

Article II. — ON THE SKULL OF EDAPHOSAURUS POGONIAS COPE.

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PLATE VII.

The description of the skull of *Edaphosaurus* is a portion of a larger work on the Pelycosauria in course of preparation by the author. The work was carried on by aid of a grant from the Carnegie Institution of Washington and is published in advance of the completed work by the permission of the Institution.

The skull is the property of the American Museum of Natural History, forming a part of the Cope Collection, and was placed at my disposal for description by the Curator of Vertebrate Palæontology, Professor H. F. Osborn, to whom my thanks are due.

Family EDAPHOSAURIDÆ Cope.

Proc. Am. Phil. Soc., Vol. XX, 1882, p. 450. Also Pal. Bull. 35.

Proc. Am. Phil. Soc., Vol. XX, 1883, p. 631. Also Pal. Bull. 36.

Type:—A nearly complete skull with the lower jaw of the left side and the imperfect axis. No. 4009, Am. Mus. Nat. Hist. Cope Coll. From Texas.

In his Systematic Catalogue of the Vertebrates of the Permian Formations of North America, published in 1888, Cope abandoned this family, placing the genus in the family Clepsydripidæ. It is here restored for reasons that appear in the text below.

Genus *Edaphosaurus* Cope.

Proc. Am. Phil. Soc., Vol. XX, 1882, p. 448. Also Pal. Bull. 35.

Trans. Am. Phil. Soc., Vol. XVII, 1892, pp., 15 l. xi, figs. 5 and 5a.

Description of the Family and Genus: — Aberrant Pelycosaurs, littoral or estuarine in habit; feeding upon molluscs and crustaceans. Skull low, wide posteriorly, and tapering to the anterior end. A large superior temporal foramen, and, probably, a smaller inferior one. Interparietal and epiotic present. Incisor teeth approaching chisel-shape; anterior maxillary teeth broadly triangular and thin with anterior and posterior cutting edges; posterior maxillary teeth conical; posterior teeth of the lower jaw all conical. On the pterygoid and palatine and on the dentary large patches of stout crushing teeth.

The specimen of *Edaphosaurus pogonias* Cope is unique, nothing identifiable with it occurring in any other collection from the Permian of North America. The depressed form of the skull and the

suggestion of the axis that the vertebræ were low and broad indicate affinities with the Cotylosauria, but the temporal region with its enormous superior temporal vacuity and almost certain inferior vacuity as well indicates affinities with the Pelycosauria. As the condition of the temporal arches is of more fundamental importance than that of the shape of the skull and the vertebræ, the animal is referred tentatively to the Pelycosauria, family Edaphosauridæ. Its habits of life must have been very similar to those of *Placodus* and if future discoveries should show that it really possessed a single temporal vacuity or that the inferior vacuity was decadent, the kinship of *Edaphosaurus* with *Placodus* as an ancestral form would be strongly suggested.

The skull is roundly triangular and flattened above; the temporal region is elevated and the upper surface descends in an almost straight

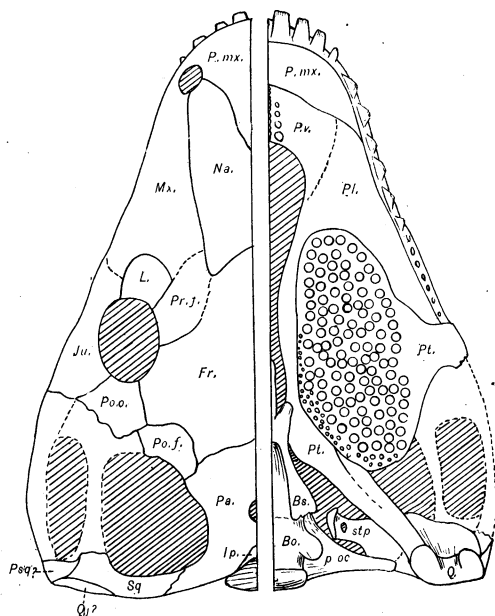


Fig. 1.

