XXIV. *An Attempt at a complete Osteology of* Hypsilophodon Foxii; *a British Wealden Dinosaur.*

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Received January 16,—Read January 26, 1882.

[PLATES 71–82.]

THE dinosauria are peculiarly interesting and instructive on account of the combinations in their skeletons of structures which now only occur separately in those of extant Sauropsida; and also on account of their forming a link between more specialised Reptiles and Birds.* The need of such an osteology of a Wealden dinosaur as might serve for a type and aid to those who are working out our fossil reptiles, long felt, has lately become increasingly urgent through the discoveries in the United States of large numbers of remains in such preservation and abundance as to make their reconstruction a relatively light task. Some of the members indicated by these remains resemble certain of our Wealden fauna, of which our knowledge is very imperfect and scanty, so that a strict comparison of the American and British Wealden forms appears likely to throw much light upon the latter.† Unfortunately our own material does not yet exist in a form available for this purpose; for although a very large number of memoirs have been written on the dinosauria of our Cretaceous and Wealden formations, nothing approaching to a complete osteology of any one of them based on the study of remains recovered from British Cretaceous and Wealden formations has yet been published. The reason is not far to seek. In our Wealden beds their remains are usually so scattered, disconnected, and not seldom mutilated, that their identification and reconstruction are exceptionally difficult. As regards *Iguanodon Mantelli* a complete osteology may be expected from Belgian workers whenever the magnificent remains in the Musée d'Histoire Naturelle at Brussels, obtained in 1878 from an extension of the Wealden formation at Bernissart, shall have been wrought out—a task which I am authoritatively informed is not likely to be accomplished for several years. But with respect to *Hypsilophodon* something

* HUXLEY, "Dinosauria and Birds." Quart. Journ. Geol. Soc., 1870, p. 12.

† In illustration of this may be cited the resemblance between *Hadrosaurus*, LEIDY., *Agathaumus*, COPE, and *Iguanodon Mantelli;* between *Lælaps* and *Megalosaurus Bucklandi;* between *Titanosaurus*, *Atlantosaurus*, MARSH, *Camarasaurus*, COPE, and *Ornithopsis*, SEELEY (Syn. *Eucamerotus*, HULKE, *Bothriospondylus*, OWEN, *Chondrosteosaurus*, OWEN); between *Laosaurus*, MARSH, and *Hypsilophodon*, HUXLEY.

may fairly be expected of English palæontologists, for its remains occur in a manner quite exceptional—large parts of skeletons of this dinosaur, the bones of which are usually well preserved, and often maintain their normal connexions, have been obtained by the Rev. WILLIAM FOX (lately deceased) and by myself.* A study of these, prosecuted in leisure intervals during several years, enables me at length to offer a connected account of the skeleton, which I venture to hope leaves but few omissions to be supplied when additional materials shall have been acquired.

The following short list contains, it is believed, the titles of all the papers which have been written on this dinosaur :—

BIBLIOGRAPHY.

1. OWEN, R. "Description of Part of the Skeleton of a Young *Iguanodon* (*Iguanodon Mantelli*) : Monograph of the Fossil Reptilia of the Wealden Formation." Pal. Soc., vol. for 1855, p. 2, plate 1.
2. HUXLEY, T. "On *Hypsilophodon Foxii :* a New Dinosaurian from the Wealden of the Isle of Wight." Quart. Journ. Geol. Soc., vol. xxvi., p. 3, plate i. 1870.
3. HULKE, J. W. "Contribution to the Anatomy of *Hypsilophodon Foxii.*" Quart. Journ. Geol. Soc., vol. xxix., p. 522, plate xxviii. 1873.
4. HULKE, J. W. "Supplemental Note on the Anatomy of *Hypsilophodon Foxii.*" Quart. Journ. Geol. Soc., vol. xxx., p. 18, plate iii. 1873.
5. OWEN, R. "Skull and Teeth of *Iguanodon Foxii :* Fossil Reptilia of the Wealden Formation." Supplement No. 5. Pal. Soc., vol. for 1873, p. 1, plates i., ii.
6. OWEN, R. Appendix to the above Supplement : "Monograph on *Iguanodon Foxii.*" P. 17.

Skull. (Plates 71, 72.)

In shape Lizard-like; the external nostrils are subterminal and divided; the orbital openings are large, and laterally directed ; the eyeball has a ring of bony plates ; and the temporal fossæ are bounded externally by an upper and a lower bar.

The present length of the best-preserved skull in Mr. Fox's collection† (Plate 71, figs. 2–4) is 9·6 centims. To this may be added 1 centim. for shortening due to displacement of the snout upon the braincase, and to slight mutilation of the occiput

* GISEMENT. Remains of *Hypsilophodon Foxii* have as yet only been found in a bed which crops out a short distance west of Barnes High Cliff, and passes under the shore a few yards west of Cowleaze Chine, on the south coast of the Isle of Wight. The rock varies much often within the space of a few yards. Generally the upper 3½ feet of it consist of a cap of grey sandstone resting on sandy clay ; this is succeeded by about the same depth of mottled-red and blue clay lying on the bands of sandstone. The *Hypsilophodon* remains are almost restricted to the lower half of the bed. The only other bones ever taken out of it by Mr. Fox and myself represent a small scuted Crocodilian (*Goniopholis ?*) and a Chelonian (*Trionyx ?*) No bones referable to *Iguanodon Mantelli* have ever been found by us in this bed.

† Described in Memoirs 2, 5. I shall refer to this as Mr. Fox's "type skull."

and of the end of the snout, making its total length 10·6 centims. The width at the occipito-parietal crest is 22 millims.; at the middle of the parietal region it decreases several millims.; at the fronto-parietal suture it increases to 33 millims.; between the orbits it slightly contracts; in front of these cavities it again slightly expands; and thence lessens to the end of the snout.

This is evidently the skull of an immature individual. A skull in my own collection (Plate 71, fig. 1) (No. 110 Catal., Coll. HULKE) was probably 5 centims. longer, and I have seen fragments which indicate that this greater length was sometimes exceeded.

For convenience, first the occiput, then the upper surface, next the under surface of the skull, and lastly the dentition will be described.

Occiput.—The occipital plane in Mr. FOX's type skull (Plate 71, fig. 3) includes an acute angle with the upper surface, but it is probable that the inclination of these surfaces is exaggerated by the crushing to which the skull has been subjected. The occipital condyle (*oc.*), 9 millims. in its horizontal diameter, is more wide than deep. The margin of the foramen magnum is slightly swollen. Above the foramen the surface is divided by a median ridge. A large par-occipital process, 23 millims. long (*popr.*), stands out from the sides of the occiput in the level of the upper part of the foramen magnum. Owing to the damage this part of the skull has undergone, effacing the sutures, the respective shares of the several bones composing the occiput cannot be now fixed with precision, but it may, I think, be safely stated that the supraoccipital enters largely into the foramen magnum, as in *Iguanodon Prestwichii.**

Upper surface of skull.—The *parietal* bone (*pa.*) appears to me single, as in *Iguanodon Mantelli*† and *I. Prestwichii.* I find no unequivocal evidence of an interparietal suture. Its two halves meet in an angular crest, which behind is prolonged beyond a line drawn transversely to the long axis of the skull through the meeting of the upper and the posterior surfaces, and overhangs the supraoccipital bone.

From this median supraoccipital process the posterior border of the parietal bends outwards, joining the inner branch of the squamosal, with which it bounds posteriorly the upper opening of the temporal fossa (Plate 71, fig. 2). Anteriorly the parietal crest declines, and ends at the interfrontal suture. From a point slightly in advance of the middle of the crest a slight ridge-like elevation of the surface curves outwards to the post-frontal bone. It marks an expansion of the front half of the parietal bone, as occurs in *Iguanodon Mantelli*‡ and *I. Prestwichii.*§

The *frontal bones* (*fr.*) are remarkably large (Plate 71, figs. 1, 2). The suture joining their median borders is slightly raised. Their orbital border also is prominent, which makes the upper surface between the orbits slightly concave in a direction transverse

* HULKE, J. W., Quart. Journ. Geol. Soc., vol. 36, plate xviii., fig. 3.

† Ibid., vol. 27, plate xi., fig. 3.

‡ Ibid., vol. 36, plate xviii., figs. 1, 2.

§ Ibid., vol. 27, plate xi., fig. 3.

to the long axis of the skull. In a direction coincident with this axis the surface is gently convex.

The *post-frontal* (*psf.*) (Plate 71, fig. 2) is a large three-rayed bone. One ray, short and stout, articulates with the postero-external angle of the frontal, and forms the posterior and upper part of the orbital opening. A descending ray, longer than the former, joins the jugal and completes the posterior border of the orbit. The third ray, directed backwards, is applied to the outer edge of the anterior branch of the squamosal, and forms the greater part of the upper temporal bar.

The *squamosal* (*sq.*) (Plate 71, fig. 2), by an anterior branch, forms the minor part of the bar just named, and by an inner process which joins the *parietal* helps to bound posteriorly the upper temporal opening. It caps the upper end of the *quadrate,* which is fitted into a recess in its under surface (Plate 72, fig. 1). Behind, it descends some distance on the back of the *quadrate,* an arrangement which must have given to the squamosal-quadrate joint great stability. A similar arrangement obtains in *Iguanodon Mantelli,* and in the Liassic *Scelidosaurus.**

A *præfrontal* and a *lacrymal* are present (Plate 71, fig. 2) in the anterior border of the orbit. The examples I have yet met with have been too mutilated for description.

A *jugal* (Plate 71, fig. 2), a rather wide bar, applied to the posterior third of the upper border of the maxilla, and connected with the descending ray of the *post-frontal,* completes the ring of the orbit.

The presence of a *quadrato-jugal* is indicated by a thin plate abutting against the lower part of the quadrate in Mr. Fox's type skull (Plate 71, figs. 3, 4). Intercalated between the *jugal* and *quadrate,* constituting with the former a lower temporal bar, its presence in conjunction with the form of the squamoso-quadrate joint would have rendered the quadrate immovable.

The *nasals* are very large and relatively wide bones (Plate 71, fig. 2). They form a considerable portion of the upper surface of the snout. Their notched lower end exclusively forms the upper or posterior boundary of the external nares. From each of its angles it sends downwards an extremely slender process. Of these processes the inner one, closely applied to the outer side of the anterior or septal process of the præmaxilla, constitutes with this the septal margin of the nostril; whilst the outer nasal process descends upon the narial border of the external ascending præmaxillary process, with which it forms the outer margin of the nostril, as described by HUXLEY.†

Præmaxillæ (Plate 71, figs. 1, 2).—There are two præmaxillary bones. That part of the body of the præmaxilla visible on the outer surface is an oblong vertical plate, the upper border of which is notched by the nostril. The lower dentigerous border is nearly straight. In a skull in my collection (No. 110 Catal., Coll. HULKE) the vertical measurement from the narial to the dentigerous border is 11 millims., and the length of the dentigerous border is 20 millims. The external surface is smooth except quite

* OWEN, R., "Fossil Reptilia of the Oolitic Formation," part i., plate v.

† HUXLEY, Quart. Journ. Geol. Soc., vol. xxvi., p. 4, plate i., fig. 1.

in front, where, as mentioned by HUXLEY in a description of Mr. Fox's type skull, it is wrinkled.*

In both this and my skull, No. 110, the extreme end of the snout is missing, so that the actual anterior termination of the præmaxillæ is not certainly known. From each end of the body of the præmaxilla a strong process ascends in the snout. Of these the median or anterior process, flattened, three-sided, tapering upwards to a point, ascends, closely applied to its fellow, between the mesial margins of the nasals for about one-third of the length of the snout (Plate 71, fig. 2*), forming with the descending narial process of the nasal lately described the internarial septum. The external or posterior præmaxillary process († in same fig.), wider, flatter, and longer than the anterior, intercalated between the *maxilla* and the *nasal,* curves upwards and backwards, resting in a groove in the anterior border of the maxilla, but not united to this by serrated suture. The dentigerous border in a space of 20 millims. in my skull, No. 110, contains in separate sockets five teeth, the same number as in Mr. Fox's type skull. Since in both the extremity of the snout is abraded, it is just possible that one additional tooth may have been present, although I do not think this probable ; or the ends of the præmaxillæ may have been bent downwards in the form of a beak as Professor HUXLEY suggests.†

Maxilla (*mx.*) (Plate 71, figs. 1, 2).—A large bone of rudely subtriangular outline. The anterior border, convexly curved, is grooved on its outer surface for the reception of the external ascending process of the præmaxilla, as was mentioned in connexion with the description of this bone. In my skull, No. 110, this border rises to a maximum height of 30 millims. above the dentigerous margin at the second molar tooth, making here an obtuse angle with the upper border which from this point curves gently downwards to a distance of 15 millims. above the last tooth. The nearly straight dentigerous border contains in a space of 43 millims. an unbroken series of eleven teeth, one more than in Mr. Fox's type skull.

In advance of the dentigerous portion of the maxilla a thin tongue-like plate formed by the convergence of the upper and the lower border is prolonged upon the deep surface of the body of the præmaxilla, nearly if not quite reaching the anterior border of this latter. The upper margin of this tongue-like process of the maxilla must be in very close proximity to the lower and outer margin of the external nostril. Behind the hindmost tooth the maxilla narrows abruptly, and it sends backwards a stout three-sided process to which the *jugal* is united (Plate 71, fig. 1). Throughout nearly its whole length the outer surface of the maxilla, nearly in the level of the tooth-roots, is pierced by a series of conspicuous foramina as in *Iguanodon Prestwichii*, *Megalosaurus*, and *Teratosaurus.*

The *quadrate* (Plate 71, figs. 3, 4 ; Plate 72, fig. 1), a large, stout bone, is antero-posteriorly compressed near its articular ends and laterally flattened intermediately.

* HUXLEY, ibid.

† HUXLEY, *loc. supra cit.*

In the fragment of a skull in Mr. Fox's collection, in which it is but little damaged and has retained its natural relations almost undisturbed, the length of the quadrate is 53 millims.; its antero-posterior dimension just below the squamosal end is 6 millims.; at the distance of 21 millims. from this end it is 10 millims; and just above the mandibular end it is 5 millims. (the length of the portion of mandible preserved which comprises the entire dentigerous and part of the edentulous spout, given for comparison, is 96 millims.). The width or transverse diameter of the quadrate near its mandibular end in a smaller mandible is 10 millims. The squamosal articulation of the quadrate was described in connexion with the former bone.

Mandible (Plate 71, figs. 3, 4; Plate 72, figs. 1, 2; and Plate 73).—This repeats in miniature that of *Iguanodon Mantelli.* It has a spout-like symphysial end (Plate 72, fig. 2); great depth of the dentigerous part; a high coronoid process from which the upper border falls abruptly to the quadrate joint, and slopes gradually towards the junction of the tooth-bearing and edentulous parts. The lower border is almost straight. The articular element is large, and the joint-surface very capacious relatively to the size of the lower end of the *quadrate,* an arrangement which would have permitted a very free movement of the *mandible* upon the quadrate. The *angular* element appears to be small, it reaches to the posterior extremity of the mandible. A splenial plate covered the large subdentinal groove.

In a slab in my collection immediately in front of a much-crushed mandible is a thin triangular bone symmetrically bent into a trough-like form appearing not unlike a continuation of the symphysial mandibular spout, one edge of the triangular bone having the same slant as the inclined border of this.

I do not identify this bone with the mandible. The close proximity of a præmaxillary tooth to it suggests that it may be connected with the præmaxilla. I mention it in order to call attention to it.

Under surface of skull.—This is described entirely from my skull No. 110, as this region in Mr. Fox's type skull appears to me too damaged to afford unequivocal evidence of the nature of the pieces of bone displayed and of their relations.

