Primates—the necessary preliminary for the

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[1] It should be borne in mind that, though in the pregnant uteri of these prolific animals the sites of former placentæ are recognizable as well as the functional structures, the sites of the two hardly ever coincide. Reichert says that he has only once seen the new placenta attach itself to the place occupied by its predecessor (*l. c.* p. 130). Matters are altogether different in the Ruminants.

[2] *L. c.* p. 16, note. See also Phil. Trans. for 1857, p. 351.

[3] Phil. Trans. for 1857, p. 351.

demonstration of an arborescent placenta being, in both cases alike, the washing away of the intervillularly placed maternal substances[1]. For, though it may be possible to make the placentæ of other deciduate Mammalia assume an arborescent appearance by maceration, as compared with the Human or with the Simious placenta they present ordinarily the appearance rather of interdigitating lamellæ[2] than that of intertwining trees.

From the facts given in this paper, imperfect as it is from the want of certain materials specified, as well as from other causes, it may seem to result that the modifications of the placental structures form a very safe basis for the classification of the Monodelphous Mammalia.

Why within the limits of so well-defined a class such wide variety should exist in the means by which is carried on and out that intra-uterine life which every member of the class lives alike, it is difficult for us to understand; but that such variety does exist there is no doubt.

Differences, however, in structural arrangements which do exist, without our being able to see why they should exist, possess a morphological value which rises in direct proportion with their physiological obscurity.

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[1] Eschricht's words as to this intercellular substance are exceedingly apposite:—"Villos microscopii ope examinans massa grumosa eos obtectos esse sæpissime vidi quam tegumentum esse a tunica serotina præbitum nullus dubito."—*De Organis*, p. 127.

[2] Eschricht, *l. c.* pp. 14, 26; Von Baer, 'Gefässverbindung,' pp. 23 & 24.

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DESCRIPTION OF PLATE L.

Explanation of the lettering of the Figures.

A.	Amnios.
B V.	Blood-vessels.
C.	Fœtal surface of deciduous serotina concentrically corrugated for reception of (PL′) upgrowth of placenta.
CH.	Chorion.
CH′.	Upgrowth of chorion supporting umbilical vessels, and joining uterine mucous membrane at U P.
C M.	Circular muscular coat.
D R.	Decidua reflexa, or remnant of it.
D S.	Deciduous serotina, or part of utero-placental mucous membrane which comes away with placenta.
D S′.	Downgrowth of deciduous serotina coming into relation and connexion with placenta.
D S″.	Fimbriæ, or tag-like outgrowths of decidua serotina, attaching it to the non-placental uterine mucous membrane.
F.	Membrane connecting upper surface of placenta with inner aspect of lower end of downgrowth of deciduous serotina by G.
G.	Membrane connecting downgrowth of deciduous serotina with process of upper surface of placenta.
L M.	Longitudinal muscular coat.
M.	Mesometrium.
M M.	Muscular walls of uterus.
P.	Peritoneal coat of uterus.
PL.	Placenta.
PL′.	Upgrowth of placenta, "Kern" of Bischoff (Meerschweinchen-Ei, pp. 43 & 44).
P S.	Persistent or non-deciduous serotina, the part of the utero-placental mucous membrane which is not separated or shed away from the placental area at or after parturition.
U C.	Umbilical cord.
U M.	Non-placental uterine mucous coat.
U P.	Parapet connecting uterine mucous coat with decidua serotina, and so mediately with the rest of the after-birth.

Observations on the Figures.

Fig. 1. Shows the placenta of the Tenrec (*Centetes ecaudatus*) detached from the deciduous serotina, shown in fig. 2, and from the utero-placental area covered with persistent or non-deciduous serotina, shown in fig. 3. Part of the amnios (A) and of the umbilical cord (U C) are left in connexion with the placenta (PL). The umbilical vessels are prolonged up into an upstanding rim of membrane, CH′, which is itself an upward prolongation of the chorion, and was continuous with the uterine tissues along a parapet of membrane, U P, in fig. 3.

Fig. 2. Deciduous serotina of Tenrec. It is separated both from placenta, fig. 1, and from the uterine structures figured in fig. 3. It is but of wafer-thickness, and centrally it has many perforations for the uterine vessels. In the natural condition of the parts its periphery would have been in connexion with the inner periphery of the circular area of corrugated mucous membrane seen in next figure, and one of its surfaces would have been in relation with the uterine aspect of the placenta, and the other with the fœtal aspect of the persistent non-deciduous serotina, P S, fig. 3.

Fig. 3. Utero-placental area of Tenrec: U P represents the parapet of uterine mucous membrane with which the chorionic upgrowth (CH′, fig. 1) was continuous. Within this limitary line is a quoit-shaped area of mucous membrane concentrically corrugated; and within it again we have a space much perforated by orifices of blood-vessels, and covered with the non-deciduous or persistent serotina, P S. The presence of the ring of corrugated mucous membrane bounding the non-deciduous serotina, and bounded itself by the circular parapet (U P) of mucous membrane, and the presence of an upgrowth of the chorion (CH′) continuous with this parapet, are phenomena, so far as is known by me, unique in the Mammalia.

Fig. 4. Section of placenta (PL) with part of chorion (CH) of Guinea Pig (*Cavia aperea*). Upon the uterine surface of the placenta there is an upgrowth, PL′, the "Kern" of Bischoff (Meerschweinchen-Ei, 1852, pp. 43 & 44), the texture of which is to the naked eye somewhat looser than that of the larger mass, PL, of which it is morphologically and histologically but a part. In the angle between its outer border and the upper surface of the placenta is seen a small piece of membrane, F, which, in the natural state of the parts, was continuous with a process (G) of deciduous serotina, which is seen in the next figure. Near to the place of attachment of this process of membrane are seen the cut orifices of vessels belonging to the "sinus circularis" system, for which see Kölliker, *l. c.* pp. 140, 147, or Robin, *l. c.* p. 130.

Fig. 5. Section of the part of the uterine cornu and of the deciduous serotina which was in connexion with the placenta of the preceding figure. The deciduous

serotina has been artificially displaced from its natural condition of apposition with the uterine wall's non-deciduous serotina. It is still connected with the uterine tissues by blood-vessels (B V) and by tags or fimbriæ, D S″, which pass from its periphery to become continuous with the uterine mucous membrane. From its concave surface there is a downward growth, D S′, which embraced the upgrowth (PL′, or "Kern" of preceding figure), and which ends in two processes, one (D R) being the remnant of the decidua reflexa, and the other (G) having been continuous with F in preceding figure, and connected the deciduous serotina with the placenta. The persistent non-deciduous serotina is a very thin layer, not separable as a distinct stratum to the naked eye from the circular muscular coat, C M; but it contains uterine glands. A wide interval, partly artificial, and containing many blood-vessels (B V), separates the circular from the longitudinal muscular coat, L M. The mesometrium (M) is attached to the convex border of the figure

Fig. 6. Decidua serotina, with remnant of reflexa, from aborted ovum of Guinea Pig (*Cavia aperea*), viewed from its placental aspect. It was found loose, and with nothing in connexion with it, in the uterine cavity of the individual whence the preparations for the two previous figures were taken. Tags or fimbriæ, D S″, by which it was attached to the uterine mucous membrane, proceed from its periphery. Two of these tags are prolonged inwards on its placental aspect to join the opposite poles of an inner raised circular cup, the decidua reflexa (D R). Within and at the bottom of this is a concentrically corrugated area of mucous membrane, which was thus thrown into folds for the reception of the placental upgrowth (PL′) of the ovum which was in connexion with it. The vessels which passed to the placenta made their way to it mainly by the depression in the centre of this area, C. (See Bischoff, Meerschweinchen-Ei, figs. 54, 55, 57.)

Fig. 7. After-birth of Rabbit (*Lepus cuniculus*), showing the prolongations of the decidua serotina at either extremity of the structure, and their continuity with the uterine mucous membrane (U M). The placenta is obscurely seen to be made up of several (two or more) lobes, which are clamped together by a centrally constricted decidua serotina (D S), the constriction corresponding to the interval between the main divisions of the placenta. The decidua serotina has its long axis at right angles to that of the uterine cornu, to the mesometrial border of which it is, in this as in every other Rodent, attached. From either end a process is very usually, as in this figure, prolonged beyond the placental area to become continuous with the uterine mucous membrane on the free half of the tube, portions of which in this connexion are drawn at U M in this figure. These two processes represent the much more numerous ones (D S″) of the Guinea Pig's decidua serotina. Just fringing the lateral

borders of the decidua serotina, along which the uterine mucous parapet was continuous with it, and passing underneath its two prolongations, D S″, is seen the decidua reflexa, which is rudimentary in the Leporidæ.

Fig. 8. Vertical section of uterus of Rat (*Mus decumanus*) through utero-placental area, after parturition. The letters U P show the line where the non-placental uterine mucous membrane became continuous with the decidua serotina which was discharged with the after-birth. The persistent non-deciduous serotina, which is inseparable from the circular muscular coat, forms a hernia-like protrusion out of, and not corresponding with, the curve of the uterine walls. A funnel-shaped depression leads down to it, and a lateral diverticulum is thus appended to the uterine tube. The persistent serotina (P S) and the circular muscular coat (C M) with which it is mixed up, filling up its interstices, is separated by an interval (B V), a little widened artificially, from the longitudinal muscular coat (L M). The non-placental mucous membrane is much corrugated, owing to the contraction of the previously distended uterus.

Fig. 9. Part of placenta, deciduæ, and uterine walls of Pig-tailed Monkey (*Macacus nemestrinus*). The placenta (PL) has been artificially separated from the utero-placental area, and is kept in connexion with the uterus by a pointed process abutting upon its uterine aspect, and consisting of decidua vera, persistent, and deciduous serotinæ. A thin lamina of membrane (D S) is seen in the intervals between the placenta and the utero-placental area, being one part of the decidua serotina, tougher, more coherent, and more separable in this Simious than in the Human placenta. The persistent serotina (P S) is loosely reticular, but limited towards the placenta by a smooth horizontally lying membrane, which would probably have been deciduous. The decidua reflexa (D R) is represented by a layer on the chorion (CH): it is separated by a wide interval from the non-placental uterine mucous membrane (U M), which might perhaps not have been deciduous (see Virchow, Gesamm. Abhandl. p. 782). The "Decidua-Fortsätze" are well seen in the section of the placenta, as in the Human placenta at six months. (Cf. Schröder van der Kolk, cit. Priestley, *l. c.* p. 57, fig. 16, or Kölliker, *l. c.* pp. 148, 177, 183, and Ecker's 'Icones Physiologicæ,' tab. 28. fig. 1, *d f.*)

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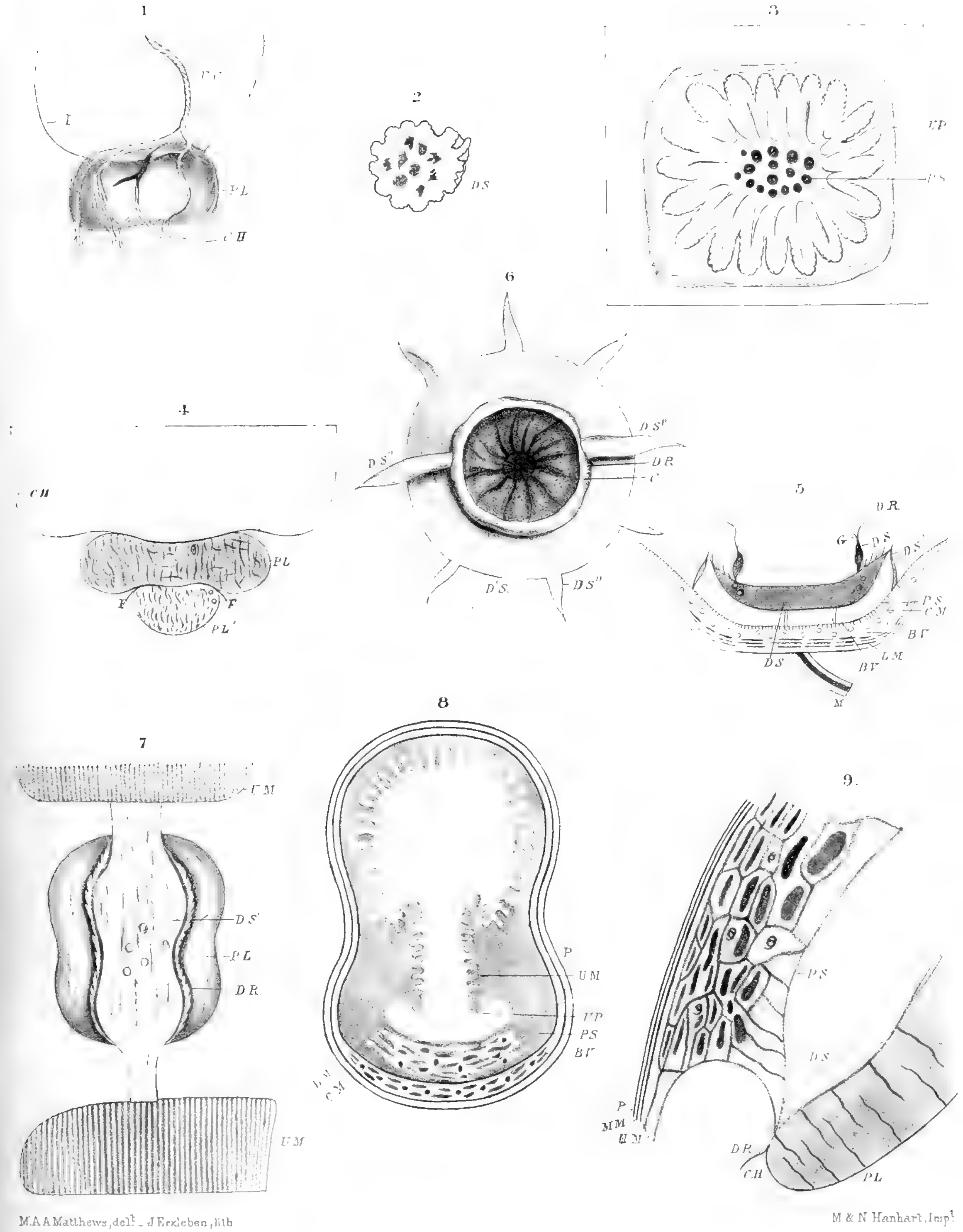


M.A.A. Matthews, del^t. – J. Erxleben, lith.

M & N Hanhart, Imp^t.

1.2.3. CENTETES ECAUDATUS. 4.5.6. CAVIA APEREA. 7. LEPUS CUNICULUS.
8. MUS DECUMANUS. 9. MACACUS NEMESTRINUS.

BRITISH MUSEUM
Z D
NATURAL HISTORY

VIII. *Description of the Skeleton of the Great Auk, or Garfowl* (Alca impennis, *L.*).

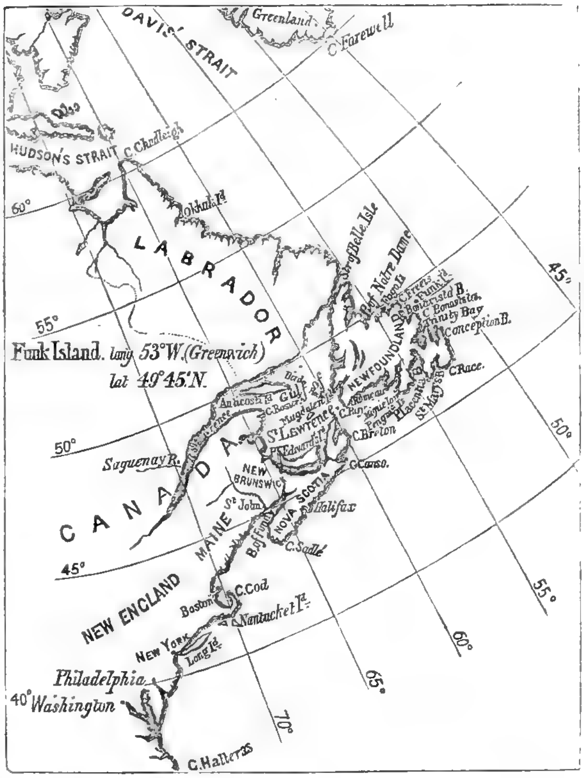
By Professor Owen, *F.R.S.*, *F.Z.S.*

Read June 14, 1864.

[Plates LI. & LII.]

Mr. ALFRED NEWTON, M.A., F.L.S., who, with his friend the late lamented and accomplished naturalist Mr. J. Wolley, has contributed valuable materials[1] for the history of the Garfowl (*Alca impennis*, L.), prosecuting his endeavours to obtain additional materials for that history, has received the body of a specimen, dried, flattened, featherless, and mummified, like the Penguins from the guano-masses of the Peruvian islands. This specimen was obtained from one of the old breeding-places of the extinct bird, Funk Island, long. 53° W., lat. 49° 45′ N., off the coast of Newfoundland, by the Bishop of that colonial diocese, and was transmitted by his Lordship to Mr. Newton, who has kindly confided it to me for description, with permission to treat the specimen as might best serve the interests of science.

A preliminary photograph of the mummy having been taken, it was accordingly macerated for the extraction of the skeleton, and has yielded the skull, bones of the trunk, scapular arch, and furculum, right humerus, right femur, tibia, and fibula.



Old breeding-ground of *Alca impennis*.

Learning that Mr. John Hancock, the accomplished and artistic taxidermist of Newcastle-on-Tyne, had extracted the bones of the extremities from a rare skin of *Alca*

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[1] See abstract of Mr. Wolley's "Researches in Iceland respecting the Garefowl, or Great Auk (*Alca impennis*, Linn.)," by Alfred Newton, Esq., M.A., F.Z.S., 'Ibis,' October 1861, p. 374.

impennis, I wrote for the loan of those of the left side, and was favoured by a prompt and kind acquiescence, the bones being stated to be from a mature female bird.

I have thus at command the materials for a description of the complete osteology of this most rare and now generally regarded as extinct bird.

In my 'Descriptive Catalogue of the Osteological Series contained in the Museum of the Royal College of Surgeons of England,'[1] I have briefly noticed characteristics of the cranium, dorsal vertebræ, scapula, coracoid, femur, and tibia of an *Alca impennis* which the founder of the collection, John Hunter, had succeeded in procuring; Mr. Blyth had previously made known the fact that the humerus "possessed a very small internal cavity, while the tibia was completely filled with marrow"[2]; and these are the only published notices of the osteology of the bird with which I am acquainted.

§ 1. *Vertebral column.*

In the present specimen there are twenty-two moveable vertebræ between the skull and sacrum, the last nine supporting moveable ribs, of which the first two pairs have free extremities; the succeeding pairs of free pleurapophyses articulate with hæmapophyses, and these with the sternum.

The sacrum appears to include fourteen vertebræ, of which the first supports a tenth moveable pair of ribs, the last of the ordinary thoracic costal series: its hæmapophysis does not reach the sternum.

The caudal vertebræ are fourteen in number, of which the last three are blended together, and the first, by its pelvic relations, might claim to belong to the sacral series.

The centrum of the atlas, anchylosed as an odontoid process to the axis vertebra, presents a pair of small facets for articulation with the posterior basal angles of its proper neurapophyses; but these are mainly supported by the hypapophysis, simulating the body of the atlas, and with which they are confluent. The back part of the hypapophysis offers a flat surface to the centrum of the axis, beneath which it is slightly produced at its lower part, being here wedged into the notch between the true bodies of the axis and atlas. The fore part of the hypapophysis combines with the neurapophyses to form the cup for the condyle of the occiput; the cup is emarginate above, and traversed by the ligamentous continuation of the "odontoid" in its way to adhere to the upper part of the occipital ball. The atlantal neurapophyses diverge as they rise, and are joined together above by a broad plate slightly arching across from one to the other neurapophysis. A process extends backward from each place of junction. There is no neural spine. The neural canal has a wide transversely elliptical area.

The body of the axis is elongate, compressed and carinate below, the keel being slightly produced and curved at the hind part. The expanded anterior end of the centrum has a small notch near or at the junction of the neurapophyses. These deve-

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[1] 4to, 1853, vol. i. p. 221, preps. nos. 1150–1160.

[2] Proc. Zool. Soc. November 14, 1837, p. 122.

lope postzygapophyses, above which are produced strong trihedral anapophyses; there is a thick, obtusely ended, slightly recurved neural spine.

The third cervical developes a compressed hypapophysis, slightly thickened and flattened below, from the hinder half of the centrum. From the sides of the base of the hypapophysis ridges diverge to parapophyses at the expanded fore part of the centrum, which is flat and triangular below; above each ridge the centrum is concave. Below the præzygapophysis a diapophysis coalesces with the short pleurapophysis, which circumscribes a vertebrarterial canal, the foremost of the series; above the postzygapophysis there projects a trihedral anapophysis, less thick than that of the axis. A sharp horizontal ridge passes from the post- to the præ-zygapophysis, having a small vertical perforation behind; the neural spine is a little higher and less thick than that of the axis. The pleurapophysis projects as a slender, straight, obtuse process about 2½ lines backward; the intervening "vertebrarterial" canal is above a line in diameter.

The fourth cervical (Pl. LII. figs. 4 & 5) resembles the third, but with shorter pleur- (*pl*), hyp- (*hy*), and an-apophyses (*a*), and with a rather shorter neural spine (*ns*). The vertical foramen in the interzygapophysial ridge (*iz*) is larger than in the third vertebra; and below this a shorter ridge (*r*) passes to the base of the præzygapophysis (*z*). The posterior part of the neural arch is broader than the interior.

In the fifth vertebra the interzygapophysial ridge is wanting; but the one beneath is more developed. The anapophyses are reduced to ridges diverging from a stumpy neural spine to the postzygapophyses (*z'*). The diapophysis makes a backward projection distinct from and above the pleurapophysis; there is an obtusely angular hypapophysial keel (Pl. LII. fig. 6, *hy*).

In the sixth to the ninth cervicals the hypapophysis is obsolete, and the parapophysis (Pl. LI. fig. 1, *p*) sends a stumpy projection downward, increasing to the ninth, where it forms the side of a quasi-hæmal canal; the backward extension of the rib is reduced to a mere angle. On the broad depressed upper surface of the neural arch, both neural spine and anapophyses are represented by low ridges: the posterior part of the neural arch is narrower than the anterior. The diapophysis (ib. *d*) continues to project outward, and becomes bifurcate by a groove.

In the tenth cervical the hypapophysis (ib. *hy*) suddenly reappears as a compressed quadrate plate from the whole under surface of the centrum, a little inclined forward, especially at the front angle.

In the eleventh cervical there is a similar but rather shorter hypapophysial plate, and the pleurapophyses begin again to project backward, and the neural spine (*ns*) to reappear.

In the twelfth cervical the hypapophysis is reduced to a short triangular process, and the neural spine forms a low thick knob; the pleurapophyses are still anchylosed as mere processes.

In the thirteenth cervical they elongate, but are fixed; the hypapophysis is a mere ridge; the parapophyses reappear as ridges; the diapophysis is widely cleft, and the hinder and lower portions afterwards alone represent this process; the neural spine is a higher tubercle than in the twelfth vertebra.

The fourteenth vertebra, retaining its pleurapophyses as free elements, may be reckoned as the first dorsal (Pl. LI. fig. 1, D); its centrum is broader than it is long, with a medial and two marginal ridges below: the first ridge is hypapophysial; the latter are parapophysial, and are most produced, each bounding a concavity on the under surface of the vertebra. The pleurapophysis (ib. *pl*) is a simple, straight style, 6 lines in length, articulated to the under part of the base of the diapophysis, which is now a broad, triangular, depressed plate. The neural spine is a strong, compressed, quadrate plate in this and the succeeding dorsals.

In the second dorsal the parapophysial or lateral hypapophysial ridges are more produced, especially at the hinder angle. The pleurapophysis is a long, nearly straight style of about 3 inches in length, and supports at the beginning of its lower or distal third an epipleural plate curving upward. The head of the rib is expanded and articulates to much of the under part of the diapophysis. The quadrate neural spine gains in fore-and-aft extent.

In the third dorsal the lateral hypapophysial plates are longer and narrower, and begin to be supported as processes from the descending inferior part of the centrum. The pleurapophysis, 3 inches 7 lines in length, articulates above by a head and tubercle with the centrum and under part of the diapophysis, and below with a straight hæmapophysis, 1 inch 5 lines in length, and expanding at its sternal end to articulate with an oblong cavity, transverse to the broad costal margin of that bone. The epipleural is a plate 1 inch in length, and from 1 to 2 lines broad.

In the fourth dorsal (Pl. LII. fig. 7), the parapophyses are converted into a hypapophysis in the form of a broad bifurcate process, the prongs diverging at a wide angle as they descend from the common produced base (*hy*). The pleurapophysis, with the head more distinct from the tubercle, and supported on a longer neck, is 4 inches in length, and articulates with a hæmapophysis 1 inch 10 lines in length. The diapophyses (ib. *d*) are long and broad; the zygapophyses (ib. *z*, *z'*) small and short. The neural spine (ib. *ns*) increases in antero-posterior but not in vertical diameter, and preserves the quadrate form.

In the fifth dorsal, the stem of the bifurcate hypapophysis lengthens. The pleurapophysis, 4 inches 10 lines in length, continues as slender as the preceding, and articulates with a hæmapophysis 3 inches 2 lines in length, and slightly bent.

The sixth dorsal has a longer and narrower stem of its bifurcate hypapophysis; but the fork is broken off. The pleurapophysis is as in the fifth, but with a longer and more curved hæmapophysis, 4 inches in length, and with a rather shorter epipleural lamina.

In the seventh dorsal the hypapophysis is a compressed subquadrate plate, a little expanded at its lower margin. The pleurapophysis, 6 inches in length, retains its slenderness; the hæmapophysis is 4 inches 8 lines in length.

In the eighth dorsal, the hypapophysis is suddenly reduced to a low triangular process. The pleurapophysis, 6 inches 3 lines in length, articulates with a hæmapophysis of more slender proportions, 5 inches 2 lines in length.

In the ninth dorsal, the hypapophysis is again represented by a low median ridge. The pleurapophysis, 6 inches 6 lines in length, articulates with a hæmapophysis (*h*) 5 inches 6 lines in length; and this is the last of those that directly articulate with the sternum.

The tenth dorsal becomes, by confluence of its centrum, the first sacral (ib. s), but retains its neural spine distinct from, though contiguous with, the long sacral ridge; its pleurapophysis (*pl*) is 6 inches 2 lines in length, and articulates with a hæmapophysis (*h*) 5 inches 2 lines in length, the distal end of which is applied to the preceding hæmapophysis about one inch from its articular end.

In the dorsal region, the articular facets of the centrum are simplified to a very slight convexity in front and a corresponding concavity behind (Pl. LII. fig. 7, *c*).

The sacrum (Pl. LI. fig. 1, s), 4 inches 2 lines in length, and including about thirteen vertebræ, presents at its beginning rather long and narrow centrums; but these expand laterally, and subside vertically to the sixth, whence they gradually again contract in breadth to the antepenultimate vertebra: the centrums are all confluent. The hinder half of the expanded rhomboid portion of the under surface of the sacrum is broadly and slightly grooved.

Transverse processes, from the second to the sixth sacral inclusive, abut against the ilia: in the next three vertebræ these processes are scarcely marked; they reappear in the following sacrals, with articular surfaces for the ilia, increasing in vertical extent. The first free caudal has also a short thick transverse process, which abuts against the ilio-ischial part of the os innominatum.

The length of the iliac element (Pl. LI. fig. 1, 62) of this bone is 4 inches 6 lines; its extreme breadth, an inch from the fore margin, is 9 lines. That margin is rounded; the outer one is at first convex, then concave, contracting before expanding again, and thickening (at 62) to contribute to the acetabulum. The expanded fore part of the ilium is a very thin lamella. The acetabulum, widely open, is overtopped by an articular facet adapted to the upper part of the neck of the femur. The ilium quickly contracts in breadth behind the acetabulum, beyond which it extends nearly 2 inches, as far back as the third caudal; it coalesces with the ischium about an inch behind the acetabulum, circumscribing an elliptic ischiadic foramen (*i*) 9 lines in length and 4 lines in short diameter.

The ischium (63), after the iliac confluence, extends backward as a pointed styloid process an inch in length. The ischium forms the back part of the acetabulum, the pubis the under part; the obturator vacuity (*o*) between ischium and pubis is only 5 lines in length and 2 lines in short diameter. The ischio-pubic harmonia beyond this is 1½ inch in length; the slender pubis (64) then extends freely backward and slightly outward and downward for 2 inches 6 lines, of a rib-like shape; its total length is 4 inches.

The first free caudal has a depressed subquadrate centrum, broad and depressed diapophyses inclined backward, with terminal pelvic articulations as above stated. The second, third, and fourth caudals diminish in size, and more so in the breadth of the diapophyses, which end freely.

A small hæmapophysial tubercle is wedged between the second and third caudal centrums; a larger plate is between the third and fourth caudals; it begins to be compressed between the fourth and fifth caudals. The next hæmapophysis resembles a short compressed spine, inclined forward; the fifth and sixth hæmapophyses diminish in size; the seventh and eighth are elongate bones underlying the centrums, with which they are nearly coextensive. One sees that the under and fore part of the terminal anchylosed mass of caudals is a confluent hæmapophysis of like shape.

The diapophyses increase in length from the fourth to the seventh caudals; these decrease in the eighth and ninth, and disappear in the tenth. The neural spines are stumpy and thick on the anterior caudals, look longer, because thinner, on the succeeding ones to the ninth, are short on the tenth and eleventh, and are represented by a continuous ridge on the terminal coalesced vertebræ. The length of the caudal region is 3 inches 9 lines.

From the position of the acetabula, and prior to sacral confluence, there would be shown eighteen free caudal vertebræ in the young Garfowl: one sees that if these vertebræ had continued free and participated in the rate of growth of the antecedent centrums, how similar a caudal appendage to that of the *Archæopteryx*[1] would have resulted.

The sternum (Pl. LI. *hs*, 60; Pl. LII. figs. 1 & 2) is long, narrow, entire, with the keel (*hs*) equalling in depth the breadth of the mid part of the bone. The episternum (*e*) is short, compressed, wedge-shaped, with its thin obtuse apex curved a little down and back. The "coracoid" grooves (*b*) are separated from each other by the base of the episternum (*e*): each is divided into an inner and an outer articular facet; the inner one (Pl. LII. fig. 2, *b*) is the largest, and is subtriangular, the broadest part being sustained by a kind of buttress-like prominence, each buttress (*f*, *f*) diverging from the fore part of the origin of the sternal keel (*hs*). The outer facet (ib. *b'*) is bounded by a short plate in front, and by the base of the costal process behind.

The "costal" process[2] (*d*) is subcompressed, triangular, with an obtuse apex directed

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[1] Phil. Trans. 1863, p. 44, pl. 1.

[2] See the definition of this and the other processes in art. *Aves*, 'Cyclopædia of Anatomy and Physiology,' vol. i. 8vo, 1836. The sternum of the bird is not the homologue of the plastron of the Tortoise; it is never developed from longitudinally consecutive series of lateral elements such as represent the hæmapophyses of certain dorsal segments in *Chelonia*. In most birds ossification of the sternum begins from a pair of centres, which, meeting and coalescing at the mid line, thence extend into the cartilaginous basis of the keel. The extra pair in the anomalous sternum of Gallinæ is special and exceptional in the Bird class. The application of the names of the elements of the Chelonian plastron to parts of the Avian sternum is to be deprecated, save in the case of the episternum, the bifurcate character of which is shown by bone in Passerines.

upward, the base intervening between the coracoid (*b*) and costal (*a*) surfaces. The latter, occupying 1 inch 9 lines of the sternal border behind the costal process, presents seven articulations (Pls. LI. & LII. fig. 1, *a*, *a*) for as many hæmapophyses (ib. *h*), progressively decreasing in size as these likewise diminish at their sternal ends. The sternum is continued 4 inches 5 lines behind the costal borders, slightly expanding before it is rounded off to the end, which is truncate, and reduced to a breadth of 9 lines.

The front border of the sternal keel, 1 inch 10 lines in depth, is concave and carinate (Pl. LII. fig. 2), the obtuse anterior angle of the keel being produced toward the furculum (Pl. LI. fig. 1, 58), but not reaching or coalescing with that bone. The keel extends, gradually losing depth, to within an inch of the hind end of the sternum, and at its subsidence a pair of curved lines (Pl. LII. fig. 1, *l*), convex backward, diverge to near the lateral borders, and are reflected forward, three or four lines from the border, to the end of the costal surface (*a*). The total length of the sternum is 7 inches 8 lines; its greatest breadth is 2 inches 3 lines.

§ 2. *Skull.*

The skull is long and narrow, the rostral part forming nearly the two anterior thirds, compressed, and deep; the orbits are large, with only the upper half of their bony rim defined. The cranium is very small, and chiefly seen at the upper half of the posterior fifth part of the entire skull (Pl. LI. fig. 2). The interorbital region slopes to the base of the upper mandible, which, rising at its compressed part, leaves a wide concavity in the contour line between the mandible and the cranium proper. Both the temporal (*t*) and the superorbital glandular (*so*) depressions are deep and sharply defined, meeting, but separated respectively, at the mid line by a low, sharp crest.

There is a large lower and a small upper vacuity in the interorbital septum, the former continuous posteriorly with the optic vacuity, the latter with the olfactory vacuity: in the anterior cranial wall there is a pair of vacuities, one on each side of the orbitosphenoidal base of the ossification, dividing the upper from the lower vacuity in the bony interorbital septum.

The occipital tubercle is subhemispheroid, projecting below the level of the basioccipital (ib. fig. 3, 1). This is transversely extended, subcarinate, divided by a pair of transverse curved ridges from the basisphenoid (ib. 5). The paroccipitals (ib. 4) are broad, obtuse, trihedral, the narrowest surface being mesiad; the fore surface is concave; the outer margin is continued as a ridge upon the occipital surface, defining the share thereto contributed by the mastoid: the fore part of the base forms the posterior tympanic cup. The mastoid (ib. 8) is short, obtuse, inclined downward and forward. The inner and back part of its base is excavated by a deep transverse oval fossa for the anterior condyle of the tympanic element (ib. 28).

The occipital surface of the cranium is vertical, subsemicircular; its upper and lateral border forms a deep and sharp ridge, dividing it from the temporal fossæ. Each fossa is divided into an anterior (Pl. LI. fig. 1, 11) and posterior (ib. *t*) compartment; the latter divisions meet above and define a short low "parietal" ridge (ib. fig. 2, 7).

The fore or postorbital part of the temporal fossa is divided from the deeper back part by a low ridge descending from the hind angle of the smooth convex frontal tract to the fore part of the mastoid. The interorbital supracranial space is occupied by the deep oblong fossæ (ib. *so*) of the superorbital glands, between which fossæ is a sharp median ridge. A lateral ridge defines each fossa from the superorbital ridge itself, which is very narrow. There is an oval vacuity for the duct of the gland at the outer and fore part of each superorbital fossa, 4 lines, by 2 lines in diameter; and there are two or three foramina at the back part of each fossa, leading to the orbit. The postorbital process (12) is depressed and triangular, impressed above by the fore part of the temporal fossa, which is there divided by a short longitudinal ridge from the superorbital glandular fossa.

The prefrontals (ib. fig. 1, 14) send outward a triangular antorbital plate, which inclines a little forward to join the lacrymal, but leaving an intermediate lacrymal vacuity about the same size as that for the duct of the superorbital gland.

