

4. SUPPLEMENTAL NOTE on the ANATOMY of HYPsilOPHODON FOXII.
By J. W. HULKE, Esq., F.R.S., F.G.S. (Read November 19,
1873.)

[PLATE III.]

At the close of last Session I read a note upon some remains of an immature *Hypsilophodon Foxii* which I had shortly before obtained in Brixton Bay, Isle of Wight, from the west end of the well-known bed which crops out at the top of the cliff at Barnes Chine and dips under the beach at Cowleaze Chine. Their chief value consisted in the additional light they threw upon its dentition, and the information they afforded of the form and the proportions of the limbs. In September I was so fortunate as to obtain in the same locality parts of two individuals (one probably fully grown) which, as they illustrate some structures better than any other remains of this Dinosaur yet before the Society, have appeared to me worthy of being made the subject of a supplementary note.

The bones are imbedded in a block of sandy clay-stone which had fallen from the cliff and had been washed to and fro by the sea until some of them had become much abraded. The most important are a skull and two chains of vertebræ, each including a considerable part of the sacrum.

Skull.—This is larger than that found by Mr. Fox, which Prof. Huxley exhibited here in November 1869. Its upper surface was exposed; and I have laid bare its right side (Pl. III. fig. 1). The maxillary apparatus is broken off from the cranium proper, and twisted round so that the dentigerous border of the maxillæ and the palate now look upwards, the pterygoids resting in the lower part of the right orbit.

The upper surface of the skull is a long rhomboid (I refer now to the part behind the front of the orbits), of which the short diameter connects the stout postorbital processes; and the sides are lines drawn from these to the front of the supraorbital arch and to the extremity of a salient occipital (*Pa'*) spine in which the parietal region terminates behind instead of presenting here the entering angle usual in lizards' skulls. Large pieces of the parietal and of the frontal bones have exfoliated, laying bare the matrix moulded to the inner surface of the vault. Between the temples this presents a ridge suggestive of a parietal crest; and between the orbits is a mesial furrow indicative of the division of the principal frontal bone. The root of the right parietal suspensory process only is preserved (*Sp.*); its direction is nearly vertical to that of the parietal crest.

The orbit is very capacious; .4 inch below its upper border lie six of the thin bony scales of the sclerotic coat of the eyeball (*S.*).

The præmaxillæ (*Prmx.*) want the edentulous anterior extremity seen in Mr. Fox's specimen; but other parts of their structure are better displayed here, owing to their partial separation from the maxillæ.

The body of the præmaxilla is a vertical plate, .45 inch deep from its nasal to its dentigerous border, smooth, except quite in front, where its surface is wrinkled. From each end rises a strong process. That in front is a compressed trihedral blade narrowing upwards, shorter than the posterior or outer process. Applied to its fellow of the other side it forms the lower part of the septum between the anterior nares. Its front edge seen on the surface of the snout is stout; the posterior edge is thin.

The posterior or outer process, broader and longer, is closely applied to the anterior border of the maxilla, but not suturally united with it. It overlaps the maxilla, which has a shallow groove for its reception. The dentigerous border, nearly straight, is .65 inch long; and in this space it contains, I think in separate sockets, five mature cylindrical teeth, of which the roots, with only small portions of the crowns, now remain. At their inner side, between the second and third and the fourth and fifth teeth, two immature crowns are just visible. A large triangular palatal process, mesially united to its fellow, completely roofs this part of the mouth. From the anterior palatine foramen to the posterior extremity of the interpræmaxillary suture measures .7 inch. This sutural margin is longer than the free posterior border, and it forms a projecting angle to which, on the right side, the front of a vomer is (*V.*) attached.

The teeth all lie behind the anterior palatine foramen; the small portion of the edge of the right jaw in front of this is smooth and toothless.

The maxillæ (*Max. Max'*.) are large subtriangular bones. The left is very perfect. Its straight dentigerous border, 1.6 inch long, contains an unbroken series of eleven* compressed sculptured teeth, of which the front four are smaller than the others. The hinder margin of the crown of each tooth slightly overlaps the front margin of that next behind it. The crowns are obliquely worn, the thickly enamelled outer contour being the longer. The number of præmaxillary teeth agrees with that of Mr. Fox's skull; the maxillary teeth are one more in my skull. The teeth themselves agree so closely with those described in my last note as to make any further account of them unnecessary. In front of its dentigerous part the lower border of the maxilla and its upper border converge and send forward upon the deep surface of the præmaxilla the thin grooved plate mentioned as receiving the posterior ascending process of the latter.