The palate is closed in front by the junction in the middle line of the triangular, præmaxillary, palatal processes (Plate 72, fig. 1). A small anterior palatine foramen is situated in the front of the palatal inter-præmaxillary suture. The posterior borders of these processes curve inwards, and, meeting in the middle line of the palate, form a backward projecting angle. This curved border is smooth, non-articular, and it apparently forms the anterior boundary of the palato-nares. To the angle are attached the two *vomers* (*v.*), which are followed by the two pterygo-palatine bars separated by a median fissure. The *palatine* bone (*pl.*), a thin bar 6 millims. wide, is deeply grooved near its union with the *pterygoid* (*pt.*). This last bone has a remarkably stout central part or body, which is traversed obliquely from without and behind inwards and forwards by a prominent ridge, ending in an angular projection at the inner border. The position and the direction of this ridge approximately coincide with those of the row of denticles in the palate of extant Iguanas. In front, the body of the pterygoid joins the palatine; behind, it has a stout boss, which doubtless articulated with a basisphenoidal swelling; and externally it sends off two processes separated by an interspace, of these one (*q.pr.*) passes backwards and outwards towards the quadrate, and the other (*ect.pr.*) outwards towards an ecto-pterygoid which connected it with the maxilla. Thus, in *Hypsilophodon* the pterygo-palatine bars are constructed upon a plan not very unlike that of the existing Iguana.

Dentition.—The dentinal formula, so far as this is shown by Mr. Fox's type skull and my No. 110, is—

Præmaxillary (incisor) teeth . . . . $\frac{5-5}{0-0}$

Maxillary and mandibular (molars) . . . . $\frac{11-11}{10-10}$?

But these numbers must be accepted only as an approximation, subject to correction or confirmation by better preserved remains.

The præmaxillary teeth are cylindric, and the maxillary and mandibular teeth compressed.

Præmaxillary teeth (Plate 72, figs. 3, 4).—A perfect tooth, selected for description, is 10 millims. long; of this, nearly 4 millims. belong to the crown, which is separated from the root by a slight constriction or neck. The root contracts slightly towards the crown and towards its opposite end, and is slightly dilated intermediately. Its cross-section is nearly circular. Its surface is smooth. Two teeth which I slit longitudinally had a large pulp-cavity filled with spar extending the whole length of the root into the crown. The crown is slightly and unequally compressed, the inner contour of its cross-section being more convex than the outer. Its apex is acuminate and slightly inflected, which makes the outer longitudinal contour convex, and renders the inner contour sinuous, concave near the point and convex near the root. The outer and inner surfaces meet angularly, forming a low wing, within which, and parallel with it, upon the inner surface is a minute shallow groove. In very perfect unworn crowns the marginal wing bears a row of minute tubercles just visible in a strong light to the unaided eye. Both surfaces are highly polished and smooth. Upon the outer surface a few very minute striæ are discernible, and towards the neck both surfaces are beset with exceedingly minute tubercles (not recognizable as such without a magnifyer), the collective effect of which to the unaided eye is an extremely fine wrinkling.

A transverse section through the root of a præmaxillary tooth in position showed it to be contained in a distinct separate socket. The successional teeth, as usual, descend at the inner side of those in use.

Maxillary and mandibular (*molar*) *teeth* (Plate 72, figs. 5–9).—The crowns of these are compressed, their contour is sub-rhomboidal, both surfaces are convex longitudinally and transversely. The root is long, cylindroid, tapering. One surface of the crown—

that towards the mouth in mandibular teeth, and that towards the cheek in maxillary teeth—is sculptured by longitudinal ridges passing from a raised cingulum at the junction of crown and root to the free border of the former.

A smaller and a larger variety of compressed sculptured tooth are distinguishable, the former occurring in the front of the series. In a nearly perfect tooth of the smaller variety (Plate 72, fig. 6) the cingulum makes an angle open towards the summit of the crown. From the nearly axial angle a principal ridge passes to the apex of the cutting border, having on each side of it a secondary ridge, one of which does not quite reach the cingulum. Between the free ends of the secondary ridges, which give this part of the crown a coarse serration, and the lateral terminations of the cingulum, the sides of the crown are very finely serrated, repeating in miniature the lamelliform serration of the crown in *Iguanodon Mantelli.*

In the larger variety of the compressed tooth (Plate 72, figs. 7–9), the ornamented surface of the crown is sculptured by a greater number of ridges, which are less unequal in size. Some of them divide near the cutting border of the crown, rendering this, before being worn by use, finely crenated. The sides of the crowns of these larger teeth are finely serrated, as are those of the smaller variety. The contour of the crown of the larger is rounder and less angular than that of the smaller teeth. The unridged surface of the crown of both varieties has a few very minute inconspicuous striæ. All crowns which project fully above the level of the outer border of the alveolar process bear marks of wear. They are obliquely ground. The sculptured surface, having a thick enamel, lasts longer, and forms a cutting edge which, at first, is serrated by the cross-sections of the longitudinal ridges, and later becomes simply sinuous as these ridges decline in height in the level of the lateral angles of the crown. The worn surface of a large crown is usually marked by slight elevations not deserving the name of ridges passing from the inner to the outer surface, and the fine attritional striæ discernible in all worn teeth have this direction, suggestive of grinding lateral movements of the mandible in addition to gliding and hinge-movement in one plane.

By the time the crown is worn to the level of the alveolar border of the jaw, the tapering cylindroid root has been nearly absorbed, so that very slight force would suffice to detach the remnant of a tooth in this condition.

The compressed ridged teeth are not so separately enclosed in distinct sockets as are the cylindric præmaxillary teeth, but as in *Iguanodon Mantelli* and *I. Prestwichii*, the outer wall of the dentary groove sends inwards partitions which separate the roots, and nearly if not always quite reaching the inner wall of the groove must have afforded the teeth very firm support. The successional teeth are evolved in cavities at the inner side and intermediately of those in wear (Plate 72, fig. 2).

The structure of the skull shows a combination of Lacertilian and Crocodilian characters with a great preponderance of the former. The *supra-occipital* bone enters into the ring of the *foramen* magnum as it does in Lizards and in Birds, but not in Crocodiles, in which it is excluded from this opening by the union of the *exocci-*

pitals. The divided *frontal* is another Lacertilian trait: in Crocodilians the primitive division of the *frontal* disappears before the young leaves the shell.* The form and proportions of the nasals, and the prolongation of their anterior angles as an external and an internal narial process are imitated in some extant Lizards, but not, I think, in any Crocodilians. The division of the anterior nares and its method, as in *Megalosaurus*, are also Lacertilian features; the septum nasi mainly consists of the ascending median præmaxillary processes (closely imitated in *Hatteria*, in which the præmaxilla is paired; confluent in other Lizards where the primitive separateness of the præmaxillæ is early lost) which scarcely exist in Crocodilians in which the bony septum of the external nostril, when present, consists almost exclusively of the intruded tapering anterior ends of the nasal bones. The exclusion of the maxilla from the outer boundary of the external nostril, cited by R. OWEN as a Crocodilian character,† is perhaps apparent and not real, because the maxilla does not cease at the posterior margin of the external ascending præmaxillary process, but it is prolonged forwards beneath this and would become visible in very close proximity to the outer and lower part of the nostril if this process were removed. The lower temporal bar, a Crocodilian feature, is present in *Iguanodon Mantelli*, in the Liassic *Scelidosaurus*, and one extant Lizard—*Hatteria*. The fixity of the *quadrate*, another Crocodilian trait, is not attained by its being wedged in between the skull-bones, as in Crocodiles, but is due to the form of the squamosal articulation and the presence of the lower temporal bar. The anterior position of the palato-nares; the form, proportions, and connexions of the pterygo-palatine bars; and the median cleft in the palate are all Lacertilian characters not present in Crocodiles. The occurrence of teeth in the præmaxilla of simpler form than those in the maxilla and mandible, and the smaller size and minor complexity of the crown of a small number of the foremost teeth of the maxillary and mandibular series are highly interesting as foreshadowing the divisions of the teeth in higher Vertebrates. In form, in attachment, and in their mode of succession, the maxillary and mandibular teeth resemble those of Lizards, and not those of Crocodiles.

Vertebral column.—No remains have yet been recovered which demonstrate the exact number of vertebræ in the præ- and post-sacral segments of the column. The sacrum certainly comprises five vertebræ.

Professor R. OWEN, in his account of "Part of the Skeleton of a Young *Iguanodon* (*I. Mantelli*),"‡ preserved in the British Museum, Cat. No. 39,460, suggests that the most anterior of a continuous chain of seventeen præsacral vertebræ corresponds to the fourth cervical vertebra of an Alligator.

Professor HUXLEY, referring to the same vertebra, finding its capitular process in the level of the neuro-central suture, as in the eighth cervical vertebra of a Crocodile,

* MIALL, 'Skull of the Crocodile,' p. 32.

† OWEN, R., "Fossil Reptilia of the Wealden Dinosaurus, *Iguanodon*," Supplement 5, p. 6.

‡ OWEN, R., "Monograph on the Fossil Reptilia of the Wealden Formation," Pal. Soc., vol. for 1855, p. 2, t. 1.

suggests that there may have been seven or eight vertebræ between the most anterior preserved in No. 39,460 and the head.*

The correctness of this inference is demonstrated by the part of a skeleton in Mr. Fox's collection represented in the accompanying sketch (Plate 73). In close proximity to the mandible and shoulder-girdle is a continuous chain of nine vertebræ, proved cervical by the position of the capitular process (*parapophysis*). In the eighth vertebra in this chain this process is in the level of the neuro-central suture, and therefore in the same position as in the most anterior of the seventeen vertebræ displayed in No. 39,460, and in the eighth cervical of Crocodiles. If to the seventeen vertebræ in this latter fossil seven are added for those missing from its neck, and we allow two or three for those in the loins hidden by the foot, the number of præsacral vertebræ will amount to twenty-seven or twenty-eight at fewest, exclusive of the atlas, which is still unknown. Of this number, reckoning as cervical all in which the capitular process is wholly or partly on the centrum, nine, exclusive of the atlas, belong to the neck. Of the others, if we reckon as lumbar all in which a short vertebral riblet, unconnected with the sternum, is attached by a single articulation to the end of a transverse process, six at fewest should be referred to the loins. The remaining ten or eleven belong to the dorsal region. The number of caudal vertebræ was considerable, probably not less than fifty.

Cervical vertebræ (Plate 73, *cv.cv′.*; Plate 74, figs. 1–8†).—These are opisthocœlous. The contour of the anterior articular end is roughly shield-shaped; it is a rhomboid figure with the upper acute angle cut off and indented by the neural canal. The vertical and horizontal diameters of this end in the most anterior vertebra of No. 39,460 Brit. Mus. Cat. (Plate 74, fig. 4) are respectively 13 millims. and 10 millims. In a corresponding vertebra in my own collection (Plate 74, fig. 7) they are 14 millims. and 11 millims. The sides of the centrum are deeply pinched in below the neuro-central suture; an expansion of the centrum towards the articular ends makes them concave in the longitudinal direction; below, they converge to a somewhat acutely angular keel. All these vertebræ have a capitular process on the side of the centrum near its front. The position of this process ascends on the side of the centrum in passing from the front to the root of the neck. All have also a tubercular process (diapophysis) on the neural arch, placed just external to the præzygapophysis. The articular surfaces of the præzygapophyses are directed upwards and inwards. The spinous process is quite dwarfed in the anterior cervical vertebræ, but at the root of the neck well developed. The postzygapophyses are a pair of long branches diverging from the back of the neural arch having the articular surface on the under side of their free end.

* Huxley, Th., Quart. Journ. Geol. Soc., vol. xxvi., p. 3, plate i. 1870.

† These vertebræ are better illustrated by the Mantel-Bowerbank fossil (No. 39,460 Brit. Mus. Catal.) than by any others I have seen. They are figured by R. Owen in "British Fossil Reptilia," Pal. Soc., vol. for 1855, plate i., figs. 2, 3, 4.

*Dorsal and lumbar vertebræ** (Plate 74, figs. 11, 12 ; Plate 76, fig. 2).—In passing from the front to the root of the neck, the convexity of the anterior and the concavity of the posterior articular end of the centrum decrease. Centra in the anterior dorsal region have their anterior articular end plane or slightly concave, and their posterior end somewhat more concave, but in much less degree than in the neck. With diminished angularity of the inferior keel, and the removal of the parapophysis from off the centrum, the contour of the articular ends of this becomes less shield-shaped and more rounded, until in the posterior dorsal region and in the loins it is approximately circular. The depression so marked in the sides of the cervical vertebræ below the neuro-central suture decreases in approaching the trunk, and from the mid-dorsal region to the loins the sides of the centrum are approximately flat in the vertical direction. In the longitudinal direction they are rendered slightly concave by an expansion of the centrum towards its ends. The transverse processes, in the anterior dorsal region stout and relatively long, have a capitular costal facet on their front edge where they spring from the neural arch, and a tubercular facet at their free end. Towards the loins the capitular facet approaches the tubercular, and in the lumbar vertebræ the relatively short stout transverse process has only a terminal facet. The average length of the dorsal and lumbar centra in No. 39,460 Brit. Mus. Coll. is 17 millims. ; that of the vertical diameter of the articular ends is 14 millims. ; and that of the middle of the centrum is 12 millims. The three last lumbar vertebræ in a piece in my collection (No. 110) are each 20 millims. long. The terminal lumbar vertebra is distinguished from the others by its greater bulk, and particularly by the enlargement of the posterior end of the centrum in adaptation to the corresponding surface of the first sacral with which it is often found anchylosed (Plates 75 and 76, fig. 2).

Sacrum (Plate 74, fig. 9 ; Plates 75 and 76).—This comprises, as already stated, five vertebræ. These and the terminal lumbar in mature individuals are usually anchylosed together, with sometimes, but less frequently, I think, the first post-sacral vertebræ. All the five sacral vertebræ are smaller than the terminal lumbar. The first sacral is distinguished from the others by the great lateral expansion of the front end of its centrum (Plate 75, 1 *s.*). The shape of the second sacral centrum is cylindroid ; it is constricted at the middle and expanded at its ends, which makes the lower outline of the sacrum sinuous. The swelling that marks the junction of the anchylosed centra is not a uniformly tumid ring, but is greater where the inferior and lateral surfaces meet, forming here a pair of small knots, as in *Iguanodon Mantelli*. Inferiorly, instead of being angulated through the inclination of the sides, as in *I. Mantelli*, the sacral centra in *Hypsilophodon* have a shallow median groove. The lower transverse processes are attached laterally at the junctions of the centra, they pass directly outwards, and their outer ends expanding antero-posteriorly coalesce and form a series of loops

* These are well illustrated by the Plate referred to in the preceding page.

or sacral foramina. The root of each lower tranverse process is therefore connected with two centra, that of the first transverse process, stouter than the others, being attached to the terminal lumbar and the first sacral centrum. The construction is that which is usual in the dinosauria. The length of the sacrum represented in Plate 75 of one in Mr. Fox's collection is 8·3 centims., and the average length of the centrum is 17 millims. The length of the last lumbar vertebra in another skeleton in the same collection is 18 millims., the diameter at the constricted middle is 14 millims., and that of the expanded posterior end is 18 millims. The superior bulk of the last lumbar centrum is well shown in two sacras in my own collection.

DIMENSIONS of centra in two sacra.

	Length.	Horizontal diameter at front.	Horizontal diameter at middle.	Horizontal diameter at posterior end.
1. In Mr. Fox's Collection.—1st sacral .	15	21	10	15
,, ,, 2nd ,, .	15	15	10	15
2. In No. 110 Coll. HULKE.—1st sacral .	17	19	13	16
,, ,, 2nd ,, .	17	16	14	..

