XXXII. *On the* MEGATHERIUM (Megatherium Americanum, CUVIER *and* BLUMENBACH). Part V.—*Bones of the Posterior Extremities.* *By Professor* OWEN, *F.R.S.*, *Superintendent of the Natural History Departments in the British Museum.*

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IN the description of the bones of the hind limbs of the Megatherium I commence with the ilium, as being the homotype or correlative of the scapula in the fore limb. The ischium, which is the homotype of the coracoid, is confluent with the ilium, as the coracoid is with the scapula: the pubis, which is the homotype of the clavicle, is confluent with both the ilium and ischium. All the three bones on both sides become confluent with the sacrum, and form therewith a single compound bone—the pelvis—which is the largest known amongst recent or extinct terrestrial Mammals, and gives the most striking feature to the skeleton of the present gigantic extinct Sloth.

As a like progressive ossification brings to pass a similar state of the pelvis in the small existing Sloths, the limits of the primitive bony constituents of that of the Megatherium can only be determined by analogy with the pelvis of its modern congeners, studied in individuals at a period of immaturity. This I have had the opportunity of doing in the young of the *Bradypus tridactylus*, prior to the completion of the coalescence of the several bones.

The five vertebræ composing the sacral part of the pelvis of the Megatherium have been described in a former memoir*, treating of the vertebral column to which they belong.

The iliac bones (Plate XXXVII., 62, and Philosophical Transactions, 1855, Plate XXIII.), as they extend from their place of anchylosis with the sacrum, expand in depth and breadth; their anterior plane is directed forward, being almost vertical and at right angles with the axis of the spine. Each ilium, after contributing its share to the acetabulum (*a*), rapidly contracts to an obtuse point bent downward and outward. The two bones, in a front view, resemble a pair of broad outstretched wings at the sides of the fore part of the sacrum. The anterior surface is slightly concave, but is undulated, with many sharp ridges that have penetrated between the fasciculi of the muscles thereto attached. The 'labrum,' or upper and outer convex border of the ilium, is unusually thick and rugged; the under concave border is also rugged, but is thin, and in some parts sharp. On the inner side of the acetabulum there is a well-defined, raised and very rough, oblong surface (*p*) for the insertion of the tendon of a powerful 'psoas' muscle.

* "On the Megatherium," Philosophical Transactions, Part II. 1851, p. 378.

The outer surface of the ilium is slightly concave near the sacrum, and is then convex in the direction of its longest diameter, which is from within outwards; in other directions it is nearly flat: its surface is much broken by numerous intermuscular ridges.

The pubis (Plate XXXVII. 64) is very slender where it forms the anterior border of the 'foramen ovale' (*o*), but expands at its extremities, and especially where it coalesces with the ischium to form the produced and pointed 'symphysis.' The extent of this symphysis is 10 inches in a straight line.

The pelvis, as in the Sloths and other *Bruta*, shows the conversion of the ischiadic notches (*i*) into foramina by the anchylosis of the ischia with the posterior sacral vertebræ (*s*). Each ischium, 63, as it extends from its confluence with the sacrum, expands into a broad smooth plate of bone, bent outward and forward, then contracting as it converges inward towards its fellow, to combine with the pubic bones at the symphysis. The hinder border, forming the tuberosity, 63, is thick and rugged; and two or three perforations here indicate the original line of its separation from the sacrum. The part of the ischium which joins the pubis on the sacral side of the foramen ovale presents on its inner surface the usual oblique channel leading to that foramen.

Among the existing species of the Order Bruta the Sloths alone resemble the Megatherium in the expansion of the iliac bones, but this is much less in comparison with the length of the trunk; the iliac expansion is relatively greater in the Megatherium than in the Elephant, and is associated with a much greater proportionate size of the whole pelvis and of its cavity or channel. The extreme breadth of the pelvis of a large Asiatic Elephant is 3 feet 8 inches, whilst in the Megatherium it is upwards of 5 feet.

The pelvis which Cuvier was led to suspect, from the defective condition of its fore part in the Madrid skeleton, to be naturally open anteriorly, as in the *Myrmecophaga didactyla*, is closed anteriorly, as in the Sloths, by a 'symphysis pubis' of short extent.

The acetabulum (Plate XXXVII. fig. 2) presents a full oval shape, with the lower margin bisected by a narrow and deep 'Haversian' groove, which extends, slightly expanding and becoming more shallow, to near the bottom of the cavity; the outer division of the lower border of the groove is most produced. The large and deep acetabula look downward and a little outward. One diameter of the hemispheroid cavity is 8 inches, the other diameter is 7 inches; it therefore presents a plane surface of 43·9824 square inches, which, multiplied by 15, with the barometer at 30 inches, gives about 660 pounds atmospheric pressure upon the hip-joint of the Megatherium.

The size and strength of the ordinary processes of the pelvis, the breadth of the rough labrum of the iliac bones, and the numerous and well-defined intermuscular crests, indicate the unusual size and vigour of the muscular masses which proceeded from the pelvis in different directions to act upon the trunk and fore limbs and upon the hind limbs and tail. They lead to the conviction that the resistance which demanded such forces for its overcoming must have have been of a very different nature and degree from any that now opposes itself to the labours of the existing vegetable feeders when engaged in supplying their daily wants; whence it may be inferred that the exertion of such forces was associated with equally peculiar habits in the megatherioid animals.

The femur of the Megatherium (Plate XXXVIII. fig. 1) is one of the most massive limb-bones in the Mammalian class; from its proportions it might rank with the 'flat' instead of the 'long' bones, but that its thickness would rather bring it into the category in which the carpal or tarsal bones are placed according to the old anatomical character derived from shape.

The head (Plate XXXIX. fig. 1) would be a smooth hemisphere, but that the antero-posterior diameter somewhat exceeds the transverse one. Its surface is unimpressed, and its periphery uninterrupted, save by a small entering notch at the middle of its back part, into which possibly some ligament like the '*ligamentum teres*' may have been implanted. The neck of the femur is short and ill-defined; the upper contour passes from the head to the summit of the great trochanter (Plate XXXVIII. *t*), which is on the same level, in a slightly concave line; the inner contour of the bone descends with a somewhat deeper concavity from the lower periphery of the head to the shaft. This is flattened from before backward, and presents a slightly oblique twist, the head and the outer condyle being on a plane anterior to the trochanter and inner condyle. The great trochanter presents a broad rugged surface, flattened obliquely from above downward and inward, divided into two somewhat flattened facets by a transverse ridge arching upward. The lower facet contracts as it descends, and is continued into the strong outer ridge which descends to the external condyle. The thick rough border of the rest of the trochanter stands out beyond the contiguous parts of the femur; least so at the upper, and most at the back part of the process, where the border defines outwardly a small but deep trochanterian fossa (ib. *f*). This fossa is bounded below by a small tuberosity. The small trochanter is represented by a rough ridge, 6 inches long, 2 inches broad, occupying the middle third of the shaft a little anterior to its inner border. A few shorter longitudinal ridges occur on the fore part of the shaft between the upper end of the small, and the upper and fore part of the great trochanter. The rest of the anterior surface of the femur is smooth, concave lengthwise, slightly convex transversely.

The back part of the femur presents a small low tuberosity below its middle part, near the inner border; the triangular surface between this tuberosity, the head, and the great trochanter, is smooth and flat. The contour of the back part of the femur, from the head to the outer condyle, is convex; that from the trochanter to the inner condyle is concave; the lower half of the back part of the shaft is convex transversely. The lower end of the femur (Plate XXXIX. fig. 2) presents two articular surfaces, the inner one (ib. *i*) being that of the internal condyle, the outer one being the combined ectocondyloid (*e*) and rotular (*r*) surfaces. The latter is extensive, and describes a semicircle from before backward, but is narrow from side to side: in this direction the rotular portion is slightly concave; its limits are indicated by a notch on the inner side: the condyloid portion is slightly convex transversely, in which direction the extent is scarcely $2\frac{1}{2}$ inches. The entocondyloid surface (*i*) is of nearly twice that breadth; is of a reniform shape, and is convex in every direction. The intercondyloid channel is roughened by decussating ligamentous impressions and ridges, with some vascular pits. Its narrowest part is anterior, and measures an inch and a half across; posteriorly it is 3 inches across. The intercondyloid border of the inner condyle is sharply defined and projects below the level of the canal, that of the outer condyle is mostly on a level with the canal. The surface of the canal meets the hind surface of the femur at almost a right angle, the intervening ridge being rounded off. The fore part of the inner condyle stops short of the fore part of the shaft; the back part of the condyle projects 1 inch beyond the back part of the shaft. The process or prominence above the inner condyle (*eminentia entocondyloidea*, Plate XXXVIII. *ic*) forms an obtuse angle, the lower side of which is rough, rather flattened, and expands as it descends towards the articular part of the condyle. The outer condyle does not project so far back as the inner one: its supracondyloid prominence (*ec*) is larger, of a similar angular form, but is bent forward as well as outward.

In the Elephant, Mastodon, and Diprotodon, the shaft of the femur is flattened from before backward; but the length of the femur so far exceeds its breadth, that, strong as the thigh-bones of these quadrupeds are and well-proportioned to the weight they had to sustain, they appear weak and even slender when placed by the side of the femur of the Megatherium. The Rhinoceros, which has the thigh-bone relatively broader and flatter than in the proboscidian pachyderms, differs more markedly from the Megatherium in the presence of the third trochanter.

The shaft of the femur is more or less flattened in all the species of *Bruta*; but the Orycteropus and Armadillos, in which this character is conspicuous, differ, like the Rhinoceros, from the Megatherium in having the third trochanter. This process is not present in the Pangolins (*Manis*), Anteaters (*Myrmecophaga*) or Sloths (*Bradypus*); but in all these genera the femur is relatively longer and more slender than in the Megatherium, and only the Sloths amongst existing Mammals, not marine, repeat the remarkable megatherioid character of the absence of a medullary cavity in the shaft of the femur.

The general characters of the femur of the Megatherium are most closely repeated in that of the Mylodon* and Scelidotherium†. In these genera, however, instead of the shallow notch, there is a deep and prolonged fossa for the ligamentum teres on the middle of the hind border of the head of the bone. The post-trochanterian depression is relatively larger in the Mylodon, the small trochanter is relatively less and higher placed; the whole femur is longer in proportion to its breadth, and the distal expansion is relatively less. Here, also, the articular surfaces offer a well-marked character of distinction; the rotular articular surface is continuous with that of both condyles, and unites them anteriorly.

* OWEN 'On the *Mylodon robustus*,' 4to. p. 111. pl. 17.

† Ib. 'Fossil Mammalia' of the 'Voyage of the Beagle,' 4to. pl. 25. fig. 5.

From the cast of a distal epiphysis, transmitted by Dr. HARLAN to the Museum of the Royal College of Surgeons, London, as of the Megalonyx, it would appear that this extinct megatherioid offered a third modification of the knee-joint, the rotular surface being distinct from those of both condyles. Thus the knee-joint of the Mylodon must have had one large synovial capsule, that of the Megatherium two, and that of the Megalonyx three such sacs.

The patella (Plate XXXVIII. fig. 2, and Plate XVII. 66′, Philosophical Transactions, 1855) is a strong, thick, subtrihedral conical bone, with the base rounded, and also the angle between the two rough outer sides. In the natural position of the bone the base is uppermost, and chiefly composed of a strong tuberosity coarsely and irregularly striated: at the lower half of the outer surface the striæ have a longitudinal and subparallel direction, giving that part of the bone the appearance of an ossified fibrous ligament. On the inner and broadest side the articular surface occupies the upper two-thirds: it is less distinctly divided by a median longitudinal rising into two channels than in the Mylodon, being more nearly level and uniform. The non-articular surface below the joint is irregularly grooved and perforated by vascular canals.

The fabella*, or post-tibial sesamoid bone (Plate XVII. 67′, Philosophical Transactions, 1855), is a smaller subhemispheric bone, with a circular, slightly concave articular surface, which was applied to part of the outer condyle of the femur: the rest of the surface is rough and fibrous, indicative of the imbedding of the bone in a flexor tendon of the leg.

