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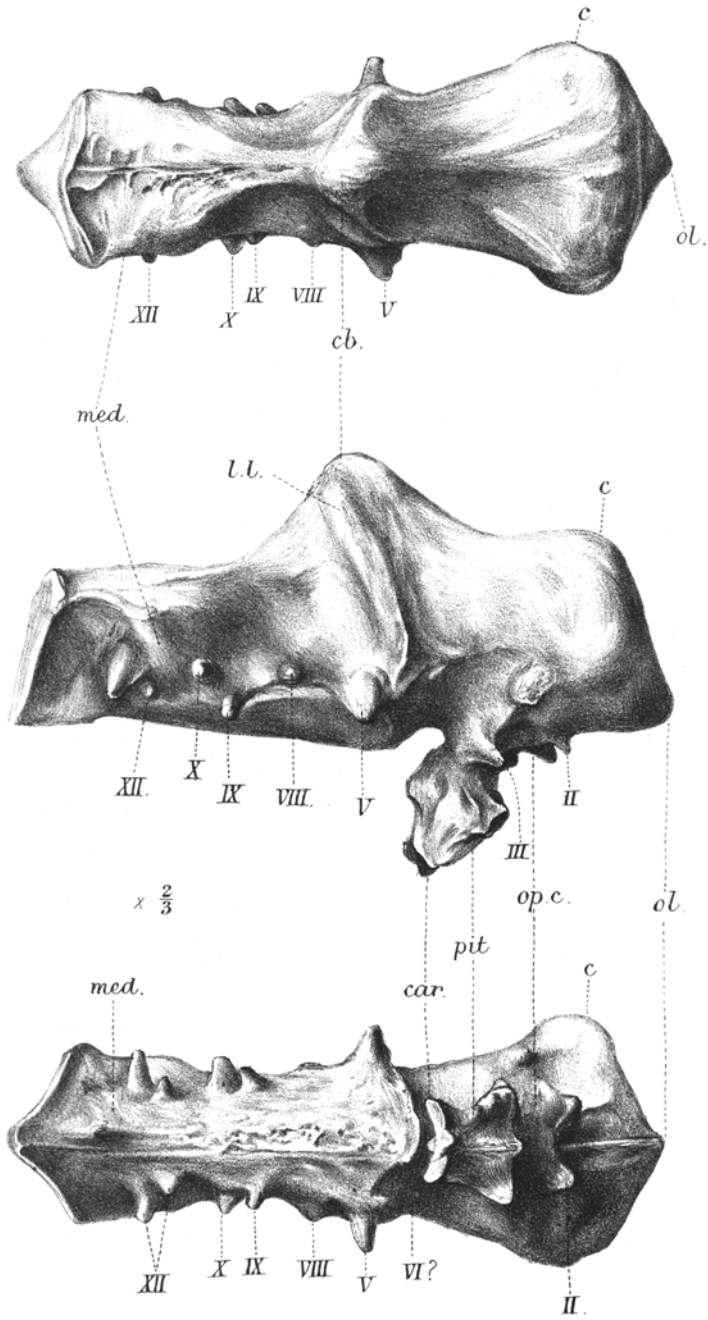
LX.—*Note on a Cast of the Brain-cavity of* Iguanodon.

By CHAS. W. ANDREWS, B.Sc., F.G.S., Assistant in the British Museum (Natural History).

[Plate XVI.]

THE brains of certain of the American Dinosaurs have been figured and briefly described by Professor Marsh, but, so far as I am aware, the only account of the structure of this organ in a European form is that given by Hulke in a paper published in the 'Quarterly Journal of the Geological Society' for 1871. The specimen * there described is the cranial portion of the skull of a large reptile which the author regarded as probably belonging to a species of *Iguanodon*. This fragment, which was found on the shore near Brook Point in the Isle of Wight, has lately been presented to the British Museum by Mrs. Hulke, and a careful comparison of it with the cast of a complete skull of *Iguanodon bernissartensis* shows that its reference to a member of that genus is no doubt correct. The form of the occipital condyle and *foramen magnum* are precisely similar in the two specimens, and, in fact, allowing for the fracturing and rolling to which the fragment in question has been subjected, it is almost identical in its structure with the corresponding portion of

* This specimen has also been noticed by Prof. H. G. Seeley in the 'Popular Science Review' (vol. xix. 1880, p. 48), one of Hulke's figures being reproduced on plate ii. fig. 2.