In the sacra to which reference has been made, the last centrum is too mutilated for description. One from a larger individual is 22 millims. long. Its anterior articular end, marked with the diverging striæ present before anchylosis, has a vertical diameter of 14·5 millims., and a horizontal diameter of 19·5 millims. The shape of the centrum is cylindroid. A mutilated transverse process, preserved on the left side, is attached to the upper part of the side of the centrum, at its front, for a space of 13 millims., and since the sutural surface of the process projects 3 millims. in advance of the anterior articular end of the centrum, it must to this extent have rested on the centrum in advance. The fifth sacral nerve escaped behind the transverse process through the intervertebral foramen between this and the first caudal vertebræ. The præzygapophyses look upwards, and slightly outwards. The spinous process, 21 millims. long and 14 millims. wide at its free end, has a slight backward slant.

Post-sacral or caudal vertebræ (Plate 74, figs. 9–13 ; Plate 75).—The first is known by the absence of chevron-facets, and the second by the presence of a single facet, the first chevron bone being articulated with the second and third caudal vertebræ. In shape the two foremost caudal centra resemble the last sacral, but the lateral surfaces below the transverse process are more flattened, which makes the third and succeeding centra less cylindroid. Transverse processes are present in about the first fourteen vertebræ, counted from the sacrum. Those of the first caudal are small and short, they project from the side of the centrum immediately below the neuro-central suture. Those of the second caudal vertebræ are longer and flatter. The length of the transverse process increases until about the eighth vertebra, behind which it rapidly shortens and becomes an inconspicuous tubercle which soon disappears. Where this occurs the length of the centrum is slightly increased. Its shape also becomes cylindroid, with a contracted middle and swollen ends, flattened slightly, laterally, and inferiorly, where also an oblique facet at each end marks the attachment of the chevrons (Plate 74, fig. 13). The spinous processes and chevrons are reduced much more slowly than are the transverse processes. In a rudimentary form they persist to the end of the tail; where most developed, in the front half of the tail, the spinous processes have the shape of flat oblong blades. The chevrons are longer than the spinous processes; their articular end is stout, and when well preserved is wedge-shaped, the anterior facet of the wedge being slightly the larger; their free end is expanded and flattened; and intermediately their shaft is contracted and slender.

In the part of the tail shown in Plate 74, fig. 13, the average length of the centrum is 25 millims., that of the spinous process is 35 millims., and that of the chevron bones 51 millims. The longitudinal streaks in this figure are ossified tendons.

The changes of shape of its articular ends and of the length of the vertebral centrum, in passing from the cranial to the caudal end of the centrum, add another to the already numerous refutations of the dictum which for many years was a great hindrance to the reconstruction of the dinosaurian skeleton, viz.: that the shape of its ends and the length of the centrum are constant throughout the column. The double costal articulation is repeated in Crocodilians, but not the opisthocœlous form of the centrum in the neck and front of the back. The great depth of the tail is probably in adaptation to swimming.

Ribs.—Ribs (pleurapophyses) are borne by all the præsacral vertebræ. (This statement does not apply to the two first vertebræ, respecting which information is still wanted.)

In the neck the riblets are short, their vertebral end is forked, the branches lie in a nearly vertical plane, and they articulate with corresponding upper and lower vertebral transverse processes. Their ventral or free end is extended antero-posteriorly. In the anterior dorsal region the capitular branch is long. Near the middle of the back the tubercular branch is reduced to a mere tubercle placed where the long, slender capitular branch or neck and the shaft of the rib join. Ribs from the posterior dorsal region show a reduction of the length of the neck with an approximation of the head to the tubercle, until in the loins both blend in a single terminal articular facet attached to the end of the transverse process. The form and the arrangement of the ribs in the neck and back are closely repeated in extant Crocodilia, but in the loins there is a small peculiarity to which allusion has been already made—the anchylosis of the rib (pleurapophysis) with the end of the transverse process, their junction being marked by a nodal swelling. I have seen this in three skeletons of adult *Hypsilophodon*, but not in those of Crocodilia.

Shoulder girdle and forelimb.

Sternum.—The breast-bone is broad and shield-shaped (Plate 73, *st.*). Its two halves are so inclined that they make a blunt median angle or ridge along the inferior surface, which starts from the bottom of a deep notch that indents the anterior border. The lateral margins bear in front the articular surfaces for the coracoids comprising a large segment of a circle. The chord of this in the fully-grown skeleton shown in the accompanying sketch is now 30 millims., but originally it measured somewhat more as it is somewhat mutilated posteriorly. Behind the coracoid surface are the marks of attachments of ribs. Of the number of these we have as yet no certain information.

Coracoid (Plate 73, *c.*; and Plate 79, fig. 1).—This is a flat bone of a simple, rudely crescentic shape. Its curved border in the articulated skeleton, mesial, is adapted to the corresponding surface of the sternum. Its outer border, much stouter than the mesial, consists of an articular part in front, and of a deeply incurved non-articular part behind. The articular part is subdivided into a thinner anterior segment firmly articulating with the scapula, and a stout expanded posterior part—the coracoid component of the glenoid fossa. In well-preserved examples a small chink passes a short way into the body of the bone from the point where these two sub-divisions of the outer border meet, and just in front of this fissure is a perforation as in *Iguandon Mantelli.* The width of the fully-grown coracoid represented in Plate 73, *c.*, measured from the middle of the outer border to the corresponding point in the inner border, is 45 millims.; and the length of the glenoid surface is 27 millims.

Scapula (Plate 73; and Plate 79, fig. 1).—This is a long, thin, narrow, slightly recurved bone, having a general likeness to that of *Iguanodon Mantelli.* Its dorsal end, in uninjured specimens, is expanded antero-posteriorly, its shape is not symmetrical, the backward extension being greater. The anterior border is sinuous, convex in its dorsal, and concave in its ventral half; and near the ventral end is an acromial projection, a repetition on a small scale of that shown in the scapula referred to *I. Mantelli* in the collection of J. B. HOLMES, Esq., of Horsham, figured by R. OWEN in his "Fossil Reptilia of the Wealden Formation, Monograph *Iguanodon,*" t. xiv. From this projection a ridge curves upwards and backwards across the outer surface ending at the upper or posterior lip of the glenoid fossa. The outer surface below this ridge is depressed, whilst that above it is slightly convex. The posterior border is slightly concave. At about two-thirds of the distance between the dorsal end and the glenoid fossa a slight projection breaks the otherwise regular curve of the posterior border (Plate 73). The ventral end of the scapula presents in front a relatively thin part suturally joined to the coracoid, and behind this a smooth articular part which with the corresponding part of the coracoid composes the glenoid fossa. The length of the scapula of an immature individual in my collection (No. 98 Cat., Coll. HULKE) (Plate 79, fig. 1) is 86 millims., being nearly that of the humerus; the width of its dorsal end is 26 millims., that of its ventral end is 32 millims., of which 10 millims. belong to the glenoid, and 22 to the coracoid segment; but these numbers have only an approximate value as the bone has been injured by pressure. Some of the dimensions of the scapula represented in Plate 73, are as follows :—Length from dorsal end to acromion 14·3 centims., length of glenoid surface 2·8 centims., and that of coracoid border about 3 centims.

Forelimb.—The structure of this is still incompletely known. I have as yet only recovered very mutilated remains of it.*

Humerus (Plate 73; and Plate 79, figs. 1 and 2).—This is nearly as long as the scapula. Its proximal end is broadly expanded, convex tranversely on its dorsal aspect, and concave in the same direction in the ventral surface. The proximal end bears, nearly at its middle, a smooth sub-spherical articular surface from which a ridge-like swelling passes some distance down the dorsal surface of the bone. The anterior, radial, border swells into a stout crest which renders its outline convex in the upper third of the bone. The contour of the posterior border is a hollow curve. The shaft seems to be slightly twisted owing to a small change in the direction of its surfaces. The distal end is condylarly divided. Behind, the condyles are separated by a wide shallow groove which ascends some distance on the shaft. The length of the humerus figured in Plate 79, fig. 1, is 13·6 centims.

Ulna (Plate 79, fig. 3).—Its proximal end is larger than that of the radius and it seems to have well-formed olecranon. The shaft and the distal end are slender. Its length slightly exceeds that of the radius.

Radius (Plate 79, fig. 3).—The length of this bone is about 12·5 centims. in a skeleton in which the humerus is about 13·6 centims. long. The breadth of its carpal end is 21 millims. The expanded carpal end is the chief support of the manus.

Manus (Plate 79, fig. 3).—A proximal row of carpalia appears to consist of a large *os radiale* and a smaller *ulnare.* The metacarpals are much smaller than the metatarsals. The ungual phalanges resemble in form those of the pes, but are smaller than these.

In its extreme simplicity the shoulder girdle of *Hypsilophodon* differs from that of most extinct Lizards. Its *coracoid,* in respect of its simple crescentic form, devoid of bony procoracoid, agrees with that of every other dinosaur yet known. It is imitated in *Hatteria* and in *Chameleo,* and is very unlike the long, narrower coracoid of Crocodilians. The sternum, in respect of its shape, resembles the (cartilaginous) sternum of Crocodiles more than that of Lizards, except *Chameleo.* The scapula, as regards its length and narrowness, closely agrees with that of *Iguandon Mantelli, I. Prestwichii,* and *Megalosaurus,* and differs from that of *Hylæosaurus,* of *Scelidosaurus,* of Crocodilia and extant Lizards except *Chameleo.* The humerus in the greater expansion of its ends and the slenderness of its shafts resembles that of a Lizard more than that of a Crocodile. The inner tuberosity of the proximal end resembles that in

* See postscript.

Iguanodon Mantelli, and in Birds. The ungual phalanges in shape resemble those of the pes, as it is now known they really do in *Iguanodon Mantelli*, the restoration of the manus of this dinosaur in the "British fossil Reptilia" being based on mistaken identifications.

Hip-girdle and hind limb.

Ilium (Plate 77).—This has the elongated form which characterises this bone in the Iguanodontidæ. Its præacetabular process, extremely long and slender, extends forwards upon the loins overhanging the posterior lumbar ribs. The acetabular arc ends anteriorly in a relatively slender pubic process directed downwards and forwards, and behind it is terminated by a low swelling which marks the attachment of the ischium. The lower border of the broad post-acetabular part, nearly straight, is slightly inflected, and is indented by a longitudinal groove.

Ischium (Plate 75; Plate 76; Plate 77).—This bone was first identified by Professor HUXLEY in the British Museum fossil No. 39,460.* It had before been considered to be a tibia.† It is the same bone which in *Iguanodon Mantelli* passed for so many years as clavicle.‡

It has the form of a long slender bar directed backwards parallel with the lower border of the post-acetabular part of the Ilium. That this is its true direction may be seen by its impression in the stone below the left Ilium in the annexed sketch made several years ago of a fossil in Mr. Fox's collection (Plate 77).§ The proximal end of the ischium is expanded. It has above a stout process, which united to a corresponding process on the Ilium behind the acetabulum, completed below and posterioly the circle of this articular hollow. This acetabular process is borne on a narrow part or neck, the axis of which makes an angle of about 90° with the long axis of the bone. Below the acetabular process and the neck is a wide rudely quadrilateral expansion directed downwards, the lower curved border of which contributes the lower margin of the acetabulum. Behind this expansion the bone rapidly contracts and continues narrow through about half its length when it again widens. Nearly midway between its acetabular and its ventral or lower end is a lip-shaped out-turned obturator process (Plate 75, *ob.p.*), against which rests the rod-like part of the *os pubis*. The lower or ventral ends of the *Ischia* seem to be symphysially united.

Pubis.—The form of this bone repeats in miniature that of *I. Mantelli* (Plate 75; Plate 76, fig. 1; and Plate 77). It has a stout short part, or body, with a smooth articular surface, which in front is attached to the pubic process of the *Ilium*, and behind meeting the *Ischium* completes below and in front the circle of the acetabulum. From

* HUXLEY, Quart. Journ. Geol. Soc., vol. xxvi., plate i., fig. 3. 1870.

† OWEN, R., "Fossil Reptilia of the Wealden Formation," Pal. Soc., vol. for 1855, p. 2, t. 1.

‡ OWEN, R., 'Fossil Reptilia of the Cretaceous Formation,' p. 105, plate xxxiv.

§ This figure shows the right *Ischium*, which has been uncovered since the above was written.

this part a broad bar-like plate extends forwards and downwards, and an extremely slender long rod passes backwards parallel with and supported by the corresponding ischial bar, which it nearly equals in length. I cannot certainly say that the ventral ends of the pubis were symphysially joined, but the appearances make this probable.

The bottom of the bony acetabulum was defective.

Femur (Plate 75; Plate 78; Plate 80).—This is a much stouter bone than the humerus. Its proximal end has a sub-globular head borne on a stout short neck, the axis of which makes nearly a right angle with that of the shaft; and a prominent outer trochanter between the upper part of which and the shaft is a deep narrow fissure. Behind the head is a small pit, and in front between the neck and the outer trochanter is a larger depression. The distal end has the usual condylar shape. The outer condyle is longer and stouter than the inner. Both project strongly backwards, and are here separated by a wide deep intercondylar groove, the outer border of which is formed by a narrow ridge which divides the intercondylar groove from a deep but much narrower groove in which the upper end of the fibula moved, the ridge itself being received in the interval between the fibula and the outer tibial condyle in flexion of the leg on the thigh. The anterior intercondylar groove is wide and shallow, contrasting strongly in these respects with the deep narrow, almost tunnel-shaped, anterior intercondylar groove in *Iguanodon*, as known in *I. Mantelli*, *I. Prestwichii*, and *I. Seelyi*. The shaft of the femur appears to be twisted owing to the alteration in the aspect of its surfaces, that which at the proximal end is external becoming at the distal end anterior. It is also bent, its upper longitudinal outline being a convex curve. The cross-section at the middle is rudely prismatic. Nearer to the upper than the lower end of the bone at the inner and posterior aspect of the shaft is a compressed triangular, in the best-preserved specimens, remarkably long-pointed inner trochanter, the apex of which is directed towards the distal end of the bone. At the inner side of this trochanter is a pit.

Tibia (Plate 80, fig. 2; Plate 81, fig. 1).—This bone in *Hypsilophodon* is longer than the femur, the opposite of that which obtains in *Iguanodon*. A nearly perfect tibia of *Hypsilophodon* measures 23·25 centims. long, the length of the femur of the same skeleton does not exceed 18 centims. The proximal end of the tibia shows a division of the articular surface into two condyles, which project posteriorly and are here separated by an intercondylar groove. A large præcnemial crest projects from the upper part of the shaft in front of the external condyle. The cross-section of the shaft is prismatic. The distal end is expanded and shaped into two malleoli, of which the outer and posterior is longer and thinner, and the inner and anterior is shorter and stouter. These are separated in front by a wide shallow groove, which ascends a slight distance on the anterior external surface, and below ends behind at a salient angle where the inner and posterior surfaces meet. The outer border of the distal half of the tibia is impressed in its anterior aspect by the fibula which here lies upon it. The axis of the shaft is twisted in such a manner that a plane laid through the long diameter of the proximal end cuts at a large angle another plane laid through the long axis of the distal end (Plate 80, fig. 8).

The following are some of the dimensions of a fully grown tibia :—Extreme length, 22·25 centims. ; breadth across the proximal condyle, 3·35 centims. ; from the back of the inner condyle to the most prominent point of the præcnemial crest, 5·7 centims. ; breadth across the malleoli, about 4·6 centims.

Fibula (Plate 77 ; Plate 78 ; Plate 81).—The upper end is flattened. It rests against the outer surface of the outer proximal condyle of the tibia behind the great præcnemial crest. In flexion of the knee it is received in a groove on the outer femoral condyle, as already mentioned. The shaft, sub-prismatic, rests in its lower half on the anterior surface of the tibia, just within its outer border. Its distal end is stout. It articulates with the anterior of the two divisions in the upper surface of the *os calcis.*

Pes.—The tarsus comprises two distinct bones corresponding to those of the proximal row of *ossa tarsalia* of other Vertebrates—an *os tibiale* or *astragalus,* and an *os fibulare* or *calcis.* Evidence of the presence and the composition of a distal row of distinct *tarsalia* is yet incomplete.