The tibia and fibula (Plate XVII. 66, 67, *tom. cit.*) become anchylosed together at both extremities in the Megatherium: they are both short, and the tibia presents massive proportions corresponding with those of the femur. Its proximal end (Plate XXXIX. fig. 3) presents two distinct and well-marked articular surfaces; the inner one (*i*) is concave, the outer one (*e*) is convex: the extent of these surfaces corresponds with the breadth of the articular part of the outer and inner femoral condyles respectively. The back part of the outer facet which bends downward affords an articulation (*f*) to the fabella. The rough interspace between the articular surfaces is a little concave transversely, and convex from before backward; its breadth equals that of the outer surface: it developes no intercondyloid process for crucial ligaments.

The fore part of the proximal end of the tibia presents a large irregularly triangular rugged protuberance for the ligamentum patellæ; the back part, below the outer condyle, developes a smaller but more prominent rugged process, the apex of which overhangs the upper part of the interosseous space: between this 'post-tibial' process and the rough inner border of the bone there is a deep and wide longitudinal channel inclining a little obliquely to the interosseous space. The shaft of the tibia gradually contracts to its middle, and as gradually expands to its distal end. It is subcompressed from before backward; is smoother behind than in front: there is a longitudinal channel on each side the back part of the lower end of the tibia, which forms a convexity between them.

* OWEN, 'Archetype of the Vertebrate Skeleton,' 8vo. p. 190.

The anterior surface is divided by a ridge extending obliquely from the rotular protuberance to the inner malleolus: the surface on the fibular side of this ridge is smoother than the other, which seems to have been wholly given up to musculo-tendinous attachments. The inner malleolus (Plate XXXIX. fig. 4, *m*) is a slight expansion below the confluence of the inner and oblique anterior ridges: it does not project below the level of the distal articular surface. This is deeply concave, and is divided into two facets by the deeper hemispherical excavation near its inner side for the reception of the inner protuberance of the astragalus: this excavation (*e*) gives to the larger and shallower facet (*i*) a full crescentic figure. The smooth surface is sometimes continued upon, sometimes interrupted by, a narrow tract from the vertical surface upon the malleolar end of the fibula, which surface is applied to the outer facet of the astragalus. There is a small orifice for a medullary artery at the middle of the back part of the tibia, but it does not open into any medullary cavity: the bone is cancellous throughout.

The fibula is thickest at its upper end, where it has a trihedral form; the outer surface is convex and rough, the inner and hinder surfaces are concave and smooth, meeting at a sharp interosseous border directed obliquely backward: this border is slightly thickened and produced at its middle part, where the shaft of the fibula is compressed: it augments in thickness and resumes its trihedral shape as it descends, and terminates in a moderately produced outer malleolus (*f*) with a very rugged surface, except where it articulates with the astragalus.

In the Mylodon, as well as in the Megalonyx and Scelidotherium, the tibia and fibula continue separate, a fact affecting the value of the evidence which CUVIER deduced from their anchylosed condition in the Megatherium in favour of its affinities to the Armadillos, to which this structure is peculiar amongst existing Mammals. But, since it is known only in the order *Bruta*, it forms an interesting additional proof of the essential relations of the huge extinct animal under description to that now anomalous group of Mammals. The tibia of the Mylodon is proportionally shorter and thicker than in the Megatherium: the outer articular surface at the upper end is of a subcircular form and slightly concave: in the Megalonyx it is convex, but in a less degree than in the Megatherium. The lower articular surface in both Mylodon, Scelidotherium, and Megalonyx, presents the additional facet for the fibula. The hemispheric excavation on the inner side of the distal articulation is relatively larger in the Mylodon than in the Megatherium. This excavation, with the concomitant protuberance of the astragalus, is peculiar to the great extinct Sloth-like quadrupeds; in which so secure an interlocking of the foot with the leg bespeaks some habits peculiar to them, connected with the requirement of unusual resistance in the foot to the forces acting upon it from the leg and thigh.

In the series of existing animals Man presents the plantigrade foot in which the weight of the body presses most nearly upon the crown of the tarsal arch; but, in the Megatherium, owing to the length of the heel and the shortness of the toes, the leg transmits the superincumbent weight nearly upon the middle of the foot. So singularly shaped and adjusted, however, are the tarsal bones in the Megatherium, that the tibia articulates with the side instead of the summit of the tarsus, so that the whole foot is turned inward and rests upon its outer edge instead of its sole (Plate XLI. fig. 1, and Plate XVII. *cl*, *a*, Philosophical Transactions, 1855).

The number of tarsal bones is reduced to six, through the absence of the entocuneiform*; but the astragalus, and especially the calcaneum, are developed to a great size.

The astragalus (Plates XL. & XLI. fig. 1, *a*) is of a peculiarly irregular form: if the foot be placed with the sole flat on the ground, as in Plate XL., the chief articular surface (*a*) for the tibia looks inward, and the small fibular facet, at right angles therewith, is uppermost. The extensive surface by which it articulates with the bones of the leg is divided into three parts, the planes of which are at right angles to each other. The middle and largest division (*a*), answering to the outer ridge of the trochlear surface in the common form of astragalus, is here expanded into a broad reniform smooth tract, horizontal in the ordinary position of the Megatherium's foot (Plate XLI. fig. 1, *a*), almost flat from before backward, convex from side to side. This surface is continued over the outer edge upon the outer side of the bone, in a triangular form, with the apex rounded off, to form the facet (*o*) for the fibula. The surface answering to the main part of the trochlea and its inner malleolar facet in ordinary astragali, is here reduced to a small triangular convexity (*ib.* & Plate XL. fig. 1, *i*), forming the third and internal division of the surface, and supported on what appears to be an obtuse pyramidal process from the inner and lower part of the bone. This convexity is wedged into the deeper excavation on the inner part of the tibial articular surface, and forms a kind of pivot on which the foot worked.

The under or calcaneal side of the astragalus slopes from behind downward and forward, and is divided by an oblique groove, about an inch broad, into two facets; the outer and posterior one is for the calcaneum exclusively; the inner and anterior one is for the calcaneum, but is continuous with the surface for the naviculare. The outer calcaneal surface is ovate, concave lengthwise, convex across its posterior broader end, nearly flat at its anterior end. The inner calcaneal surface is of much less extent and is nearly flat; its anterior end suddenly bends forward and upward to be continued into the outer convex part of the navicular surface, which surface is divided into this convex portion and a contracted subcircular concavity. The lower part of the convex facet rests upon an articular concave surface on the cuboides.

Only a small proportion of the outer surface of the astragalus is non-articular, and this is chiefly on the outer, or, in the megatherian position of the foot, the upper surface (Plate XLI. fig. 1). The groove dividing the calcaneal surfaces begins at their lower part and passes backward and inward, with slight terminal bends, which give it the form of the italic *f*. It is divided by a ridge from a wider channel, excavating the under part of the inner process; from which a third channel extends backward, dividing part of the

* 'Os cuneiforme internum' of SŒMMERRING.

inner calcaneal facet from the naviculo-cuboid surface. Both this channel and the calcaneal one are perforated by conspicuous vascular canals.

The calcaneum (Plates XL. & XLI. fig. 1, *b*) is a long irregular pyramidal bone, with an obtuse apex: the base is obliquely truncated, forms the fore part of the bone, and supports two articular surfaces (Plate XLI. fig. 2): the upper and outer surface (*as*) is ovate, concave where that on the astragalus is convex, and *vice versâ*: the oblique channel which divides this astragalar surface from the astragalo-cuboidal surface (*as'*) is as deep as in the astragalus, and, like it, is perforated by vascular canals. The slightly concave triangular inner astragalar facet (*as'*) is continued below, at an obtuse angle, into the semielliptic slightly concave surface (*cb*) for the os cuboides. External to the astragalar facet a strong vertically extended tuberosity (Plate XLI. fig. 1, *t*) forms the fore part of a wide and deep tendinal canal (*u*); a narrow and feeble ridge bounds it behind; a second and more shallow groove (*v*) succeeds; and, behind this, is a wide and deep vascular perforation (*w*). The under part of the calcaneum is very rugged and flat. The obtuse hinder extremity of the heel-bone shows by its sculpturing and the outstanding osseous spiculæ, the force with which the attached cable-like 'tendo Achillis' must have acted on so unusually produced a calcaneal lever.

The os naviculare (Plates XL. & XLI. fig. 1, *c*) is a transversely oblong bone, compressed from before backward. Its posterior surface is occupied by the articulation for the astragalus, which is equally divided into an inner concavity and an outer convexity, the latter approaching the conical form. From the lower part of this is continued at a right angle a small flat triangular surface for the cuboides (Plate XL. fig. 3, *cb''*). The upper non-articular surface is narrowest at its middle, and is developed into a low oblong tuberosity on each side. On the fore part of the bone (Plate XL. fig. 3) is the articular surface, divided into the narrow oblong tract (*cm*), with two slight convexities, for the mesocuneiforme (*ib.* fig. 1, *f*), and into the almost flat triangular tract (fig. 3, *ci*) for the ectocuneiforme (fig. 1, *e*). The latter surface (fig. 3, *ci*) is divided by a very narrow non-articular tract from the cuboidal surface (fig. 3, *cb''*). The inner (tibial) part of the anterior surface is non-articular, and extends beyond the mesocuneiform articulation to where the entocuneiforme would have been, had that bone existed in the tarsus of the Megatherium.

The mesocuneiforme (Plates XL. & XLI. fig. 1, *f*) is a laterally compressed reniform bone, with a thick rough convex inferior border: the inner (tibial) surface (Plate XL. fig. 1, *f*) is irregular and flattened: the similarly modified outer (fibular) surface (Plate XL. fig. 2, *f*) is varied by a flat elliptic articular facet (*iii*) near its upper part, for a similar surface on the side of the metatarsal of the 'digitus medius.' The back part of the bone is chiefly occupied by the narrow surface for the naviculare. The fore part of the bone is obtuse and rough. Not a vestige of the toe (digitus secundus), usually supported by the mesocuneiforme, is developed in the Megatherium.

The ectocuneiforme (Plates XL. & XLI. fig. 1, *e*) presents the normal wedge-like figure of the tarsal cuneiform bones. It is flattened from before backward; with its thick base (*e*) rough and convex. The posterior surface presents the almost flat, slightly concave articular surface for the naviculare. The outer border or surface is rough and tuberous; the inner one less rough and flat. The anterior convex facet (Plate XL. fig. 2, *iii*) for the base of the metacarpal does not extend to the upper or under borders of the bone. The articulation with the contiguous cuneiforme, as with the cuboides, is by syndesmosis.

The cuboides (Plate XLI. fig. 1, *d*) presents an articular surface divided into three facets on its upper, or tibial, and back part; the anterior and smallest facet is for the naviculare (*c*), the middle and largest for the astragalus (*a*), and the posterior for the calcaneum (*tb*): the latter surface is at almost a right angle with the astragalar one, and looks backward. On the under, or fibular, and fore part of the bone is the articular surface for the two outer metatarsals; that for the fourth toe (Plate XL. fig. 2, *iv*) being concave transversely and slightly convex lengthwise; that for the fifth toe (ib. *v*) being uniformly but very slightly convex.

A broad non-articular surface, rough and with two oblique low ridges on the upper and outer part of the bone, divides the back from the front articular surface; a narrower non-articular tract, but produced into a strong obtuse ridge, divides the same surfaces on the inner or under side of the bone. The fore part of the bone is produced into an angular process (Plate XL. fig. 2, *p*), which forms the inner part of the articular channel for the fourth metatarsal. The under part of the bone is impressed by the broad tendinal groove continued from that which impresses the outer part of the calcaneum.

The above-described composition of the tarsus of the Megatherium has been deduced from the study of three entire specimens of the bones of the hind foot; and it demonstrates that the digits of that foot were but three in number, and that they answered to the 'third,' 'fourth,' and 'fifth' of the pentadactyle type. Not a rudiment of the 'second' exists, and every vestige of the first, together with the cuneiform bone supporting it, is absent. There are no little bones missing on the inner side of the 'mesocuneiforme,' as Dr. PANDER conjectured might be the case in the Madrid skeleton; and there is no 'os cuneiforme' for the hallux ('grand doit du pied'), as CUVIER supposed.

Metatarsus.—The metatarsal of the 'third' toe (Plates XL. & XLI. fig. 1, m_3) resembles rather an 'os cuneiforme,' by reason of its extreme shortness, or fore-and-aft compression. Its upper non-articular surface is the broadest, and is rough and convex, like that of the ectocuneiforme. The proximal or posterior surface for that cuneiform bone is triangular and slightly concave (Plate XLI. fig. 3, *ci*); the bone is prolonged into a tuberous process beneath it, forming a lever of advantage for the insertion of a flexor tendon. On the inner side of the bone, at its upper part, is the small flat surface (*cm*) adapted to that on the mesocuneiforme; on the outer side of the bone is a larger surface, partly convex, partly concave, for articulating with the side of the base of the fourth metacarpal (Plate XLI. fig. 1, m_4); the rest of the outer surface is very irregular, as if honeycombed. The distal or anterior articular surface presents a vertical median prominence, passing into a partly flat surface internally, and into a vertically concave surface externally. The lower part of the vertical prominence is most produced (*ib.* fig. 2, *p*).