The basisphenoid rapidly narrows as it advances forward, and does not send out processes (pterapophyses) for the tympanic or pterygoid bones; its presphenoid prolongation (ib. fig. 3, 9) diminishes in transverse but increases in vertical extent, developing upward the lower part of the interorbital ridge, which is continuous with the ossified anterior part of the interorbital septum, and, by means of its backward extension, with the orbitosphenoids (ib. 10). The lower border of the presphenoid is convex, and rests upon the groove formed by the approximated palatines (20) and intervening vomer (13).

The very thin fore part of the cranial wall shows four large vacuities, one medial and superior, triangular, and giving exit to the crura of the olfactory lobes, which slightly groove the under surface of the interorbital part of the frontals on their way to the prefrontals. On each side and a little below the olfactory aperture is an irregular oblong vacuity. An ossified tract of the interorbital septum extends from the confluent orbitosphenoids, between the above vacuities and below the olfactory one, forward to the anterior ossified part of the septum: a narrow unossified tract lies above, and a broader unossified oblong space is beneath this upper ossified part of the septum. The inferior vacuity gives exit to the optic and orbital nerves.

The palatines (ib. fig. 3, 20) are broadest behind, and present each towards the palate a long triangular surface sloping from within outward and downward, and defined mesially by a low vertical plate bounding an angular cavity thus formed on that surface. The narrower anterior prolongations of the palatines are confluent with the palatal processes of the maxillaries (ib. 21), near to which they also develope from their inner border a low vertical ridge. The upper surface of each palatal, near its middle part, developes the curved outer wall of the posterior nostril, which is convex externally; the palatal terminations of these nostrils are longer and narrower, and are divided by the compressed elongate vomer (13).

The nasals, confluent behind with the frontals, prefrontals, and lacrymals, soon divide into their premaxillary (Pl. LI. fig. 2, 15) and maxillary (15′) branches ; the former, at first divided by a fissure from the nasal part of the premaxillary (22), coalesce therewith anteriorly ; the longer styliform maxillary processes coalesce by their lower end with the maxillary.

The broad part of the palatal plate of the maxillary (ib. fig. 3, 21), whence its palatine, malar, nasal, and premaxillary processes diverge, is perforated by the oblique foramen (*l*) conveying the lacrymal and superorbital secretions to the angle of the mouth. The premaxillary processes are divided by the back part of the long prepalatine fissure (*f*), about 2 lines in breadth. The malar process is depressed, about an inch in length, and underlaps the fore half of the malar. The nasal process rises to the inner side of, and is partly confluent with the maxillary process of the nasal bone; which process (ib. fig. 1, 15′) is subcylindrical, and extends downward and forward from the interspace between the lacrymal bone and the premaxillary part of the nasal, dividing the large external nostril (15′) from the antorbital (21′) vacuity.

The premaxillary chiefly forms the compressed, subarcuate, pointed upper mandible, which is grooved on the narrow palatal surface (ib. fig. 3, 22″) for an extent of 1 inch 6 lines from the apex, where the prepalatal vacuity commences. The fore end of the groove is divided by a short delicate median ridge. The nasal process of the premaxillary (22) assumes behind the rostral part of the bone a trihedral shape, gradually becoming flat and then concave below; it is grooved above, the groove deepening to a fissure, and dividing the back part of the process where it joins the frontal. The nasals (15) are also partly divided by linear fissures from this part of the premaxillary, with which they are confluent at both ends.

The pterygoids (fig. 3, 24) are slender, slightly bent, trihedral bones, articulating anteriorly to short pterygoid processes at the inner and back part of the palatines, and posteriorly with an articular tubercle on the inner side of the base of the inner division of the lower articular end of the tympanic (28). The limits of the styliform malar (ib. fig. 3, 26) and squamosal (27) are indicated by grooves; the latter articulates with the outstanding lower and outer angle of the tympanic.

The tympanic articulates by two convex condyles with the mastoid and paroccipital; its body slightly contracts below these, and sends from its fore part a long compressed triangular process, with the apex obliquely truncate; its lower end is much expanded, and supports two articular surfaces: the outer one (fig. 3, 28) is oblong and oblique, convex anteriorly, and concave posteriorly, where it is extended upon a short posterior process, forming the squamosal cup; the inner and smaller facet is convex, and above this is the pterygoid tubercle.

The lower tympanic condyles are adapted to two corresponding cavities on the articular part of the mandibular ramus, which developes behind them a vertical triangular surface, the outer and inner margins of which are produced into cristæ. There is a small coronoid process external and anterior to the outer articular surface. The surangular part of the ramus shows an oval vacuity, about 3 lines by 2 lines; the groove defining the surangular from the angular part widens as it advances, and leads to an oblong fissure between the surangular and dentary elements.

The splenial element retains its distinctness posteriorly, and a groove upon the lower margin of the ramus indicates the extent of its forward production: the posterior limits of the posteriorly bifurcate dentary element are clearly defined. The right and left of these elements coalesce to form a compressed, pointed symphysis, 1 inch long, half an inch deep at the back part, gradually contracting forwards to a point, with a grooved upper surface; the upper margin of the symphysis is slightly convex lengthwise, the under margin slightly concave lengthwise.

The outer surface of the symphysial part of the jaw is roughened by numerous small perforations and grooves, indicating the vascularity of the periosteum in connexion with the reproductive matrix of the horny sheath of the beak: the tip of the premaxillary has a similarly sculptured surface.

The basihyal, including the urohyal, is 10 lines in length; the fore end of the basihyal is slightly expanded, and occupied by a trochlear articular surface, convex transversely, concave vertically. The bone again expands to form the pair of concave oval articular facets for the thyrohyals, beyond which it is continued as a slender pointed style (urohyal) for about 4 lines; the part anterior to this is the true basihyal. The thyrohyals (hyobranchyals) are slender, slightly bent styles, 2 inches long, swelling into a small knob at both ends, the one articulated to the basihyal being rather the largest.

§ 3. *Scapular Arch and Appendage.*

The bladebone (Pl. LI. fig. 1, 51), 3 inches 8 lines in length, extends backward to the ninth rib, gradually expanding vertically and more quickly flattening laterally to its free extremity, which is truncate obliquely from above downward and backward. The proximal end has opposite dimensions, being much expanded laterally or transversely to the axis of the trunk, and narrowest vertically; it presents a broad transverse condyle, which is a little expanded at each end, to the coracoid. The outer end is the broadest; the inner one the most produced. The shaft of the scapula quickly contracts to a transverse diameter of 3 lines, and then begins to grow thin and broad, but as if with a kind of twist, the inner or medial border near the head of the bone becoming the upper border about a fifth of the way from that end. The inner end of the condyle is connected by a strong ligament with the end of the furculum.

The coracoid (ib. 52) has a breadth at its sternal end of 14 lines: the medial side of this end is thick, with the posterior angle produced; the outer side is thin, and sends off above the sternal articulation a lamelliform process. The inner side of the sternal expansion is slightly concave. The coracoid contracts to a diameter of 5 lines, continuing thick and convex along its medial border; it sends off from the inner and back part of its proximal end a strong compressed process, which is perforated, and which developes the articular cavity for the inner condyle of the scapula, and is attached by a short ligament to the end of the furculum: the main continuation of the body of the bone supplies the rest of the joint for the scapula, with the major part of that for the humerus, and then arches forward as a strong process to abut against the articular surface of the clavicle (furcular prong), situated upon the upper and outer part of that bone, about 6 lines from the extremity, which is ligamentously connected with the scapula and inner part of the clavicular process of the coracoid. The body of the coracoid is, as usual, straight and inclined from the sternum upward, forward, and slightly outward, losing breadth, gaining thickness, and assuming the trihedral form as it rises.

The clavicle (Pl. LI. fig. 1, 58), anterior to the coracoid articulation, becomes compressed, curves with a strong convexity forward, and then bends inward and backward, thickening and expanding to become confluent with its fellow, in the form of an inverted but somewhat narrow arch (Pl. LII. fig. 3). The length of each half of the so-formed furculum, following the curve, is 4 inches 6 lines; a short convex ridge is developed from the point of confluence, which does not reach the anterior apex of the sternal keel.

The humerus (Pl. LI. fig. 1, 53; Pl. LII. figs. 8, 9, 10), 4 inches 2 lines in length, is much expanded at the proximal end (Pl. LII. fig. 8), where it measures 1 inch across: the shaft is compressed, measuring 6 lines in long diameter, and only 2½ lines in short diameter, midway between the two ends (as in the outline above the fig. 9).

The articular head (*a*) is a semioval convexity, 8 lines by 4½ lines, overhanging the concavity (*d*) on the anconal side, with the long axis extending from the radial (*b*) to the ulnar (*c*) side, and with the ends continued upon the beginning of the radial and ulnar (*c*′) crests, of which the former is upper, the latter lower, in the natural position of the bone. The radial crest or tuber is directly continued, contracting, into the pectoral ridge. The ulnar crest is prominent, subtriangular, convex palmad, concave anconad, and sending off on this surface a thick ridge (*c*′) which divides the concavity into a proximal depression (*d*), and a deeper distal one (*e*), into which an air-cell has entered, but without pushing itself into the interior of the bone. From near the radial end of the articular convexity, a thick ridge or raised rough surface (*f*) extends about 8 lines down the bone; it gives insertion, by a well-marked narrow elliptical depression, to the second pectoral muscle, the raiser of the wing. Below this ridge the convexity of the shaft rapidly subsides into the almost flattened outer or radial surface. The opposite surface at the proximal end of the shaft is concave, but becomes slightly convex, transversely, down the rest of the shaft. The borders bounding the flattened shaft, of which the radial one is formed chiefly by the pectoral ridge, describe very slight sigmoid curves. The pectoral ridge is long and low, much less developed than in birds of flight. A short ridge (Pl. LII. fig. 9, *g*), abruptly rising from the end of the radial border, extends to the middle of the distal anconal side of the radial condyle.

This (fig. 10, *h*) is long and narrow, extending further proximad by half its length than the ulnar condyle (ib. *i*) does. The ulnar condyle is shorter and thicker: both project towards the palmar aspect, and do not terminate the bone distally. The broad articular surface of the ulna is adapted to both condyles, but covers only the distal half of the radial one, the radius gliding upon the upper half. The breadth of both condyles is 5 lines. The anconal surface (fig. 9) is divided into two grooves by three ridges, the ulnar one (*k*) being the longest, the radial one (*l*) the shortest; and the ulnar anconal groove is consequently larger than the radial one. All the three anconal ridges project distally beyond the condyles. There is a well-marked flat surface above the ulnar condyle for the attachment of a strong lateral ligament.

The shaft of the humerus contains a narrow medullary cavity (fig. 9′). The orifice of the medullary artery is close to the anconal border, about an inch below the ulnar edge.

The radius (Pl. LI. 54) and ulna (55), connected only at their extremities, have opposite curves, leaving a wide interosseous space. The radius is but half the thickness of the ulna, and is more bent. A tuberosity projects on the radial side just below the thickened proximal articular end: below this the shaft is slightly contracted; it then expands and becomes compressed, with the radial border more convex than the ulnar one is concave. The anconal surface is longitudinally channelled near the radial edge, deepening towards the wrist, where there is a second but short groove ulnad of the longer one.

The olecranon is short, obtuse, with a longitudinal groove on each side of its base, narrowing the bone between the process and the articular surface of the ulna. A sesamoid in the biceps flexor tendon plays in the palmar groove; it is the homotype of the patella: two other sesamoids in the triceps extensor tendon play in the two grooves in the anconal part of the distal end of the humerus: these answer homotypally to the fibular extension which plays in the popliteal groove of the outer femoral condyle. The shaft of the ulna, though compressed, is at the proximal half three-sided, the narrowest side being toward the radius, and contracting to a sharp border at the distal half. There are no quill-pits. The distal articular surface is convex from the radial to the ulnar side, but slightly concave transversely, and is accordingly somewhat trochlear. A tuberosity projects above it on the outer side, near the radius. The length of the antibrachium is 2 inches 4 lines.

The radial carpal bone (ib. 56) presents a trochlear surface, concave from the radial to the ulnar end, convex transversely to the magnum, here confluent with the base of the mid metacarpal (III). The ulnar carpal (55′) is the smaller bone, and offers a deeper groove to the convex compressed process of the base of the fourth or "annulus" metacarpal (IV) The second or index metacarpal (II) is 6 lines long, compressed, and confluent by its whole length to that of the medius. It supports a phalanx (1), 10 lines long and pointed at the end, which does not quite reach that of the mid metacarpal.

This (Pl. LI. fig. 1, III) is 1 inch 9 lines long, inclusive of the magnum, and is confluent with the fourth slender metacarpal (IV) at both ends, leaving an interosseous space 1 inch 1 line long and 2 lines wide.

The proximal phalanx of the medius (III. 1) is broader than the metacarpal, having its ulnar border extended into a ridge and slightly produced beyond the distal articular end. To this is joined a second phalanx (ib. 2), terminating, like that of the forefinger, in a point. The length of the hand is 3 inches 6 lines. The broad and flattened general character of the bones of the fore limb relate to the support of a surface in the shortened wing adequate, as a fin, to strike the water with effect.

§ 4. *Pelvic Arch and Appendage.*

The pelvic arch has been described. Its appendage departs less from the general ornithic type than does that of the scapular arch.

The femur (Pl. LI. fig. 1, 65; Pl. LII. fig. 11), 2 inches 10 lines in length, shows the usual extension of articular cartilage from the head to the upper part of the neck and great trochanter, expanding upon the latter. The ligamentum teres is implanted in the upper part of the head. The trochanter does not rise to a higher level; the ridge at its fore part descends about 6 lines upon the bone, gradually subsiding; the back or outer side of the trochanter is broad and nearly flat; the popliteal side of the shaft of the proximal part is flattened, the rotular side is concave. The shaft soon assumes a full elliptic transverse section, is very slightly bent, with the concavity backward; it slightly expands to the distal condyles. It has a large medullary cavity. The rotular groove is wide, and is partially defined from the intercondyloid or popliteal groove, in which are the depressions for the crucial ligaments, The outer condyle has the usual backward or popliteal production, vertically grooved for the compressed head of the fibula.

The tibia (Pl. LI. fig. 1, 66; Pl. LII. fig. 12) is 5 inches 2 lines in length. The proximal articular surface is but feebly defined; the tibial or inner division is the largest; the fibular division is convex. The rotular process, of a triangular form, with a base as broad as the tibia, rises half an inch above the articular surface, and sends off a procnemial (Pl. LII. fig. 12, *p*) and an ectocnemial (*e*) ridge. The latter is short, thick, and angular; the former is long, thin, and also forms a low angle. The proximal part of the shaft of the tibia is trihedral: there is an oblong tuberosity on the inner or tibial side. Eight lines below the articular surface commences the fibular ridge, which has a similar extent; the fibula is anchylosed therewith in the skeleton from the mummified specimen, but not in the bones of the Great Auk sent to me by Mr. John Hancock. After an interval of separation of about 3 lines, the fibula (ib. 67) coalesces in both specimens with the tibia, and can be traced to within an inch of the distal end of the bone. The shaft of the tibia soon acquires a form giving an ellipse in transverse section, elongated from side to side; it very gradually diminishes to within an inch of the distal end, and then slightly expands to the condyles. The precondyloid groove (*f*) for the tendon of the extensor communis muscle is bridged over by ligament, not by bone; it subsides upon the shaft an inch below its summit; it is submedian in position; its lower outlet is transversely elliptical, and just above the intercondyloid space. Of the anterior prominent parts of the distal condyles, the outer (fibular) one (*b*) is rather broader than the inner (*a*), and is narrower than the intercondyloid space.

The canal leading to the bridge is wide and bounded by a ridge chiefly on the tibial side. The ectocondyloid surface is almost flat, slightly concave; the entocondyloid surface is made more concave by the prominence of the periphery of the condyle, and is divided by a ridge developing a tubercle towards the posterior part of the condyle. The posterior trochlear surface of the condyle is very slightly concave transversely, with a low median convexity. The transverse and antero-posterior diameters of the distal condyles are equal.

The metatarse (Pl. LI. fig. 1, 69; Pl. LII. fig. 13), 2 inches 2 lines long, has the outer condyloid concavity (*b*) lower than the inner one (*a*) anteriorly; the calcaneal ridge is low and vertically perforated. In the anterior concavity there is a smaller fore-and-aft canal. The inner (tibial) element (*a*, *ii*) is the shortest; the trochlea of the middle one extends 3 lines beyond it; the cleft between this and the outer trochlea extends anteriorly to the lower fore-and-aft canal (*c*), but not posteriorly. The outer condyle (*iv*) ends about a line above the middle one.

The inner toe (Pl. LI. fig. 1, *ii*), of three phalanges, is 2 inches 5 lines long; the middle toe (*iii*), of four phalanges, is 3 inches 3 lines long; the outer toe (*iv*), of five phalanges, is 3 inches 2 lines in length, and the slenderest of the three, the middle one being the thickest.

Save in parts of the cranium, no bone in the skeleton of *Alca impennis* is pneumatic; but the humerus has a medullary cavity, as well as the femur and tibia.

§ 5. *Comparison of the Skeleton.*

In *Alca impennis* there are twenty-two free vertebræ between the skull and sacrum, in *Alca torda* twenty-one; but, in the specimen in the museum of the Royal College of Surgeons[1] yielding that number, the homologue of the twenty-second vertebra in *Alca impennis*, supporting the penultimate pair of free thoracic ribs, has coalesced with the sacrum. The last pair of ribs, articulated in both species to a sacral vertebra, have hæmapophyses which do not reach the sternum. The chief numerical difference in the vertebral column is in the excess of caudal vertebræ in the Garfowl. The dorsal vertebræ have the same simple shallow ball-and-socket joint, the ball being anterior in *Alca torda*, as in *A. impennis*; and this structure I have also found more feebly developed in the dorsal of *Uria grylle*: in *Phaleris* both co-adapted surfaces are nearly flat. The main difference in the skull is the shortness, greater relative depth, and stronger convex curve of the

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[1] Catalogue of Osteology, 4to, 1853, vol. i. p. 221, no. 1146.

upper contour of the solid prenarial part of the premaxillary: every other better character of affinity is very closely repeated.

The sternum of *Alca torda* repeats the characteristics of that of *Alca impennis*, with the exception of a notch on each side of the back part, 1 inch long by 3 lines wide. In *Alca* (*Phaleris*, Temm.) *psittacula*, Pallas, the sternum is more dilated posteriorly, and the notches are represented by oblong foramina of a wider form. The interorbital part of the cranial roof is narrower, and the upper end of the lacrymal projects upward and backward as a process. In *Uria grylle* (Pl. LII. fig. 14), besides the posterior notches (*f*) answering to those of *Alca torda*, there is a small perforation, sometimes two (ib. f', f''), on the inner side of each.

The furcular and scapular arches of *Alca torda* closely correspond with those of *Alca impennis*. The coracoid is similarly perforated for a branch of the pectoral artery.

The humerus closely agrees in shape and proportion; the difference in the wing-bones, in adaptive relation to the power of flight, of *Alca torda*, begins to manifest itself in the antibrachial bones, which are longer and less compressed than in *Alca impennis*, the ulna also having a row of quill-pits or knobs: the bones of the head are shorter relatively to the ulna than in *Alca impennis*.

A closer resemblance is maintained between *Alca torda* and *A. impennis* in the bones of the pelvic limb, and is especially seen in the shape and proportions of the rotular process, with its pro- and ecto-cnemial ridges, and in the proportions and attachments of the fibula.

The sum of the comparisons of the skeleton of *Alca impennis* with that in other Auks, Phalerins, and Puffins, and also in Guillemots, goes to exemplify the close affinity of the Garfowl to those sea-birds, and to indicate that it is a modified apterous member of the *Alcadæ*.

The Penguin, similarly apterous or with wings reduced to the function of fins, shows its essential distinction from the Garfowl in all the flight-giving parts of the skeleton. The number of vertebræ between the skull and sacrum is, indeed, the same; but only eight support moveable ribs, the total number of which is nine pairs, the last pair being sacral. The atlantal hypapophysis is produced below into a compressed process; the anapophyses of the axis and two following vertebræ are mere tuberosities, not elongated into processes. The pleurapophyses are styliform and produced backward in the third to the tenth cervical, thence are shortened to the fourteenth, when the pleurapophysis reappears as a separate styliform rib. The first four cervical vertebræ have each a single posterior hypapophysis; the sixth to the tenth inclusive have a pair of parapophyses simulating anterior hypapophyses.

The parapophyses begin to project downward in the sixth cervical, increase in size and convergence to the ninth, and at the tenth have a common median base, like a bifurcate anterior hypapophysis; in the eleventh cervical they disappear, and are replaced by a true hypapophysis from the mid line of the under surface of the centrum:

it is a compressed subquadrate plate, decreasing in length in the three succeeding cervicals, in the last of which the parapophyses reappear as short horizontally extended plates, the origins of which, approximating in the second dorsal, combine in the third to form the lamelliform stem of a pair of diverging plates, which decrease in size in the fourth with antero-posterior increase of the base of the stem, and in the fifth dorsal are reduced to an expansion of the end of the stem, which now has reassumed the character and position of a compressed lamelliform hypapophysis, which gradually diminishes to the last dorsal[1]. In the sacrum it is represented by a hypapophysial ridge, which subsides in the fourth of the coalesced series of vertebræ.

In *Alca impennis* the lamelliform hypapophysis first appears on the tenth vertebra, is reduced to a tubercle on the twelfth, and disappears on the thirteenth and fourteenth. The fore part of the sacrum is carinate below in the Penguin, but not in the Garfowl. The number of free caudal vertebræ is eight in the Penguin, eleven in the Garfowl.

The cranial part of the skull is proportionally larger and longer in the Penguin; it is smooth and more convex above; neither the temporal nor superorbital glandular depressions meet at the mid line, and the temporal depression is narrower above, and is not divided into an anterior and posterior facet as in the Garfowl. In *Eudyptes chrysolophus* the glandular depressions are large, deep, and meet for a short extent anteriorly: the temporal fossæ are more than an inch apart on the calvarium. The cerebellar prominence projects much further at the back of the skull in the Penguin than in the Garfowl. The paroccipital process is stronger than the mastoid, whilst in the Garfowl they are equally developed. The condyles of the tympanic are bent more back, the orbital process of this bone is relatively shorter, and the distal articular end is narrower, in the Penguin. The pterygoids are more expanded anteriorly; the palatines are broader, and are convex below, in the Penguin, instead of being concave.

The nasal bone retains its distinctness from the premaxillary and maxillary in the Penguin, and has coalesced only with the frontal and prefrontal posteriorly; its maxillary prong is inclined more forward, at an acuter angle with the premaxillary prong, than in the Garfowl, and it ends in a free point. The lacrymal is broader and longer, reaching the malar below in the Penguin. The premaxillary is comparatively short and rounded: the Penguins have a quite different type of beak from that in the *Alcadæ*. The malo-squamosal zygoma is sigmoidally bent, chiefly concave below, not straight as in the Garfowl. The mandible retains as instructive marks of its primitive composition in the Penguin as in the Garfowl, and enables one to see that in the former the surangular is relatively longer, the dentary shorter, but with its lower prong more produced posteriorly; the angular is more produced behind the articular; the rostral part of the dentary corresponds in shape with the same part of the premaxillary, and differs in the same degree from that of the Garfowl[2].

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[1] Phil. Trans. 1851, pl. 52. figs. 48–51.

[2] In *Sula* the basioccipital is impressed by a pair of large and deep circular pits for the insertion of strong

The sternum, perhaps the most characteristic of natural affinity of any single bone in the bird's skeleton, exemplifies the essential distinction of the two species, which are alike adaptively modified for marine existence, with abrogation of the power of flight.

In the Penguin the sternum is destitute of episternal process, and has two posterior notches, equalling in depth half the length of the entire bone. The front and lower borders of the keel are straight. The coracoid grooves meet at the mid line, and their posterior wall is developed into a broad triangular process, with an obtuse apex, the outer angle of the base of which answers to the costal process of the sternum in *Alca impennis.* The costal part of the lateral border is relatively shorter in the Penguin, and affords articulation to only six hæmapophyses. The lateral margins behind the costal portion converge to the posterior part of the sternum, the middle part of which between the lateral styles narrows to a point where the keel ends.

The coracoids in *Aptenodytes* are conspicuous for their great length and strength, for their columnar-like convexity transversely on the outer or fore surface, and their flattened hinder or inner surface, which is concave transversely at its lower third. In *Aptenodytes antarcticus* the length of the coracoid is four-fifths that of the sternum; in *Alca impennis* it is less than two-fifths. The inner lamelliform process from the scapular end is more produced in *Aptenodytes*, and is notched in *Eudyptes*, instead of being perforated; the outer lamelliform process from the sternal end is much less produced. The scapula in *Aptenodytes* is remarkable for its unusual breadth as compared with that of other birds; it is nearly twice as long as the humerus, whereas in *Alca impennis* it is shorter than the humerus.

The clavicles in the Penguin are also of unusual breadth towards their upper ends, and converge to their medial union at a more acute angle than in *Alca impennis.* The humerus, besides being relatively shorter in the Penguin, is broader and more compressed, less expanded at both ends, but especially proximally.

The pneumatic fossa is much deeper, but does not extend into the shaft; the two olecranial grooves are relatively narrower, and restricted to the posterior inferior angle of the lamelliform shaft; a sesamoid in the extensor tendon plays upon each. The articular surfaces for the radius and ulna are feeble convexities upon almost the same transverse line, and the joint scarcely allows of the movements of flexion and extension. In the *Alca impennis* it is adapted for much freer motions.

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musculi recti capitis antici: these pits are bounded externally by strong ridges descending and diverging from the sides of the occipital condyle to the hypapophysial tuberosities. From the outside of the base of each tuberosity a buttress flies upward and outward to the paroccipital, circumscribing the space in which lie the carotid and pneumogastric foramina. The pretympanic fossa between the alisphenoid and mastoid rises vertically for more than half an inch; its inferior subcircular opening or entry is 4 lines in diameter. There are no pterapophyses. The coalesced palatines present a narrow, oblong, flattened surface below; and from the mid line of the posterior part descends a triangular crest of bone, between the pterygoid articulations. The palatal nostril is single, medial, 2 lines wide by 8 lines long.

The radius and ulna are of equal size in the Penguin, are much compressed, straight, and leaving a mere linear interosseous space. The shaft is solid[1]. The ulnar carpal bone projects as a flattened triangular plate from that side of the wrist, and simulates by its distal extension a metacarpal bone. The radial (index) metacarpal is feebly indicated by a low ridge from the proximal half of that border of the mid metacarpal—this is broad and flat; the narrower but similarly shaped "fourth" metacarpal coalesces, as usual, by both ends with the third; each of these supports a proximal phalanx, which is pointed in the "fourth"; that of the mid digit supports a second phalanx, also compressed and pointed. The "hand" in the Penguin is longer than the humerus; in the Garfowl it is shorter.

The iliac bones in the Penguin are remarkable for their divergence as they advance from the acetabula, and for their convergence anteriorly; they describe a sigmoid curve, and are flattened horizontally: the sacrum is more expanded, and more abruptly so anterior to the acetabula. The crest of the sacrum is more developed throughout its whole length in the Penguin. The more extensive co-ossification of ilium and ischium reduces the ischiadic foramen to a much smaller relative size than in the Garfowl. The obturator foramen is continuous with the linear interval between the ischium and slender pubis, and this is much shorter relatively than in the Garfowl, extending scarcely as much beyond the ischium as this does beyond the ilium.

The femur of the Penguin is thicker in proportion to its length. The rotular process of the tibia is shorter; the hollow between the pro- and ecto-cnemial crests is deeper; the patella is relatively larger. The anterior distal tendinous groove is bridged over by bone. The ridge on the tibial side of the back part of the distal trochlea is more produced in the Penguin. But the most marked distinction in the bones of the leg of the Penguin is the shortness, breadth, and persistent amount of distinctness of the three confluent metatarsals. The toes are also relatively shorter and thicker; and there is a rudiment of a hallux or inner toe[2], which is entirely wanting in *Alca impennis*.

The result of this comparison is to show that the Urinatores of Blyth (Orr's Cuvier's 'Animal Kingdom,' 8vo, 1840, p. 267) is an artificial group, and that the wingless sea-bird of the southern region is of a family distinct from that to which the wingless sea-bird of the north belonged: but we have not yet found among the winged ea-fowl of the south any that manifest so close an affinity with *Aptenodytes antarcticus* as many of the northern winged sea-fowl show to *Alca impennis*. To speculate upon the derivative origin of either bird would be more agreeable than useful or really instructive.

Since the foregoing pages were in type, I have been favoured by Samuel Laing, Esq.,

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[1] Catalogue of Osteology, vol. i. p. 219, no. 1137.

[2] Descriptive Catalogue of the Osteology, Mus. Coll. Surg. vol. v. p. 216, no. 1117.

of Keiss Castle, Wick, N. B., with an inspection of the remains of animals serving as food to an ancient race of the flint age, in Caithness-shire.

Amongst the bones of birds in this kitchen-midden, including those of the Gannet (*Sula bassana*), Shag (*Phalacrocorax graculus*), Cormorant (*Phalacrocorax carbo*), and Razor-bill (*Alca torda*), were the following bones of the Garfowl (*Alca impennis*, L.) :—

The anterior or free extremity of the premaxillary ; a right and left humerus ; a left tibia, and parts of three other tibiæ, left and right.

The premaxillary showed a little more vertical diameter than that of the specimen from Newfoundland, here described. In both, the extent from the tip to the fore margin of the bony external nostril is 2 inches ; the vertical diameter in front of the nostril in one is 9½ lines, in the other it is 11 lines.

The more recent testimonies of the Garfowl in the N.W. coasts of Scotland may be seen in MACAULAY, 'History of Kilda,' 1764, and in SIBBALD, 'Scotia Illustrata,' 1684.

DESCRIPTION OF THE PLATES.

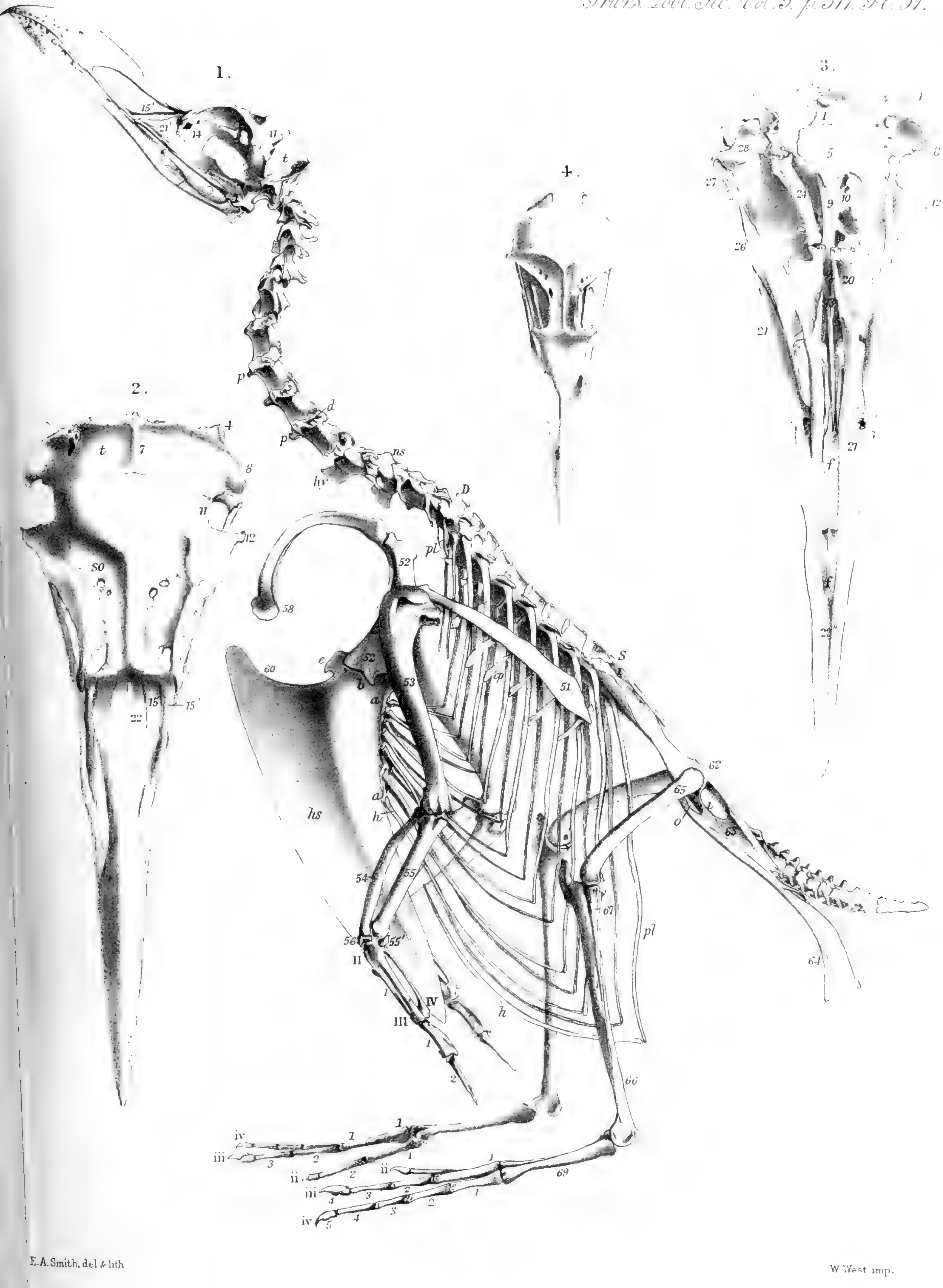
PLATE LI.

Fig. 1. Side view of the skeleton of the Garfowl (*Alca impennis*) : half nat. size.
Fig. 2. Upper view of the skull : nat. size.
Fig. 3. Under view of the skull : nat. size.
Fig. 4. Upper view of the skull of *Uria Grylle* : nat. size.

PLATE LII.

Fig. 1. Under surface of the sternum of *Alca impennis*.
Fig. 2. Fore part of the same sternum.
Fig. 3. Furculum of *Alca impennis*.
Fig. 4. Under view of fourth cervical vertebra of *Alca impennis*.
Fig. 5. Upper view of fourth cervical vertebra of *Alca impennis*.
Fig. 6. Side view of fourth cervical vertebra of *Alca impennis*.
Fig. 7. Back view of fourth dorsal vertebra of *Alca impennis*.
Fig. 8. Proximal half of humerus, anconal or outer side, *Alca impennis*.
Fig. 9. Distal half of humerus, anconal side, *Alca impennis*.
Fig. 9′. Outline of section of shaft and medullary cavity of *Alca impennis*.
Fig. 10. Distal end of shaft and medullary cavity of *Alca impennis*.
Fig. 11. Front view of left femur, *Alca impennis*.
Fig. 12. Front view of left tibia and fibula, *Alca impennis*.
Fig. 13. Front view of right metatarsus, *Alca impennis*.
Fig. 14. Under surface of the sternum of *Uria Grylle*.

(All the figures of Plate LII. are of the natural size.)



E. A. Smith, del & lith.

W. West imp.

FIGS. 1_3. ALCA IMPENNIS.   FIG. 4. URIA GRYLLE.

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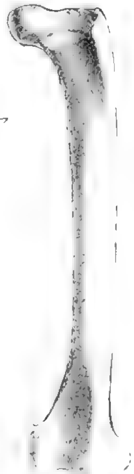

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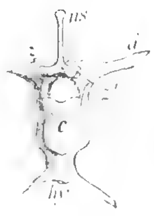

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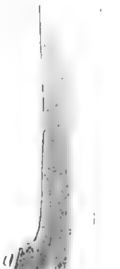

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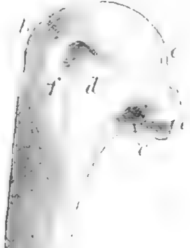

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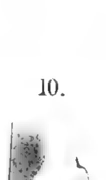

E.A.Smith, del & lith.