Above this plate the anterior border of the maxilla rises in a sinuous curve to a height of 1.1 inch above the second tooth, making here a blunt angle with its upper border, which behind this declines in a gentle hollow curve to a height of .45 inch above the last tooth. Above this tooth, at the height of .35 inch, the surface of the maxilla is angulated, and a strong triangular process, at least .6 inch long, passes backwards. The uncertainty whether a narrow line obliquely crossing the junction of this process and the body of the maxilla is an accidental crack or a suture leaves it doubtful whether this process is part of the maxilla or a separate bone.

* Perhaps one tooth is missing between the second and the third.

In the body of the maxilla above the third to sixth tooth is a large subtriangular gap; it is the aperture between the orbit and external nostril seen in Mr. Fox's skull. Below this, and extending nearly the whole length of the bone, the outer surface of the maxilla is pierced by a chain of conspicuous foramina, such as are seen in the maxillæ of *Megalosaurus* and *Teratosaurus*.

The divergence of the maxillæ posteriorly partially exposes the palatal apparatus, the hinder part of which lies in the right orbit. The pterygoids (*Pt*, *Pt'*), not mesially joined, but separated by a fissure, have a remarkably stout body, the posterior border of which bears a very large basisphenoidal process, anteriorly limited by a prominent ridge produced downwards, and terminating angularly at the mesial border. The left pterygoid (*Pt'*) retains the root of a strong quadrate process directed outwards and backwards, in front of which the hollow outer border runs out in an ectopterygoid. In front of the pterygoids the palatals (*Pl*, *Pl'*) are partially visible, their inner borders also separated by a fissure. The left palatal, which is best seen, is a flat rod .35 inch wide, with (so far as it is exposed) parallel margins. Its buccal surface is longitudinally grooved.

It is almost superfluous to remark that the skull of *Hypsilophodon*, as was, indeed, shown by Mr. Fox's specimen, is constructed after the lacertilian and not after the crocodilian pattern. In this respect, so far as the material allows of the comparison being made, it agrees with the large skull from Brooke which I brought under the notice of the Society two years ago, and provisionally referred to *Iguanodon Mantelli*.

Spinal Column (fig. 2).—Crossing the block from right to left, at a little distance from the skull, is a continuous chain of eight consecutive vertebræ. The ventral surface of the centra is uppermost. The first three from the right are too much mutilated for description; the fourth is much abraded, the fifth less so; but the sixth, seventh, and eighth are sufficiently preserved to exhibit all their essential characters. These three last centra are inseparably ankylosed, every trace of their primitive separateness (which is still evident between each of the central (*1s*, *2s*) to their right) has quite disappeared. The seventh and eighth centra are further distinguished by the confluence of the expanded distal ends of their transverse processes. These two marks—confluence of the vertebral centres of the outer ends of the transverse processes—make it certain that the seventh and eighth vertebræ are part of the sacrum. The sixth vertebra (*L*) has distinct transverse processes which stand out from the neural arch in the form of flattened, tapering blades, .4 inch long. Confluent with that border of the transverse processes furthest from the sacrum, at their union with the neural arch, is a pair of articular processes, the articulating surfaces of which have an upward and inward aspect; this aspect and their position prove them to be *præzygapophysys* (*Prz.*). A vertebra whose centrum has coalesced with that of a next sacral, which yet has its own separate transverse processes, and also whose articular processes *furthest* from the sacrum bear the characters of *præzygapophysys*, must

precede the sacrum and cannot follow it; the sixth vertebra must in fine be the last lumbar.

The length of this centrum is rather less than .9 inch, the same as that of the fifth and fourth centra. Its form is cylindrical, its contour transversely convex, and longitudinally hollow, the middle slightly contracted and the ends swollen, particularly that which is ankylosed to the first sacral. Its transverse diameter at its middle is .6 inch, at its front end .8, and at its posterior end somewhat more. The transverse processes of the second, third, and fourth lumbar vertebræ have slender ribs ankylosed to their extremities, a distinct knot marks the union of dia- and pleurapophysis. They differ in this respect from the corresponding vertebræ in the Alligator (*A. lucius*) and other existing crocodilians, in which the traces of the primitive separateness of the transverse process and rib disappear with the maturity of the individual.