J. Green del. et lith. Mintern Bros. imp.

CAST OF BRAIN CAVITY OF IGUANODON.

the Belgian skull. Its dimensions, however, are considerably smaller, and since the sutures between the bones of the *basis cranii* are closed, it no doubt belonged to an adult individual, probably of the type species, *I. Mantelli*.

Since this interesting fragment has been in the Museum a plaster cast of the cranial cavity has been prepared, which seems worthy of description, because it gives a clearer idea of the form of the brain than can be gathered from the description and figures of the specimen itself.

As Hulke remarked in the paper referred to above, the form of the brain in reptiles can only be deduced approximately from casts of their brain-cavity, since in these animals it fills that cavity less completely than in the higher vertebrates, though to a greater extent than in amphibians and fishes. But judging from the remarkable completeness of the cranial walls in this specimen, it seems possible that the brain may have been more closely invested in bone than in other reptiles, and that consequently the shape of the cast may give a fairly accurate idea of its general form.

The olfactory lobes were either very small or perhaps pedunculate. The space which they, or more probably their basal portion, occupied is entirely filled with ironstone, so that the only trace of them in the cast is a slight angular projection from the middle of the antero-ventral border of the cerebral hemispheres (*ol.*).

The hemispheres (*c*) themselves are of moderate size: their anterior face is abruptly truncated and is only slightly convex. In vertical section the conjoined hemispheres were oval in outline, the long axis of the oval being horizontal: their greatest width is immediately behind their anterior face, at which point they formed prominent lateral lobes and measured about 62 mm. in width. Their dorsal and ventral surfaces are nearly straight and parallel in a longitudinal direction. On the ventral surface about an inch behind the anterior extremity there is a prominence, the *optic chiasma* (*op.c.*), from which diverge outwards and forwards the roots of the optic nerves (II.). Immediately behind this and arising from the floor of the *thalamencephalon* is the *infundibulum*, to the lower end of which is attached the pituitary body (*pit.*). This, so far as can be gathered from the cast of the fossa which it occupied, was relatively of very large size: its general form and relations are shown in the figures. Its ventral surface, which slopes obliquely downward and backward, is quadrate in outline; the prominent posterior angles mark the position of the foramina by which the internal carotids (*car.*) enter the skull, while the exact form

of the anterior region cannot be determined, the walls of the fossa being there deficient, owing to the presence on either side of a large irregular vacuity. This opening corresponds to that occurring in the same position in the skull of the crocodile, where it can be seen to be an irregular interval between the basi- and ali-sphenoid bones. The posterior surface of the pituitary body is nearly vertical and is triangular in outline.

On each side of the infundibulum there is in the cast a projecting process (III.), which marks the point of exit of the third (oculo-motor) nerve*.

Behind the infundibulum the ventral surface of the brain is furrowed by a broad transverse depression which is occupied by the thick posterior clinoid ridge, and marks the division between the mid- and hind-brain.

Turning again to the upper surface, we find that immediately behind the region occupied by the cerebral hemispheres the cranial cavity undergoes a great increase in height, and at the same time is much narrowed from side to side, particularly in its upper portion. The cast of the chamber thus formed (*cb.*) shows a pointed elevation which rises high above the hemispheres, and is so much compressed laterally that its superior surface is reduced to a mere rounded ridge. On each side of this prominence there is a strong ridge which extends downward and forward from a little behind and below its apex to a point a little in front of and above the roots of the trigeminal nerve.

This portion of the cranial cavity was no doubt occupied in life by the optic lobes and the cerebellum. In the cast itself, however, no indication of the form and position of the former is visible, and probably, therefore, they were comparatively small, or, at any rate, did not project sufficiently to impress the walls of the cranial cavity. The cerebellum, on the other hand, was large, and the oblique ridges on its sides above referred to, seem to indicate that it probably possessed fairly developed lateral lobes (*l.l.*); it is, however, possible that they may merely mark the position of blood-sinuses. Behind these lobes the cast of the cerebellar chamber is slightly con-

* It should be noted that the projections on the cast, which are marked with the numbers of the cranial nerves, do not necessarily indicate the points of origin of those nerves, but merely the position of the foramina by which they passed out of the skull. In most instances, of course, the point of exit is nearly opposite the place of origin; but in the present case (that of the oculo-motor root) the nerve no doubt arose not in the position shown in the cast, but from the floor of the thalamencephalon behind the infundibulum.

