Article XXVIII.—DESCRIPTION OF THE SKULL OF BOLOSAURUS STRIATUS COPE.

BY E. C. CASE.

PLATE XLVIII.

During the summer of 1907 the author made a collecting trip in the Permian beds of north central Texas the proceeds of which passed into the possession of the American Museum of Natural History in New York. Among the material collected were two skulls of a small reptile, Bolosaurus striatus Cope, hitherto known from a very imperfect skull which formed the type. The purpose of the present paper is to describe these two skulls and to establish the position of the family Bolosauridae, which has been in some doubt.

The two skulls were found close together with numerous bones of Clepsydrops, Dimetrodon, etc., in a bed of conglomerate in the Clear Fork division of the Texas Permian beds. The locality is near the mouth of Godlin Creek, in the northern portion of Archer County, Texas.

Order COTYLOSAURIA Cope.

Fam. BOLOSAURIDÆ Cope.

The family was originally regarded by Cope as belonging to the Pelycosaurs. He said¹: "The division Pelycosaurs is established primarily upon the genera Clepsydrops and Dimetrodon, but their cranial structure renders it highly probable that Ectocynodon, Pariotichus and Bolosaurus belong to it. It is also probable that the genera Empedocles, Embolophorus and others determined from vertebrae belong to it, as the later are frequently accompanied by pelvic bones of the type of that of Dimetrodon. All the genera known from teeth and crania, are of carnivorous habit, excepting Bolosaurus and Diadectes; they may be referred to a single family on this account, which I call the Clepsydropidae. Bolosaurus will form the type of another family characterized by the transverse position of the crowns of the teeth, under the name Bolosauridae." In his Systematic Catalogue of the Permian Reptiles published in 1888² Cope placed Chilonyx in the family

Bolosauridae, indicating that he recognized the Cotylosaurian character of the skull.

Revised description of the family: Small Cotylosaurians with the cheek teeth elongate transversely and with a prominent cusp, in the upper series on the outer edge and in the lower series on the inner edge; the cusps showing slight wear in mature specimens. The family is distinguished from the Pariotichidae by the presence of the cusps on the teeth and by the presence of but a single row in the lower jaw, and from the Diadectidae by the presence of an elongate parasphenoid rostrum and a prominent outer process of the pterygoid bearing a row of teeth on the lower edge.

Genus Bolosaurus Cope.

Bolosaurus striatus Cope.

Original description of the genus and species, 1878:\[1\] “Teeth fixed in shallow alveoli, and with the crowns expanded transversely to the axis of the jaws. The crowns swollen at the base, and with low apex, divided vertically into two equal portions. The postero-internal half in the maxillary series is low and horizontal; the anterior external portion forms a low cusp, which has a semicircular section. The teeth of the lower jaw are similar, but the relative positions of the ledge and cusp are reversed. Anterior teeth of superior series composed of external cusp and internal ledge. No enlarged canine or incisor teeth. Bones of face not sculptured.”

“Char. Specif. The external surface of the crown is marked to the apex with waved grooves of enamel. The edges of the elevated cusp, which presents posteriorly in the maxillary teeth, constitutes the abrupt termination of the exterior face, and is serrate by the interference of the sulci. The edge of the basal ledge is slightly serrate. The muzzle is rather elongate, and the sides of the maxillary and dentary bones are plane and smooth. The mandible is narrow, and forms a narrow wedge in the profile outline. It rises posteriorly behind the dental line. The teeth are separated by intervals as wide as the tooth.

“Measurements. \[1\]

<table>
<thead>
<tr>
<th>Measurement</th>
<th>M.</th>
</tr>
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<tbody>
<tr>
<td>Long diameter of the orbit No. 1</td>
<td>.0130</td>
</tr>
<tr>
<td>Depth of upper jaw at orbit</td>
<td>.0045</td>
</tr>
<tr>
<td>Depth of lower jaw at front of orbit</td>
<td>.0050</td>
</tr>
<tr>
<td>Four teeth in (lower jaw)</td>
<td>.0080</td>
</tr>
<tr>
<td>Elevation of a crown</td>
<td>.0025</td>
</tr>
<tr>
<td>Transverse diameter of molar number 2</td>
<td>.0025”</td>
</tr>
</tbody>
</table>

The foregoing description was evidently taken in large part from the

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type skull, No. 4320 Am. Mus. Nat. Hist., Cope Coll., but there are some
parts which were taken from No. 4321, and perhaps from other speci-
mens.