The fourth metatarsal (Plate XLI. fig. 1, m_4) has its base compressed laterally, and expanded vertically; but the distal end is still more produced in that direction, so as to be almost hammer-shaped. The vertically extended articular surface at the base of this metatarsal is narrow, convex transversely, and adapted to the channel in the cuboides (Plate XL. fig. 2, *p iv*). On the inner or tibial side of the base is the articular surface, concave posteriorly, less convex anteriorly, for the interlocking joint with the 'third' metatarsal. In front and below this articular surface is a very rough honeycombed tract of bone for firm syndesmotic junction with the similarly modified surface of the third metatarsal.

On the outer or fibular side of the base are two articular surfaces for the fifth metatarsal: the hinder and smaller one is flat, and is continued, at right angles, with the basal surface; the larger surface is subcircular and rather undulating: in front and below these surfaces is a narrow rugged tract for ligamentous junction with the fifth metatarsal. The part of the shaft of the fourth metatarsal which stands out free is smooth upon its inner and upper sides, is traversed by a wide oblique tendinal groove below, and is rather rough and irregular externally.

The vertically produced distal surface presents a large rough protuberance at its upper part (Plate XL. fig. 1, *iv*), and three protuberances at its under part, of which the innermost is the most produced, the outermost the least. The articular surface resembles in character that on the end of the third metatarsal, but is relatively smaller; it consists of a longitudinal median prominence, continuous with a smooth narrow tract on the inner side, on which surface articular cartilage and synovial membrane seem to have existed at only a small part at its lower end. On the outer side, the smooth tract is limited to the upper half of the prominence; this is slightly concave vertically or lengthwise. It is a form of articulation calculated rather for firm and unyielding junction than for flexibility.

The outermost metatarsal (Plate XLI. fig. 1, m_5), answering to the fifth of the pentadactyle foot, is the longest, but from its more backward articulation with the tarsus it does not reach so far forward as the fourth.

The proximal end is a free rough tuberosity, somewhat more than an inch anterior to which, on the tibial side, is the oval slightly concave articular surface adapted to the cuboides (Plate XL. fig. 2, *v*), which surface is continuous with the short transverse flattened surface for the fourth metatarsal; and, in advance of this, is the larger, subcircular, slightly undulated surface for the corresponding surface on the fourth metatarsal. The second surface is on the middle of the inner surface of the fifth metatarsal, and is bordered in front and beneath by the very rough honeycombed surface for ligamentous junction with the adjoining metatarsal. This combination of synovial with syndesmotic joints admits of that degree of slight elastic movement of the very firmly attached fourth and fifth metatarsals, which must have facilitated the heavy tread of the ponderous quadruped, and have alleviated the effect of the enormous pressure on the two gradatorial toes. The whole outer and under part of the non-articular surface of the fifth metatarsal is strongly sculptured by irregular ridges, tubercles, grooves, and foramina, indicative of the hoof-like callosity of the outer border of the sole in which it was chiefly imbedded. The upper and inner non-articular surfaces are comparatively smooth. The inner side is flat, and is traversed by an oblique shallow (tendinal?) groove. On the distal surface are two small articular facets; the inner one, which is the best marked, is subcircular, about 8 lines in diameter.

Phalanges.—The bones of this class are unusually reduced in number in the foot of the Megatherium, even admitting the accuracy of the figures of the hind foot of the Madrid skeleton, in which two stunted phalanges appear to terminate both the fourth and fifth toes. For, as the great unguiculate toe, like that of the fore-foot, has only two moveable phalanges, the total number of these bones is but six, not exceeding that of the tarsal bones of the same foot.

The phalanx (Plate XLI. figs. 1 & 3, $_{1\,\&\,2}$) of the innermost toe (*iii*), answering to the third of the pentadactyle foot, represents, as in the corresponding digit of the fore foot, the proximal and middle phalanges connate. The compound bone (*ib.* fig. 3, $_{1\,\&\,2}$) is shaped like a wedge with an oblique edge, deeply notched. It has articular surfaces not only on its proximal and distal ends, but upon its upper or dorsal surface. The two former surfaces, which are the 'ends' of the bone in ordinary phalanges, here form the 'sides' of the wedge: the sides of the phalanx are the 'margins' of the wedge: the dorsal surface forms the base, the plantar or under surface is represented by the two processes of the cleft apex or edge of the wedge. The proximal articular surface presents a longitudinal channel, convex vertically, concave transversely, from which a flat surface extends from nearly the whole of the tibial side, and a convex surface from the upper part of the fibular side; the whole articular surface being the counterpart of that on the metatarsal (ib. *m*), with which the present remarkable bone is, by this interlocking joint, firmly united. The lower prominence of the median rising of the distal joint of the metatarsal (*p*) protrudes through the lower notch in the phalanx (*n*). A yielding, elastic, slightly-sliding movement was all that could take place between these bones. The complex distal articulation is adapted to an equally restricted junction with the enormous terminal phalanx ($_3$); it consists of four distinct articular surfaces, two on the anterior and two on the upper part of the connate phalanges ($_1$ & $_2$). The internal of the two distal surfaces is the largest and is slightly concave, the external one, near the upper and outer angle of the bone, is slightly convex; they are divided by a rough tract, indicating strong ligamentous union with the claw-phalanx, of half an inch in breadth; and they cover the smaller proportion of the distal surface of the bone. Below the outer articular surface there is a protuberance, with a smooth but non-synovial surface in the present bone, which is adapted to a definite smooth surface upon the claw-phalanx. The two upper surfaces are subcircular, each about half an inch in diameter, very slightly convex, and about 5 lines apart.

The great terminal phalanx of the present toe (Plates XL. & XLI. *iii*, $_3$) is modified, like its homotype on the fore foot, for the firm fixation and development of a powerful claw, the hollow base of which covered the bony core, and was encompassed by a bony sheath of 5 inches in length.

The base of the phalanx, whence both core and sheath extend forward, is a surface of a long, narrow, vertically elliptical form, with the upper third produced backward so as to overhang or cover the confluent supporting phalanges; and the lower third sloping forward at nearly the same angle with the vertical middle third, but terminated by a backwardly projecting ridge. There are two articular surfaces on the middle division, two on the upper division, and one on the lower division of the base. The innermost of the middle articulations is slightly convex, the outermost as slightly concave; they both look directly backward. The lower articular surface is flat and subcircular; it is on the hinder and outer angle of the lower third of the base, and looks downward and a little backward; the two small surfaces on the upper third of the base are subcircular and flat, and look downward: these different articular surfaces are counterparts of those on the distal and upper parts of the connate phalanges. On each side of the lower third of the base of the claw-phalanx is a large canal, leading forward to the interspace between the bony core and sheath of the claw, and giving passage to the vessels and nerves of the formative matrix of that instrument. The tibial side of the sheath (Plate XL. fig. 1, $_3$) is gently convex; the fibular side (Plate XLI. fig. 3, $_3$) is flatter: a similar modification affects the claw-core, the narrow basal part of which is divided by sharp borders from the sides. The point of the core projects about 3 inches in advance of the lower border of the sheath: its form, broken in the specimen, is restored in dotted outline in the figures.

The distal articular surface of the fourth metatarsal shows that it supported a phalanx so articulated with it as to have no movements of flexion or extension, and only a slight degree of bending from side to side. The illustrations of the Madrid skeleton, especially plate 5, fig. 5, show that this phalanx (Plate XLI. fig. 1, *iv*, $_1$) was very short, and that it supported a second phalanx (ib. *iv*, $_2$) of a subhemispheric form, terminated obtusely.

The distal articular surface of the fifth metatarsal indicates that it supported a phalanx smaller than the proximal one of the fourth toe; and the figure, above cited, of the Madrid skeleton shows such a phalanx (ib. *v*, $_1$), and also a second small stunted hemispheric phalanx (ib. *v*, $_2$)*; and this, from the analogy of the Mylodon, is most probably the true structure.

If we contemplate the bones of this singularly constructed foot in their natural

* In the original memoir, by Bru and Garriga, on the Skeleton of the Megatherium at Madrid, the metatarsus and toes of the hind foot are said to agree with those of the fore foot, except that there is only one toe with a claw, instead of three ("Tambien se advierte que en este hay solo un *Dedo* con uña, quando en la *Mano* se registran tres; en lo demas convienen en un todo," p. 16). In the description of the outermost (fourth developed) toe of the fore foot it is stated that it has two phalanges, and that there is nothing to be remarked except that they are rounded ("Los dos *Falanges* del *quarto* que se reconocen en J. y L. no tienen cosa que advertir mas que son casi redondas," p. 13).

co-adaptation, the same relation of the osseous masonry to the transference of pressure from the leg to the outer border of the foot will be appreciated, as has been pointed out in the fore limb. The broad surface of the astragalus—the great keystone of the tarso-metatarsal arch (Plate XLI. fig. 1, *a*)—transmits the superincumbent weight in two chief directions, backward upon the massive heel-bone (*b*), forward upon the metatarsus. By the naviculare (*c*) it is transmitted through the ectocuneiforme (*e*) and the produced outer angle of the base of the mid-metatarsal (m_3) to the fourth (m_4), and thence to the fifth metatarsal (m_5). The cuboides (*d*), receiving the weight from both astragalus and naviculare, transmits it by its produced fore part to the base of the fourth metatarsal; and partly by that medium, but chiefly by direct articulation, to the side of the base of the fifth metatarsal. The tendency in the cuboides to yield under this pressure and slip back, is resisted by the abutment of the calcaneum (*b*, *t*) against its back part.

Comparison of the Bones of the Hind Foot.

No known recent Mammal offers in its astragalus any repetition of the peculiarities of that bone in the Megatherium. In the Anteaters and Armadillos the upper surface of the astragalus has the usual configuration, and is received into a deep tibio-peroneal mortice. In the Sloths the outer part of the astragalus is excavated by a deep cell, in which the pivot-shaped end of the fibula rotates: the inner side is applied, as usual, against a malleolar process of the tibia. There is an analogy in the pivoted part of the articulation, but the process and the cavity are on reverse parts of the ankle-joint, as compared with the Megatherium.

The convex protuberance or pivot on the inner half of the tibial surface of the astragalus is common to all the extinct Megatherioids hitherto discovered, but it is associated with well-marked modifications of the bone in each genus, and with minor differences in different species. In the Mylodon* the calcaneal surface is single, and is continuous with the navicular one; no part is insulated by a bisecting groove, as in the Megatherium: the middle division (*a*) of the upper articular surface is less convex; the upper half of the navicular surface is flat, instead of being concave.

The astragalus of the Scelidotherium† agrees with that of the Mylodon in the less depth of the middle division of the upper surface, and the more open angle at which it joins the inner convexity; it agrees with that of the Megatherium in the division of the calcaneal surface; but it differs from both in the presence of two deep concavities upon the naviculo-cuboid surface, the portion to which the cuboides articulates being concave instead of convex.

As the modification of the calcaneal surface of the astragalus governs that of the co-adapted surface in the calcaneum, this bone, in the Mylodon, is distinguished by the uninterrupted continuity of the articulation presented to the astragalus, with which

* "Description of the Skeleton of the *Mylodon robustus*," 4to, 1842, p. 117. pls. 21, 22, & 23. figs. 1 & 2.

† "Fossil Mammalia," Voyage of the Beagle, 4to, pl. 26.

that for the cuboides is continuous; the posterior part of the astragalar surface is less convex than in the Megatherium: the posterior prolongation of the calcaneum is relatively shorter and is less pointed: the posterior wall of the great outer tendinal groove is more developed in the Mylodon. In the Scelidotherium the posterior termination of the calcaneum is broader, and terminated by a less angular convexity than in the Mylodon; but in the separation of the posterior from the anterior part of the astragalar surface it agrees with the Megatherium and with the Sloths. These, of all recent *Bruta*, most resemble the Megatherioids in the posterior prolongation of the calcaneum, and more especially the Megalonyx in the compression and distal expansion of that lever; but, in the Megalonyx, this expansion in the vertical direction is extreme, and gives the heel-bone more the form of an os ilium than of a tarsal bone.