W West, imp

FIGS. 1_13. ALCA IMPENNIS. FIG. 14. URIA GRYLLE.

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IX. *On* DINORNIS (Part IX.): *containing a Description of the Skull, Atlas, and Scapulo-coracoid Bone of the* Dinornis robustus, *Owen. By* Professor OWEN, *F.R.S., F.Z.S., &c.*

Read December 13, 1864.

[PLATES LIII.–LVI.]

§ 1. *Skull of* Dinornis robustus, *from 'Timaru', Middle Island, New Zealand.*

I HAVE been favoured by the kindness of Dr. D. S. Price, of the Crystal Palace, Sydenham, with the opportunity of inspecting a series of bones from the Middle Island of New Zealand, which were obtained under the following circumstances.

"They were found at the bottom of a pit or crevice, about 50 feet deep, in limestone rock, the upper opening of which was scarcely large enough to admit the body of a man, but gradually widening as it descended, measuring at the bottom 30 feet by 4 feet. The opening is on the top of a broken ridge of limestone rock, situated a few miles south of 'Timaru.' There are many such holes in the immediate vicinity, in all of which we found bones."[1]

From this series I have selected for the present description a mutilated cranium and lower jaw of a species of *Dinornis*, which, by its superiority of size over that of "a large kind" described in a former Memoir[2], confirms the accuracy of the reference of that species to the *Dinornis ingens*, and leads me to refer the present specimen to the *Dinornis robustus*. The following are a few comparative admeasurements of the two crania:—

	Dinornis ingens.		*D. robustus.*	
	in.	lines.	in.	lines.
Breadth of cranium across the mastoids	3	8	4	0
Length of cranium from superoccipital crest to premaxillary fossa	2	9	3	7
Breadth, greatest, of premaxillary	2	4	2	10
Breadth of cranium across the temporal fossæ	2	8	2	8

From these dimensions it will be seen that the present cranium, referred to *D. robustus*, differs not only in size but in proportions from that of *D. ingens*, the breadth across the temporal fossæ being the same in both. This difference arises from the greater relative depth of the fossæ in *D. robustus*, indicating more power in the temporal muscles, and is associated with mandibles which are more massive and broader in proportion to their length. These and other differences will be readily appreciated by comparing figs. 1 & 2

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[1] Extract of a letter addressed to me by Dr. David S. Price, dated "Crystal Palace, Sydenham, August 20th, 1863."

[2] "On DINORNIS" (Part v.), Trans. Zool. Soc. vol. iv. p. 59, pl. 23.

of Pl. LIII. and fig. 1 of Pl. LIV. of the present Memoir with Pl. XXIII. of the Memoir (Part v.) above cited.

The mutilation of the two crania is nearly the same in kind and degree; but with the present specimen there is a tympanic bone and the mandible.

The base of the occipital tubercle (Pls. LIII. & LIV. fig. 1, 1) is 4 lines across, $2\frac{1}{2}$ lines vertically; the foramen magnum (Pl. LIII. fig. 3, *m*) is 7 lines vertically and 6 lines across. The superoccipital, or confluent upper parts of the exoccipitals, slightly overarches the foramen; the middle of the transverse occipital ridge (ib. 3) is 8 lines above the foramen, and extends outward with a slight descent to the paroccipital (ib. 4), having a total transverse extent of 3 inches 3 lines. The broad and low superoccipital surface, so defined superiorly, is divided by a thick, low, median vertical ridge. It shows no cerebellar protuberance, but four rough and shallow muscular depressions, defined by a protuberant part of the middle of each half of the transverse occipital ridge. A venous canal extends from each protuberance to a foramen (ib. *w*) near the middle of the outer depression. The basioccipital (Pl. LIII. fig. 3, 1*j*) descends 5 lines below the tubercle, this vertical part showing a pair of depressions (ib. & Pl. LIV. fig. 1, *j*); it swells out below on each side into a pair of large smooth tuberosities (ib. 1′) with extremely thin walls, covering the pneumatic cellular structure of the bone.

The basisphenoid (Pl. LIV. fig. 1, 5) probably contributes the anterior part of these tuberosities (ib. *m*), between which it is concave. The Eustachian canals (ib. fig. 1, *e*, *e*), with sharp margins, groove the sides of the basisphenoid, converging as they extend forward, and losing definition as they approach the middle of the fore part of 5. The beginning of the posterior ridge forms the outer boundary of the fossa for the sympathetic and entocarotid foramina (ib. *s*, *c*). The alisphenoid is indicated by the foramen for the third and second divisions of the trigeminal nerve, and by the fossa of the optic lobe on its inner surface. The loss of the outer plate of the connate basi- and pre-sphenoids exposes the pneumatic diploë and the wall (ib. *d*) of the 'sella' or bony cup for the hypophysial appendage of the mesencephalon, which marks the boundary of the second and third cranial vertebræ.

The mastoid (8) is large, thick, and obtuse, excavated below by a single oblong, oblique articular cavity (Pl. LIV. fig. 1, *u*) for the undivided similarly shaped convex head of the tympanic (ib. fig. 2, *e*); the articular cavity is directed from behind forward and outward. There is no epiphysis upon the border of the tympanic cavity, which is large, and shows several pneumatic foramina besides the stapedial fossa leading to the fenestra ovalis.

The temporal fossa (Pls. LIII. & LIV. fig. 1, 7′), which excavates the contiguous parts of the alisphenoid, mastoid, parietal, and postfrontal, is narrow and deep, subsiding gradually upon the upper surface of the cranium (Pl. LIII. fig. 1, 7), which is smooth, broad, and slightly convex, for an extent of nearly 2 inches, between the fossæ. The whole cranium is remarkably broad and depressed (ib. fig. 3): its greatest vertical diameter, from the parietal to the basioccipital tuberosity (1′), is 2 inches 3 lines; its breadth across the postorbital processes (Pl. LIII. fig. 1, 12) is 5 inches. Its length from the paroccipitals (ib. 4) to the fore part formed by the coalesced nasals (ib. 15) is 5 inches 2 lines.

The flattened end of the nasal process of the premaxillary (ib. fig. 1, 22′) rests on a shallow elliptical depression of the nasals (ib. 15), which are confluent with the fore part of the frontals (ib. 11). This depression is rounded posteriorly, is 1 inch 3 lines in length and 1 inch in breadth. The rhinal or olfactory fossæ (Pl. LIV. fig. 1, *n*, 14′) are 2 inches 9 lines in length and 2 inches in breadth, divided by a convex transverse projection of the roof (*n*′) into a larger posterior compartment (*n*) and a smaller and more shallow anterior compartment (14′); both are subdivided by a low median ridge, sharpest and most produced in the posterior compartment. At the back and upper part of each lateral division of this compartment are seen the fine, radiating grooves diverging from the foramina of the cribriform plate (14).

The tympanic (Pl. LIII. 28) is a triradiate bone, with short and strong rays, the lowest being the broadest and thickest. The mastoid condyle (Pl. LIV. fig. 2, *e*) of the tympanic is 11 lines in long diameter, 3 lines in the short diameter. The stem contracts transversely, expands in the opposite direction, assuming a trihedral shape, widely excavated on the inner facet by the fossa (*g*), terminating in the large pneumatic canal. The anterior or orbital process (*k*) is subcompressed, obtuse, 7 lines in depth, 10 lines in length; it is impressed, externally, by an oval facet for the pterygoid (*pt*). The suddenly and largely expanded lower end presents the usual posterior, narrow, oblong concavity (ib. fig. 3, *i*, *h*) and the anterior, smaller, but similarly shaped convexity (ib. *i*′) placed at a right angle to the foregoing. On the outer side of the lower end is the usual subcircular, deep depression (Pl. LIII. fig. 2, *h*), for the squamosal element of the zygomatic arch.

Mandible.—The articular part of the mandible (Pl. LIV. fig. 4) is deeply excavated between the articular surfaces (*i*, *i*′) which are adapted to those so marked on the tympanic (fig. 3). An obtuse angular ridge projects from the inner side of the wall of this concavity; a pneumatic canal perforates its base. The ramus, extended forward from the articular end, is divided by two longitudinal fissures into three parts, the upper representing the surangular (Pl. LIII. fig. 2, 29′), the lower the angular (30); and the intermediate portion appears to be the back part of a splenial (31). The surangular developes a low convex ridge, with a rough surface external to it, for the insertion of the temporal muscles. Its fore part is excavated externally, to be overlapped by the upper prong of the dentary element (32′): the angular is more extensively excavated, to be overlapped in a similar manner by the lower prong (32″) of the dentary: this element had not coalesced with the rest of the mandible, and has been drawn forward to show the articular grooves The dentary curves gently down as it approaches the thick symphysis, where it coalesces with its fellow to form a broad external symphysial prominence (32), measuring 7 lines across the back or lower part and 9 lines across the upper border. The length of the symphysis is 1 inch 3 lines. The upper border of the dentary swells outward, increasing in depth as it approaches the symphysis, the surface of which is perforated by the numerous nutritious vessels of the matrix of the horny beak, the thinner hind part of the dentary being smooth. The alveolar border (Pl. LIV. fig. 4, *b*) is impressed by a shallow groove.

The premaxillary (Pls. LIII. & LIV. fig. 1, 22) is very broad, depressed, with the usual triradiate division posteriorly; the upper ray (Pl. LIII. fig. 1, 22′) is a backward continuation of the middle raised part of the body of the bone, which expands transversely and becomes flattened from above downwards as it extends backward to rest upon the nasal fossa (15); the sides of this process, before it quits the body of the bone, are concave, as it were pinched in; the least breadth of the upper part of the process is 6 lines. The maxillary processes (22″) are short; both, however, are broken: the breadth of the palatal part of the premaxillary (Pl. LIV. fig. 1) is 3 inches; it has a small posterior emargination, on the under surface of which is a canal leading forward into the bone: on the upper surface are three similar orifices, also leading forwards. The upper or nasal surface of the plate (22″) of the premaxillary shows a shallow posterior excavation for the support of the palatal part of the maxillary. The alveolar borders of the premaxillary show a shallow multiperforate broad groove (*b*).

§ 2. *Skull of* Dinornis robustus *found, with the Skeleton almost entire, in the Valley of Manuherikia, Otago.*

The foregoing description of the parts of the skull of the *Dinornis robustus*, from 'Timaru,' was drawn up in the course of last winter with a view to communication to the Zoological Society in the session of 1863–64. But my visit to the south of France to explore the cavern of Bruniquel, in January 1864, compelled me to lay the subject for a while aside; and after my return to the British Museum, I received the following letter, dated "Dunedin, 15th February, 1864," from Dr. Hector, F.G.S., the accomplished and efficient Provincial Geologist of Otago, New Zealand, informing me of the discovery of "an unusually perfect skeleton of a Moa," which had been "recently found by some gold-diggers in the interior" of that province. "The skeleton," he writes, "was not that of one of the largest-sized Moas, the tibia, for instance, being only 27 inches in length, whereas I have frequently seen them as much as 36 inches." This skeleton Dr. Hector proceeds to describe "as the most perfect I have ever heard of, as all the bones, excepting five or six, are present; and it is further, I believe, a unique specimen in so far that portions of the integuments and feathers still remain attached to the sacrum. There is also a portion of the sole of the foot; and the joints of one leg have their ligaments and interarticular cartilages preserved."

Dr. Hector then proceeds to give the following instructive and valuable account of the geological characters of the locality and district where the discovery was made:—

"The bones were found in one of the large basins which characterize the auriferous region, and lie among the mountains in the interior of the island. These basins are of ancient Tertiary date and of large size, being always partially filled up with a Tertiary deposit that in physical character, and perhaps also in geological age, may be compared to the 'Molasse' in Switzerland. This Tertiary deposit has been partially denuded and then overspread by the dispersed materials derived from ancient moraines that at a later period were thrown down from the neighbouring mountain ridges. A system of lakes then occupied these basins, and indeed over a large area of the province still continue to occupy them. During the gradual drainage of the lakes that occupied these basins, the incoherent materials were shaped into successive terraces that narrowed the basins, and, according to the times of their formation, have more or less relation to the present water-run of the country. Wide ascending valleys, bounded by lake-terraces, were thus formed, and it is in the terraces which were again formed in these valleys that the earliest traces of Moa-bones are to be found.

"I have not visited the Manuherikia Valley, where these bones were found, since their discovery; but I enclose a rough section[1], showing its contour and contents, which I observed nearly two years since on my first arrival in this country.

"As Moa-bones are to be found, however, in every deposit of more recent date than the above, as, for instance, in river-silts and old water-courses, and even in great quantities lying quite exposed on the surface of the plains, I am therefore unable to indicate the precise geological position in the section from which they were extracted. I understand that they were met with in sinking a shaft on one of the terraces through a bed of dry incoherent sand-rock. The plains which I have referred to as existing in the interior have a dry arid climate as compared with the rest of New Zealand, so that they are clothed only with wing-grass, that grows in tufts, or 'tussocks' as they are called. The dry climate and the fact that the bones were imbedded in dry sand prevent our necessarily inferring, from the well-preserved condition of the skeleton, that it is of more recent date than the bones that are usually found; and, moreover, as some parts of the skeleton are quite as much decomposed as the generality of the Moa-remains, it is more natural to suppose that the preservation of the more perishable parts of the remainder of the skeleton has been due to an accidentally favourable position in the soil.

"As this interesting skeleton will no doubt be fully examined and described, and the species determined, by you, when it arrives in England, it is unnecessary for me to transmit to you my notes and measurements of the individual parts of the skeleton. I will preserve them, however, for future reference should the specimen itself be accidentally lost or destroyed.

"I remain, dear Sir,
"Yours very truly,
"JAMES HECTOR, M.D., F.G.S.,
"*Provincial Geologist, Otago, N. Z.*

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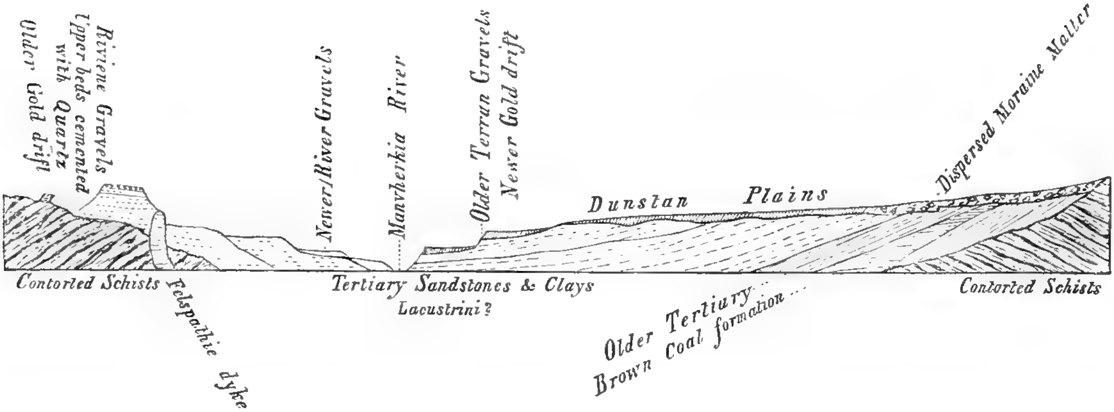
[1] See figure 1, next page.

Fig. 1.



"Section of the contour and formation of Manuherikia Valley."—J. H.

Fig. 2.

"Terrace-formation of the basins in the interior of the Province of Otago. The peaks in the distance are 8000 feet high: at their base lies the Wanaka Lake."—J. H.

"Enclosing—

"Photographic copy of drawing of entire skeleton.

"Photographic copy of drawings of the parts of the skeleton in the state they were found.

"Photographic copy of sketch of the terrace-formation of the Upper Chetha Valley, one of the basins in the interior.

"Sketch-section showing the contour of the Manuherikia Valley, where the remains were found.

"*Professor Owen, F.R.S., British Museum.*"

The cut, fig. 1, is of the "sketch-section of the contour and formation of the Manuherikia Valley" where the bones were found. The cut, fig. 2, is copied from the photograph of the "terrace-formation of the Upper Chetha Valley, one of the basins in the interior."

Sketches with admeasurements of the principal bones were also enclosed, indicating a skull in a more perfect condition than the one I had received from Dr. Price, but of similar size; and, as in the case of the skull, the proportions of the femur, tibia, and metatarse resembled those of *Dinornis robustus*, not those of *D. ingens* or *D. elephantopus*. Besides the sternum and the pelvis of the adult skeleton, there were also sketches of parts determinable as moieties of the sternum, an ilium (8 inches 5 lines long), and an ischium with the pubis (about 6 inches long) of immature birds, which led me to infer that the difference of length of the tibia (27 inches), as contrasted with that of 32 inches[1], might indicate a sexual difference of stature, and that the skeleton from the Manuhirikia Valley was probably that of a female which had perished with her chicks[2].

Dr. Hector finally informed me that these remains were destined by their owner for the Museum at York, where they safely arrived at the latter end of May of the present year. Mr. Thomas Allis, F.L.S., brought some of the bones to London, and kindly submitted them to my inspection, from which I was confirmed in my opinion as to the species. These bones, with photographs of others of the same collection, were exhibited by him to the Linnean Society, June 16th, 1864[3], accompanied by some observations; among the more interesting of which was the announcement of his discovery of the "rudimentary wing-bone, for which he had before sought in vain" ('Proceedings,' p. 52), and which had been long a subject in much request by myself. Mr. Allis, also

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[1] "On DINORNIS" (Part vii.), Zool. Trans. vol. iv. p. 151: this is the length of tibia of *Dinornis robustus* as compared with that (24 inches) of *Dinornis elephantopus*.

[2] The experienced ornithologist, Dr. P. L. Sclater, suggested, in the discussion following the reading of this paper, that, as in the majority of the Struthious birds the male, and not the female, has been observed to incubate, the bones of the *Dinornis* there described might be those of a male. I am not aware that this part of the economy of the Kivi has been determined: if the male of the *Apteryx* rears the young, a similar conclusion as to *Dinornis* would be as safe a one as can be deduced from analogy.

[3] See 'Journal of the Proceedings of the Linnean Society' (Sept. 3), vol. viii. p. 50.

alluding to the still more remarkable evidence of preservation noticed by Dr. Hector, made mention of "a considerable portion of the skin, studded with the quill-parts of the feathers, which are bifid as in the Emu: some of the feathers preserve a portion of the web" (*loc. cit.* p. 51).

I have been favoured by Mr. Allis with copies of the photographs exhibited by him to the Linnean Society, in one of which the bone (fig. 1 of photograph) is described as the "anterior limb of adult." All are referred to the *Dinornis robustus*, although in the text (Proc. Linn. Soc. p. 52) this determination of the species is accepted with doubt. "Dr. Gibson has carefully measured the leg-bones, and does not find them agree in all respects with any described by Professor Owen, though the difference," Mr. Allis suggests, "may possibly be only sexual" (ib. p. 52). Mr. Allis adds the following particular to the history of the finding of this series of bones given by Dr. Hector, viz., "It appears that the skeleton was discovered by some persons who were on a 'prospecting' expedition in search of gold, almost completely buried in a heap of sand, and having beneath it the bones of four young ones."

It does not appear that any portions of the egg-shell were obtained or noticed by the finders.

With the concurrence of Mr. Allis I wrote to the Council of the "Yorkshire Philosophical Society," of which he is Honorary Secretary, requesting the loan for description of certain parts of the skeleton, the discovery of which had been notified to me by Dr. Hector; and I was favoured with the transmission of the skull (Pls. LV. & LVI.), the supposed 'anterior limb' or 'rudimentary wing-bone' (Pl. LV. figs. 2, 3, 4), and the portion of the foot, with the ligaments, tendons, and tegument.

In the present communication I propose to describe the skull and so-called 'wing-bone.'

§ 3. *Skull of* Dinornis robustus, *from Manuherikia.*

This is a little smaller than the one from 'Timaru,' the lower jaw being 7 inches in length, as against 7 inches 6 lines; and this may be accounted for by difference of sex, if not by the range of size of individuals of the same sex. The present skull, like the rest of the skeleton, bears all the marks of mature age.

It supplies the following deficiencies in the skull first described:—the paroccipital, mastoid, and postfrontal processes; the basisphenoid complete, with the pterapophyses; the presphenoid; the prefrontals and anchylosed ossified parts of the olfactory capsules; the lacrymal, nasals, premaxillary entire to the tip, the maxillary, and malosquamosal zygomatic arch of one side.

The occipital condyle (Pl. LVI. figs. 1 & 2, 1) is of a full reniform figure, slightly notched above, and with a shallow groove extending therefrom to the middle of its convexity; its breadth is $5\frac{1}{2}$ lines, its height $3\frac{1}{2}$ lines; it is supported on a short pedicle, contracting below as well as laterally, then quickly expanding to its attached base; its axis is directed backward and a little downward. The occipital foramen (Pl. LVI. fig. 2, *m*) is shield-shaped, expanding to its upper border, which is overhung by the lower transverse superoccipital ridge (ib. 2, 2); the sides also slope toward the margin of the foramen: it is broader than in Pl. LIII. fig. 3, but this I believe to exemplify range of individual variety. The basioccipital descends with a strong curve to its bimammillate (1') inferior line of union with the basisphenoid (ib. fig. 1, 1', 5): in the hollow of this curve, at the base of the peduncle, are the two rather unequal venous pits, perforated by small foramina of diploic venules. The precondyloid foramina (*p*) are two in number, on each side of the base of the condyle; they are very small. About one or two lines external to these is the large vagal foramen (*v*), perforating the bone, from within, obliquely downward and outward, and giving passage (in *Apteryx*) to the spinal accessory as well as the respiratory (eighth) nerve. Three lines external and in advance of the 'vagal' is the fossa, perforated anteriorly and inferiorly by the carotid (*c*), and posteriorly by the sympathetic and glossopharyngeal nerves and by a tympanic vein (*s*).

The superoccipital, as in Pl. LIII. fig. 3, is of unusual breadth, and slopes from the lower transverse ridge (2, 2) obliquely upward and forward. From the medial vertical ridge (3) to the paroccipital ridges (4') it is concave: the paroccipital ridge extends from the outer angle of the upper transverse ridge, downward and inward, to the pneumogastric fossa. The ridge is bent backward (ib. fig. 1, 4), and the upper half of the hinder part is thick and rough. The position of the paroccipital diapophysis in the *Dinornis* departs less from that in Crocodiles and Dicynodonts than in any other bird.

On the superoccipital surface a venous groove extends, as in the first-described skull, from near the superoccipital tuberosity downward and outward, and terminates in a foramen penetrating the diploë. The lower superoccipital ridge formed by the exoccipitals (ib. 2) is more bent than the upper one, and its projection is chiefly due to, or shown by, the excavation of the surface of the bone beneath it; the part extending to the upper border of the foramen magnum is nearly horizontal, overhanging that foramen like a pent-house; the ridge laterally subsides about an inch from the paroccipital. Such configuration of the occipital surface (Pl. LVI. fig. 2) is rare in the class of Birds.

The basisphenoid (ib. fig. 1, 5) is square-shaped; its hinder angles swell into the mamillar tuberosities (ib. 1'), which it conjointly forms with the basioccipital, and its anterior ones develope the pterapophyses (ib. 5'): these are about half an inch in length, directed outward, slightly forward and downward, with obliquely truncate ends, presenting a flat, roughish surface upward and outward to abut against the pterygoids. The sides of the basisphenoid are grooved by the Eustachian canals (*e*), which extend from the lower part of the tympanic cavity about a line in advance of the carotid fossa (*c*) forward and inward, gradually subsiding or becoming shallow to near the anterior border of the square basisphenoid platform (fig. 1, 5): the breadth of the Eustachian groove is 1½ line: near the commencement, the hinder wall of the groove shows an oblong vacuity.

The fore part of the basisphenoid platform is impressed by a pair of curved, shallow fossæ, concave forward. The substance of the basisphenoid is pneumatico-cellular: on removing the thin compact crust of the lower surface, as in Pl. LIV. fig. 1, the wall of the hemispheroid pituitary fossa or 'sella' (Pl. LVI. fig. 1, *d*) is shown, demonstrating the boundary between the basi- and pre-sphenoids.

The lower surface of the basisphenoid platform is gently concave lengthwise and transversely between the produced anterior angles; but, across the mid part, it is concave medially and convex laterally. The lateral margins, forming the lower part or floor of the medial extension of the tympanic cavity, are sharp and jagged, concave lengthwise, between the mammillar (1′) and pterapophysial (5′) productions, where they are impressed by the Eustachian channels. The tract of bone (*r*) from the outside of the mammillar protuberance to the lower end of the paroccipital ridge forms the back part of the beginning of the Eustachian groove (*e*) and the fore part of the carotid fossa (*c*).

The mastoid sends off three processes in many birds, the 'mastoid' process proper (8), the 'post-tympanic' (8″), and the pretympanic (8′). The post-tympanic is the longest in *Dinornis*, and the shortest in *Aptornis*[1] and *Didus*. The pretympanic process is very long in *Notornis* and *Porphyrio*[2].

Internal to the pretympanic process and between it and the post-tympanic, the mastoid forms, by a sharp ridge, the outer and front boundary of the anterior fossa for the condyle of the tympanic bone (28). The mastoid process (8) projects from above the base of the post-tympanic (8″), and is tuberous and rough.

The paroccipital (ib. 4) with the post-tympanic (8″) forms a smooth arch of bone overhanging the membrana tympani: the anterior surface of the paroccipital, forming the back part of this arch, is divided by the narrow ridge for the attachment of the ear-drum into the ectotympanic and entotympanic surfaces.

The tympanic cavity (ib. fig. 1, *t*, *u*) is of a triangular form, bounded externally by this ridge, the post-tympanic process, and the tympanic plate of the mastoid, posteriorly by the paroccipitals (ib. 4), internally by the basisphenoid (ib. 5), and anteriorly by the alisphenoid (ib. 6). The cavity presents a most irregular surface. On the outermost part of the roof, immediately within the ear-drum, is a large oval pneumatic foramen, immediately mesiad of which is part of the single, deep, oblong, smooth, articular cavity (*u*) for the tympanic bone, 10 lines in length and 5½ lines in breadth at its anterior and widest part; whence it extends inward and backward from the mastoid to the paroccipital. Anterior to and mesiad of the articular cavity is a second large oval pneumatic vacuity (ib. fig. 1, *u*) leading to a vertical fossa in the cranial wall, homologous with that wider and more conspicuous 'pretympanic'

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[1] Zool. Trans. vol. iii. pl. 52, 8″.

[2] Ib. pl. 56. figs. 1 & 7, 8″.

fossa which characterizes the cranium in *Sula* and other *Pelecanidæ*. From the back part of this extends the groove for the tympanic vein leading to the postlacerate fissure[1] (Pl. LVI. fig. 1, *s*). Mesiad of the inner pneumatic foramen is the fossa terminated by the orifices of the vestibular fenestræ (rotunda et ovalis), which are divided by a short subvertical bar. Below the fenestral fossa begins the Eustachian groove (*e*). Anterior to the groove leading to the fenestral fossa are two other large oval pneumatic foramina. The tympanic cavity anterior to these is smooth; but mesially, where it undermines the basisphenoid, it becomes reticulate. The chief part of the floor of the tympanic cavity is membranous.

At the fore part of the base of the pretympanic plate of the alisphenoid (ib. 6) opens the foramen ovale, partly divided into a larger inferior passage for the third, and a smaller upper one for the second, division of the fifth nerve. This foramen is 2 inches 2 lines distant from that of the opposite side, and 8 lines behind the prelacerate fissure[2] (ib. 10). This, as in most other birds, includes the optic foramen, with those for the transmission of the nerves to the orbit, viz. the sixth and fourth and the anterior division of the fifth pair. The optic foramen is on the mesial side of the fissure, and is better defined from the orbital nerves and vessels than in most other birds; a more remarkable peculiarity is the extent of separation of the left from the right prelacerate fissure, the optic foramina being 1 inch 6 lines apart in *Dinornis robustus*.

The optic groove, which extends across the fore part of the sella, from one optic foramen to the other, the floor of which is shown in Pl. LIV. fig. 1, *m*, defines the coalesced bases of the orbitosphenoidal neurapophyses. These bases rest upon a prolongation of bone from the basisphenoid, suddenly narrower than that part, convex transversely, contracting anteriorly, and called in ornithotomy the 'rostrum' or 'sphenoidal rostrum' (ib. 9).

If we may extend the more general comparisons of the vertebrate endoskeleton to this part of the base of the skull, we should view this 'rostrum' as the anterior continuation of the series of vertebral elements called 'centrums,' but which have been ossified, like the lower cortical or hypapophysial part of the centrum of the atlas,fr om the capsule of the notochord. The presphenoid, indeed, is only semicylindrical, and offers a close resemblance to the corresponding base of the sacrum, succeeding that which, by its greater breadth and flatness, forms, as a thin floor of bone, the base of the sacral cranium, or neural cavity for the sacral expanse of the myelencephalon, and so closely and instructively repeats the characters of the basioccipital and basisphenoid at the base of the bird's encephalic cranium. To the chambers in which the foremost productions of the myelencephalon expand, this ornithotomical 'rostrum' exists in the relation of a centrum, both developmentally, connectively, and functionally: the coalesced orbitosphenoids and prefrontals have like relations thereto as neurapophyses.

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[1] "Fissura lacera posterior" and "foramen lacerum posterius" of Anthropology.

[2] "Fissura lacera anterior," "foramen lacerum anterius," and "fissura sphenoidalis," ibid.

There is not an interorbital septum in *Dinornis*, as in birds generally; so, if such septum can, on any ground, be regarded as 'the body of an anterior cranial vertebra,' whether 'compressed,' or 'third,' or 'last,' or 'most anterior,'[1] then such 'body' must be denied to the *Dinornis*, and the 'presphenoid' be left without general homological significance. The truth is, however, that the compressed interorbital septum is the result of special ornithic modifications of the general vertebrate type; not, however, common to all the class, but an inconstant feature therein. In such low forms as *Apteryx* and *Dinornis* we see it not: the common vertebrate type is here more closely adhered to. The real 'body,' or representative centrum, of the prosencephalic cranial vertebra is wanting in no bird; it exemplifies its general homological character more clearly where the general vertebrate type is least departed from. Developmentally it is the product of the notochordal capsule, and of a part of such extending anteriorly beyond the gelatinous contents of the chorda, and it may include only the inferior cortical or 'hypapophysial' part of the cervical or dorsal centrum, as in the similarly produced part of the cranial vertebræ in *Cetacea*: but whether it be specially denominated 'sphenoidal rostrum,' 'presphenoid,' or 'vomer,' such median inferior parts of the floor of the osseous encompassings of the foremost parts and productions of the neural axis are in the relation of 'centrums' or 'bodies' to such 'neurapophyses' and 'neural spines.'

As the basioccipital is coalescent with the exoccipitals and basisphenoid, and this again with the alisphenoids, so the forward production of the cranial base is coalescent with the orbitosphenoids, which, by their confluent bases, support the optic groove, and are at the outer end of this groove pierced by the optic foramina. In *Dinornis* the orbitosphenoids coalesce with the antecedent pair of plates to form the walls of the vast rhinal chamber. The presphenoid (Pl. LVI. 9), connate as well as confluent with the basisphenoid, presents the usual ornithic or oviparous condition of a long rostrum, but here may be said rather to resume the usual subcylindrical shape of the vertebral centrums. It is, however, semicylindrical, rounded below from side to side, broad and flattened above, where it coalesces with the laminæ (14) protecting the most anterior developments of the neural axis. It measures from the fore part of the 'pterapophyses' 3 inches 3 lines, contracting to 6 lines across, near its origin, then gradually expanding to a breadth of 8 lines opposite the rhinal apertures, before more gradually contracting to its apex. Its free surface is convex transversely and smooth, consisting of a very thin plate of bone; its substance is highly pneumatic, receiving air from the sphenoidal communications with, or extensions of, the tympanic cavity. Hollow slender columns of bone act as tie-beams on each side, near its confluence with the fore part, connecting the lower and lateral walls with the upper wall of this elongate cranial centrum.

The neurapophysial plates arising from its upper and lateral parts slightly converge posteriorly before bending upward and outward to form the combined optic (*op*) and

[1] Melville, 'Osteology of the Dodo,' 4to, p. 87 (1848).

prelacerate (*f*) foramina, beneath which there is thus a smooth depression (10) capable of receiving the end of a man's thumb on each side and above the origin of the presphenoid. In advance of these depressions the outer plates of the neurapophyses (Pl. LVI. fig. 1, 14) extend obliquely outward as they rise, forming the sides of the larger rhinal chamber (Pl. LIV. fig. 1, *n*), and passing uninterruptedly to coalesce with the superorbital expansions of the frontal (neural spine, Pl. LIII. fig. 1, 11). From the upper and anterior half of the presphenoid rostrum, the inner plates of the neurapophyses (14)—foremost terminal ones of the series—converge and coalesce into a vertical wall of bone (Pl. LVI. fig. 3, 14′), thickest, lengthwise, at its middle part and thence gradually thinning off to both posterior and anterior margins, but thinnest vertically at its middle part, and expanding both below and above. Superiorly the expansion attains a breadth of 8 lines, with a flattened upper surface (ib. fig. 3, 14′) supporting the fore part of the nasals (15), which part is overlapped by the premaxillary, and with the under surface forming an arch on each side over the fore part of the rhinal chamber.

The base of each of these neurapophysial plates, prior to their rising to converge and coalesce, developes a strong, thick, dense, and smooth girdle of bone around the orifice of communication between the rhinal chamber and the corresponding nasal passage: the girdle (ib. fig. 1, *g*, *g′*, *g″*) is not entire; about one-sixth is incomplete at its fore part; the orifice it otherwise would encompass is of a triangular form, with the angles rounded off (ib. 19). The hinder side or bar (*g*) is transverse to the skull's axis, and is 1 inch long; the medial side (*g′*) is in the skull's axis, and is 10 lines long; the third side, partly formed by the bending of the outer end of the hind bar, extends obliquely forward and inward for 6 lines, leaving about the same extent of the circumference incomplete at its middle, between the above and the process (ib. *g″*), which extends transversely outward. The inner part of this thick border or girdle is defined from the base of the neurapophysis developing it by a narrow groove; the hind part increases in depth as it extends outward and makes a bold bend forward and inward, with the convexity projecting into the fore part of the orbit, as it bends to form the anterior part of the girdle. There is a small perforation at the convex bend, and the upward continuation of this part of the wall, which is concave forward, becomes as thin as fine paper, subreticulate, and continuous with the delicate bony support of a turbinal (ib. 19). We have here the commencement of the accessory or apophysial part of the neurapophysis, which becomes developed into the most conspicuous part of the 'frontal antérieur' of Cuvier, *e.g.* in Reptiles. But in *Dinornis* the 'prefrontals' are unwontedly developed in their essential parts, and almost exclusively devoted to the olfactory chamber, which is serially homologous with the orbit and the tympanum, as the antecedent nasal passage conducting the air thereto is the homotype of the meatus auditorius externus in the hinder organ of special sense.