Fig. 2.

Fig. 1.—Diagram of the upper surface of the skull of *Edaphosaurus*. $\times \frac{1}{2}$. *P.mx.* premaxillary, *Na.* nasal, *Mx.* maxillary, *L.* lachrymal, *Pr.f.* prefrontal, *Ju.* jugal, *Fr.* frontal, *Po.o.* postorbital, *Po.f.* postfrontal, *Pa.* parietal, *Ip.* interparietal, *Sq.* squamosal, *Psg.* prosquamosal, *Q.j.* quadratojugal. $\times \frac{1}{2}$.

Fig. 2. Lower surface of the same. *P.v.* prevomer; *P.l.* palatine; *P.t.* pterygoid; *stp.* stapes; *Bo.* basioccipital; *Bs.* basisphenoid; *p.oc.* paroccipital. $\times \frac{1}{2}$.

something like that of the modern rodents, or the ancient *Placodus*. The teeth projected slightly forward from the alveolar edge.

line to the anterior end. The external nares are small and nearly terminal but open laterally. The orbits are of moderate size and look nearly straight outwards. The dentition is very peculiar, varying from chisel-shaped incisors to thin, triangular cutting teeth in the anterior portion of the maxillary and conical teeth in its posterior portion.

The premaxillary is short and relatively broad but with a long posterior prolongation in the median line which extends back to join the nasals. There are four teeth in each premaxillary which are badly worn but were apparently furnished with a strong terminal cutting edge

The posterior edge of the bone forms the anterior edge of the nares.

The *maxillary* is a broad plate extending upward somewhat obliquely and uniting with the nasals above and the premaxillary anteriorly. The anterior edge forms the posterior edge of the nares and the posterior end lies below the middle of the eye socket. There are fourteen teeth in the bone; the anterior five are thin triangular

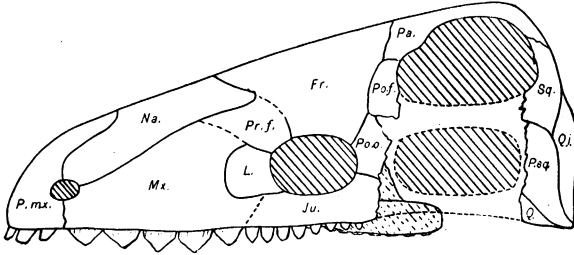


Fig. 3.—Diagram of the lateral view of the skull of *Edaphosaurus*. Lettering the same as in figure 1. x $\frac{1}{2}$

plates that originally had well developed anterior and posterior cutting edges but these have been largely destroyed by decay. The posterior nine teeth are conical. All the teeth are in sockets and rest against the outer edge of the bone, which descends lower than the inner.

The *nasals* are broad flat plates embracing the premaxillaries anteriorly and extending between the frontals posteriorly.

The *frontals* are very broad and flat; they meet the parietals posteriorly in a wide suture and form the major portion of the upper edge of the orbit.

The *prefrontals* form the upper anterior corner of the orbit.

The *lachrymals* are short bones, rounded anteriorly and extending back on the floor of the orbit to the anterior third of the lower edge.

The *parietals* are flat anteriorly with a good-sized parietal foramen but the posterior portion is somewhat convex. The bones of the two sides meet in a slight depression so that the crown of the skull is arched antero-posteriorly and depressed in the midline. The outer edge is concave and forms the upper border of the superior temporal vacuity. From the posterior outer corner a process curves gently outward and downward to unite with the squamosal.

The *interparietal*. Between the parietals posteriorly is a small diamond-shaped bone which extends downwards beyond the parietals and separates the pair of bones below.

The *postfrontal* is represented by a fragment of bone between the

frontal and parietal whose posterior edge forms the anterior edge of the superior temporal vacuity; the lower edge is missing.