In the os cuboides of the Mylodon the two surfaces for the fourth and fifth metatarsals are nearly on the same plane; in the Megatherium they are nearly at a right angle. In the Scelidotherium the surface by which the cuboides joins the astragalus is convex, instead of concave, as in the Megatherium and Mylodon. In the latter genus the surface on the os naviculare for the mesocuneiform bone is relatively broader than in the Megatherium; and the upper division of the astragalar surface is flat, instead of being convex.

With respect to the digits, it is significant of the true affinities of the Megatherium to find that the Sloths alone amongst the existing *Bruta* show a suppression of certain toes: in all the other existing genera of the order the hind foot retains the typical number of digits.

The Armadillos, including the *Chlamyphorus*, resemble the Megatherium in the terminal confluence of the tibia and fibula; but these bones articulate in the *Dasypodidæ* in the normal way with the astragalus, and the foot is planted firmly on the ground by its flat surface. The hallux is not only present in the *Chlamyphorus*, but is longer than the fifth toe. All the five toes are armed with claws; and anomalous as the three-toed hind feet of the Sloths may appear, they have more real resemblance with the feet of the Megatherioids than have those of any of the Armadillo family. The great extinct *Glyptodon* agrees with the *Chlamyphorus* in the pentadactyle condition of the hind foot, the os naviculare having three facets for as many cuneiform bones, the innermost of which supports a well-developed hallux. This toe is abortive in existing Sloths, and is represented by a small compressed bone, consisting apparently of the connate entocuneiform and metatarsal: it retains its distinctness in the Unau, as the similar representative of the second toe does in the Megatherium; and the meso- and ecto-cuneiform bones are also distinct; but in the Ai each cuneiform bone is confluent with its metatarsal, with each other, with the naviculare, and with the cuboides.

In the Megatherium, the mutilation of the foot has commenced on its outer side by the removal of the ungual phalanx from the fifth and fourth toes; in the Sloths the mutilation is restricted to the fifth toe, but is carried further, viz. to the removal of all the phalanges and the reduction of size of the metatarsal: nevertheless, the Sloths alone, amongst existing *Bruta*, manifest in any degree the characteristic megatherioid condition of the extreme toes of the pentadactyle series: and the minor modifications of this character, differentiating the existing from the extinct phyllophagous *Bruta*, are such as intelligibly relate to the different powers and habits of creatures so different in size and mode of progression.

The mutilation of the two outer toes in the Megatherium is accompanied by modifications which adapt them to the important office of the support and progression of the body on level ground: in the scansorial Sloths, the three middle digits being equally developed for prehensile purposes, and none being needed for walking, one toe on the outer and one on the inner side of the foot is reduced to the metatarsal basis, and is concealed beneath the skin. In the Megatherium the hallux and its cuneiform bone are wanting: the second toe is represented by its cuneiform bone, with, perhaps, a connate rudiment of a metatarsal: only the third toe can be compared, by its size and the claw it supports, with the condition of the three unguiculate toes in the Sloths; and, like those of the Ai, it has but two moveable phalanges. The reduction of the claws to one in the hind foot of the Megatherium, its enormous size and strength, its secure attachment to the phalanx, and the solidity of the articulations of the constituent bones of the whole toe, relate to the contrasted mode of obtaining the leafy food in the colossal extinct Sloth as compared with the diminutive climbing species which still exists. If the hind foot were put by the Megatherium to the preliminary work of exposing and loosening the roots of the tree about to be prostrated, its efficiency for that purpose would be greater by having but one claw, than if it had two or three: for the single claw, like a pickaxe, would clear away the soil from the interstices of the root-ramifications, the more easily by not being associated with a second contiguous claw, impeding such operation by striking upon the root itself.

Physiological Summary.

To sum up the results of the foregoing descriptions of the known fossilized parts of the extinct giant of the order *Bruta*, as indicative of its habits and affinities. The teeth agree in number, kind, mode of implantation, and growth, with those of the Sloth (*Bradypus*), and their structure is a modification of that peculiar to the same genus. All the modifications of the skull relating to the act of mastication, especially the large and complex malar bones, repeat the peculiarities presented by the existing Sloths. There are the same hemispheric depressions for the hyoid bone in the Megatherium as in the Sloth. In the number of cervical vertebræ, the Megatherium, like the Two-toed Sloth, agrees with the Mammalia generally *. In the accessory articular surfaces afforded by the anapophyses and parapophyses of the hinder dorsal and lumbar vertebræ †, the Megatherium resembles the Anteaters (*Myrmecophaga* ‡); but it does not resemble the Armadillos (*Dasypus* §) in having long metapophyses, the peculiar development of which

* Philosophical Transactions, 1855, Plate XVII. *C.*

† Ibid. Plate XXVI. *a* and *p.*

‡ Ibid. 1851, Plate XLIX. fig. 20.

§ Ibid. Plate XLIX. figs. 18, 19.

in those loricated *Bruta* has a direct relation to the support of their bony dermal armour. In the mesozygapophyses of the middle dorsal vertebræ*, the Megatherium is peculiar amongst Mammalia. In the small extent of the produced and pointed symphysis pubis it resembles the Sloths; and in the junction of both ilium and ischium with the sacrum, it manifests a character common to the Edentate order; but in the expanse and massiveness of the iliac bones, it can only be compared with other extinct members of its own peculiar family of phyllophagous *Bruta*. The habits of the Megathere necessitating a strong and powerful tail, we find this resembling in its bony structure that of other *Bruta* with a similar appendage, especially in the independency of the two hæmapophyses of the first caudal, a character which obtains in the Anteaters† and in some Armadillos; but this is no evidence of direct affinity to either of those families: the habits of the small arboreal Sloths render their eminently prehensile limbs sufficient for their required movements, and the tail is wanting. Had that appendage been proportionally as large as in the Megatherium, we cannot suppose that the caudal vertebræ would have materially differed from those of other *Bruta*.

In the coalescence of the anterior vertebral ribs with the bony sternal ribs, the Megatherium resembles the Sloths. This essential affinity is still more marked in the peculiarities of the scapula and of the carpus. In the *Myrmecophaga jubata*, the scaphoid is distinct: in the *Manis* it coalesces with the lunare: in the *Dasypus gigas* the trapezoides is anchylosed to the second metacarpal: in the *Das. sexcinctus* it has coalesced with the trapezium. Not any of these characteristics are manifested by the Megatherium: its carpus repeats the peculiarities of that in the Sloths, viz. the reduction of the number of carpal bones to seven by the coalescence of the scaphoid with the trapezium. The first digit (pollex), which is retained in the Anteaters and Armadillos, is obsolete in the Megatherium, as in the Sloths and Orycteropus: three digits are fully developed and armed with claws, as in the *Bradypus tridactylus*; and the fifth, though incomplete in the Megatherium, is better developed, because it was required in the ponderous terrestrial Sloth for its progression on level ground. In no existing ground-dwelling member of the *Bruta* is the fifth digit deprived of its ungual phalanx, as in the Megatherium. The bones of the fore foot of that extinct animal are thus seen to be modified mainly after the type of the *Bradypodidæ*.

The long bones of all the limbs are devoid of medullary cavities, as in the Sloths. The femur lacks the ligamentum teres, as in the Sloths. The fibula is anchylosed to the tibia at both ends in Megatherium, as in *Dasypus*; but this is not the case in the closely-allied extinct Megatherioids called Mylodon, Megalonyx, and Scelidotherium, a fact which diminishes the force of the argument which CUVIER deduced from the coalesced condition of the bones in the Megatherium in favour of its affinities to the Armadillos. The semi-inverted but firm interlocking articulation of the hind foot to the leg shows the peculiarities of that joint in the Sloths exaggerated, and departs further from its characteristics in other *Bruta*. In all the existing members of the order, save the

* Philosophical Transactions, 1855, Plate XIX. *mz*.

† Ibid. 1851, Plate LIII. fig. 60.

Sloths, the hind foot is pentadactyle, and four of the toes have a long claw, even in the little arboreal *Myrmecophaga didactyla*: the departure by degradation from the pentadactyle type is a peculiar characteristic of the Sloth-tribe in the order. It is carried further in the same direction in the Megatherium and other great extinct terrestrial Sloths.

Guided by the general rule that animals having the same kind of dentition have the same kind of food, I conclude that the Megatherium must have subsisted, like the Sloths, on the foliage of trees; but that the greater size and strength of the jaws and teeth, and the double-ridged grinding surface of the molars in the Megatherium, adapted it to bruise the smaller branches as well as the leaves, and thus to approximate its food to that of the Elephants and Mastodons. The Elephant and the Giraffe are specially modified to obtain their leafy food; the one being provided with a proboscis, and the entire frame of the lofty ruminant adapting it to browse on branches above the reach of its largest congeners. If the Megatherium possessed, as CUVIER conjectured, a proboscis, it cannot, judging from the suborbital foramina, have exceeded in size that of the Tapir, and could only have operated upon branches brought near the mouth. Of the use of such a proboscis in obtaining nutritious roots, on the Cuvierian hypothesis that such formed the sustenance of the Megatherium, it is not easy to speculate: the Hog's snout might be supposed to be more serviceable in obtaining those buried parts of vegetables; but no trace of the prenasal bone exists in the skull of the Megatherium. A short proboscis might be useful in rending off the branches of a tree when prostrated and within reach of the low and broad-bodied Megatherium, but this office has been provided for by the organization of the tongue, of which, both the hyoid skeleton by its strength and articulation, and the foramina for the muscular nerves by their unusual area, attest the great size and power.

As regards the limbs, the Megatherium differs from the Giraffe and Elephant in the unguiculate character of certain of its toes, in the power of rotating the bones of the fore arm, in the corresponding development of supinator and entocondyloid ridges on the humerus, and in the possession of complete clavicles. These bones are requisite to give due strength and stability to the shoulder-joint for varied actions of the fore arm, as in grasping, climbing, and burrowing. But they are not essential to scansorial or fossorial quadrupeds: the Bear and the Badger have not a trace of clavicles, and merely rudiments of these bones exist in the Rabbit and the Fox. We must seek, therefore, in the other parts of the organization of the Megatherium, for a clue to the nature of the actions by which it obtained its food. In habitual burrowers the claws can be extended in the same plane as the palm, and they are broader than they are deep. In the Megatherium the depth of the claw-phalanx exceeds its breadth, especially in the large one of the middle finger; and not any of the claws can be extended into a line with the metacarpus, but they are all more or less bent inward and downward. Thus, although they might be used for occasional acts of scratching up the soil, they are better adapted for grasping; and the whole structure of the fore foot militates against the hypothesis of PANDER and D'ALTON*, that the Megatherium was a burrowing animal.

The same structure equally shows that it was not, as Dr. LUND† supposes, a scansorial quadruped; for, in the degree in which the foot departs from the structure of that of the existing Sloths, it is unfitted for climbing; and the outer digit is modified, after the ungulate type, for the exclusive office of supporting the body in ordinary terrestrial progression. It may be inferred from the diminished curvature and length, and from the increased strength and the inequality of the claws, especially the disproportionately large size of that weapon of the middle digit, that the fore foot of the Megatherium was occasionally applied by the short and strong fore limb in the act of digging: but its analogy to that of the Anteaters teaches that the fossorial actions were limited to the removal of the surface-soil, in order to expose something there concealed, and not for the purpose of burrowing. Such an instrument would be equally effective in the disturbance of roots and of ants; it is, however, still better adapted for grasping than for delving. But to whatever task the partially unguiculate hand of the Megatherium might have been applied, the bones of the wrist, fore arm, arm, and shoulder, attest the prodigious force which would be brought to bear upon its execution. The general organization of the anterior extremity of the Megatherium is incompatible with its being a strictly scansorial or exclusively fossorial animal, and its teeth and jaws decidedly negative the idea of its having fed upon insects; the two extremes in regard to the length of the jaws are presented by the phyllophagous and myrmecophagous members of the order *Bruta*, and the Megatherium in the shortness of its face agrees with the Sloths.

