44. *Note on the CRANIAL CHARACTERS of a large TELEOSAUR from the WHITBY LIAS preserved in the WOODWARDIAN MUSEUM of the UNIVERSITY of CAMBRIDGE, indicating a new Species, TELEOSAURUS EUCEPHALUS.* By PROFESSOR H. G. SEELEY, F.R.S., F.G.S., &c.
(Read June 23, 1880.)

[PLATE XXIV.]

THE Woodwardian Museum of the University of Cambridge has long contained the cerebral region of the skull of a large Teleosaur from the Lias of Whitby, which differs in important characters from the Teleosaurs hitherto described, and adds some interesting points to our knowledge of the cranial characters in this extinct suborder of animals. Attention was briefly drawn to the specimen at p. 121 of my 'Index to the Fossil Remains of Reptilia &c. in the Woodwardian Museum,' 1869. The skull has been transversely fractured anteriorly, posterior to the suture between the parietal and frontal bones, so that no part of the frontal region is preserved, and therefore no indication is given of the anterior expansion of the skull beyond the long temporal fossæ. The crest of the parietal bone appears to have been more than usually wide and strong, but that, too, is imperfectly preserved. The quadrate and squamosal bones are broken away at the sides; the base of the occipital region is fractured, and the pterygoid bones are absent; but the very imperfections of the specimen led to its being sawn through in the median line, so as to display a vertical section of the brain-case. Care has been taken to make the section so as to throw light on the lateral modifications of the brain-case; and I now venture to submit to the Geological Society some account of the characters thus displayed. In existing Crocodiles the brain-case is relatively small, owing to the shortness of the parietal region, and it is imperfectly closed anteriorly; here it is much longer and larger in proportion and closed by bone in front. The thickness removed by cutting and polishing the cerebral section makes the right half of the skull about half or three quarters of a centimetre narrower than the left half.

On the left side (Pl. XXIV. fig. 1) the extreme length of the fragment, from the basioccipital articular surface to the anterior fracture, is about 19 centimetres; the extreme depth of the specimen as preserved is about 12 or 13 centimetres; the brain-cavity is narrow and about 14 centimetres long, but on this side appears to have extended anteriorly a little beyond the extremity of the bone. The termination of the brain-cavity is 2 centimetres deep, and 8 millimetres in transverse width, as seen on the anterior fracture, where the outer margin is convex. The cranial cavity is long, and has its superior and inferior walls slightly diverging as they extend backward. At a distance of $1\frac{1}{2}$ centimetre posterior to the anterior fracture the

depth increases to more than 3 centimetres, and the base and roof of the brain continue nearly parallel to each other for between 6 and 7 centimetres. The cause of the sudden anterior decrease in depth is that a large nerve 8 millimetres thick is given off at the anterior end of the brain, in the median line; and this, according to analogy, I regard as being the olfactory nerve (fig. 1, *olf*). At the distance of about $6\frac{1}{2}$ centimetres backward a slight angular bend occurs in the roof of the brain-case, so that it increases in height for the next 4 centimetres as it extends backward. This part of the roof is straight; the anterior part is very gently arched. Below the point where this angle occurs is the entrance to the pituitary fossa (*pf*). The depth from the roof of the brain-case to its base is 6 centimetres. The pituitary fossa extends backward under a strong forwardly directed process of the sphenoid bone, and from it a canal is prolonged forward, which becomes a little narrower as it extends below the canal for the olfactory nerve, from which it is separated by a thickness of a centimetre of bone. This nerve I regard as the optic (fig. 1, *op*). The base of the brain-cavity from the sphenoid to the superior extremity of the basioccipital, where the spinal cord enters the skull, is gently concave in length. At $10\frac{1}{2}$ centimetres from the anterior end of the specimen a slight bony process descends downward and forward from the roof of the brain-case, as though to make a posterior termination to the cerebrum. At this point the depth of the brain-case is about $4\frac{1}{2}$ centimetres; a narrow excavation appears behind this process, not more than a centimetre wide, and rather compressed above, as though marking the position of the optic lobe of the brain (*o*). Posterior to this the roof of the brain-case, which is convex in length, descends rapidly to the foramen magnum (*FM*), which is less than 2 centimetres high. This constriction I take to indicate the relatively small size and depressed shape of the cerebellum (*C^m*). Posterior to the brain-cavity the superior concave neural surface of the basioccipital bone (*Bo*) extends backward for $2\frac{1}{2}$ centimetres; so that, in its median line, the brain-case is remarkable for the comparative parallelism of its inferior and superior margins, disturbed mainly by the elevation of the optic lobes and hinder part of the cerebrum and by the depression of the cerebellum.

