

ON DINOSAURIAN REPTILES FROM THE TWO MEDICINE FORMATION OF MONTANA

By CHARLES W. GILMORE

Curator of Vertebrate Paleontology, United States National Museum

INTRODUCTION

The Blackfeet Indian Reservation in northern Montana has been the object of two expeditions by the Smithsonian Institution. It was here in deposits of the Two Medicine (Upper Cretaceous) formation that, in 1913, I discovered the type specimen of *Brachyceratops montanensis*.¹ The collections of this first expedition were so promising that it was deemed highly desirable that the region should be visited a second time. This desire was realized in 1928, and the specimens described in the following pages are a part of this latter collection, which, as a whole, adds considerably to our knowledge of this meagerly known fauna and places it on a basis where comprehensive comparisons with Upper Cretaceous faunas of adjacent regions are now possible.

The bulk of the collection will be described in a later paper, but I have thought it advisable to record as soon as possible the discovery of three genera new to the fauna, which include two new species.

1. A NEW SPECIES OF PALAEOSCINCUS

Among vertebrate fossils collected from the Two Medicine formation (Upper Cretaceous) of Montana, by a Smithsonian paleontological expedition in 1928, is a disarticulated skeleton of an armored dinosaur displaying characters which indicate it to be an undescribed species of the long established but little known genus *Palaeoscincus*.

Palaeoscincus costatus,² founded by Dr. Joseph Leidy in 1856 on a single tooth (pl. 4, fig. 3) was the first named North American armored dinosaur. For more than half a century this remained a genus of doubtful affinities, but with the acquisition by the American

¹ Gilmore, C. W., Prof. Paper 103, U. S. Geol. Surv., 1917.

² Proc. Phila. Acad. Sciences, vol. 8, 1856, p. 72.

Museum of Natural History of an unusually well preserved anterior portion of a skeleton (pl. 8) with the armor in place, a real conception of the extraordinary characteristics of this animal was first disclosed. A few teeth found in the cavities of the skull are said by Matthew³ to be identical in character with the type of *Palaeoscincus costatus* thus establishing its identity.

Reference of the present specimen to the genus *Palaeoscincus* is based on similarity of dermal armor and skull resemblances to the American Museum specimen. Although much of the anterior portion of that skeleton is present, it has not yet been described, and for comparative purposes one must rely almost entirely upon the excellent illustrations published by Matthew.

The specimen from the Two Medicine formation, considered here, contributes so much to our knowledge of the skeletal anatomy of the animal that it is described in considerable detail. The teeth, however, although having the general cut of the *Palaeoscincus costatus* tooth, differ sufficiently in their details to indicate a distinct species.

The new genus and species *Edmontonia longiceps* recently described by C. M. Sternberg,⁴ displays such striking likeness in its skull structure to the *Palaeoscincus* cranium now before me as to raise a question as to the validity of this new genus. In the arrangement and number of skull plates, and structure of the palate, the two skulls are almost identical, differing principally in proportions. The teeth also are not greatly unlike the typical *Palaeoscincus* tooth. At this time I am not fully satisfied that there are good generic distinctions for separating these two genera but shall withhold final judgment until other parts of the *Edmontonia* type have been studied.

The occurrence of *Edmontonia* in the geologically higher Edmonton formation, may lend some weight to the possibility of its generic distinctness, for few dinosaurian genera are known to pass over from one formation to another.

PALAEOSCINCUS RUGOSIDENS, new species

Plates 1, 2, 3, 4, Figure 1; Plates 5, 6, and 7

Type.—No. 11868, U.S.N.M., consists of a complete skull; right ramus; coössified atlas and axis; the third and two other cervical vertebrae; ten dorsal and eleven caudal vertebrae; sacrum; two ischia; portion of right ilium; right pubis; seventeen ribs half of which are complete; chevrons; numerous parts of bones; and fifty dermal ossifications of various kinds. The specimen was found by George F. Sternberg, June 3, 1928.

³ Natural History, vol. 22, No. 4, 1922, p. 334.

⁴ Trans. Roy. Soc. Canada, vol. 22, 1928, pp. 93-106.

Type locality.—Sec. 16, T. 37 N., R. 8 W., Milk River, Blackfeet Indian Reservation, Glacier County, Montana.

Horizon.—Two Medicine formation, Upper Cretaceous.

The specimen on which the present description is based was found on the north side of Milk River about one-half mile west and south from the locality where the type of *Brachyceratops montanensis*⁵ was discovered by the writer in 1914. All the bones were disarticulated and widely scattered, but it was quite apparent they pertained to a single individual as there was no duplication of parts.

Skull.—The skull, aside from slight flattening due to postmortem crushing, is in an almost perfect state of preservation. Normally depressed, it diminishes in both height and breadth toward the muzzle, which is squarely truncate. Widest immediately posterior to the orbits, the breadth abruptly contracts behind the eyes, forming a distinct notch on either side as contrasted with those of much lesser degree in both *Panoplosaurus mirus* and *Edmontonia longiceps*. The orbits are of moderate size and set far back. The narial openings are large and open outward and upward. The lateral temporal fenestra look outward and slightly backward.

The whole of the exposed skull surface, top, front, and sides, is covered by a few ossified dermal plates. These are coössified with the underlying skull bones, concealing them from view. The plates are defined by shallow circumscribing sulci, which in this specimen can not be traced out in their entirety, as is shown in Plate 2.

In so far as the number, form, and proportions of these head plates can be determined, they most nearly resemble those of *Edmontonia longiceps*. The observed difference in form and proportions between the plates of *Palaeoscincus rugosidens* and those of *E. longiceps* and *Panoplosaurus mirus*, in all probability are of but little anatomical significance, for in dermal bones there seems to be considerable variation among individuals of the same species.

Viewed from the side the superior outline of the skull is moderately convex from front to back and likewise from side to side. Behind the line of the orbits on either side of the midline are large shallow depressions as in the cranium of *E. longiceps*. The withdrawal inward of the dentigerous border of the maxillary, brings about a depressed buccal area of considerable extent, well illustrated in Figure 2. Dermal ossifications cover the entire side of the skull, thus obliterating all sutures between the individual bones.

In the posterior view (fig. 1) the skull bones are free from dermal covering and although the individual elements can be determined, all of the sutures are coalesced thus rendering it impossible to determine their precise limits.

⁵ Gilmore, C. W., Prof. Paper, 103, U. S. Geol. Surv., 1917.

The occipital condyle is relatively large and directed obliquely downward in relation to the longer axis of the skull, indicating the normal pose of the head to form an obtuse angle with the neck. The condyle is subspherical, the greatest diameter being transverse. It has a greatest width of 58 mm., and a greatest vertical diameter of 52.5 mm.

The exoccipitals extend outward and backward, their outer ends projecting backward beyond the occipital condyle. The outer or paraoccipital processes form the two small horn-like projections shown in the superior view of the skull (pl. 2). These bones are indistinguishably fused with the exoccipitals.

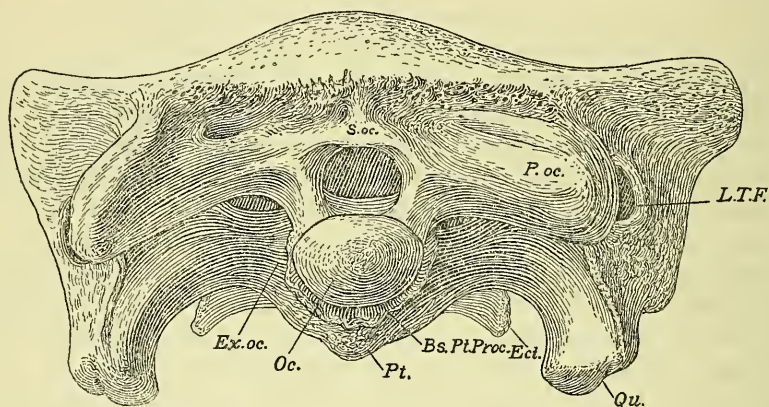


FIGURE 1.—SKULL OF *PALAEOSCINCUS RUGOSIDENS*. TYPE. No. 11863, U.S.N.M. POSTERIOR VIEW. ONE-THIRD NATURAL SIZE. *Bs. pt. Proc.*, BASIPTERYGOID PROCESS, OF THE BASISPHENOID; *Etc.*, ECTOPTERYGOID; *Ex. oc.*, EXOCCIPITAL; *L. T. F.*, LATERAL TEMPORAL FENESTRA; *Oc.*, OCCIPITAL CONDYLE; *P. oc.*, PARA-OCCIPITAL PROCESS; *Pt.*, PTERYGOIDS; *Qu.*, QUADRATE; *S. oc.*, SUPRAOCCIPITAL

The supraoccipital strongly overhangs the foramen magnum. The latter is suboval in outline, and has a greatest transverse diameter of 33 mm. and a vertical diameter of 28 mm.

The quadrates are wide transversely, and of moderate thickness. A wide process that projects forward and inward is firmly coalesced with the pterygoids. The upper end is fully enveloped by the overlying squamosal and posteriorly these ends are coalesced with the paraoccipitals. Viewed from below the distal articular end of the quadrate is triangular in outline (fig. 2). The main articular face for the ramus has its greatest diameter fore and aft. Toward the outside it slopes upward. From an external view only the thin edge of the quadrate is seen and it is covered by a roughened dermal growth of bone.

The palate side of the skull is in an excellent state of preservation. Slight crushing and loss of a few minor pieces is all that mars

its perfection. Unfortunately most of the sutures are obliterated, making it quite impossible to determine the extent of many of the elements. Except for differences in proportion, the palate structures seems to be identical with *Edmontonia longiceps* as described by Sternberg.⁶

The outstanding peculiarities of structure observed in the palate of this specimen are the ladle-shaped form of the premaxillary region; the division of the mouth longitudinally by a vertical plate of bone that extends backward from the median junction of the premaxillaries; the great shortening of the pterygoids, the inward curvature of the tooth rows, and the wide overhanging buccal area along the outer sides of the maxillary bones.

The edentulous premaxillary bones form the greater part of the large rectangular muzzle. As mentioned above, their combined inner surfaces are hollowed out, in form suggesting a ladle. The outer anterior borders curve strongly downward, forming a sharp cutting edge that in life was doubtless covered by a chitinous sheath. On either side external to this sharp ridge of bone the premaxillaries are widened by dermal bones that are firmly coössified to it. A low, subacute median ridge rising on the anterior third extends backward to the junction with the prevomers. On either side of the midline the premaxillaries are pierced by small rounded foramina that lead upward and forward through the floor of the anterior nares. The sutures between premaxillaries, maxillaries, and prevomers are clearly determinable as shown in Figure 2. On the right side the border of the premaxillary shows deformation in the form of a notch, evidently due to an injury received in life, since the edges of the bone had healed as indicated by their rounded borders.

The maxillae have the greater portion of their outer surfaces hidden by the covering of dermal bone. Anteriorly they meet the premaxillae, internally the prevomers, and toward the posterior end the ectopterygoids. The striking characteristic of these bones is the curved nature of the dentigerous border. The teeth are borne on a downwardly descending plate that gradually recedes in height toward the front. The tooth rows are wide apart posteriorly (144 mm.), but curve in rapidly to a point forward of their mid-length where they become parallel. In front the teeth of opposite sides are only 77 mm. apart, exactly half the space of the posterior ones. There are sixteen alveoli in each maxillary bone, and these occupy a space of 120 mm. measured in a straight line. Judging from the relative sizes of the alveoli, the teeth decrease in size from back to front.

⁶ Trans. Roy. Soc. Canada, vol. 22, 1928, pp. 98-100, pl. 2.

The spear-shaped bone filling the interspace between the maxillae is here regarded as the combined prevomers. The pointed end is interposed between the coalesced premaxillae, while the hinder ends

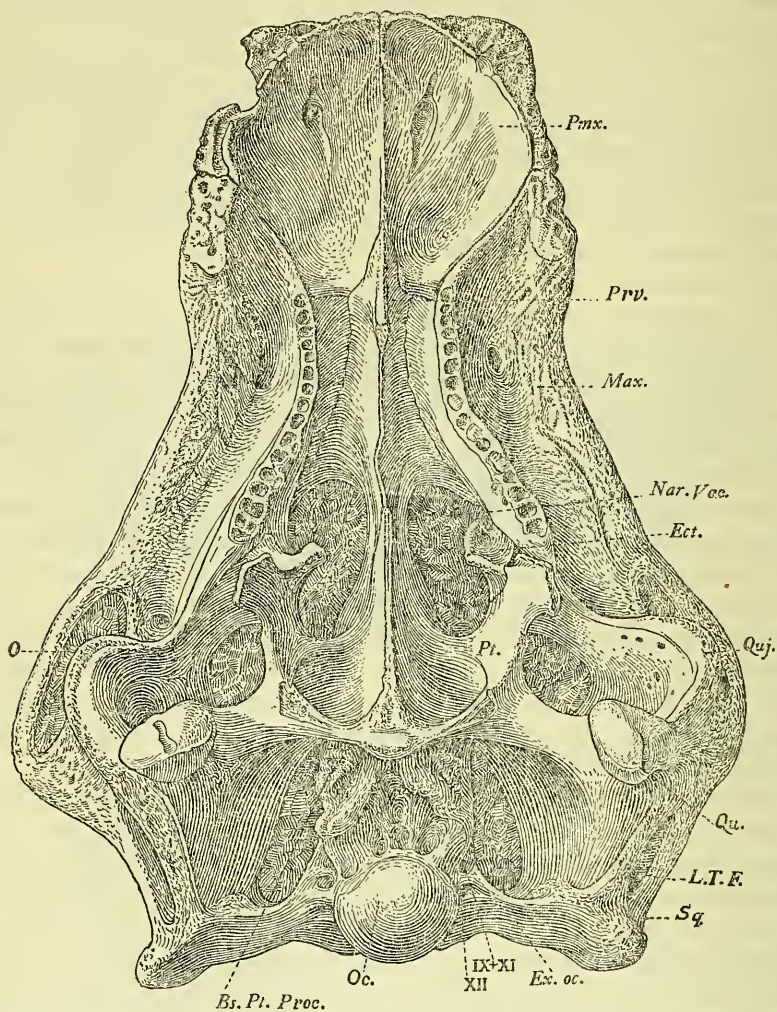


FIGURE 2.—SKULL OF *PALAEOSCINCUS RUGOSIDENS*. TYPE. NO. 11868, U.S.N.M. INTERIOR VIEW. ONE-THIRD NATURAL SIZE. *Bs. Pt. Proc.*, BASIPTERYGOID PROCESSES; *Ect.*, ECTOPTERYGOID; *Ex oc.*, EXOCCIPITAL; *L. T. F.*, LATERAL TEMPORAL FENESTRA; *Max.*, MAXILLARY; *Nar. Vac.*, NARIAL VACUITY; *O.*, ORBIT; *Oc.*, OCCIPITAL CONDYLE; *Pmx.*, PREMAXILLARY; *Prv.*, PREVOMER; *Pt.*, PTERYGOIDS; *Qu.*, QUADRATE; *Quj.*, QUADRATOJUGAL; *Sq.*, SQUAMOSAL; *IX, XI, XII*, EXITS FOR CRANIAL NERVES

form the anterior borders of the internal nares, and on the midline articulate with the palatines. Sternberg was certainly mistaken in regarding this portion of the palate in *Edmontonia longiceps* as

being a posterior extension of the premaxillae. The most striking feature of these bones is the development of a vertical plate that extends downward and divides the mouth longitudinally. This plate anteriorly extends below the level of the tooth rows. In the specimen under consideration the greater part of this plate is missing, but is completely preserved in the type of *Edmontonia longiceps* and has been described in detail by Sternberg,⁷ who says: "This plate seems to be a development of the fused premaxillae." In this, however, I think he is mistaken; for in specimen No. 11868 this ridged plate certainly develops on the prevomers as shown in Figure 2. The purpose of this longitudinal plate is as yet unexplained, but that it had a function there can be no doubt. A suggested similarity is found in the palate of *Troödon validus*, but in that genus it consists only of a pointed pendant⁸ process.