Astragalus (Plate 80, figs. 3–7).—The upper surface of this, the largest tarsal bone, is the counterpart of that of the tibia ; it is concave from front to back, and in this direction divided by a ridge that marks out two portions corresponding to the inner and part of the outer tibial malleolus. The under surface is pulley-shaped, convex from front to back, and sinuous transversely, being in this direction convex towards the ends and concave intermediately. The anterior margin is a thin lip, the posterior margin is stout. The inner end is non-articular and sub-cutaneous, the outer end (very thin by the approximation of the upper and under surface) articulates with the *os calcis.*

Os calcis (Plate 80, figs. 3–7).—The outer, non-articular, sub-cutaneous surface is crescentic. The upper border, nearly straight, is interrupted by a slight elevation, the outer end of a ridge which divides the upper surface into an anterior moiety that receives the end of the fibula, and a posterior in which the outer part of the external tibial malleolus rests. The under surface is convex from front to back. The inner surface, or rather border, very narrow, articulates with the astragalus.

The *astragalus* and *os calcis* conjointly form a pulley-shaped articular surface on which the front part of the pes moves. The interlocking of the upper surface of the conjoined bones with the ends of the tibia and fibula renders impossible any movement of them upon the leg-bones.

In a right foot of a nearly fully-grown *Hypsilophodon* I found a wedge-shaped bone inserted between the proximal end of the IVth. metatarsal and the *os calcis.* Its position and shape correspond to a bone in the pes of *Scelidosaurus Harrisonii** and

* Owen, R., "British Fossil Reptilia of the Oolitic Formation," part ii., plate x., fig. 1.

certain American Dinosauria* regarded as the homologue of the *cuboid.* In another foot between the astragalus and the base of IVth. metatarsal I found a small bone which may be the homologue of the *external cuneiform.* These identifications must be accepted with reservation; they must be confirmed or corrected by new and less disturbed materials.

Metatarsus (Plate 77; Plate 79, fig. 4; Plate 81, figs. 2, 3).—The metatarsus of *Hypsilophodon* contains five bones, of which four are large and support functional toes, and one is rudimentary. The proximal ends of the four large metatarsals are in closest mutual apposition. Those of the two inner ones with the two distal *tarsalia* (if the identification of these latter be correct) form the distal half of the mid-tarsal joint where movement of the foot on the leg takes place.

The distal ends of these *metatarsalia* are stout, their articular surface is pulley-shaped, the pits for the attachment of lateral ligaments are large and deep. Their long, slender, prismatic shafts have a slight forward and inward curve. Counted from the inner to the outer border of the foot, the IIIrd. is the longest and largest metatarsal; the IVth. is slightly longer than the IInd.; and this latter slightly exceeds the Ist. The following table gives some dimensions of the metatarsals in a fully-grown *Hypsilophodon*:—

	I.	II. millims.	III. millims.	IV. millims.	V. millims.
Length	†	93·	105·	87·5	32·
Breadth of proximal end. . .	..	12·	12·5	..	8·5
Breadth of distal end . . .	..	..	20·	15·	..

The Vth. metatarsal is a small tapering styliform bone, its distal end bluntly pointed does not support any phalanges. I found it first in 1876 in close relation to the IVth. metatarsal and *os calcis,* and I have since observed it in five other hind feet.

Phalanges (Plate 79, fig. 4).—The four functional toes have respectively two, three, four and five phalanges, and therefore correspond to the Ist., IInd., IIIrd., and IVth. toes in the foot of existing Lizards and Birds. The second, third, and fourth phalanges of the IVth. (outer toe) are shorter than the other phalanges, but this shortening is less than in the same phalanges in the foot of *Iguanodon Mantelli* and *I. Prestwichii.*

The ungual phalanges are long, pointed, slightly curved (Plate 79, fig. 4); their proportions to the metatarsals and other phalanges can be seen from the annexed table of measurements of the foot of an immature individual.

* MARSH, O. C., "Principal Characters of American Jurassic Dinosaurs," from American Journal of Arts and Sciences, vol. xvi., Nov., 1878, plate ix., fig. 3. *Laosaurus.*

† Too mutilated for measurement.

Lengths	Ist. toe. millims.	IInd. toe. millims.	IIIrd. toe. millims.	IVth. toe. millims.	Vth. toe. millims.
Metatarsals	..	63·	69·	56·	..
1st phalange	..	23·	25·	17·	..
2rd phalange	17·	14·	17·	12·	..
3rd phalange	..	21·	13·5	8·	..
4th phalange	..	..	23·5	8·	..
5th phalange	..	..	..	17·	..

The *sacrum*, as in all true dinosauria, differs in the greater number of vertebræ composing it from that of *Saurii* and *Crocodilini*. The *Ilium* closely imitates that of Aves in the great extension of its præacetabular part—a part which in *Saurii* and *Crocodilini* exists only as a mere rudiment.

The *Ischium* in respect of its length and slenderness and its direction parallel to the lower border of the post-acetabular part of the Ilium differs entirely from that of Lizards and Crocodilians and closely resembles that of Aves, as noticed first by Professor HUXLEY. The slender rod-like part of the *pubis* (*post-pubis,* O. MARSH) directed backwards parallel to the Ischium is obviously the homologue of the pubis in Aves and in *Saurii.* Its broad *præpubic* or præacetabular plate (*præpubis,* O. MARSH) has no homologue in *Saurii;* in Aves it exists as a mere rudimentary tubercle. Its homology with the bone called pubis in Crocodilians deserves consideration.

The *Ilium, Ischium,* and *Pubis* all contribute to the formation of the acetabulum, as I believe occurs in all other dinosauria of which the pelvic bones are known, *Omosaurus* being no exception to this, for the suggestion that in this dinosaur the pubis articulates only with the Ischium and is thus "seemingly" excluded from the acetabulum* obviously arises from a misconception of the homologies of the several parts of the pubic bone. A comparison of its pubis with those of *Iguanodon Mantelli, Hypsilophodon Foxii*, and certain *American dinosaurs* must make this apparent to every unbiassed mind.

The different proportions of the *femur* and *tibia* in *Hypsilophodon* and *Iguanodon Mantelli* have been noticed. In the former it is longer than the tibia, in the latter it is shorter than the tibia. In *Hypsilophodon* the inner trochanter is nearer the proximal end than it is in *Iguanodon Mantelli,* and it is also more pointed than in this. The differences in the anterior intercondylar groves in these two dinosauria are striking. The tibia is more slender than in *Iguanodon Mantelli.* The Avian resemblances of femur, tibia, and proximal row of tarsalia are very striking. The pes differs from that of *Iguanodon Mantelli* notably in the presence of a fourth functional toe. This alone would, I submit, suffice to exclude it from the genus *Iguanodon* in which the pes has but three functional toes. In having four functional toes and the rudi-

* OWEN, R., 'Mezozoic Reptilia,' part ii., p. 64.

ment of a fifth, probably also in the presence of two distinct tarsalia answering to those of the outer side in the distal row of tarsalia in higher Vertebrates, the hind foot of *Hypsilophodon* closely agrees with that of the Liassic *Scelidosaurus Harrisonii.* The sharp pointed curved ungual phalanges, of very different form to the blunt depressed unguals of *Iguanodon Mantelli,* are obviously related to a different habit of life. *Hypsilophodon* was adapted to climbing upon rocks and trees.

Postscript.

(Added October 9, 1882.)

Since the above was written, further work by the skilful mason of the Palæontological Department, Mr. Barlow, upon a block of sandstone in the Fox Collection in the British Museum, has very recently brought into view several additional parts of the skeleton, of which the pelvis is represented by Plate 75. These afford much information respecting the structure of the fore limb, and an opportunity of comparing the fore and the hind limbs in the same individual. In the left fore limb the coracoid and scapula remain naturally articulated, and the natural relations of the humerus, ulna and radius are only slightly disturbed, but the manus had broken up and its bones were scattered before the consolidation of the rock. The right ulna and radius with the manus attached, the dorsal surface towards the spectator, are well preserved.

The shapes and proportions of the coracoid, scapula and humerus agree so nearly with those already given from other specimens as to make any detailed description of them superfluous—the chief apparent difference is the absence of the slight projection from the posterior border of the scapula shown in Plate 73. A textural difference in the fossil marks off the expanded vertebral end of the bone as a supra-scapula. The length of the scapula including its supra-scapular part is nearly 9·7 centims., and that of the humerus is 9·5 centims.

The fore-arm (Plate 79, fig. 3) is shorter than the arm. The length of the left ulna is 8·7 centims. (that of the right ulna 8·5 centims., the slight difference is explained by the different exposure of the proximal end); the radius is shorter, its length being 7·8 centims. (the right radius 7·7 centims.).

The ulna is stout and massive at its articular ends; and its shaft is laterally so compressed as to greatly narrow the posterior surface in this part. The distal end of this bone, 1·3 centims. wide, appears to me to afford—relatively to the radius—a larger support to the carpus than the same bone in *Iguanodon Mantelli.* The radius is a more slender bone than the ulna and its figure is more cylindroid. Its proximal end is slightly expanded. The capitellum is followed by a slight contraction or neck which merges into a relatively slender shaft, widening and flattening distally towards the carpal extremity; the breadth of which appears to be somewhat less than that of the corresponding part of the ulna.

In the carpus (Plate 79, fig. 3) (through which unfortunately passes a crack filled with carbonaceous matter) a proximal row of *ossa Carpalia* is clearly recognisable. This appears to me to comprise a wedge-shaped *os ulnare* proximally articulating with the ulna and radially with a polygonal *os intermedium*, whilst its distal border corresponds to the base of the IVth., and slightly to that of the IIIrd. metacarpal bone. The *intermedium* is proximally in relation chiefly with the ulna, but its radial border touches the lower end of the radius here coming into contact with an ossicle, which from its situation with respect to the radius must be regarded as an *os radiale*. This is unfortunately damaged by the crack through the rock already mentioned. Distally the *os intermedium* corresponds principally to the base of the IIIrd., and in a less extent to that of the IInd. metacarpal bone. The *os radiale* is opposed distally to the base of the Ist. and slightly to that of the IInd. metacarpal bone. The condition of this part of the fossil does not permit me to speak confidently of the presence of a distal row of *Carpalia*.

Five digits are recognisable: numbering these from the radial to the ulnar border of the paw, the Ist. metacarpal is 1·7 centim. long, and so is slightly shorter than the IInd., which is 1·85 centim. long. This, again, is slightly exceeded by the IIIrd., which is 1·95 centim. or 2 centims. long, and is the longest one, the IVth. attaining only 1·2 centim.; whilst the length of the bone which I regarded as the Vth. metacarpal is only 8 millims. In its shape and its proportions this bone has more resemblance to a digital phalanx than the other metacarpals, but in these very points, as also in its different direction to that of the other metacarpals, it corresponds so well to the Vth. metacarpal in *Iguanodon Mantelli* that I may not hesitate to regard it as such. Proximally it articulates with the *os ulnare*. Its distal end is pulley shaped, distinctly articular. The phalangeal continuations of the toe are missing. On a small scale the shape and proportions of the other metacarpals repeat the metatarsals and do not require particular description.

In the Ist. toe two digits are discernible. In the IInd. toe three phalanges are apparent, of which the proximal is nearly hidden by that of the IIIrd. toe. This latter (the IIIrd.), the line of which is slightly displaced from that of its metacarpal, certainly has four phalanges, the lengths of which are 9 millims., 5·5 millims., 4 millims., and 8 millims. (the lengths of the proximal and 2nd phalanges of the IIIrd. hind toe of the same skeleton are 2·5 centims. and 2·1 centims.).

It is fortunate that the number of phalanges, four, in this toe (IIIrd. of manus) is beyond question, because this shows an essential structural difference between the fore foot of *Hypsilophodon* and that of *Iguanodon Mantelli*, in which, upon the evidence of undisturbed specimens in the Brussels Museum, no digit has more than three phalanges. In the IVth. toe of our fossil the proximal phalanx is succeeded by a second, of which the distal half is missing, as is also the continuation of the toe, so that the number of phalanges it had before mutilation is unknown. The ungual phalanges of the manus resemble on a small scale those of the pes, as already stated. Evidently the manus of *Hypsilophodon* conforms more nearly to that of existing Lizards, its type is more generalised than that of the manus of *Iguanodon Mantelli,* which is highly specialised.

The relative smallness of the fore limb in *Hypsilophodon,* shown for the manus by the lengths of the metapodia and phalanges already given, is evident also upon a comparison of the other corresponding segments of the fore and hind limb, as may be seen by the following numbers :—

TABLE of Lengths.

	centims.
Femur*	15·0
Tibia*	15·5
IIIrd. metatarsal	7·6
Humerus.	9·5
Ulna	8·7
Radius	7·8
IIIrd. metacarpal	1·9

EXPLANATION OF PLATES.

** *Denote fossils formerly in the collection of the late Rev.* WM. FOX, *recently acquired by the British Museum.* *** *Denote fossils in my own collection. Unless otherwise stated the figures represent the natural size of the fossils.*

PLATE 71.

The following lettering applies to all the figures in this plate.

pa. The parietal bone.
fr. The principal frontal bone.
prf. The præfrontal bone.
psf. The post-frontal bone.
nas. The nasal bone.
nar. The anterior nares.
pmx. The præmaxilla. * Its median ascending process. † Its lateral ascending process.
mx. The maxilla.

* These bones are slightly mutilated and their real lengths are somewhat more.

orb. The orbit.
utb. The upper temporal bar.
ltb. The lower temporal bar.
sq. The squamosal bone.
popr. The parotic process.
fm. The foramen magnum.
oc. The occipital condyle.
qu. The quadrate bone.
mn. The mandible.

Fig. 1. An oblique view of a skull of an adult *Hypsilophodon.* It represents the upper surface and the right side of the brain-case, and the palatal aspect of the snout which, wanting the mandible, has separated from the hind part of the cranium in front of the orbits, and is twisted on its long axis and laterally displaced.***

Fig. 2. Oblique view of the upper surface and the right side of a skull of a smaller individual.**

Fig. 3. A posterior view of the same skull.** (From a sketch by the author before the occipital condyle was mutilated.)

Fig. 4. Oblique postero-inferior view of the left mandible with the quadrate, and a piece of the lower temporal bar attached to the latter.

PLATE 72.

Fig. 1. Inner view of lateral parts of a skull (much abraded) in which the quadrate bone preserves its normal relations.**

qu. The quadrate bone.
sq. The squamosal bone.
mn. The mandibular.

Fig. 2. Inner view of the anterior part of a left mandibular ramus.**

ed.sp. Marks the edentulous symphysial spout.
sy. The symphysis.

Fig. 3. Outer view of a præmaxillary tooth.***

Fig. 4. Side view of the same.***

Fig. 5. Two worn teeth from near the front of the maxilla with the crown of a successional tooth.***

Fig. 6. An unworn tooth from near front of the maxilla.***

Fig. 7. A crown of a larger maxillary tooth, posterior in position to figs. 5 and 6.***

Fig. 8. Side view of the same.***

Fig. 9. A large nearly perfect maxillary tooth.***

(The mark I indicates the actual length of the teeth.)

PLATE 73.

Part of a skeleton of a fully-grown *Hypsilophodon*.**

cv′, *cv*. On the left hand of the figure is a continuous chain of cervical vertebræ.

In front of *cv′* is the reversed mandible *Mn*.

sc. The right scapula.

h. The right humerus, its proximal end still resting in the glenoid fossa.

c. The right coracoid.

st. The sternum.

PLATE 74.

In this plate *sp* marks the spinous process. *dp*. The diapophysis. *pp*. The parapophysis. *tr*. The transverse process. *ch*. Chevron bones. *prz*. The præzygapophysis. *psz*. The postzygapophysis. *k*. The inferior keel. *nap*. The neurapophysis.

