XV. *On the* Megatherium (Megatherium Americanum, Cuvier *and* Blumenbach). Part IV.—*Bones of the Anterior Extremities. By Professor* Owen, *V.P.R.S., Superintendent of the Natural History Departments in the British Museum.*

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The bones of the limbs of the Megatherium are not less fraught with interest to the Comparative Anatomist and Physiologist, than are those of the trunk and head, by reason of their peculiar proportions and configurations, and more especially as the unguiculate type on which they are constructed is exemplified in a quadruped of such enormous bulk. The anterior extremities (Plate XVIII.) exceed the posterior ones in length: in their bony structure they include a complete clavicle ($_{58}$) with the scapula ($_{51}$), a humerus ($_{53}$), an antibrachium, consisting of fully developed and reciprocally rotating radius ($_{55}$) and ulna ($_{54}$), carpus, metacarpus, and four digits; they manifest, in short, all the main perfections of brachial structure, save the opposable thumb, observable in the mammalian class. These perfections, moreover, are associated with proportions and processes indicative of enormous strength, and bespeak a limb fitted not only to take its full share in the support of the body, but to be employed on operations in which unusual resistance had manifestly to be overcome. In no respect, perhaps, does the Megatherium more strikingly differ in its osseous structure from the existing quadrupeds of corresponding bulk, than in the bony fulcra of the anterior extremity.

Scapula.—The scapula (Plate XVIII. $_{51}$, and Plate XIX. figs. 1 and 2) is a vast expanse of bone, with a double spinous process; the normal one expanding into a large acromion, which is continued into, and is confluent with, the coracoid process. The scapula usually presents an inequilateral triangular form (Plate XIX. fig. 1), of which the acromion (k) is the apex. The upper border (b, c) is the shortest; but, in one specimen, owing to the greater development of the basal border, as indicated by the dotted outline in Plate XIX., the upper border appeared to begin at the part of the base marked a, and to form a low angle, as if continued about one-fourth of the distance from the base parallel with the lower border, whilst the rest of the costa inclines downward towards the coracoid (c), with a slight concave outline. The upper border increases in thickness as it passes into the origin of the coracoid. The base of the scapula, from the point a, is straight as far as the origin of the spine, a'; it then bends, with a convex curve, and increases in thickness to the inferior angle of the scapula (d), close to which commences the second or lower spine. The inferior costa of the scapula extends forward, straight and parallel with the lower spine, for some way, and then is lost upon the inner

surface, the lower spine itself appearing, at *e*, to form the inferior costa for the rest of its course to the glenoid cavity (*g*).

The normal spine of the scapula, notwithstanding its being the superior of the two, commences at only one-fourth of the entire base of the bone from the inferior angle; it is thence continued forwards, gradually rising or gaining depth, parallel with the inferior costa, and thus marks out a very large proportional extent of the outer surface of the bone for the supraspinal fossa (Plate XVIII. 51). As the spine advances, it increases in breadth as well as depth, until it springs clear of the main body of the bone as the acromial process, *k*. This large, thick and rough process (Plate XIX. fig. 2, *k*) arches forward and upward over the glenoid articular cavity (*g*), and meets and coalesces with the coracoid (*c*), spanning the anterior outlet (*f*) of the supraspinal fossa by a strong and broad bridge of bone. Through the reciprocal modification of the coracoid, the passage for certain vessels and nerves, which is usually in Mammals a mere notch of the upper border of the scapula, is converted into a complete foramen (Plate XIX. fig. 1, *h*). The second spine, which answers to the ridge defining the upper part of the fossa for the 'teres major' muscle in Man, runs parallel with the upper spine, and then bends down to terminate in the low angle (*ib.* fig. 1, *e*), projecting from the inferior costa of the scapula, about one-third of the length of that border from the glenoid cavity (*g*). The shape of that cavity is almost an ellipse (Plate XIX. fig. 2, *g*), the lower end being scarcely more contracted than the upper one: both these parts of the periphery are rather more produced than the lateral borders. The entire margin of this moderately deep and well-defined articular cavity is thin, but convex. The inner surface of the scapula (Plate XIX. fig. 1) is divided into many shallow depressions by intermuscular ridges (*i*, *i*), having a general tendency to converge from the basal border, where most begin, towards the centre of the bone, though none extend so far. The inferior costa (*d*) is continued more directly towards the inner side of the glenoid cavity by a smooth, convex rising of the inner surface, which grows broader as it gradually subsides: the fore-part of the lower costa (fig. 1, *e*) is rather a continuation of the inferior spine; between which and the portion of the lower costa (*d*), is the wide channel, attesting the size and force of the homologue of the *teres major*. The vigour of the enormous *subscapularis* muscle is manifested by the intermuscular ridges (*i*, *i*).

Compared with the scapula of the Mylodon, that of the Megatherium differs in the lower position of the spine, and the consequent greater expanse of the supraspinal fossa: the base is straighter and relatively longer, the inferior costa relatively shorter. The ridge extending from the inferior and posterior angle forwards upon the under surface of the scapula, is relatively stronger in the Megatherium, and gives to the homologue of the inferior costa in the Sloth's blade-bone the character of a second spine. As such 'second spine,' with a prolongation of the scapula below, characterizes that bone in the Anteaters, this indication of affinity to *Myrmecophaga*, or rather manifestation of the more general characters of the order *Bruta*, by the Megatherium, is not without interest.

The confluence of the acromion with the coracoid is peculiar to the Sloths amongst existing Mammals.

Clavicle.—Before the discovery of the Megatherium, Man was usually cited in Manuals of Comparative Anatomy as the largest animal possessing a 'collar-bone': he is, in fact, the largest existing animal so endowed. But whilst the length of the human clavicle averages but 6 inches, that of the Megatherium is 15 inches. In its general shape and sigmoid curve, this bone (Plate XX. fig. 1) singularly resembles the human clavicle, but is thicker in proportion to its length. No single bone would have better excused the common conclusion of the mediæval anatomists as to the nature of large fossil bones, viz. that they were those of human giants, than the collar-bone of the Megatherium.

The sternal end is expanded, obliquely truncate, with a rough, irregular, undulating, but mainly convex articular surface, much fitted for strong ligamentous attachment to the manubrium sterni, and with a narrow, rather flattened facet above this surface, where it abuts against the same part in its fellow, as shown at Plate XVIII. $_{58}$.

The shaft of the bone is most contracted at its sternal third part; thence it gradually expands to the acromial end; the anterior surface is moderately smooth and convex: the posterior surface (Plate XX. fig. 1) is rough and more flattened, and is traversed obliquely by a broad ridge, which terminates outwardly, or developes the rugged upper border of the acromial half of the bone. This expanded end bends downward, as the sternal end bends upward. There is a large tuberosity on the outer or fore-part of the acromial expansion, which terminates in an oblong convexity, adapted to the concavity beneath the expanded end of the acromion. The strong aponeurotic character of the periosteum of the clavicle is well shown by the linear decussating ridges on most parts of the surface of the shaft. The bone is solid.

The closer affinity of the *Bradypus didactylus*, as compared with the *Brad. tridactylus*, to the Megatherium, is illustrated by the complete clavicles which attach the scapulæ to the sternum; but they are straighter, relatively more slender, and more suddenly expanded at the sternal end than in the Megatherium. One species or variety of Three-toed Sloth has only a small styliform clavicular bone, appended to the coracoid process. The clavicle in *Orycteropus* and *Myrmecophaga* is complete, but has a single curvature. The clavicle of the Mylodon is intermediate, in its form and proportions, between that of the Megatherium and that of the Two-toed Sloth.