Proceeding, then, to other parts of the skeleton for the solution of the question as to how the Megatherium obtained its leafy food, it may be remarked that the pelvis and hind limbs of the strictly burrowing animal, *e. g.* the Mole, are remarkably slender and feeble, and they offer no notable development in the Rabbit, the Orycterope, or other less powerful excavators. In the climbing animals, as, *e. g.*, the Sloths and Orangs, the hind legs are much shorter than the fore legs; and even in those Quadrumana in which the prehensile tail is superadded to the sacrum, the pelvis is not remarkable for its size or the expansion of its iliac bones. But, in the Megatherium, the extraordinary bulk and massive proportions of the pelvis and hind limbs arrest the attention of the least curious beholder, and become to the physiologist eminently suggestive of the peculiar powers and actions of the animal. The enormous pelvis was the centre whence muscular masses of unwonted force diverged to act upon the trunk, the tail, and the hind legs, and also by the 'latissimus dorsi' on the fore limbs. The fore foot being adapted for scratching as well as for grasping, may have been employed in removing the earth from the roots of the tree and detaching them from the soil: but the hind foot, which, like a pickaxe, had but one strong perforating and digging pointed weapon, was more pro-

* Das Riesen-Faulthier, &c. fol. 1821, p. 16.

† Blik paa Brasiliens Dyreverden för sidste Jordomvæltning, af Dr. LUND, 4to. Kjöbenhavn, 1838, p. 21.

bably the instrument mainly employed in removing the earth from the ramifications of the root. The fore limbs, terminated each by three claws, appear to have been more especially adapted for grasping the trunk of a tree; and the forces concentrated upon them from the broad posterior basis of the body must have cooperated with them in the labour, for which they are so amply organized, of uprooting and prostrating the tree. To give due resistance and stability to the pelvis, the bones of the hind legs are extraordinarily and massively developed, and the strong and powerful tail must have concurred with the two hind legs in forming a tripod, as a firm foundation for the vast pelvis, thus providing adequate resistance to the forces acting and re-acting from and upon that great osseous centre. The large processes and capacious spinal canal indicate the strength of the muscles which surrounded the tail, and the vast mass of nervous fibre from which those muscles derived their energy. The natural co-adaptation of the articular surfaces shows that the ordinary inflection of the end of the tail was backward, as in a *cauda fulciens*, not forward, as in a *cauda prehensilis*. Dr. LUND's hypothesis, therefore, that the Megatherium was a climber and had a prehensile tail, is destroyed by the now known structure of that part.

But viewing the pelvis of the Megatherium as being the fixed centre towards which the fore legs and fore part of the body were drawn in the gigantic leaf-eater's efforts to uprend the tree that bore its sustenance, the colossal proportions of its hind extremities and tail lose all their anomaly, and appear in just harmony with the robust claviculate and unguiculate fore limbs with which they combined their forces in the Herculean labour.

Finally, with reference to the hypothesis of the German authors and artists* of the gradual degeneration of the ancient Megatherioids of South America into the modern Sloths, it may be admitted that the general results of the labours of the anatomist in the restoration of extinct species, viewed in relation to their existing representatives of the different continents and islands, have been such as might naturally suggest the idea that the races of animals had deteriorated in point of size. Thus the palmated Megaceros is contrasted, by its superior bulk, with the Fallow-deer, and the great Cave-bear with the actual Brown Bear of Europe. The huge Diprotodon and Nototherium afford a similar contrast with the Kangaroos and Koalas of Australia, as do the towering Dinornis and Palapteryx with the small Apteryx of New Zealand. But the comparatively diminutive aboriginal animals of South America, Australia, and New Zealand, which are the nearest allies of the gigantic extinct species respectively characteristic of such tracts of dry land, are specifically distinct, and usually by characters so well marked as to require a subgeneric division, and such as no known outward influences have been observed to produce by progressive alteration of structure. Moreover, as in England, for example, our Moles, Water-voles, Weasels, Foxes, and Badgers, are of the same species as those that coexisted with the Mammoth, Tichorhine Rhinoceros, Cave Hyæna, Bear, &c.; so likewise the remains of small Sloths and Armadillos are found associated with the Megatherium

* PANDER and D'ALTON, *loc. cit.*

and Glyptodon in South America; the fossil remains of ordinary Kangaroos and Wombats occur together with those of gigantic herbivorous Marsupials in Australia; and there is similar evidence that the Apteryx coexisted with the Dinornis in New Zealand. I have been led, therefore, to offer the following suggestions as more applicable to, or explanatory of, the phenomena than LAMARCK's progressive hypothesis of the origin of species by transmutation *, or BUFFON's retrograde hypothesis by degradation †.

"In proportion to the bulk of an animal is the difficulty of the contest which, as a living being, it has to maintain against the surrounding influences which are ever tending to dissolve the vital bond and subjugate the organized matter to the ordinary chemical and physical forces. Any changes, therefore, in the external circumstances in which a species may have been adapted to exist, will militate against that existence in probably a geometrical ratio to the bulk of such species. If a dry season be gradually prolonged, the large Mammal will suffer from the drought sooner than the small one; if such alteration of climate affect the quantity of vegetable food, the bulky Herbivore will first feel the effect of the stinted nourishment; if new enemies are introduced, the large and conspicuous quadruped or bird will fall a prey, whilst the smaller species might conceal themselves and escape. Smaller quadrupeds are usually more prolific than larger ones. The actual presence, therefore, of small species of animals in countries where the larger species of the same natural families formerly existed, is not to be ascribed to any gradual diminution of the size of such larger animals, but is the result of circumstances which may be illustrated by the fable of the 'oak and the reed;' the small animals have bent and accommodated themselves to changes under which the larger species have succumbed ‡."

EXPLANATION OF THE PLATES.

PLATE XXXVII.

Fig. 1. Side view of the pelvis: one-fifth the natural size.

Fig. 2. The acetabulum. (By permission of the President and Council, from the specimen presented by Sir WOODBINE PARISH, K.H., to the Museum, of the Royal College of Surgeons.)

PLATE XXXVIII.

Fig. 1. Back view of the left femur.

Fig. 2. Back view of the left patella.

One-third the natural size.

* Philosophie Zoologique, 8vo. 1809, tom. i. ch. vii.

† Histoire Naturelle, 4to. tom. iv. (1766), "Dégéneration des Animaux," p. 311.

‡ "On the genus *Dinornis*" (part 4), Transactions of the Zoological Society, vol. iv. p. 15.

PLATE XXXIX.

Fig. 1. Proximal end of the femur.
Fig. 2. Distal end of the femur.
Fig. 3. Proximal end of the tibia.
Fig. 4. Distal ends of the anchylosed tibia and fibula.

One-third the natural size.

PLATE XL.

Fig. 1. Tibial side of the bones of the foot.
Fig. 2. Front view of the two cuneiform and the cuboid bones.
Fig. 3. Front view of the navicular bone, and parts of the astragalus and calcaneum.

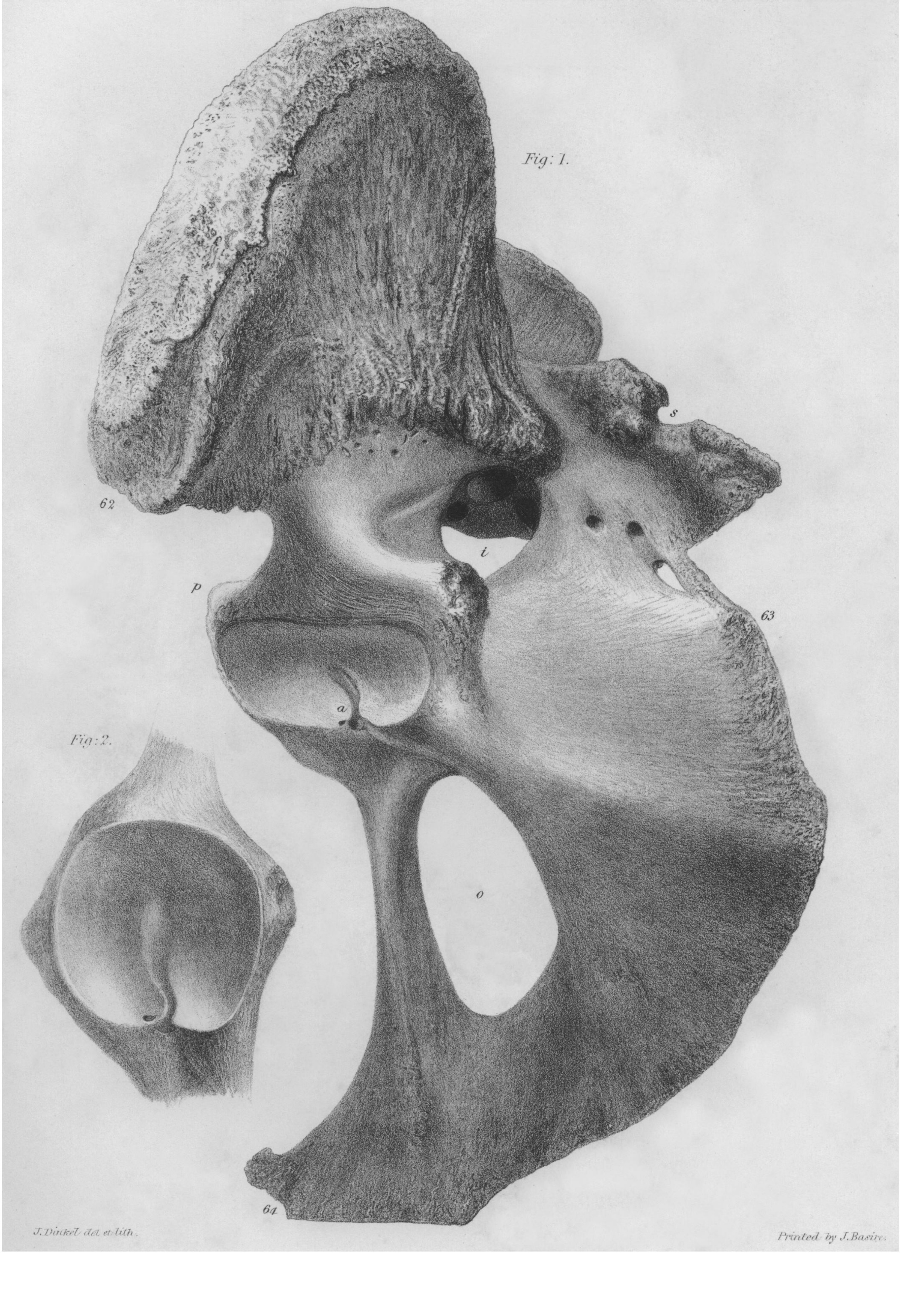
One-half the natural size.

PLATE XLI.

Fig. 1. Upper view of the bones of the foot.
Fig. 2. Front view of the calcaneum.
Fig. 3. Fibular side of the bones of the great unguiculate toe.

One-half the natural size.