The palatines as distinct bones can not be differentiated in this skull. It is presumed, however, that they form the median bar of bone which separates the internal nares. That they probably form the posterior boundary of the nares is indicated in the type of *Edmontonia longiceps*, where Sternberg was able to trace out a part of the palatine-pterygoid suture. In the present skull all trace of this suture has been obliterated. If correct in the determination of these bones, the palatines form a considerable portion of the vertical plate which divides the mouth cavity. Anteriorly they join the prevomers, apparently intercalated between slender posteriorly directed processes of those bones.

The pterygoid bones, as in nearly all of the armored Dinosauria, are greatly shortened antero-posteriorly. Each element may be said to consist of three plates of bone, a rather narrow wing that extends backward and outward and joins the quadrate, further in front a nearly vertical lamina that extends forward to articulate with the ectopterygoids, and at the junction of the two processes mentioned above a heavier vertical plate extends transversely to meet its counterpart of the opposite side on the median line. At their junction the bone swells out into a truncated triangular process that projects downward considerably below the rest of the bone. A median septa continues forward and upward from this process to meet the palatines. On either side of this septa the pterygoids are hollowed out. The sutural contact with the ectopterygoids seem to be as indicated in Figure 2, but I have some misgivings as to whether they are fractures or true sutures.

⁷ Trans. Roy. Soc. Canada, Art. 3, Vol. 22, 1928, pp. 99-100.

⁸ Gilmore, C. W., Univ. of Alberta, Bull. No. 1, 1924, pl. 5.

Table of comparative measurements

	Type of <i>Palaeoscincus</i> <i>rugosidens</i>	Type of <i>Edmontonia</i> <i>longiceps</i>	Type of <i>Panoplosaurus</i> <i>mirus</i>
	Mm.	Mm.	Mm.
Greatest length of skull, in straight line-----	470	490	355
Greatest breadth just back of orbits-----	340	290	294
Breadth of beak, anterior end-----	145	110	121
Greatest breadth of beak-----	187	150	-----
Breadth of paroccipital processes-----	240	210	-----
Length of quadrate-----	¹ 150	118	-----
Distance between distal ends of quadrates-----	185	165	-----
Greatest length of orbit-----	64	70	66
Vertical diameter of orbit-----	-----	50	47
Greatest diameter of foramen magnum-----	40	32	58
Transverse diameter of occipital condyle-----	57	50	58

¹ Estimated.

Lower jaw.—The right ramus is preserved almost in its entirety as shown in Figure 3. Its outstanding peculiarities of structure are the great depth of the posterior third; the brevity of the post-coronoidal portion; the curved dental row; and the short, inwardly curved symphysial end. It probably includes all of the elements common to the ramus of the predentate dinosauria but in this specimen most of the sutures are fully fused so that the separate elements of the jaw can not be differentiated.

Much of the outer and lower surface of the ramus, except at the posterior end, is covered by a thick dermal bone which effectually conceals most of the underlying elements. The keeled nature of this dermal bone is well shown in Plate 3. The dermal plate is everywhere fully fused to the underlying bones. The armor does not cover the posterior end of the ramus and here the posterior mandibular elements can be seen. The angular-surangular suture remains distinct from the posterior border to the point where it passes beneath the overlying armor. It shows the angular to have a greatest posterior depth of 42 millimeters, but this rapidly diminishes as the bone passes forward. All of the sutures of the internal side of the ramus are obliterated through fusion. The dentary, which constitutes fully two-thirds of the entire ramus, is roughly rectangular with a much narrowed portion that turns strongly inward to form the symphysis. The alveolar border shows sockets for 21 teeth, the same as in *Euoplocephalus tutus*, but three more than in the ramus of *Edmontonia longiceps*. These occupy a space 140 millimeters in extent, indicating the teeth to be slightly smaller than in *E. longiceps* where 18 teeth occupy a space 155 millimeters in length. The tooth row forms a sinuous curve that con-

forms to the curved maxillary row (fig. 3B). Posterior to the last alveolus the superior border curves gently upward as a pointed process that is enveloped by the coronoid which appears to be astride it. On the internal side the splenial completely covers Meckel's groove. On this side a horizontal ridge is developed which becomes more prominent anteriorly where it finally forms the posterior boundary of the symphyseal part of the dentary. Here the main body of the bone changes from a vertical to a horizontal position. The union of the dentary with the posterior elements can not be determined.

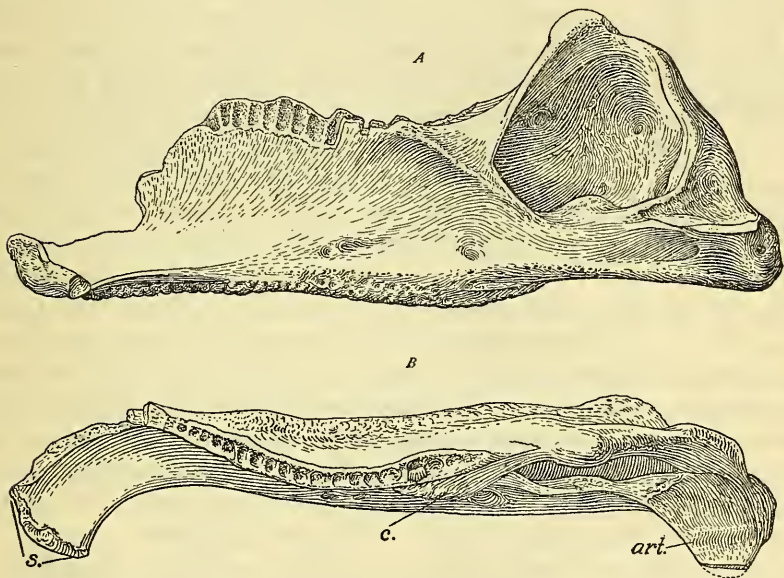


FIGURE 3.—RIGHT RAMUS OF *PALEOSCINCUS RUGOSIDENS*. TYPE. No. 11868, U.S.N.M. A, INNER VIEW; B, SUPERIOR VIEW. BOTH ONE-THIRD NATURAL SIZE. Art., ARTICULAR; C., CORONOID; S., SYMPHYSEAL BORDER

The coronoid sends forward an anterior portion that laps along the supero-posterior portion of the dentary as shown in Figure 3. It forms much of the anterior border of the mandibular fossa, which is extensive. A second process is sent forward on the outside of the dentary but its full extent can not be determined. Posteriorly, however, it is so fully fused that its limits can not be recognized.

The articular is prominently developed extending inward as a shelf-like platform that, viewed from above, is subtriangular in shape. The cotylus is shallowly concave antero-posteriorly, being divided into two parts by a low, rounded, longitudinal ridge. The prearticular is probably present but is thoroughly coössified.

Measurements of ramus

	Mm.
Greatest length of ramus.....	360
Greatest depth through coronoid.....	121
Greatest depth of dentary at center.....	87
Greatest depth of dentary at symphysis.....	17
Length of dentigerous border.....	140

Teeth.—Four teeth are preserved, three in the left maxillary and one in the right dentary. The tooth illustrated (fig. 4) is the fifth enumerated from the posterior end of the maxillary, while the germ

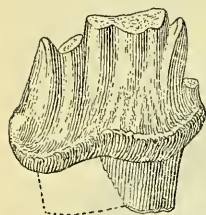


FIGURE 4.—MAXILLARY TOOTH OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. INTERNAL VIEW. TWO AND ONE-HALF TIMES NATURAL SIZE

tooth shown in Figure 5 is the twelfth of this same series. These teeth are retained in their respective alveoli in such a manner that only their internal surfaces are visible and for that reason can not be completely compared with the teeth of other described forms. The functional tooth consists of a laterally compressed crown and evidently a long cylindrical root. The crown is swollen at the base with a roughened cingulum as shown in Figure 4. It is to this roughening of the lower part of the crown that the specific name *rugosidens* refers. The anterior and posterior margins of the crown are denticulate, there

being three denticles posterior and four anterior to the apical denticle, making eight in all. The three central denticles, which in this tooth are missing, appear to have been united as they are in the typical *Palaeoscincus costatus* tooth (fig. 3, pl. 4). The other denticles are sharp pointed and continue down the inner face of the crown as low, well-defined ridges. The germ tooth has seven denticles, all displaying distinct points, as shown in Figure 5. The apical denticle is slightly posterior to the central vertical line. The anterior teeth, judging from the relative sizes of the alveoli, are smaller than the posterior.

In relative size, the one functional tooth present agrees almost precisely with the type tooth of *Palaeoscincus costatus*. They also agree in having a similar number of denticles with the median ones closely united. On the other hand their successive arrangement differs, and whereas *P. rugosidens* has the lower part of the crown ornamented with a rugose crinkling of the surface, the crown surface in *P. costatus* is always smooth.

In the paleontological collections of the United States National Museum there are between 50 and 60 teeth from the Judith River beds of Montana, that with a few exceptions are of similar pattern



FIGURE 5.—CROWN OF GERM MAXILLARY TOOTH OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. INTERNAL VIEW. TWO AND ONE-HALF TIMES NATURAL SIZE

and can be identified as *P. costatus*. None of these, however, shows sculpturing of the crown surface. From this brief review it is quite apparent that the teeth are near enough alike to indicate congeneric relationships, but are sufficiently unlike, in the light of our present knowledge, to show them to pertain to distinct species.

Three other species of this genus have been proposed at various times, *Palaeoscincus asper* Lambe,⁹ *P. latus* Marsh,¹⁰ and *P. magoder* Hennig.¹¹ The last is said by Hay¹² to be a *nomen nudum* and may, therefore, be dismissed from further consideration. The type of *P. latus*, from the Lance formation, is a stegosauroid style of tooth that can at once be distinguished from the teeth of *P. rugosidens* by its low crown and the regularity of its denticles. (See pl. 4, fig. 4.) *P. asper* may likewise be distinguished by the more numerous denticles, sides of crown more conspicuously ridged, and a double row of denticles at one end of the cutting edge. (See pl. 4, fig. 2.)

Atlas and axis.—The atlas and axis are fused together by their centra, nuchal arches, and spines, a condition previously observed by Sternberg¹³ in *Panoplosaurus mirus*. The English *Scelidosaurus*¹⁴ likewise has a fusion of the atlas and axis. In *Stegosaurus* these bones remain distinct.

The cup on the anterior extremity of the atlas for the reception of the occipital condyle is deep and subcircular in shape. It has a depth of 31 millimeters and a greatest estimated transverse diameter of 57 millimeters. The atlas is long, broad, relatively low and without ventral keel. It bears strong, coösfied, single-headed cervical ribs that project downward and strongly backward, as shown in Figure 6A. It is estimated that the atlas centrum had a length of about 88 millimeters.

The pedicels of the neuropophyses set well back from the anterior margin of the centrum. (See fig. 6A.) On the posterior borders they develop a thin process that extends upward, backward, and inward. These converge and unite medially with the neural spine of the axis arching over the anterior border of the neural canal, as well as the vertebral arterial canals. Above and posterior to the vertebral arterial canal, these processes are completely fused with the axis, leaving hardly a trace of the anterior zygapophyses of the axis or the posterior zygapophyses of the atlas. A broad anterior process of the neuropophyses extends inward above the neural canal but does

⁹ Lambe, L. M., Geol. Surv. Canada, Cont. Can. Pal., vol. 3, pt. 2, 1902, p. 54, pl. 17, fig. 5.

¹⁰ Marsh, O. C., Amer. Jour. Sci., ser. 3, vol. 44, 1892, p. 173, pl. 3, fig. 3.

¹¹ Hennig, Edwin, Naturw. Wochenschr., new ser., vol. 18, no. 51, 1919, p. 771.

¹² Hay, O. P., Second Bibliography of the Fossil Vertebrata of North America, vol. 2, 1919, p. 237.

¹³ Trans. Roy. Soc. Canada, vol. 15, 1921, pp. 93, 94, pl. 1, fig. 1.

¹⁴ A monograph of the Fossil Reptilia of the Liassic formation, pt. 2, Paleontographical Soc., 1863.

not meet its fellow of the opposite side, thus leaving the spinal cord exposed for a considerable space, a condition also found in *Scelidosaurus* as well as in the ceratopsian dinosaurs.

The axis centrum is heavier than that of the atlas but apparently subequal in length. The posterior articular face is deeply cupped,

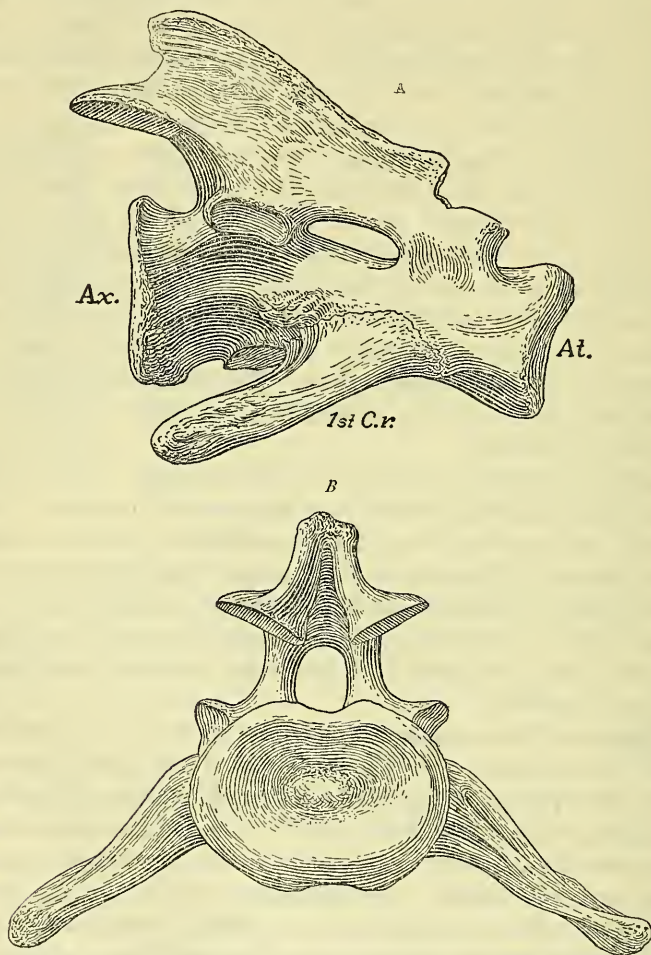


FIGURE 6.—ATLAS AND AXIS OF *PALAEOSCINCUS RUGOSIDENS*. TYPE. No. 11868, U.S.N.M. A, LATERAL VIEW; B, POSTERIOR VIEW OF AXIS, ABOUT ONE-THIRD NATURAL SIZE. At., ATLAS; Ax., AXIS; 1st C. R., FIRST CERVICAL RIB

as shown in Figure 6B. The lateral surfaces are concave and there is a heavy median keel, on either side of which, on the anterior half, are well developed parapophysial facets. The neural arch is low and massive. The postzygapophyses strongly overhang the posterior border of the centrum. Their articular faces are flat and es-

pecially expanded. The diapophyses are short and stout, extending outward at nearly right angles from the extreme lower side of the arch. They have ovate, slightly cupped articular ends that look downward and backward.