The supposed peculiarity in the articulation of the clavicle of the Megatherium with the first rib instead of the sternum, which CUVIER inferred from the figures and descriptions of the fossil animal which had been published in his time*, is shown by the more perfect specimens since received, not to exist in nature; and the suspicion expressed by the great anatomist, viz. that it might be due to some misarticulation in the Madrid skele-

* "D'après les figures et les descriptions, il paraîtrait que cette clavicule s'articulerait, non pas avec le sternum comme à l'ordinaire, mais avec le bas de la première côte qui est recourbée, et présente une concavité pour la recevoir. Ce serait une singularité dont je ne connais pas d'exemple."—Ossemens Fossiles, Ed. 1835, 8vo, tom. viii. p. 349.

ton, is thus proved to be well-founded. The true connexions of the sternal ends of the clavicles with each other and with the manubrium sterni, are well shown in the view of the skeleton in the British Museum, given in Plate XVIII.

Humerus.—The humerus (Plate XX. figs. 2—5) is remarkable for the vast expanse of the lower fourth part of the bone; but this is limited to the transverse direction; so that, viewed sideways (as in Plate XVII. Phil. Trans. 1855), the humerus of the Megatherium appears to be a comparatively weak and slender bone: the whole shaft, however, gives indications of the force of the thick muscular masses which surrounded and operated on it.

The head of the bone (Plate XX. fig. 4) presents a smooth convexity of an elliptical form, corresponding with that of the glenoid cavity of the scapula; the long axis of the ellipse is from before backward. The head rises clear above the outer and inner tuberosities, neither of which are so developed as to interfere, as in ungulate quadrupeds, with the free rotation of the bone.

The rugged surface of the inner tuberosity (*ib.* figs. 2 and 3, *a*) slopes downward and inward (ulnad) from the peripheral groove of the head, marking the attachment of the joint-capsule. The pectoral ridge is continued from the lower, slightly outstanding, part of this tuberosity. The outer tuberosity (ib. *b*) projects from a lower level, is larger and more prominent than the inner one; and is divided into two subequal rough facets. The outer deltoid ridge begins from the outer side of the tuberosity; the inner deltoid ridge (ib. *d*) some inches lower down, and nearer the inner side of the shaft: these ridges converge, strengthen as they descend, and coalesce at the beginning of the lower third of the shaft, defining a long and narrow angular tract for the implantation of the powerful deltoid muscle. A tuberosity (ib. *c*) is developed from the outer (radial) side of the humerus, one-third down the bone, from which a strong ridge descends along the same side of the middle third: this ridge is defined below, and divided from the supinator ridge, by a deep and smooth oblique channel (ib. *e*) for the passage of vessels and nerves from the back to the fore-part of the bone. The supinator ridge (ib. *f*) is the most prominent feature of the lower third of the humerus; it presents a long, triangular, rough outer facet, widening as it descends, and with a secondary ridge from its middle part. The longitudinal contour of this facet forms an obtuse angle with the lower half of the ridge, extending to the outer condyle of the humerus: the outer facet of this half is rough, triangular, with the base upward. The pectoral ridge (*ib.* fig. 3, *i*) terminates in a low tuberosity (ib. *h*) on the inner side of the middle of the shaft; whence a second ridge is continued upward upon the back of the shaft. This surface is flatter than the fore-part, especially at its lower expanded third; at the bottom of which, midway between the outer and inner supracondyloid productions, and just above the lower articular surface, is a small but well-defined olecranal depression. The inner supracondyloid angular production (ib. *k*) has the flat rough facet only upon its lower half. Owing to the production of these ridges, the articular condyles themselves (ib. *g*, *l*) appear to occupy but a small part of the distal end of the bone; for the extreme breadth of this end being

13 inches, that of the articular surface is but $7\frac{1}{2}$ inches. It consists of two convexities, side by side, divided by a narrow and deep channel, continued from the front non-articular surface half-way towards the back part of the bone. Both convexities have a full elliptic periphery; the outer one (*ib.* figs. 2, 3, 5, *g*) with the long axis from before backward, the inner one (ib. *l*) with the long axis from side to side: the outer condyle is the larger and more prominent of the two; it forms more than a hemisphere, the antero-posterior contour describing full three-fourths of a circle. The extent of flexion and extension of the fore-arm on the arm is thus shown to be considerable. The articular surface continued from one condyle to the other is concave transversely.

The centre of the shaft of the humerus is occupied throughout by a coarse cancellous structure. A very small medullary artery penetrates the back part of the bone, below the pectoral tuberosity, the canal extending obliquely downward and outward.

The *Myrmecophaga didactyla*, amongst existing *Bruta*, most resembles the Megatherium in the development of the supinator or outer supracondyloid ridge.

In its general proportions the humerus of the Megatherium resembles that of the Megalonyx; and is more slender, in proportion to its length, than in the Mylodon or Scelidothere. The articular head forms a larger proportion of a sphere, and projects more freely beyond the tuberosities: these are relatively smaller, and are more equal than in the Mylodon or Scelidothere: the external tuberosity, in particular, is more developed in these smaller Megatherioids. In them also the external ridge is continued from above the 'musculo-spiral' groove inwards, along the front of the humerus to the apex of the deltoidal tract, forming its outer boundary: in the Megatherium, a smooth concave surface divides the outer ridge from the deltoidal elevation, which is absolutely narrower. The vertical outline of the back part of the shaft of the humerus in the Megatherium is almost straight, being but a little bent forwards at its lower third, as it is likewise in the Megalonyx; and, in both, the olecranal depression is well defined: in the Mylodon and Scelidotherium, the same outline of the humerus is slightly concave; the lower third of the bone being, as it were, a little bent back below the deltoidal platform; and the olecranal fossa is not defined. The inner supracondyloid plate is produced at its upper part into a strong tuberosity, in both the Mylodon and Scelidotherium, but not in the Megatherium.

In the existing Sloths, the humerus at this part, viz. above the inner condyle, is perforated in one genus (*Cholœpus*) and not in another (*Acheus*, F. Cuvier): and the same difference occurs in the great extinct Sloths. In the Megatherium the humerus is imperforate, as it is in the Mylodon: in the Megalonyx and Scelidotherium it is perforated above the inner condyle. Yet the Megalonyx most resembles the Megatherium, not only in the general proportions of the humerus, but in the configuration of its two articular ends. The inner or ulnar condyle, *e. g.*, is convex in every direction in the Megalonyx as in the Megatherium: in the Mylodon and Scelidotherium it is convex only from before backwards, but is concave from side to side. In the more robust proportions, in the shape of the articulations and the development of the processes of the

humerus, the Mylodon and Scelidotherium as closely resemble each other, as the Megatherium resembles the Megalonyx in the same characters; yet the humerus of the Scelidotherium has the inner perforation, and that of the Mylodon a groove merely, for the brachial artery and nerve. This variety, and the corresponding one above noticed between the Megatherium and Megalonyx, show the inapplicability of the final cause commonly assigned to the ento-condyloid hole, the existence or otherwise of which depends merely on the ossification or non-ossification of the aponeurosis extending from the shaft of the humerus to the ento-condyloid process.

Ulna.—The bones of the fore-arm in the Megatherium, as in the Megalonyx, exemplify by their greater length, as compared with those of the same segment in the hind limb, the Bradypodal affinities of these huge extinct quadrupeds.

The ulna in the Megatherium (Plate XXI. figs. 1, 2, 3) is, however, peculiar for the vast expanse of its proximal end, in connexion with its long and slender shaft. The olecranon (ib. *a*) is twice as broad as it is long; its inner border, springing from the notch which penetrates the inner and back part of the humeral articular fossa, extends obliquely upward and inward for $3\frac{1}{2}$ inches, the ridge or edge of the plate being about an inch in thickness: the plate from this ridge sweeps round the back part of the bone, subsiding and increasing in breadth as it approaches the radial side, where it terminates in a tuberosity, divided by a groove from the radial articular cavity (ib. *b*), and prolonged downward into the ridge bounding the radial side of the upper half of the ulna. The olecranon projects rather backward than upward, and is strengthened and supported at its highest part by a strong angular buttress, which gradually subsides upon the back of the ulna.