On removing the centrum and lower portions of the neurapophyses of this region of the skull, the rhinal chambers are exposed (as in Pl. LIV. fig. 1, 14, *n*). These, in transverse vertical section, are of a triangular form, the apex being formed by the bases of the prefrontals where they coalesce with the presphenoid. Each prefrontal divides into an inner or 'medial' and an outer or 'lateral' plate. The lateral plates diverge and bend upward and outward, forming the side-wall of the rhinal chamber, from which the turbinals (middle and posterior, Pl. LVI. fig. 3, 19) are developed; the medial plates coalesce and ascend, forming the rhinal septum (ib. 14', and Pl. LIV. fig. 1, between *n* and 14), expanding above and partly overarching the rhinal chamber, the main part of the roof of which is formed by the frontals and nasals, with which, however, a thin layer of the prefrontals seems to be blended as it diverges from the upper part of the septum. At the upper and back part of the rhinal chamber this layer of bone (ib. 14) is perforated by numerous minute foramina leading to fine grooves which radiate to conduct the olfactory nerve-filaments to the pituitary membrane.

This 'cribriform plate' is a peculiarity in which the *Dinornis* participates with the *Apteryx*: in birds generally the olfactory foramen is single on each side; sometimes they are blended into one. Cuvier called the combined neurapophyses and sense-capsules, which chiefly form and occupy the rhinal chambers in birds, by the same name which anthropotomists had given to those parts in Man. He rightly determined the bones marked 15, 15', Pls. LIII.–LVI. to be 'nasals,' but those external to them and next the orbit might be either 'anterior frontals' or 'lacrymals'[1]. Cuvier inclined, however, to adopt the latter homology[2], but for a reason which is rebutted by the marked development of the 'posterior frontal' (Pls. LV. & LVI. fig. 1, 12) in the *Dinornis*.

The phenomena of development lend no help to the determination of this question; the same spread of blastema, between and expanding transversely in front of the eyeballs, becomes the seat of the histological stages which issue in the bones (14, 15, 73) prior to their mutual confluence in Birds. I doubt if I should have been able to settle this matter, which to some now appears so obvious, if I had not been guided by the light of general homology. That showed me first what was the essential and constant, what the secondary and superadded, growth of the bones called by Cuvier 'frontaux antérieurs' in the Fish and Reptile. The determination of the neurapophysial parts of these bones in Pisces and Reptilia led me to recognize their homologues in all the groups (Batrachia, Aves, Mammalia) in which Cuvier and other anatomists, up to 1844, held the 'anterior frontals' to be absent, or to be represented by the lacrymals. Cuvier was unacquainted

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[1] His able coadjutors and editors, F. Cuvier and Laurillard, retained this opinion:—"Les os externes et plus voisins de l'orbite seraient presque comme on le voudrait, ou des frontaux antérieurs ou des lacrymaux" (Leçons d'Anat. Comp., ed. 1837, tom. ii. p. 580).

[2] "Ce que pourrait faire croire que c'est le frontal antérieur qui manque, c'est que dans les oiseaux il n'y a point de frontal postérieur, et que la paroi antérieure de l'orbite, à l'endroit où le frontal antérieur se trouve ordinairement, est manifestement formée en grande partie par une lame transverse de l'ethmoïde" (*ib.*).

with the term 'prefrontal,' nor is it a synonym of 'anterior frontal.' By 'prefrontals' are meant not only the 'anterior frontals' of Cuvier in Fishes and Reptiles, but also his 'os en ceinture' in Batrachians and parts of his 'ethmoïde' in Birds and Mammals: the term 'prefrontal' is the sign of the settlement of a homological question which was far from being an easy one or of obvious attainment when it became my duty to grapple with it in describing the "Osteological Series" of the Museum under my charge in 1843. Notwithstanding the devotion of twelve pages[1] to that subject, by which I believe that now the matter ought to be sufficiently plain, Dr. Melville is unable to understand it. Accepting the choice offered by Cuvier in the skull of birds, he takes the opposite of that to which Cuvier inclined[2]. Seeing that of the three names which Cuvier had given to what I believe to be one and the same bone, two of them were applied to it in pretty equal proportions of the vertebrate series, I balanced for a while whether to adopt 'ethmoid' or 'anterior frontal.' I considered, however, that by 'ethmoïde' Cuvier meant not only the neurapophysial part of the prefrontal, but also the superior portions of the rhinal or turbinal capsules, and that the term, moreover, borrowed from anthropotomy, indicated a structure which, with the two exceptions discovered by me in the class of Birds, was limited to Mammals, and not constant in that class. Inclining, then, to the name referring to the bone in question in Fishes and Reptiles, I constructed a term near enough to it to suggest so much of the homology as was true, but sufficiently distinct from it to show that it was not a synonym, but signified something different and much besides.

In ordinary birds the olfactory nerves, or rather rhinencephalic crura, emerge from the cranium at the upper angle between the hind wall, roof, and septum of the orbit, groove the upper part of the septum as they pass forward to penetrate the prefrontal, and expand into the rhinencephalon, dispersing the olfactory nerves to the turbinal membranes. The frontal olfactory foramen in *Raptores* is smaller than the prefrontal one. Between the Vulture and the Crocodile the difference is that the rhinencephalic crura extend along a common canal above the interorbital space in the Reptile, while in the Bird the ossification of the septum divides the rhinencephalic fossa into two. The bones which hold the neurapophysial relation to the rhinencephalon, anterior to the frontals, are the same or homologous in both *Ovipara*; but in the Bird the secondary peripheral or apophysial developments of the prefrontals are suppressed, as in Batrachians and some fishes (*Xiphias*), in which they form the anterior wall of the

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[1] "On the Archetype and Homologies of the Vertebrate Skeleton," pp. 46–59.

[2] "The bone which has heretofore been denominated the lachrymal in birds is undoubtedly the homologue of the prefrontal in the cranium of fishes and reptiles. The true lachrymal bone, which is external to the lachrymal duct, exists in certain Saurians and in the *Crocodilidæ*; it does not occur in the higher Vertebrates (*Aves* and *Mammalia*), while the prefrontal only disappears in certain exceptional instances among mammals; in birds and mammals it has erroneously been regarded as the true lachrymal, and is so named by the learned Hunterian Professor: this false homology masks one of the most beautiful instances of the unity of organization," &c. ('Osteology of the Dodo,' 4to, p. 87, 1848.)

orbit, occupying the anterior part of the interorbital space, joining each other at the median line by an extensive vertical cellular surface, and dividing the orbital from the rhinal cavities. In *Apteryx* and *Dinornis* the latter cavities are so developed as to extend backward between the orbits to the cranium, the front wall of which forms the back wall of the rhinal instead of the orbital cavities.

The temporal fossa (Pls. LIII., LIV., LV. 7′) is divided by the pretympanic ridge and process of the mastoid 8″) into a posterior compartment (Pl. LV. fig. 1, 8) for the posterior 'temporalis' muscle, of a triangular shape, 10 lines broad at the upper part, and an anterior larger and deeper depression (ib. 7′), rounded above, 1 inch 5 lines in breadth, and bounded anteriorly by the broad, triangular, vertically descending postfrontal (ib. 12). These temporal fossæ, as in the less perfect skull (Pl. LIII. fig. 1, 7′), are nearly 2 inches apart on the broad, flattened upper surface of the cranium (7), where the boundary-ridge is scarcely, if at all, defined.

The orbit (Pl. LV. *o*) is smaller in proportion to the size of the skull than in most birds, but is much better defined than in the nocturnal *Apteryx*. The bony boundary is formed posteriorly by the convex border of the postfrontal (12′), above and in front of this by the thin superorbital part of the frontal, which is gently wavy; it then curves down as a thicker triangular process (*a*) to form the fore part of the orbital frame. The inner surface of this process developes a low vertical ridge, in part articulated with the outer portion of the rhinal cincture; and the lower part of this ridge is pierced by the lacrymal foramen, indicating the process to be a lacrymal (ib. 73) confluent with the frontal and prefrontal.

The nasal is, in like manner, confluent by its upper border (Pl. LIII. fig. 1, Pl. LVI. fig. 3, 15) with the frontal, its outer descending maxillary process (Pl. LV. fig. 1, Pl. LVI. fig. 3, 15′) terminating freely by a slight expansion which rests upon the maxillary (Pl. LV. fig. 1, 21). The premaxillary process of the nasal (15) is broad and flat, supported by the prefrontal expanse (Pl. LVI. fig. 3, 14′); it is in great part excavated above by the shallow rough depression for the premaxillary stem (Pl. LIII. fig. 1, 22′), and shows a narrow, thickened, and smooth tract bounding that depression externally or laterally.

The plane of the orbital cavity, so far as it is formed by bone, is directed from behind obliquely forward and upward at an angle of 45° with the axis of the skull, the eyes thus being directed more forward and downward than in birds generally. The downward cast of the eyes relates to the great height of the *Dinornis*, and the position of its food upon the ground. The roof of the orbit shows an oblong shallow depression at its back part for the Harderian gland, and a deeper anterior pit for the lacrymal gland. The fore part of the maxillary (Pl. LVI. fig. 1, 21′) is an oblong, bony, pneumatic capsule, 2 inches in length and 1 inch 3 lines in breadth, flattened below, where the surface is equally divided between the sutural part underlapped by the maxillo-palatal part of the premaxillary (22″) and the free, smooth surface, extending thence the bony roof of the mouth. It is convex above, where it forms a very thin shell of bone; on the outside of this tumid part of the maxillary is the sutural surface for the premaxillary and nasal bones, the latter being the smaller part. The malar process of the maxillary (Pl. LV. fig. 1, 21) extends backward from the outer and posterior angle; the inner angle terminates in a point, which was underlapped by the palatine.

Neither palatines nor pterygoids are preserved in the present skull. The maxillary (21), malar (26), and squamosal (27) coalesce to form the usual slender and straight zygomatic arch in birds. This increases in depth and diminishes in thickness at the squamosal part, which shows a feebly convex upper border: its posterior end is thickened to form the convexity adapted to the cup (Pl. LIII. fig. 2, *h*) on the outer part of the tympanic (28).

The modifications of certain parts of the skull of the *Dinornis robustus* are of a nature to throw light on some moot points in the craniology of birds.

Dr. Melville contends that "the interorbital septum in Birds is the homologue of the Mammalian presphenoid."[1] But of this presphenoid in Pigeons he describes the "ossified portions of the ethmoid, or olfactory capsule," to be processes[2]. Moreover, he admits that the 'interorbital septum' appears on the upper surface of the cranium "behind the premaxillary, and between the nasals," "in the Emu and other Struthionidæ."[3] It is shown in this exposed position in the Ostrich (art. *Aves*, Cyclop. of Anat. vol. i. p. 274, fig. 127, *l*) as part of the 'ethmoid', in the Emu (Zool. Trans. vol. iii. pl. 39. figs. 1 & 2, 14) as 'prefrontals,' and in the *Rhea* (Zool. Trans. vol. v. pl. 42) as the 'middle ethmoid' or 'perpendicular ethmoid.'

I have not, however, met with any instance, in any class, in which the 'anterior sphenoid' afforded attachment to 'turbinals' or ossified parts of the olfactory capsule. Anthropotomists describe and figure the homologue of the 'presphenoid' as the "'rostrum'[4] of the sphenoid bone, to which is articulated the vomer and the perpendicular part of the ethmoid."

The 'rostral' form and proportions of the 'anterior sphenoid' in *Cetacea* approach nearer to those of the 'rostrum of the sphenoid' in Birds and Reptiles than in most other mammals. I am unable, therefore, to accept the special homology of the 'interorbital septum' in birds proposed or adopted by Dr. Melville. His views of the "general homology" of the part in question are expressed as follows:—"For reasons which cannot be discussed here, I regard the interorbital septum as the compressed body of the third and last or most anterior of the cranial vertebræ."[5] But, in this case, we have the body or centrum of a vertebra appearing at the upper surface of a neural arch, and displacing the moieties of a neural spine, projecting, *e. g.*, "between the nasals," as in the Struthious birds already adduced. And beneath this part so

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[1] "Dodo and its Kindred," 'Osteology of the Dodo,' 4to, 1848, p. 87.
[2] Ibid.
[3] Ibid.
[4] 'Anatomy, Descriptive and Surgical,' by H. Gray, 8vo, p. 33, fig. 30.
[5] *Op. cit.* p. 87.

exposed the alleged 'vertebral body' gives off a process "arching over the foramen, for the transmission of the olfactory and ophthalmic nerves."[1] But this is, surely, a relation rather of a 'neurapophysis' than of a 'centrum' of a vertebral segment.

Some who appeal to developmental phenomena will reject the "general homology" proposed for the interorbital septum by Dr. Melville, on the ground of the non-extension of the 'chorda dorsalis' so far forward in the cephalic blastema of the embryo. I may presume, however, that the arguments for the insufficiency of this ground of objection given in my 'Archetype of the Vertebrate Skeleton' (8vo, p. 6) are held to be conclusive by the learned Professor in Queen's College, Galway. My objections to his view rest on the more decisive and demonstrative homological bases of 'connexion' and 'relative position.'

Mr. Parker confines himself to the question of special homology in regard to the 'interorbital septum' of birds, and points out in it, in the illustrations of his paper on the "Osteology of Gallinaceous Birds,"[2]—*ps*, the 'presphenoid'; *eth*, the 'middle ethmoid' and 'vertical ethmoid'; *prf*, the 'upper prefrontal'; *pe*, the 'perpendicular ethmoid'; *aet*, the 'ali-ethmoid lamina'; *ao* 1, the 'upper antorbital'; *ao* 2, the 'lower antorbital.'

I believe that all these are but parts of the coalesced 'prefrontals,' including a small portion of the rhinal sense-capsule connected therewith; and in regard to the more general relations of homology, I retain my conviction that the 'prefrontals,' under all their modifications as the 'interorbital septum' in birds, are essentially 'neurapophyses,' serially homologous with the 'orbitosphenoids,' and belonging, not to the 'third' cranial vertebra, but to the 'fourth' or most anterior one. The huge eyeballs in most birds press hardly upon the blastemal basis of these poor neurapophyses, interrupting their normal development, and squeezing, so to speak, the rhinal sense-capsules out of all proper position: hence the value of small-eyed birds with mammalian noses, like the *Apteryx* and *Dinornis*, in testing the divers notions which the 'interorbital septum' has raised in the anatomical mind, and in demonstrating the true and essential nature of the part.

But the interorbital septum is not the only stage on which a supposed plurality of bones, with their several denominations, play their parts. Ossification of the blastemal basis of the basisphenoid being stimulated to begin by the channels through which the blood actively and abundantly passes to the rapidly growing brain, a pair of centres, besides the median one, characterize the ossification of this vertebral element in Birds as in many Reptiles. Are these parial ossifications superadded vertebral elements, or indications of two bones calling for special denominations?[3] Considering the varying number of points at which ossification commences in the body of a vertebra in the

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[1] "Dodo and its Kindred," &c., 4to, p. 87.

[2] Zool. Trans. vol. v. p. 149.

[3] 'Basitemporals,' *e.g.*, as proposed in the memoir "On the Osteology of the Gallinaceous Birds," &c., Trans. Zool. Soc. vol. v. p. 176.

different vertebrate classes, the fact did not so weigh with me in considering the serial homology of the vertebral centrums at the base of the skull, and I cannot assign more value to the osteogeny of the basisphenoid in Birds and Lizards than did the embryologist Rathke. The 'pituitary floor' of the 'sella turcica,' which marks the place of the bifurcation of the blastemal capsule of the notochord in the embryo, shows unmistakeably, in the dissection of the base of the *Dinornis* skull (Pl. LIV. *d*), the boundary-line between basi- and pre-sphenoid. If I understand Mr. Parker, he regards the bones (8) in Pls. LIII.–LVI., which he calls 'temporal' and 'squamosal,' as standing in neurapophysial relation to his 'basitemporals.' Whether 8 be homologous with Cuvier's 'mastoïde' in Reptiles, or with his 'écaille du temporal' in Mammals, is discussed in my work 'On the Archetype,' &c., 8vo, 1848, pp. 29–42. The only additional argument bearing upon this question is based upon the assertion that the bone 8, in Birds, is not ossified in and from cartilage, but is a 'membrane bone' like the squamosal in Mammals. This assertion does not square with my experience. The ossification of no. 8 in Birds, as in Reptiles and Fishes, begins and ends in the cartilage external to the labyrinth. In adducing other reasons for regarding it as the homologue of Cuvier's 'mastoïde' in other *Ovipara*, I should only repeat what I have elsewhere adduced. But I may here remark that, in the quest of the nature and homologies of the bones in the Bird's cranium, the comparison should be made ascensively from the developmental phenomena and anatomical connexions and relations of the parts in the Cold-blooded Vertebrates, rather than descensively from those in Mammals.

§ 4. *Atlas of* Dinornis robustus.

This vertebra consists of the 'hypapophysis' and the 'neurapophyses' in a coalesced state (Pl. LIII. figs. 4, 5, 6): the 'centrum' articulating with the back part of the base of each neurapophysis, having coalesced with the centrum of the succeeding vertebra, is not here present. The hypapophysis (ib. *hy*) is wedge-shaped; the base is convex transversely, with a medial protuberance from its back part and a smaller one on each side: the anterior surface is excavated and smooth, forming the lower two-thirds of the occipital cup (ib. fig. 4); the posterior surface (fig. 5) is plane and roughish for a close attachment to the centrum of the atlas; the upper margin of the wedge is concave transversely, thick and convex longitudinally. The coalesced bases of the neurapophyses send each a process inwards, which is concave anteriorly, contributing the upper third of each side of the occipital cup, and resting in part upon the body of the atlas, which occupies their interspace (fig. 4, *c*). Each neurapophysis then inclines upward and outward, and suddenly expands; it sends a process from its outside downward, which coalesces with the side of the hypapophysis and circumscribes the vertebrarterial foramen (ib. *v*); it sends a larger process backward, with an articular surface (fig. 5, *z*) on its under and inner part for articulation with the prezygapophysis of the axis-vertebra; it is convex externally, with a tuberosity on its outer and hinder surface (fig. 6, *z'*), and then rapidly diminishes in thickness, curving inward towards its fellow, which it does not quite meet, above the neural canal (Pl. LII. fig. 5, *n*). The anterior end of the centrum of the atlas occupies the notch (*c*) between the hypapophysis and neurapophysis, completes the occipital cup, and gives attachment to the ligament answering to the 'odontoid' in anthropotomy. The figures of the atlas in Pl. LIII. are of the natural size: the specimen was obtained with the incomplete skull from the fissure at 'Timaru.'

§ 5. *Scapulo-coracoid Arch of* Dinornis robustus.

The existence of such arch in the skeleton of *Dinornis* was inferred, in my Second Memoir, from the articular depressions in the sternum[1]; and, by the peculiarly small size, shallowness, and shape of these depressions, I recognized the convex extremity of the bone (Pl. LV. figs. 2, 3, 4, *x*), forming part of the skeleton of the *Dinornis robustus* from Manuherikia, as being the sternal end of the coracoid. It presents a rather irregular convexity, of an oval shape, 10 lines by 6 lines in the two diameters, with a rough surface indicative of ligamentous union with the sternal fossa, not of articulation by a synovial joint, as in birds of flight. From the tuberosity (*x*) the bone (52) rises straight, decreasing in thickness and increasing in breadth at its upper end, which is confluent with a much longer and thinner bone (51), forming with the coracoid a widely open angle, and slightly curved in its course. This bone I take to be the 'scapula' confluent with the coracoid, partly from characters of proportion and shape and partly from the analogy of the scapulo-coracoid arch in the *Apteryx*[2]. In this bird the coracoid and scapula are confluent, and present relative proportions as to length like those in *Dinornis*. But the coracoid is relatively much broader in the *Apteryx*; its sternal end is adapted to a long groove, as in most other birds; it also shows a perforation near its scapular end, and a more important difference in the presence of the glenoid cavity for the humerus on the posterior margin of the scapulo-coracoid confluence. There is no trace of such articular cavity in the scapulo-coracoid archof *Dinornis*, but in place thereof a rough, slightly produced ridge (*r*), to which, if any rudiment of humerus existed, it must have been suspended by ligament. I, however, infer that such appendage of the scapular arch did not exist in the living bird; that the *Dinornis* offers the previously unknown and unique exception to the tetrapodal type in Birds; that the anterior members, like the posterior ones in Cetacea, were represented only by their supporting arch, and that this arch was limbless, as it is in *Anguis* among the Lacertian Reptiles.

The scapula (Pl. LV. figs. 2, 3, 4, 51) soon decreases in breadth, from 11 lines at the confluent part (*m*) to 7 lines within an inch from that part, beyond which it more gradually narrows to a breadth of 5 lines at the extremity; the thickness of the bone gradually decreases also from the coracoid confluence (fig. 4, *m*), viz. from 4 lines to

[1] Trans. Zool. Soc. vol. iii. p. 316, pl. 43. figs. 1–3.

[2] Ibid. vol. ii. p. 308, pl. 55. *e*, *f*, *g*.

2 lines, near the free end of the bone. The total length of the scapula is 5 inches; that of the tibia of the same bird is 2 feet 3 inches—a strange disproportion! The scapulo-coracoid arch exists in this huge wingless bird solely in physiological relation as the lever by which the respiratory muscles act to depress the sternum, expand the thoracic air-cells, doubtless developed as in *Apteryx*, and so cause the rush of air by the trachea into the lungs.

DESCRIPTION OF THE PLATES.

PLATE LIII.

Fig. 1. Upper view of the skull of *Dinornis robustus*, from the bone-fissure at "Timaru." (The premaxillary is figured about 8 lines too far in advance of the cranium.)

Fig. 2. Side view of the same skull. (The dentary (32, 32′, 32″) is figured about half an inch too far in advance of the surangular (29′) and angular (30), in order to show the articular grooves.)

Fig. 3. Back view of the cranium of the same skull.

Fig. 4. Front view of the atlas-vertebra of a large *Dinornis*.

Fig. 5. Back view of the same vertebra.

Fig. 6. Side view of the same vertebra.

PLATE LIV.

Fig. 1. Base view of the skull of *Dinornis robustus*, from the bone-fissure of "Timaru." (The premaxillary is figured about half an inch too far in advance.)

Fig. 2. Inner or mesial surface of the left tympanic bone of the same skull.

Fig. 3. The same tympanic bone, viewed from below. *e′*, mastoid condyle; *p*, posterior pneumatic foramen; *q*, antero-internal pneumatic foramen; *k*, orbital process; *pt*, articular surface for pterygoid; *h i*, postero-external condyle, *i′*, antero-internal condyle, for the articular part of the mandible.

Fig. 4. Upper view of mandible of the same skull.

PLATE LV.

Fig. 1. Side view of the skull of *Dinornis robustus*, from the skeleton in the arenaceous deposit at "Manuherikia."

Fig. 2. Outside view of scapulo-coracoid bone of the same skeleton.

Fig. 3. Inside view of the same scapulo-coracoid bone.

Fig. 4. Posterior margin of the same bone, showing the ridge (*r*) in place of a glenoid cavity.

PLATE LVI.

Fig. 1. Base view of the skull from the same skeleton of *Dinornis robustus.*
Fig. 2. Back view of the cranium of the same skull.
Fig. 3. Front view of the cranium of the same skull.

(All the figures are of the natural size.)

The figures of the parts of the skeleton of *Dinornis robustus* from "Manuherikia," now in the Museum of the Philosophical Society at York, have been taken by permission of the President and Council of the Society.

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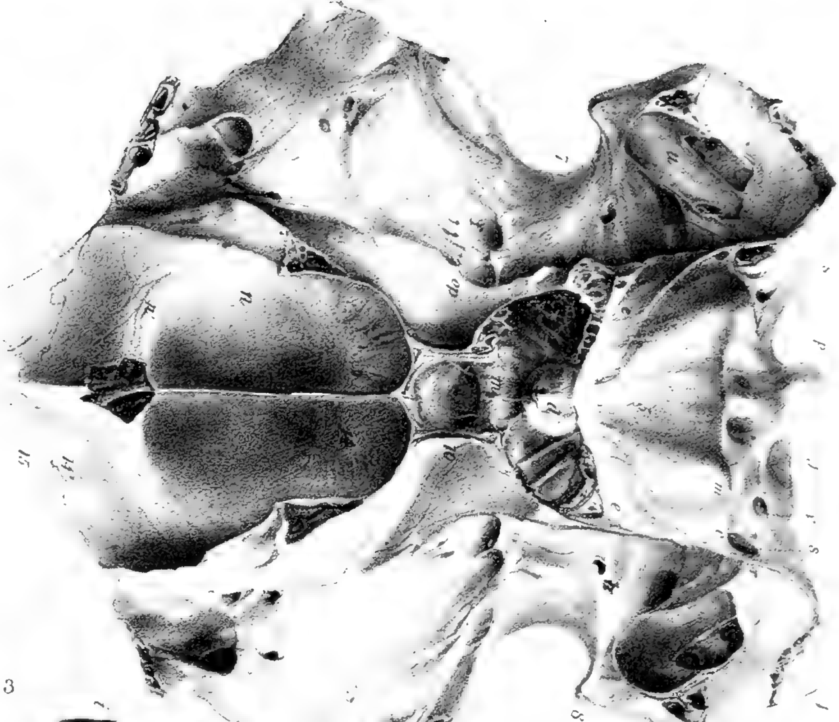

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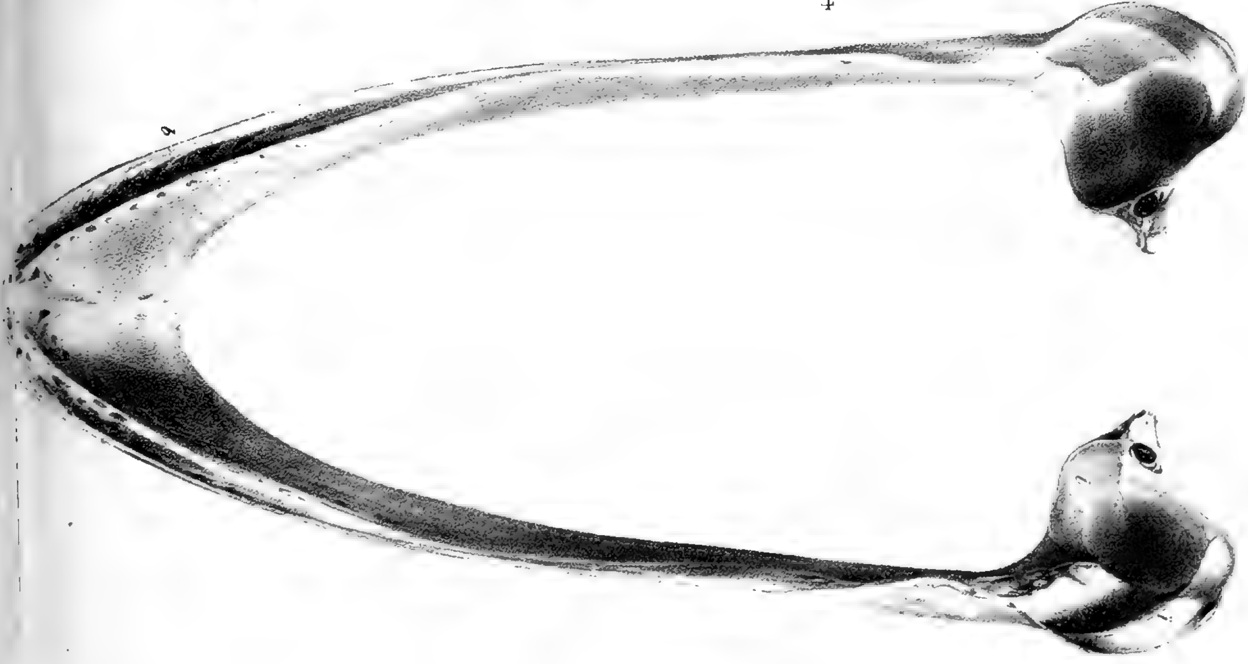

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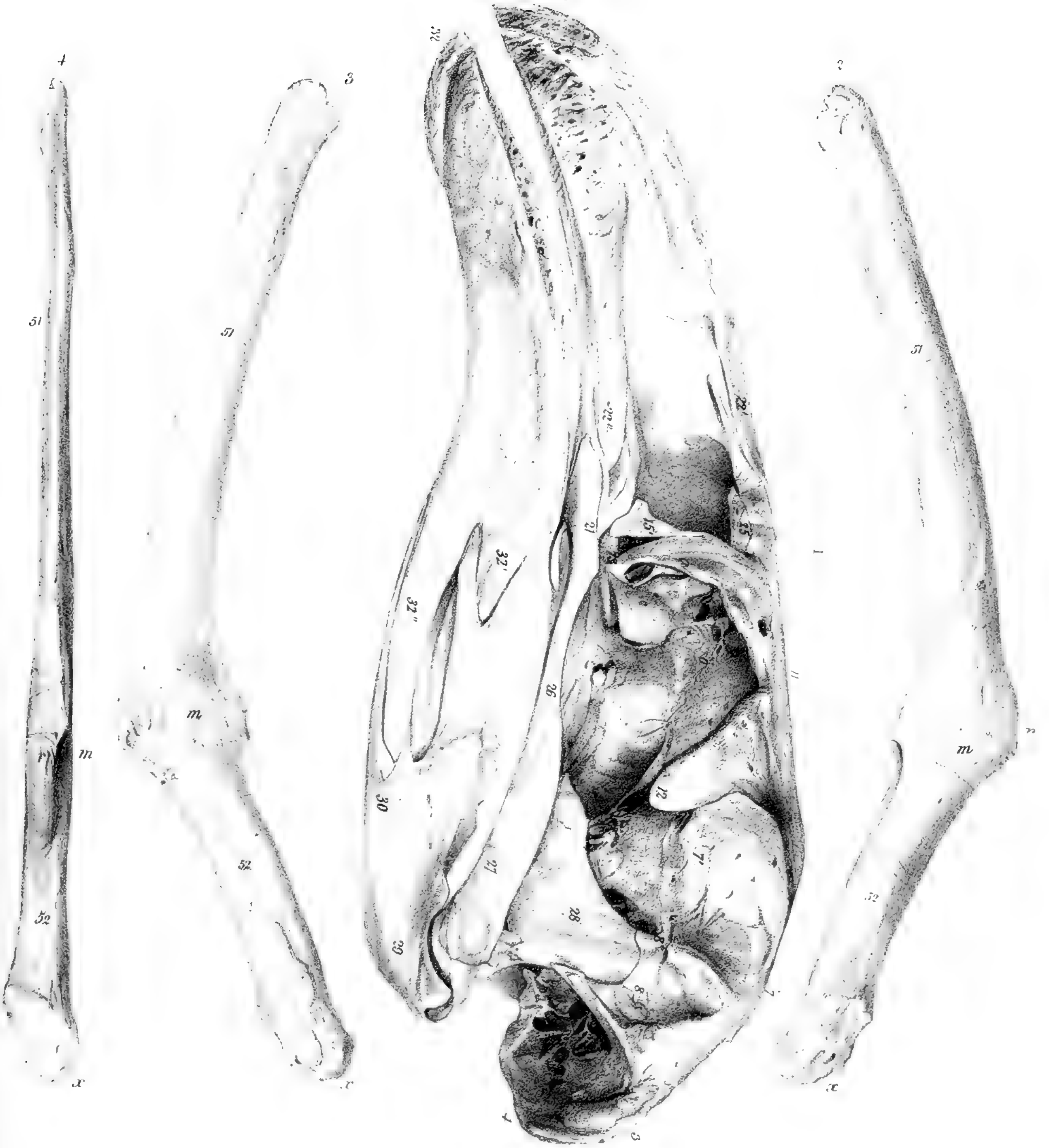

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DINORNIS ROBUSTUS

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X. *On New or imperfectly known Species of Marine* Ostracoda.

By GEORGE STEWARDSON BRADY.

Read March 14, 1865.

[PLATES LVII.–LXII.]

OF the sixty-seven species described in the following paper, ten have been identified with forms already described and figured from fossil (chiefly Tertiary) specimens; *two* species, *Bairdia subdeltoidea*, Münster, and *Cythere setosa*, Baird, were already known in the recent state, but appeared to require further illustration. The remaining *fifty-five* species I have been unable to refer to any published forms[1], though many of them have, as might be expected, very near relatives amongst the Tertiary fossils. The ten fossil species of which descriptions are now given for the first time, from recent specimens, are as follows:—*Cytherella beyrichi*, Reuss; *Bairdia ovata*, Bosquet; *Cytherideis gracilis*, Reuss; *Cytheridea mülleri*, Münster; *Cythere jurinei*, Münster; *C. canaliculata*, Reuss; *C. plicatula*, Reuss; *C. clathrata*, Reuss; *C. subcoronata*, Speyer; *C. scabra*, Münster.

The difficulty of identifying Ostracoda merely by reference to figures and descriptions is much increased by our uncertainty as to the characters which can rightly be considered as indices of specific rank. A vast number of species have been founded on peculiarities of surface-marking; but it is quite certain that this, unless accompanied by other distinctions, is in most cases a character upon which no reliance whatever can be placed. The range of variation, in this respect, which may be observed in the same species as the result of age or peculiarity of habitat, is very great, and may be appreciated by reference to the figures (Pl. LIX. fig. 14, *a–g*) of *Cythere mutabilis*, Brady, M.S. There is, indeed, scarcely any species which does not exhibit very great variety of surface-marking: nevertheless, so far as my observation extends, the variation is always in the same direction for the same species; that is to say, a species—*Bairdia subdeltoidea*, for instance—may run through many shades of sculpturing, from a perfectly smooth to a strongly punctate carapace, but the intermediate forms will be characterized merely by greater or less development of the typical form of sculpture. There will never be any tendency to a rugose, striated, tubercular, or any other system of ornamentation. If such a deviation were observed, it would lead one to suspect a specific difference[2].

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[1] Since this was written, three of the species here described, *Jonesia simplex*, *Cythere latissima*, and *Cytheridea papillosa* have been figured and described from British specimens by the Rev. A. M. Norman.

[2] Yet, even in this respect, it is necessary to speak with some reservation; for we find it an almost uniform

And if little dependence can be placed on surface-markings, neither can we any more rely upon the spinous armature which is often observed at the extremities or round the margins of the valves. These also vary much with age, and in the same gathering may often be found either entirely absent or very well developed. Even the hinge-articulation, which has been taken as a principal generic distinction, is liable to vary in degree of development, not only in the same genus, but in different examples of the same species; so that, even in mature individuals it is often difficult to say to what genus the species ought to be referred. This may very sufficiently account for the various positions to which some species are assigned by different authors.

The lucid spots afford, in some cases, excellent generic and possibly even specific characters. Good illustrations of this are afforded by the genus *Cytherella*, by *Jonesia simplex*, *Bairdia fusca*, *Cytheridea kirkbii*, &c. But the features on which most reliance is to be placed are the general form and proportions of the carapace in its lateral and dorsal aspects and the character (not the quantity) of surface-ornament. The probability of a small and slightly marked specimen being the young of some species is always to be kept in view. Examples of young forms, which I at one time supposed to be distinct species, are figured at Pl. LIX. figs. 9 & 10 (*Cythere clathrata*, var. *nuda*), ib. fig. 14 *a*, *b* (*Cythere mutabilis*, Brady), and Pl. LVIII. fig. 12 (*Cythere setosa*).

For two groups which possess well-marked distinctive characters I have here proposed the generic names *Jonesia* and *Normania*. The only other new genus which I have found it necessary to establish is *Heterodesmus*—a highly curious and interesting natatory form, allied to the fossil Carboniferous species *Entomoconchus scouleri*, M'Coy. For this, as well as for the species of *Cypridina* now described, I am indebted to Arthur Adams, Esq., R.N., by whom they were taken in the towing-net in the Japanese and Chinese seas. My thanks are due also to Professor T. Rupert Jones and Messrs. W. K. Parker, E. C. Davison, and W. M. Wake, who have kindly furnished me with most of the specimens from which the following descriptions have been drawn up.