Measurements of atlas and axis

	Mm.
Greatest length of combined centra.....	165
Greatest length of atlas centrum (estimated).....	88
Greatest length of axis.....	77
Greatest height of axis centrum.....	68
Greatest height of atlas centrum.....	58
Greatest length of first crevical rib.....	126

Cervicals posterior to the axis.—In addition to the atlas and axis there are three cervical vertebrae, one of which can be positively identified as the third and the remaining two are provisionally regarded as the fifth and seventh respectively. The third, except for its slightly increased size, has the proportions of the axis, as shown in Figure 7. The cupped parapophysial facet has moved upward on

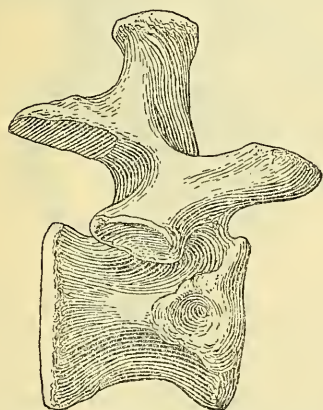


FIGURE 7.—THIRD CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. LATERAL VIEW. ONE-THIRD NATURAL SIZE

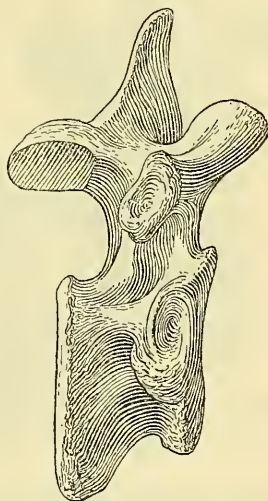


FIGURE 8.—FIFTH? CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. LATERAL VIEW. ONE-THIRD NATURAL SIZE

the median anterior border of the centrum and the diapophyses have increased in length and general robustness. The top of the low stout spine is somewhat expanded transversely. The centra of all the cervicals are deeply amphicoelous. In the center of these cupped ends, both front and back, are transversely elongated notochordal projections that stand out prominently from the surrounding surface.

The vertebra regarded as the fifth of the cervical series is illustrated in Figure 8. It differs considerably from those both anterior and posterior to it in having a much shorter centrum, and narrower (antero-posteriorly) neural arch, and in having the anterior articular face at a higher level than the posterior articular, as may be seen in the figure. In an articulated series, this would give the neck a decided upward inflection. This feature is little if at all developed in the other cervicals. The neural spine also shows the peculiarity of being very thin antero-posteriorly, whereas the spines of the other cervicals both front and back are of the usual stout form.

The sides of all the cervicals are deeply concave and there is no evidence of a ventral keel. The vertebræ increase in general robustness posteriorly; the diapophyses become slightly longer and heavier,

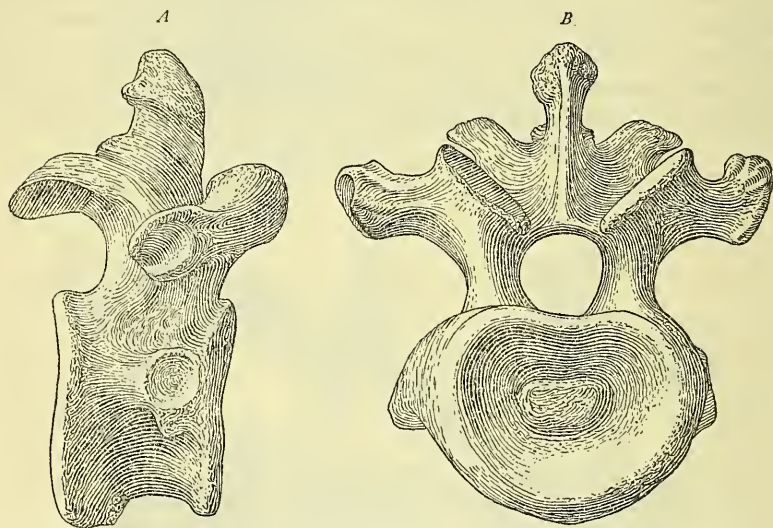


FIGURE 9.—SEVENTH? CERVICAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. A, LATERAL VIEW; B, ANTERIOR VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

the neural canal increases somewhat in size, and the pleuropophyses gradually rise on the side of the centra as is shown in Figure 9A. The spines, however, do not increase in height posteriorly.

The complete cervical series is as yet unknown in any of the armored dinosaurs from the Upper Cretaceous. Nopsca recognized six as cervical in the articulated skeleton of *Scolosaurus* in the British Museum, and the atlas and axis and perhaps more were missing from the anterior end of the articulated column. Thus there were at least eight. Gilmore regarded *Stegosaurus* as having twelve in the complete cervical series.

Measurements

	Cervicals		
	Third	Fifth	Seventh
	Mm.	Mm.	Mm.
Greatest length of centrum.....	82.5	55	66
Greatest width of centrum.....	107	120	123
Greatest height over all.....	¹ 150	172	187
Width of neural canal.....	39	53	48

¹ Estimated.

Dorsal vertebrae.—There are 10 vertebrae of the dorsal region representing all parts of the column. About half of these are perfectly preserved, while the other half are either much distorted by crushing or important parts are missing.

The centra are relatively short and amphicoelous throughout the series; articular faces expanded and sides deeply excavated (fig. 10A). In the dorsals the transverse diameter of the centra always

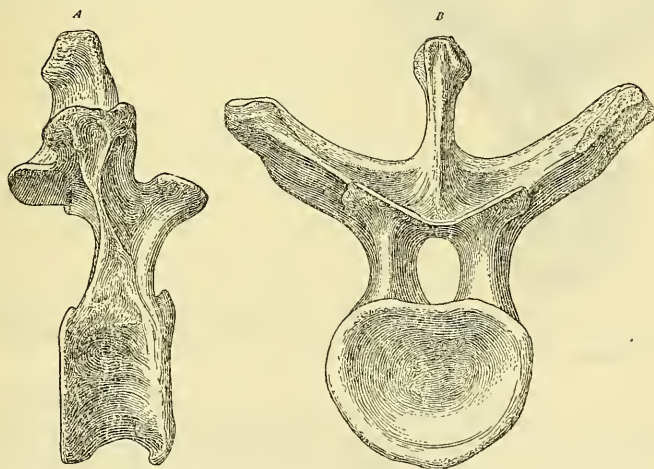


FIGURE 10.—ANTERIOR DORSAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. A, LATERAL VIEW; B, ANTERIOR VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

exceeds the vertical. The centra of greatest length are near the middle of the thoracic region. In the anterior half of the column the centra have a well developed median keel bordered on either side by shallow depressions. Posteriorly, however, the distinct keel disappears and the bottom of the centra is obtusely rounded. The neural arch is low and massive throughout (fig. 10B). The transverse processes are massive, of moderate length, and project obliquely upward but not so sharply as in *Stegosaurus*. They are deeply

cupped on their outer ends for close union with the ribs. In the posterior part of the series, these processes become so fully fused that the line of demarcation between the two elements can be distinguished with great difficulty, as shown in Figure 11.

In describing *Ankylosaurus*, Brown¹⁵ points out that "in the four posterior dorsals preserved the ribs are firmly coossified to the vertebra." Three such vertebrae are present in this specimen, but this condition probably continues in those dorsals ankylosed with the sacrals. In *Panoplosaurus mirus* all of the ribs are said to be free.

The pleuropophyses gradually rise from the top of the mid part of the centrum to a point well up on the side of the arch. In the mid-dorsal region this facet is large and cupped. The neural canal is large and vertically oval but diminishes slightly in size posteriorly.

The anterior zygapophyses are much enlarged, trough-like, and united. The posterior zygapophyses have flattened articular faces,

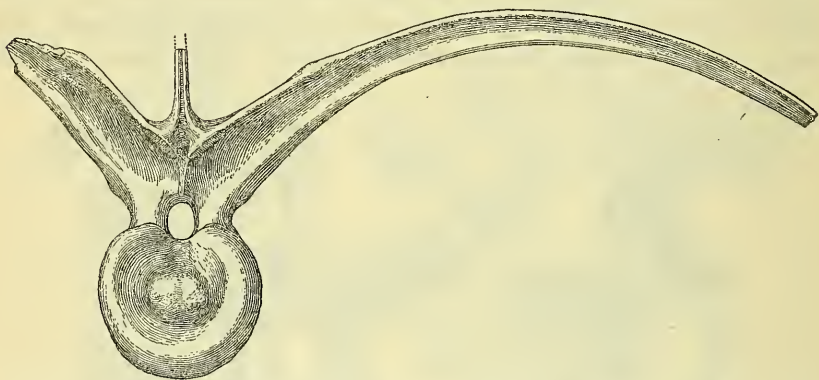


FIGURE 11.—POSTERIOR DORSAL VERTEBRA WITH COOSSIFIED RIB OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. POSTERIOR VIEW. ABOUT ONE-FIFTH NATURAL SIZE

not rounded as in *Ankylosaurus*, and are distinct one from the other. The spines are relatively short, thin plates with transversely enlarged extremities, this enlargement being mainly on the posterior half.

The last free dorsal is peculiar in having the posterior articular face of the centrum smaller than the anterior, and also in having it raised to a higher level, which gives the vertebra an inclined appearance when viewed laterally. In the articulated backbone this would serve to accentuate the curve of the sacro-lumbar region. The notochordal projections, if they may be so designated, described in the cervicals, persist throughout the dorsal series, gradually increasing in size posteriorly. On the most posterior vertebra they occupy fully one-half of the entire articular face of the centrum.

¹⁵ Bull. Amer. Mus. Nat. Hist., vol. 24, 1908, p. 193.

The transverse processes of the posterior dorsals appear, when viewed from the end, to originate far down on the side of the arch, but this is brought about by the fusion of the rib heads with the parapophyses, as shown in Figure 11, whereas in reality these processes originate some distance above. The posterior dorsals of *Ankylosaurus* are even more deceptive in this respect.

Measurements of dorsal vertebrae

	Anterior	Middle	Posterior
	<i>Mm.</i>	<i>Mm.</i>	<i>Mm.</i>
Greatest length of centrum-----	65	83	68
Greatest height of centrum, posterior end-----	97	95	100. 5
Greatest height over all-----	235	¹ 258	-----
Greatest expanse of transverse process-----	248	200	180

¹ Estimated.

Sacrum.—The sacrum of *Palaeoscincus rugosidens* consists of three sacral vertebrae in the primary sacrum, four presacrals (sacro-lumbar), and two sacro-caudals, all coalesced into a synsacrum complex of nine vertebrae in all. This is the same number and arrangement as in *Nodosaurus textilis* as described by Lull.¹⁶ In *P. rugosidens* only the ventral surface of the sacrum is preserved, as shown in Plate 4. The upper side was eroded away before the final entombment of the skeleton. Viewed laterally the sacrum complex is bowed from end to end, especially posteriorly. The centra are so firmly coössified that the line of demarcation between successive vertebrae has practically been obliterated. The usual dilation of the ends of the centra is missing, hence no clue is to be had from that feature. Ventrally the sacrum is characterized by a longitudinal groove that traverses all except the first two sacro-dorsals and the last sacro-caudal.

The anterior coössified centra are relatively long and slender, broadening into a wide plate in the true sacral region, narrowing again in the sacro-caudal region. The three sacrals bear long, relatively slender ribs which are coössified to their respective centra, their lower margins being on the same level as that of the centra. The expanded distal ends are coössified, especially one and two, together forming the sacricostal yoke which abuts against the inner side of the ilium. Dorsally these ribs appear to have been continuous with the diapophyseal lamina.

The transverse processes are lacking in the first sacro-caudal, but in the second they are preserved as long, slender processes origi-

¹⁶ Amer. Journ. Sci., vol. 1, 1921, p. 102.

nating on the posterior half of the centrum extending outward, strongly backward, and slightly upward. These processes are T-shaped in cross section. The first pair may have abutted against the posterior border of the ilium as in *Nodosaurus*.

Measurements

	Mm.
Greatest length of sacral series.....	725
Greatest width across sacral ribs.....	540

Caudal vertebrae. There are 11 free caudal vertebrae present but these do not form a continuous series, at least five being necessary to fill the gaps in addition to an unknown number missing from the distal end. In the complete caudal series of *Dyoplosaurus*, Parks¹⁷ recognized no less than 23 vertebrae, and it seems quite probable that the animal here described may have had an equal number.

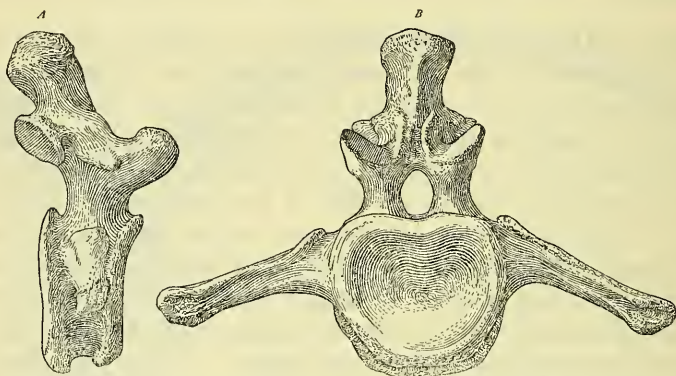


FIGURE 12.—THIRD CAUDAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. A, LATERAL VIEW; B, ANTERIOR VIEW. BOTH FIGURES ABOUT ONE-THIRD NATURAL SIZE

The caudal centra are short, articular faces wider than high, amphicoelous, and having the notochordal protuberances at the center as in the presacrals. The sides of the centra are deeply excavated in those vertebrae having transverse processes, but more moderately so posteriorly. A single vertebra from the region posterior to the middle of the tail is considerably longer than any that precede it.

The transverse processes are long, horizontal, and, excepting the anterior three which articulate in part with the side of the arch, all spring from the superior side of the centrum; posteriorly their length decreases regularly. The transverse processes of the first three have slightly expanded ends (fig. 12). Those of the second caudal are directly slightly forward and are in contact with those of the first on the outer border where there is a rugose roughening. Similarly, number one was in contact with the last sacro-caudal.

¹⁷ Univ. Toronto Studies, Geol. ser., 1924, pp. 14-16.

Whether these combined outer ends gave support to the ilium cannot be determined from this specimen. The wedge shape of the anterior centra, especially the third (fig. 12A), indicates a rapidly dropping tail, a feature also found in the Jurassic *Stegosaurus*.

In all of the anterior caudals the arch is massive and the short spines are heavy, angularly rounded in cross-section with expanded extremities. In the mid-caudal region, however, the spines are flattened with slight transverse dilation of their upper ends (fig. 13.) All of the spines on the anterior two-thirds of the tail strongly overhang the centra. In the smallest vertebra present the spine no longer stands upright but persists as a low, rounded ridge without lateral expansion, terminating posteriorly in a bluntly rounded point projecting directly backward beyond the posterior zygapophyses which are fast becoming sessile.