The letters and figures on the several Plates are explained in the text.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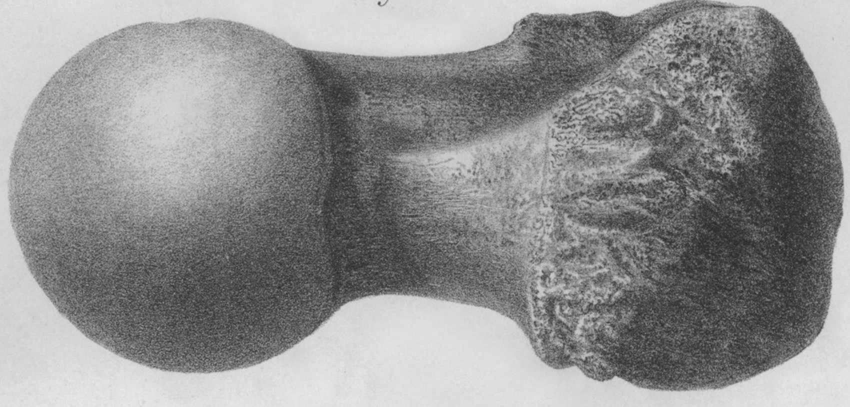

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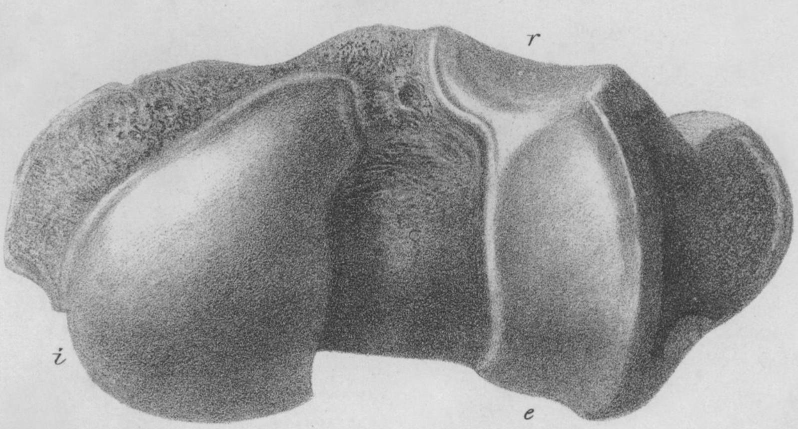

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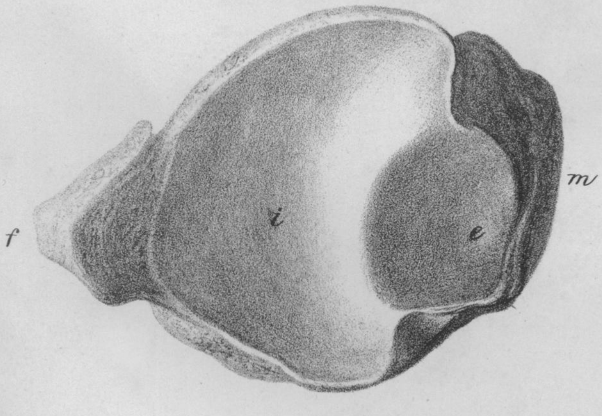

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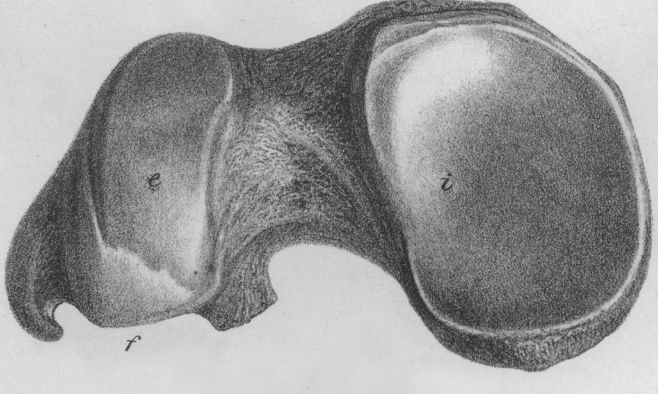

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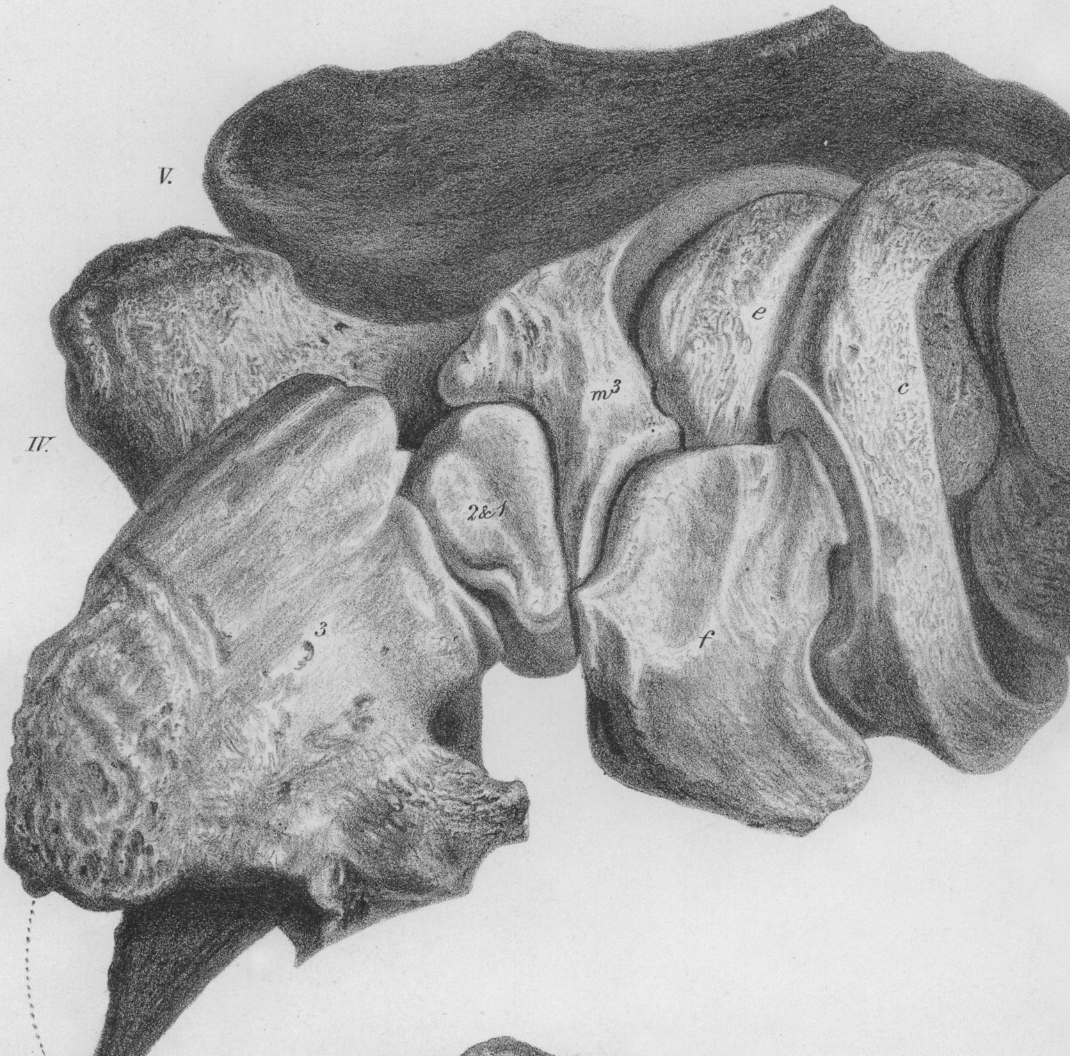

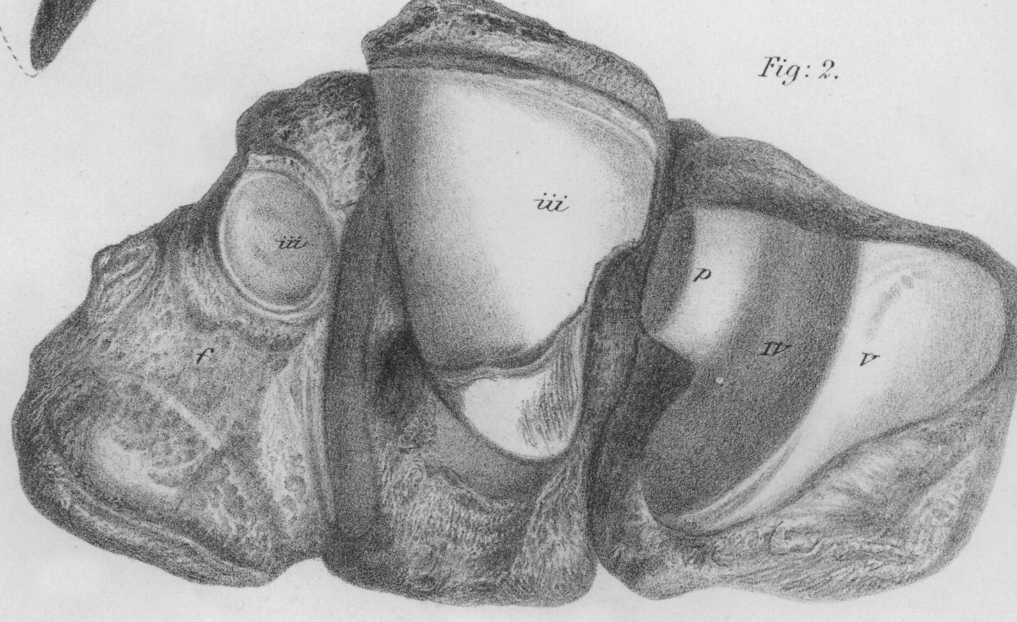

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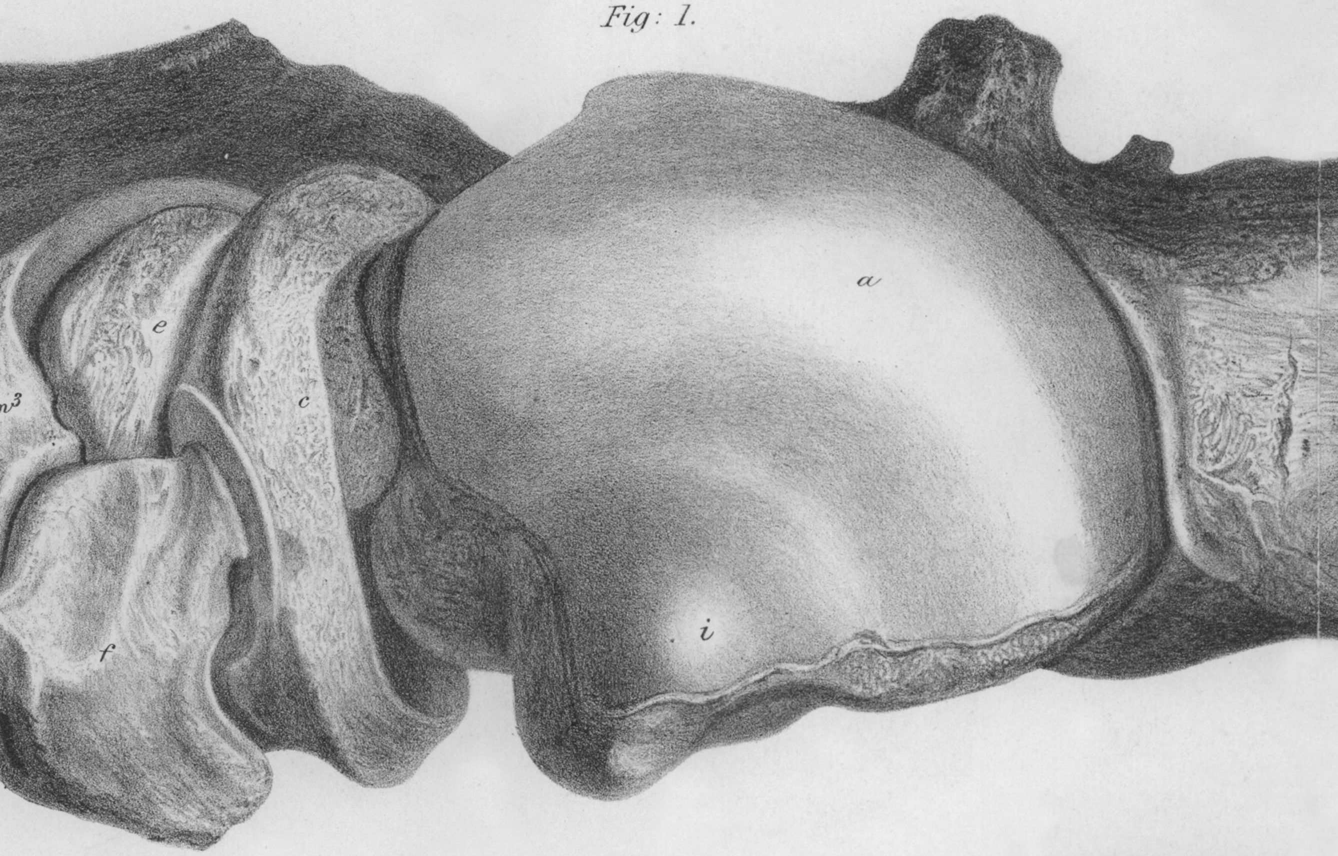

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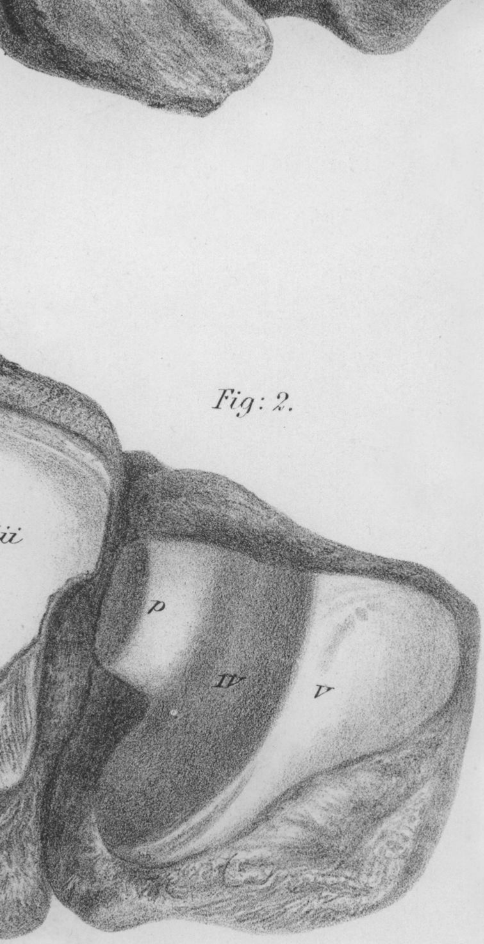