The great 'sigmoid' articular surface is divided into two facets by a median portion, which is produced forward in the longitudinal or vertical direction, and is convex from side to side; the divisions so defined are concave. The inner one (ib. *c*), for the inner humeral condyle, describes a semicircle from behind forwards; it has little more than half that extent from side to side, and is encroached upon by a narrow, rather deep, rough channel, continued from the inner origin of the olecranon, expanding, to near the middle of the cavity. The outer division of the sigmoid fossa (ib. *b*) has reverse proportions, the transverse being nearly double the extent of the longitudinal diameter, and it is less concave than the inner division; about half an inch of its lower border bends a little back for the articular margin of the head of the radius, just above the rough fossa, for the reception of the non-articular part of the same head: the rest of the outer division of the sigmoid cavity receives the back part of the outer condyle of the humerus. Below the outer division the radial fossa (ib. *d*) presents a triangular form, bounded by a rough ridge externally and by a tuberosity internally. The ridge is continued upon the radial side of the shaft of the ulna to within a fourth part of its distal end; the surface of this side of the bone is irregularly sculptured, indicating the strong ligamentous connexion between the ulna and radius at this part. The back and inner sides of the shaft of the ulna are comparatively smooth.

A vascular canal, somewhat larger than the rest, is seen near the fore-part of the outer surface, entering the bone obliquely upward. A rising of the surface, with a linear series of three or four rough tubercles, marks the lower fourth of the inner side of the bone; a short wide longitudinal channel marks the back surface of the distal end (fig. 3), which is slightly expanded and convex, and so impressed as to indicate its ligamentous junction with the carpus.

The ulna of the Megatherium differs from that of the Mylodon, not only in its longer and more slender proportions, but also in the absolutely as well as relatively minor height or length of the olecranon; in the much less relative vertical or longitudinal extent of the outer division of the 'sigmoid' cavity; and in the 'haversian' fossa on the inner division. It differs in the much narrower channel dividing the articular cavity from that part of the base of the olecranon which is continued into the posterior ridge or border of the shaft; it differs, also, in the convexity of the distal end and the absence of the articular facet, which is distinctly present in that part of the ulna in the Mylodon and Scelidotherium.

Radius.—The radius (Plate XXI. figs., 4, 5, 6), like the ulna, of the Megatherium resembles in its longer and more slender proportions that bone in the Megalonyx, and differs from the proportionally thicker and shorter radius of both the Mylodon and Scelidotherium. The proximal end is circular, and is occupied by a smooth, moderately shallow, articular cavity (*ib.* fig. 5), with a well-defined border, over which the articular surface extends, on the ulnar side of the head, for about half an inch down; which tract is adapted to the lower portion of the outer division of the sigmoid cavity of the ulna. The articular modification of the head of the radius is as completely adapted for the superadded rotatory movements of the antibrachial bones, as in the human subject, to the head of the radius of which the resemblance of that of the Megatherium is strikingly close.

The shaft of the radius gradually narrows, in the antero-posterior diameter, along the upper fourth part, but maintains the same diameter as the head, transversely. Three inches below the head, on the inner and fore-part of the shaft, is the tuberosity (ib. *a*) for the tendon of the biceps, which measures 3 inches in long diameter and $1\frac{2}{3}$ inch across. Here the bone bends a little outward (radiad); and the ridge bounding that side is developed into what may be termed a process (ib. *b*), with a low angle, whence the ridge is continued straight down the lower half of the shaft to near the tuberosity above the styloid process (ib. *c*), where it curves outwardly to terminate in that tuberosity. The fore-part of the shaft is moderately smooth and convex across; it describes, lengthwise, a slight concavity; on the inner side of the bone, a broad and very rugged tract begins, about an inch and a half below the bicipital tuberosity, and extends along the middle third of the shaft; a less rough tract is continued thence, gradually expanding to the cavity for the lower end of the ulna. The outer side of the shaft of the radius is smooth, convex across, and with a slight convexity in its longitudinal contour: from the external process downward the radius maintains an equal breadth near the lower end, and

there it expands in all directions to form the large articular cavity (ib. *d* and fig. 6) for the major part of the carpus. Above this cavity, on the ulnar side, is the rough and shallow depression for the ligamentous junction of the corresponding end of the ulna; on the front side a broad low ridge extends obliquely from the suprastyloid tuberosity to the border of the cavity; on the back part three oblong, short, thick ridges or tubercles divide the surface into four channels, for tendons; three of these are longitudinal and parallel, progressively increasing in width from the innermost (or one next the ulna) to the third; the outermost passes obliquely between the suprastyloid tubercle and the styloid process. This process is short and thick, rounded at the end; flattened in front, with the smooth articular surface continued for a few lines upon the lower border of this surface, from the general articular cavity which is extended over the lower end of the radius including the styloid process. This cavity presents a triangular form with the angles rounded off; the base next the ulna is short and oblique; the anterior border or side is the longest, the opposite border is the thickest, and is notched near the styloid process: the cavity is moderately concave, and articulates with the scaphoid and lunar bones of the carpus.

In the Mylodon the radius is not only thicker in proportion to its length, but is more extensively and deeply impressed by the muscles of the fore-arm, especially on the back part of the bone. The tuberosity for the insertion of the biceps is further from the proximal joint, and augments the power of the muscle in the same degree: the proximal articular cavity is of an oval form.

Carpus.—The carpus (Plate XXII. *s*....*u*) consists of seven bones, four in the proximal and three in the distal row.

Scapho-trapezium.—The first of the proximal row (ib. *s*) includes the bone (ib. *t*) answering to the first of the distal row in Man and most Mammals, and is consequently a 'scapho-trapezium' (*s*, *t*)*, as it is also in the Sloths, the Mylodon and Scelidotherium. It is of an irregular triangular shape, with its base applied to the 'lunare' (ib. *l*), and with the apex somewhat twisted. It presents a broad convex articular surface (*ib. s*) for the outer half of the concavity of the radius; and this surface is continuous with a crescentic one of about one inch in breadth, which covers the proximal part of the side of the bone next the os lunare. The palmar or anterior horn of the crescent is continuous with an oval flat articular surface joining the os magnum (ib. *g*): the opposite or dorsal horn is separated by a rough tract from a convex subquadrate surface which also articulates with the os magnum. On the outer side of this surface, and, like it, on the fore-part of the bone, is a surface concave in one direction and convex in the opposite direction, for articulation with the small trapezoides (ib. *z*). External to this, the fore-part of the produced and twisted apex of the bone, which represents the trapezium, articulates with the stunted metacarpal of the pollex (ib. *m* I), chiefly by

* This is the bone called 'cuneiforme' in CUVIER's chapter on the Megatherium, and which is marked *r* in the copy of Dr. PANDER's figure of the Madrid skeleton introduced into plate 217, fig. 3, of the edition of the 'Ossemens Fossiles,' 8vo, 1835, here cited.

ligament, but also by a small elliptical flat surface which seems to have been covered with articular cartilage. Between the two facets for the os magnum the bone is deeply excavated and has been perforated by blood-vessels.

Lunare.—The 'os lunare' (Plate XXII. *l*) offers, as in Man, some rude resemblance to a crescent; its proximal surface, very convex from before backward and rather convex from side to side, is wholly covered by the smooth articular surface which plays upon the ulnar half of the terminal cavity of the radius; and this surface is continued upon the radial side of the bone to form there the crescentic tract, adapted to the similarly-shaped tract on the scaphoid. The inner horn of this tract is continuous with the surface, convex at the fore-part, then deeply concave from before backwards, for the os magnum (ib. *g*): this articular surface is continuous with a similarly deeply excavated and irregular one on the ulnar half of the fore-part of the bone, which is subdivided into three facets, the middle one for the os cuneiforme, the two smaller ones for two parts of the os unciforme.

