DESCRIPTION OF FOSSIL FISHES FROM THE UPPER CRETACEOUS OF NORTH AMERICA.

JOHN H. DANTE.

ABSTRACT. The skulls and anterior sections of two Upper Cretaceous fishes, *Paleoclupea dakotaensis*, n.g., n.sp., and *Thrissopater intestinalis*, are described in detail. The former is an early member of the clupeoids and is compared with other members of this family. The latter shows the bones of the skull which were imperfect or missing in the type specimen.

THE United States National Museum has in its collections two specimens of fossil fishes that, owing to their unusual preservation, seem worthy of description. One of these is the silicified remains of a hitherto undescribed fish and the other is a specimen of *Thrissopater intestinalis* Moodie. Both fossils have the skull, scales, and part of the body preserved in the natural form of the fish. The undescribed specimen is covered by a layer of silica that has replaced many of the bones and covers most of the body as a hard matrix. The second specimen, however, is entirely free from matrix. The exact geological horizons from which these two specimens came are not known, but examination of the United States Geological Survey maps of the areas where they were found leads to the belief that both are from the Upper Cretaceous. Careful comparison with other species from the Upper Cretaceous shows the first specimen to have many affinities with the clupeoids, yet to differ from *Clupea* and its relatives in so many ways as to constitute a distinct genus. The second specimen is distinctly elopid in character and agrees with the genus *Thrissopater* in almost every characteristic. I wish to thank Messrs. J. B. Reeside, Jr., L. P. Schultz, and E. D. Reid for their help in identifying the specimens and the formations in which they were found.

Family CLUPEIDAE.

Genus PALEOCLUPEA, new genus.

Trunk fusiform, head narrow, pointed. Frontals large, divisible into two parts, center rugose, marked by small ridge in circular depression near union with the parietals; prefrontals long, thin; parietals small, united along the median line. Snout not produced; cheek plates covering side of head. Premaxillary small; maxillary long and thin, both bones entering upper

border of mouth; gape extending slightly beyond middle of orbit; two supramaxillaries; teeth short, strong, acuminate. Preoperculum long and thin, serrated with many long, strong spines; branchiostegal rays few in number. Vertebral centra well ossified, constricted, and strengthened with few longitudinal ridges. Pectoral fin long; pelvic fin set about middle of body. Scales large, thick, longitudinally striated, with a fold running around the outer margin.

PALEOCLUPEA DAKOTAENSIS, new species.

Plate I, Figs. 1, 2, 3, 4.

Type.—U.S.N.M. 16162, consisting of head and anterior part of body.

Found by Charles E. Young in 1919.

Type locality.—(In the middle of a field) 5-6 miles north of Oacoma, Lyman County, South Dakota.

Horizon.—Pierre Shale, (?) Upper Cretaceous.

Description.—Body long, narrow, compressed ventrally; head long and pointed, widest behind the orbits at the parietals. Skull with operculum approximately two and one-fourth times as long as it is wide, two-thirds as deep as long, and one and one-fifth times as deep as wide. From a lateral point of view the head is sharply pointed anteriorly while from a dorsal aspect it tapers to a blunt point.

Most of the bones of the skull are present, but the exact differentiation of some of them is impossible. The ethmoid is an arched, smooth, rectangular bone which joins posteriorly to the frontals, anteriorly to the premaxillaries, and laterally to the prefrontals and nasals.

The frontals are long triangular paired bones, narrowest near the ethmoid but growing wider as they pass the orbits, reaching their greatest width at their junction with the parietals along a line about even with the preoperculum. They meet along a median suture that is open for about three quarters of the way back. Where the frontals join the ethmoid, there is a triangular open space 18 mm. long and 5 mm. wide. The frontals seem to be divided into two parts: a subovoid, rugose central portion and a smooth, outer triangular part that begins at the orbit and runs back under the parietals. The outer portion is bordered anteriorly by the supraorbital and overlain by the sphenotic, and ventrally it is overlain by the pterotics and parietals. The central portion is subovate

or lance-shaped, and covered with dermal rugosities. Posteriorly, 50 mm. from the tip of the snout, the central section tapers to a point. Here the bone is marked by a small subcircular depression, 8 mm. wide, which is bisected longitudinally by a low rounded ridge.