Revised description of the genus and species. The following description
is taken almost entirely from the two skulls recently discovered, as the type
skull shows very little that can be depended upon, other than the character-
istic form of the teeth in the lower jaw. The
condition of the type renders it impossible to
make out the separate bones, and the teeth of
the upper jaw have been nearly all broken away.
The whole skull has been crushed forward giving
a false appearance of elongation (see Fig. 1).

The two skulls, Nos. 4685, 4686, are of nearly
equal size and in a good state of preservation;
one has been crushed downward so that the top of
the skull is broken in, but the palatal surface is
well shown; the other has been crushed some-
what from side to side, but with the exception of
the tip end of the nose there has been little loss. Unfortunately both speci-
mens have been so injured in the temporal region that it is impossible to
make out the limits of the individual bones, but there is no doubt that
there was a complete roof with no trace of temporal vacuities.

The skull was roughly triangular in form, wider and higher posteriorly
and terminating in a blunt snout anteriorly.
The interorbital space is moderately wide and
slightly concave or flat and is pierced by a fair
sized parietal foramen. The facial portion of
the skull seems to have been rather sharply
rounded above. The anterior end of the skulls
is so injured that it is not possible to deter-
mine the exact position of the nares but they
were nearly terminal and apparently looked
outward rather than forward. The orbits are
large and were nearly circular in outline; the
antero-posterior diameter is nearly equal to the
preorbital length of the skull. The edges of
the orbit are prominent above and anteriorly
but are less so below; there is no pit in the prefrontal such as is so char-
acteristic of the Pelycosauria.

From the condition of the specimen it is impossible to make out the shape
or relations of all the bones but it is evident that their surface was smooth
and free from sculpture except along the anterior edge of the orbit.
The maxillary is rather elevated with a convex superior edge and a nearly straight alveolar edge; posteriorly it extends almost to the back of the orbit but is prevented from taking any part in it by the jugal which overlies the posterior fourth. There are 16 counted teeth in the best preserved specimen, which is evidently a nearly perfect premaxillary and maxillary series. The anterior three teeth, which probably belong to the premaxillary, are larger than the anterior maxillaries and probably functioned as incisors. In common with the anterior maxillaries they are simple cones with large pulp cavities. Beginning with the sixth tooth the maxillary series increases in size to the tenth or eleventh, and then decreases in size to the posterior end; the last two are abruptly smaller and are only minute cones. The teeth from the sixth to the fourteenth show the characters of the family and genus. They are transversely expanded, much as in the Diadectidae, but in a less degree, and on the outer edge there is a prominent cusp which descends considerably below the rest of the crown. The apex of this cusp was originally sharp but seems to have been worn blunt by attrition. The shape of these teeth indicates the assumption of an herbivorous habit and perhaps indicates the method of development of the Diadectid teeth.

The exact outlines of the frontals, nasals, prefrontals and lachrymals cannot be made out; the frontals were paired and took part in the upper edge of the orbit.

Fig. 4. Diagram of the lower surface of No. 4686, showing the form of the various bones.

The jugal is a long and slender bone which underlay the orbit and extended relatively far anterior and posterior to it; it did not extend upward to form a portion of the posterior edge as in the Polycosauria.

The postorbital region is crushed in both specimens but in them and in the type specimen it is evident that the region was covered by a complete roof without temporal vacuities. The form of the separate bones is obscure. The quadrate is a vertical plate and the articular surface has two condyles, elongate antero-posteriorly as in the Diadectidae.

