

ART. IX.—*The Skull and Brain of Claosaurus*; by
O. C. MARSH. (With Plates IV and V.)

IN previous numbers of this Journal, the writer has described and figured various remains of Cretaceous Dinosaurs belonging to the genus *Claosaurus*, and a restoration of one very perfect specimen was given in the number for October last.* Another specimen apparently of the same species has the skull in remarkable preservation, thus affording an opportunity to make out all its principal characters. This skull is well represented in the accompanying plates, and the description is given below. The brain in this genus had many points of interest, and a cast of the brain-cavity is also described briefly and figured in the present communication.

The Skull.

The skull of *Claosaurus* is long and narrow, with the facial portion especially produced. The anterior part is only moderately expanded transversely. Seen from the side (Plate IV, figure 1), the skull shows a blunt, rugose muzzle, formed above by the premaxillary and below by the prementary, both probably covered in life with a thick, corneous integument.

Behind the upper part of this muzzle is an enormous lateral cavity, which includes the narial orifice, but was evidently occupied in life mainly by a nasal gland, somewhat like that in the existing Monitor, and also seen in some Birds. This cavity is bounded externally by the nasal bone and the premaxillary. The median septum between the two narial orifices was only in part ossified, the large oval opening now present in the skull probably having been closed in life by cartilage.

The orbit is very large, and subtriangular in outline. It is formed above by the prefrontal, frontal, and postfrontal, and below mainly by the jugal. There are no supra-orbital bones. A distinct lachrymal forms a portion of the anterior border. The infra-temporal fossa is large, and is bounded above by the postfrontal and squamosal, and below by the jugal. The quadrate forms a small portion of the posterior border.

Seen from in front (Plate IV, figure 2), the skull of *Claosaurus* is subovate in outline, with the narrow portion above. The premaxillaries and the prementary bone forming the rugose muzzle are especially massive and prominent, and the powerful lower jaws seem out of proportion to the more delicate bones of the cranium.

* This Journal, vol. xxxix, p. 423, May, 1890; vol. xliii, p. 453, May, 1892; vol. xlv, p. 171, August, 1892, and p. 344, October, 1892.

Seen from above (Plate IV, figure 3, and Plate V, figure 5), the structure of the skull itself is shown to the best advantage. In front are the large premaxillaries, deeply excavated for the nasal openings. These bones are separate, and each sends back a long, slender process inside the anterior projection of the nasal, and a still longer process forming the lower border of the nasal orifice, and extending to the lachrymal. The front of the premaxillaries is especially massive, and its surface rugose, indicating that it had been covered with a horny beak. The lower border is sharp, conforming to the corresponding surface of the prementary bone, which was doubtless also enclosed in a horny covering. The premaxillaries were entirely without teeth.

The nasal bones are long and slender, and especially produced in front, where they embrace the posterior median extensions of the premaxillaries. They also meet the lateral processes of the premaxillaries behind the nasal openings, and likewise touch the lachrymals. Further back, they meet the prefrontals, and closely unite with the frontals, as shown in Plate IV, figure 3.

The frontal bones are quite short, and nearly as wide as long. They are united to each other by a well-marked suture. Their upper surface is smooth, and there is a slight depression on either side, posterior to the suture with the prefrontals. Each frontal bone forms a portion of the upper border of the orbit, and behind this meets the postfrontal. Posteriorly, the frontals form the anterior border of the supra-temporal fossæ, and between these unite by suture with the coössified parietals.

The latter bones are quite small, and appear on the upper surface of the skull mainly as a narrow ridge separating the supra-temporal fossæ, and ending behind in a point, between the median processes of the squamosals. The parietals expand below, where they cover the posterior portion of the brain-cavity.

The squamosal bones are robust, and their position and connections are well shown on Plate IV, figures 1 and 3. On the median line above, they meet the narrow extension of the parietals, and exterior to this, they form the posterior borders of the supra-temporal fossæ. In front, they unite by a strong process with the posterior branch of the postfrontals. Their posterior border is joined mainly to the exoccipitals. On the outer surface of each squamosal, there is a deep pit to receive the head of the quadrate, and in front of this, a short narrow process extends down the quadrate, forming a part of the border of the infra-temporal fossa.

The quadrate bone and its main connections are shown on Plate IV, figures 1-3. It is firmly supported above by the

squamosal, but its distinct, rounded head indicates the possibility of some motion. On the outer surface in front, it joins by open suture the strong jugal bone, and below this, unites with the small, discoid quadrato-jugal. Its inner margin extends forward into a broad, thin wing for union with the pterygoid. The lower extremity is massive, and moderately expanded transversely for articulation with the lower jaw.

The jugal is one of the most characteristic parts of the skull, as may be seen from the figures on Plate IV. Its main portion is robust, much compressed, and convex externally. On its upper margin, it forms the lower border of the orbit and of the infra-temporal fossa, sending up a strong process between them, which extends inside and in front of the postorbital branch of the postfrontal. In front, it is strongly united to the maxillary, and above joins by suture with the lachrymal.

The maxillary bone in *Claosaurus* is of moderate dimensions, and seen from the outside is overshadowed by the pre-maxillary and jugal, as shown in Plate IV, figure 1. Its lower dentary border is thickly studded with a regular series of teeth, which slightly overlap those of the lower jaw. From above, only a small portion of the maxillary is visible, as seen in Plate V, figure 5, *m*.

The lower jaws are long and massive. The prementary bone is robust, and especially fitted for meeting the strong beak above. The dentary bones are large and powerful, with elevated coronoid processes. The angular and surangular bones are, however, quite short, and not especially strong.

The Teeth.