The parietals are roughly triangular, paired bones which join along the median line. Anteriorly they overlie the frontals and are longer than wide. The supraoccipital lies under a bone that seems to be the epiotic and is represented only by a small lump that may be a trace of the crest. The pterotics on either side of the parietals are roughly semi-circular bones. Anteriorly they overlie the frontals, and posteriorly they end in a straight line. The sphenotic is a trapezoidal bone lying behind the orbit at its dorsal end and joining the supra- and postorbitals on its anterior and ventral sides. It is flat and smooth, measuring 13 mm. long by 12 mm. wide.

Jaws.—The lower jaw is compressed, and pushed up onto the upper jaw, so that the teeth cannot be seen. The premaxillary has been shoved down between the lower jaws and is therefore unavailable for study. The maxillary is 35 mm. long; near the front the bone is very thin, having a width of only 2 mm. On the right side, at the midlength of the jaw, there are several round, slender, recurved teeth, that measure about 1 mm. in length. The two supramaxillaries lie above the maxillary and partially cover it. They are wide, flat bones placed one behind the other below the suborbitals.

The dentary is a long, wide bone which unites with the articular about 20 mm. from the anterior end of the lower jaw. The two jaws do not join in front as they were broken apart and separated, owing to the crushing of the specimen. The premaxillary has been detached from above and lies between the two rami of the mandible, partially under the left ramus. The gape of the jaws extends slightly beyond the middle of the orbit.

Cheek bones.—The lacrimal is a large, flat, smooth bone longitudinally striated, measuring 24 mm. in length and 14 mm. in width. The prefrontal is wide and curved, lying in front of and above the orbit. Anteriorly, it joins the lacrimal; posteriorly, the frontal.

The nasal is here represented by a long, thin bone lying on the left side of the skull. It lies on top of the prefrontal, connects with the lacrimal antroventrally, and with the frontal and prefrontal posteriorly. The right nasal is missing.

The orbitals are mostly turned inward into the eye sockets and are obscured by the overlying matrix. The postorbitals are in three parts, the bottom section going under the suborbitals and on the right side, where the bone appears to be missing the silica matrix, it contains the impressions of serrations or spines on its lower side that are up to 5 mm. in length. The postorbital is 12 mm. long, covering the whole cheek from the orbit to the preoperculum. Only a trace of the supraorbital remains on the posterodorsal part of the left eye. It is a long, smooth bone 8 mm. in length by 6 mm. wide. A trace of the suborbital also remains. This resembles the supraorbital, measuring 15 mm. long by 4 mm. wide. The orbit is large, being longer than deep. On the left side, fragments of bone in the orbit may represent traces of the sclerotic ring. The length of the eye is 30 mm. and the depth 28 mm.

The preoperculum is a long, L-shaped bone that is serrated on its posterior and ventral sides. These serrations are long, wide spikes coming from the bone. Only parts of the opercular bones show on the left side as they are mostly covered with silica. On the right side, parts of the bones have been replaced by silica but enough of each is present to give a good idea of the shape of the bone.

A radiograph taken of the specimen shows that there are about 16 vertebrae present together with their ribs. The vertebrae are about 10 mm. long by 5 mm. high. The pelvic fin is represented by the pelvic bone, which is broken off at its posterior end; what is present measures 35 mm. by 14 wide. It begins about 232 mm. from the anterior end of the fish and is about 131 mm. behind the beginning of the pectoral fin.

The pectoral fin is about 23 mm. long and is so covered by silica that nothing can be made of the individual fin rays. It has left a folded trace or impression in the side of the specimen about 58 mm. in length. The dorsal fin cannot be determined with certainty. There are traces that look like interspinal bones in the radiograph, about 180 mm. from the anterior end, but they are not very clear.