Cuneiforme.—The 'os cuneiforme' (ib. *c*), which is the smallest of the three proximal carpals, presents at its radial side a triangular convex surface for articulation with the lunare; and at its fore-part an irregular concavo-convex oblong surface for the unciforme (ib. *u*). Its proximal surface is tuberous and rough for ligamentous attachment to the ulna, except where the smooth articular surface for the os pisiforme is situated: this surface is in great part convex.

In the Mylodon the os cuneiforme is the largest of the carpal bones.

Pisiforme.—The os pisiforme (Plate XXII. *p*) is conical with an obtuse apex, having on its base the articular surface for the os cuneiforme, and with the rest of its exterior surface more or less irregular, for implantation of a tendon and ligaments.

Trapezoides.—The homologue of the trapezium being connate with the scaphoid, and noticed in the description of that compound bone, the trapezoides (ib. *z*) is the first independent carpal bone of the distal row. It is the least of the carpal series, and is a relatively smaller and flatter bone than in the Mylodon: the proximal or scaphoidal surface is convex transversely, concave from behind forward, and plays in a corresponding concavo-convex surface in the scaphoid. The distal surface is almost wholly convex: both surfaces are joined by a small articular facet on the radial side of the bone, which is adapted to a corresponding facet in the small metacarpal bone of the thumb; and by a more extended articular surface on the ulnar side of the bone for junction with the os magnum.

Magnum.—This bone, arbitrarily so termed, comes next after the trapezoides and pisiforme, in the order of size, being much inferior to the other carpals. It is almost wholly covered by smooth articular surfaces. The small non-articular rough surface (ib. *g*) exposed upon the back of the wrist is of a transversely extended hexagonal figure, with the outer and inner sides the shortest. The surface for the lunare is concave anteriorly, but very convex in the greater part of its extent. It is continuous at its radial border, with the two surfaces, one concave, the other flat, for the scaphoides; and at its ulnar

border with the flat surface for the unciforme. The concave scaphoidal surface is continuous with the surface for the trapezoides, which is much narrower than is the same surface in the Mylodon, the scaphoidal surface being broader than in the Mylodon. The largest articular surface is that for the base of the great middle metacarpal, which is slightly convex except at its fore-part, which is produced into a cone.

Unciforme.—Of all the carpals the os unciforme (ib. *u*) differs most in form from that of the Mylodon; it is a thick transversely extended bone, the free tuberous surface on the back of the wrist being hexagonal, with the two inner and the two outer sides very short; one of the outer sides is formed by a protuberance separating the articular surfaces for the os cuneiforme and fifth metacarpal, which meet at an acute angle in the Mylodon.

The proximal oblong concavo-convex surface for the cuneiforme is continuous, at the radial side of the bone, with the surfaces for the lunare and os magnum; and the latter with the broad surface along the distal part of the base which is obscurely divided into three facets, the middle and largest for the base of the fourth metacarpal, the next in size for the outer facet or the base of the third metacarpal, and the outermost and smallest facet for the small part of the base of the fifth metacarpal which articulates with the carpus. The inner or palmar rough surface of the unciforme has an oblong tuberosity, which is narrower than that upon the dorsal surface.

Metacarpus.—The innermost or first metacarpal (Plate XXII., I, *m*), answering to that of the pollex or thumb, resolves, by its rough obtuse distal termination, as well as by its diminutive size, one of the points considered doubtful by CUVIER, in the structure of the fore-foot of the Megatherium, by proving that the pollex was absent, or represented solely by the rudimental metacarpal, which must have been concealed beneath the integument. The bone is of an irregular subcubical shape, broader than it is long. At its base are two separate subcircular flat surfaces articulating with corresponding facets on the trapezial part of the scapho-trapezium: on the side next the second metacarpal is a convex articular surface, having the lower part obscurely defined for articulation with the trapezoides, and the rest lodged in the concavity, partly articular, partly rough, upon the outside of the base of the second metacarpal. The outer side of the rudimental first metacarpal is obliquely flattened, the surface here being apparently for the insertion of a strong tendon.

The metacarpal of the second digit (ib. *m* II*) has a very irregular exterior; its comparatively small base is excavated obliquely to receive the fore-part of the trapezoides; on the outer or radial side it shows a triangular excavation, the lower half of which has a smooth articular surface for the rudimental metacarpal, *m* I. On the ulnar side of the base there is a convex articular surface divided into a proximal narrow tract for the os magnum, and a distal broader tract for the contiguous side of the base of the middle metacarpal. Above or beyond this the middle third of the bone supports a rugged protuberance, which has been attached by ligament to a similar rough surface on

* Referred to the 'annulaire' or fourth digit in the 'Ossemens Fossiles,' *ed. cit.* pl. 216, fig. 8.

the middle metacarpal; so that little more than one-third of the bone projects freely from the metacarpus. This free part is subcompressed and expands in the direction from the back to the palm of the hand, so as to form the surface for a trochlear articulation of great extent in that sense. A ridge from the back surface of the metacarpal expands into a tuberosity near the dorsal end of that articulation; and a similar but smaller tuberosity projects from the palmar end of the same articulation, along each side of which there runs a thickish edge. The distal surface itself presents a median vertical or longitudinal prominence, beyond the lower half of which the articular surface is produced laterally so as to make the surface concave transversely on each side the median ridge; whilst at the upper half the whole surface is convex transversely, as it is, in a minor degree, longitudinally.

The middle metacarpal (ib. *m* III) is a little longer than the second, but is twice as thick, with a quadrate transverse section, the four sides of the shaft being flat and sharply defined. The base of the bone is produced 'ulnad' and 'proximad,' so as to be wedged between the fourth metacarpal, the magnum and the unciforme. The articular surface on the ulnar side of this production for the fourth metacarpal is extensive, and for the most part slightly convex; the surface on what may be termed the truncate end of the production, for articulation with the unciforme, is slightly convex on the dorsal half, slightly concave on the palmar half. The surface for the magnum on the proper base of the metacarpal sinks into a conical cavity near its dorsal end; the rest being nearly flat. On the radial side of the base is an oblong articular tract for the second metacarpal, and beyond this the extensive rough surface for the ligamentous connexion with the same bone. The radial surface is grooved above the rough facet, obliquely by a wide and moderately deep canal; apparently for the passage of a tendon to the digit. The dorsal surface shows an oblique broad tuberosity, extending from above the tendinal groove to the upper or dorsal end of the distal articulation. The smooth and almost flat dorsal surface gradually deepens into a broad and shallow oblique channel on the ulnar side of the oblique tuberosity. The ulnar side of the bone, beyond the articular surface for the fourth metacarpal, is occupied by a rugged flat tract for ligamentous connexion with the same bone. The palmar surface is pretty smooth, flat transversely, slightly concave lengthwise; produced into a tubercle below the middle prominence of the distal joint. The articular surface of this joint does not cover the whole distal end of the bone; it is long and rather narrow, extending obliquely from the palmar forward to the dorsal surface; the dorsal side of the bone being longer than the palmar one. It is traversed lengthwise by a median prominence, convex transversely, almost straight lengthwise; and the surface is continued upon a flat tract on each side of the prominence, that on the radial side of the prominence being the broadest.

The general form of this bone is more like that of a brick or of an ashlar stone for a strong wall, than like that of the usual support of a flexible digit of a fore-paw or hand.