Figs. 1–4. Three foremost cervical vertebræ in the MANTELL-BOWERBANK fossil. No. 39,460, Brit. Mus. Cat. (Figured by R. O. in "Brit. Foss. Rept.," Pal. Soc., vol. 1855, tab. i.)**

Fig. 1. Left lateral view.

Fig. 2. Upper view.

Fig. 3. Under view.

Fig. 4. Anterior view of *a* in fig. 1.

Fig. 5. Lateral view of a cervical vertebræ of a younger individual.***

a. The anterior surface.

Fig. 6. Inferior view of the same.***

Fig. 7. Anterior view of the same.***

Fig. 8. Posterior view of the same.***

Fig. 9. Lateral view of the 5th sacral, and two foremost caudal vertebræ.**

Fig. 10. Front view of 5th sacral in the preceding figure.**

Fig. 11. Lateral view of a dorsal vertebra.**

Fig. 12. Lateral view of a lumbar vertebra. Its spinous process postzygapophyses, and transverse process (foreshortened) are broken off.**

Fig. 13. Lateral view of three caudal vertebræ with their chevron bones.**

PLATE 75.

Inferior view of the sacrum and pelvic bones of an immature *Hypsilophodon*.**

Ll. The last lumbar vertebra.

1–5 s. The sacral vertebræ.
1–5 f. The sacral foramina.
P. The right os pubis.
P′. The left os pubis.
Is. The right ischium.
Is′. The left ischium.
ob.p. Obturator process.
Sy. The symphysis.
Fm. The femora.
cv, cv′. Caudal vertebræ.
ch. Chevron bones.

PLATE 76.

Fig. 1. Inferior view of sacral and lumbar vertebræ with ischia and pubis of an immature *Hypsilophodon.***
Is. Ischium.
P. Os pubis.

Fig. 2. Inferior view of lumbar and sacral vertebræ of a fully-grown *Hypsilophodon.****
s. Sacral vertebræ.
Ll. Last lumbar vertebra.
a. Acetabulum.

PLATE 77.

The pelvic bones and right hind limb of a fully-grown *Hypsilophodon.***
For their better individual representation the artist has removed these bones slightly from their relative positions in the fossil.
Il. The ilium.
Is. The ischium.
Pra. The præacetabular portion of the os pubis.
Psa. The postacetabular part of the same.
f. A foramen corresponding to that which in the Bird transmits the tendon of the Obturator internus muscle.
a. The acetabulum.
Fm. The femur.
Fb. The fibula.
T. The tibia.
C. The os calcis.
1–5 m. The metatarsal bones.

PLATE 78.

Figs. 1–5. Views of the left femur of the skeleton of which the shoulder-girdle, &c., are shown in Plate 73.***

Fig. 1. Outer surface.
Fig. 2. Inner surface.
Fig. 3. Inferior surface.
Fig. 4. Superior surface.

ot. Outer trochanter.
i.tr. Inner trochanter.
cap. Capitulum.

Fig. 6. Side view of a femur with the tibia and fibula in almost undisturbed natural relation.***

T. Tibia.
F. Fibula.

Fig. 7. Front view of the lower end of the same femur as fig. 6.***

PLATE 79.

Fig. 1. The scapula, *Sc;* humerus, *H;* and coracoid, *C,* of an immature individual.***

g. The glenoid fossa.

Fig. 2. The right humerus of the individual whose pelvic bones are represented in Plate 75.*** Its proximal end is mutilated.

Fig. 3. The forearm and manus of the same individual.***

R. The radius.
U. The ulna.
1–5. The digits.

Fig. 4. A right hind foot.

T. The tibia.
1–4. The digits.
M. The metatarsals.

PLATE 80.

Fig. 1. Femur of an almost fully-grown individual.***

cap. The capitulum (mutilated).
ot. The outer trochanter (mutilated).
it. The inner trochanter.

Fig. 2. Outer view of a tibia (the left) of an almost fully-grown individual.***

ic. The inner condyle.
pr.c. The præcnemial crest.

Fig. 3. Front view of the lower end of the bones of the leg with the proximal tarsalia.

F. The fibula.

T. The tibia.

As. The astragalus.

Ca. The os calcis.

Fig. 4. Outer view of the same.

Fig. 5. Posterior view of the same.

Fig. 6. Inner view of the same.

Fig. 7. Inferior view of the same.

Fig. 8. View of the proximal end of the tibia (fig. 2), projected on a dotted outline of the distal end to illustrate the directions of their long axes.

PLATE 81.

Fig. 1. Front view of the same tibia as shown in Plate 80, fig. 2.

pcr. The præcnemial crest.

Fig. 2. Lateral view of bones of right hind leg and foot.

T. The tibia.

F. The fibula.

Ca. The os calcis.

1–5 *m.* The metatarsals.

Fig. 3. Oblique outer view of a left hind foot. The lettering as in fig. 2.

PLATE 82.

Restoration of the skeleton of *Hypsilophodon.*

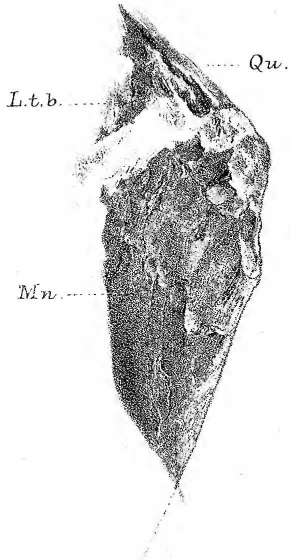
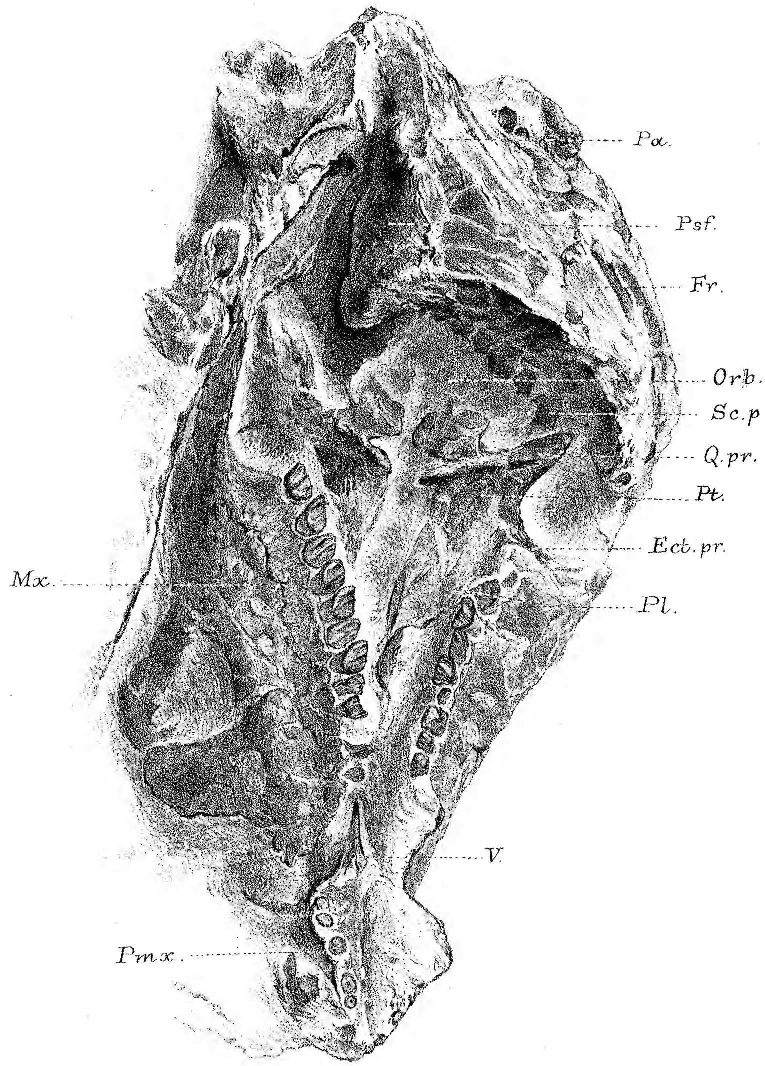


Fig. 4.

Fig. 1.



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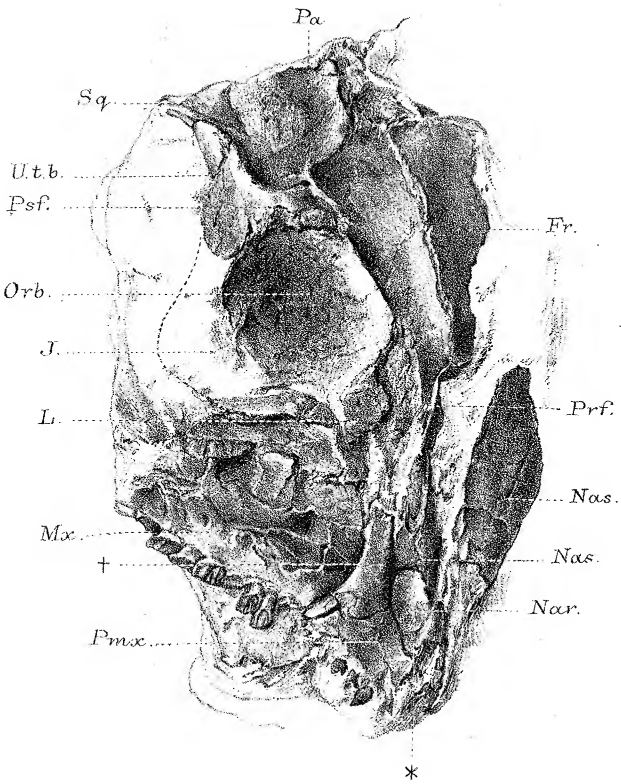

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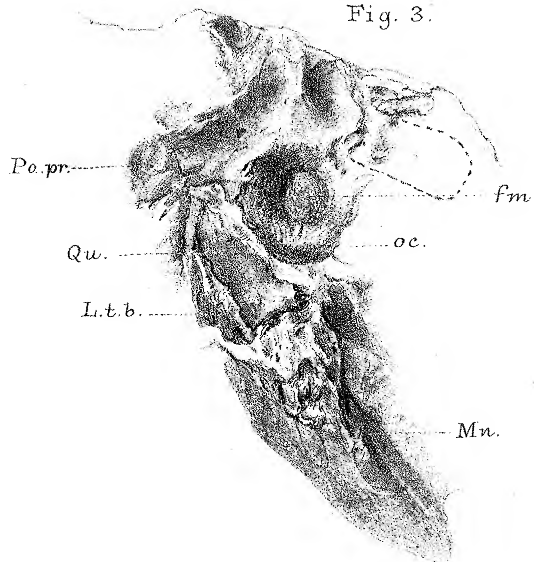

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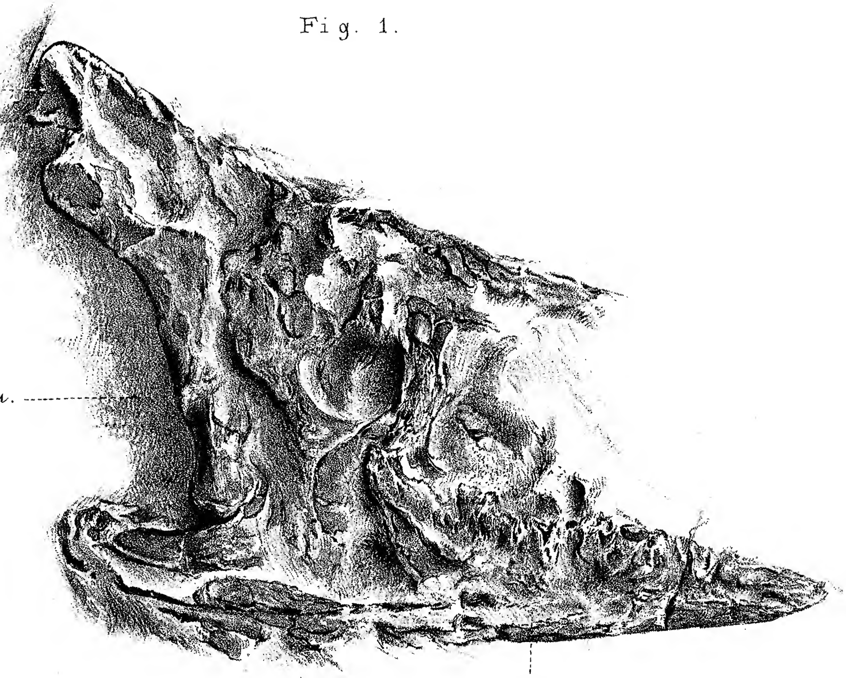

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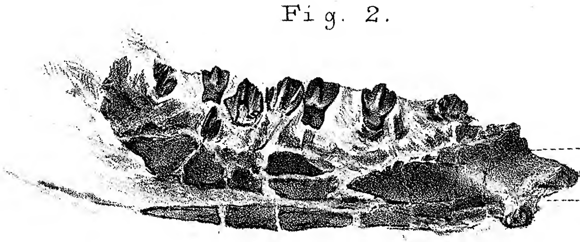
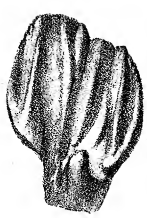


Fig. 3.

4.

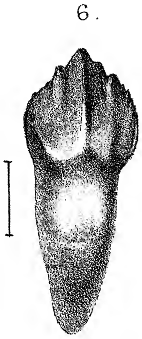
9.



7.

8.

6.