The *postorbital* and *jugal* are not distinct.

The *quadrate* resembles that of the other *Pelycosauria*; the upper portion is thin and plate-like and the lower end carries two large condyles, the outer somewhat more posterior than the inner. The long axis of the condyles is inclined somewhat inward. The outer condyle is extended backward as in *Dimetrodon*, forming a sort of shelf on which rests the lower end of the quadratojugal.

The *quadratojugal* and *prosquamosal* occupy the same relative positions as in *Dimetrodon*. The first rests against the posterior edge

of the quadrate and overlies the posterior edge of the prosquamosal. There are indications that a quadrate foramen was present but it is closed in the specimen, perhaps by pressure. Superiorly the quadratojugal passes below the lower ends of the squamosal and a second bone, the epiotic (?). The anterior end of the prosquamosal is

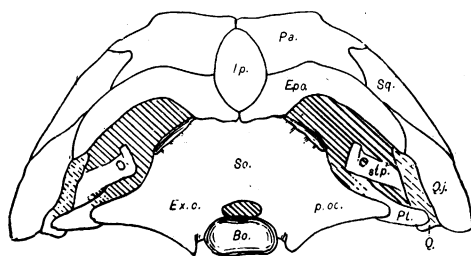


Fig. 4.—Posterior view of the skull of *Edaphosaurus*. Lettering the same as in figure 1. Ex.o. exoccipital, So. supraoccipital, Ep. epiotic. $\times \frac{1}{2}$.

broken away, but it reaches up as far as the upper edge of the quadrate touching the lower end of the squamosal.

The *squamosal* is a thin and slender element, convex in curvature, which joins the parietal above and the quadratojugal and the prosquamosal below. At its lower end a wide process started forward toward the postorbital, but this is broken so that its anterior connections cannot be made out. The process evidently is a portion of a bridge across the temporal vacuity; Cope considered that there was but one such bridge and that the animal had a single temporal arch, but the condition of the specimen makes probable the presence of a second arch below.

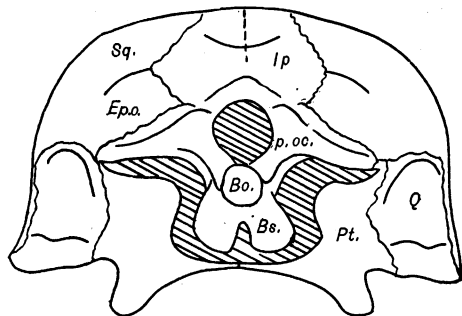


Fig. 5.—Posterior view of the skull of *Placodus*. After v. Huene. Lettering the same as in figure 1.

Epiotic (?).—This is the element referred to by Cope as “perhaps a transverse process of the supraoccipital.” Below the parietal and interparietal and above the posterior wall of the cranial cavity is a pair of slender curved bones; lying next to the lower edge of the squamosal they extend outward and downward until they touch the upper ends of the quadratojugal. These bones are in the exact position of the epiotics and there is little doubt that they are homologous with the same bones in the *Cotylosauria* and *Stegocephalia*. They do not occur in the other families of the suborder. The name epiotic was originally used for a different element; it is here used for the element so called by Cope in *Cotylosauria*.

The posterior surface of the cranium is formed by a single mass of bone, the sutures between the *basioccipital*, *supraoccipital*, *exoccipitals*, and the *paroccipitals* are not distinguishable. The plate is partly obscured in the specimen by the crushing which has forced the parietals with the interparietal and the epiotics down over it as far as the foramen magnum. The paroccipital processes extend outward nearly to the quadrate. The occipital condyle is relatively broad and oval in outline, with no pit marking the position of the anterior end of the notochord.

The *basisphenoid* has the same form as in *Dimetrodon* but is relatively longer. It has a strong parasphenoid process, well developed articular faces for the pterygoids, and a large pit on the lower surface.