The determination of the first lumbar carries with it that of the next succeeding vertebra, it is the first sacral (1 s.); we have then the first, and not the posterior moiety of the sacrum. The first and second sacral centra are much smaller than the last lumbar, a similar difference of bulk obtains in the sacrum assigned to *Iguanodon Mantelli*; but this difference does not extend to their figure, which has a general resemblance to that of the lumbar vertebræ. It too is cylindrical, constricted at the middle and expanded at its end, which gives the lower contour of the chain a sinuous outline, hollow at the middle of the centra and convex at their coalesced extremities. The swelling which marks the junction of the coalesced centra is not a uniformly tumid nodal ring; but it is greatest at the union of the sides and inferior surface, forming here a pair of small elevations similar to those in the reputed sacra of *Iguanodon Mantelli* and *Hylæosaurus*. The transverse process of the first sacral vertebra springs from the junction of this vertebra with the last lumbar, standing out from here vertically to the axis of the sacrum. It is remarkably stout, the antero-posterior diameter of its root is .6 inch; its anterior contour merges into the lateral contour of the last lumbar centrum, greatly increasing the apparent bulk of this. At .5 inch distance from its origin, it bends backwards nearly at a right angle to its first direction, and joins the dilated outer end of the second transverse process springing from the union of the second and first centra, and it includes with this a large subcircular loop. A third transverse process in like manner abuts on the junction of the third and second sacral centres, and from two of the loops with the second and fourth transverse processes, making in all three of those loops or nerve-foramina; but the third and fourth centra are missing, the third having been broken off just behind its union with the second. Against the strong buttress formed by the confluent dilated ends of the transverse processes on the right side lies a fragment of the right ileum (*Il.*).

Below this chain of vertebræ lies a second chain of seven smaller vertebræ with part of a sacrum including four centra. It appeared so unlikely that this should be part of the spinal column

of a second individual, and so probable that it might be the posterior moiety of the near-lying larger sacrum with part of the tail, that at first I rather hastily imagined it to be such; but unwilling to leave it doubtful, I laid bare the articular and transverse processes of the two vertebræ next the sacrum, which proved them to be lumbar. After this I could not resist the conviction that I had investigated in the same block of stone the remains of two distinct individuals; the smaller sacrum repeats all the essential features of the larger one. The third centrum (3 s.), missing in that, is here well preserved, as is also the second; but the first and the last lumbar centra are badly mutilated. The third lumbar centrum is better preserved than any other; its lateral surface is less convex and more plane vertically than the corresponding part of the first lumbar centrum of the larger individual.