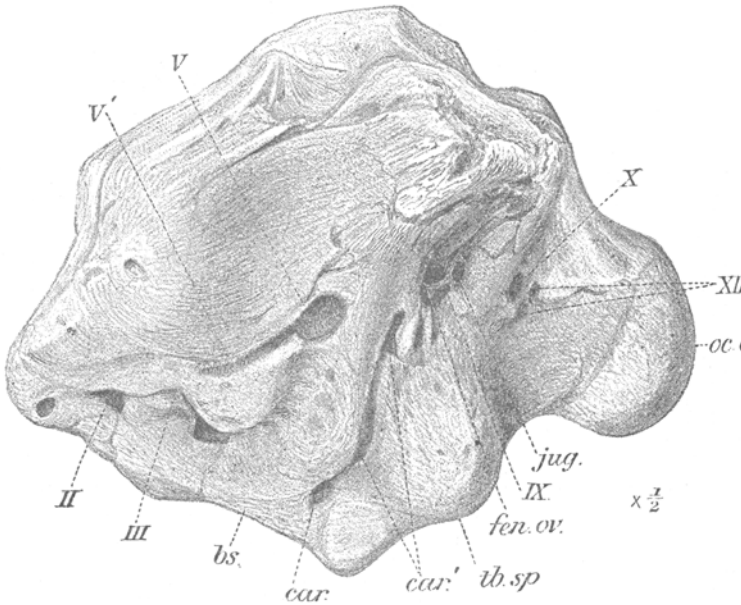
cave on either side, the concavities indicating the projection inwards of the auditory region of the skull.

The ventral region of the *medulla oblongata* (*med.*) is bounded anteriorly by the transverse groove above mentioned. Longitudinally its ventral surface is at first convex and posteriorly concave; from side to side it is convex throughout its length, the mid-ventral line being marked by a slight ridge. Anteriorly the sides of the cast of the medullary region pass up into the cerebellar prominence; in its middle portion its upper and lateral surfaces are impressed by the prominent auditory region. Posteriorly it widens out considerably and is roughly triangular in section, the angles of the triangle being rounded and corresponding to the mid-ventral ridge and the supero-lateral borders; the upper surface of this posterior region is convex. The cast no doubt gives an accurate idea of the actual form of the medulla so far as its ventral and lateral portions are concerned; but it is probable that dorsally there was a considerable space between the overhanging cerebellum and the upper surface of the medulla, so that here the real shape of the latter is not shown, no trace of the position of the fourth ventricle and other structures being seen. Further back, however, where it is about to pass into the spinal cord, it probably nearly or quite filled the cranial cavity, and its true form is therefore shown by the cast.

The determination of the roots of the cranial nerves arising from the medulla presents some difficulties, but by comparison with the crocodilian brain, and by examining the relations of the various foramina to one another and to the surrounding structures, it has been possible to determine most of them with a considerable degree of certainty. On the whole, these agree with the determinations of Hulke, who, however, employs the older terminology of Willis in his description.

On the ventral surface of the medulla close to its anterior end is a slight prominence, which probably marks the point of origin of the *abducens* (VI.). Above and a little behind this on the side wall of the medulla is the large root of the trigeminal (V.). This passes out of the skull by a very large foramen which opens externally into a fossa, from which a deep channel runs forward along the inner wall of the orbit, and, no doubt, lodged the ophthalmic branch (V′.). Behind the trigeminal foramen the skull-wall is perforated by a small opening, which enlarges towards the outside and is continued on the side of the cranium as a well-marked groove (*car.*?) which runs downward and somewhat forward. Its lower end passes round to the external opening by which the

internal carotid entered the pituitary fossa. From the relations of this groove, which is bounded anteriorly by a well-defined rounded ridge, I am led to conclude that it probably lodged a branch of the carotid which entered the skull by the foramen at its upper end.



Side of cranium of *Iguanodon*, showing the various foramina. ½ nat. size.

bs., basisphenoid; *car.*, carotid foramen; *car'.*, (?) channel for branch of carotid; *fen.ov.*, fenestra ovalis; *jug.*, (?) foramen for branch of jugular vein; *oc.c.*, occipital condyle; *tb.sp.*, tuberculum sphenoccipitale. The foramina for the nerves are marked:—II., optic; III., oculo-motor; V., trigeminal; V'., channel for the ophthalmic branch of the trigeminal; IX., glosso-pharyngeal; X., vagus; XII., hypoglossal.