The chief difference between the middle metacarpals of the Megatherium and Mylodon is in the form of the distal articulation. This surface, in the smaller Megatherioid,

is convex from above downward, whilst in the Megatherium it is straight, or rather concave, and it joins the dorsal surface at an acute angle. The lateral depressions of the pulley are narrower in the Megatherium, and the vertical inflexions of the phalanx must have been more limited than in the Mylodon.

The fourth metacarpal (ib. *m* IV), as compared with the third, is longer and more slender in the Megatherium than in the Mylodon; but its articulation by an obliquely extended base with the third and fifth metacarpals and the unciform bone, closely corresponds with that in the Mylodon*.

The two oblique metacarpal surfaces are nearly parallel, the radial one is concave, the ulnar one slightly convex; both are separated by a sharp angle from the intermediate or carpal surface, which is nearly square and is slightly concave. The proximal half of the bone is bounded by four flat equal sides, with intervening angles, sharp on the radial side. The upper and under sides are nearly smooth, with a broad low tuberosity near the proximal end; the outer and inner sides are rugged for close syndesmosis with the adjoining metacarpals. Only the distal half of the bone stands freely out; it expands in vertical breadth to the articular surface for the fourth finger. The angle between the upper and radial sides is rounded off; that between the upper and ulnar sides is, in one specimen, developed into a sharp ridge.

The distal articular surface resembles that of the second metacarpal, but occupies a smaller relative proportion of the whole distal surface; the vertical prominence, convex transversely, is broader, more concave vertically, and extends obliquely from the upper and radial angle to the lower and ulnar one: the flat lateral extension of the articular surface is confined to the radial side of the prominence. A single flat surface for a sesamoid bone is situated below, but distinct from, this part of the articulation. A large and strong tuberosity projects below the prominent part of the joint; an oblique channel divides this tuberosity from a longer one on the ulnar side of the distal end of the metacarpal.

The distal articular surface of the fourth metacarpal in the Mylodon is reduced to a small, vertical, oblong, nearly flat surface; this difference relating to the stunted development and limited function of the digit it has to support. In the Megatherium such simplification of the distal joint of the metacarpal is limited to the fifth of that series of bones (ib. *m* V): this metacarpal †, of the same length as the fourth, is more slender; its proximal end is wedge-shaped, the radial articular surface and the flattened outer facet converging to the narrow rough tract which is joined by ligament to the carpus. The articular surface on the radial side has a small terminal part obscurely marked off for a facet on the unciforme; the rest receives the convexity on the ulnar side of the fourth metacarpal: beyond this is a rough surface for the syndesmotic union of the contiguous bones. Rather more than half the fifth metacarpal stands freely out; it is traversed above by a longitudinal ridge expanding into a broad tuberosity at the distal end; the

* *Op. cit.* p. 92. pl. xv. *m* 4.

† Referred to the index or second digit in the 'Ossemens Fossiles,' *ed. cit.* pl. 16. fig. 11.

bone is smooth and rounded on the palmar side. The small terminal articular surface is oval, slightly concave vertically, concave transversely, upon the radial half of the distal expansion. There is no articular surface for a sesamoid.

The metacarpals are so united and wedged together and with the carpus, as to transmit from the oblique carpal surface which sustains the radius the weight of the fore part of the Megatherium to the fifth digit, the stunted extremity of which was imbedded in the marginal hoof-like callosity on which the ponderous quadruped trod, with the claw-bearing toes bent inwards.

From the scapho-trapezium and lunare the weight was transmitted to the second row of carpal bones; and by the oblique production of the base of the second metacarpal, and especially of the third metacarpal, it was concentrated through the medium of the fourth metacarpal upon the fifth. The lateral pressure thus occasioned explains the extent of syndesmotic and sutural union along the basal part of the metacarpals, and also the squared angular shape of the constituents of this masonry of the huge fore-paw.

On comparing the structure of the carpus in the Megatherium with that in existing Mammals, it is found to be repeated in the Unau or Two-toed Sloth (*Bradypus* (*Cholœpus*) *didactylus*), and in that species or subgenus exclusively; the carpal bones being seven, and the reduction to that number resulting, also, from the connation of the scaphoid and trapezium. A scapho-trapezial bone exists in the Ai or Three-toed Sloth (*Bradypus* (*Acheus*) *tridactylus*), but the carpus is further reduced in this species or subgenus to six bones by the confluence of the trapezoides with the os magnum. The trapezius is a distinct ossicle in the Chlamyphorus, as in most other Armadillos; in the *Dasypus sex-cinctus* it coalesces with the trapezoides. In the Pangolins (*Manis*) the scaphoid coalesces with the lunare, not with the trapezium. In the true Anteaters (*Myrmecophaga*), and in Orycteropus, the ordinary eight carpal bones retain their individuality.

Digital Phalanges.—The stunted metacarpal of the pollex, in the Megatherium, bore no rudiment of a digit. They were powerfully developed and unguiculate in the three following digits.

The index digit (Plate XXII., II) has three phalanges: the proximal one ($_1$) is almost twice as broad, and more than twice as deep as it is long; the metacarpal surface presents a deep and wide, vertically elongated, subangular concavity, fitting the vertical prominence and lateral facets of the distal joint of the metacarpal; the distal surface of the proximal phalanx presents a vertical angular fissure dividing two oblong convexities. The mid-phalanx (*ib.* II, $_2$) has a proximal trochlea playing on the preceding, the median vertical ridge being overhung by the produced upper rough surface; the distal articulation repeats that of the proximal phalanx, but the median fissure is less deep, and the lateral convexities are more regularly rounded and prominent. The ungual phalanx (*ib.* II, $_3$) exceeds the length of both preceding phalanges; the upper or dorsal side of its base is produced backwards into an obtuse point; the rough sheath of the claw extends along three-fourths of the phalanx; it is convex radiad, vertical and flat ulnad;

the core presents a rough edge radiad and a vertical rough surface ulnad, and is smooth and convex transversely at its base, both above and below.

The proximal and middle phalanges of the digitus medius (*ib.* III, 1...2) are confluent, the line of anchylosis being indicated by a vertical ridge along both the inner and the outer sides, and by a curved ridge convex backwards on the upper or dorsal side. The proximal articular surface presents a deep vertical channel, with a narrow elongated subconcave surface continued from its radial side, and a still narrower flat surface from the opposite side. The distal articular surface of the composite bone has a deep median vertical groove dividing two convexities. The compound phalanx presents two rough tuberosities below, one terminating each bank of the vertical articular proximal channel; there is a smooth depression above, and another below, close to the distal trochlea. The enormous distal phalanx (ib. III, 3), of twice the vertical breadth of the adjoining claw phalanges, is very little longer than that of the second digit; it is flattest on the ulnar side, to which the upper convexity slightly inclines. The base or palmar part of the phalanx is the broadest, is convex both lengthwise and transversely, and is perforated by two canals, for the large vessels and nerves supplying the claw-core. The surface, in which was implanted the flexor tendon, shows many linear impressions radiating from the median tuberosity, forward and laterally. The articular surface excavates obliquely the base of this phalanx which overhangs the joint; the concave border of the median angular prominence describes a semicircle from above forward and downward; the ulnar excavation is longer in that direction than the radial one. The well-marked trochlear joint restricts the movements of the great claw to flexion and extension on a vertical plane, whilst its position effectually prevents retraction of the claw, the preservation of the effective condition of which is due to an opposite bend to that in the Cat-tribe, as was well explained by CUVIER in his description of the Megalonyx*. The major part of this enormous phalanx goes to form the sheath of bone protecting the base of the claw. The bony core or peg on which the claw was fixed and moulded is compressed, with a sharp edge above and flat below, where it projects beyond the sheath.