It will now be convenient to describe the characters shown on the right side of the section, fig. 2. Notwithstanding the comparative thinness of the vertical layer which has been removed from this side, the brain-case is only 11 centimetres long, showing that the cerebrum must be compressed from side to side, so as to taper anteriorly at a rapid rate. The floor of the brain-case is concave in length, but the concavity is divided into two principal portions—the posterior one corresponding to the basisphenoid region, and the anterior one, which is less regular, occupying the presphenoid region. The roof of the brain-case now has two bony processes extending into it; first, the small one, already described, which has not greatly altered its shape, though it is perhaps a little nar-

rower and directed further downward and is more anterior in position. The portion of the brain or cerebral region anterior to this ridge, which is thus shown to extend transversely and obliquely forward and outward over the brain, is about 5 centimetres from the superior termination of the brain in front, as seen in the section; and different from the condition in the middle line, this upper surface of the cerebrum now appears in this lateral position to have been slightly concave in length. Its depth at the somewhat abrupt anterior termination is less than $2\frac{1}{2}$ centimetres; but the form of the section shows that the cerebrum was here slightly wider at the base than at its upper border. The depth of the cerebrum increases posteriorly to 3 centimetres, so that its upper surface must have been convex from side to side, since the depth decreases on passing out laterally from the middle line. At the position where the pineal gland should be, the cerebrum on this section has a depth of $3\frac{1}{2}$ centimetres. Behind its small limiting transverse ridge, already alluded to, is the deep excavation upward for the optic lobe (*o*). Its height from the base of the brain-case is, however, now reduced to 4 centimetres; its antero-posterior extent is less than 2 centimetres; it is margined posteriorly by a strong bony mass which separates it from the cerebellum. The cavity for the optic lobe is a little compressed superiorly and directed backward; but since it rises high above the cerebrum and occurs in the position where the brain-case becomes widest, the optic lobes may be inferred to be more developed laterally than in the median line, and probably extend outward laterally as far as the cerebrum. The bony mass, which at first sight resembles a tentorium, descends for more than 3 centimetres from the roof of the brain-case, so as to leave a channel less than a centimetre deep between this part of the brain-cavity and the floor of the brain-case. Its antero-posterior measurement is about $1\frac{1}{2}$ centimetre, though its outline is irregular and it is rather compressed inferiorly. As it does not extend transversely across the brain it is clearly a mass bulging inward from the side of the brain-case. Examined carefully it shows a long Y-shaped groove or canal which is occupied by matrix. The bones lying respectively in front of and behind the long stem of the Y are probably the prootic and opisthotic of Professor Huxley, while the bone above would be the epiotic. In some living Crocodiles these bones extend inward into the brain-case, though never to this great degree; nor have I observed any approximation to this character in the cranial cavities of other Teleosaurians; hence, as the surface of the bone is removed and the margins of the groove are sharp, the diverging branches of the Y (fig. 2, ?, '') may be anterior and posterior semicircular canals. The section of the cavity for the cerebellum is subquadrate, being flat above and below, with the sides nearly parallel. It is 2 centimetres deep, and about $2\frac{1}{2}$ centimetres long. The cerebellum obviously very narrow, though the transverse width of the foramen magnum, which was transversely ovate, was about 3 centimetres.