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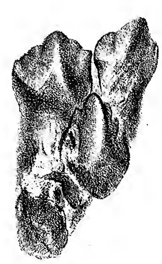
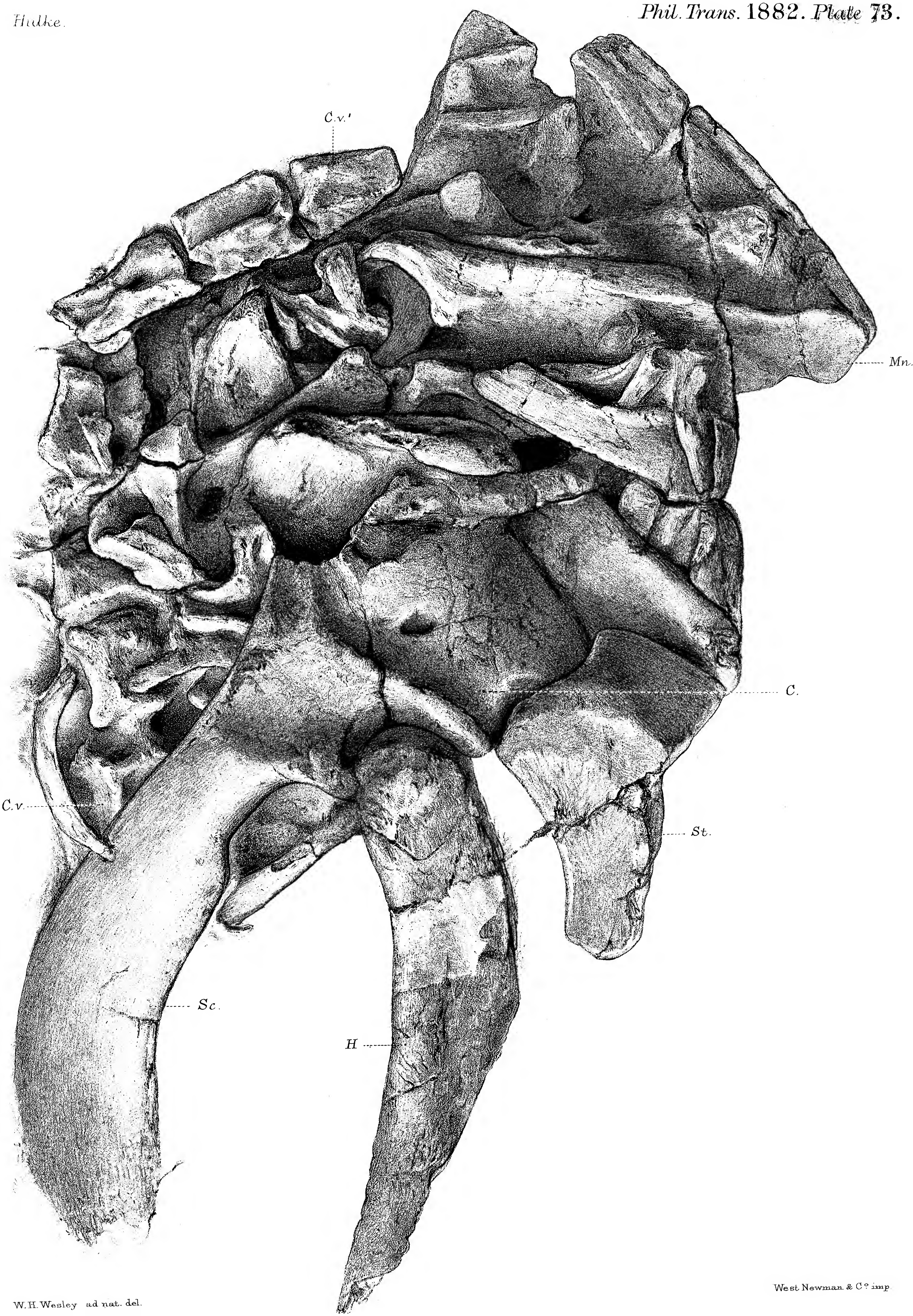
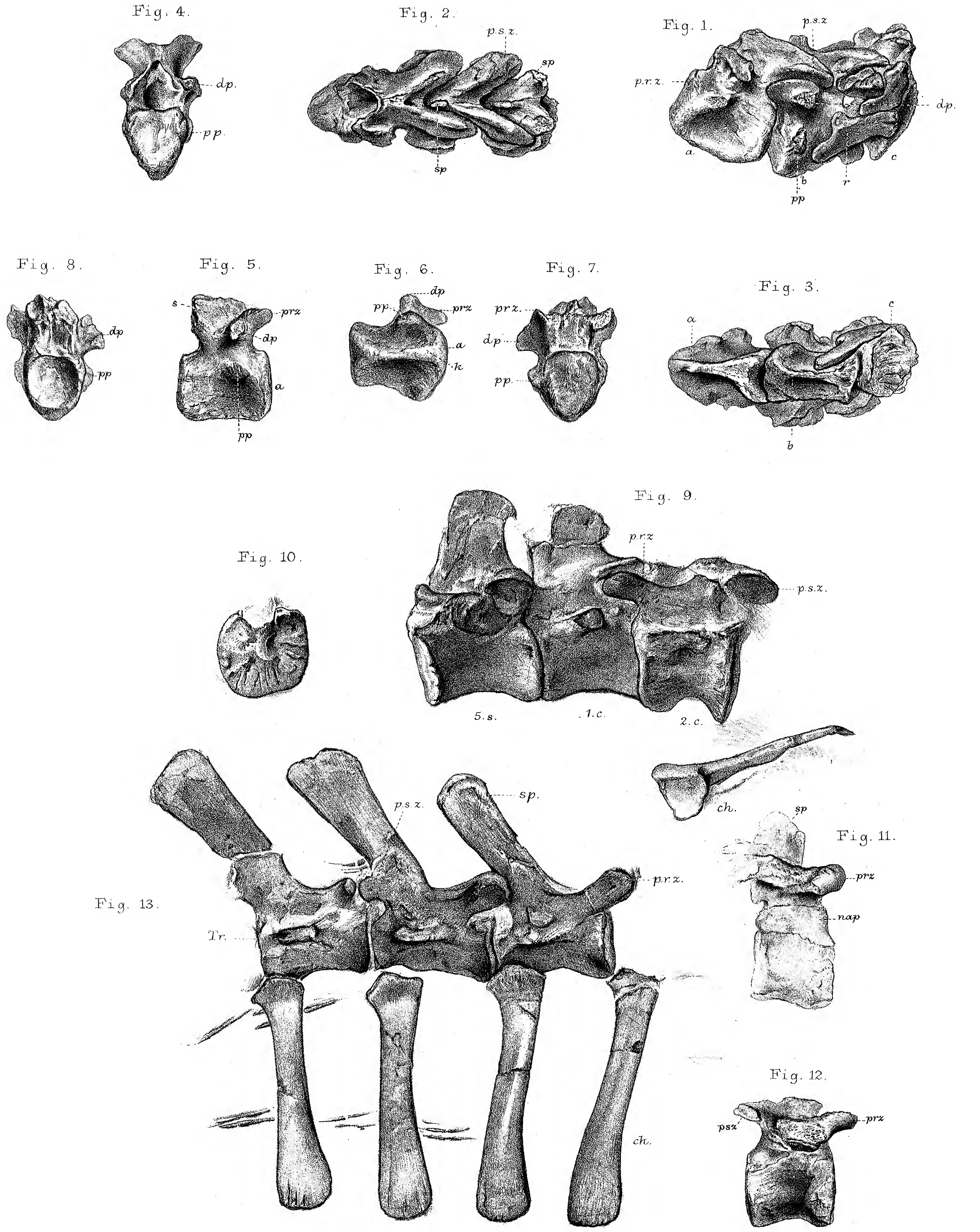


W.H. Wesley ad nat. del.

West, Newman & C° imp.


C.v.'
Mn.
C.
C.v.
St.
Sc.
H



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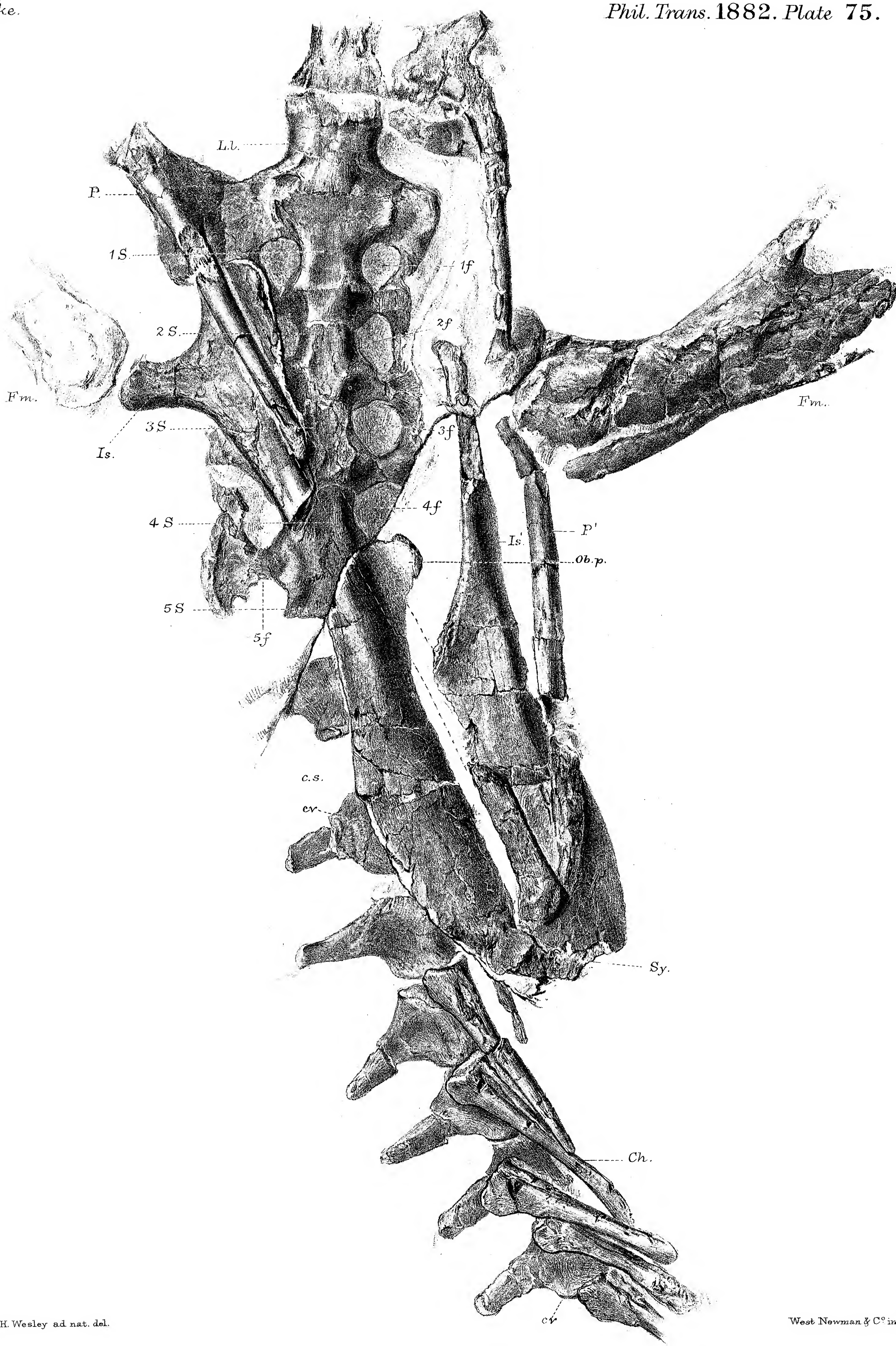

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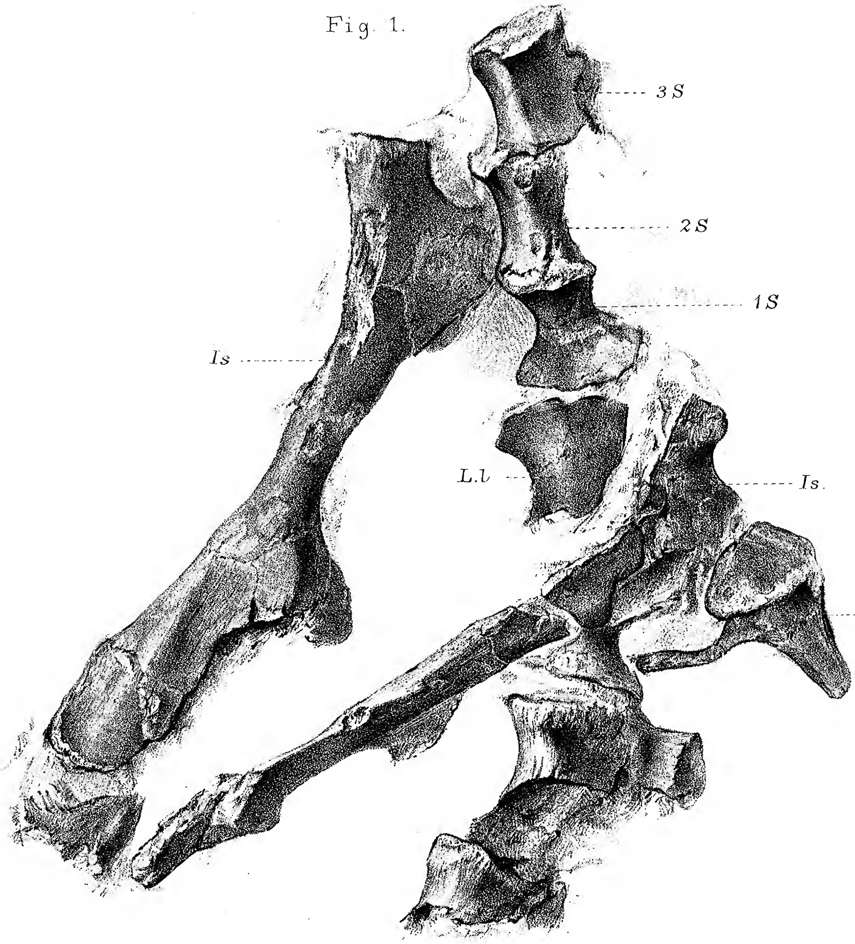

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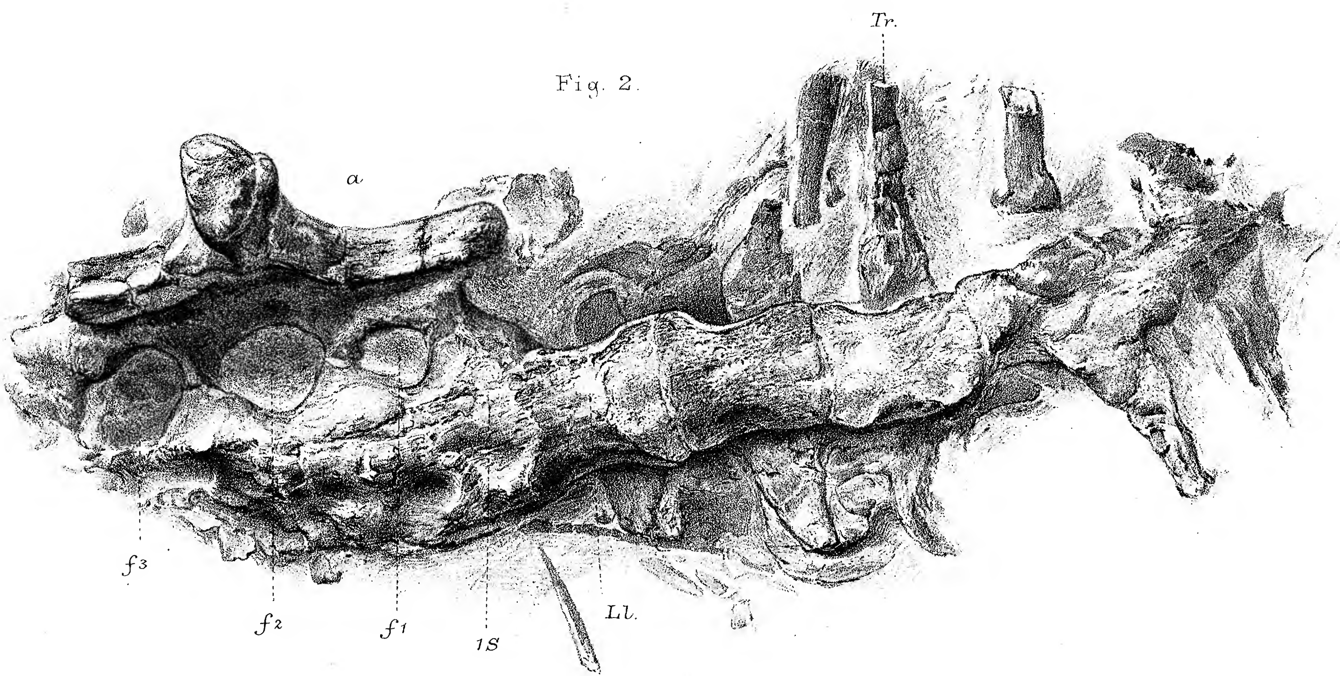