No indication of a "tail-club" was found and but two vertebrae from the anterior half of the tail showed indication of ankylosis. These have their centra fully coössified, a condition, as indicated by the deformed nature of the bones, brought about by an injury.

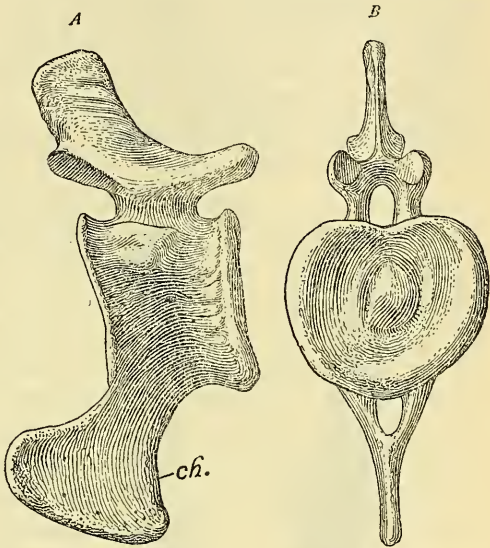


FIGURE 13.—MEDIAN CAUDAL VERTEBRA OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. A, LATERAL VIEW; B, ANTERIOR VIEW; Ch., CHEVRON. BOTH FIGURES ABOUT ONE-THIRD NATURAL SIZE

Measurements of caudal vertebrae

No. of vertebra in series	Greatest length of centra	Greatest width of centra (post. end)	Greatest width of transverse processes	Greatest height over all	Remarks
	Mm.	Mm.	Mm.	Mm.	
1.....	57	107	404	211	
2.....	52	107	367	208	
3.....	49	103	310	200	
5(?).....	44	100	216	190	
7(?).....	57		194		Coössified.
8(?).....	58	85	183	172	Centrum only.
9(?).....	44	88			
11(?) or 12(?).....	56	85	90	107	
14(?).....	52	86			
15(?).....	56	81		135	
(?).....	66	66		87	

Chevron.—The first chevron is carried on the fourth caudal as in *Dyoplosaurus* and all are coösfified with the vertebral centra. The anterior chevrons are intervertebral but posteriorly articulate entirely with their respective vertebrae. These bones of the anterior half of the tail have the proximal articular ends bridged across with bone but more posteriorly these ends are distinct. The anterior chevrons are long and bladelike with slightly expanded ends, but as the shaft shortens posteriorly their distal ends become correspondingly enlarged as shown in Figure 13.

The haemal canal is large anteriorly but becomes very small in the posterior part of the series.

Ribs.—There are parts of no less than 28 ribs present, half of which are complete. These pertain to both right and left sides

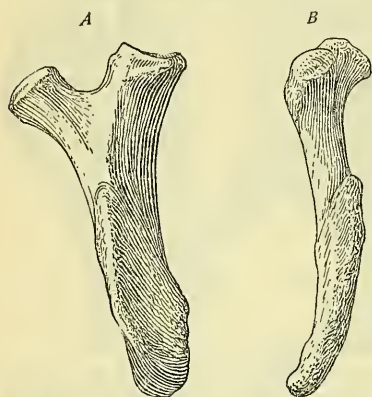


FIGURE 14.—SECOND? LEFT CERVICAL RIB OF *PALAEOSCINCUS RUGOSIDENS*. TYPE. NO. 11868, U.S.N.M. A, LATERAL VIEW; B, VENTRAL VIEW. BOTH FIGURES ONE-THIRD NATURAL SIZE

representing all sections of the body. The outstanding features of the ribs are their general massiveness and wide spread. The thoracic ribs, when articulated, rise as high as the top of the spines, thus forming an exceedingly broad back and great girth.

Of the above-mentioned ribs six are regarded as cervical, the first pair being firmly coössified with the coalesced atlas and axis, as shown in Figure 6. They are single headed, with widely expanded ends which not only articulate with the centrum of the atlas but are in contact with

the anterior end of the axis as well. The shaft is stout, sub-ovate in cross-section, with a bluntly pointed distal extremity. The rib of the right side is 130 millimeters long.

The cervical rib illustrated in Figure 14 is tentatively identified as the second of the left side. It was found widely separated from the axis, but the spread of the tubercular and capitular processes is in agreement with the dia- and parapophysial facets on the axis. Its slightly increased length over the first cervical rib corroborates this assignment. On the other hand, when compared with the second cervical rib of *Panoplosaurus mirus* as described by Sternberg,¹⁸ such differences are found, especially in the proximal end, as to raise a question as to its really being the second of the series. This rib has a greatest length over all of 143 millimeters. The tubercular and capitular processes are of about equal length, the former as usual

¹⁸ Trans. Roy. Soc. Canada, vol. 15, 1921, pl. 1, figs. 3.

being much the stouter. The shaft is flattened, the distal fourth curved slightly inward and terminated with a bluntly rounded end. The external surface is angularly convex transversely. On the external surface there is a longitudinal ridge-like roughening of the bone which occupies its distal two-thirds, as shown in Figure 14B. The proximal half of a larger rib, probably the fourth or fifth of the left side, records the following changes: The capitular process has become much longer than the tubercular, the shaft is more rounded, and the posterior side deeply concave. On the external surface the roughened longitudinal area has assumed a somewhat lower position on the shaft; the distal end is missing. The proximal has a spread of 101 millimeters as compared with 70 millimeters in the second.

The proximal end of a right rib farther back in the series displays a decided lengthening of the capitular process which is slender and nearly circular in cross section. A right rib from the posterior part of the cervical series much curved from end to end is illustrated in Figure 15C. The distal extremity is missing, but from the tapering character of the bone above the break it is quite evident that it was pointed. On the upper half the posterior margin extends backward from the heavier shaft, forming a deep longitudinal concavity on the posterior side. This rib, measured over the curve from the top of the tuberculum, is estimated to have a length of 375 millimeters and a width at the center of 40 millimeters; the broken distal end measures 11 millimeters antero-posteriorly.

A complete anterior rib of the left side which may possibly represent the first thoracic rib is illustrated in Figure 15B. That it may have been joined to the sternum is indicated by its slightly enlarged distal end. In cross section below the tuberculum, the shaft has a peculiar shape in so much as the usual elliptical rib has its outer surface developed posteriorly into a thin flange that forms a deep longitudinal concavity on the posterior side. The tuberculum is merged into and extends inward on the upper edge of the capitular process, which is nearly as wide and heavy as the shaft itself. This bone, measured over the curve from the tuberculum, has a length of 510 millimeters.

The longest rib of the entire series is shown in Figure 15A. It measures 890 millimeters in length and is heavy and massive throughout. The upper portion is T-shaped in cross section. At a point midway between the middle and the distal end is an enlarged roughened area which morphologically appears to correspond to the position of an uncinat process. Whether these processes existed as distinct elements in the armored Dinosauria has not yet been determined. Nopsca¹⁹ attributed the flangelike overhang of the anterior thoracic

¹⁹ *Geologica Hungarica*, Budapest, vol. 1, 1928, p. 56.

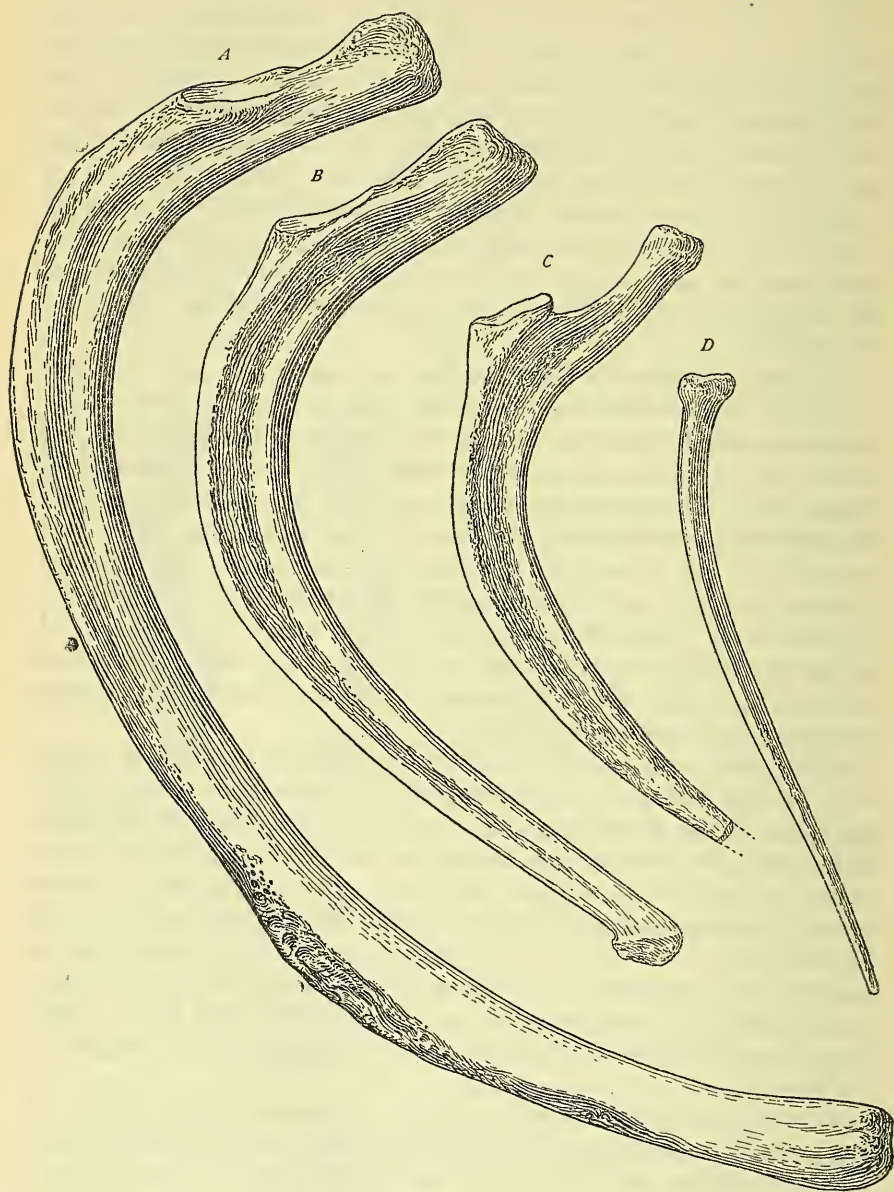


FIGURE 15.—RIBS OF *PALAEOSCINCUS RUGOSIDENS*. TYPE. NO. 11868, U.S.N.M. A, THORACIC RIB; B, FIRST? THORACIC RIB; C, POSTERIOR CERVICAL RIB; D, RIB OF UNDETERMINED POSITION. ALL FIGURES ABOUT ONE-FOURTH NATURAL SIZE

ribs as representing the *processus uncinatus*, but I believe he was mistaken in this. A more logical explanation, it seems to me, is the one given by Brown that this enlarged area on the anterior ribs may have served for attachment of the heavy shoulder muscles in *Ankylosaurus*.

Posteriorly the ribs become progressively more slender with pointed distal extremities. There is evidence that at least three of the posterior dorsals had the ribs fully coössified with the neural arch as shown in Figure 11. So complete is this coalescence that the line of demarcation between the two bones can scarcely be detected. These most posterior ribs are exceptionally wide and thin below the T-shaped section of their upper portion.

In addition to the above-described ribs there are three single-headed ribs of the type of the one illustrated in Figure 15D. They have a roughened rugose articular proximal end slightly bowed from end to end, shaft of moderate width, tapering to a pointed end. I am unable to determine their proper position in the skeleton. That they do not pertain to the sacro-dorsals seems to be indicated by the flat, wide ends found attached to the blade of the ilium (fig. 3, pl. 7), whereas these have narrow pointed ends. The most perfect one of the three which lacks the extreme distal end measures 350 millimeters in length.

Ilium.—The preacetabular portion of the right ilium and a few scattered, much-worn fragments are all that was preserved of the ilia. This anterior blade is platelike, thickened, nearly straight on the inner border, gradually thinning toward the anterior and outer margins, the latter presenting a sharp edge. The anterior end is obtusely pointed, its most anterior projection being well toward the inner side of the bone; externally the border rounds off toward the lateral margin as shown in Plate 7, Figure 3. The upper surface of this portion is smooth, slightly convex from side to side; the under surface is concave both transversely and anteroposteriorly.

There is no indication of dermal plates having been united to the superior surfaces of the ilium as in *Stegopelta*, although on the outer half of the mid part of this section of the ilium there are shallow transverse grooves, probably for blood vessels suggesting a cutaneous investment that was closely applied to this surface of the ilium. Lull²⁰ has noted a similar condition on the ilia of *Nodosaurus*.

On the ventral side the distal ends of three posterior ribs remain securely coalesced with this surface of the ilium as shown in Plate 7, Figure 3. The end of the anterior rib projects slightly beyond the margin of the ilium, the remaining two terminating an inch or more inside its border.

²⁰ Lull R. S., Amer. Journ. Sci., vol. 1, 1921, p. 105.

Pubis.—The small bone illustrated in Figure 16 is regarded as the right pubis. It is a remarkably small bone for so large an animal, the whole prepubic portion measuring only 140 millimeters in length, less than one-half the length of the *Stegopelta* pubis.²¹ The anterior portion is a thin vertical blade of bone terminated anteriorly by a slightly thickened rugose end that is rounded off from above downward. On the internal surface at about its mid length the postpubis branches off, continuing backward and downward. The postpubic branch terminates in a vertically expanded end that in this specimen is perfectly preserved (fig. 16). On the outer side much of the surface has been eaten away, leaving one at a loss to understand where



FIGURE 16.—RIGHT PUBIS OF PALAEOSCINCUS RUGOSIDENS. TYPE. NO. 11868, U.S.N.M. LATERAL VIEW. A., ANTERIOR END; p., POSTERIOR END; pp., POST-PUBIS. ONE-THIRD NATURAL SIZE

and how this bone articulated with the ilium, as there is no indication of an enlarged articular area.

The small size of the pubis in these Upper Cretaceous armored dinosaurs has been indicated by Nopcsa in *Scoelosaurus*, but it was so poorly preserved that he could not determine its

shape. *Ankylosaurus* also has a very much reduced pubis²² apparently coossified to the ischium and Nopcsa remarks that "it neither seems very large in *Polacanthus*." The outer surface is much roughened.

Ischia.—Both ischia are present, the left one being complete, the right lacking its distal fourth. The ischium is a moderately long curved bone having a widely expanded proximal and a bluntly pointed distal extremity. On the outer surface the proximal end is concave fore and aft and forms a part of the acetabulum. The acetabular margin is unusually straight. Below this end the shaft is flattened transversely and gradually decreases in width toward the distal end, the taper becoming more pronounced a little below the mid-length where the bone also bends downward, as shown in Figure 17. A flat roughened area on the external surface at this bend indicates the point of attachment of an important ligament. On the inner side the surface of the bone gives no indication that it was in contact on the midline with its fellow of the opposite side though doubtless there was a cartilaginous union of the two.

²¹ Moodie, R. L., Kans. Univ. Sci. Bull., vol. 5, No. 14, 1910, p. 265, pl. 58, fig. 1.