From this description it will be manifest that the brain of this Teleosaur differs remarkably from that of living Crocodiles in the

compressed form of the optic lobes, in the cerebrum tapering anteriorly, and in the development of bony processes corresponding to the divisions between the chief elements of the brain. The existence of these processes may perhaps be taken as indicating that the brain filled the cerebral cavity; and therefore these animals present no analogy to Chelonians, which have the brain sheathed in cartilage. This condition of the cerebral region makes a marked difference from Plesiosaurs on the one hand and existing Crocodilia on the other, and supports the idea that the TELEOSAURIA constitute a reptile type in which the obvious resemblances to the living Crocodiles have been somewhat too emphatically insisted upon. It is instructive to compare this section with that of a skull of *Iguanodon* figured by Mr. Hulke, where the posterior region, presumably occupied by the cerebellum, is similarly depressed, and anterior to this the brain rises into a convexity for the posterior part of the cerebrum and optic lobes, only without any trace of a bony division between these two regions, such as is seen in this Teleosaur; and then the brain becomes depressed anteriorly much after the Teleosaurian pattern, only the cerebrum is relatively short in the Dinosaur, and the brain has its chief extension posterior to the pituitary fossa, which is the reverse of what obtains in the Teleosaurian.

The Gavial of Caen, named by Geoffroy *Teleosaurus cadomensis*, has been well figured by Cuvier in the seventh plate of the 'Ossements Fossiles.' His fig. 1 represents a longitudinal section of the skull, which displays a side view of the cast of the cerebral cavity. The total length of the cerebral cavity is 6 centimetres. The specimen shows the cerebrum to consist of a posterior part with an ovate inflation and smooth lateral surface, which is 2 centimetres long; but it contracts and becomes depressed anteriorly, and extends forward for about another centimetre. This anterior portion of the brain, something like the olfactory lobes of a mammal or fish, extends under the frontal bone and in advance of its transverse expansions which form the front border of the large temporal fossæ. Posterior to the cerebrum the optic lobes are well defined; they are less wide than the cerebrum, with the sides flattened and depressed in the middle. The cerebellum is rather narrower than the optic lobes, and was evidently less high, with its lateral aspect more rounded. It is thus seen that the anterior part of the brain only occupies about half its length; and it is difficult to suppose that this length would be greatly augmented were the section made in the middle line of the skull. The optic lobes are far longer than in the Whitby fossil, indicating, I think, a different genus. There are indications of a bony ridge separating the optic lobes from the cerebellum, but no evidence that it descended between these parts of the brain like the otic bones in the specimen described.

It is impossible to state accurately the depth of bone which covers the brain in the Whitby fossil, because, as already mentioned, the median crest is partly broken away; but, as preserved, the depth at the posterior termination of the cerebrum is about $2\frac{1}{2}$ centimetres, while the thickness of the bone at the anterior termination is about

18 millimetres. Over the posterior part of the brain the thickness of the bone was more than doubled. The section shows the basioccipital to be large and strong, and very closely blended with the basisphenoid. There is no separate suture indicating the presphenoid. In the median line, and in the basisphenoid bone, below and somewhat behind the pituitary excavation, there is an inverted flask-shaped cavity 18 millimetres wide, which terminates downward in a tube nearly 1 centimetre wide, which is directed backward and imperfectly preserved, and appears almost to impinge upon the basioccipital bone. This tube (*Eu*) I regard as the Eustachian tube; and the ovate cavity with which it communicates (*TA*) I regard as being a portion of the tympanic air-cell, which would thus appear to have no bony separation dividing the portions on the two sides of the head. This tympanic air-cell on the right-hand section has become more irregular in shape, and is larger, being about $2\frac{1}{2}$ centimetres deep and about a centimetre high, though a bony process indents the posterior margin considerably. The fractured condition of the external part of the right half of the brain-cavity shows another section of the tympanic air-cell, still irregular in form, but subquadrate and enlarging as it passes outward; while the vertical fracture parallel to the median line of the skull, seen on the outer part of the left side of the skull, shows this air-cavity, which has a thin border formed in front by the prootic bone of Huxley (alisphenoid bone of Owen), to be subovate, rather irregular in outline, about $4\frac{3}{4}$ centimetres long and $3\frac{1}{2}$ centimetres deep, with a sharp plate of bone penetrating inward from the middle of its posterior side. Anterior to this cavity (which attains a development altogether unparalleled among the living Crocodilia), the left-hand side of the median section of the skull shows an ovate perforation $1\frac{1}{2}$ centimetre in advance of it. This cavity is $2\frac{1}{2}$ centimetres long and less than 1 deep; its border is somewhat irregular, and I regard it as a section of the carotid canal (*cc*). It lies just below and on one side of the position of the pituitary pit; and appears to be a canal which passes still further outward as it extends forward. The basioccipital has much the same form as in Plesiosaurs. The occipital condyle is rounded, $4\frac{1}{2}$ centimetres deep and about $5\frac{1}{2}$ wide; it has a central depression, and is margined by a sharp ridge where the external articular surface ends. This ridge increases in sharpness as it descends; and there is a deep excavation or constriction under its inferior border, so that from the neural canal to the base in front of the ridge the depth is $3\frac{1}{2}$ centimetres; and here the excavation is concave. The bone extends downward and a little backward in the median line, on the side of which a nutritive foramen enters the bone. The texture of the bone is dense posteriorly towards the articular surface, and the cells are arranged longitudinally; but in the anterior part of the bone the cells become relatively very large. The length of the bone cannot be certainly stated, but appears to be about $5\frac{1}{2}$ centimetres; its anterior border is convex from above downward. The basisphenoid (*Bs*) is densest