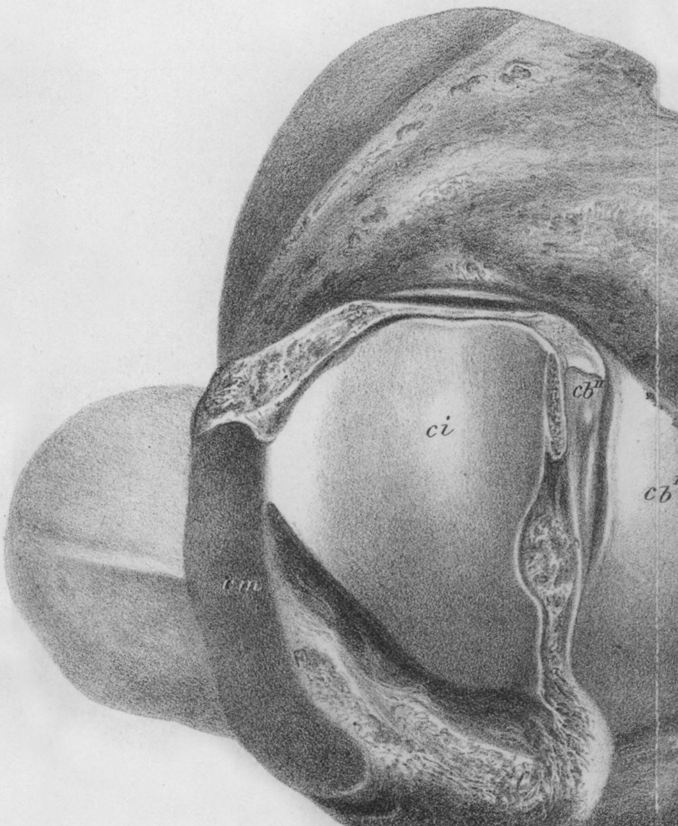

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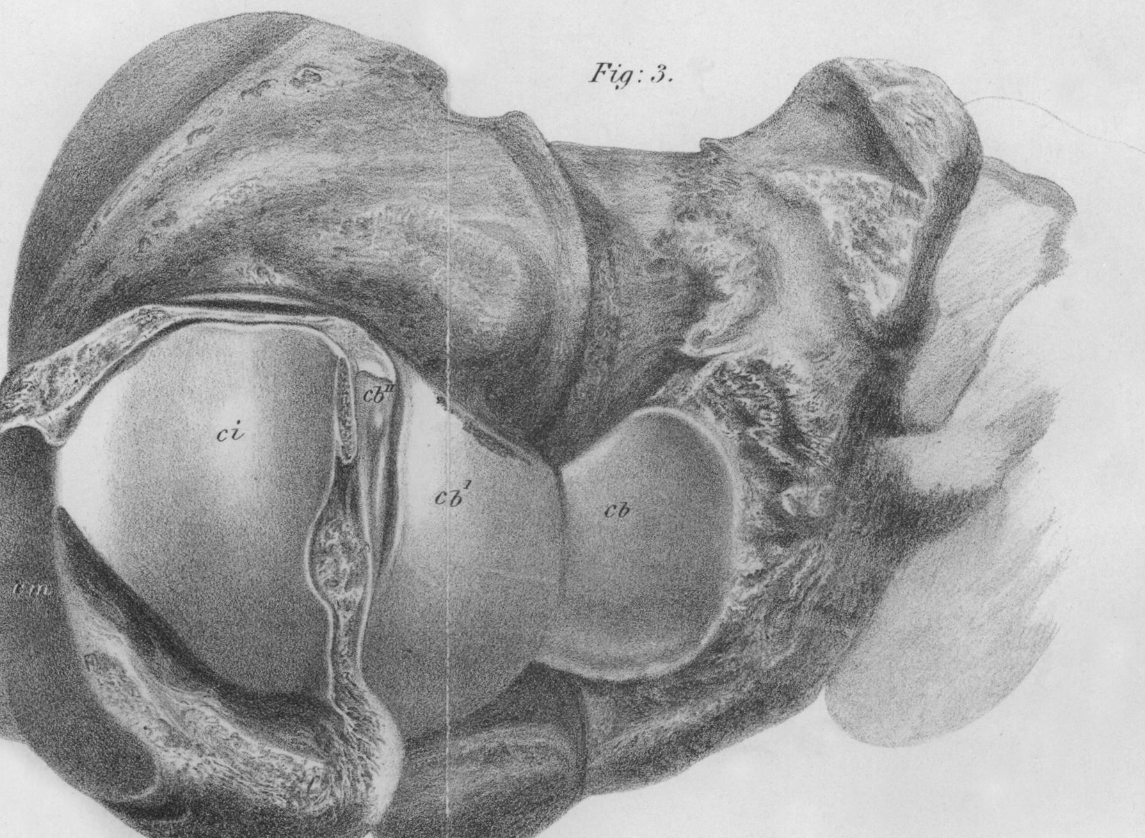

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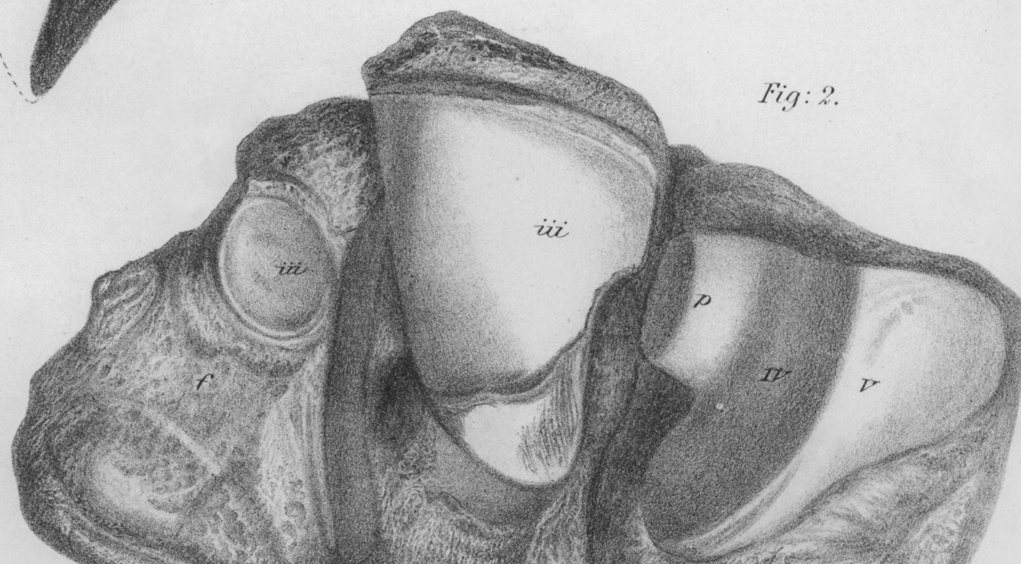

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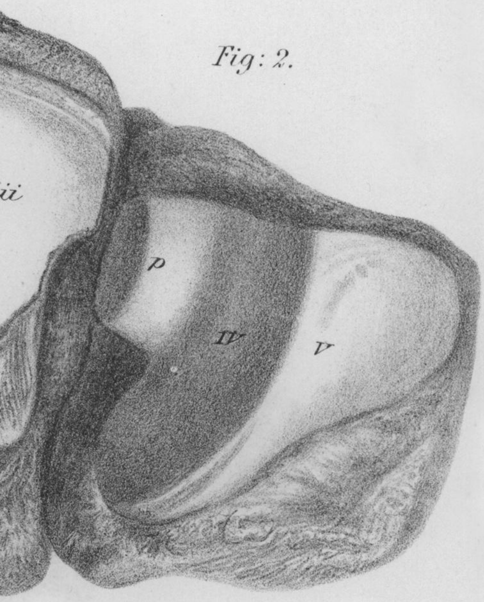

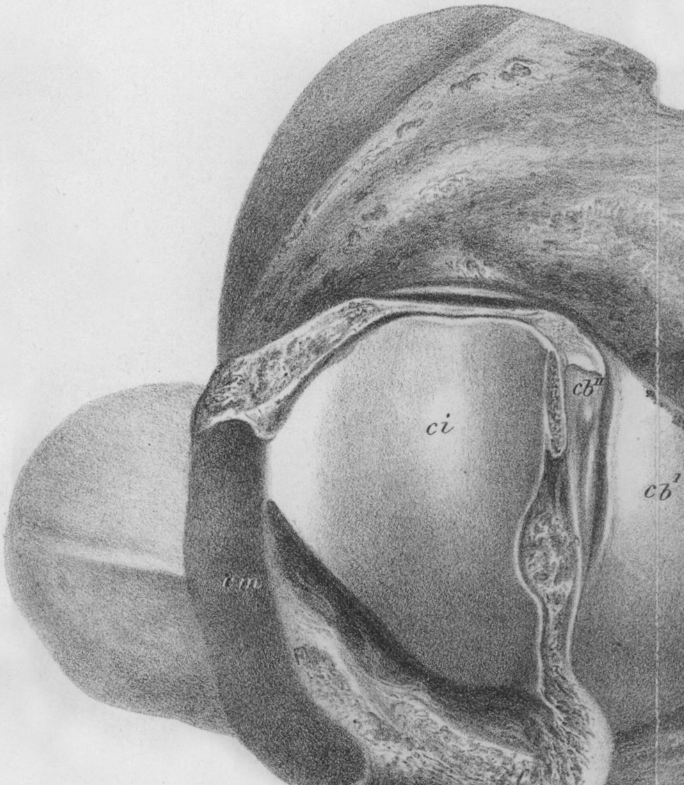

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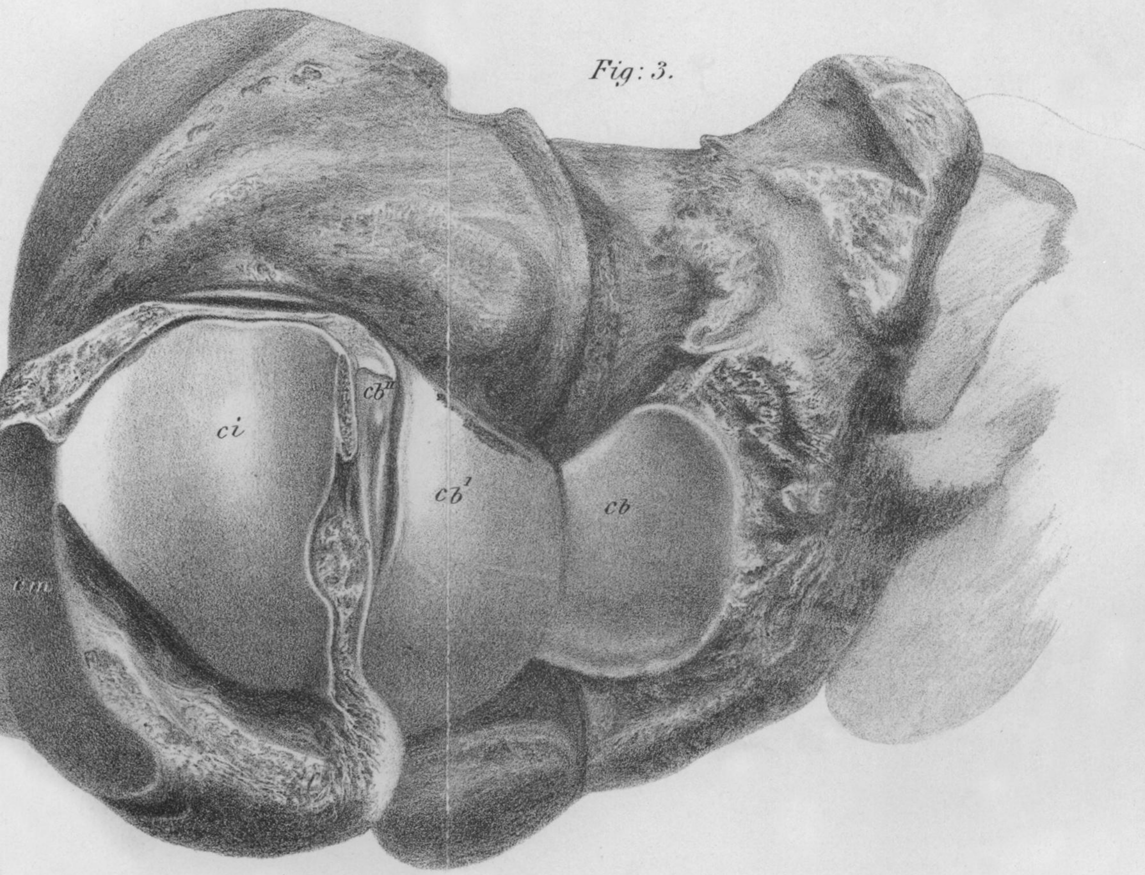