The finger of the fourth digit has three phalanges and is unguiculate, with a claw resembling in shape and size that of the second digit. The proximal phalanx (*ib.* IV, 1) is so compressed in the direction of its axis, that the proximal and distal articular surfaces almost meet above, only about $1\frac{1}{2}$ line's breadth of rough surface there intervening: the proximal articular surface is a wide and moderately deep vertically-elongated channel, with a semielliptic flat surface continued from the lower half of the radial border; the outer and inner sides of the phalanx are narrow, elliptic rough convexities; the distal articular surface is gently convex vertically, sinuous laterally. The second phalanx (*ib.* IV, 2) is deeper than long; its upper surface is produced backward over the proximal phalanx into a rough obtuse process; the under surface is much shorter, but is broader than the upper surface; the convexity of the distal articular surface describes a semicircle from above downward, and is divided by a vertical trochlear groove into two parts,

* Ossemens Fossiles, *ed. cit.* t. viii. p. 510.

of which the ulnar one is the larger. The ungual phalanx (*ib.* IV, 3) is long, triedral, with the radial side of the sheath vertical, the under surface rough and flattened, and the ulnar surface sloping from above downward and outward to join the under surface. The upper posterior tuberosity, overhanging the joint, inclines radiad, and is somewhat flattened; the proximal surface presents a median vertical rising for the channel in the preceding joint.

The small elliptical surface on the radial half of the distal end of the fifth metacarpal supports a very short lamelliform phalanx, produced outward some way beyond the joint; and to this is articulated a stunted second phalanx with a rough, obtuse, non-articular end. In some instances the above two phalanges are blended together.

Amongst existing Mammals the Sloths alone present the connation of the scaphoid with the trapezium, the Two-toed Anteater and the Armadillo that of the first with the second phalanx. This latter character, peculiar to the middle digit in the Megatherium, is limited also to the same digit in the *Myrmecophaga didactyla*; in *Dasypus* it affects the third, fourth and fifth digits.

The *Bradypus tridactylus* has but two flexible phalanges in each of the three unguiculate toes, but this reduction is due to the early anchylosis of the proximal phalanx with the metacarpal, not, as in Megatherium, with the second phalanx. In the *Bradypus didactylus* the unguiculate digits preserve the normal number of free phalanges.

The pollex is atrophied in the Megatherium, as it is in both existing species of Sloth; and, as in the *Bradypus tridactylus*, only the second, third and fourth digits support claws; but the fifth digit, instead of being wanting, as in the Ai, is developed, so far as was needed for the purposes of terrestrial progression, in the Megatherium. The small existing arboreal Sloths are seldom obliged to walk on the ground, and there can only crawl along with difficulty. In the Mylodon the pollex was developed and unguiculate, but both the fourth and fifth digits were terminated by a stunted second phalanx. In the Unau, not only the fourth and fifth digits, but also the first are suppressed in the fore-foot. Yet this is the Sloth, as already remarked, which so peculiarly illustrates the bradypodal affinities of the Megatherium in the structure of the carpus, notwithstanding the degree to which the adaptive modifications of the Megatherioid type of fore-foot are carried in relation to the exclusively arboreal life of this small existing tardigrade. The coalescence of the scaphoid and trapezium, which CUVIER was the first to recognize in the existing Sloths, he continued to affirm in the latest edition of the 'Ossemens Fossiles' to be peculiar to them. The bony structure of the fore-foot of the Megatherium he regarded as most resembling that of the *Dasypus gigas*. M. LAURILLARD, after the subsequent reception of casts of the carpal bones of the Megatherium, which had been transmitted to England, with other bones of the Megatherium, by Sir WOODBINE PARISH, K.H., inferred that the fore-foot of the Megatherium had a greater analogy with that of the *Myrmecophaga jubata*, but he did not detect the connation of the scaphoid with the trapezium. The form of the scapho-trapezial bone in both existing Sloths bears an unmistakeable resemblance to that in the Megatherium, but in the Unau it

describes a deeper curve towards the palmar aspect, and the trapezial portion (described by DE BLAINVILLE as the sesamoid of the pollex*) is relatively longer than in the Megatherium. The base of the stunted metacarpal of the pollex is expanded, and abuts by one part against the trapezium and by another against the base of the second metacarpal. The trapezoides is a small bone articulated, as in the Megatherium, with the scapho-trapezial, the os magnum, and the second metacarpal; the os magnum presents almost the same pentagonal contour, dorsally, as in the Megatherium, the anterior facet being also partly convex for adaptation to a concavity in the base of the middle metacarpal, which likewise is so extended as to interpose itself between the fourth metacarpal and the carpus.

The atrophy of the fifth finger, which has proceeded in the Megatherium to cause the absence of the ungual phalanx, and which atrophy similarly affects both the fifth and fourth digits in the Mylodon and Scelidotherium, has proceeded in the Unau to the removal of all the bones of those digits, save the metacarpal of the fourth, which is reduced to a rudiment of even smaller size than that which forms the vestige of the thumb on the radial side of the hand: it rests, as a great part of the fourth metacarpal in the Megatherium does, upon the expanded base of the third metacarpal.

In the Ai (*Bradypus tridactylus*) the metacarpal rudiment of the pollex is anchylosed at its lateral joint to the base of the metacarpal of the index, but it retains its free articulation with the scapho-trapezium. The chief modifications of both hand and foot in the Three-toed Sloth are the extensive anchyloses of different bones: this character is shown by the coalescence of the trapezoides with the os magnum, such compound bone supporting the base of the second metacarpal and a great part of that of the middle metacarpal; thus fulfilling the same relations to the metacarpus as do the separated bones in the Unau and Megatherium.

The great extent to which the metacarpals are suturally united to each other in the Megatherium, is a character repeated in those of the Ai, but the suture is speedily, in the living Sloth, converted into bony union, and the three metacarpals, like the three metatarsals, thus form one compound bone, as in Birds. The unguiculate digits which this bone supports in the fore-paw, are the homologues of the three claw-bearing toes in the Megatherium. The rudiment of the fifth finger appears as a mere process from the outside of the base of the metacarpal of the fourth: the huge terrestrial predecessor of the small leaf-eating and tree-dwelling quadrupeds retained the fifth toe, minus its terminal phalanx, yet of great size and strength, and modified expressly for the purpose of supporting the ponderous body in terrestrial progression.

The fore-foot of the Mylodon more closely conforms, in its essentials, to the type of that of the Unau, inasmuch as the two outer digits (fourth and fifth) were mutilated and clawless; they were, however, developed to the same degree as the fifth digit is in the Megatherium, and for the same end, but probably made little show, externally, in the entire foot. The pollex, however, instead of being rudimental, was fully developed,

* Ostéographie de Paresseux, 4to, p. 22.

though small, in the Mylodon. In the Megatherium this digit is rudimental, as in both forms of existing Sloth; but the bones of the fore-foot correspond more closely with the type of the manus in the Ai; there being, indeed, as regards the digits, only this essential difference, that the fifth, instead of being, like the first, a mere rudiment, was developed to be adapted to progression on the ground. It is most interesting, however, to trace the interchangeable relations between the two above-cited great extinct Megatherioids and the two existing forms of Sloth, respectively.

In regard to other existing Edentata, the *Myrmecophaga jubata*, by reason of the clawless condition of its fifth digit, and the *Myrmecophaga didactyla*, by that of the rudimental pollex as well as fourth and fifth digits, ought to succeed the Sloths as next of kin to the Megatherioid quadrupeds, the interval being due to the difference of carpal structure.