in its middle part. The anterior median process has large longitudinal cells; the posterior part has the cell-matter arranged vertically. The distance from the basioccipital margin to the median anterior process of the basisphenoid, where the excavation occurs which descends into the bone, is less than 5 centimetres; and the depth of this process, which is rounded in front, is 17 millimetres. The roof-bones of the skull are marked by the large longitudinal cells, except where the dense substance of the otic bones extends inward, and where the cells are directed obliquely downward and forward at the junction of the supraoccipital bone with the parietal.

The occipital aspect of the skull appears to have conformed to the usual Teleosaurian pattern, but is too imperfectly preserved for description. The exoccipital bones (*Eo*) entered into the upper and outer parts of the occipital condyle, and are divided from the basioccipital, on the articular surface, by a deep suture, which, after leaving that surface, becomes prolonged downward and outward after the manner of existing Crocodiles. The occipital region appears to have been nearly vertical. The exoccipital bones were laterally expanded, much as in living Crocodiles, but more prolonged outward, below the foramen magnum, descending to a level with the base of the occipital condyle. About $1\frac{1}{2}$ centimetre from the foramen magnum laterally is a round perforation for the vagus nerve (*Va*); and below this, and further outward, $3\frac{3}{4}$ centimetres from the foramen magnum, is a larger perforation like that in the Crocodile. The exoccipital is fractured vertically at about $6\frac{1}{2}$ centimetres from the middle line of the skull. I cannot say whether the opisthotic or paroccipital is distinct; if so, it is very large and makes the hinder wall of the great air-cell. The arrangement of the roof-bones of the skull conforms entirely to the usual Teleosaurian pattern.

The skull becomes greatly expanded transversely at its hinder part (fig. 4), chiefly owing to the excavation of the large tympanic air-chamber which penetrates the bones; and anteriorly the skull is constricted, so that its least measurement from side to side is about $6\frac{1}{2}$ centimetres at this distance from the anterior fracture. The skull then widens out again, so that at the anterior fracture its width must have been about 10 centimetres (fig. 4). Seen from the side, a rounded median ridge (fig. 3), which becomes sharpened in front and which is necessarily concave from front to back, divides the lateral region of the brain-case into superior and inferior aspects. The superior aspect slopes obliquely downward from the median longitudinal crest. Its upper part throughout the length of the specimen is occupied by the parietal bone (fig. 4, *P*). This is fully 4 centimetres deep in front, becomes reduced to less than half that depth in the middle (fig. 3, *P*), where the skull is most constricted from side to side, and again widens somewhat as it runs backward, and curves outward in a T-shape in the transverse line of the occipital crest. Its outward extension is a thin plate, resting upon a large expanded bone which forms the posterior half of the wall of the brain-case below the parietal. This bone forms the upper part of the wall