It is with considerable hesitation that I have felt myself compelled to adopt the genus (or subgenus) *Cythereis*. The species—our British *C. jonesii*, for instance—which may be looked upon as typical of that group, are so well marked and so peculiar in

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rule that a pitted sculpture on the lateral aspect of the valves is converted into furrows, more or less distinct, on the ventral surface. In some species this is very well marked (*Cythere septentrionalis*, &c.), and appears to be produced by a coalescence of the pits. Occasionally the process of formation of longitudinal furrows may be observed in an intermediate stage (*Cythere hodgii*). And, seeing that in some species there exist small elevated tubercles on the spaces between the pittings, it is quite conceivable that, by the filling up of the excavations, the shell might come to exhibit only small tubercles or papillæ on a smooth surface. But I have seen no examples in which this alteration can be traced; and, if it were so, a species which had assumed a constant character of its own by this means must have attained it by a long course of natural modification, and would, I conceive, be entitled to rank as a distinct species. I have, however, observed that some species, which in young and early adult life present a smooth surface studded with papillæ, become in old age encrusted with a calcareous coat which exhibits pits or depressions in place of the papillæ.

their characters that it would be very satisfactory to be able without misgiving to place them in a distinct genus. But the characters which have been proposed for the genus *Cythereis* slide so insensibly, and through so many osculant forms, into *Cythere*, that I have found it almost impossible, in many cases, to determine to which genus a particular species ought to be referred. *Cythere septentrionalis*, *C. costata*, *C. cristatella*, &c., may be taken as examples of these debateable forms. Under these circumstances, there seemed to be but two reasonable courses open to me—either to reject the genus altogether, or to restrict it by some arbitrary line to the conspicuously fimbriated, spinous, and quadrilateral species so well represented by *C. jonesii.* I have chosen the latter course as being, on the whole, of the greater practical utility. A more perfect knowledge of the various species, and especially of the anatomy of the animals, will probably in time lead to a better classification.

Order OSTRACODA, *Latreille.*

Family CYPRIDÆ, *Baird.*

Subfamily CYTHERINÆ, *Dana.*

Genus CYTHERELLA, *Jones* (subgenus).

Generic Characters.—"*Animal* unknown. *Carapace* oblong, compressed; smooth or pitted; no terminal denticulations: contact-margins of the right (larger) valve grooved or rabbeted on its inner edge for the reception of a flange presented by the contact-margin of the left (smaller) valve; both groove and flange stronger at the posterior than at the anterior portion of the valves." *Lucid spots* arranged in a curved pinnate series on an oblong, obliquely placed depression near the centre of the shell. The depression appears internally as an elevation or tubercle. The number of the spots is from twelve to sixteen, and in shape they are linear-oblong, increasing in length towards the ventral margin.

1. CYTHERELLA PULCHRA, n. sp. (Pl. LVII. fig. 1, *a–d.*)

Carapace elliptic-oblong. *Dorsal* and *ventral* margins nearly straight, parallel, slightly sinuated. *Extremities* rounded. Dorsal aspect ovate-oblong, compressed. *Surface* smooth, white. *Lucid spots* near the middle of the ventral half of the carapace, consisting of about sixteen linear-ovate spots arranged in a pinnate manner along a central curved line, the larger spots being nearest to the ventral margin; the whole group is situated in a slight depression of the valves, and is very conspicuous also on the inner surface.

Length $\frac{1}{42}$ in. (·6 mm.).

Hab. Australia.

2. CYTHERELLA PUNCTATA, n. sp. (Pl. LVII. fig. 2, *a*, *b*.)

Oblong-oval, convex, narrowed anteriorly. The *dorsal margin* is straight, the *ventral* irregularly sulcate on its anterior half; its posterior half sloping steeply backwards. *Dorsal aspect* compressed, ovate or subcuneate. *Surface* thickly set with round punctations, irregularly puckered towards the ventral border. *Lucid spots* similar to those of the preceding species.

Length $\frac{1}{45}$ in. (·57 mm.).

Hab. Levant (sponge-sand).

3. CYTHERELLA BEYRICHI, *Reuss*. (Pl. LVII. fig. 3, *a*, *b*.)

Cytherina beyrichi, Reuss, Zeitsch. Deutsch. Geol. Ges. iii. p. 89, t. 7. fig. 65.

Cytherella beyrichi, Bornemann, Zeitsch. Deutsch. Geol. Ges. vii. p. 354, t. 20. fig. 1. Speyer, Ostracoden der Casseler-Tertiärbildung, p. 54, t. 1. fig. 1, *a–c*.

Cytherella compressa, var. 1, Jones, Entom. of Tert. Form. of England, p. 55, pl. 5. fig. 18.

Valves compressed, oblong oval. *Extremities* rounded, posterior rather the broadest. *Ventral* and *dorsal margins* gently sinuated in the middle. *Surface* smooth, closely punctate. Seen from below, the carapace is compressed, oblong, quadrilateral, narrowed in front, and truncate at each extremity.

Length $\frac{1}{32}$ in. (·8 mm.).

Hab. Norway (*Messrs. M'Andrew and Barrett's dredgings*).

4. CYTHERELLA RUGOSA, n. sp. (Pl. LVII. fig. 4, *a*, *b*.)

Carapace quadrilateral, surrounded by a flattened border. *Dorsal* and *ventral margins* parallel; ventral sinuated, dorsal nearly straight. *Extremities* rounded; the posterior rather flattened, with rounded angles. Seen from below, the carapace is compressed, cuneate. *Surface* of valves minutely and closely pitted, raised into irregular flexuous elevations. *Lucid spots* similar to those of *C. pulchra*.

Length $\frac{1}{45}$ in. (·57 mm.).

Hab. Australia.

Genus JONESIA, nov. gen.

Limbs long and slender. *Antennæ* exceedingly small, slender, and destitute of spines. *Carapace* elongated, compressed, rounded in front, narrowed or acutely pointed behind. *Shell* thin and fragile, mostly without sculpture of any kind. *Hinge-margins* perfectly simple; consisting of two thin opposing edges held together by a ligamentous tissue: straight, or slightly sinuous towards each extremity. *Lucid spots* linear-oblong in shape, arranged in a parallel series, those in the middle being the longest; the whole group forming an obliquely-transverse oval patch near the centre of the valve.

1. JONESIA SIMPLEX, *Norman*. (Pl. LVII. fig. 11, *a–e*.)

Cythere simplex, Norman, Nat. Hist. Trans. Northumberland and Durham, vol. i. p. 17, pl. 5. figs. 1–4.

Carapace compressed, elongated, rounded and narrowed in front, acuminate behind. *Dorsal margin* straight; *ventral margin* bulging considerably behind; the two margins are parallel for the greater part of their length, but converge suddenly and equally behind, forming an acuminate extremity. Anterior *extremity* narrowed, somewhat obliquely rounded. Viewed from above, the carapace is compressed, oblong oval, tapering at each extremity, subacute in front, pointed behind. *End view* broadly ovate. *Lucid spots* about six in number; each spot linear-oblong and slightly curved, arranged in a parallel series, those in the middle being the longest, thus forming an oval patch placed in an oblique direction across the central portion of the shell. *Surface* smooth.

Length $\frac{1}{20}$ in. (1·27 mm.).

Hab. Hunde Islands (*Dr. P. C. Sutherland's dredgings*). Shetland, Dogger Bank, and Holy Island (Northumberland). Isle of Bute (*Mr. D. Robertson*).

This species was very recently (1865) described by Mr. Norman from specimens taken on the Dogger Bank. The perfectly simple character of the hinge-joint does not allow of its being classed under any of the established genera; and as it, in common with some other species, possesses further distinctive characters, I here propose for their reception the genus *Jonesia*, named after Professor T. Rupert Jones, whose valuable labours amongst the fossil Entomostraca need no further comment. In addition to the present species, *Cythere contorta*, Norman, and *C. variabilis*, Baird, may be noted as coming under the genus *Jonesia*.

J. simplex is an exceedingly well marked species, and apparently very constant in its characters, there being little or no difference observable between the specimens from the various localities mentioned above. I have also seen fossil specimens collected by Mr. D. Robertson from the glacial clay of the Clyde district, which are in no respect distinguishable from the recent ones. The species figured by M. Bosquet (Crustacés Fossiles de Limbourg) as *Cytheridea harrisiana*, Jones, is either identical with, or very nearly allied to, the present species. The true *Bairdia harrisiana*, of which Mr. Jones has kindly allowed me to examine the type specimens, is an entirely different thing.

Genus BAIRDIA, *M'Coy*.

Animal a *Cythere* (?). *Carapace* varying from a broadly triangular form with rounded or obtuse extremities, to a narrow, elongate, subtriangular form with somewhat acute extremities. *Surface* quite smooth, finely punctate, or occasionally setiferous; no central tubercle. *Lucid spots* mostly well marked. The right valve is much the smaller of the two, and its edge lies within, and on the dorsal margin is overlapped by, that of the left. The dorsal edge of the right valve is quite simple. Ventral margin incurved.

1. Bairdia bosquetiana, n. sp. (Pl. LVII. fig. 5, *a–e*.)

Carapace reniform, much compressed. The *dorsal margin* is arched, highest a little in front of the centre; *ventral margin* gently sinuated. *Extremities* rounded, the posterior slightly narrowed. *Surface* smooth, white, with opaque patches, sparingly beset with small papillæ. *Lucid spots* four, rather large and crowded together. *Dorsal outline* compressed, oblong-oval, with pointed extremities.

Length $\frac{1}{40}$ in. (·635 mm.).
Hab. Atlantic Ocean, 470 fathoms (*Commander Dayman's soundings*).

In its lateral aspect this species is strikingly similar to *Cytheridea papillosa*. The lucid spots are, however, differently arranged, and the structure of the hinge-joint distinctly shows it to belong to the genus *Bairdia*.

2. Bairdia amygdaloides, n. sp. (Pl. LVII. fig. 6, *a–c*).

Carapace broadly ovate, convex, tapering to a point posteriorly, rounded in front. *Dorsal margin* boldly arched, *ventral* slightly convex. Seen from below, the outline of the carapace is oval, rather narrowed posteriorly. *Surface* smooth.

Length $\frac{1}{33}$ in. (·78 mm.).
Hab. Australia, 17 fathoms (*Prof. Jukes's soundings*).

I do not feel quite certain that this may not be a variety or the young of *B. fusca* or *B. ovata*.

3. Bairdia ovata, *Bosquet*. (Pl. LVII. fig. 7, *a–c*.)

Cytheridea ovata, Bosquet, Crustacés Fossiles du Limbourg (1853), p. 63, pl. 5. fig. 6, *a–d*.

Carapace ovate. *Dorsal margin* boldly arched; *ventral* nearly straight, with a slight median sinuation. Anterior *extremity* broad, well rounded; posterior narrow, rounded. *Dorsal aspect* ovate. *Surface* white, smooth or slightly hairy.

Length $\frac{1}{26}$ in. (1 mm.).
Hab. Abrolhos Bank.

4. Bairdia fusca, n. sp. (Pl. LVII. fig. 9, *a–d*.)

Carapace subtriangular, about once and a half as long as broad. *Extremities* rounded; the posterior scarcely, or not at all, beaked. The *dorsal margin* is boldly arched, and very high in the middle; the *ventral* is slightly sinuated. Seen from below, the carapace is oval, with pointed extremities. Right valve overlapped by the left, as in *B. subdeltoidea*. The *surface* of the valves is finely punctate, and covered, more especially on the posterior half, with long brown setæ. *Colour* brown. *Lucid spots* well marked (when the valves are denuded), forming a rosette of one central and six encircling spots.

Length $\frac{1}{30}$ in. (·84 mm.).
Hab. Australia.

This appears to be a very distinct species, characterized chiefly by the brown hirsute carapace, rounded form of the valves, and the compressed oval outline as seen from above or below. I have a single valve from Honduras which is probably referable to the same species, but is rather intermediate in form between it and *B. amygdaloides.*

5. Bairdia subdeltoidea, *Von Münster.* (Pl. LVII. fig. 8, *a–h.*)

Cythere subdeltoidea, Von Münster, 1830, Jahrbuch für Mineralogie, p. 64.

Bairdia subdeltoidea, Jones, 1849, Entom. of Cretaceous Formation, &c., p. 23, pl. 5. fig. 15, *a–f.* Bosquet, 1852, Entom. Fossiles des Terrains Tertiaires de la France, p. 29, pl. 1. fig. 13, *a–d.* Jones, 1856, Entom. of Tertiary Formation, p. 52, pl. 4. figs. 2 *a*, 2 *b*, 3; pl. 6. figs. 1 *a*, 1 *b*, 2. Egger, 1858, Ostrakoden der Miocän-Schichten, p. 5, t. 1. fig. 1, *a–c.* Speyer, 1863, Ostracoden der Casseler-Tertiärbildungen, p. 43, t. 1. fig. 5, *a–c* (right valve), and *B. oviformis,* ib. fig. 6, *a–c* (left valve).

Carapace triangular or subtriangular, convex. The *left valve* is larger and much less angular than the right; its ventral margin arched (sometimes flattened); dorsal margin inverted so as to overlap the opposite valve, broad and obliquely rounded in front, more or less produced, tapering, or beaked behind. The *right valve* is narrower, its dorsal border truncate in the middle; the ventral border sinuated and having a well-marked convex protuberance on the anterior third, strongly beaked posteriorly, broad and obliquely convex anteriorly: both extremities are often produced, in old specimens, into flattened, denticulate lamellæ; the dorsal edge is slightly inverted at its anterior and posterior thirds. *Dorsal aspect* oval or subrhomboid. *End view* broadly ovate or suborbicular. *Lucid spots* arranged in a rosette, but seldom so regular as in the preceding species. *Surface* of the valves smooth, often finely punctate, milk-white or pellucid with cloudy patches. The older specimens are mostly quite opaque.

Length $\frac{1}{20}$–$\frac{1}{30}$ in. (1·27–·846 mm.).

Hab. Australia, West Indies, Turk's Island, Crete (360 fathoms, *Capt. Spratt*), Serpho (*Capt. Spratt*).

This species is very widely distributed both in the fossil and recent state; and there are a large number of varieties which appear to be fairly referable to it, being connected by a perfect gradation of intermediate forms. The surface-markings are very much dependent upon age, young specimens being generally pellucid, smooth, and free from hairiness or pittings; adults milk-white in colour, often punctate or slightly pubescent; while old specimens are more rugged in aspect, their punctuation obsolete, and the extremities occasionally developed into dentated laminæ. Besides these various conditions, there are doubtless many varieties resulting from habitat, &c. I do not feel sure that the form described by the Rev. A. M. Norman[1] as *Cythere* (*Bairdia*) *inflata* is properly separable from *B. subdeltoidea,* though its much narrower form renders it, at least, a very distinct variety. Some examples of this form (*B. inflata*), dredged by

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[1] Annals and Magazine of Natural History, 3rd series, vol. ix. plate 3. figs. 6, 7, 8.

myself off the Isle of Man, have the posterior extremity remarkably spinous, and are likewise beset with strong brown setæ, in this respect somewhat resembling *B. fusca.*

6. Bairdia crosskeiana, n. sp. (Pl. LVII. fig. 10, *a–d.*)

Triangular, convex, compressed posteriorly. *Left valve* large and overlapping the right; broad, obliquely rounded anteriorly, and tapering to an acute, produced posterior extremity; highest at anterior third. The anterior border is armed with several short, pointed tubercles or spines; the posterior is acutely pointed, and has a squamous lamina, which is continued along the posterior third of the ventral border. *Ventral margin* convex; the *dorsal margin* much elevated at its anterior third, from which it slopes steeply to the posterior extremity. The *right valve* is smaller, its dorsal margin truncated in the middle; anterior extremity broad, obliquely convex, and denticulate; posterior extremity beaked; ventral margin slightly sinuated. Viewed from below, the carapace is hastate in outline, very acute posteriorly, and broadest at its anterior third. *Surface* of the valves smooth, finely punctate. *Lucid spots* as in *B. subdeltoidea.*

Length $\frac{1}{25}$ in. (1 mm.).

Hab. Levant (sponge-sand).

Well characterized by the hastate outline as seen from above, the greatly produced tapering hinder extremity, and the spinous anterior border. There are, however, some forms of *Bairdia subdeltoidea*, from Australia, which closely approach it; and it is a matter of the greatest difficulty to determine the real limits of the various species. My impression is, that the most correct and natural arrangement would be to retain the present *B. subdeltoidea* as the typical form of the species, classing under it, as mere local varieties, *B. amygdaloides*, *B. crosskeiana*, and possibly some of the fossil species described by Continental authors.

Genus Cytherideis, *Jones* (subgenus).

Animal a *Cythere.* *Carapace* oblong-oval, reniform, or subtriangular. "*Hinge-margin* simple, except that, the central portion of the dorsal margin of the left valve being somewhat incurved under that of the right valve, the anterior and posterior angles of the dorsal margin of the left valve remain somewhat projecting, and present internal shallow furrows for the reception of the corresponding angles of the opposite valve: ventral margin partially incurved."

1. Cytherideis decora, n. sp. (Pl. LVII. fig. 13, *a–c.*)

Carapace elongated, triangular, slightly narrowed posteriorly, and highest in the middle. Both *extremities* rounded, the posterior somewhat produced. The *dorsal margin* is arched and rather flattened; *ventral margin* slightly arcuate. Seen from below, the carapace is oval, compressed. *Surface* smooth, with scattered hairs. *Lucid spots* arranged in an obliquely transverse row near the centre of the carapace.

Length $\frac{1}{25}$ in. (1·05 mm.).

Hab. Australia, 17 fathoms (*Prof. Jukes's soundings*).

Closely related to *Cythere minna*, Baird, but not much more than one-third of the size, and the posterior extremity is not nearly so acute. The greatest height is about the middle, whereas *C. minna* is highest near the front.

2. CYTHERIDEIS MACULATA, n. sp. (Pl. LVII. fig. 12, *a*, *b*.)

Oblong, arcuate, compressed, nearly thrice as long as broad. Anterior extremity tapering to a rounded point; posterior broader, rounded, and produced below the level of the ventral border. *Dorsal margin* arched, highest in the middle. *Ventral margin* gently incurved, with a median convexity. *Surface* smooth, white, marked with a large, oval, pellucid central patch, on which are several (generally three) cloudings of opaque white.

Length $\frac{1}{23}$ in. (1·16 mm.).

Hab. Australia, West Indies, Turk's Island.

3. CYTHERIDEIS GRACILIS, *Reuss*. (Pl. LVIII. fig. 1, *a–d*.)

Cytherina gracilis, Reuss (1850), Haidinger's Abhand. Band iii. p. 52, t. 11. f. 3.

? *Bairdia lithodomoides*, Bosquet, Entom. Fossil. des Ter. Tertiair. p. 36, pl. 2. fig. 3.

Carapace elongate, subarcuate, convex, about twice and a half as long as broad. *Dorsal margin* arched; *ventral* deeply sinuate at anterior third. Anterior border compressed; posterior broad, obliquely rounded. *Dorsal aspect* compressed, ovate. The *shell* is smooth, transparent, mostly of a yellow tint, and, in some specimens, marked on its anterior portion with several concentric undulations or faint ridges, which run nearly parallel with the margins of the valves.

Length $\frac{1}{36}$ in. (·73 mm.).

Hab. Levant (sponge-sand).

Very nearly allied to *Cythere angustata*, Von Münster, but altogether smaller and more fragile, and possibly only a variety of it. I have ascribed my specimens to *C. gracilis* merely from comparison with the figures of that species, having seen no authentic specimens of it; and I am not able to detect any valid distinction between it and *C. angustata*.

In outline this agrees very closely with Reuss's figure, and in surface-marking with Bosquet's; so that it would seem probable that these may properly be regarded as varieties of one and the same species. Yet, in most of my specimens, the concentric rugæ are absent, and in some the sinuation of the ventral margin is scarcely perceptible.

4. Cytherideis (?) oryza, n. sp. (Pl. LVIII. fig. 2, *a*, *b*.)

Valves elongate, convex. *Dorsal margin* arched; *ventral* nearly straight, slightly protuberant posteriorly. *Anterior margin* somewhat obliquely flattened; *posterior* rounded, more pointed than the anterior. *Dorsal aspect* oblong ovate. *Surface smooth*, pellucid, mottled with white or straw-coloured patches.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Hunde Islands (*Dr. Sutherland's dredgings*).

Not unlike in outline to Egger's figure of *Bairdia arcuata*; but distinct from that species as described and figured by M. Bosquet and Professor T. R. Jones.

5. Cytherideis lata, n. sp. (Pl. LVIII. fig. 4, *a*, *b*.)

Carapace reniform, flattened, broadest in front. *Extremities* rounded. *Dorsal margin* arched, highest a little in front of the middle. *Ventral margin* rather deeply sinuated. The *anterior border* forms a flattened lamina, which is continued halfway along the ventral margin. *Surface* smooth or very faintly pitted. *Dorsal aspect* oblong, much compressed.

Length $\frac{1}{33}$ in. (·78 mm.).

Hab. Abrolhos Bank.

6. Cytherideis nobilis, n. sp. (Pl. LVIII. fig. 9, *a–e*.)

Reniform, convex, narrowed in front, nearly twice as long as broad. *Dorsal margin* forming a flattened arch; *ventral* deeply sinuate in the middle. *Anterior margin* narrow, well rounded; *posterior* forming a strongly marked angle at its junction with the ventral border. A narrow, flattened lamina or flange runs along the ventral margin, and is most developed posteriorly. *Dorsal aspect* oval. *Lucid spots* large, mostly six in number; five of them forming an irregular rosette, the sixth slightly apart toward the dorsum. *Surface* smooth, pale brown, mottled with darker spots, and bearing a few distant, short setæ.

Length $\frac{1}{16}$ in. (1·8 mm.).

Hab. Suda Bay, Crete, 40 fathoms (*Capt. Spratt's soundings*). Many specimens.

Young specimens have the two extremities equal, and are destitute of the produced posterior angle. The posterior portion of the valve in mature individuals is marked with a reticulated pattern (which, however, is often obscured by opacity), in this respect, as well as in its angular character, bearing a remarkable resemblance to the freshwater *Candona lucens*.

7. Cytherideis (?) pulchra, n. sp. (Pl. LVIII. fig. 3, *a–c*.)

Ovate, convex, highest in front. *Dorsal margin* arched; *ventral* straight, or very slightly sinuated anteriorly. *Extremities* rounded, the anterior being much the broadest. *Dorsal aspect* ovate, narrowed in front. *Surface* smooth, white, marked with thickly set rounded pits of irregular size. In the intervals between the hollows, especially near the ventral border, small tubercles are situated. These, however, are few in number compared with the pits.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Hunde Islands, 28–40 fathoms (*Dr. Sutherland's dredgings*). One valve.

The shell-sculpture of this species agrees very much with that of *Cythere kostelensis* as described by Dr. Egger; but in other respects it seems to be perfectly distinct.

8. **Cytherideis tigrina**, n. sp. (Pl. LVIII. fig. 5, *a–d.*)

Valves oval, convex; extremities rounded, nearly equal. *Anterior margin* forming a wide flattened lamina. *Dorsum* arched. *Ventral margin* slightly convex, sinuate at its anterior third. Seen from above, the carapace is ovate, pointed in front, well rounded behind. *Surface* smooth, white or light grey, marked with bands or patches of brown, and bearing a few scattered papillæ.

Length $\frac{1}{50}$ in. (·5 mm.).

Hab. Australia (littoral shell-sand, Melbourne). Many specimens.

Genus Cytheridea, *Bosquet.*

Animal a *Cythere*. *Carapace* subtriangular or triangularly ovate, highest usually beneath the anterior hinge. *Surface* smooth, papillose, or pitted, occasionally reticulated. *Hinge-margin* of the right valve marked by a series of small tubercles, which are received into corresponding depressions of the opposite (left) valve. These tubercles or crenulations are mostly disposed in two terminal groups (see Pl. LVIII. fig. 11 *d*, fig. 13 *d*), and the intervening portion of the valve-margin is plain or may be marked by minute tubercles on the *left* and corresponding fossæ on the *right* valve. *Ventral margin* somewhat incurved. *Lucid spots* arranged in a transverse row near the centre of the valve; mostly one or two detached spots in front of the main group.

1. **Cytheridea kirkbii**, n. sp. (Pl. LVIII. fig. 14, *a–c.*)

Valves oblong, oval or subtetragonal, not twice as long as broad, scarcely at all narrowed posteriorly. The *ventral margin* is nearly straight, with a slight median convexity. The anterior, posterior, and dorsal *margins* are all arched and somewhat flattened. The anterior and posterior borders are often armed on their lower portions with a series of blunt teeth, about eight in number at each end; but very frequently one or both extremities are destitute of these. *Dorsal aspect* oblong-oval. *Surface* quite smooth or marked with faint, shallow, and distant pittings, bearing also a few scattered hairs. *Lucid spots* large, angular, arranged irregularly a little in front of the centre of the valve.

Length $\frac{1}{30}$ in. (·84 mm.).

Hab. Honduras (calcareous sand, shallow water). Many specimens.

2. Cytheridea minima, n. sp. (Pl. LVIII. fig. 10, *a–d.*)

Valves triangularly ovate, convex. *Dorsal margin* well arched; *ventral* nearly straight. *Extremities* rounded. *Dorsal aspect* ovate. *Surface* perfectly smooth, milk-white.

Length $\frac{1}{75}$ in. (·36 mm.).

Hab. West Indies (shallow water). One specimen.

3. Cytheridea margaritea, n. sp. (Pl. LVIII. fig. 6, *a–d.*)

? *Cytherina ovulum,* Reuss, Haidinger's Abhandl. Band iii. p. 55, t. 8. f. 19.

Carapace ovate, convex, very broad in front, suddenly narrowed behind. *Dorsal margin* boldly arched; *ventral margin* convex, slightly sinuated at the posterior third. *Extremities* well rounded, the posterior being very narrow. *Dorsal aspect* broadly ovate, pointed in front. *Surface* smooth, pearly white, thickly set with elevated papillæ, and marked, in the adult, with patches of white opacity.

Length $\frac{1}{45}$ in. (·57 mm.).

Hab. Levant (sponge-sand). Many specimens.

Very similar to *Cytheridea aurantia*, Baird, but more profusely papillose and less tumid. It differs also in being higher in front than behind, the opposite being the case with *C. aurantia.* It agrees precisely in shape with *Cytherina ovulum,* Reuss; but the character "superficie remote scrobiculata" prevents my referring it with certainty to that species. I have seen no trace of pitting in *C. margaritea.*

4. Cytheridea (?) curta, n. sp. (Pl. LVIII. fig. 7, *a*, *b.*)

Carapace subtriangular, reniform, convex, about once and a half as long as broad. The *dorsal margin* strongly arched, somewhat gibbous in the middle. *Ventral margin* slightly concave. *Posterior border* flattened, broad, rounded at the angles. *Anterior extremity* narrow, rounded, and rather produced downwards. Seen from below, the carapace is broadly ovate, scarcely once and a half as long as broad. *Surface* smooth, sparingly papillose.

Length $\frac{1}{42}$ in. (·6 mm.).

Hab. West Indies (shallow water). One specimen.

5. Cytheridea papillosa, *Bosquet.* (Pl. LVIII. fig. 8, *a–g.*)

Cytheridea papillosa, Bosquet, Entom. Fossil. des Ter. Tertiair. p. 42. pl. 2. fig. 5.

Cythere bradii, Norman, Nat. Hist. Trans. Northumberland and Durham, vol. i. p. 15, pl. 5. figs. 5–8 (see also note, p. 28).

Carapace subtriangular, ovate, rounded anteriorly, obliquely pointed behind. *Dorsal margin* arched; *ventral margin* straight or very slightly sinuated. *Dorsal aspect* oval oblong, broadest in the middle, the extremities nearly equal. *End view* suborbicular. *Surface* of valves white, smooth or sparingly punctate, bearing a few scattered papillæ.

Lucid spots about four, in a transverse row, with one or two more detached from and in front of the main group.

Hab. Hunde Islands, 25–30 fathoms (*Dr. Sutherland*). Norway (*Messrs. M'Andrew and Barrett*) British north-eastern and north-western coasts, 20–46 fathoms.

Length $\frac{1}{30}$ in. (·84 mm.).

A species allied to *Cytheridea pinguis*, Jones. Of frequent occurrence both on the eastern and western shores of the North Sea. It is one of the commonest of living species in the deep water off the Northumberland and Durham coasts. I have also seen fossil specimens collected by Messrs. Robertson and Crosskey, of Glasgow, from the glacial clay of that district.

6. CYTHERIDEA MÜLLERI, *Von Münster*. (Pl. LVIII. fig. 11, *a–d.*)

Cythere mülleri, Von Münster, Leonhard und Bronn's Jahrbuch (1830), p. 62; and Neues Jahrbuch, &c. (1835), p. 446.

Cytherina mülleri, Reuss (1850), Haidinger's Abhandl. Band iii. p. 55, t. 8. fig. 21.

Cytheridea mülleri, Bosquet, Ent. Fossil. des Terrains Tertiaires, p. 39, pl. 2. fig. 4 *a–f.* Jones, Monog. Tert. Entom. p. 41, pl. 5. figs. 4, 5; pl. 6. figs. 10, 11, 12. Egger, Ostrak. der Miocän-Schicht. p. 18, t. 2. fig. 7. Speyer, Ostr. der Casseler-Tertiärbild. p. 48, t. 1. fig. 8.

Valves elongated, siliquose, tapering to the posterior extremity, twice as long as broad. *Anterior border* rounded, and armed with a variable number of sharp spines. *Dorsal margin* arched, and forming a regular curve as far as the posterior ventral angle, which is somewhat produced. The *ventral margin* is straight or gently sinuated. *Dorsal profile* oval. The *surface* of the shell is marked with subquadrate pits arranged in longitudinal series.

Length $\frac{1}{35}$ in. (·74 mm.).

Hab. Mouth of Hermus, Smyrna; Australia.

Genus CYTHERE, *Müller*.

Carapace mostly convex, varying in outline, but mostly oval or irregularly oblong, and highest beneath the anterior hinge, the anterior (and sometimes the posterior) hinge forming indistinct angles on the dorsal margin. The *hinge* occupies the middle portion of the dorsal margin, and consists, on the right side, of a ridge with two terminal teeth, the anterior of which is the most strongly developed. The hinge-margin of the left valve exhibits two fossæ for the reception of the teeth of the right valve. The anterior fossa sometimes forms a complete circular perforation of the marginal plate. Between the terminal depressions there is a longitudinal groove adapted to the bar of the opposite valve, and also two terminal projections, much smaller than those of the right valve. The bar and furrow are in many cases obsolete. The *edges* of the carapace are often produced into thin projecting laminæ, especially on the anterior and ventral margins. The lower portion of the posterior border often much produced and toothed. *Surface* of the valves smooth or marked with all varieties of sculpture.

1. Cythere setosa, *Baird.* (Pl. LVIII. fig. 12, *a–c*; fig. 13, *a–d*; fig. 15, *a–e.*)

Cythere setosa, Baird, Proceedings of Zoological Society of London, part xviii. 1850, p. 258; Annulosa, pl. 18. f. 28–30.

Valves oblong-oval or subreniform, compressed, highest at anterior third, surrounded wholly or in part by a broad flattened fillet. *Dorsal margin* arched, somewhat flattened. *Ventral margin* sinuated. *Extremities* broad, obliquely rounded. *Dorsal aspect* oblong-oval, keeled, often slightly indented near the middle. *End view* broad, oval. *Surface* smooth or slightly pitted, and bearing a few short hairs.

Length $\frac{1}{50}$ in. (young), $\frac{1}{35}$–$\frac{1}{30}$ in. (adult), (·5–·74–·84 mm.).

Hab. Hunde Islands (*Dr. P. C. Sutherland's dredgings*). Levant.

2. Cythere jurinei, *Von Münster.* (Pl. LIX. fig. 1, *a–f.*)

Cythere jurinei, Von Münster, Leonh. & Bronn's Jahrbuch, 1830, p. 62. Bosquet, Entom. Fossil. des Terr. Tertiair. de la France, p. 56. pl. 2, fig. 9. Speyer, Ostrac. der Casseler-Tertiärbild. p. 15. t. 2. fig. 5.

Oblong, convex; extremities equal, or nearly so. *Dorsal margin* straight, *ventral* slightly sinuated. *Extremities* obliquely rounded. *Dorsal profile* elongate, ovate. *Surface* of the valves marked with shallow (scarcely excavated) longitudinal grooves, along which are scattered faintly marked pittings. *Lucid spots* about six, rather small, circular, arranged in two transverse rows.

Length $\frac{1}{30}$ in. (·84 mm.).

Hab. Levant (sponge-sand).

This is a well-marked species, which, however, varies considerably in the amount of surface-marking, the grooving and pitting being often almost or entirely obsolete. The longitudinal striæ are very shallow, more like facets than grooves, looking as if they might have been produced with a joiner's plane rather than with a gouge. The pittings, when well marked, remind one strongly of the appearance of a section of coniferous wood under the microscope.

Var. costata. (Pl. LIX. fig. 2, *a–d.*)

Oblong, subquadrangular. *Extremities* obliquely rounded, the anterior being broadest. *Dorsal* and *ventral margins* nearly straight, the former sloping backwards from the anterior hinge-joint. *Dorsal aspect* oblong subovate, only slightly narrowed in front: outline somewhat sinuous. *Surface* marked with delicate longitudinal ridges, which, on the central portion of the valves, are connected at distant intervals by oblique cross-ridges. The furrows are dotted with small pits, often arranged in pairs.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Levant (sponge-sand).

Extreme forms of this variety are very distinct from well-marked examples of the typical *C. jurinei*; but in the gathering from which my specimens were taken there occur many individuals intermediate between the two. This, with the smaller size and more delicate marking of the variety *costata*, leads me to infer that it is only the young or a variety of *C. jurinei.*

3. CYTHERE HODGII, n. sp. (Pl. LIX. fig. 3, *a*, *b*.)

Carapace oblong-oval, convex. *Dorsal* and *ventral margins* gently arched. The *anterior border* is well rounded, forming a flattened lamina, and is armed inferiorly with several short, blunt teeth. *Posterior border* narrowed, bearing three spines, one of which is very long. *Dorsal aspect* ovate. *Surface* of the shell smooth, marked on its posterior half with longitudinal rows of pittings, which partially coalesce so as to form moniliform furrows.

Length $\frac{1}{33}$ in. (·79 mm.).

Hab. Levant (sponge-sand). One specimen.

4. CYTHERE (?) MAMILLATA, n. sp. (Pl. LIX. fig. 6, *a–c*.)

Oblong, subreniform, broadest in front, twice as long as broad. *Anterior margin* well rounded, produced downwards below the level of the ventral margin; *posterior margin* narrow, bent in the middle at an obtuse angle. *Dorsal margin* arched; *ventral margin* straight. *Dorsal profile* oval. *Surface* of the valves minutely punctate, and raised into several irregularly placed, rounded elevations or mamillæ.

Length $\frac{1}{80}$ in. (·32 mm.).

Hab. Atlantic Ocean, 110 fathoms. One valve.

5. CYTHERE OBLONGA, n. sp. (Pl. LIX. fig. 5, *a–d*.)

Carapace oblong, quadrilateral, convex, more than twice as long as broad. *Extremities* truncate, anterior obliquely rounded and often toothed, posterior obliquely flattened, produced and often serrated inferiorly. *Dorsal margin* slightly convex, *ventral* incurved along its whole length. *Dorsal aspect* broadly oval. *End view* oval, broadest in the horizontal diameter. *Surface* of valves marked with somewhat distant, oblong, pittings.