²² Romer, A. S., Acta Zoologica, vol. 8, 1927, fig. 8, p. 243.

Measurements

	Mm.
Greatest length in a straight line.....	570
Greatest width of proximal end.....	275
Greatest width of distal end.....	23

Dermal armor.—Intermingled with the scattered parts of the skeleton some fifty dermal bones of this one individual were collected. These present a variety of kinds, spines, large and small; coössified plates; rounded scutes, with and without keels; and numerous granular ossifications. Although this specimen will contribute but little to our knowledge of the arrangement of the dermal armor, it does give a considerable insight into the character of the osseous dermal covering.

Comparison of these scattered plates and spines with those of *Palaeoscincus* in the American Museum of Natural History, New York, where the armor has been preserved *in situ* enables me to recognize the proper location of many of these scattered bones. Furthermore the close similarity in shape, size, and association makes it at once apparent that we are dealing here with two animals that are generically alike.

Neck plates.—The dermal armature covering the neck is represented by three plates each composed of either two or three coössified bony scutes. These are illustrated in Plate 5. The smallest of these plates, a complex of three scutes (fig. 3, pl. 5) is tentatively regarded

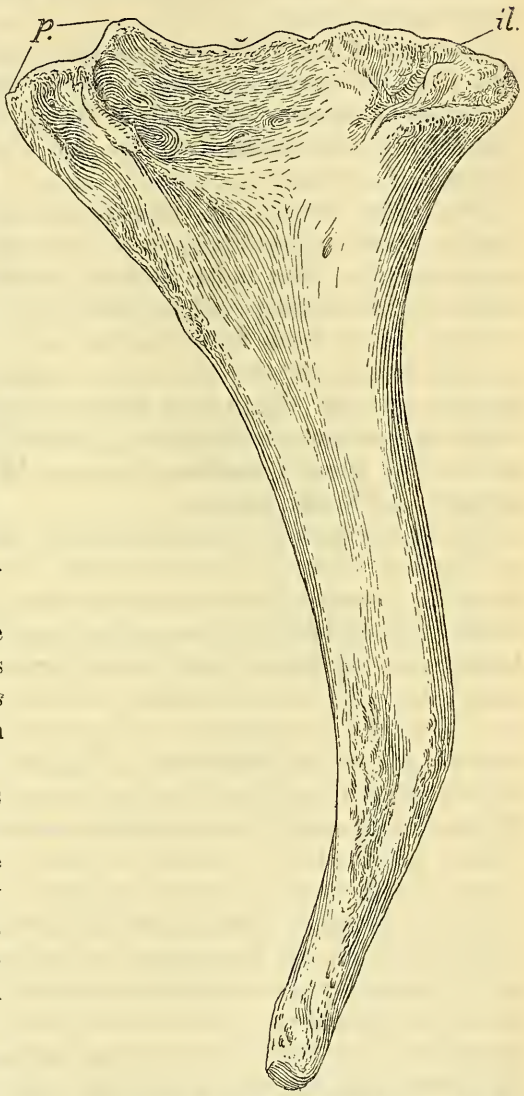


FIGURE 17.—LEFT ISCHIUM OF PALAEOSCINCUS RUGOSIDENS. TYPE. No. 11868, U.S.N.M. LATERAL VIEW. *il.*, ARTICULATING SURFACE FOR ILIUM; *P.*, ARTICULATING SURFACE FOR THE PUBIS. ABOUT ONE-FOURTH NATURAL SIZE

as the right half of the first transverse ring. The largest plate, a composite of two paired scutes, is identified as the median part of the second ring (fig. 1, pl. 5); the third plate consisting of two scutes is provisionally regarded as completing the right half of the second ring (fig. 2, pl. 5).

The articulated *Palaeoscincus* skeleton illustrated by Matthew²³ (pl. 8, fig. 1) shows the rings over the neck to consist of six scutes each, the narrowest ring lying in front, and it is largely on the evidence of this specimen that the provisional identification of these elements is made.

The upper surfaces of these plates are roughened by irregular, shallow vascular pits and grooves that are so distinctive of all dermal elements. The under surfaces are fairly smooth and show no traces of the coalescence of the individual scutes further than a slight swelling of the bone following the course of the sutural union, but on the dorsal surfaces their line of junction is marked by deep straight grooves. Each scute has a low longitudinal keel that originates on the front border, rising posteriorly where it terminates in an obtusely pointed overhanging, spine-like projection. These keels are asymmetrically placed.

The first ring in its entirety evidently consists of six scutes divided in this individual at the center into two plates. It appears very probable, however, that other individuals might have the two halves fused at the middle into one continuous ring of bone, although Sternberg found the same divided condition in the type of *Edmontonia longiceps*.²⁴ The ring is broadly arched and has a length, measured in a straight line across the arch, of 350 millimeters, a width on the median line of 90 millimeters. The medial scute is rectangular in outline with its greatest diameter transverse. Viewed from above, however, this scute is pentagonal in shape due to the low lying projecting spine, which strongly overhangs the posterior border of the scute. The keel on this scute is placed nearest the external side and is slightly divergent from the median line as it runs backward. The median scute has the keel nearest to the inner side, and the overhanging spinous projection is more rounded and pointed than on the scute previously described. The outer of the three scutes is subrhombic in outline when viewed from above and the keel which originates on the inner, anterior corner, pursues a diagonal course outward and backward, the conical spine strongly overhanging its outer border.

On the anterior border at the junction of the scutes there are roughened indentations that suggest the points of attachment of smaller dermal elements. Otherwise this border is beveled from

²³ Matthew, W. D., *Natural History*, vol. 22, 1922, pp. 334-335.

²⁴ Sternberg, C. M., *Trans. Royal Soc. Canada*, vol. 22, 1928, sec. 4, p. 104.

below upwards, leaving a narrow rounded edge whose surface is slightly roughened. The scutes vary from 26 to 36 millimeters in thickness around their borders. From the rounded character of the outer border of the third or lateral scute, it seems quite probable that it represents the lateral termination of the first ring.

The two coössified scutes, shown in Figure 1, Plate 5, are thought to represent the median pair of the second dermal row which in this instance are fully coössified on the median line as in *Panoplosaurus*. These scutes in transverse curvature, thickness, outline of posterior border, and keel development show a close resemblance to the homologous elements of *Panoplosaurus mirus*. In proportion and outline as a whole and in minor features they show many dissimilarities and strongly suggest that differences found in the armor of *Palaeoscincus* and *Panoplosaurus* when fully known will greatly assist in distinguishing these genera.

The median coössified plates of the second row measured in a straight line across the ventral side have a greatest transverse width of 390 millimeters; on the median line a length antero-posteriorly of 130 millimeters. The keels of these scutes are placed nearest the outer border, whereas in *Panoplosaurus* they are near the inner edge. The posterior end of the keel develops a low, obtusely rounded spine that overhangs this edge.

The third plate consisting of the two coössified scutes shown in Figure 2, Plate 5, is identified as completing the right half of the second ring. That the smaller one represents a lateral scute seems to be indicated by the rounded outer border and the strong diagonal trend of the keel.

Spined scutes.—Massive, long, sharply pointed spined scutes, such as are found on the shoulders and along the sides of *Palaeoscincus* (see pl. 8) are present, and are illustrated in Plate 6, Figures 1, 2, 3, and 4.

A pair of moderately sized spinous scutes apparently corresponding to those lateral to the ends of the second transverse ring (fig. 3, pl. 6) in the *Palaeoscincus* skeleton are in perfect preservation. Their bases are subovate in outline, measuring 205 millimeters in the longest diameter and 133 millimeters in the shortest. These ends are deeply concave and around the borders a rugose band indicates clearly the depth of their insertion in the integumentary covering. On the superior surface, a high, triangular-shaped spinous keel is developed, overhanging the basal portion. Over all, this scute has a greatest height of 290 millimeters. The surface of these bones is covered by the usual shallow vascular pits and grooves.

A single scute, the largest of the series, doubtless corresponds to the second in this row of lateral spines, and occupies a position over

the left shoulder and lateral to the third transverse ring in the *Palaeoscincus* skeleton (pl. 6, fig. 1). Viewed from below the base of this scute is subrectangular in outline, having a greatest length of 350 millimeters, and a width at the center of 120 millimeters. This surface is traversed by a median longitudinal depression that gradually deepens toward the spinous end. The base is concave from end to end with a torqued posterior end. The shape of the basal surface is probably an adaptation in better conformation with the underlying bones of the shoulder region. Its depth of insertion in the skin is clearly indicated by a rugosely roughened band that extends entirely around the basal portion of the scute. On the dorsal surface is a high, sharp edged keel that has its origin on the posterior internal angle and extends diagonally across the scute. This keel gradually increases in height from its point of origin terminating in a high, sharply-pointed but compressed spine that strongly overhangs the posterior basal part of the scute. Measured from the base to the tip this spine is 242 millimeters long.

A dermal plate illustrated by Lambe²⁵ and provisionally associated with *Euoplocephalus tutus*, may, on account of its close resemblance to the plate just described, be quite certainly referred to the genus *Palaeoscincus*.

A pair of large triangular shaped, sharply pointed spines, each coössified with a smaller scute carrying a very much smaller and blunter spine undoubtedly represent the next two spines of the lateral series which project outward from the side of the body above the fore leg. In *Palaeoscincus*, however, these two elements appear to remain distinct. These coössified plates have a greatest basal length of 460 millimeters. The taller spine measures 400 millimeters in height, the shorter only 180 millimeters. These spines are figured in Plate 6, Figure 4.

Among the dermal elements there are three other scutes which may be classified as spines but no clue has yet been obtained as to their position. These are of much smaller size than those previously described and one is shown in Plate 6, Figure 2. These have subovate, concavely excavated bases, low asymmetrically placed keels, that pass into two obtusely pointed compressed or angularly rounded spines that project backward at a low angle. Two of these are the right and left elements of a pair.

The position of this lateral row of spined dermal elements in the *Palaeoscincus*, skeleton (pl. 8), having the spines projecting outward and forward seems entirely opposed to a natural placing. In such a position they would have been a source of constant annoyance and trouble to the animal by constantly catching on small trees

²⁵ Contrib. Canadian Paleont., vol. 3, 1902, p. 57, fig. 13.

and shrubbery. Had they not been found *in situ*, a study of living creatures on the basis of analogy would not have placed them as they are. Reversed in position or at most having the spines directed straight out from the body, would be more in accord with those spined quadrupedal creatures known to-day. Furthermore, the specimen of *Scolosaurus* in the British Museum has somewhat similar scutes preserved along the neck *in situ*, and these are in accord with living lizards. It is not my purpose to question the position of the spines in the *Palaeoscincus* skeleton but I do seriously doubt that during the life of the animal they occupied their present forwardly directed position.

Sacral armor.—That *Palaeoscincus* had a shield-like bony covering over the sacrum as in *Nodosaurus* seems to be indicated by the presence of a number of large fragmentary plates. These plate pieces are clearly shown to consist of a number of thin, coössified scutes of several sizes and varying shapes, although most of them seem to be suboval in outline. From this fragmentary evidence it would appear that there may be a row or rows of large scutes surrounded by smaller ones. It would seem quite probable that all of these pieces may have been parts of one continuous bony shield. The nodular prominences on these scutes are almost obsolete, except for a slight thickening near the center of the largest. On the dorsal surface shallow depressions follow the course of the sutures, clearly marking out their limits. A few detached scutes of the same nature probably represent elements that pertain to nearby areas. Good examples of these are shown in Plate 7, Figure 1.

Undetermined scutes.—In addition to the dermal scutes described above and whose position on the animal has been determined with some degree of assurance, there are in the collection no less than twenty other dermal elements whose origin at this time is unknown. These scutes are of various dimensions, strongly keeled, short spined, broadly to narrowly suboval in outline, always excavated below, but usually deepest beneath the highest part of the keel or spine. On either side of the keel the external surface slopes both ways to the edge, either flatly or with a varying amount of concavity, depending largely upon the height of the keel or spine. In none of these smaller scutes does the spine overhang the border. The short spines, if they may be so designated, show a great variety of form; some are obtusely pointed, others compressed and sharp edged, others have the keel running the full length of the scute, while still others have only a nodular projection.

A great many small rounded granular ossifications were found scattered through the quarry. These filled the interspaces between the larger scutes, and are well shown in specimens of *Palaeoscincus*

and *Scolosaurus*. Similar ossifications are probably present in the skin of nearly all armored dinosaurs.

Relationships.—The genus *Palaeoscincus* falls readily into the family Nodosauridae as redefined by Lull,²⁶ and on the basis of the skull structure it would appear to have its closest relationships with *Panoplosaurus* and *Edmontonia*. These three genera should be grouped to form the subfamily Panoplosaurinae recently proposed by Nopsca.²⁷ Of the other four genera *Dyoplosaurus*, *Hierosaurus*, *Scolosaurus*, and *Stegopelta*, included by Nopsca in this subfamily, *Dyoplosaurus*, as shown by the recently discovered skull described later in this paper, should now be removed to the Ankylosaurinae. The skull structure of the three remaining genera is unknown and their precise systematic position is much in doubt. The presence in all of transverse rows of nuchal plates is one reason for their provisional retention in the Panoplosaurinae.

The definition of this subfamily may now be emended by the inclusion of the following skull characters: *Skull covered superiorly by a few large plates; orbits placed far posteriorly; lateral temporal fenestra opening laterally; nostrils latero-terminal; large quadrate + quadratojugal dermal plate absent.*

While it is not my intention to attempt a revision of the Nodosauridae, yet the study of the specimens in hand has disclosed relationships of certain American members of this family which appear worthy of record.

Dyoplosaurus, as mentioned above, is here transferred from the Panoplosaurinae to the Ankylosaurinae. In establishing this subfamily Nopsca referred to it the following genera: *Ankylosaurus*, *Euoplocephalus*, *Hoplitosaurus*, *Palaeoscincus*, *Polacanthus*, *Polacanthoides*, *Sarcolestes*. With this grouping I can agree only in part. *Ankylosaurus*, *Euoplocephalus*, *Dyoplosaurus* and *Anodontosaurus* are true members of this subfamily. On the basis of the skull structure I would amend Nopsca's definition of the Ankylosaurinae by the inclusion of the following cranial characters: *Skull covered superiorly by numerous small plates; orbits placed submedially; lateral temporal fenestra covered by dermal bone; nostrils terminal; large quadrate + quadratojugal dermal plate present.*

The other genera can not be definitely assigned on the basis of their cranial structure, the skull being unknown. *Polacanthus*, with its complete bony carapace over the sacral region and tail, compressed dermal elements unlike any found with the more typical Ankylosaurinae, will, I believe, eventually be found to belong to a distinct subfamily. The American *Hoplitosaurus* is apparently closely allied and should be grouped with *Polacanthus*.

²⁷ *Dinosaurierresti*, Geologica Hungarica, Budapest, 1929, pt. 5, p. 70.

²⁶ *Amer. Journ. Sci.*, vol. 1, February, 1921, p. 123.

In the light of our present knowledge of the genus *Nodosaurus*, I can see no justification for its inclusion in a separate subfamily, the Nodosaurinae, as proposed by Nopsca. Certainly nothing is found in its known anatomy that would prevent its assignment to the Ankylosaurinae.