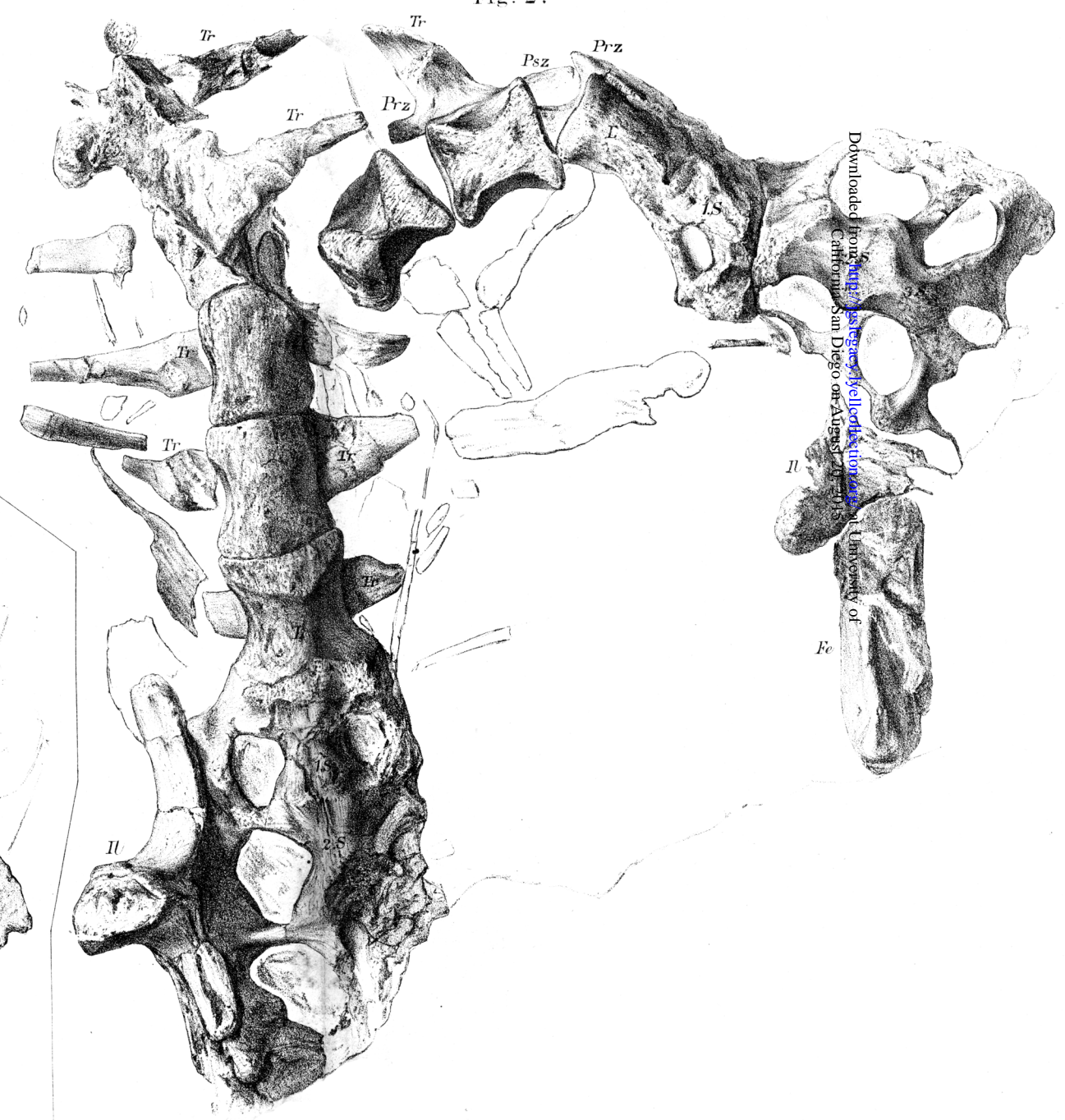
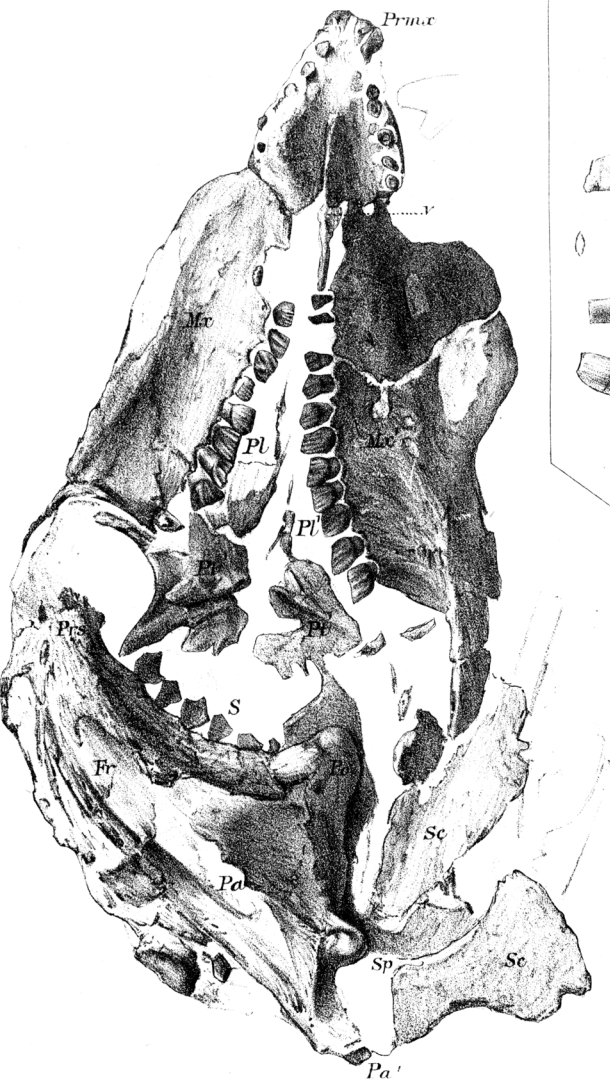
From beneath the right side of the sacrum, partly hidden by a fragment of a pelvic bone, the proximal half of the right femur projects (*Fe.*). Its inner trochanter is well preserved, wanting only the thin triangular lower angle. At its inner side is a very distinct shallow pit. Near the skull and beneath the larger chain of vertebræ, I found several very thin bony plates having one surface granular, the other smooth and furrowed by a vascular net. Their shape was irregularly polygonal; and their size varied much, some attaining an area of about 1 square inch. I regard them as thin scutes (fig. 1, sc.).