The posterior surface of the skull is composed of a nearly vertical plate in which the sutures are mostly indistinguishable; the exoccipital is fused with the basioccipital and extended well up on the sides of the large and nearly circular foramen magnum. The occipital condyle is slightly oval and is marked by a pit showing the termination of the notochord. The opisthotic is separate from the exoccipital and extends out to the quadrate as a strong process. On either side of the posterior face of the skull there is a good sized posttemporal vacuity. There is no trace of a foramen quadratum.
The under surface of the skull is most interesting, showing the strong resemblance to the Pariotichidæ in the presence of the strong parasphenoid rostrum and the external process of the pterygoids, points in which it differs from the Diadectidæ. The basisphenoid is shaped much like that in the Pelycosauria and the Pariotichidæ; attached to the anterior end is a slender parasphenoid rostrum, which is of exceptional length; it extended far forward between the palatines. The posterior end is expanded and the lower surface is excavated by a shallow pit; near the anterior end are prominent basipterygoid processes which bear smooth articular faces. There is no trace of foramina for the external carotids on the lower surface but these may be very obscure because of their minute size and the condition of the surface of the bone. In the specimen numbered 4685 the basioccipital has been pushed forward out of place and lies partly in the pit at the posterior end of the basisphenoid.

The pterygoid has the tripartite form made familiar in the Pelycosauria and the Diadectidæ. The anterior process extends forward and fuses with the palatine so intimately that the suture cannot be made out; between the pterygoids and palatines of the two sides there is considerable space which is divided by the elongate parasphenoid rostrum; it is probable that the anterior end of the dividing plate is formed by the vomer. The external process of the pterygoid curves outward from the middle of the bone and presents a prominent vertical face to the inner side of the lower jaw. The lower edge of this process carries a row of prominent, bluntly conical teeth set in sockets. There are six teeth in the best preserved row with the base of a seventh set off to one side; the outer end of the row of teeth is bent sharply forward with the process.

The lower jaw is very high posteriorly and becomes more slender anteriorly. The alveolar edge is nearly straight as in the maxillary, and there are 13–14 counted teeth and alveoli; this series does not seem to be complete and there were probably one or two more. As in the upper jaw, there is no trace of enlarged canines and the teeth in the middle of the series are somewhat larger than those at the ends; the last two teeth are abruptly smaller. The teeth of the middle portion of the series have a very similar appearance to those of the maxillary; the base of the crown is swollen and the inner edge is continued upward in a cone which was sharp originally but seems to be worn blunt by use. The articular region shows two cotyli for the condyles of the quadrate, and is expanded laterally for their accom-
modation as in the Diadectidae. Though the posterior portion of the jaw is very high there is no distinct coronoid process, and there are no vacuities in the outer surface of the jaw. The relations of the various bones cannot all be made out but it is evident that the splenial extends far forward and took part in the symphysis.

<table>
<thead>
<tr>
<th>Measurements</th>
<th>mm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of the lower jaw of No. 4685, perfect</td>
<td>31</td>
</tr>
<tr>
<td>Width across the posterior end of the skull</td>
<td>28</td>
</tr>
</tbody>
</table>

With the skulls there were found numerous limb bones and vertebrae of some animal or animals of about the size indicated by the skulls, and they may belong to *Bolosaurus*, but as they were found in a bone bed, and as the remains of several small specimens of *Clepsydrops* were found in the immediate vicinity, it seems hardly profitable to describe them until further evidence has been obtained.

The affinities of this small Cotylosaurian are evidently with the Pariotichidae rather than with Chelydosauria, but it differs from the Pariotichidae in the presence of but a single row of teeth on the lower jaw and in the presence of cusps on the teeth. The swollen base of the teeth strongly resemble those of *Pantylus coicodus* Cope, but that form is much larger and the teeth are without cusps. *Bolosaurus* is evidently a representative of a family of the Cotylosauria which was just assuming the habit of an herbivorous diet.

**Explanation of Plate XLVIII.**

Upper jaw of *Bolosaurus*, No. 4321, Am. Mus., Cope Coll.  *A*, external view; *b*, internal view; *c*, inferior view. Enlarged four diameters. Photo by A. E. Anderson.
Bolosaurus striatus.