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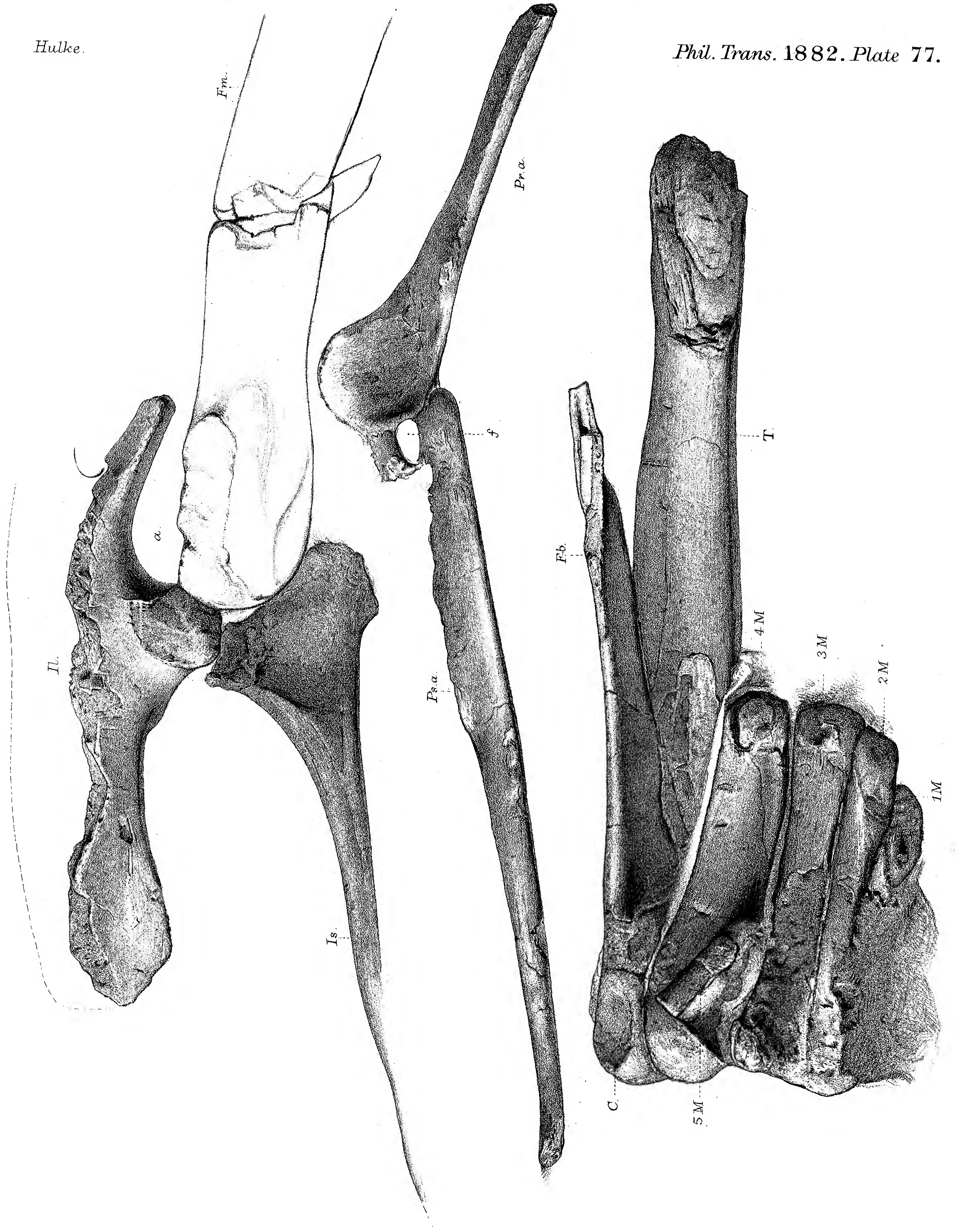

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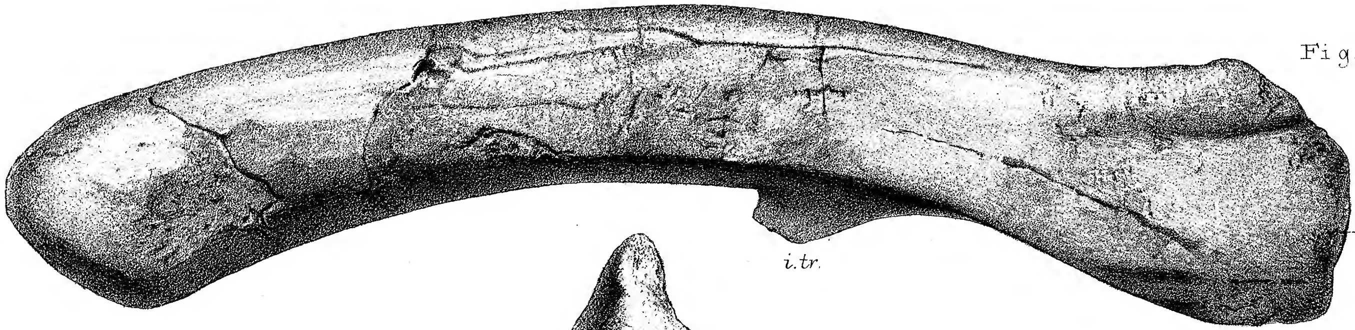

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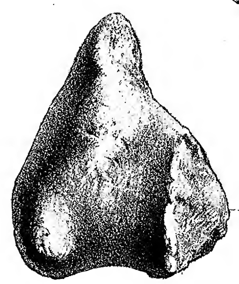

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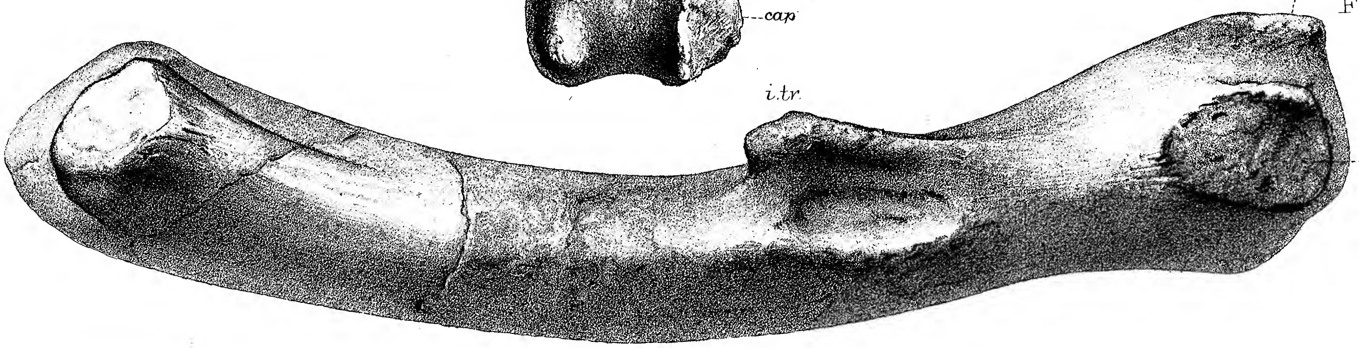

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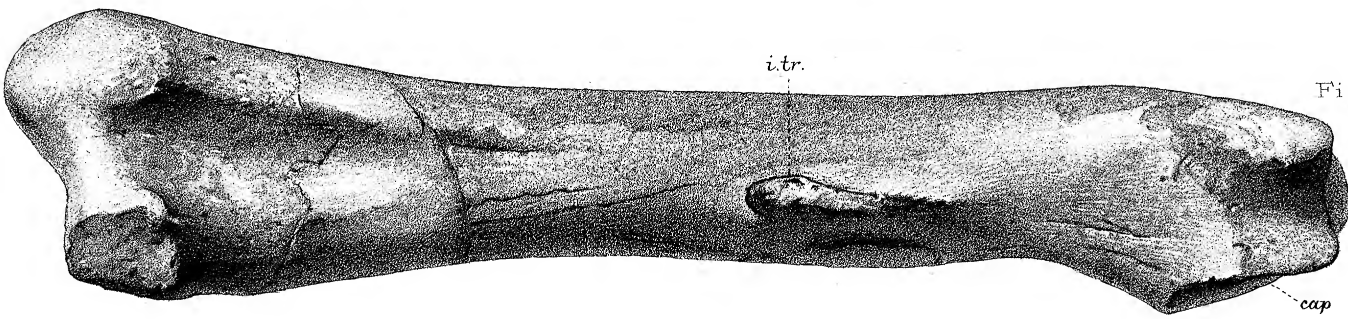

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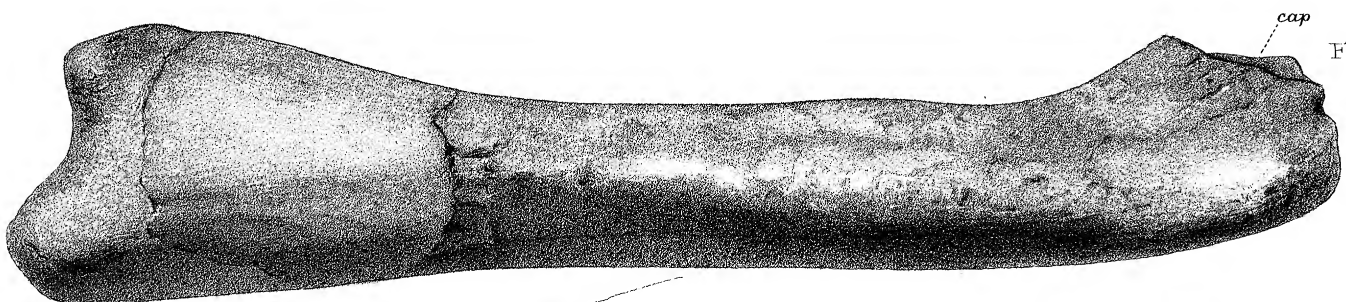

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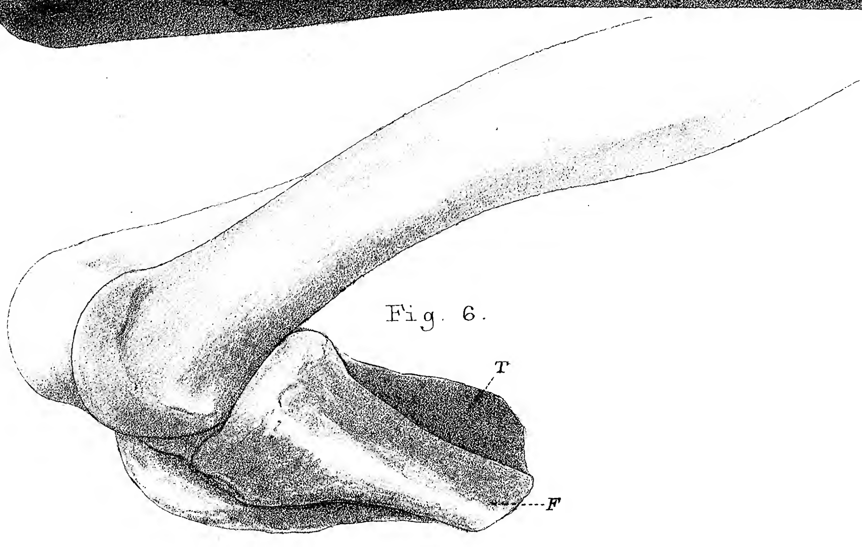

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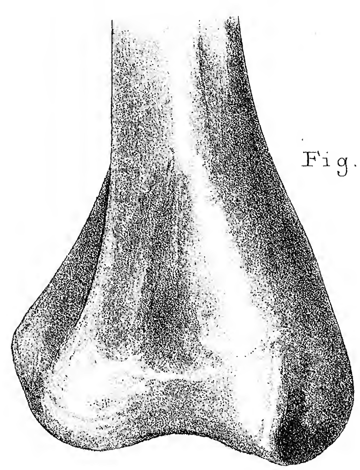

Fig. 7.

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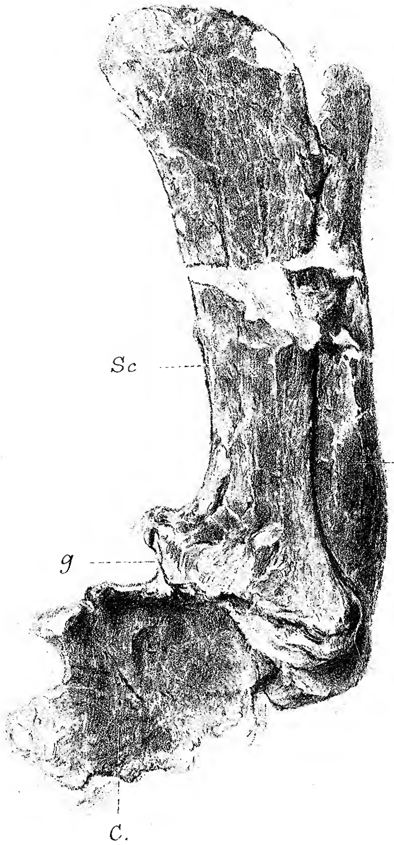

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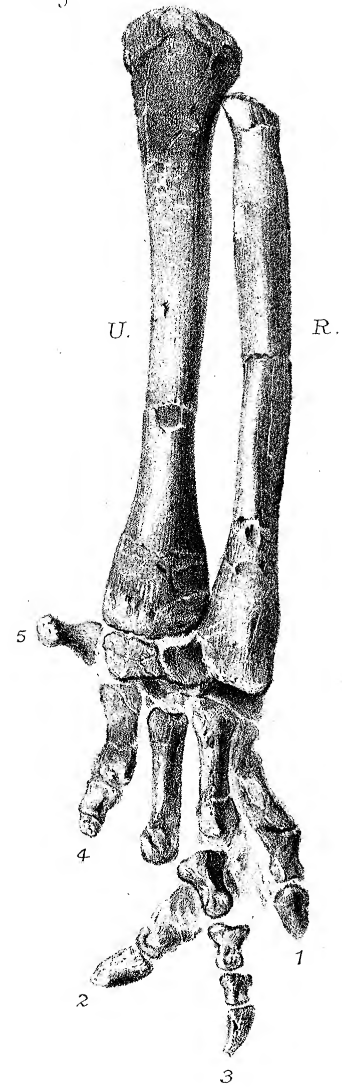

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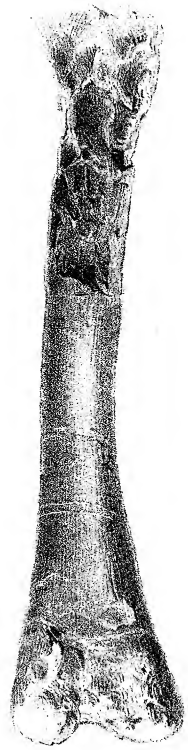

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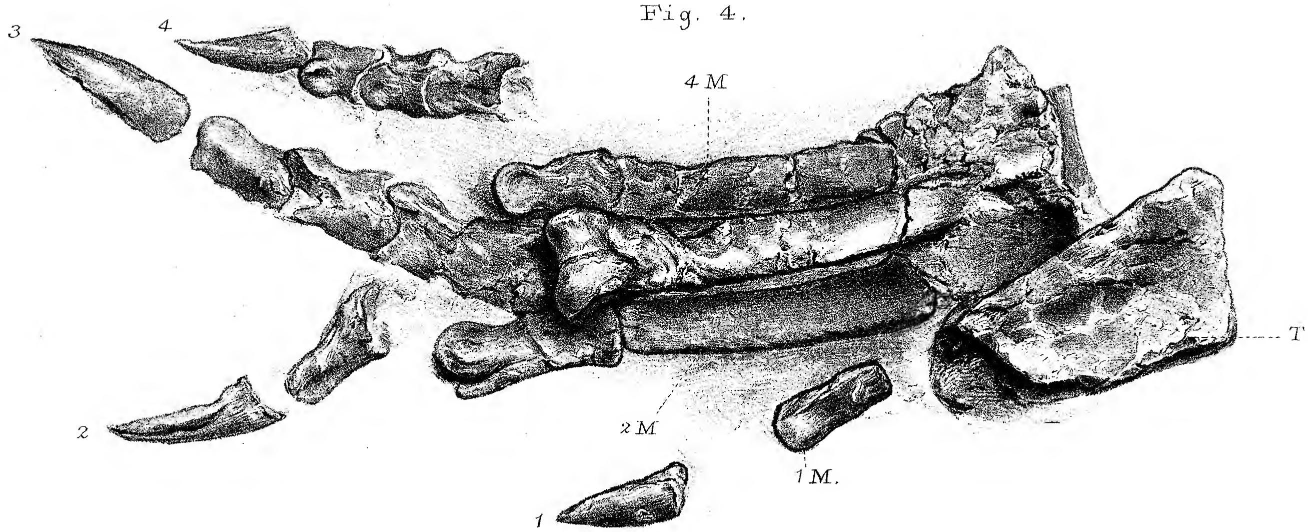

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West Newman & Co. imp.