Prof. Owen has taken exception (Quart. Journ. Geol. Soc. vol. xxix. p. 531) to the generic distinctness of *Hypsilophodon*, and maintained its identity with the genus *Iguanodon*, basing his argument mainly on the similarity of their compressed, ridged teeth, on the peculiar mode in which these wear down, and on the spout-like form of the edentulous anterior extremity of the mandible in both. Fully recognizing these points of structural agreement as evidence of a very close affinity, it appears to me that there remain so many and so great differences as to fully justify the adoption of the separate genus *Hypsilophodon*. As I stated fully in my first note what appeared to me the chief structural differences, it is unnecessary to recapitulate them here; they were chiefly those presented by the limbs, and had respect to their form and proportions, and to the number of toes. In his paper of November 10, 1869, Prof. Huxley noticed certain vertebral differences; but his comparison did not extend to the sacra, this segment of the spinal column being hidden in the Mantell-Bowerbank fossil, the subject of the paper. I have therefore taken the opportunity which my recent acquisitions afford, to compare my *Hypsilophodon* sacra with the type specimen of the *Iguanodon-Mantelli* sacrum figured in the 'Fossil Reptilia of the Wealden Formation'*. The result is that I find the form of the vertebral centrum quite different, being cylindroid, rounded below in *Hypsilophodon*, laterally compressed, so much as to be angulated or almost keeled below, in *Iguanodon*; this difference seems to me of higher than specific value.

* Fossil Reptilia of the Wealden Formation, order "Dinosauria," p. 11.

Fig. 2.

Fig. 1.



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EXPLANATION OF PLATE III.

Remains of *Hypsilophodon Foxii*.

- Fig. 1. Skull: *Pa.* parietal bone; *Pa'*. its supraoccipital spinous process; *Fr.* frontal bone; *Po.* postorbital process; *Pro.* præorbital process; *Sp.* suspensorial process; *S.* bony plates of sclerotic coat of eyeball lying beneath orbital arch; *Mx.* right maxilla; *Mx'*. left maxilla; *Prmx.* præmaxillæ; *V.* vomer; *Pl.* right palatal bone; *Pl'*. left palatal bone; *Pt.* right pterygoid; *Pt'*. left pterygoid; *Sc.* scutes.
2. *L.* last lumbar vertebra; *1s, 2s, 3s,* first, second, third sacral vertebra; *Prz.* præzygapophysis; *Psz.* postzygapophysis; *Il.* ileum; *Fe.* femur.

DISCUSSION.

Mr. BOYD DAWKINS thought there was as much distinction between *Hypsilophodon* and *Iguanodon* as between *Hipparion* and *Equus*, and that this was quite sufficient to be regarded as generic rather than specific. He was not satisfied as to the additional bone in the foot in Mr. Beccles's specimen, but thought it might belong to some other part of the animal. He considered that all the teeth of *Iguanodon* were always ground flat by wear.

Mr. SEELEY considered that the author was likely to substantiate his opinions. He pointed out certain differences in the structure and form of the maxillary and other bones of the skull in *Hypsilophodon* and *Iguanodon*, and especially in the maxillary. He attached great importance to the thickening of the enamel at the base of the teeth of *Hypsilophodon*, which approximated to that which was found in some mammals. The teeth commonly reputed to be those of *Iguanodon* might, he thought, belong to different species, if not genera, and showed some divergence in character. The observations on the palatal bones of *Hypsilophodon* were, he thought, calculated to throw great light on the anatomy of Dinosaurs.