Length $\frac{1}{30}$ in. (·84 mm.).

Hab. Levant (sponge-sand). Several specimens.

6. CYTHERE CANALICULATA, *Reuss.* (Pl. LIX. fig. 4, *a–f*.)

Cypridina canaliculata, Reuss, Haidinger's Abhandl. iii. p. 76, t. 9. fig. 12.
Cythere canaliculata, Egger, Ostrak. der Miocän-Schicht. p. 33, t. 5. figs. 10, 11.

Carapace oblong, sigmoid, compressed. *Extremities* well rounded, the anterior distantly and bluntly serrated. The antero-inferior and postero-superior angles somewhat produced. *Dorsal margin* slightly arched, *ventral* sinuate. *Dorsal profile* elongate, oval, truncate behind; contact margins depressed so as to form a deep elongated sulcus posteriorly. *Surface* deeply excavated into large irregularly sinuous pits.

Length $\frac{1}{60}$ in. (·42 mm.).

Hab. Hobson's Bay, Australia.

7. CYTHERE VENATA, n. sp. (Pl. LIX. fig. 8, *a–c.*)

Carapace elongated, broad in front. Anterior margin rounded, feebly and distantly serrated. Posterior margin very narrow, sharply rounded. Dorsal margin arched, having a conspicuous gibbosity over the anterior hinge. Ventral margin sinuated. *Dorsal aspect* ovate, with produced extremities. Valves smooth, marked with anastomosing ridges, the principal of which are thus distributed:—three rising beneath the dorsal protuberance, and running parallel with the anterior margin until lost on the inferior aspect; three longitudinal ribs rising in two loops near the posterior extremity, running forwards and fading out about the middle of the valve; and one rib parallel with the posterior and part of the ventral margin.

Length $\frac{1}{50}$ in. (·5 mm.).

Hab. Hobson's Bay, Australia. A few specimens.

A small species, the surface-markings of which vary considerably, its most conspicuous character being a faint longitudinal venation. In some specimens the surface is also raised into slight eminences or undulations.

8. CYTHERE PLICATULA, *Reuss.* (Pl. LX. fig. 1, *a–c.*)

Cypridina plicatula, Reuss (1849), Haidinger's Abhandl. iii. p. 44, t. 10. fig. 23.
Cythere plicatula, Bosquet (1850), Ent. Foss. des Terr. Tertiair. de la France, p. 92, pl. 4. fig. 13.

Carapace oblong, subquadrangular. Dorsal and ventral margins nearly parallel, the latter slightly sinuated, the former arched and gibbous anteriorly. Anterior extremity rounded; posterior nearly straight, armed with several (four) strong teeth, which project straight backwards. *Surface* pitted, marked with four distinct longitudinal ribs. *Dorsal aspect* oval-oblong.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Smyrna (shallow water). Levant (sponge-sand).

9. CYTHERE CATENATA, n. sp. (Pl. LX. fig. 2, *a–d.*)

Carapace subtriangular, once and a half as long as broad; broadest in front, and encircled, except on the dorsal margin, with a flattened lamina or fillet. The ventral and dorsal margins converge towards the posterior extremity, which is rounded and narrow. Anterior margin broad and well rounded. The *dorsal aspect* is ovate, narrowed in front. The *surface* of the valves is ornamented with minute tubercles arranged over the central portion in an angular network; but towards the margins the pattern becomes more lax, longitudinal rows taking the place of the meshes.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Norway (*Messrs. M'Andrew and Barrett's dredgings*).

Cythere kostelensis, Reuss, as figured by Egger (Die Ostrak. der Miocän-Schicht. t. 4. fig. 4), is very similar in form and general characters to our *C. catenata.* Reuss's original figure is, however, very different; and both authors concur in ascribing to *C. kostelensis* a *pitted* surface, the former adding that minute tubercles are found between the "thickly set pores," which on the ventral surface are replaced by delicate furrowings. *C. catenata*, however, is wholly devoid of pittings, and is ornamented only with minute projecting spines or bosses.

10. CYTHERE SEPTENTRIONALIS, n. sp. (Pl. LX. fig. 4, *a–f.*)

Oblong, subquadrilateral, convex. Anterior margin broad and obliquely rounded; posterior narrower and somewhat flattened. Dorsal margin straight, with a slight convexity in the middle, and sloping gently backwards from the anterior hinge. Ventral margin somewhat convex. *Surface* marked with large angular pittings, which gradually coalesce towards the margins, forming on the ventral surface sharply cut longitudinal furrows. The pitted or reticulated sculpture prevails on the central parts of the dorsal and lateral aspects; but over the whole ventral surface longitudinal grooving only is visible. *Dorsal aspect* ovate. *End view* broadly ovate, flattened and grooved below.

Length $\frac{1}{20}$ in. (1·27 mm.).

Hab. Hunde Islands, 60–70 fathoms (*Dr. P. C. Sutherland's dredgings*). Many specimens.

This is possibly allied to a Tertiary (Eocene) species, *C. scrobiculata*, Münster. There is, indeed, less difference between the recent *C. septentrionalis* and some figures of the fossil *C. scrobiculata* than between some of the fossil forms referred by different authors to the latter species. Dr. Baird remarks also that his *C. quadridentata* is nearly allied to *C. scrobiculata* as originally described by Von Münster. It is, however, very widely different from the present species. The marks which I should especially insist upon as diagnostic of *C. septentrionalis* are the strong development of the anterior hinge, and the oval outline and distinct longitudinal fluting of the ventral aspect. But the whole group to which it belongs is a perplexing one, its various members running into each other by imperceptible gradations, which, to my mind, speak plainly of one common origin.

11. CYTHERE COSTATA, n. sp. (Pl. LX. fig. 5, *a–f.*)

Carapace compressed, oblong, narrowed posteriorly. Anterior margin rounded, and occasionally fringed with hairs; posterior margin rounded, bearing four or five short processes or tubercles on its inferior portion. Dorsal margin arched, irregularly sinuous, highest at its anterior third. Inferior margin nearly straight, with a slight median convexity. *Dorsal aspect* compressed, angular, oblong-ovate. *End view* subquadrangular, compressed, about once and a half as long as broad. *Surface* of the valves marked with several conspicuous ridges, one of which runs longitudinally along the ventral margin, another in a curve parallel with the anterior border, and two or three more in an oblique direction from the ventral ridge towards the dorsum. Between the primary ribs the shell is marked with large subquadrate pits or reticulations.

Length $\frac{1}{25}$ in. (1·05 mm.).

Hab. Hunde Islands, 60–70 fathoms (*Dr. Sutherland*).

Cythere neptuni (Egger) seems to be the nearest described relative of this fine species.

12. Cythere clathrata, *Reuss.* (Pl. LIX. fig. 9, *a–c*; fig. 10, *a–c*; fig. 11, *a–d*; fig. 12, *a–c*; fig. 13, *a–c*.)

Cypridina clathrata, Reuss (1849), Haidinger's Abhandl. iii. p. 71, t. 9. fig. 31.

Cythere lyrata, Reuss, Beiträge zur Charak. der Tertiär-Schicht. des nördl. u. mittl. Deutschlands, p. 62, t. 10. fig. 99. Speyer, Ostrac. der Casseler-Tertiärbild. p. 25, t. 3. f. 4.

Cythere latimarginata, Speyer, Ostrac. der Casseler-Tertiärbild. p. 22, t. 3. fig. 3.

Carapace oblong, subquadrilateral, somewhat ear-shaped, broadest in front. There is a conspicuous rounded tubercle a little in front of the centre of the valve, and two large elongated eminences considerably behind the centre, which coalesce so as to form a much elevated transverse ridge. This ridge is continued forwards more or less distinctly along the ventral margin. The anterior margin of the carapace is obliquely rounded and armed, in the adult, with a series of equal rounded teeth, varying from about fifteen to thirty in number. Posterior margin narrow, rounded, and produced at its inferior angle, where it bears a few (mostly five or six) teeth. Ventral margin straight or slightly convex. Dorsal margin straight, often corrugated, and sloping backwards from the anterior hinge. *Dorsal aspect* oblong, angularly ovate or subquadrilateral. *Surface* (in the adult) marked with closely set and tolerably large pittings or reticulations.

Length $\frac{1}{35}$–$\frac{1}{28}$ in.

Hab. Hunde Islands (vars. *nuda*, *latimarginata*, *lyrata*). Norway (*C. clathrata*, and vars. *nuda*, *latimarginata*).

The number of species which I have thought it necessary to include under the specific designation of "*clathrata*" might, I believe, be fairly increased by the addition of two more species, *Cythere hexangulatopora*, Speyer, and *C. bornemanni*, Speyer. The characters upon which these and the previously quoted species rest appear to depend partly upon local variation, but chiefly upon the age of the specimen. I have arrived at this conclusion from the careful examination of a large number of specimens of all ages; and, so far as I have been able to ascertain, the following changes may generally be observed in tracing upwards a series of specimens from the youngest to the fully formed adult.

In the young state the valves are very fragile, pellucid, smooth, and much elongated; the anterior margin is produced into a wide, projecting, flattened border, and the posterior margin is likewise considerably produced at its inferior angle: the three tubercles on the lateral aspect of the valves are very large and conspicuous. This state, which I propose to call var. *nuda*, is represented in Pl. LIX. figs. 9 & 10. In a further advanced stage of growth the surface-markings (pittings or reticulations) become apparent, the tubercles more fused together and less prominent, and there is a wide, flattened, marginal border nearly or quite round the shell. At the same time the general outline is more rounded, and the terminal teeth begin to appear. In this stage it is referable to *C. latimarginata*, Speyer (Pl. LX. fig. 13, *a–c*). In the mature state the teeth are more numerous; the flattened marginal belt is, in great measure, lost; the reticulations or pittings are well developed, and the tubercular eminences less conspicuous. This stage of growth coincides with *C. lyrata*, Reuss, and is shown in Pl. LIX. fig. 12, *a–c*. In extremely old specimens the surface-markings become almost obsolete, being either worn away by attrition or perhaps obliterated by constant deposit of new shell in the interstices of the sculpture. The difficulty of investigating these closely related forms has been considerably increased by the mutilated condition of most of the specimens. It is seldom that I have been able to meet with perfect shells, the valves being almost always separated. On this account the figures of the dorsal and ventral aspects of the different varieties are not so complete as I could have wished. My observations of their development have been made, therefore, to a considerable extent on an undescribed British species (*C. mutabilis*, Brady, MS.) which is nearly allied to the present. Several stages of the growth of this form are figured in Pl. LIX. fig. 14, *a–h*. The varieties there shown (which, it can scarcely be doubted, are dependent chiefly upon stages of growth, but partly also upon habitat) have their precise counterparts amongst the Norwegian and Arctic specimens, also figured in Pl. LIX.

13. Cythere lactea, n. sp. (Pl. LX. fig. 3, *a–c*).

Carapace quadrangular, convex. Extremities nearly equal; anterior rounded, posterior flattened and produced along its lower half. Dorsal and ventral margins nearly straight, slightly sinuate. The lateral aspect of the valves exhibits a very large rounded tubercle, connected with a posterior transverse ridge by a longitudinal eminence. A flattened belt runs round the anterior margin, and is crossed at intervals by short ridges. *Dorsal profile* angular, oval, very broad. *Surface* of the shell closely reticulated.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Australia (17 fathoms, in sand). One specimen.

Var. RUDIS. (Pl. LX. fig. 6, *a–c.*)

More rounded in outline; the tubercles and ridges of the carapace obsolete. *Surface* undulated, marked with large oval pittings, chiefly on the anterior half of the valves. Posterior extremity bearing a few small teeth.

Length $\frac{1}{68}$ in. (·36 mm.).

Hab. Atlantic Ocean (223 fathoms, *Commander Dayman's soundings*).

The form which I have named *rudis* appears in all important characters to agree with the present species (*C. lactea*). Probably the paucity and indistinctness of its surface-markings may be attributed to the combined effects of old age and peculiarity of habitat.

14. CYTHERE PUMILA, n. sp. (Pl. LX. fig. 7, *a–d.*)

Carapace compressed, oblong, quadrilateral. Anterior extremity broad, obliquely rounded; posterior narrow, flattened, produced below. *Ventral* and *dorsal margins* nearly straight. Seen from below, the outline of the carapace is compressed, oblong, with parallel sides and truncated pyramidal extremities. *Surface* covered with strong, irregularly disposed ribs, marking out about four large and several smaller fossæ, and dividing somewhat dichotomously towards the anterior margin.

Length $\frac{1}{48}$ in. (·54 mm.).

Hab. Australia. One specimen.

15. CYTHERE PRODUCTA, n. sp. (Pl. LIX. fig. 11, *a–d.*)

Carapace oblong, quadrilateral, convex; extremities equal. Anterior margin rounded, forming a flattened border, which is much produced at the ventral angle. Inferior half of the posterior border produced backwards into an irregularly toothed process. Dorsal and ventral margins parallel, nearly straight. *Dorsal aspect* ovate. *Surface* of the valves marked with quadrangular pits arranged in longitudinal rows, and becoming obsolete towards the dorsal margin.

Length $\frac{1}{35}$ in. (·74 mm.).

Hab. Honduras (shallow water in calcareous sand).

16. CYTHERE PAVONIA, n. sp. (Pl. LXI. fig. 2, *a–d.*)

Carapace oblong, compressed, rather gibbous in the centre, ending posteriorly in an oblique ridge, which forms three crescentiform excavations near the lower posterior angle. The anterior border is broad and well rounded; the posterior narrow, oblique, and emarginate. Dorsal margin nearly straight; ventral slightly sinuated. The *ventral profile* is compressed, lanceolate, showing on the posterior half of each valve three large and deep circular fossæ, which are surrounded by elevated borders. These, seen in profile, form the crescentic ridges which are visible on the lateral aspect. Valves marked with longitudinal rows of punctations, coalescing on the ventral surface into grooves or striæ. *End view* cordate.

Length $\frac{1}{48}$ in. (·54 mm.).

Hab. Levant (sponge-sand).

17. Cythere pumicosa, n. sp. (Pl. LXI. fig. 3, *a–c.*)

Carapace oblong, convex, quadrilateral, considerably elevated, and marked more or less distinctly with two sigmoid ridges and an intervening depression. Anterior margin broad, somewhat flattened, with rounded angles; posterior rounded, denticulate. Dorsal margin nearly straight; ventral slightly sinuated. *Dorsal profile* ovate. Surface-sculpture consisting of angular excavations of irregular shape, but mostly oblong and disposed in longitudinal series.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Turk's Island (shallow water).

18. Cythere cribriformis, n. sp. (Pl. LXI. fig. 6, *a–d.*)

Subquadrangular, trapezoid, convex; *margins* (except the ventral) strongly and irregularly toothed. *Extremities* straight, with rounded angles, converging towards the dorsum. Dorsal border straight; ventral convex, emarginate, and nearly devoid of spines. Dorsal aspect broadly ovate. *Surface* of the carapace covered with a strong, elevated reticulation enclosing angular cells of irregular shape, the whole structure being very similar in appearance to the calcareous plates of some of the sea-cucumbers.

Length $\frac{1}{35}$ in. (·74 mm.).

Hab. Levant (sponge-sand). One specimen.

19. Cythere normani, n. sp. (Pl. LXI. fig. 5, *a–d.*)

Carapace convex, trapezoid in outline. Dorsal and ventral margins slightly arched outwards. Anterior margin beset, along its inferior half, with long, blunt teeth. Posterior margin armed with two or three strong teeth and several smaller ones. *Dorsal aspect* oval, with several projecting spines towards the extremities. *Surface* covered with a network of sharply defined ribs, crossing each other nearly or quite at right angles, but becoming less distinctly angular towards the edges of the valves. A sharp keel, bearing posteriorly a single strong spine, runs along the lower border, and mostly bifurcates on the ventral aspect, the upper branch being continued along the posterior border of the valve to the dorsal margin, thus bounding the reticulated portion of the shell.

Length $\frac{1}{33}$ in. (·78 mm.).

Hab. Abrolhos Bank. Several specimens.

The only described species which bears any close resemblance to the present is *C. arachnoidea*, Bosquet. It differs from *C. normani* in outline, also in having a row of conspicuous tubercles along the ventral margin, in place of the simple ridge which characterizes the present species. *C. arachnoidea* bears also small tubercles at the points of intersection of the surface network, and another row of them just within the finely serrated anterior border.

I have inscribed this species to my friend the Rev. A. M. Norman, whose numerous contributions to carcinology and other branches of science are widely known, and to whom I am indebted for much valuable help in the study of natural history.

20. CYTHERE SCABRA, *Von Münster*. (Pl. LXI. fig. 8, *a–d.*)

Cythere scabra, Von Münster (1830), Jahrbuch für Mineralogie, p. 63. Bosquet, Entom. Fossil. des Terr. Tertiair. de la France, p. 105, pl. 5. fig. 7. (?) Egger, Ostrak. der Miocän-schicht, p. 26, t. 4. f. 10.

Carapace oval, broadest in front. Extremities well rounded. Dorsal and ventral margins slightly arched. *Dorsal outline* ovate. *Surface* thickly covered with spines, which vary considerably in size, and give a rough, bristling appearance to the whole shell.

Length (Atlantic) $\frac{1}{25}$ in. (1 mm.), (Abrolhos) $\frac{1}{33}$ in. (·78 mm.), (Crete) $\frac{1}{45}$ in. (·57 mm.).

Hab. Atlantic, 2050 fathoms (*Com. Dayman*); Abrolhos; Crete (mud) 360 fathoms (*Capt. Spratt*).

21. CYTHERE PARKERI, n. sp. (Pl. LXII. fig. 1, *a–e.*)

Quadrilateral, convex, once and a half as long as broad. All the margins gently arched, and terminating in obtuse angles. *Dorsal aspect* broadly oval; margins slightly serrated: a stout, blunt tooth or tubercle on each valve in the position of the anterior hinge. The lateral separated from the ventral surface by a rounded keel or angle. *End view* subpyramidal; angles rounded; lower border flat. *Surface* pitted.

Length $\frac{1}{45}$ in. (·571 mm.).

Hab. Australia. Several specimens.

I have pleasure in inscribing this species to W. K. Parker, Esq., to whom I am indebted for the opportunity of describing many of the species noticed in this paper.

22. CYTHERE COMPACTA, n. sp. (Pl. LXII. fig. 3, *a–d.*)

Carapace subtriangular, scarcely once and a half as long as broad. Anterior extremity broad, obliquely rounded; posterior narrow, angular. Ventral margin convex; dorsal margin highest at anterior third, arched, somewhat angular. *Dorsal outline* oval, with truncate extremities. The ventral ridge is most conspicuous behind, where it crosses the shell transversely in an irregular line, and is continued along the dorsal margin. *End view* subquadrilateral. *Surface* marked by strong reticulations enclosing large quadrangular pits.

Length $\frac{1}{50}$ in. (·508 mm.).

Hab. Turk's Island (shallow water).

23. Cythere areolata, n. sp. (Pl. LXII. fig. 2, *a–d.*)

Triangular, oblong, cuneiform. Ventral margin convex; dorsal margin elevated and angular at the anterior hinge, forming two or three rounded protuberances behind. The posterior border is very narrow and rounded off; the anterior broad, arched, and angular at its extremities. *Dorsal aspect* ovate, angular, keeled. *End view* triangular, its angles well marked, base convex. *Surface* of shell finely punctate, and marked out into small areolæ by a delicate reticulated ribbing. Near the middle of the valve is a strong longitudinal rib, and one or two smaller ones between it and the ventral margin. On the dorsal side of the median rib the valve is covered with numerous large, tubercular elevations.

Length $\frac{1}{50}$ in. (·508 mm.).

Hab. Hunde Islands, 25–30 fathoms (*Dr. Sutherland*).

In outline and general characters this agrees closely with *C. plicata* as figured by Reuss. The prominent tuberculation which exists in the present species, however, seems sufficient to give it a distinct specific rank, the only markings of the typical *C. plicata* being described by the terms "*tricostato, punctato.*" The species referred by M. Bosquet to *C. plicata,* Reuss, is certainly widely different from the present.

24. Cythere rhomboidea, n. sp. (Pl. LXII. fig. 5, *a, b.*)

Obliquely quadrilateral, convex. Borders of the valves convex, irregularly sinuated; angles rounded. Ventral ridge sharply defined. *Dorsal profile* broadly ovate, with subacute extremities. *Surface* irregularly undulated, obscurely pitted in patches.

Length $\frac{1}{80}$ in. (·317 mm.).

Hab. Atlantic Ocean, 43 fathoms (*Com. Dayman's soundings*).

The specimen from which this description is taken is probably old and worn; but it seems to be quite distinct from any hitherto described species. Its nearest relative is probably *Cythere triangularis,* Reuss; or rather the species figured by Professor T. Rupert Jones under that name (Monog. Tert. Entom. pl. 6. fig. 5).

25. Cythere latissima, *Norman.* (Pl. LXII. fig. 4, *a–e.*)

Cythere latissima, Norman, Nat. Hist. Trans. Northumberland and Durham, vol. i. p. 19, pl. vi. fig. 8.

Carapace triangular, very tumid, once and a half as long as broad. The valve inclines rapidly outwards from the dorsum, forming at the ventral border a bold curved ridge, which loses itself on the surface of the valve near each extremity. Anterior and posterior margins produced, rounded, the latter very narrow. Dorsal margin boldly arched, highest in the middle. *Dorsal outline* subquadrate, with produced, subacute extremities. *End view* triangular; sides convex; base somewhat concave;

angles acute. *Surface* marked with oblong, angular pittings, which tend to run into transverse striæ.

Length $\frac{1}{40}$ in. (·635 mm.).

Hab. Hunde Islands, 25–30 fathoms (*Dr. Sutherland*).

Genus NORMANIA, nov. gen.

Animal like *Cythere*: limbs long and slender; antennæ bearing long filaments, and quite devoid of spines. Outline of carapace flexuous, obliquely oval or subtetragonal ("peach-stone" shaped). *Valves* convex, produced round the whole, or at parts only, of their circumference into a flattened laminar border. *Dorsal outline* oval, tapering at both extremities, often strongly keeled. *Hingement* as in *Cythere* proper; the terminal processes somewhat feebly developed, with mostly an intervening, finely crenuláted bar. *Surface* smooth, punctate or papillose, the sculpturing having mostly a concentric arrangement.

1. NORMANIA AVELLANA, n. sp. (Pl. LXI. fig. 15, *a–c*.)

Carapace obliquely oval. *Dorsal margin* gently arched; *ventral* obliquely convex, sinuated anteriorly. *Anterior border* obliquely rounded; *posterior* narrow, obliquely truncate and sinuated rather deeply in the middle. *Dorsal profile* oval, keeled. *Surface* marked with large and thickly set pittings.

Length $\frac{1}{35}$ in. (·74 mm.).

Hab. West Indies. One specimen.

This approaches, perhaps too closely, *Cythere cicatricosa*, Reuss; but, so far as I can judge from the figures given by Reuss and Bosquet, there seems sufficient difference, both in form and sculpturing, to warrant my considering it a distinct species.

2. NORMANIA AFFINIS, n. sp. (Pl. LXI. fig. 12, *a–d*.)

Carapace obliquely quadrilateral, convex. *Anterior* and *posterior extremities* nearly equal, obliquely rounded, the latter produced inferiorly into a broad, flattened lamina, which is continued along the posterior portion of the ventral margin, vanishing in the middle and reappearing in front, whence it is continued round the anterior margin. *Dorsal* and *ventral margins* parallel, straight or slightly sinuated. *Dorsal aspect* oval, broad in the middle; extremities pointed. *Surface* of the valves covered with closely set, deep punctations, which, on the ventral surface, coalesce so as to form longitudinal furrows.

Length $\frac{1}{42}$ in. (·6 mm.).

Hab. Levant (sponge-sand); common.

3. NORMANIA GLABRA, n. sp. (Pl. LXI. fig. 11, *a–d*.)

Valves obliquely quadrilateral, excessively convex in the centre, with a wide, flattened border, which is much produced anteriorly. *Dorsal margin* nearly straight; *ventral margin* convex, sinuated at its anterior third. *Extremities* narrow, rounded. *Dorsal outline* broadly oval, with produced, pointed extremities. *Surface* smooth, polished, bearing distant scattered papillæ. *Lucid spots* about four, somewhat obliquely placed near the centre of the valves.

Length $\frac{1}{42}$ in. (·6 mm.).

Hab. Levant (sponge-sand). Several specimens.

4. Normania grisea, n. sp. (Pl. LXI. fig. 10, *a–c*.)

Carapace obliquely quadrilateral, convex. *Dorsal* and *ventral margins* convex, the latter slightly sinuate posteriorly. *Anterior extremity* broad, rounded, bordered by a flattened lamina. *Posterior extremity* narrowed, rounded. *Dorsal profile* oval, with acute extremities. *Surface* smooth, finely and sparingly punctate; the punctations surrounded by areolæ of a lighter colour than the rest of the shell.

Length $\frac{1}{50}$ in. (·508 mm.).

Hab. Smyrna (shallow water). One specimen.

5. Normania modesta, n. sp. (Pl. LXI. fig. 13, *a*, *b*.)

Valves oblong-oval, convex. *Extremities* obliquely rounded and narrowed; the anterior produced into a flattened lamina, the posterior obliquely truncate above. The *dorsal margin* is straight; the *ventral* convex, and indented at its junction with the flattened anterior border. *Surface* punctate. *Dorsal profile* ovate-oblong, with somewhat pointed extremities, slightly keeled.

Length $\frac{1}{48}$ in. (·58 mm.).

Hab. Smyrna (shallow water). One specimen.

6. Normania dorso-tuberculata, n. sp. (Pl. LXI. fig. 14, *a–g*.)

Carapace obliquely quadrilateral, convex. Anterior extremity compressed, rounded; posterior broad, obliquely rounded. Ventral margin arched, sinuate at anterior third; dorsal margin straight behind, sloping steeply in front. *Dorsal outline* ovate: on each side of the median line posteriorly there is a large tubercular elevation, directed backwards. In front of this, and extending nearly to the posterior extremity, is a row of minute spines running parallel to the hinge-margin of each valve. Some specimens exhibit an additional tubercle on the centre of each valve.

Length $\frac{1}{45}$ in. (·57 mm.).

Hab. West Indies (shallow water). Several specimens.

Genus Cythereis, *Jones* (subgenus).

Animal unknown. *Valves* quadrilateral, longitudinally rugose or tuberculated, bordered with elevated ridges or rows of spines; the tubercle over the anterior hinge strongly developed. *Hinge joint* as in *Cythere*; the bar and furrow obsolete.

1. Cythereis batei, n. sp. (Pl. LX. fig. 8, *a–d.*)

Valves oblong, quadrilateral, compressed. Anterior margin elevated, rounded, irregularly waved and dentate. Posterior extremity narrowed, produced inferiorly into a thin, rugose lamina which, at its edge, is broken into irregular dentations. Dorsal and ventral margins nearly straight. Viewed *from below*, the carapace exhibits a central quadrilateral portion, traversed in the median line by a broad keel (the hinge-margins) which projects considerably before and behind, forming broad, truncate prolongations. The lateral surface of each valve is marked by a strong longitudinal median ridge, which is puckered and dentate.

Length $\frac{1}{33}$ in. (·78 mm.).

Hab. Levant (sponge-sand).

I have pleasure in naming this very distinct species after Mr. C. Spence Bate, of Plymouth.

2. Cythereis cristatella, n. sp. (Pl. LXI. fig. 1, *a–d.*)

Carapace compressed, oblong, bearing a central longitudinal eminence. The *margins* are much elevated, particularly at the extremities. The *extremities* are well rounded (the anterior being a little the broadest), and at their lower margins are slightly serrated. The *dorsal* and *ventral margins* are sinuated in the middle, and about the anterior third of the dorsal edge there is a marked angular elevation. Dorsal outline compressed, hastate, with a broad, projecting keel. Surface smooth.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Australia.

3. Cythereis subcoronata, *Speyer.* (Pl. LX. fig. 9, *a–e.*)

Cythere subcoronata, Speyer, Ostrac. der Cassel. Tertiärbild. p. 38, t. 4. figs. 9, 10.

Valves oblong oval, compressed, much elevated in the centre, twice as long as broad. Dorsal and ventral margins straight or but slightly convex. Anterior margin broad and somewhat flattened. Posterior margin rounded, armed with about nine strong teeth, which increase in size towards the ventral margin. *Dorsal profile* elongate oval, very prominent in the middle, tapering rapidly to the extremities. *Surface* of the valves smooth and polished, rising to a peak near the middle of the ventral border. A broad flattened border encircles the central elevated portion, and is beset at intervals with strong square teeth. Within the ventral margin is a row of rounded tubercles, five, six, or more in number, and the dorsal margin is irregularly armed with blunt, square teeth. *End view* pyramidal.

Length $\frac{1}{30}$ in. (·84 mm.).

Hab. Smyrna (shallow water). Three or four specimens.

In surface-ornament this does not exactly agree with Speyer's figures of *C. subcoro-*

nata, but is so near as to be fairly referable to that species. The recent specimens are deficient in the spines which beset the posterior half of the valves of the fossil species; and the marginal rows of spines appear also to be less fully developed, though still following the same distribution.

4. Cythereis militaris, n. sp. (Pl. LXI. fig. 9, *a–d.*)

Carapace oblong, broadest in front. Anterior margin boldly rounded, gibbous at the dorsal angle. Posterior extremity rounded, narrow. Dorsal margin sloping backwards, much elevated at the anterior hinge. Ventral border rather convex. *Dorsal aspect* oval, with acutely tapering extremities; on each valve two spinous ridges, the last spine of each being very long and strong. *Surface* of the valves smooth and polished, bearing, a little below the centre, a longitudinal row of six or seven spines, the hindermost of which is very long and pointed. The anterior margin bears a beautifully regular row of similar teeth, twenty in number, commencing at the dorsal protuberance, and ceasing directly below that point on the ventral margin, which is fringed by a row of equally regular but much smaller teeth nearly to the posterior angle, where they give place to four longer, curved spines. The posterior margin is irregularly spinous. The dorsal margin bears a series of seven strong spines, beginning at the anterior hinge and increasing in length from the first to the last, which is situated at a considerable distance from the hinder extremity.

Length $\frac{1}{50}$ in. (·5 mm.).

Hab. Hobson's Bay, Australia.

5. Cythereis lacerata, n. sp. (Pl. LXI. fig. 4, *a–e.*)

Oblong, subquadrilateral, nearly twice as long as broad. Anterior and posterior margins beset with strong, blunt spines, the former rounded, the latter angular. Dorsal margin arched, highest at the anterior hinge; ventral straight. *Dorsal profile* oval, spinous in front and behind. *Surface* of the shell wrinkled, covered with elevated, sinuous laminæ, the edges of which are irregularly waved or jagged. On each valve three or four of these laminæ are strongly developed, one of them forming a strong dorsal ridge.

Length $\frac{1}{30}$ in. (·84 mm.).

Hab. Abrolhos Bank.

6. Cythereis fungoides, n. sp. (Pl. LXI. fig. 7, *a–d.*)

Quadrangular, trapezoid, convex. Dorsal and ventral margins parallel, irregularly cut and waved. Extremities oblique, slightly rounded, unequally dentate. *Dorsal aspect* broadly oval, angular, displaying three longitudinal ridges on each valve; the hinge-margins or keel broad, much expanded and angular posteriorly. *Surface* of the valves covered with irregular, sinuous, projecting laminæ, the free edges of which are variously cut and cleft.

Length $\frac{1}{40}$ in. (·63 mm.).

Hab. Australia, 14 fathoms.

7. CYTHEREIS SPINOSISSIMA, n. sp. (Pl. LX. fig. 10, *a–e.*)

Valves compressed, oblong-oval, twice as long as broad. Dorsal and ventral margins nearly parallel, slightly arched. Anterior margin obliquely rounded, bearing five or six large, blunt teeth. Posterior margin narrower, rounded, bearing about eight blunt teeth and one very long pointed spine at the ventral angle. *Dorsal aspect* ovate, with irregularly dentated outline and tapering extremities. *Surface* of the valves beset with blunt processes, which are crowded together in irregular rows, producing a resemblance to the growth of a lichen or nullipore.

Length $\frac{1}{25}$ in. (1 mm.).

Hab. Norway (*Messrs. M'Andrew and Barrett's dredgings*).

This species approaches in general aspect *C. lichenopora*, Bosquet; but the ventral aspect, instead of being marked with rows of excavations (as in *C. lichenopora*), bears several series of stout, sharp spines.

Family CYPRIDINIDÆ.

Genus CYPRIDINA, *Milne-Edwards.*

Eyes two; antennæ two; feet two pairs. Abdomen terminated by a broad lamellar plate, armed with claws and spines. Carapace consisting of two distinct valves; produced in front into a more or less prominent beak, with a subajacent hollow or notch facing the ventral margin.

1. CYPRIDINA JAPONICA, n. sp. (Pl. LXII. fig. 8, *a–d.*)

Carapace oval, obscurely pointed behind. Dorsal and ventral margins both well arched, the former most strongly. Anterior extremity broad and well rounded, with a large, acutely pointed beak; the underlying notch large, cuneate. *Ventral profile* oblong-oval, twice as long as broad, the notch forming a transverse, oblong depression at the anterior extremity. End view oval. *Surface* smooth, distantly and slightly pitted. *Colour* light buff, mottled with patches of white and brown.

Length $\frac{1}{10}$ in. (2·54 mm.).

Hab. Japan. Taken in the towing-net (*Mr. A. Adams*).

2. CYPRIDINA ELONGATA, n. sp. (Pl. LXII. fig. 9, *a–d.*)

Valves oblong-oval, twice as long as broad, mucronate behind, flattened in front. Dorsal and ventral margins gently arched. Posterior extremity produced into a flattened, triangular lamina. *Beak* small, sharp, with a rounded, shallow notch. *Dorsal* *aspect* oval, fully twice as long as broad, pointed in front, mucronate behind. *Surface* smooth, white.

Length $\frac{1}{14}$ in. (2 mm.).

Hab. Pescadore, China. Taken in the towing-net (*Mr. A. Adams*).

3. Cypridina bairdii, n. sp. (Pl. LXII. fig. 7, *a–m.*)

Carapace horny, suborbicular, convex, about one-third longer than broad, obtusely mucronate posteriorly, flattened in front, Dorsal and ventral margins convex, uniting behind to form a rather broad, obtuse, terminal spine. The anterior margin is sulcate in the middle. *Beak* short and broad; notch rather small. Seen from the ventral surface, the outline of the carapace is oval, oblong; its anterior extremity truncate, posterior subacute. *End view* oval, with broad, truncate extremities. The *right valve* bears on its ventral margin, a little in front of the beak, a rounded prominence, which is absent from the left valve. The left valve is, however, larger and more rounded in outline, so that it overlaps the projections of the opposite valve much in the same way as the large and rounded valve of *Bairdia* overlaps the smaller and angular one. *Surface* ornamented with large and thickly set circular pits, which, on the ventral and dorsal aspects, coalesce so as to form jagged furrows.

Length $\frac{1}{10}$ in. (2·54 mm.).

Hab. Pescadore, China. Many specimens taken in the towing-net (*Mr. A. Adams*).

Genus Heterodesmus, nov. gen.

Carapace subglobose. *Dorsal margin* slightly arched, forming at its extremities two largely developed hinge-processes; the anterior process somewhat waved and scroll-like; the posterior a truncate cone, projecting directly upwards. *Ventral margin* strongly arched. *Animal* unknown.