The inclusion of the genus *Troödon* in the Nodosauridae by Nopsca is so obviously in error that I take this opportunity to challenge the propriety of the assignment. *Troödon* is a typically bipedal animal with greatly reduced fore limbs, and a slender elongated scapula; premaxillary teeth present; ilium with postacetabular portion vertical and subequal in length with preacetabular portion; ischium slender, ceratopsian like; ribs slender; tibia and femur subequal in length; pes having phalanges with tongue and groove joints; a segmented abdominal cuirass.

The features briefly reviewed above are certainly an array of characters that, taken together, do not permit of the inclusion of the genus in the family Nodosauridae.

At the time of describing the osteology of *Troödon*²⁸ attention was directed to the curious mixture of characters found in the skull and skeleton and it was my conclusion that the relationships of *Troödon* would be best expressed by its reference to a distinct family of the Ornithopoda known as the Troodontidae, a conclusion, after again reviewing all of the evidence, that I see no reason to alter.

Chronological list of North American Nodosauridae

Name, authority, and date	Formation and locality	Nature of type
<i>Palaeoscincus costatus</i> Leidy, 1856.....	Judith River, Mont.....	Tooth.
<i>Priconodon crassus</i> Marsh, 1888.....	Arundel, Md.....	Do.
<i>Nodosaurus textilis</i> Marsh, 1889.....	Benton, Wyo.....	Parts of skeleton and armor.
<i>Palaeoscincus tutus</i> Marsh, 1892.....	Lance, Wyo.....	Tooth.
<i>Hoplitosaurus marshi</i> Lucas, 1901.....	Lakota, S. Dak.....	Parts of skeleton, dermal armor.
<i>Palaeoscincus asper</i> Lambe, 1902.....	Belly River, Alberta.....	Tooth.
<i>Stereocephalus tutus</i> Lambe, 1902.....	do.....	Fragment of skull, dermal armor.
<i>Stegopelta landerensis</i> Williston, 1905.....	Benton, Wyo.....	Parts of skeleton, dermal armor.
<i>Ankylosaurus magnivertus</i> Brown, 1908.....	Hell Creek, Mont.....	Skull; much of skeleton, and dermal armor.
<i>Hierosaurus sternbergi</i> Wieland, 1909.....	Niobrara, Kans.....	Dermal armor.
<i>Panoplosaurus mirus</i> Lambe, 1919.....	Belly River, Alberta.....	Skull; parts of skeleton and armor.
<i>Dyoplosaurus acutosquameus</i> Parks, 1924.....	do.....	Fragment of skull; posterior part of skeleton.
<i>Scolosaurus cutleri</i> Nopsca, 1928.....	do.....	Much of armor and skeleton.
<i>Edmontonia longiceps</i> Sternberg, 1928.....	Edmonton, Alberta.....	Skull, armor, and parts of skeleton.
<i>Anodontosaurus lambei</i> Sternberg, 1929.....	do.....	Skull and armor.
<i>Palaeoscincus rugosidens</i> Gilmore, 1930.....	Two Medicine, Mont.....	Skull; much of skeleton and armor.

2. ON A SKULL OF THE GENUS DYOPLOSAURUS

Plate 9, Figures 1 and 2

In 1924 Prof. W. A. Parks²⁹ established the genus *Dyoplosaurus*, based on a partial but very interesting skeleton, consisting princi-

²⁸ Gilmore, Charles W., Bull. No. 1, University of Alberta, 1924, p. 39.
²⁹ Univ. Toronto Studies, No. 18, 1924, pp. 5-24.

pally of the posterior part of the axillary skeleton. Of the head only fragmentary skull parts and a few teeth remain.

In the 1928 collection from the Upper Cretaceous of Montana was a somewhat imperfect skull with four teeth which is identified as *Dyoplosaurus acutosquameus* Parks. The identification rests very largely upon similarities found in the teeth. If correct in this assignment, the specimen is of great interest in giving the first adequate knowledge of the skull structure of the genus. This specimen, No. 11892, U.S.N.M., was collected by George F. Sternberg, May 26, 1928, from the Two Medicine formation, Upper Cretaceous, from the south side of Milk River, NW. $\frac{1}{4}$ sec. 27, T. 37, N., R. 8 W., on the Blackfeet Indian Reservation, Glacier County, Mont.

The skull has its closest resemblances in *Euoplocephalus tutus* Lambe from the Belly River formation, Canada, of which two nearly perfect skulls³⁰ are now known in addition to the poorly preserved type.

The skull before me has the superior surfaces much checked as shown in Plate 9. It lacks the beak in front of the nares, and the palate is so badly crushed and broken that little can be determined of the mouth structure.

Viewed from above the skull is subtriangular in outline, longer than broad, and doubtless having a broadly rounded nose as in *Euoplocephalus*. The anterior half is strongly arched both anteroposteriorly and transversely. Between and behind the line of the orbits the top is depressed, especially on either side of the median line. This surface terminates posteriorly as a short overhanging crest, that is, slightly concave transversely.

Coössified dermal plates cover the surface at the top and side of the skull, thus completely obscuring all of the underlying cranial elements. The median posterior border is ornamented by a row of four small quadrangular scutes, the same number as found in the fragmentary skull of the type of *Dyoplosaurus acutosquameus*. *Ankylosaurus* also has a similar number, but in *Euoplocephalus* there are only two with a plain interspace between. The superior surface is so badly checked that the form of the scutes can be made out with great difficulty. They seem to resemble those of *Euoplocephalus* except for the lack of a large element on the nose. The surface of these scutes is undulatory, roughly rugose and covered with vascular pits and grooves. Their edges are usually angular but none has the depressed central areas found in *Euoplocephalus*. Deep circumscribing grooves set off the scutes from one another.

³⁰ Gilmore, C. W., The Canadian Field Naturalist, vol. 37, No. 3, 1923, p. 47; Nopcea, F. B., Geologia Hungarica Paleontological Series, vol. 1, 1928, pp. 51-54, pl. 5.

The nearly vertical lateral surface between the orbits and the external nares is covered by two large plates, the anterior one bending over to contribute to the dorsal surface. It also forms a part of the posterior boundary of the narial opening. In *Euoplocephalus* three plates cover this area.

On the angle of the skull above each orbit is a large, bluntly edged scute that slightly overhangs the eye but to a lesser degree than in *Euoplocephalus*. On each posterior external angle of the skull is a large subtriangular spinelike scute that projects prominently backward beyond the posterior border much as in *Ankylosaurus*. *Euoplocephalus* has somewhat similar protuberances but sharper edged and extending more upward. It is quite apparent that these two scutes are missing from the posterior part of the *Dyoplosaurus* skull figured by Parks.³¹

The posterior end of the skull is in fair preservation and presents a good idea of the arrangement of the occipital region, but many of the palatal elements are entirely missing, or so badly crushed that but little conception of its normal condition can be obtained.

The occipital condyle is reniform in outline and directed backward and downward. It seems quite apparent that the basal portions of the exoccipitals participate in its formation much as they do in *Stegosaurus*.³² The condyle has a greatest transverse diameter of 54 mm., a greatest vertical diameter of 32 millimeters. The reniform shape of the condyle offers a striking contrast to the much larger subspherical condyle in *Palaeoscincus* as shown in specimen No. 11868, U.S.N.M. The foramen magnum is suboval in outline and the supraoccipital border above it deeply notched.

The basioccipital is about as long as it is broad. The ventral surface between the condyle and the expanded anterior end is broad and deeply concave with a shallow longitudinal depression occupying the central area. The basioccipital processes are very short. The exoccipitals extend outward nearly horizontal and with but little angulation posteriorly. As mentioned above, their pedicles contribute somewhat to the formation of the occipital condyle. At their outer ends they join the quadrates by means of the paraoccipital processes resting against a rugose area on the posterior sides of those bones. They do not seem to be coalesced with the paraoccipital as in *Palaeoscincus rugosidens*.

The supraoccipital can not be differentiated. The quadrate is relatively long, straight, and slender as compared with the more plate-like element in the *Palaeoscincus* skull. The thin process that extends forward and inward to meet the pterygoid is less than half

³¹ Univ. Toronto Studies, No. 18, 1924, pl. 4, fig. 1.

³² Gilmore, C. W., Bull. No. 89, U. S. Nat. Museum, 1914, p. 92, fig. 4.

the width of this process in the type of *Palaeosincus rugosidens*; likewise the articular distal end is much smaller.

There are some remnants of the palate present but a description of these would add nothing of interest.

The lateral temporal fenestra opens outward and backward between the quadrate and the enveloping armor.

Beneath and somewhat posterior to the orbit on either side is a large scute whose strongly developed keel is directed downward and outward. Its anterior outer border is acutely edged and rounded off from the front toward the back. This process completely hides the articulation of the lower jaw with the quadrate, and furnishes it with ample protection.

The orbits are suboval in outline, with a diameter anteroposteriorly of 76 millimeters and dorso-ventrally about 30 millimeters.

The skull is widest across the orbits and much constricted transversely in front, a feature that will at once distinguish *Dyoplosaurus* from *Euoplocephalus* and *Ankylosaurus*.

Measurements of the skull

	Mm.
Greatest length (estimated) median line.....	365
Greatest breadth across center of orbits.....	325
Greatest breadth immediately posterior to nares.....	175

Teeth.—There are five teeth preserved, one in the center of the right maxillary and the crowns of four others found in the dirt near the skull. Since there were no other animal remains with this specimen, there can be no doubt of the association. As the lower jaw was entirely missing it may be inferred that all of these teeth belong in the upper or maxillary series. The teeth are alike in form and size. Their very small size appears to be distinctive, a fact that can not be attributed to their being germ teeth as shown by one much worn tooth which has the same proportions as the unworn. Each consists of a laterally compressed crown with a long cylindrical root. The crowns measure 4.7 mm. antero-posteriorly, 4 mm. transversely through the cingulum, and about 5 mm. in height. The crown at the base has a swollen cingulum that is especially pronounced on the outer side. The edges of the teeth are denticulate, there being nine or ten denticles on each tooth, four and five respectively on either side of the apical one which is decidedly posterior to the central vertical line as shown in Figure 18. On the outer side the crown is divided into five principal columns by vertical fluting (see fig. 18B) which subsides on the internal side before reaching the cingulum. The three larger denticles are transversely flattened with acute edges, the others presenting more or less rounded points. The teeth are worn on the inner side showing that the lower teeth bite inside the

upper as would be expected. Both surfaces of the crown are marked by fine, irregular, vertical wrinkling. The line of smaller denticles on the anterior border curve inward while those of the posterior border curve outward, so that viewed from the end, the line of denticles form a sigmoid curve. The roots of the teeth are long, smooth surfaced, and subcylindrical.

These teeth have the general characteristics of other North American armored Dinosauria; that is, laterally compressed crowns with denticulated borders, basal cingulum, and long more or less cylindrical roots. Teeth are now known of the following genera: *Stegosaurus*, *Ankylosaurus*, *Stegopelta*, *Princonodon*, *Palaeoscincus*, *Panoplosaurus*, *Edmontonia*, and *Dyoplosaurus*. Compared with teeth of these various genera those belonging to the present specimen have their nearest resemblances in those of *Dyoplosaurus*.

Through the kindness of Dr. W. A. Parks, a maxillary fragment containing teeth of the type of *Dyoplosaurus acutosquameus* was loaned me for study. A direct comparison of these teeth

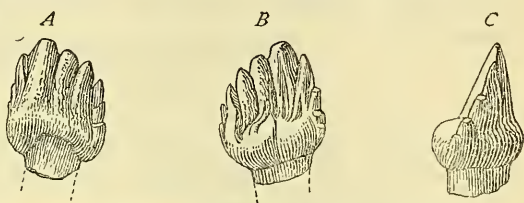


FIGURE 18.—RIGHT MAXILLARY TOOTH OF DYOPLOSAURUS ACUTOSQUAMEUS PARKS. NO. 11893, U.S.N.M. A, INNER VIEW; B, OUTER VIEW; C, POSTERIOR VIEW. ALL THREE TIMES NATURAL SIZE

with those of the specimen from the Two Medicine formation shows such close similarities in size, proportion, denticulation, and sculpture as to leave no doubt that the two specimens are conspecific. This maxillary fragment of the type was regarded by Parks²³ "as the anterior portion of the dentigerous region of the left maxillary," but, after comparing it with the broken maxillae of the skull here considered, I am fully convinced that it represents the posterior portion of the right maxillary. This determination is of importance as definitely fixing the position of the teeth in the jaws; that is, the highest part of the crowns are toward the posterior border. It was also found that the published illustration of the tooth does not accurately depict the original, being in error in that the denticles on the anterior border are too acutely pointed and too widely spaced. The second denticle posterior to the apical one should be lower, and the first point posterior to the apical denticle should be omitted, a fact recognized by Doctor Parks; on the posterior border at least two denticles should be added. These are now plainly shown on the specimen, though previously hidden by adhering matrix. In the Canadian tooth, however, they are barely visible from a lateral view, passing more to

²³ Univ. Toronto Studies, No. 18, 1924, p. 9.

the outer side than in the tooth of No. 11892, U.S.N.M., as shown in Figure 18A, where they are slightly visible from an inner view.

3. A NEW HORNED DINOSAUR

A fragmentary posterior portion of a ceratopsian frill is among the specimens from the Two Medicine formation collected during the summer of 1928. The presence of long horn-like processes on the posterior border of the frill shows its affinities to lie within the genus *Styracosaurus*, but these differ to such an extent in form and arrangement from those of *Styracosaurus albertensis* Lambe, from the Belly River of Alberta, as to indicate a distinct species, for which I now propose the name *Styracosaurus ovatus*, the specific name being suggested by the ovate character of the horn-like processes.

STYRACOSAURUS OVATUS, new species

Plate 10, Figure 2

Type.—Cat. No. 11869, U.S.N.M., consists of the posterior portion of the frill and numerous detached fragments. Collected by George F. Sternberg, 1928.

Type locality.—T. 37 N., R. 8 W., Milk River, Blackfeet Indian Reservation, Glacier County, Mont.

Horizon.—Two Medicine formation, Upper Cretaceous.

A nearly entire posterior end of a median frill bone with its attached processes is present. (See pl. 10, fig. 2.) This element in the ceratopsian frill has been variously designated the parietal, dermosupraoccipital, interparietal, and fused postfrontal. Sternberg³⁴ has recently attempted to show it to be the parietal in *Styracosaurus*, but, although it appears to represent that bone in *Protoceratops*, it certainly can not be the parietal in American horned dinosaurs, as evidenced by the juvenile *Brachyceratops* and other ceratopsian skulls in the National collections. I am unable as yet to decide certainly on its homologies, and, as a matter of expediency, shall continue to designate it the dermosupraoccipital.

The outstanding peculiarity of the skull of *Styracosaurus albertensis* is the large horn-like processes that project outward and backward from the posterior border of the frill. Somewhat similar processes are present on the frill before me. The two processes forming the hindmost pair lack their tips but it is quite evident they were not as long as in the Canadian specimen. (Compare figs. 1 and 2, pl. 10.) Furthermore, these two horns are convergent as opposed to the divergent processes in *S. albertensis*. It would seem

³⁴ Trans. Roy. Soc. Canada (ser. 3), vol. 21, 1921, pp. 135-143, pls. 1, 2, and 3.

that if completely preserved the extremities of these two horns would nearly meet on the median line. Those of the next pair in advance are nearly as large as the hinder pair but point outward more than backward. That there was a third pair is shown by the presence of a small lateral section of the frill, from the side of which a small, stubby process projects outward (pl. 10, fig. 2). If, as is apparent, this fragmentary part represents the third pair, these processes have their origin considerably forward of the second pair as shown by the smooth, rounded border between them. In *S. albertensis* these processes are relatively shorter, curved, and twinned with the second pair at the base.