Cuvier has observed that the fore-foot of the *Dasypus gigas* is one of the most extraordinary among quadrupeds; and, he adds, that it alone would give the key to all the anomalies in that of the Megatherium*. But this could only have been affirmed under a misconception of the real nature of those anomalies. In the *Dasypus gigas* the fore-foot is pentadactyle; all the digits are unguiculate, and, in three of them, the claw-phalanges furnish a bony sheath as well as core to the claws; but these belong to the third, fourth and fifth toes, not, as in the Mylodon, to the first, second and third, or, as in the Megatherium, to the second, third and fourth toes; they moreover successively decrease in size from the radial to the ulnar aspect, instead of the reverse proportions which they present in the Mylodon. No doubt the claw on the middle digit is the most developed, as in the Megatherium, and the first and second phalanges of this digit have coalesced; but here ends the particular resemblance between the Megatherium and the great Armadillo, in regard to the bony structure of the fore-foot.

We can state with confidence, what M. Laurillard suggests†, viz. that the fore-feet of the Megatherium, as represented by the skeleton in the Madrid Museum, are not transposed, the right being on the left and the left on the right side, as Cuvier was led to suspect; but that the articulation of those complex parts by the laborious Prosector and Curator Bru, was in the main correct.

The bony structure of the fore-limb of the Megatherium is now, indeed, as completely understood, and the homologies of every constituent bone as exactly defined, as in any existing species of quadruped. And, to the degree in which so important a part of the frame throws light on the whole, the Naturalist may thereby trace the affinities, and the Physiologist infer the habits, of the great extinct beast.

* "La main du *tatou géant* est une des plus extraordinaires qu'il y ait parmi les quadrupèdes, et à elle seule elle expliquerait toutes les anomalies que nous verrons dans celle du Mégathérium."—Ossemens Fossiles, *ed. cit.* tom. viii. p. 242. No qualifying note is appended by the editors to this statement.

† See the note (1) appended by that able anatomist to the chapter on the Megatherium, in the posthumous edition of the 'Ossemens Fossiles,' 8vo, t. viii. p. 355.

Description of the Plates.

PLATE XVIII.

Oblique front view of the skeleton of the Megatherium, on the scale of half an inch to a foot, showing the true position of the manubrium sterni, and the articulation there-with of the clavicles.

PLATE XIX.

Fig. 1. Inner surface of the scapula, one-fourth the natural size.
Fig. 2. Glenoid cavity and acromiocoracoid arch.

PLATE XX.

Fig. 1. Under surface of the right clavicle.
Fig. 2. Front view of the left humerus.
Fig. 3. Back view of the left humerus.
Fig. 4. Head, or proximal articular surface, of the left humerus.
Fig. 5. Distal articular surface of the left humerus.

PLATE XXI.

Fig. 1 Antero-radial surface of the left ulna.
Fig. 2. Proximal end of the ulna.
Fig. 3. Distal end of the ulna.
Fig. 4. Anterior surface of the left radius.
Fig. 5. Proximal end of the radius.
Fig. 6. Distal end of the radius.

The above figures of Plates XX. and XXI. are less than one-fourth the natural size.

PLATE XXII.

Dorsal or upper surface of the bones of the right fore-foot: less than one-half the natural size.

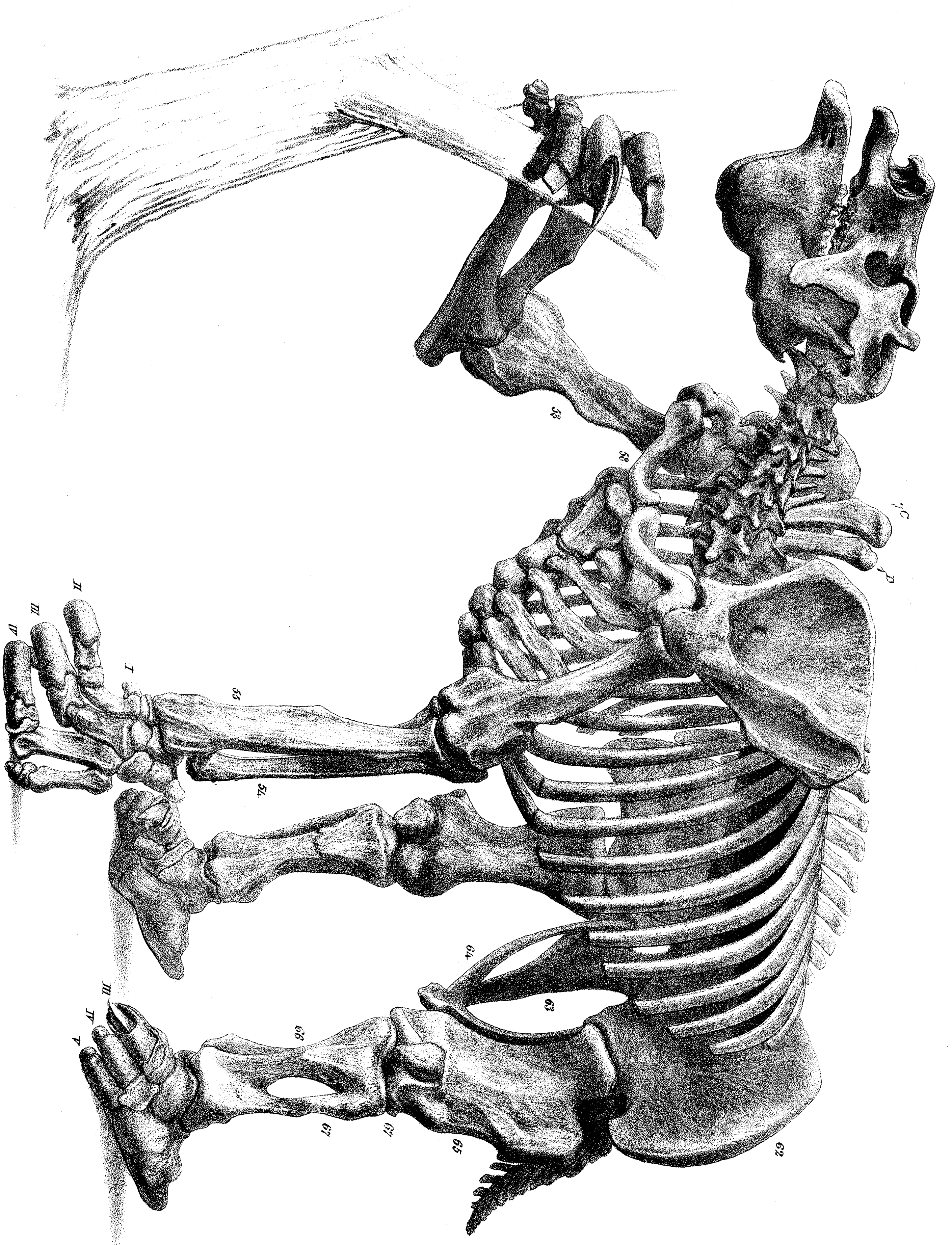

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Fig. 1.