of the tympanic cavity, but no satisfactory suture can be distinguished between it and the exoccipital bone. It is in the position of the prootic bone of the Crocodile, but is enormously developed so as to present the most distinctive feature of the cranial region of a Teleosaurus. This bone, which is imperfectly preserved at its outer and posterior border, has a nearly vertical anterior suture less than 4 centimetres long, like that in living Crocodiles, a straight inferior suture, and a curved superior outline, determined by the overlap of the parietal bone. The bone is wider in front than behind: its greatest depth is $4\frac{1}{4}$ centimetres; its greatest length, as preserved, $7\frac{1}{4}$ centimetres; its surface is smooth and concave. Almost immediately below the anterior suture of this bone, at a distance of about a centimetre, and looking on to the under part of the skull, is a large transversely ovate perforation with rounded borders, 2 centimetres in length, into which it does not enter. This is, I presume, the outlet for the fifth nerve (fig. 3, V). It is placed just behind the pituitary body. If this perforation is rightly determined, and the nomenclature adopted by Professor Huxley is followed, the bone which lies in front of this perforation is the alisphenoid; and if the orbito-sphenoid has any separate existence, the condition of the specimen is such that it cannot be recognized. But if we were rather to name the bone alisphenoid which unites with the basisphenoid, following the nomenclature of Prof. Owen, then the orbito-sphenoid would form the anterior wall of the brain-case. The bone posterior to the nerve-outlets is certainly the quadrate, as in living Crocodiles. In perfect Teleosaurus skulls it meets the squamosal above and the exoccipital behind; and it forms the anterior and inferior wall of the tympanic cavity. The anterior wall of the brain-case or alisphenoid (*als*) is imperfectly preserved anteriorly. It is a large oblong bone, concave and irregular on the underside, where the pterygoid lapped along its length, slightly concave in length above, and slightly convex from above downward. It appears to be about 6 centimetres deep, and the greater part of it lies above the longitudinal angular ridge running along it already alluded to. Owing to the form of the parietal it is much deeper behind than in front. The base of the skull is too much worn for useful description.

So far as I can judge by comparison with the type specimens in the British Museum, this species differs materially in the outer shape of the brain-case from the *Teleosaurus Chapmani*. The *Teleosaurus brevior* is too imperfectly preserved in this region for satisfactory comparison. I am not acquainted with any species from the Secondary rocks which closely resembles this species in the form of the prootic bone, or of the tympanic region, or the general shape of the brain-case. As its characters are likely to be of some interest, it may be useful to name the species for the present *Teleosaurus eucephalus*.

EXPLANATION OF PLATE XXIV.

Teleosaurus eucephalus.

Fig. 1. Left side of skull, nearly in median line.

2. Right side of skull, showing a section parallel to fig. 1.

These figures are of the natural size.

3. Lateral view of left side of same skull, greatly reduced.

4. Superior view, reduced.

5. Diagram of anterior end of fig. 1 (reversed).

In all the figures the lettering is the same:—*So*, supraoccipital; *Bo*, basioccipital; *Bs*, basisphenoid; *ps*, presphenoid; *Va*, vagus nerve; *FM*, foramen magnum; *Ex*, exoccipital; *P*, parietal; *Eu*, Eustachian tube; *TA*, tympanic air-cell; *V*, outlet for fifth nerve; *cc*, carotid canal; *als*, alisphenoid; *po*, prootic bone; *Q*, quadrate bone; *C^m*, cerebellum; *o*, optic lobes; *C*, cerebrum; *olf*, olfactory nerve; *op*, optic nerve; *pf*, pituitary fossa; *?*, posterior semicircular canal; *?'*, anterior semicircular canal.

DISCUSSION.

Mr. CHARLESWORTH mentioned that the Earl of Zetland had presented another interesting specimen of a Saurian to the York Museum, which was described by Prof. Phillips under the name of *Plesiosaurus Zetlandicus*; but M. Deslongchamps regards it as so peculiar in its characters as to entitle it to form the type of a new genus.

The PRESIDENT thought, with Mr. Charlesworth, that the specimen in the York Museum does not belong to the genus *Plesiosaurus*.