The teeth of *Claosaurus* are confined entirely to the maxillary and dentary bones. In each, the teeth are very numerous, and are arranged in vertical series, so that they succeed each other as the functional teeth are worn away. This is seen in Plate V, figures 1-3, which show the form of the teeth and their relations to each other in the same series. The number of teeth in each series depends upon the position, those near the middle of the jaw having the greatest number, sometimes six or more. The teeth of the upper jaw have the external face of the crown covered with enamel and ridged. In the lower jaw, this is reversed, the ridged face of the crown being on the inside. This arrangement greatly increased the cutting power of the jaws. The food was probably soft vegetation.*

*In describing the skull and teeth of *Hadrosaurus*, an allied form, Cope made many serious errors, among them the following: the prementary bone is mistaken for the dentary, the dentary is regarded as the surangular and as the splenial, while the squamosal is called the parietal. (Proc. Phil. Acad., 1883, p. 97, plates vi-vii.) Another mistake in the same paper is the statement that the name *Atlantosauroidæ* was given in 1882. It was given by the writer in 1877. See this Journal, vol. xiv, p. 514.

The Brain.

The brain of *Claosaurus* was very small, its size in proportion to the skull being represented in Plate V, figure 5, which also shows the exact position of the brain in the cranium. A cast of the brain-cavity is shown in the same plate, figure 4, one-fourth natural size. The brain as a whole was considerably elongated, especially the posterior half. The olfactory lobes were well developed, and not separated by an osseous septum. The cerebral hemispheres were comparatively large, forming nearly or quite half of the whole brain. The optic lobes were narrow, but considerably elevated. The cerebellum was rather small, and also much compressed. The medulla was of good size, and nearly circular in transverse outline. The pituitary body was quite large. The interpretation of some of the more minute features of the brain is a matter of difficulty, and will be more fully discussed elsewhere.

The specimens here described were obtained by Mr. J. B. Hatcher and Mr. A. L. Sullins, in the Ceratops beds of the Laramie, in Wyoming. In the same horizon were found other herbivorous Dinosaurs, especially the gigantic *Ceratopsidæ*, and with them various small Cretaceous mammals.

New Haven, Conn., Dec. 14th, 1892.

EXPLANATION OF PLATES.

PLATE IV.

FIGURE 1.—Skull of *Claosaurus annectens*, Marsh; seen from the left.

FIGURE 2.—The same skull; front view.

FIGURE 3.—The same skull; seen from above.

All the figures are one-tenth natural size.

PLATE V.

FIGURE 1.—Series of five lower teeth of *Claosaurus annectens*; inner view.

FIGURE 2.—The same teeth; side view.

FIGURE 3.—The same teeth; outer view.

The figures are one-half natural size.

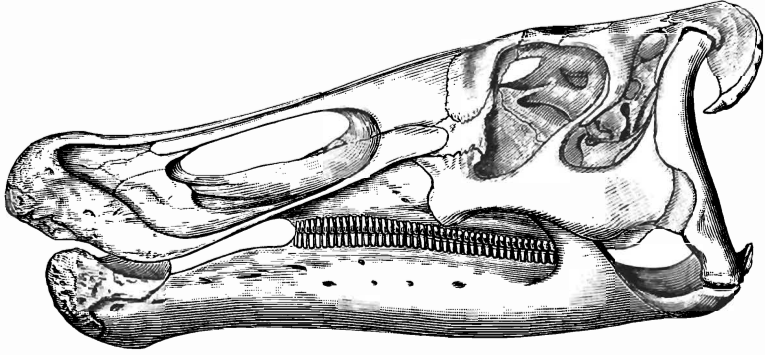
FIGURE 4.—Brain cast of *Claosaurus annectens*; side view; one-fourth natural size.

c, cerebral hemispheres; *cb*, cerebellum; *m*, medulla; *ol*, olfactory lobe; *on*, optic nerve; *op*, optic lobe; *p*, pituitary body.

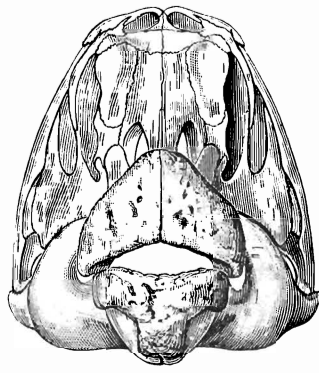
FIGURE 5.—Skull of *Claosaurus annectens*, with brain cast: top view; one-tenth natural size.

a, nasal opening; *b*, orbit; *c*, infra-temporal fossa; *d*, dentary; *e*, exoccipital; *f*, frontal; *fp*, postfrontal; *j*, jugal; *l*, lachrymal; *m*, maxillary; *n*, nasal; *pf*, prefrontal; *pm*, premaxillary; *q*, quadrate; *qj*, quadrato-jugal; *s*, squamosal.

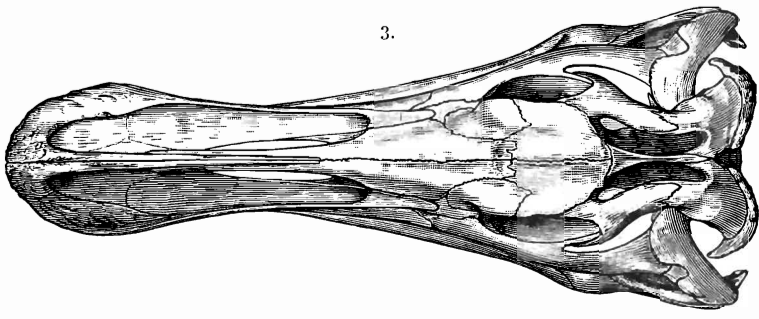
1.



2.



3.



CLAOSAURUS ANNECTENS, Marsh.