The *stapes*.—On either side of the basisphenoid is a short, wide bone which occupies the position of a stapes. The inner end is smaller but terminates in a flat surface; just below the extremity the bone is pierced by a foramen.

The *palate* is well preserved on one side. There is a great median vacuity forming the posterior nares but there are no palatal vacuities. The sutures between the pterygoids, palatines, and prevomers cannot be made out.

The *prevomers* are thin plates connecting anteriorly and laterally with the premaxillaries and anteriorly with each other; more posteriorly they are cut out on the median line so that when the two were in position there was an elongate heart-shaped vacuity in the median line. At the anterior end where the two bones meet there are four conical teeth on each bone; the posterior is the larger.

The *pterygoids* articulate with the basisphenoid in the midline and send a strong process backward which articulates with the inner side of the lower end of the quadrate. There is no descending external

process forming a buttress for the lower jaw as in the other Pelycosauria. The line of union with the palatine cannot be made out.

Covering a large portion of the pterygoid and the palatine is an oval plate studded thickly with stumpy conical teeth irregularly arranged. On the inner edge there are some teeth of smaller size. Most of the teeth are injured by decay but it can be seen that the ends were very blunt, resembling the pharyngeal teeth of *Labrus*. The plate bearing the teeth is very heavy and extends backwards underlying the anterior half of the temporal region.

The *lower jaw* of the left side is nearly perfectly preserved. The sutures between the separate bones cannot be made out. The anterior symphysis is very strong and was formed by the splenial as well as the dentary. There are twenty counted teeth and alveoli and there were perhaps three or four more at the posterior end. The anterior teeth are similar to the premaxillary teeth above but there are none corresponding to the triangular teeth of the anterior portion of the maxillary; all are conical, growing smaller toward the

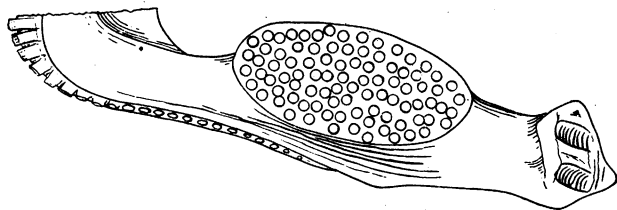


FIG. 6.—Lower jaw of *Edaphosaurus*. $\times \frac{1}{2}$.

posterior end. The alveolar edge is somewhat elevated. In the posterior half of the jaw is a dentigerous plate corresponding in size and shape to the pterygoid plate above and studded with the same kind of teeth. It is probably supported largely by the dentary but the splenial may also take part. The articular region has two cotyli corresponding to the condyles of the quadrate above. There are no openings on the outer side of the jaw and none can be made out on the inner side.

The *axis* has a short centrum with elongate pits on either side as in *Naosaurus*. The transverse processes rise from the neural arch and the upper edge of the centrum; the posterior edge is continued as a long ridge on the side of the centrum to the posterior edge. The anterior face is elongate vertically but it has been crushed so that the form is obscured. The spine is low but it was very heavy, curving

forward over the anterior face; the posterior zygapophyses are large but the anterior ones are small. The posterior edge of the spine is very wide, extending out over the sides of the centrum.

Position and Relationships.—It is most unfortunate that the vertebræ and limbs of this form are not known. The evidence of the skull shows that it has little in common with the rest of the Pelycosauria and that it is very far removed from the genus *Naosaurus* with which it was most closely connected by Cope. The probable similarity of habits to *Placodus* has been pointed out above and a comparison of the skulls shows many points of resemblance. These are best shown in a comparative table:

<i>Placodus.</i>	<i>Edaphosaurus.</i>
Skull low and broad.	Skull low and broad.
A single temporal vacuity.	Probably two temporal vacuities.
Incisor teeth chisel-shaped, projecting forward from the skull.	Incisor teeth approaching chisel-shape and projecting forward from the skull.
Maxillary teeth flat and adapted to crushing or grinding.	Maxillary teeth thin and sectorial.
Posterior nares a single opening between the prevomers and premaxillaries.	Posterior nares a single opening between the prevomers.
Palatine teeth few and large.	Palatine teeth numerous and smaller.
Teeth of the lower jaw reduced to the incisors and crushing teeth.	Lower jaw with teeth on the border as well as the crushing teeth.
Pterygoid without external process.	Pterygoid without external process.
Interparietal and epiotic present.	Interparietal and epiotic present.
Occurring in the Triassic.	Occurring in the Permian.

There is not sufficient evidence to warrant the conclusion that there is an actual relationship between *Edaphosaurus* and *Placodus*, but the similarity of the two is certainly very suggestive. If *Placodus* is a true synapsidan form, related to the Anomodonts as held by many authors, it could have no connection, genetically, with *Edaphosaurus*, but it must have passed through a similar stage of evolution in the growth of the palatine and dentary crushing teeth and the loss of the teeth on the edges of the maxillary and the dentary. Two things are worthy of note in the study of the relations of the two: (1) It is not proven that *Edaphosaurus* had two temporal vacuities, though I believe it to have been the case. (2) The new genus *Anomosaurus* of v. Huene, which he believes to be a Pelycosaurian and which is certainly very closely related to that suborder, comes from not only the same horizon

but even from the same locality as *Placodus*,¹ and some of the vertebræ, at least, may belong to it. Should this turn out to be true it may be that future discoveries will show that *Edaphosaurus* occupies an ancestral position to the Placodontia.