Heterodesmus adamsii, n. sp. (Pl. LXII. fig. 6, *a–h.*)

Carapace subquadrilateral, convex; length about one-fourth greater than the breadth. Ventral margin prominently arched. Dorsal margin slightly arched, terminating posteriorly in a strong, truncated, conical process, which projects upwards beyond the plane of the dorsum. The anterior *hinge-process* forms a swollen, scroll-like protuberance situated at the upper angle of the anterior margin, and hollowed out beneath so as to form a somewhat flattened beak with a subjacent shallow notch. Posterior margin straight, formed chiefly by the posterior hinge-process. *Dorsal aspect* broadly ovate, once and a half as long as broad, somewhat narrowed in front. *Surface* smooth. *Colour* light buff, mottled with patches of a rather deeper tint. *Animal* unknown.

Length $\frac{1}{15}$ in. (1·9 mm.).

Hab. Japan. Taken in the towing-net (*Mr. A. Adams*).

This curious species is nearly allied to *Entomoconchus scouleri*, M'Coy, but, so far as

I can gather from published descriptions and the examination of fossil specimens, is generically distinct. I much regret that in the attempt to separate the valves of my specimen, for the purpose of examining the animal, one of them was destroyed; so that I am able to describe the hinge-apparatus of the right valve only. The posterior process is hollow (apparently) quite to its extremity; from its anterior basal margin a curved claw-like process projects backwards, and probably articulates with a similar process of the opposite valve. This is represented at Pl. LXII. fig. 6, *d*, *g*, *h*. The anterior hinge consists of a strong projection, analogous to that of *Cythere* and *Cypridina*, and of a concave facet, which appears adapted to receive a protuberance of the opposite valve (fig. 6, *d*).

The species is named after Arthur Adams, Esq., R.N., to whose kindness I am indebted for it and for the *Cypridinæ* described in this paper.

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PLATE LX.

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a. Perfect carapace, left side, × 40.
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a. Left valve, outside, × 40.
b. do. inside, × 40.
c. do. dorsal view, × 40.
d. do. end view, × 40.
Fig. 9. *Cythereis militaris.*
a. Left valve, outside, × 50.
b. do. dorsal outline, × 50.
c. do. ventral outline, × 50.
d. do. end view, × 50.
Fig. 10. *Normania grisea.*
a. Perfect carapace, right side, × 40.
b. do. dorsal aspect, × 40.
c. do. end view (single valve), × 40.
Fig. 11. *Normania glabra.*
a. Perfect carapace, right side, × 40.
b. do. dorsal view, × 40.
c. do. ventral view, × 40.
d. do. end view, × 40.
(The anterior extremity in *a, b,* and *c* is placed downwards.)
Fig. 12. *Normania affinis.*
a. Perfect carapace, left side, × 40.
b do. ventral view, × 40.
c. do. dorsal view, × 40.
d. do. end view, × 40.
(The anterior extremity in *a, b,* and *c* is placed downwards.)
Fig. 13. *Normania modesta.*
a. Left valve, outside, × 40.
b. do. inside, × 40.

Fig. 14. *Normania dorso-tuberculata.*
a. Perfect carapace, right side, ×40.
b. do. dorsal aspect, ×40.
c. do. ventral aspect, ×40.
d. do. dorsal aspect (variety), ×40.
e. do. end view (posterior), ×40.
f. do. end view (anterior), ×40.
g. Right valve, from behind, ×40.
(The anterior extremity in *a*, *b*, *c*, *d*, is placed downwards.)

Fig. 15. *Normania avellana.*
a. Perfect carapace, right side, ×40.
b. do. ventral aspect, ×40.
c. do. end view, ×40.

PLATE LXII.

Fig. 1. *Cythere parkeri.*
a. a. Perfect carapace, left side, ×40.
b. do. dorsal aspect, ×40.
c. do. ventral aspect, ×40.
d. Right valve, dorsal outline, ×40.
e. End view of carapace, ×40.

Fig. 2. *Cythere areolata.*
a. Perfect carapace, left side, ×40.
b. do. dorsal view, ×40.
c. do. ventral view, 40.
d. do. end view, ×40.

Fig. 3. *Cythere compacta.*
a. Perfect carapace, left side, ×40.
b. do. dorsal aspect, ×40.
c. do. ventral aspect, ×40.
d. do. end view, ×40.

Fig. 4. *Cythere latissima.*
a. Perfect carapace, right side, ×40.
b. do. dorsal aspect, ×40.
c. do. ventral aspect, ×40.
d. Right valve, inside, ×40.
e. End view of carapace, ×40.

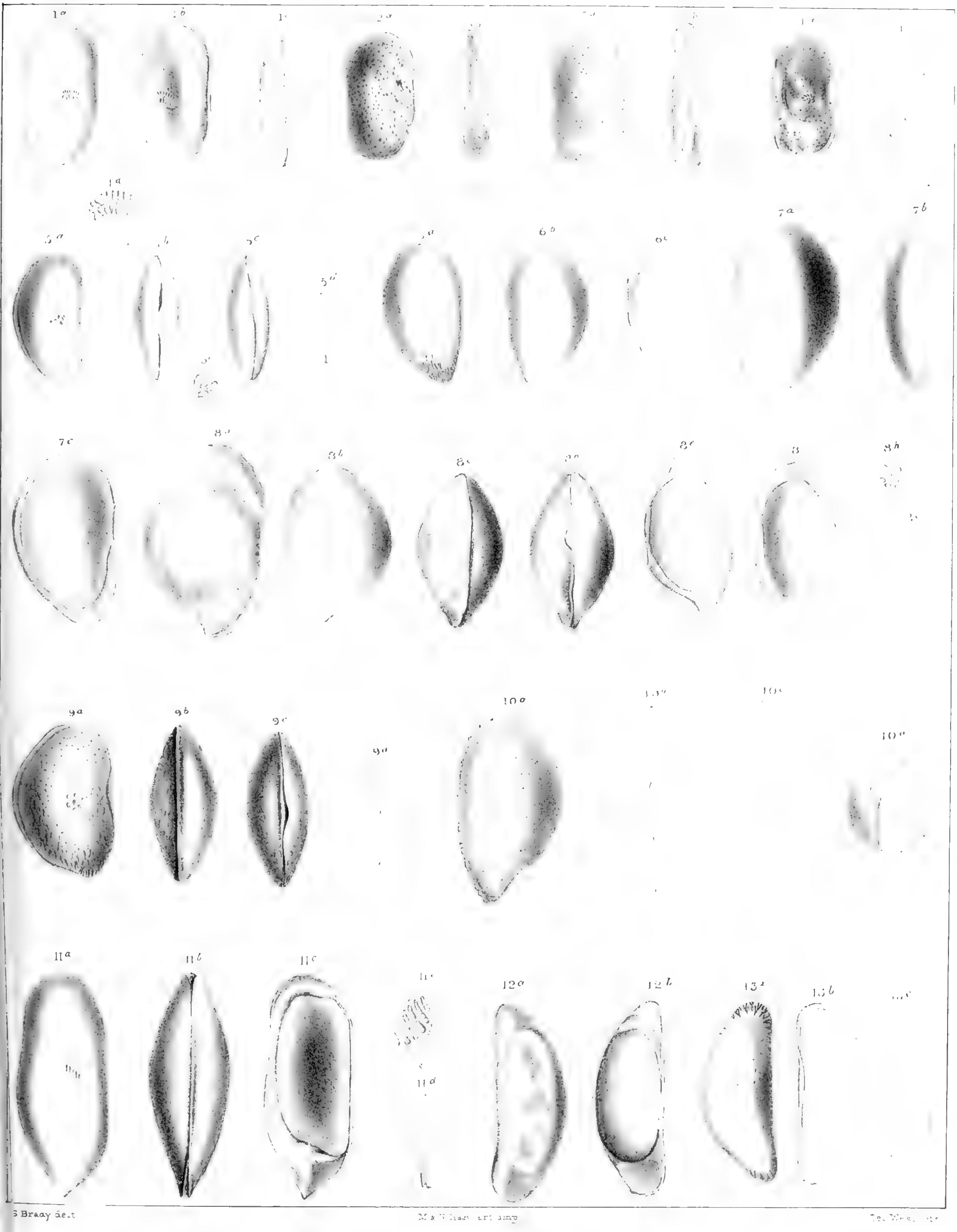
Fig. 5. *Cythere rhomboidea.*
a. Left valve, outside, ×80.
b. do. dorsal aspect, ×80.

Fig. 6. *Heterodesmus adamsii.*
a. Perfect carapace, left side, ×16.
b. do. dorsal view, ×16.
c. do. ventral view, ×16.
d. Right valve, dorsal view, ×16.
e. Right valve, front view, ×16.
f. do. back view, ×16.
g. Posterior hinge of right valve, vertical view, ×16.
h. Posterior hinge of right valve, oblique view, ×16.

Fig. 7. *Cypridina bairdii.*
a. Perfect carapace, right side, ×16.
b. do. dorsal view, ×16.
c. do. ventral view, ×16.
d. do. end view, ×16.
e. Contact margin (portion), left valve, ×16.
f. do. right valve, ×16.
g. Abdomen, ×80.
h. Inferior antenna, ×80.
i. First and second maxillæ (?), ×80.
k. Terminal setæ (first maxilla) ?, ×210.
l. Natatory foot, ×60.
m. Superior antenna, ×60.

Fig. 8. *Cypridina japonica.*
a. Perfect carapace, left side, ×16.
b. do. dorsal view, ×16.
c. do. ventral view, ×16.
d. do. end view, ×16.

Fig. 9. *Cypridina elongata.*
a. Perfect carapace, right side, ×16.
b. do. ventral aspect, ×16.
c. do. dorsal aspect, ×16.
d. do. end view, ×16.



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NEW MARINE OSTRACODA

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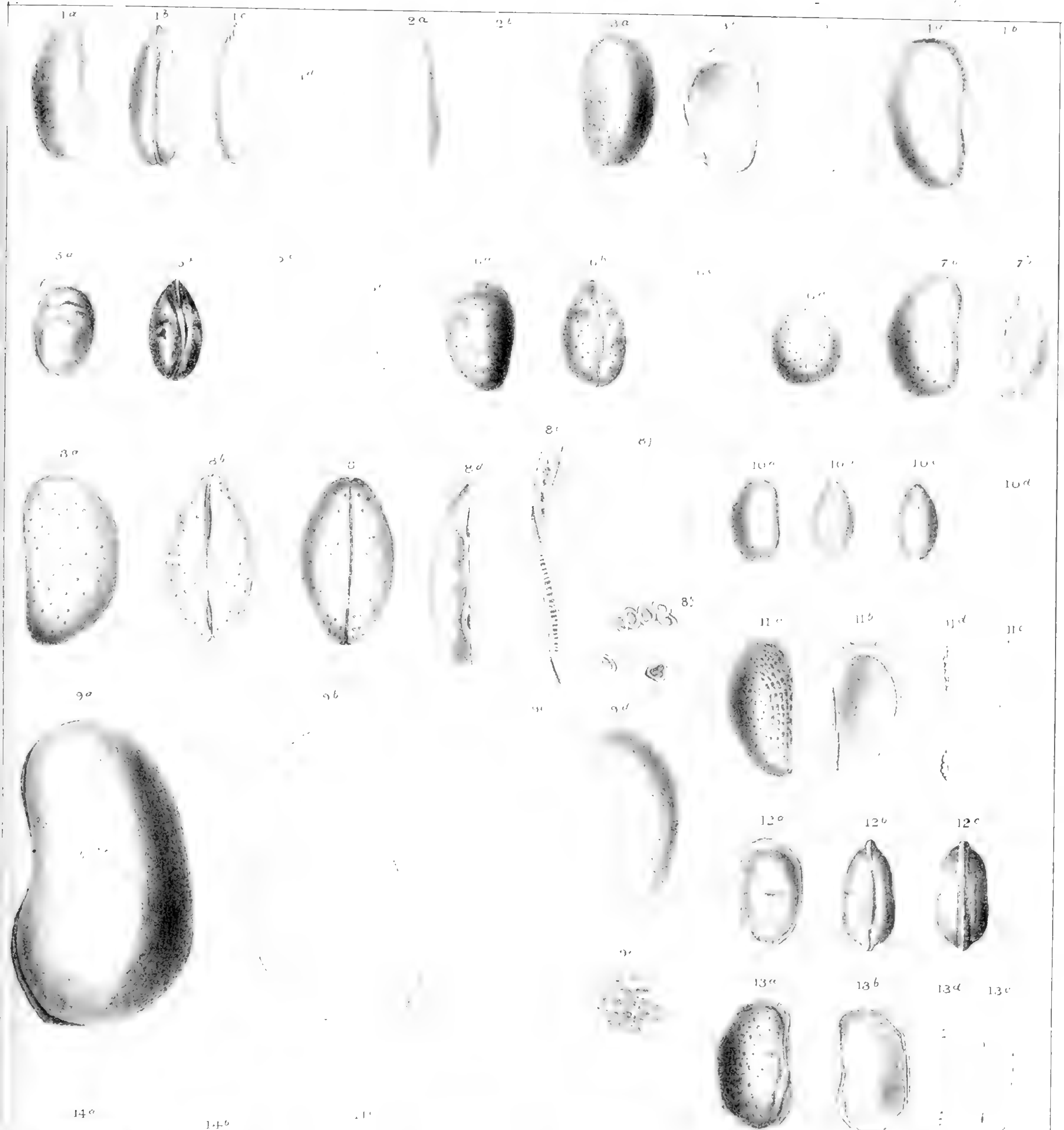

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NEW MARINE OSTRACODA.

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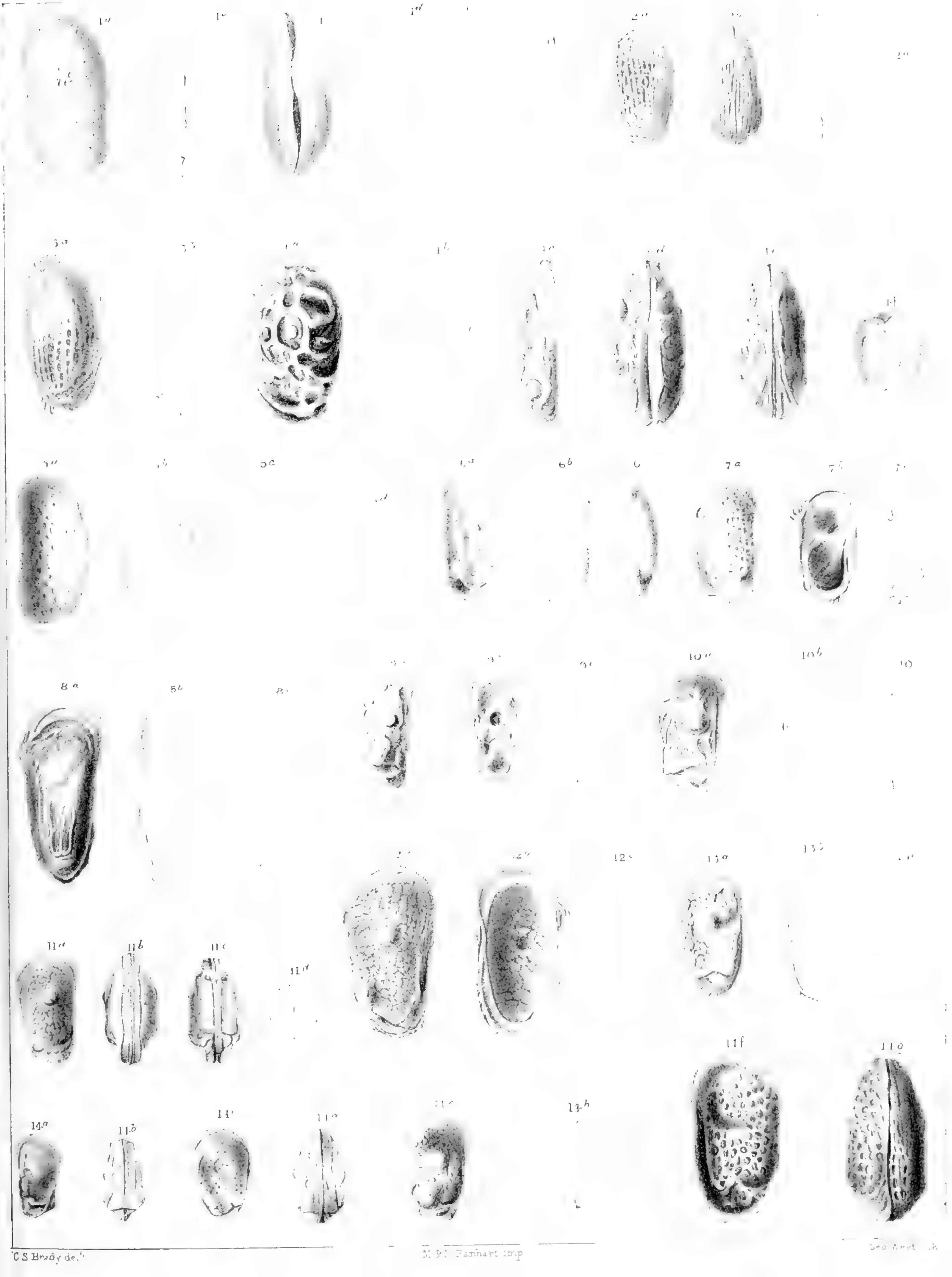

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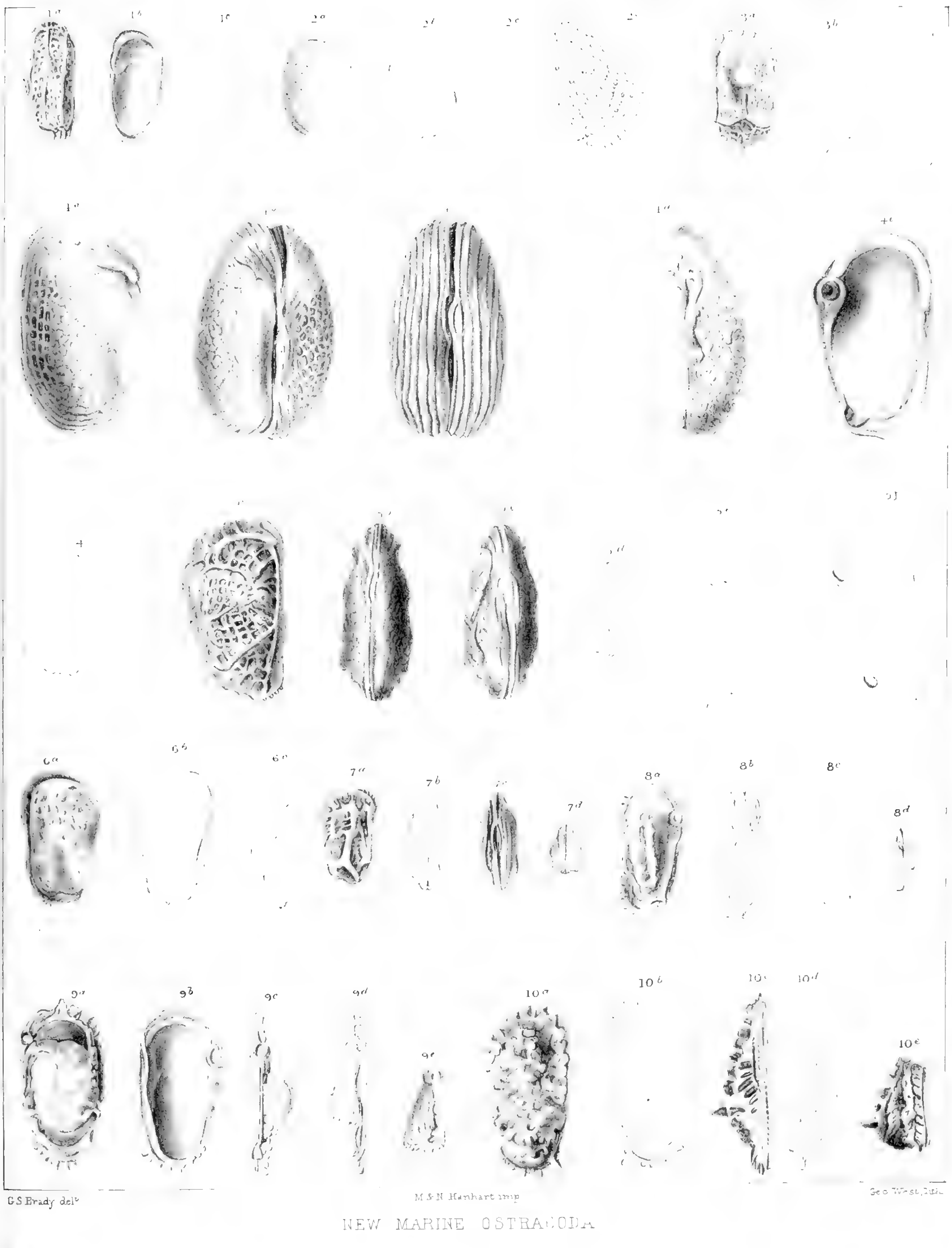

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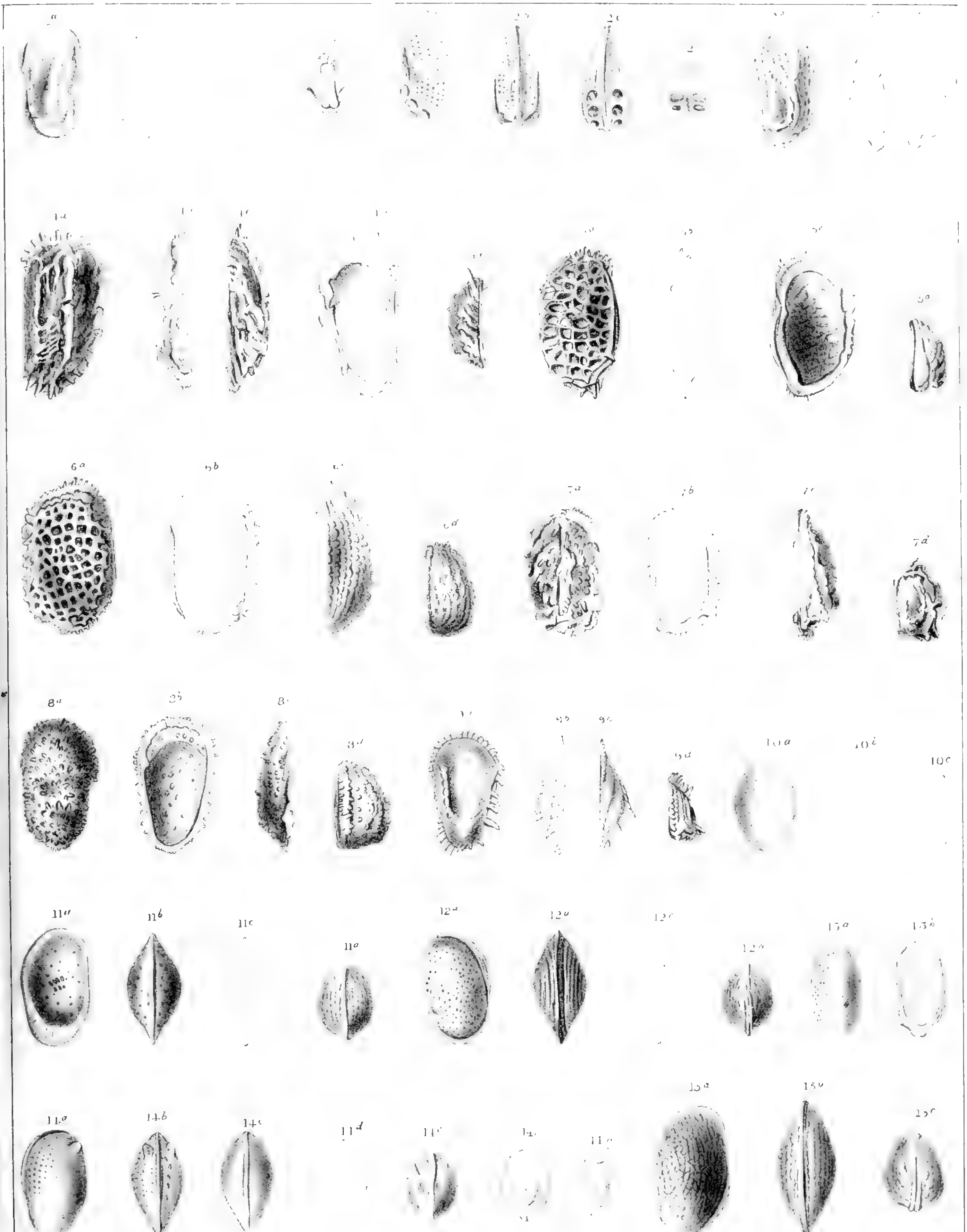

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NEW MARINE OSTRACODA

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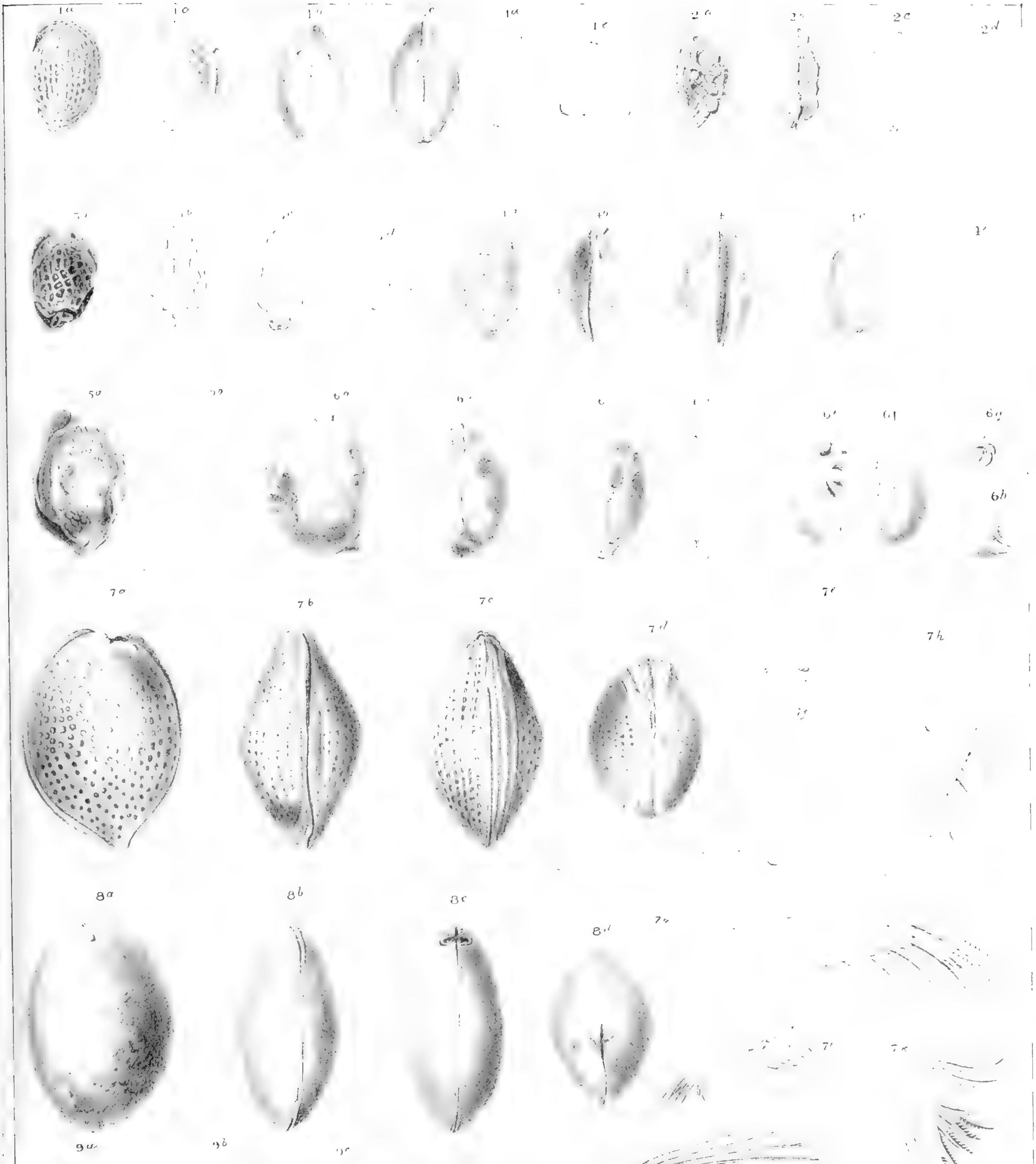

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NEW MARINE OSTRACODA

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NATURAL HISTORY

XI. *On* Dinornis (Part X.): *containing a Description of part of the Skeleton of a flightless Bird indicative of a New Genus and Species* (Cnemiornis calcitrans, *Ow.*). *By* Professor Owen, *F.R.S.*, *F.Z.S.*, *&c.*

Read May 23, 1865.

[Plates LXIII.–LXVII.]

In the collection of bones, including the skull of *Dinornis robustus*, Ow. (described in Part IX.), gathered from the bottom of the fissure in the limestone rock at 'Timaru,' Middle Island of New Zealand, there were remains of smaller birds, the tibia of one of which attracted attention by the unusual size of the muscular crests and processes at its proximal end.

A comparison of this tibia with that bone in other birds proved it to belong to a species hitherto unknown, and gifted with legs, if one might judge by the unusual provision for muscular attachments, capable of being applied with greater force than in the rest of the class: for not only does the epicnemial process rise high above the knee-joint, as in *Colymbus*, but both procnemial and ectocnemial plates are as extraordinarily developed.

This tibia was about the size of that in *Aptornis didiformis*[1] and *Dinornis geranoïdes*; nearly equalling in length, but exceeding in thickness and strength, that of the larger Argalas and Storks; more closely resembling in both proportions the tibia of the Mooruk Cassowary.

With the tibia from Timaru was a femur of proportional size, and fitting thereto as well as the loosely adjusted articular surfaces of the bones forming the knee-joint admit of in birds. There was also a metatarsus more decidedly belonging to the same bird by the closer adaptation to the distal trochlea of the tibia; and the three bones gave a total length of leg of about 24 inches.

A pelvis, by its proportions to this limb, and more especially by the relative size of the acetabulum to the head of the femur, claimed to be entered in the list as part of the same bird. To the fore part of this pelvis fitted the articular surfaces of the back part of one of some dorsal vertebræ belonging to the same backbone; and the characters of size led to the like conclusion in regard to part of the series of cervical vertebræ.

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[1] The tibia of this species, referred in Part I., 1843, to *Dinornis didiformis* (Zool. Trans. vol. iii. pl. xxv. figs. 5 & 6, pl. xxvi. figs. 5 & 6), and the skull referred in Part III., 1848, to *Dinornis casuarinus* (Zool. Trans. vol. iii. pl. lii.), were determined as belonging to the genus *Aptornis* in 1856 (Zool. Trans. vol. iv. p. 62), and have been so labelled in the exhibited series of the fossil remains of birds in the British Museum since that date.

Some portions of ribs had been collected, corresponding in the size and relative position of the capitular and tubercular joints with the answerable articular surfaces on the dorsal vertebræ: the size of the costal articular surfaces on the margins of an otherwise small and keel-less sternum similarly supported the inference that it belonged to the same bird, and that this was one of those singularly numerous feathered species of New Zealand that were without the power of flight.

Finally, there was a humerus which, from the feeble development of its proximal processes, had evidently belonged to some such flightless bird. The size of this bone was, indeed, disproportionately small compared with the tibia, according to the ordinary avian skeleton, but it bore nearly the same proportion to the sternum as does the humerus in *Notornis*, and rather a larger proportion to the leg-bones than in the Emeu. I, therefore, have strong faith in the accuracy of the reference of all the bones from the limestone fissure above enumerated to the same species, if not the same skeleton; the more so, as there were no other bones of other species sufficiently similar in size to the leg-bones, pelvis, and vertebræ, to which the keel-less sternum and feeble humerus could be supposed to belong.

The bird of the Middle Island of New Zealand, about the size of the Mooruk, and now, perhaps, extinct, will be shown, I believe, by the characters of so much of its skeleton as has been obtained, to have been the type of a genus unknown to science; and for which I propose the name *Cnemiornis*[1], indicating the present species by the term *calcitrans*, as being capable of kicking much more violently than the *Apteryx*, after full allowance for difference of size.

Cervical Vertebræ.

Of the cervical vertebræ, some (Pl. LXIII. figs. 1 & 2) present a remarkable expanse of the neural arch (*n*), which may be 2 inches 6 lines across, the smallest transverse diameter of the centrum (fig. 4, *c*) being but 5 lines. In such a vertebra the centrum sends down a short, compressed hypapophysis (ib. *h*) from its hinder part. The length of the centrum is 1 inch 9 lines; it expands, being concave and smooth below, toward the anterior articular surface (figs. 1 & 2, *c'*), and to each side of this expanded part the pleurapophysis (figs. 1, 2 & 4, *pl*) is confluent, completing a vertebrarterial canal (ib. *v*), almost as wide as the neural one (*n*); the prezygapophyses (*z*) are wide apart, looking upward and forward; a horizontal plate of bone (figs. 3 & 4, *iz*) extends from each to the postzygapophysis (*z'*), expanding and forming a slightly thickened, convex border (*d*) before its termination; there is a low and strong tuberosity (figs. 1 & 3, *t*) above each postzygapophysis; at the back of the neural platform is a low, compressed, neural

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[1] Κνήμη, tibia, ὄρνις, avis: in composition, *cnemi*, as in "anticnemion," "gastrocnemius," &c., signifying the genus of wingless birds remarkable for the size of the processes of the tibia. For the opportunity of describing this series of bones I am indebted, as for the skull of *Dinornis robustus* from the same locality, to Dr. DAVID S. PRICE.

spine (*ns*), the base of which is less than half the length of the neural arch; on each side the spine, at some distance from it, there is a vacuity (*o*) in the neural platform. This vertebra, from the analogy of the cervical region in the skeleton of *Dinornis* and *Casuarius*, has come from the anterior part of the neck, and was probably the third or fourth of the series.

A cervical vertebra (Pl. LXIV. figs. 5 & 6), from the lower or hinder third of the neck, shows a hæmal canal (*h*) beneath the fore part of the centrum (fig. 1, c'), formed by the parapophyses (*p*, *p*); the hypapophysis has disappeared from the back part of the centrum (c''). The thick and short pleurapophysis (*pl*) shows three longitudinal, shallow, wide grooves; the diapophysis (*d*) forms a thick, obtuse, sub-bifid projection, external to and below the prezygopophysis (*z*), from the back part of which extends a slender bar of bone (*b*) to the side of the centrum, unequally dividing the hinder outlet of the vertebrarterial canal (*v*). The interzygapophysial plates are here wanting, as is also the neural spine, its place being occupied by a chevron-shaped, rough tuberosity (*t*), as in the vertebræ of the bend of the neck, which is concave neural.

In a cervical vertebra, contiguous or near to the preceding, the posterior aperture of the vertebrarterial canal (*v*) is more equally divided by a horizontal bar of bone.

Other cervicals do not present characters worthy of special notice.

Dorsal Vertebræ.