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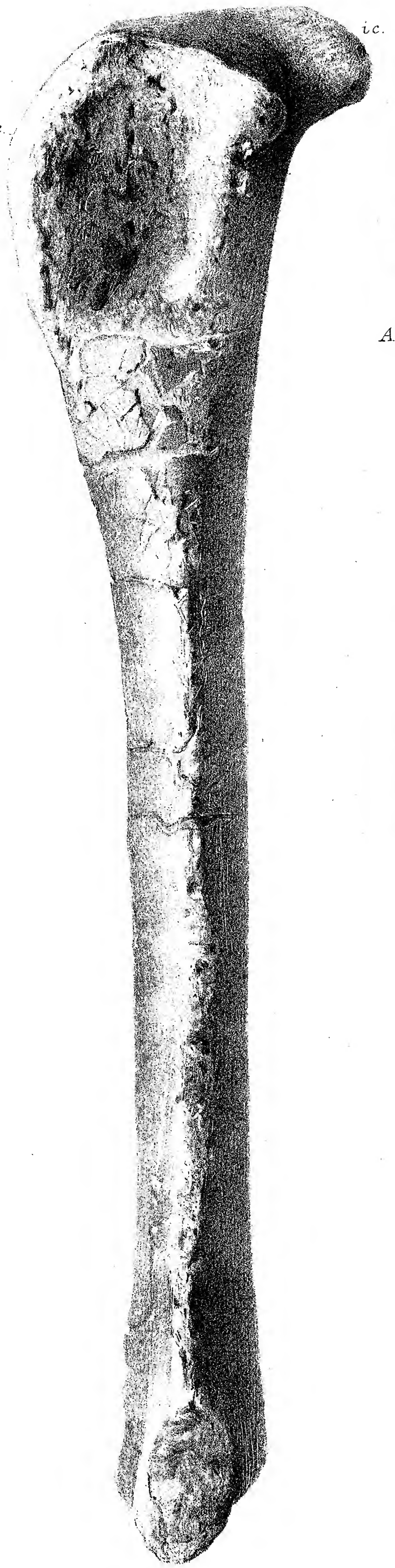

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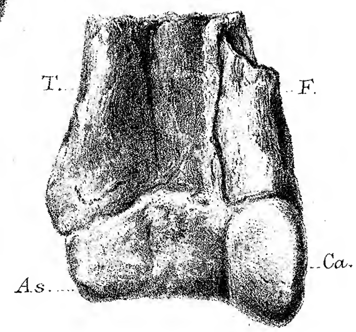

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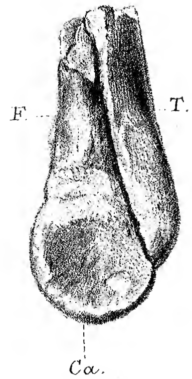

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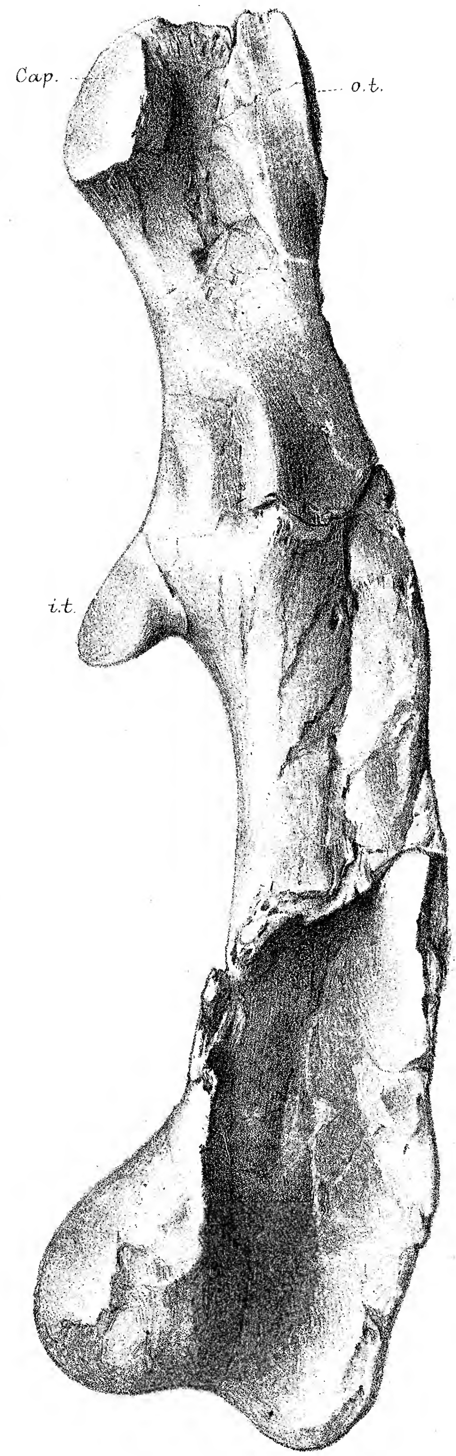

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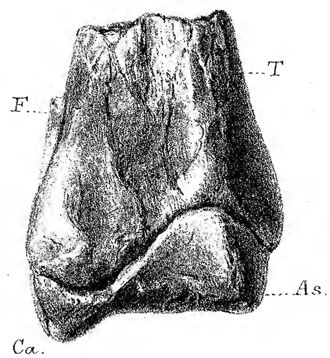

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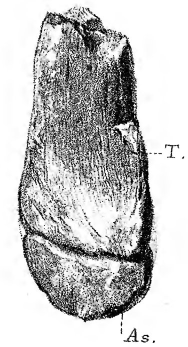

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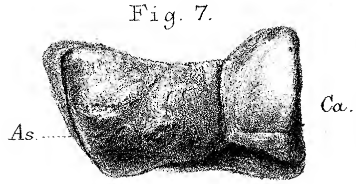

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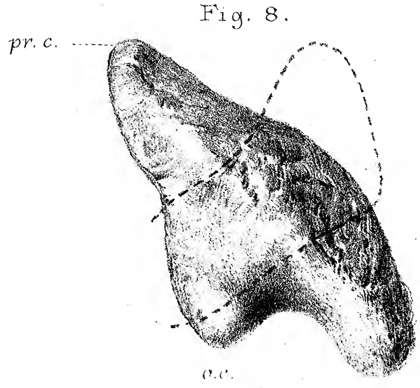

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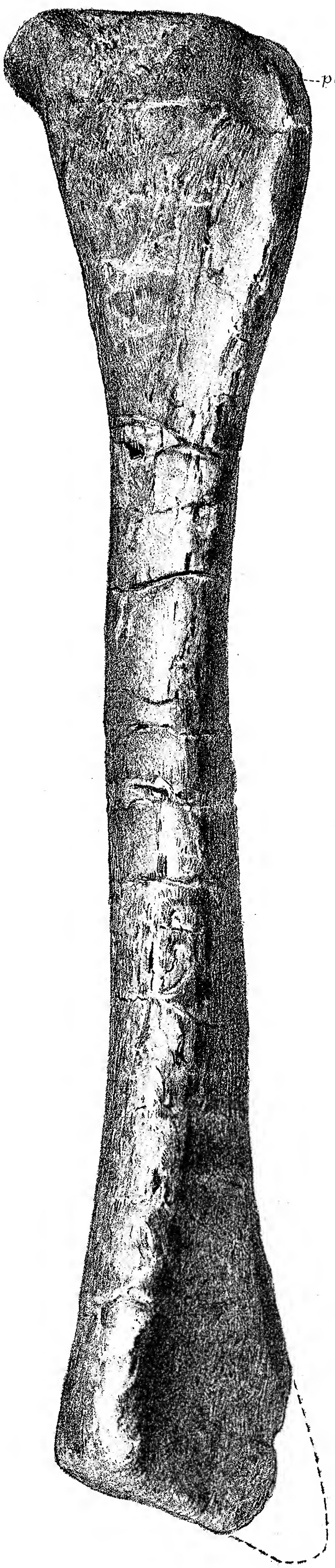

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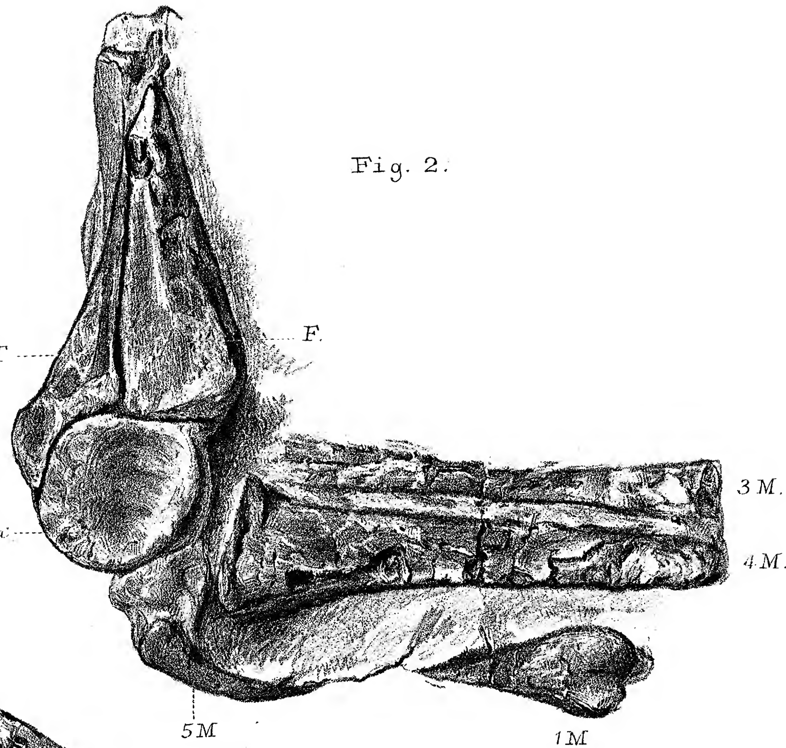
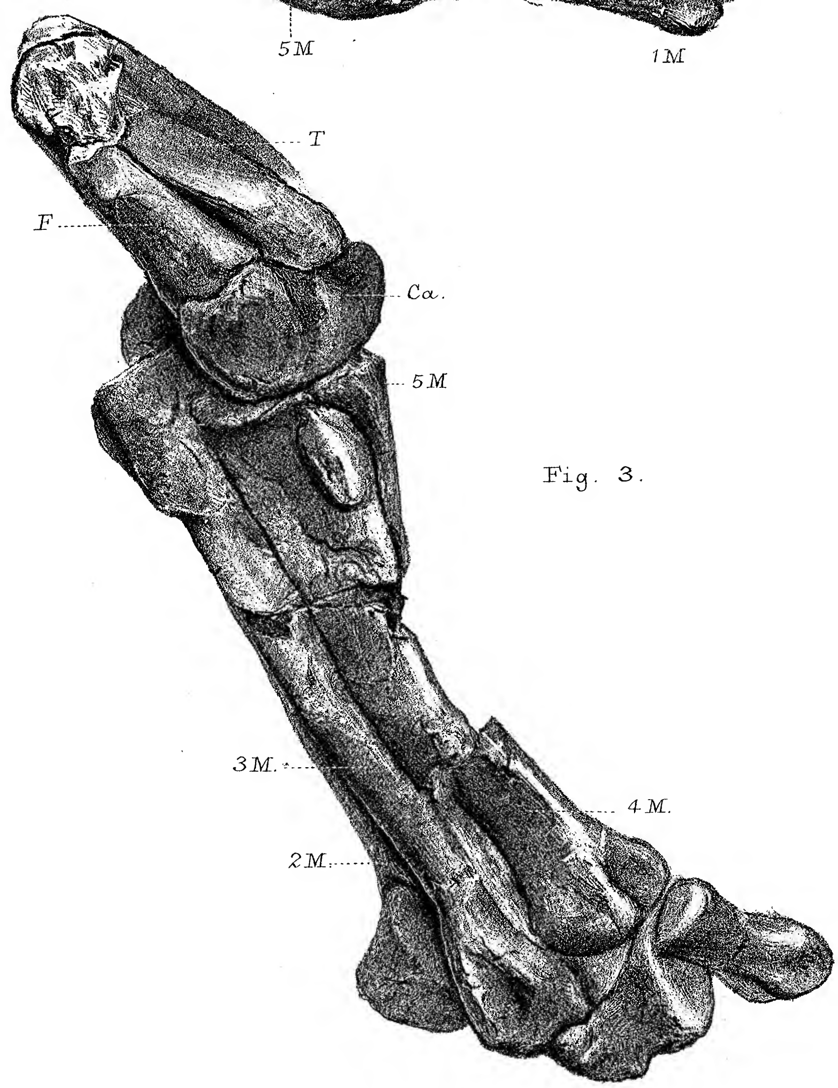
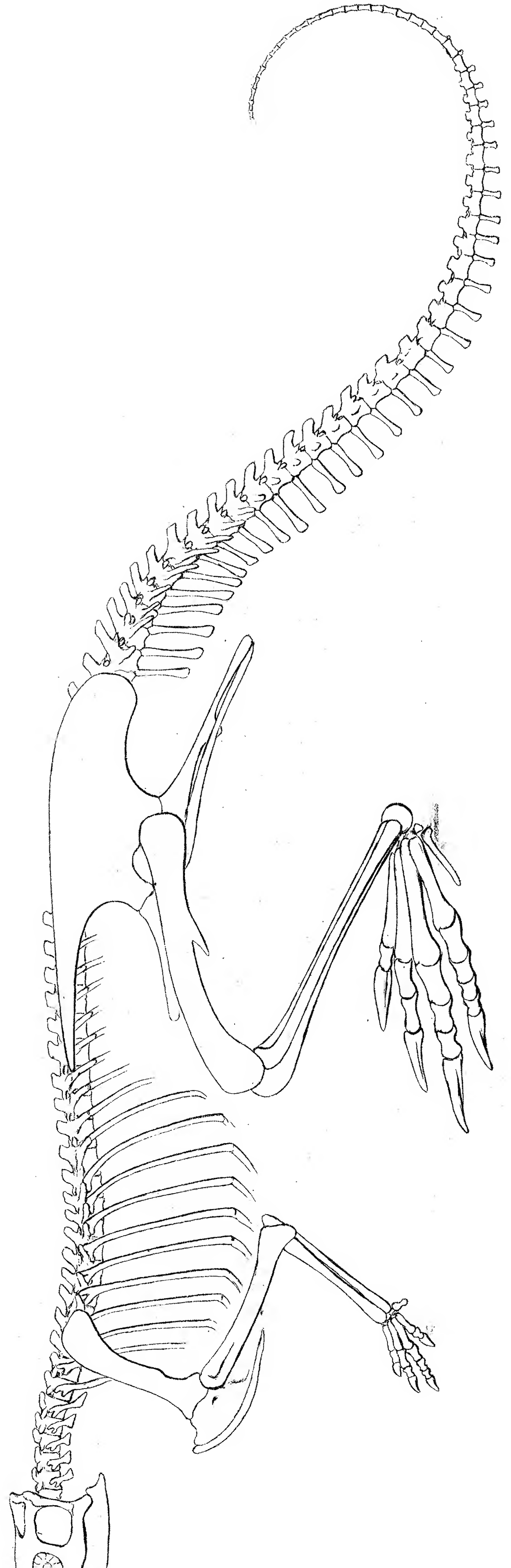


Fig. 3.



W.H.Wesley ad nat. del. West Newman & Cº imp.



RESTORATION OF SKELETON OF HYPSILOPHODON.

W. H. Wesley lith.

West Newman & C° imp.