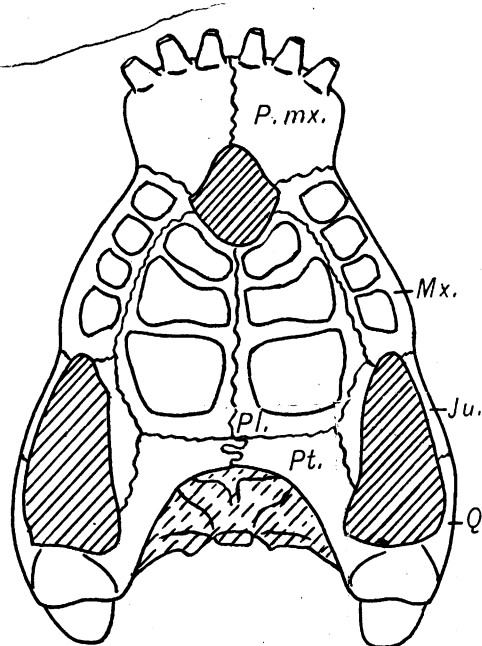


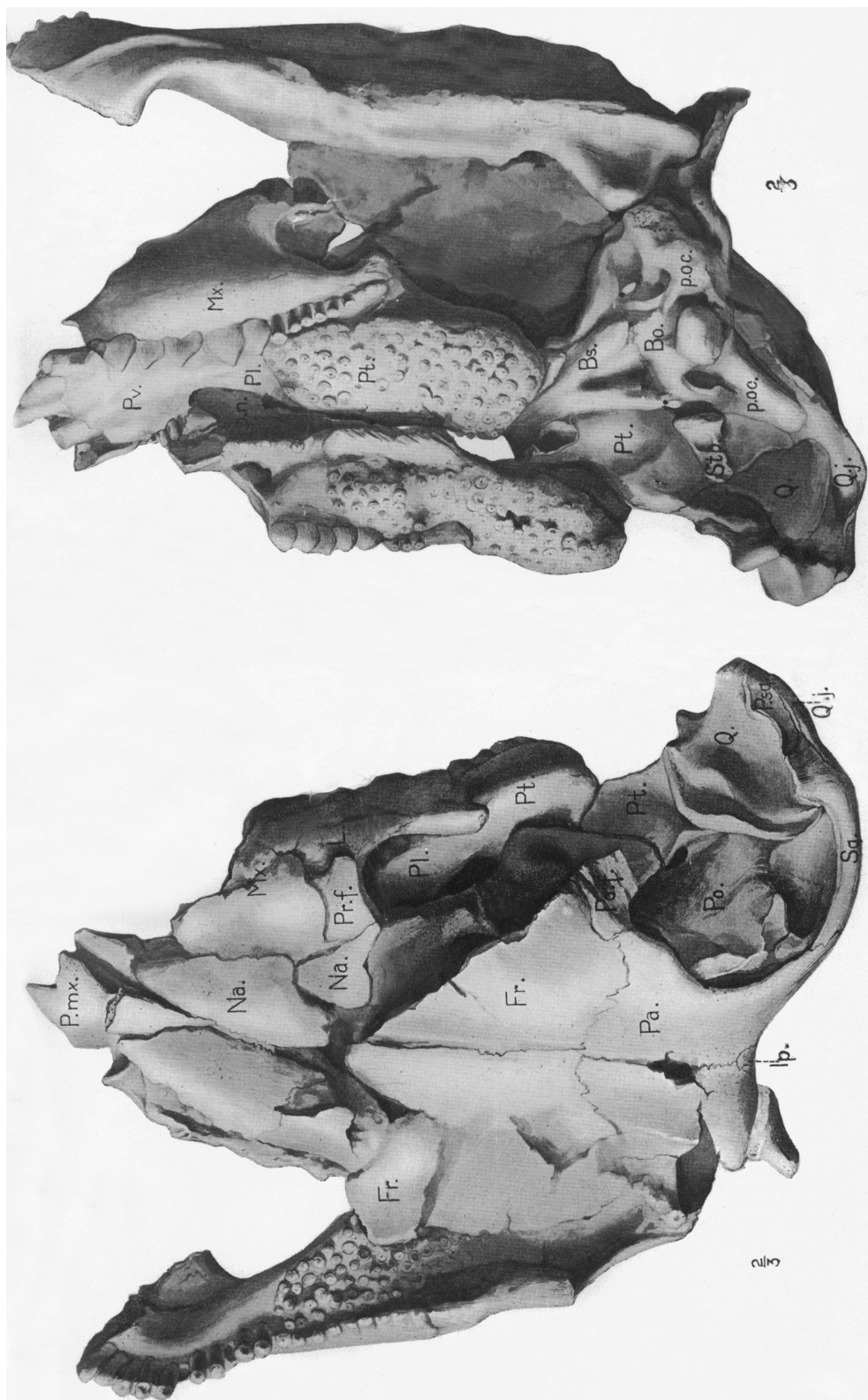
FIG. 7.—Palatal view of the skull of *Placodus*. After v. Huene. Lettering as in figure 2.

EXPLANATION OF PLATE VII.

FIG. 1. — Upper surface of the skull of *Edaphosaurus pogonias* Cope. No. 4009 Am. Mus., x $\frac{2}{3}$. *pmx.* premaxillary, *n.* nasal, *mx.* maxillary, *pf.* prefrontal, *l.* lachrymal, *pl.* palatine, *pt.* pterygoid, *f.* frontal, *po.* paroccipital, *p.* parietal, *ptf.* postfrontal, *q.* quadrate, *qj.* quadratojugal, *sq.* squamosal, *psq.* prosquamosal.

FIG. 2. — Lower view of the same. Lettering as in figure 1 and; *pv.* prevomer, *pn.* posterior nares, *bs.* basisphenoid, *bo.* basioccipital, *st.* stapes.

¹ Pelycosaurier in deutschen Muschelkalk. Neuen. Jahrb. f. Min., Geol., u. Paleont., Beilage Bd. XX, 1905, p. 336.



EDAPHOSAURUS POGONIAS *Cope*.