Returning again to the cast, we find some 5 mm. behind the base of the fifth nerve a blunt prominence, which fills a depression in the skull-wall below and in front of the convex otic mass; no foramen can be seen to pass out of the skull at this point, and there can be no doubt that this prominence marks the point of origin of the auditory nerve (VIII.), and perhaps the facial (VII.) may arise with it. The next root lies 15 mm. behind the eighth and at a somewhat lower level; this seems to be the glosso-pharyngeal (IX.). Its foramen is

small; it runs upward and outward, reaching the exterior below and a little behind the *fenestra ovalis* (*f.o.*). About 1 cm. above and behind the root of the ninth is the large vagus root (X.), which passes out of the skull by a passage which, shortly after leaving the cranial cavity, forks, one branch running backwards and outwards in the same direction as the common base, the other directed forward and outward at right angles to the first. The latter opens behind and below the *fenestra ovalis* at the bottom of the same depression in the skull-wall; the former just behind the prominent oblique ridge forming the hinder boundary of the tympanic depression. This posterior branch probably transmitted the vagus (X.), and a considerable enlargement of its calibre just external to the fork probably indicates the position of the ganglion. As to what passed through the anterior branch there is some doubt, but it may be suggested that it transmitted a branch of the jugular vein (woodcut, *jug.*). About 15 mm. behind and at the same level as the roots of the ninth and tenth respectively, are two nerve-roots, of which the upper is much the larger. These pass into the cranial wall by two foramina, about 7 mm. apart, leading into passages which run outward and backward, converging so that they have opened close together in a common depression (woodcut, XII.). These nerve-roots, I believe, both belong to the hypoglossal (XII.), but perhaps the spinal accessory may also have passed out of the skull by one of the foramina of which these prominences are the casts.

It will be seen that the determination of the regions of this brain here adopted differs somewhat from that given by Marsh in some of his figures of this organ in the American Dinosaurs, the chief difference being that while he regards the middle prominence as representing in most cases a cast of the optic lobes, I think that these probably did not project far enough to leave any traces in a cast of the brain-cavity, the enlarged middle chamber of which was mainly occupied by the cerebellum. In the crocodile certainly a cast of the brain-cavity gives no idea of the form of the optic lobes. Marsh's figure* of the brain of *Ceratosaurus nasicornis*, in which the optic lobes are marked as lateral structures not appearing on the dorsal surface of the brain, probably most nearly represents the actual condition of things. In the figure of the brain of *Claosaurus annectens* on the same plate the nerve-roots marked agree in the main with the interpretation

* Marsh, "The Dinosaurs of North America" (Sixteenth Annual Report of the U.S. Geological Survey 1896), pl. lxxvii. fig. 2.

here adopted. The brain in this Dinosaur seems to resemble that of *Iguanodon* more closely than any other of which figures have been published.

Some measurements of this specimen are appended :—

	millim.
Greatest width of cerebral hemispheres	62
„ height „ „	46
„ „ at cerebellar prominence.....	69
„ width „ „	38
Depth of pituitary body from base of infundibulum ..	31
Width between roots of trigeminal	36
Width of medulla at vagus root	30
Height „ „ „	38

EXPLANATION OF PLATE XVI.

Brain of *Iguanodon*, ⅔ natural size :

1. From above.
2. From side.
3. From below.

car., point of entry of the internal carotids into the pituitary fossa; *c.*, cerebral hemispheres; *cb.*, cerebellum; *l.l.*, lateral lobe of cerebellum; *med.*, medulla; *ol.*, base of olfactory lobes; *op.c.*, optic chiasma; *pit.*, pituitary body.

The Roman numerals refer to the numbers of the cranial nerves.

LXI.—*Ostracoda from the* Chara-*marl of Hitchin, Herts.*

By Frederick Chapman, A.L.S., F.R.M.S.

[Plate XV.]

The *Chara*-marl or "freshwater bed" of Hitchin, Herts, is so remarkably rich in Ostracoda that it appears desirable to put upon record more detailed information regarding them than has been attempted up to the present time.

These Ostracoda of Hitchin have already been referred to in a note by Messrs. Jones and Sherborn, in 1887, on a collection made by W. Hill, Jun., Esq., F.G.S.* The four species there recorded are *Cypris incongruens*, Ramdohr; *Scottia Browniana* (Jones); *Erpetocypris reptans* (Baird); and *Candona candida* (Müller).

The same authors subsequently † note an additional species from the Hitchin beds—*Cypridopsis vidua* (Müller); whilst for the previously recorded *Cypris incongruens* they substitute *Candona pubescens* (Koch) ‡.

* Geol. Mag. dec. iii. vol. iv. p. 459.

† Suppl. Monogr. Tert. Entom. (Pal. Soc.) 1889, p. 10.

‡ *Op. cit.* p. 12.