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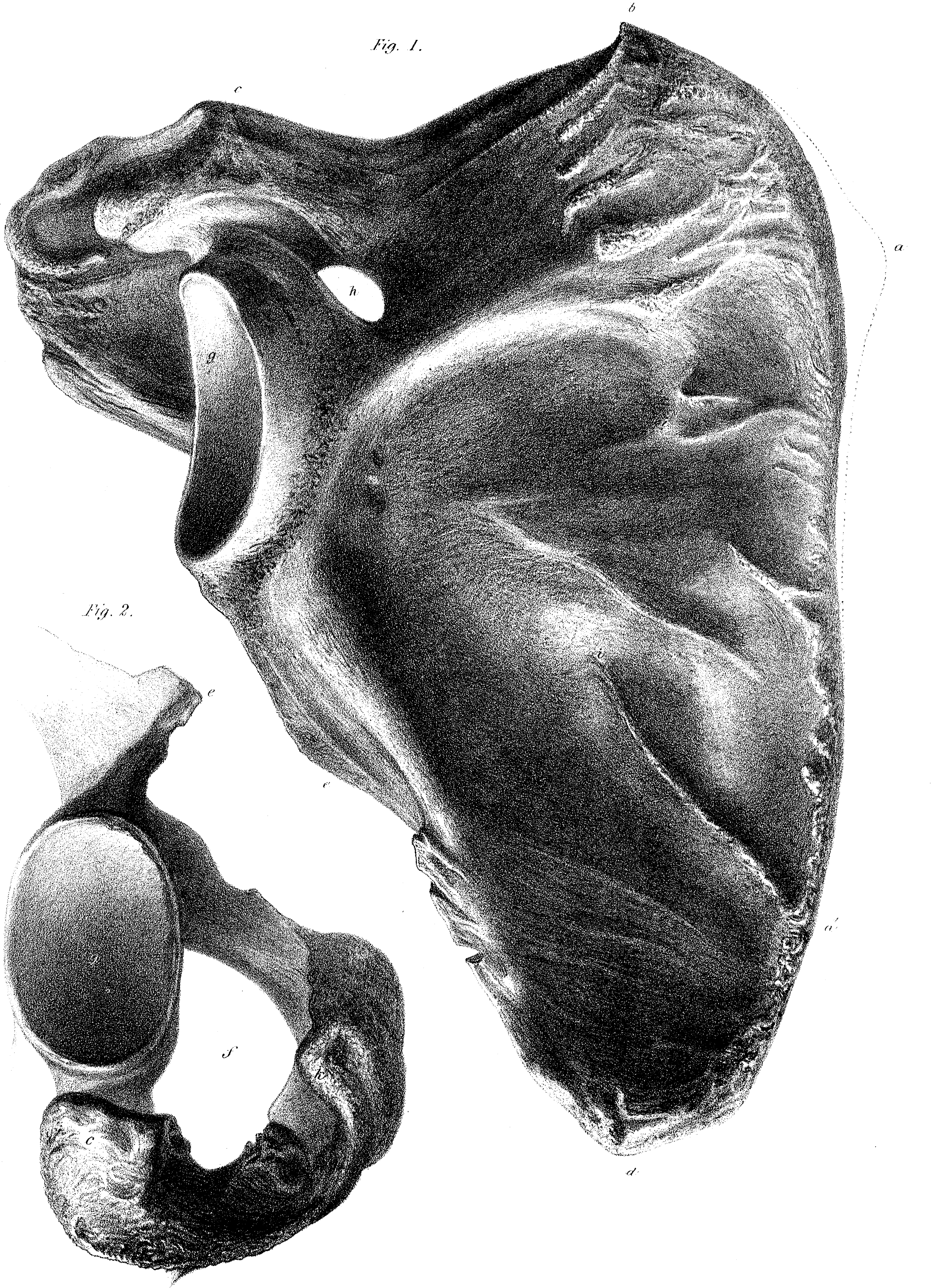

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Fig. 2.

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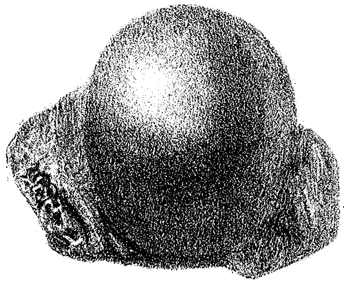


Fig. 3.

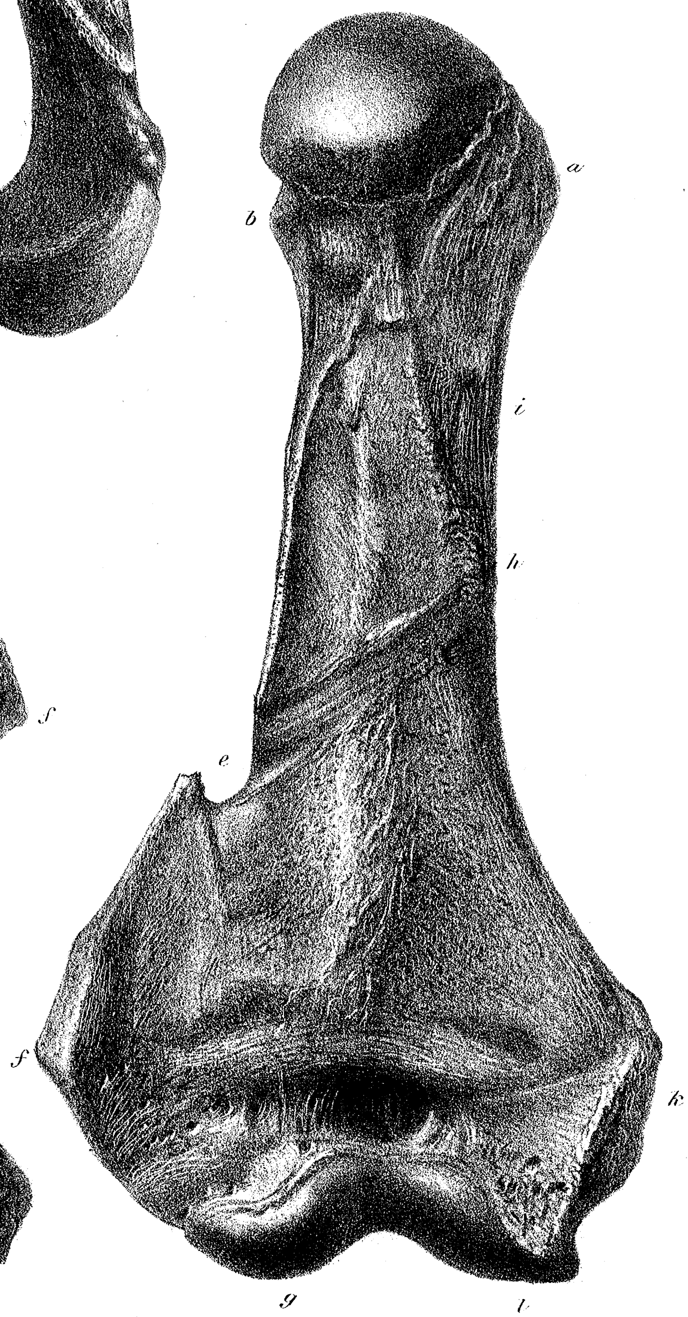
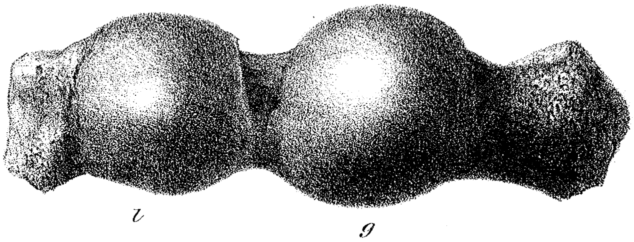


Fig. 5.



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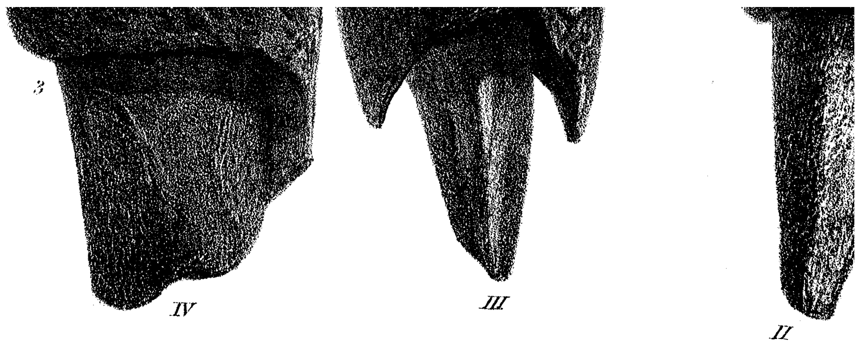

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