The central part of the posterior border of the interparietal between the posterior pair of processes is thick and rounded and when viewed from above (pl. 10, fig. 2) displays a decided notch on the median line. That large fontanelles were present on either side of a median bar as in *S. albertensis* is shown by the rapid thinning of the bone on the anterior borders on either side of the middle, and also of the posterior portion of the bar which is preserved. This part of the median bar is broadly rounded transversely on the upper side but flattened beneath.

The upper and lower surfaces of the frill parts are marked by the usual vascular grooves. The horn-like processes are much flattened above and below and cross sections taken from almost any part would be broadly ovate in cross section.

Measurements

	Mm.
Greatest width from tip to tip of second pair of processes-----	800
Greatest length of right process of second pair-----	295
Greatest width of same at base-----	93
Greatest length of shortest process-----	108
Greatest width of median notch-----	57

Reference of the present specimen to a new species on such fragmentary material is a procedure that may be open to some question, especially where the specific characters are based upon structures which may be subject to much variation. However, the difference noted in these hornlike processes, except for their much greater size, appear to be comparable to the changes found in the different species of living horned lizards (*Phrynosoma*). In the latter case, however, the differences in horn structure are confirmed by other characters such as coloration and scutellation, features that of course are not available to the paleontologist. However, in establishing this species on the available material, fragmentary though it may be, it is with the hope that more complete specimens will disclose other and perhaps more stable characters.

EXPLANATION OF PLATES

PLATE 1

View of the excavation where the skeleton of *Palaeoscincus rugosidens* was collected. In the middle foreground is a large plastered block containing the sacrum. Photograph by George F. Sternberg.

PLATE 2

Skull of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. Superior view. About one-third natural size.

PLATE 3

FIG. 1.—Skull. Viewed from right side.

FIG. 2.—Right ramus of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. Lateral view. About one-third natural size.

PLATE 4

FIG. 1.—Sacrum of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. Ventral view. About one-fifth natural size.

FIG. 2.—Tooth of *Palaeoscincus asper* Lambe. Type. After Lambe.

FIG. 3.—Tooth of *Palaeoscincus costatus* Leidy. Type. Inner, end, and outer views. Three times natural size. After Leidy.

FIG. 4.—Tooth of *Palaeoscincus latus* Marsh. Type. *a*, natural size; *b*, twice natural size. After Marsh.

PLATE 5

Dermal bones of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M. All viewed from above.

FIG. 1.—Median pair of coössified dermal plates of the second nuchal row.

FIG. 2.—Lateral coössified plates (left side) of the second nuchal row.

FIG. 3.—Coössified dermal plates forming the left half of the first nuchal ring. All about one-fourth natural size.

PLATE 6

Dermal bones of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M.

FIG. 1.—Large spine that occupies a position lateral to the third transverse row of nuchal plates. Side view.

FIG. 2.—Dermal plate from side of the animal immediately posterior to the large spine shown in Figure 4. Top view.

FIG. 3.—Spine, from the end of the second transverse row of nuchal plates. Side view.

FIG. 4.—Large double-spined plate that projected outward from the side of the animal immediately above the fore leg. Lateral view. All figures about one-fifth natural size.

PLATE 7

Dermal plates and ilium of *Palaeoscincus rugosidens*. Type. No. 11868, U.S.N.M.

FIG. 1.—Thin ovate dermal scutes probably from above the sacral region. Superior view. About one-fourth natural size.

FIG. 2.—Median pair of nuchal plates of the second transverse row. Ventral view. Same as Figure 1, Plate 5. About one-fourth natural size.

FIG. 3.—Anterior end of right ilium, showing ends of three coössified dorsal ribs. Ventral view. About three and six-tenths natural size.

PLATE 8

Mounted skeleton of *Palaeoscincus* as exhibited in the American Museum of Natural History, New York, showing the dermal armor as it was found *in situ*.

FIG. 1.—Viewed from above. After Matthew.

FIG. 2.—The same viewed from the left side. Photograph by Amer. Mus. of Nat. History.

PLATE 9

Skull of *Dyoplosaurus acutosquameus* Parks. No. 11892, U.S.N.M.

FIG. 1.—Viewed from right side.

FIG. 2.—Viewed from above.

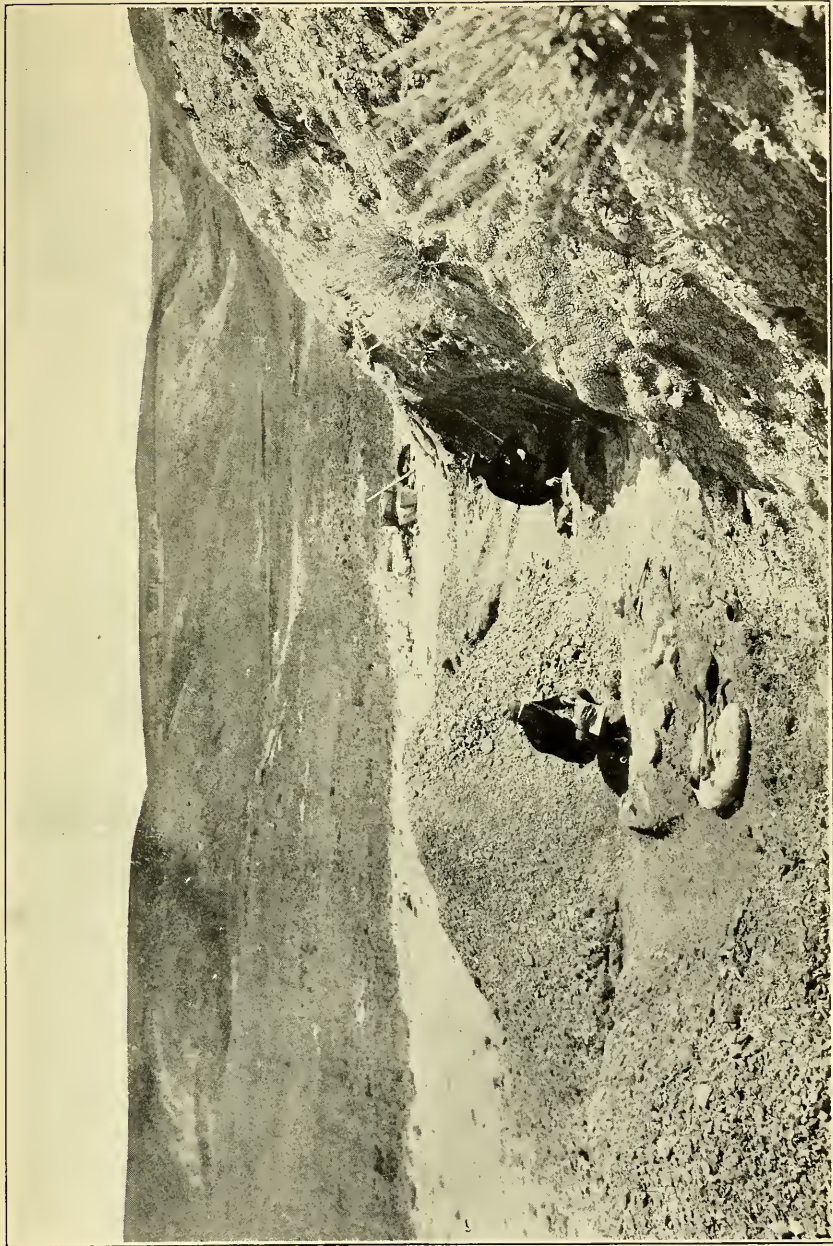
Both figures one-fourth natural size.

PLATE 10

FIG. 1.—Posterior part of frill of *Styracosaurus albertensis* Lambe. Type. Viewed from above. About one-twelfth natural size. After Lambe.

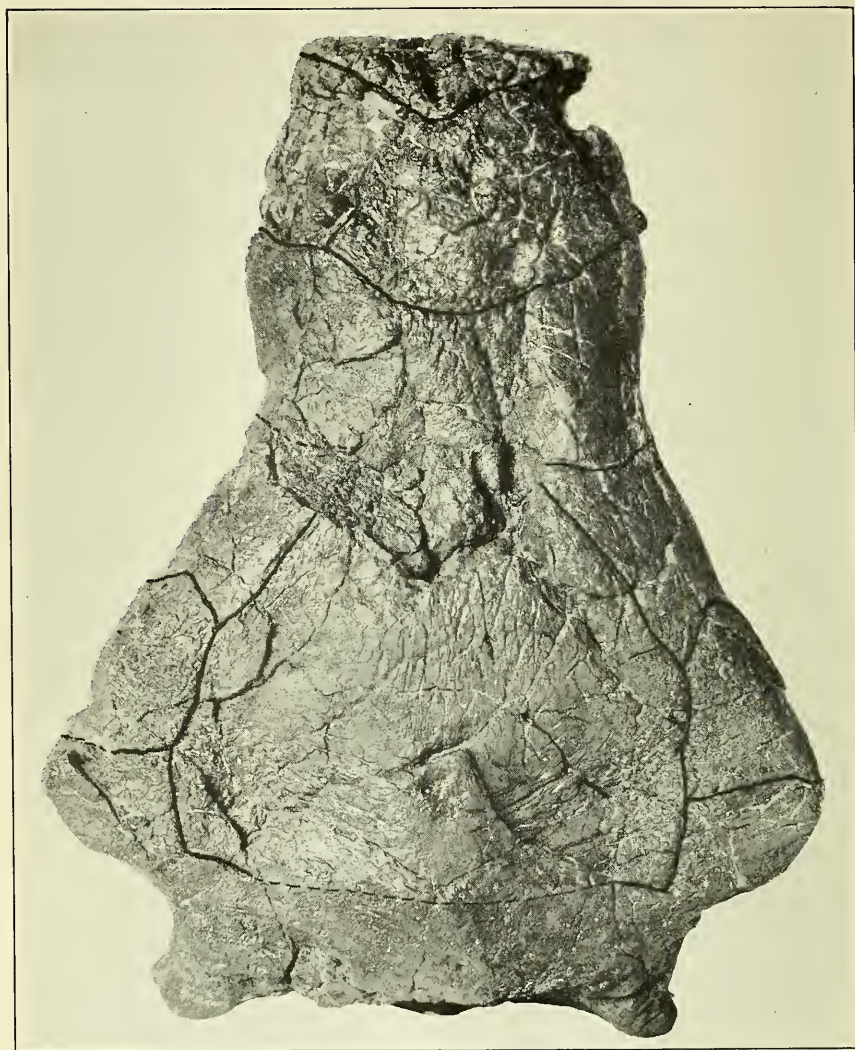
FIG. 2.—Posterior part of frill of *Styracosaurus ovatus*. Type. No. 11869, U.S.N.M. Viewed from above. About one-ninth natural size.





EXCAVATING SKELETON OF PALAEOSCINCUS RUGOSIDENS

FOR EXPLANATION OF PLATE SEE PAGE 38.



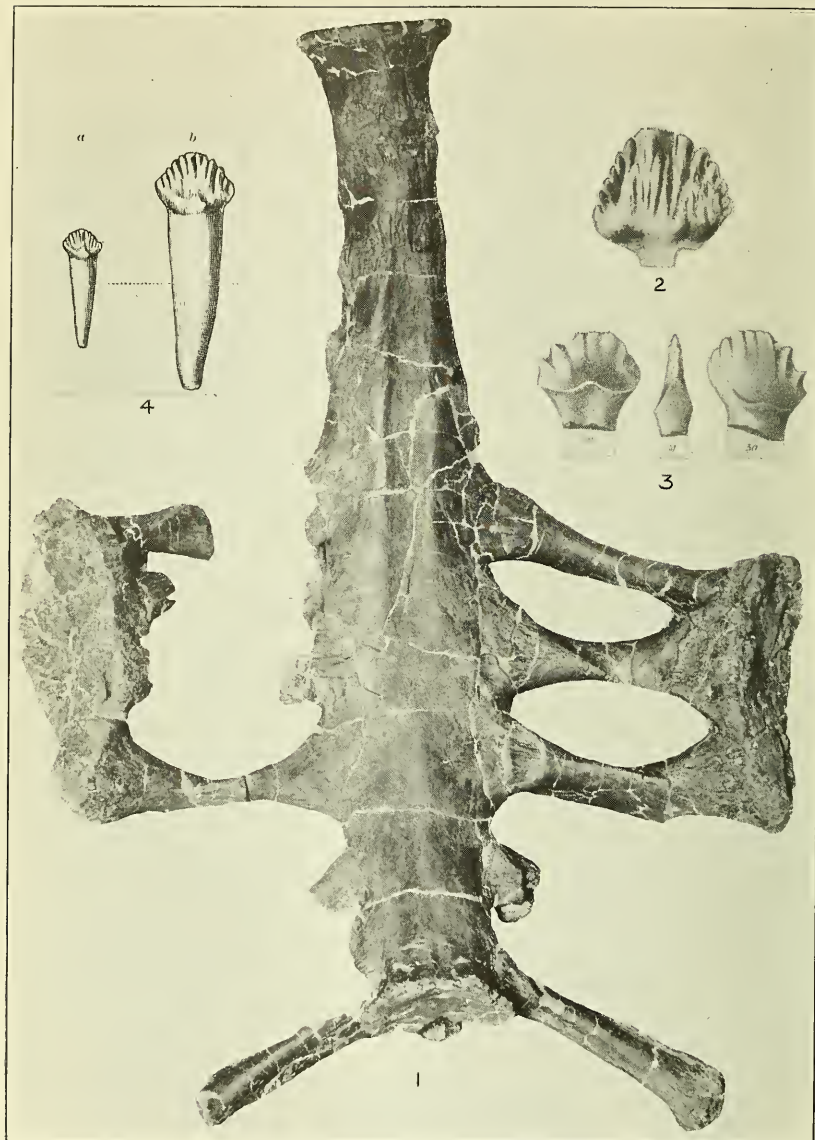
SKULL OF *PALAEOSCINCUS RUGOSIDENS*

FOR EXPLANATION OF PLATE SEE PAGE 38.