The bodies of the dorsal vertebræ (Pl. LXIV. figs. 3 & 4) have the usual terminal concavo-convex articulations, the concavity being transverse on the anterior surface (c'); the last is compressed, the sides converging below to a ridge, representing a hypapophysis. The neural spine (*ns*) is 1 inch 6 lines in height, 10 lines in fore-and-aft diameter, moderately thick, with a truncate, subexpanded, transversely convex summit; the diapophyses (*d*) are strong, trihedral, being supported by a trihedral buttress (fig. 4, *b*). In the antecedent dorsals, of which seven are preserved—probably the entire number—the lower part of the centrum is produced into a compressed hypapophysis (fig. 3, *hy*); the articular surface for the head of the rib is an oval depression, near the front margin of the centrum, supported upon a slightly produced parapophysis (*p*); the terminal subconcave surface on the diapophysis (*d*), by its distance from the parapophysis, gives the length of the neck of the rib, and enables one to identify, as belonging to *Cnemiornis*, some of the ribs in the promiscuous lot of bones raised out of the fissure at Timaru.

Pelvis.

The pelvis (Pl. LXIV. figs. 5, 6, 7) includes seventeen sacral vertebræ with the coalesced ossa innominata; from which, however, the pubic and ischial bones have been broken off. The bodies of the sacral vertebræ diminish in breadth to the third (fig. 6, *c*), where the sides converge to a ridged inferior termination; they then expand to the seventh, which has a broad, flattened inferior surface, rather concave transversely; beyond this they again contract, and reassume the inferior ridge, to which the flat sides converge and meet at a right angle. The first and second sacral vertebræ show the subcircular, shallow depressions, at the upper and anterior border of the centrum, for the long ribs; the third shows a similar, but much smaller, surface, indicative of a short and loose pleurapophysis which has been lost; the five following vertebræ send parapophysial abutments (*p*, *p*) against the ilia (*i*, *i*), of which the seventh is the shortest and thickest, affording the chief resistance against the pressure from the acetabulum (*a*). The three following vertebræ have no parapophyses: the lateral pairs of orifices for the separate issue of the sensory and motory roots of the sacral nerves are here conspicuous; the parapophyses reappear in the twelfth sacral vertebra, and are continued on to the seventeenth, mostly in the form of broad, thin, antero-posteriorly compressed plates, continuous with the diapophyses, and about an inch in length in the first three, thence gradually diminishing and abutting in a direction upward, outward, and backward against the junction of the ilia with the osseous expansion from the neural spines of the posterior sacral vertebræ (Pl. LXIV. fig. 5, *ns*).

The long iliac bones, as they extend from their anterior border backward, converge to coalesce with the ridged summits of the spines of the first seven sacral vertebræ, then rapidly diverge to the thirteenth, and again converge to the seventeenth vertebra, leaving a rhomboidal space, 4 inches in length and 2 inches in breadth, where the pelvic roof is formed by a thin expanse of bone (*ns*), continued from the neural spines and the upper borders of the diapophyses to the ilia; this part of the roof is straight lengthwise, concave across, with a smooth, medial convexity formed by the summits of the confluent spines, 4 lines in breadth. A few small foramina alone here indicate the primitive division of the sacrum (fig. 5, *o*). The ilia, at their fore part, do not extend outward beyond the parapophysial abutments of the anterior sacrals, but rise, at first concave and then convex, to the summits of the spines; the concavity is bounded by a curved ridge, convex upward. The acetabulum (fig. 7, *a*) is circular, 1 inch 2 lines in diameter, with an irregular, oval vacuity of 11 lines in long diameter; the anterior wall is deepest, having an extent of 8 lines, the posterior wall becomes reduced to 3 lines; the articular surface of the upper part of the cavity is continued upon the superacetabular prominence (*b*), which is applied to that upon the upper part of the femur; the large ligamentous depression upon the head of the femur projected, in the living bird, through the acetabular vacuity. There is a pneumatic fossa above the upper border of the acetabulum: the superacetabular surface is supported by a thick, strong, subtrihedral part of the ilium, strengthened by the three longest abutments (fig. 6, *p*, *p*) of the posterior sacrals. The ischium (63) contributes the lower and posterior third of the acetabulum: the pubis (64) was attached to about one-fifth of the lower part of the cavity.

Sternum.

The three portions of the sternum of *Cnemiornis* include the right costal border and process (Pl. LXIII. figs. 5 & 6), part of the left (figs. 7 & 8), and the middle part of the bone (fig. 9)[1]. The costal border (*c*) is 3 inches 6 lines in length, and includes seven articular ridges (*h*) for the sternal ribs, the last contracting to the form of a tubercle; and there is also a tubercle of smaller size at the angular beginning of the border. The costal process (*d*) is quadrate, slightly concave on the inner side, convex lengthwise on the outer side, and smooth, as if for some articulation; the pneumatic foramina are at the base of this process, on the inner side of the sternum, and are also seen at the costal border, at the interspaces of the articular ridges on the medial side of the base of the costal process. The posterior boundary of what appears to be the shallow and narrow coracoid groove (*b*) extends from above these foramina mesial, the body of the sternum being broken away from near the base of the costal process. The greatest breadth of the body of the sternum preserved, at the end of the costal border (fig. 5, *c*, *a*), is 1 inch 8 lines; the length of this right portion of the sternum preserved is 4 inches 5 lines, and shows no trace of posterior notch; it is gently convex lengthwise, concave transversely, but in a less degree; and the fore part of the sternum, for more than an inch behind the costal process, shows a shallow excavation. A smaller proportion of the body of the sternum remains connected with the left costal margin: it cannot, therefore, be positively affirmed that the keel was absent, but this may be inferred from the thinness of the sternum at the fractured mesial margins (*a'*) of the two lateral portions. From the sternum of *Notornis* that of *Cnemiornis* differs in the greater extent and different direction of the costal border, the greater number of articular ridges, the presence of the costal process, and the much greater breadth of the body of the sternum.

The middle portion of the body of the sternum (fig. 9) includes a length of 4½ inches, with a breadth of 2¼ inches, of that part of the bone. Its thickness does not exceed 2 lines at the fore and mid part. It is very feebly convex externally, and correspondingly concave on the opposite surface. A pair of shallow muscular surfaces nearly meet at a slightly raised median tract (*s*), convex transversely, and from 2 lines to 3 lines across, extending from the anterior fractured margin about 1 inch along the bone, leaving more than 3 inches beyond free from even this feeble indication of a keel.

Humerus.

The humerus (Pl. LXVI. figs. 7–10), by its small size, slender proportions, and feeble development of the parts at the proximal end, accords with the characters of the sternum, and indicates the incapacity of the *Cnemiornis* for flight: the articular head (*a*) is narrow in proportion to its length, and is not broader or more convex at its middle part, as in birds of flight; its margin projects posteriorly, but anteriorly falls into a shallow concavity. The inner (ulnar) tuberosity (*c*) rises above the articular

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[1] These figures have been drawn on the stone, without being reversed.

surface, slightly projects towards the back (anconal) side of the bone, where it is divided by a groove from the articular head, but there is no excavation below it for a pneumatic foramen. The outer (radial) tuberosity (*b*) is almost obsolete, being represented by the short, thickish ridge continued from the outer end of the head downward and a little forward, with a deepish cavity behind. The pectoral ridge, instead of being continued directly from the tuberosity, as in birds of flight, is represented by a tubercle (*b'*), an inch below this part. There is a shallow, transverse depression (*d*) below the head on the palmar side, and a subsemicircular, slightly concave, smooth surface below that depression. The shaft of the humerus is slightly bent forward; it is subcircular, a little expanded and flattened at the distal end. This shows, feebly developed, the ulnar articular convexity (*f*), and the longer, narrower, and more prominent radial one (*e*); there is a slight ento-condyloid tuberosity (*h*), and a very feebly indicated, transversely concave, anconal depression.

Femur.

The femur (Pl. LXV. figs. 1 & 2), about the size of that of *Dinornis geranoïdes* (ib. figs. 5 & 6), differs in being more compressed from behind forward, especially at the proximal end. The head is more sessile; the depression for the round ligament is deeper and larger, and is on the upper part (fig. 2, *a*). The articular 'epitrochanterian' surface (*b*), extended from it to the great trochanter, is more horizontal; that process (*c*) being less elevated, and forming a more abrupt ridge at the outer boundary of the articular surface. There is a low trochanter minor (*d*), for the iliacus internus, about 9 lines below the head, in the femur of *Cnemiornis*, of which no trace appears in that of *Dinornis geranoïdes* (fig. 5). The shaft has an oval, transverse section, with the small end acute, formed by the inner side or border of the shaft: the posterior ridge is nearer this border than in *Dinornis geranoïdes.* The outer condyle (*e*) extends lower than the inner one (*f*) to a degree greater than in *Dinornis.* The rotular fossa (*p*), and that for the head of the tibia, are deeper than in *Dinornis.* There is no pneumatic foramen. The canal for the medullary artery is very small, and perforates the back of the shaft, in one specimen, above the middle. There is a curved, rough ridge above and behind the outer condyle, but not the fossa which impresses this part above the vertical groove for the fibula in *Dinornis geranoïdes* and most other species of *Dinornis*[1].

As compared with that of *Aptornis* (figs. 3 & 4), the femur of *Cnemiornis* is much thicker in proportion to its length, but resembles it in the ridged character of the trochanter major, in the high position of the depression for the ligamentum teres, which, however, is more posterior in *Aptornis* (fig. 4, *a*), in the more compressed character of the upper part of the bone, and in the approximation of the posterior ridge to the inner side of the shaft; but that ridge is interrupted an inch above the inner condyle in *Cnemiornis*, and is continued sharply to it in *Aptornis*, in which also the

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[1] Zool. Trans. vol. iv. p. 142.

outer condyle is less produced downward, and the rotular channel (*p*) shallower and less defined. There is a rough depression above the fibular groove of the outer condyle in *Aptornis*, as in *Dinornis*.

Tibia.

The tibia (Pl. LXVI. figs. 1–5) is about the length of that of *Dinornis geranoïdes*, but, like the femur, is more slender in its proportions, and differs more widely in other particulars. The chief of these is the much greater development of the ectocnemial (*e*) and especially of the procnemial (*p*) processes. The latter is a compressed, rhomboid plate, 1 inch 8 lines in vertical, 1 inch 3 lines in transverse or antero-posterior, extent; it rises an inch and a quarter above the intercondylar tubercle (*i*), and is directed forward and a little outward. The ectocnemial process (*e*) is a thicker plate, of a triangular form, 1 inch 3 lines in the extent of its base, and the same in length; it is divided above from the procnemial plate by a notch in the epicnemial common base (*k*) of the two lamelliform processes. The principal articular entocondylar surface of the proximal end (*d*) is applied to the broad back part of the inner femoral condyle: the ectocondylar surface is on a small mammillar eminence (*t*); a smaller 'intercondylar' tubercle (*i*) projects into the intercondylar space of the femur. A small articular tract, on a prominence (*s*) on the outer side of the tibial head, articulates with the side of the head of the fibula. There is a strong gastrocnemial tubercle (*g*) on the inner side of the shaft, an inch below the produced margin of the entocondylar surface[1], of which tubercle there is no trace in *Dinornis*. The fibular ridge (*h*, *h*) begins opposite the lower end of the gastrocnemial tubercle, and is 1 inch 7 lines in extent, rather thick and prominent, with the surface well defined; the canal for the medullary artery (*o*) begins about half an inch below this ridge, toward the back part of the bone. The fore part of the shaft (fig. 1) is traversed by a low and narrow intermuscular ridge, commencing from near the base of the procnemial process, and terminating on the inner side of the extensor-tendinal canal, above the bridge (*l*); a similar ridge runs along the outer border of the shaft from its middle to the ectocondylar fossa, near which it bounds outwardly a narrow, longitudinal, tendinal groove (*n*). The canal (*f*) of the extensor tendon is crossed by a broad bridge of bone (*l*), is medial in position, not toward the inner side, as in *Dinornis*[2]; its lower outlet is transversely oval, and immediately above the intercondylar fossa (*c*); the anterior convexities of the two distal condyles are more nearly equal than in *Dinornis*: the trochlear canal (*v*) is less deep than in *Dinornis*. There is a well-marked tubercle near the middle of the entocondylar fossa (fig. 5, *a*), which is not so developed in *Dinornis*.

As compared with the tibia of *Aptornis*, the most striking differences in that of

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[1] The lower head of the 'gastrocnemius internus' rises from this part of the tibia in *Apteryx* (Zool. Trans. vol. iii. p. 295, pl. 35. R**).

[2] Zool. Trans. vol. iv. pl. 43. fig. 4 *f*.

Cnemiornis are seen in the development of the ectocnemial and more especially of the procnemial plates; the extensor-tendinal canal is more strictly medial in *Cnemiornis*, and the fore part of the inner distal condyle is less produced and less compressed. The gastrocnemial tubercle is wanting in *Aptornis*, as in *Dinornis*.

Fibula.

The fibula (Pl. LXVI. fig. 6), about 6 inches in length, shows the usual subcompressed, convex head, with an articular surface, about 14 lines long by 4 lines broad, slightly curved backward: the head is slightly hollowed on the inner side, slightly convex externally; the shaft gradually contracts to the usual pointed termination about two-thirds down the tibia; it shows the broad, rough, articular surface for the tibia on the tibial border, and two rough tuberosities for tendinous insertions (*u*, *v*) on the outer side of the bone.

Metatarsus.

The metatarsal (Pl. LXVII. figs. 1–4), which equals in length that of *Dinornis geranoïdes* (ib. figs. 5 & 6), has less than two-thirds its breadth, but almost equals it in fore-and-aft extent of the proximal end, owing to the greater development of the calcaneal ridge, which is perforated as in *Aptornis*. The inner condylar cavity (*i*) is much less extended from before backward; the anterior intercondylar prominence (*r*) is broader and more produced: the calcaneal process extends downward, as a low ridge, to within an inch of the distal trochlea; the calcaneal canal is 10 lines in length, and 4 lines in long diameter. The surface, sloping to the outer condyle, is excavated by three well-marked longitudinal grooves, increasing in width as they approach the outer condyle (*e*); the antero-posterior canal, between the outer and middle metatarsal, opens behind at the end of the outermost groove; that between the middle and inner metatarsal opens behind upon the inner side of the base of the calcaneal process; the transverse section of the middle of the shaft is subtrihedral, not transversely oval as in *Dinornis*; the inner trochlea (*ii*) is not produced lower than the outer one (*iv*); the middle trochlea (*iii*) is narrower in proportion to its length, and less produced forward; in each trochlea, and especially the outer and inner ones, the longitudinal canal is deeper than in *Dinornis*; the interspace between the outer and middle trochleæ is the widest, not, as in *Dinornis*, narrowest. The posterior boundary of the middle trochlea is more prominent, projecting further back beyond the shaft than in *Dinornis*. As compared with *Palapteryx*, the metatarse is longer in proportion to its breadth; the calcaneal process in *Aptornis* is shorter, more prominent, and more widely excavated; there are no tendinal grooves on its outer side; the posterior ridge is not continued from it, and is nearer the inner border of the shaft; the inner trochlea is not produced so low as the outer one in *Aptornis*, and there is an antero-posterior canal above the interspace between the outer and middle trochleæ.

DESCRIPTION OF THE PLATES.

PLATE LXIII.

Cnemiornis calcitrans.

Fig. 1. Cervical vertebra, front view.
Fig. 2. Cervical vertebra, back view.
Fig. 3. Cervical vertebra, upper view.
Fig. 4. Cervical vertebra, under view.
Fig. 5. Right costal border of sternum, outer view.
Fig. 6. Right costal border of sternum, marginal view.
Fig. 7. Left costal border of sternum, outer view.
Fig. 8. Left costal border of sternum, inner view.
Fig. 9. Middle portion of sternum, outer view.

(Figs. 5–9 have been drawn without being reversed on the stone.)

PLATE LXIV.

Cnemiornis calcitrans.

Fig. 1. Posterior cervical vertebra, front view.
Fig. 2. Posterior cervical vertebra, back view.
Fig. 3. Middle dorsal vertebra, front view.
Fig. 4. Posterior dorsal vertebra, front view.
Fig. 5. Pelvis, upper view.
Fig. 6. Pelvis, under view.
Fig. 7. Pelvis, side view.

PLATE LXV.

Fig. 1. Femur, *Cnemiornis calcitrans*, front view.
Fig. 2. Femur, *Cnemiornis calcitrans*, inner side of proximal end.
Fig. 3. Femur, *Aptornis didiformis*, front view.
Fig. 4. Femur, *Aptornis didiformis*, upper view of proximal end.
Fig. 5. Femur, *Dinornis geranoïdes*, front view.
Fig. 6. Femur, *Dinornis geranoïdes*, upper view of proximal end.

PLATE LXVI.

Cnemiornis calcitrans.

Fig. 1. Tibia, front view.
Fig. 2. Tibia, back view.
Fig. 3. Tibia, inner side of proximal end.
Fig. 4. Tibia, upper view of proximal end.
Fig. 5. Tibia, inner side of distal end.
Fig. 6. Fibula, outer side.
Fig. 7. Humerus, outer side.
Fig. 8. Humerus, inner side.
Fig. 9. Humerus, upper view of proximal end.
Fig. 10. Humerus, distal articular surface.

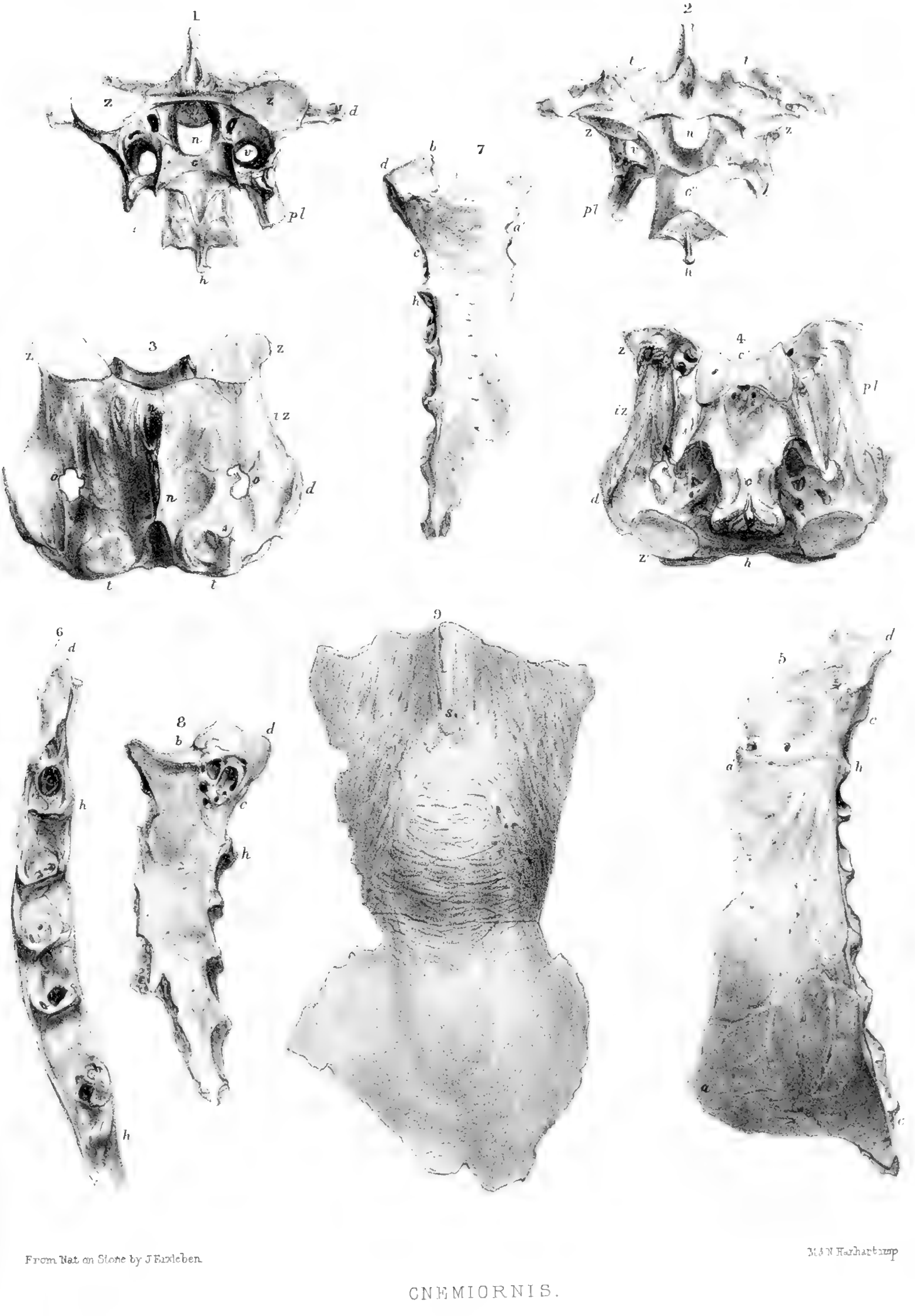
Tibia.

a. Inner distal condyle.
b. Outer distal condyle.
c. Intercondylar fossa.
d. Entocondylar surface.
e. Ectocnemial process.
f. Precondylar groove or canal.
g. Gastrocnemial tubercle.
h. Fibular ridge.
i. Interarticular tubercle.
k. Epicnemial ridge.
l. Precondylar bridge.
m. Intermuscular ridge.
o. Medullarterial orifice.
p. Procnemial process.
s. Fibular articular surface.
t. Ectocondylar convexity.
v. Trochlear canal.

PLATE LXVII.

Fig. 1. Metatarsal, *Cnemiornis calcitrans*, front view.
Fig. 2 Metatarsal, *Cnemiornis calcitrans*, proximal surface.
Fig. 3. Metatarsus, *Cnemiornis calcitrans*, back view.
Fig. 4. Metatarsus, *Cnemiornis calcitrans*, inner view of proximal end.
Fig. 5. Metatarsus, *Dinornis geranoïdes*, front view.
Fig. 6. Metatarsus, *Dinornis geranoïdes*, proximal surface.

(All the figures are of the natural size.)



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CNEMIORNIS.

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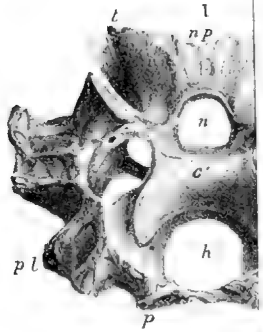

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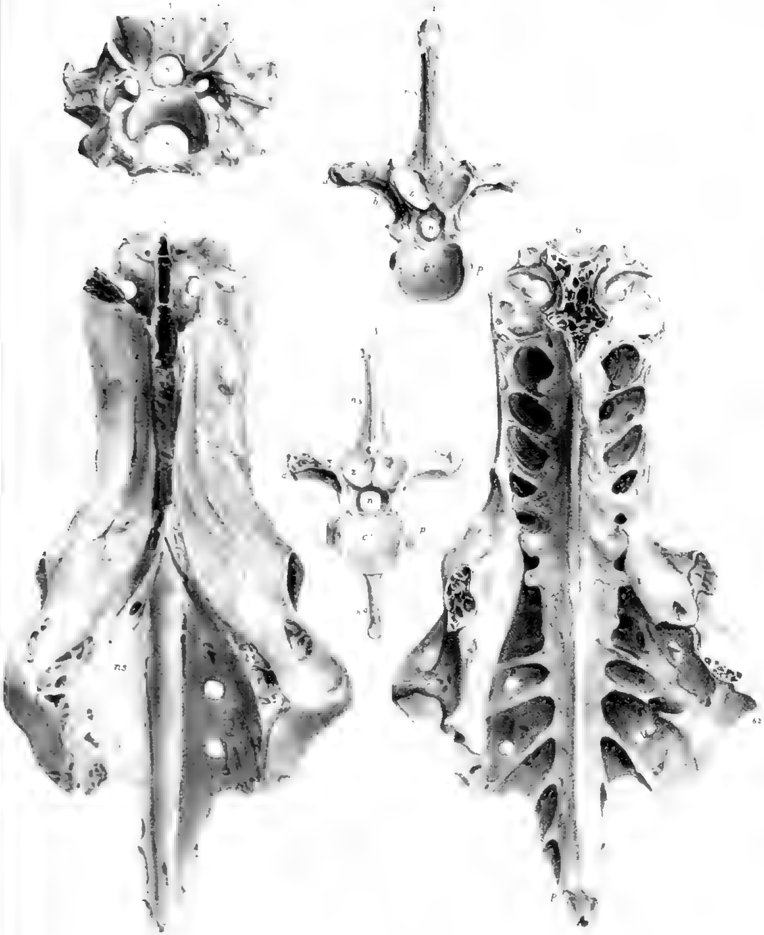

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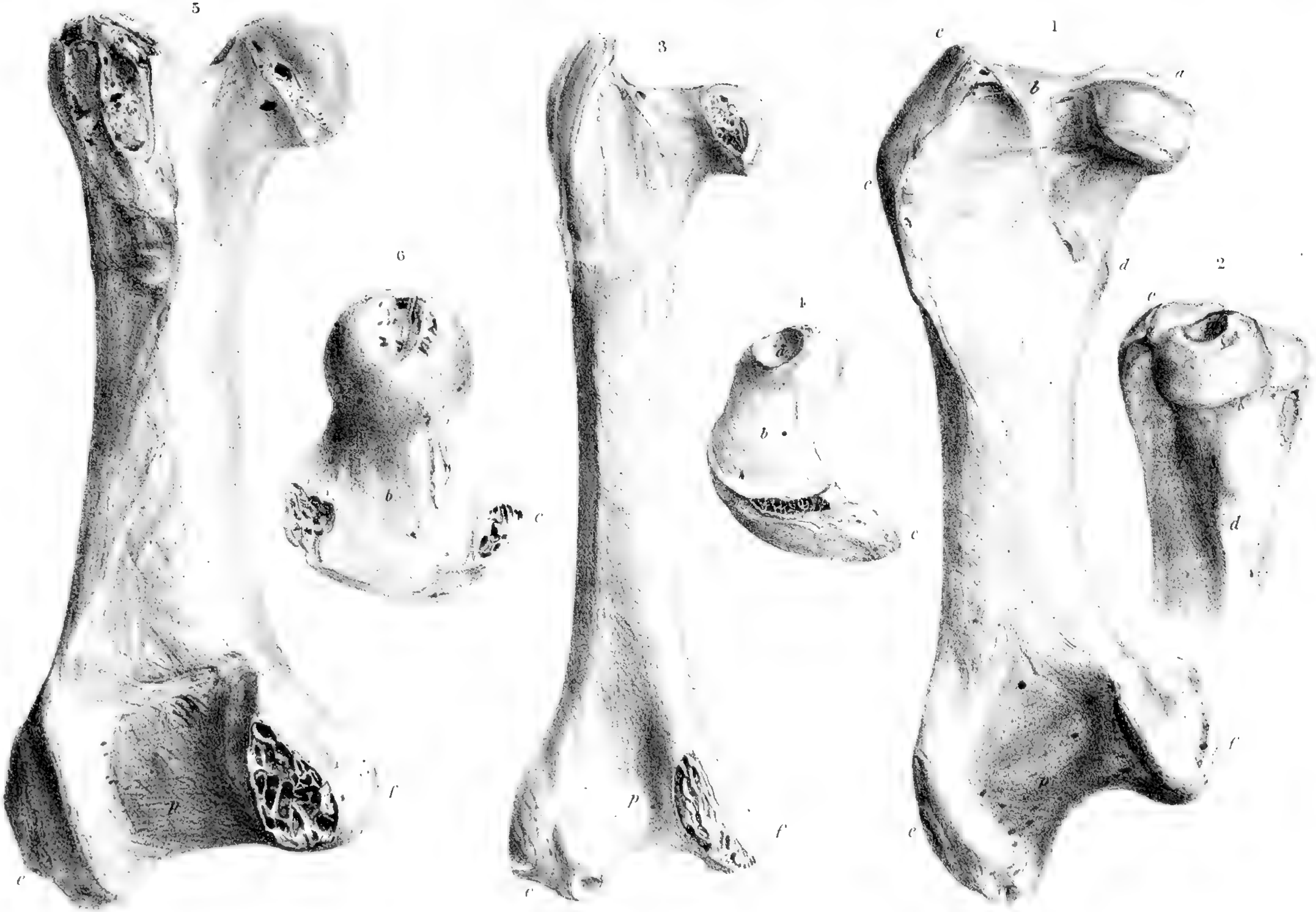

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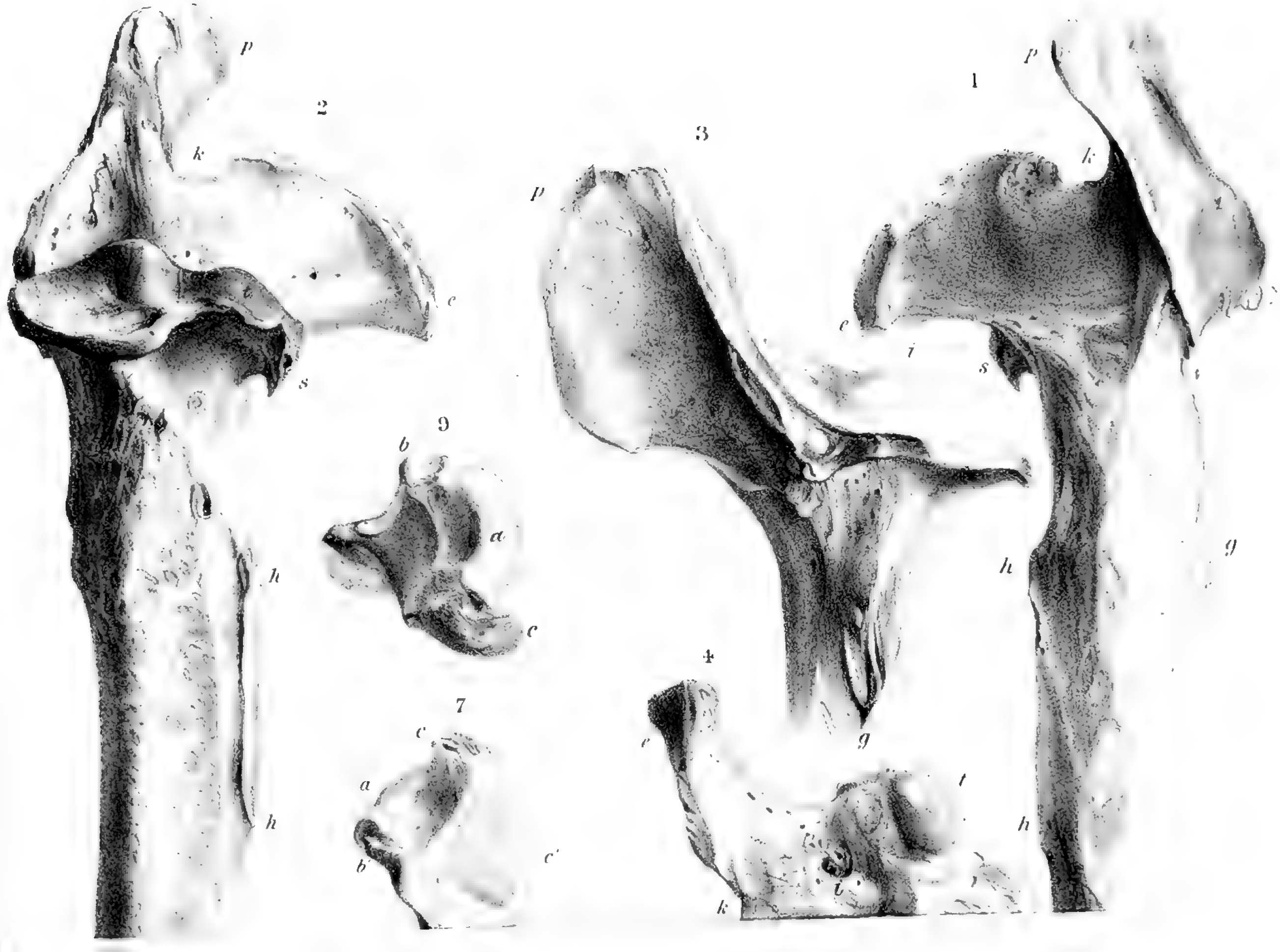
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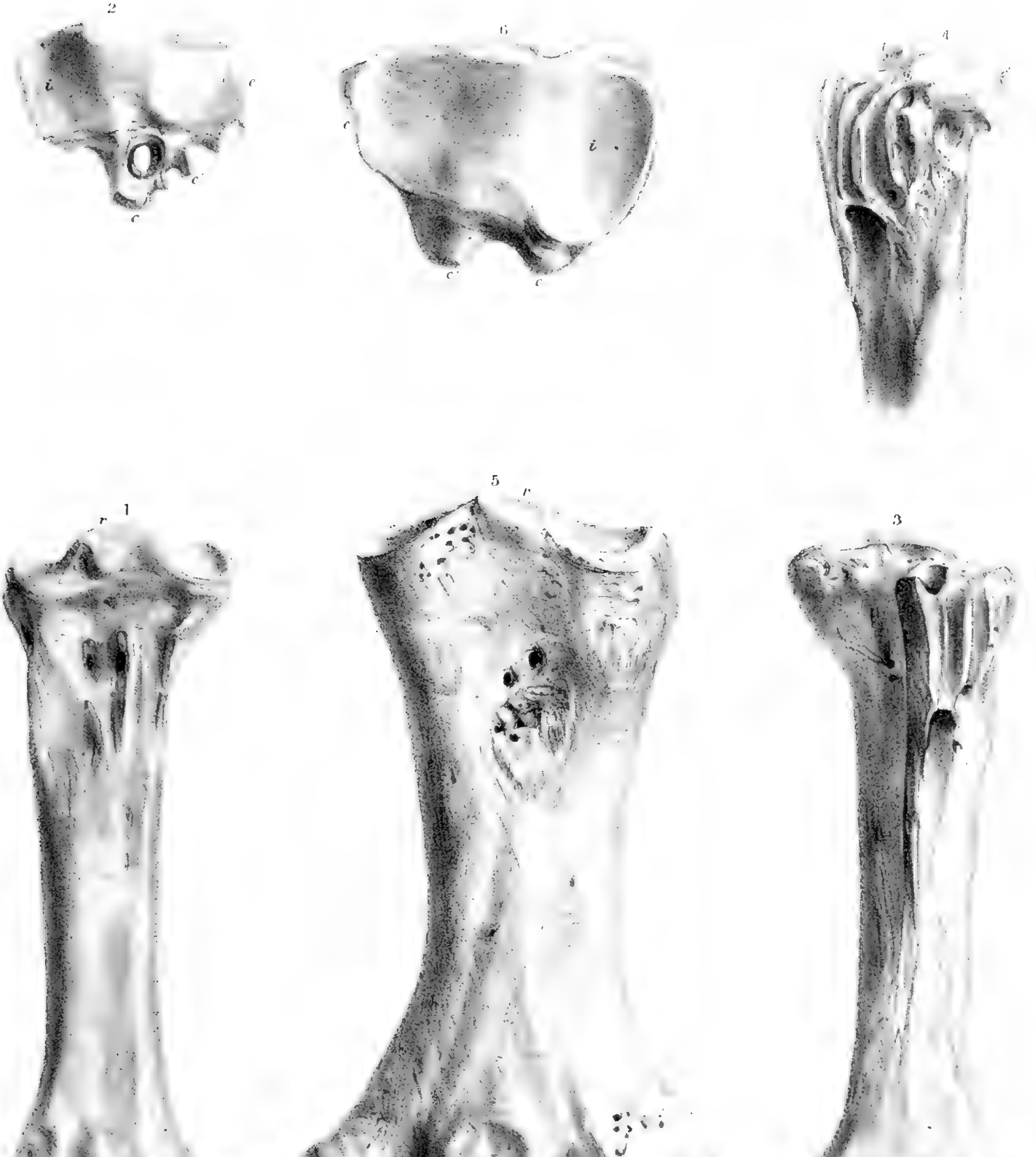

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1.4. CNEMIORNIS. 5.6. DINORNIS GERANOÏDES.

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