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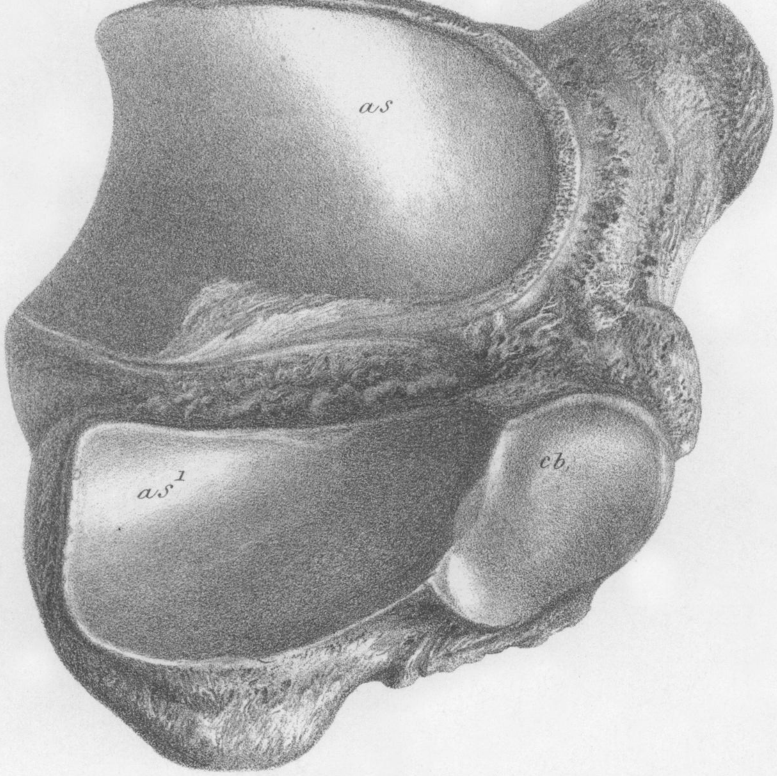

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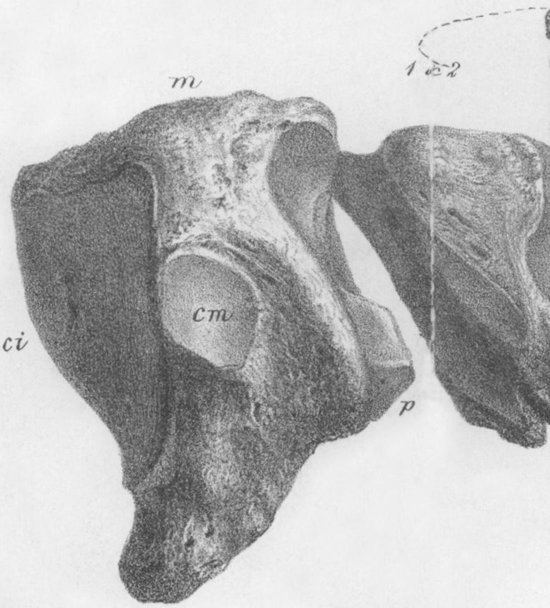

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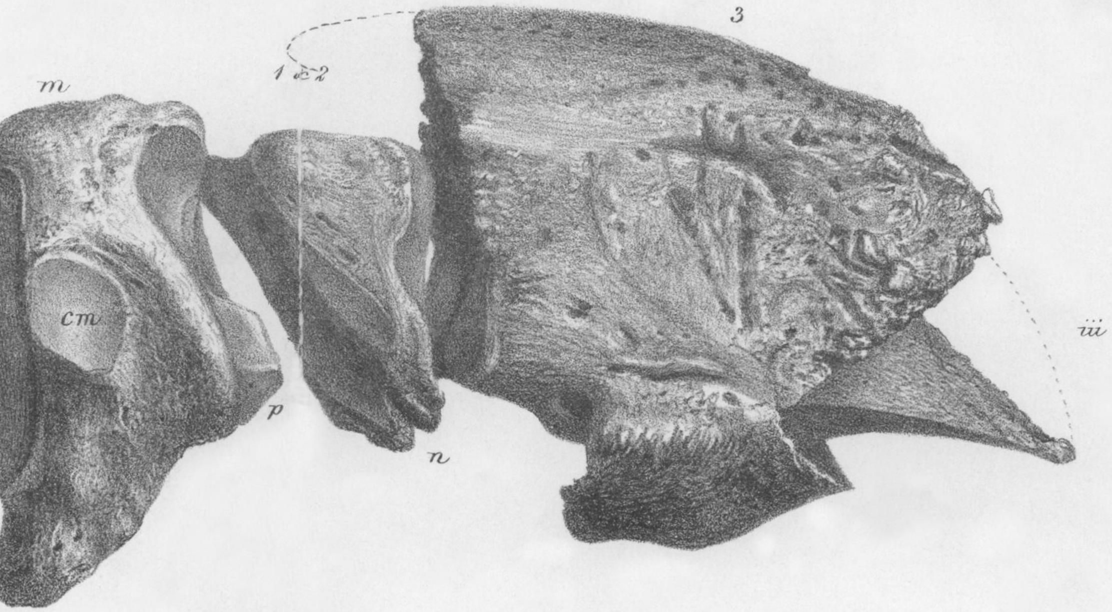

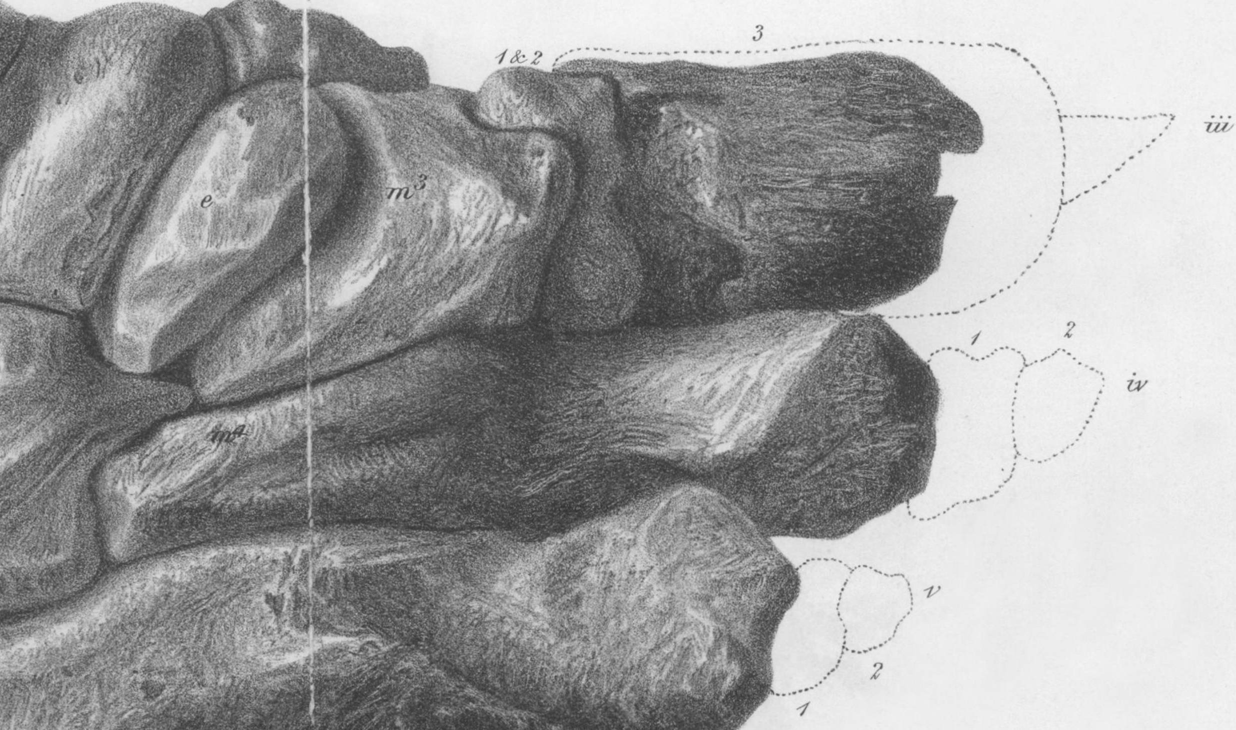

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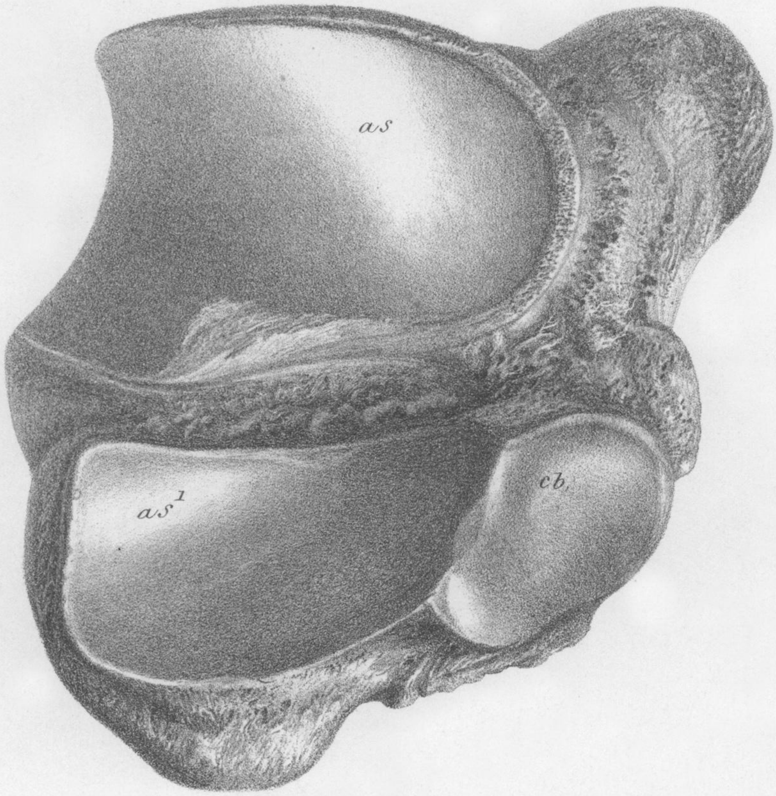

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Fig. 3.

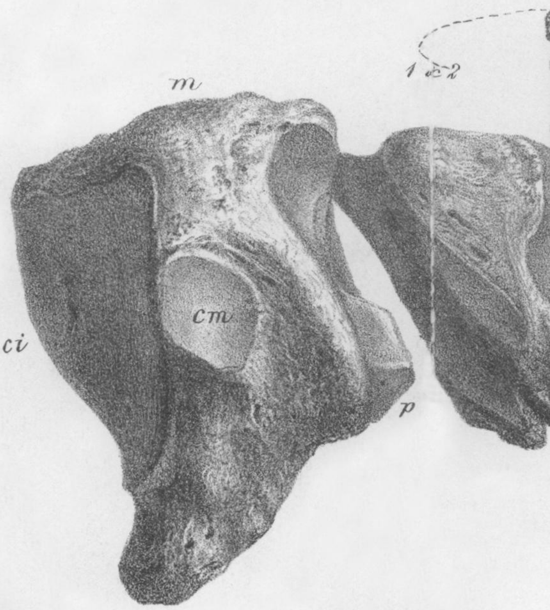

Fig. 1.

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