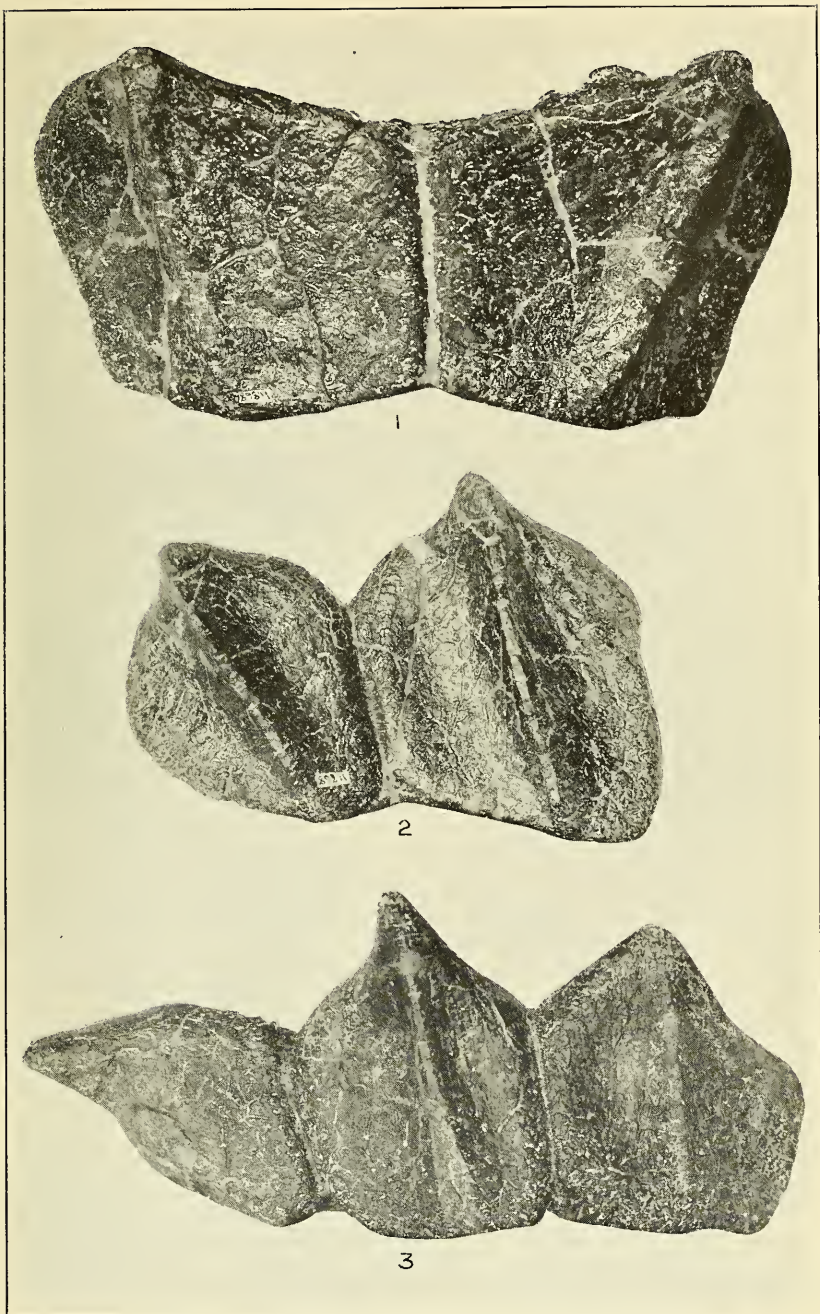
SKULL AND RAMUS OF *PALAEOSCINCUS RUGOSIDENS*

FOR EXPLANATION OF PLATE SEE PAGE 38.



SACRUM AND TEETH OF PALAEOSCINCUS

FOR EXPLANATION OF PLATE SEE PAGE 38.



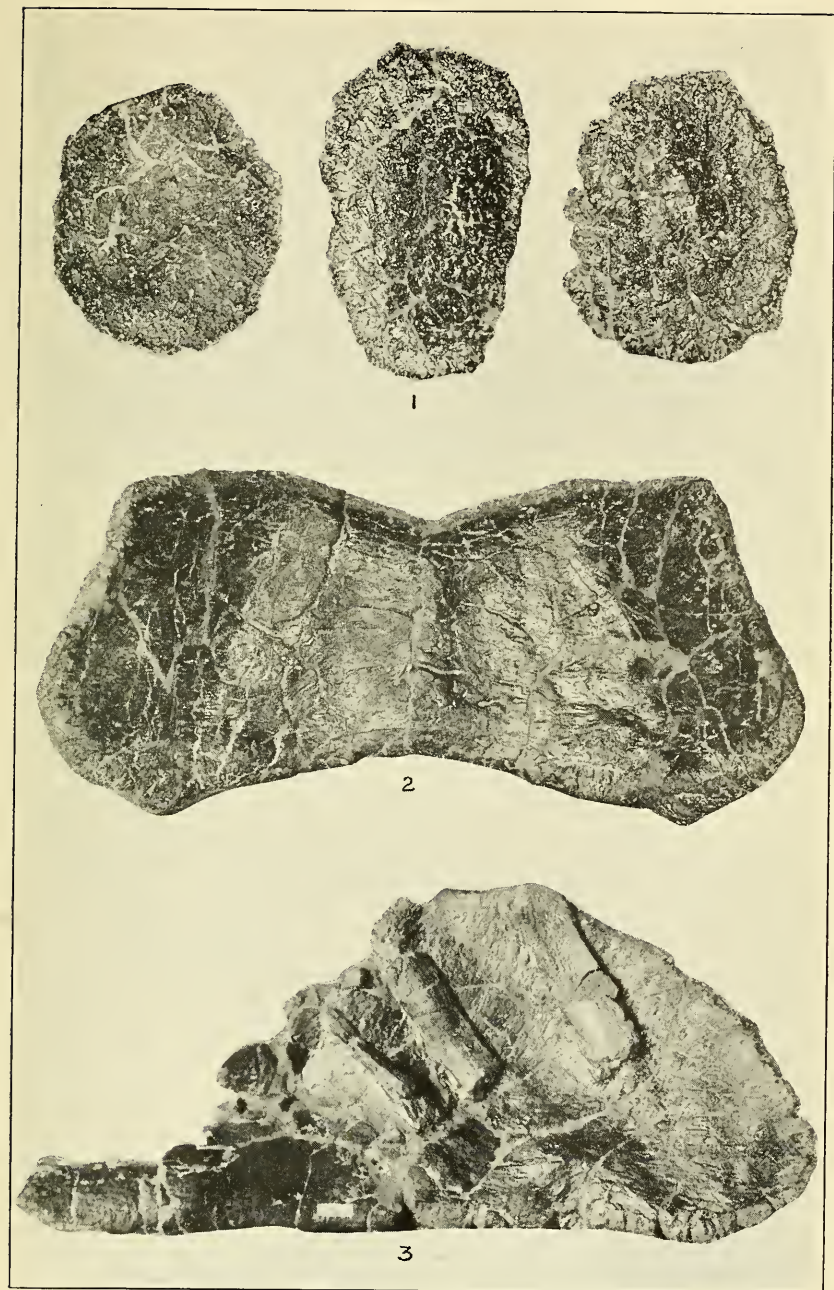
DERMAL SCUTES OF *PALAEOSCINCUS RUGOSIDENS*

FOR EXPLANATION OF PLATE SEE PAGE 38.



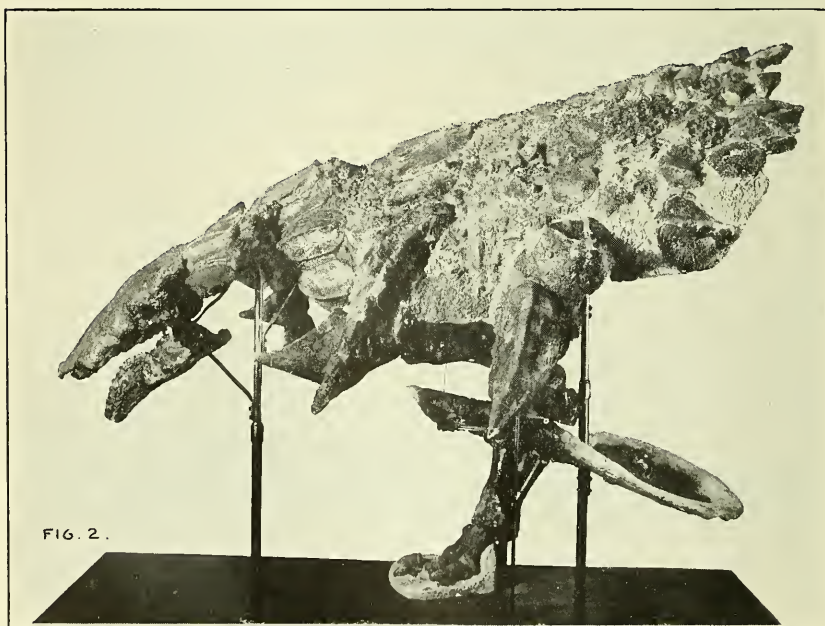
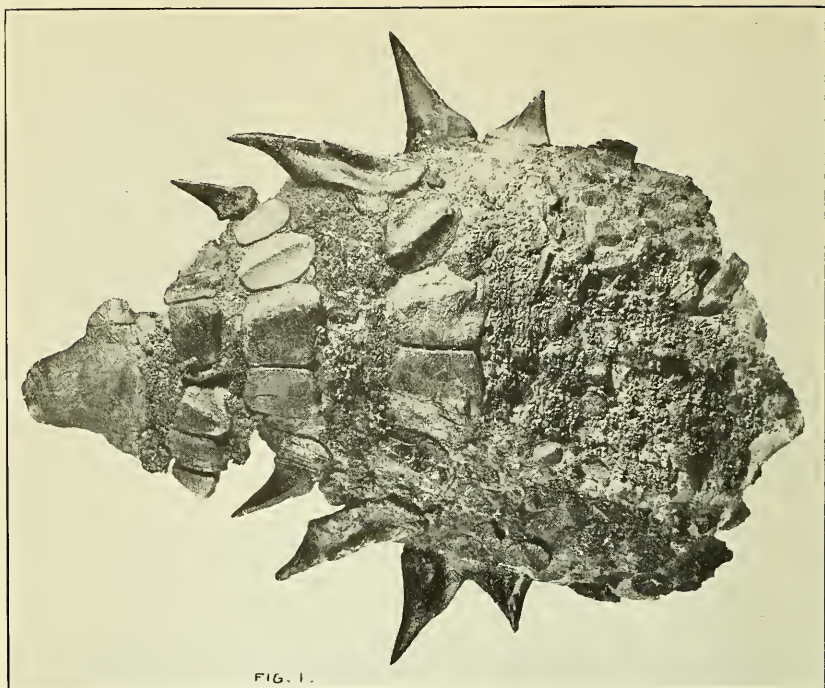
DERMAL SPINES OF *PALAEOSCINCUS RUGOSIDENS*

FOR EXPLANATION OF PLATE SEE PAGE 38.



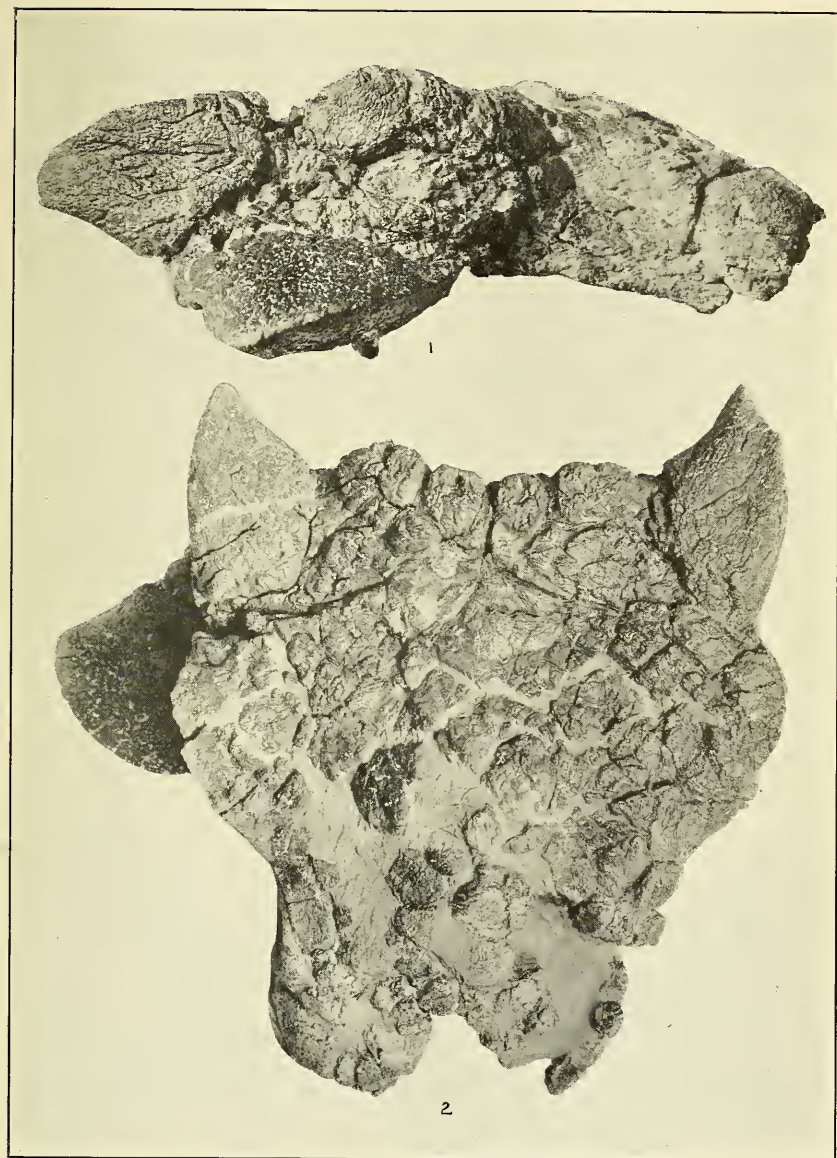
ILIUM AND DERMAL BONES OF *PALAEOSCINCUS RUGOSIDENS*

FOR EXPLANATION OF PLATE SEE PAGE 39.



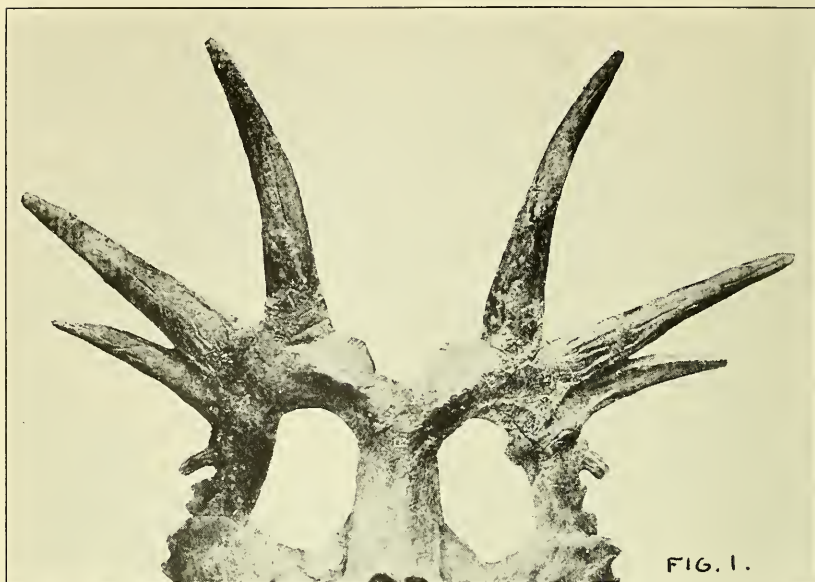
SKELETON OF PALAEOSCINCUS

FOR EXPLANATION OF PLATE SEE PAGE 39.



SKULL OF DYOPLOSOSAURUS

FOR EXPLANATION OF PLATE SEE PAGE 39.



FRILLS OF STYRACOSAURUS

FOR EXPLANATION OF PLATE SEE PAGE 39.