The scales are large, round, and thick with longitudinal striations, but as far as can be seen there are no circuli. This may be due to the fact that the outer covering of the scales has been removed. There seems to be a ridge running around the scale which extends inward 1.5 mm. from the posterior edge. In most of the scales, the outer surface has been chipped off,

leaving the plain middle part of the scale. The lateral line is conspicuous and medial.

Comparison with other genera of the Clupeidae.—The shape of the vertebrae shows that the specimen is an isospondylous fish. The general outline of the body, structure of the head, and the character of the scales separate it from all the other families of fishes except the clupeoids, and show its close affinity to *Clupea*. It differs, however, from the other Cretaceous clupeoids in many ways. *Paleoclupea* differs from *Crossognathus*[1] in its scales being crenulated while the scales of the latter are smooth. The lateral line of the former is in the middle, whereas that of the latter arises low down on the flank not far above the pectoral fin. The long pectoral fin in *Paleoclupea* is medial, that of *Crossognathus* is smaller and arises near the ventral border.

In *Syllaemus*,[2] the trunk is subcylindrical and not much compressed laterally. *Paleoclupea* is more compressed laterally, more subovate in shape, and the body is longer. The former has a short head, small orbit, and the cranial roof slightly arched, with a median depression in the frontal region. The latter has a longer head, large orbit, and a strongly arched cranial roof, with the central part of the frontal region of larger size. *Syllaemus* has the pectoral fin rather far back from the head, and the scales are small and smooth. *Paleoclupea* has scales that are two to three times as large and striated, and the pectoral fin is closer to the head.

Pseudoberyx[3] has a slight expanded preoperculum and small paired fins; *Paleoclupea* has a serrated preoperculum and the paired fins are long. The scales in the former are not enlarged or thickened, and there are no ventral ridge scales. The latter has thick scales and there seem to be conspicuous ridge scales, although the radiograph does not show the presence of pterigophores for the scales.

Histiothrissa[4] has vertebral centra that are as long as deep; those of *Paleoclupea* are longer than deep. The former has relatively large fins, the scales are of moderate size, very deeply overlapping, and none is pectinated. There are no enlarged thickened ridge scales, and the lateral line is inconspicuous. In the latter, the fins are large; the scales large and deeply overlapping. The thick, ridge scales are enlarged, and the lateral line is conspicuous.

In *Diplomystus*,[5] the gape of the mouth does not extend

beyond the anterior border of the orbit; in *Paleoclupea*, however, it extends slightly beyond the middle of the orbit. In the former, the preoperculum is slightly expanded, whereas in the latter it is serrated. The former has the paired fins of moderate or small size, the pectorals are inserted above the ventral border, the scales are small or of moderate size, and there is a series of thickened ridge scales. The latter has long pectoral fins, large, thick scales, and there is also a ventral row of thick, ridge scales.

Scombroclupea,[6] like *Diplomystus*, does not have the gape of the mouth extend beyond the anterior border of the orbit; the teeth are minute or absent. *Paleoclupea* has a larger gape and teeth. In the former, the preoperculum is a great triangular expansion, the paired fins are small or of moderate size, and the pectorals are inserted above the ventral border. In the latter, the preoperculum is long and thin, the fins are larger, and the pectorals are inserted one-third the way up the side. The former has scales of moderate size, a stout row of ridge scales on the ventral border between the pectoral arch and the origin of the anal fin, and the lateral line is inconspicuous. The latter has large, thick scales, ridge scales on the ventral edge and possibly on the back, and the lateral line is conspicuous.

MEASUREMENTS.

	mm.
Greatest depth of specimen	88
Length of head with operculum	90
Greatest width of operculum	41
Greatest width of head	39
Greatest depth of skull at occiput	66
Tip of snout to origin of dorsal fin, about	48
Tip of snout to insertion of pectoral fin, about	100
Length of upper jaw	40–45
Length of lower jaw	45
Length of ethmoid	14
Length of frontal	47
Width of frontal	32
Width of central part of frontal	16
Length of prefrontal	21
Length of pterotics	15
Length of postorbitals	15
Width of postorbitals and circumorbitals	30
Length of supramaxillaries	18
Width of supramaxillaries	5-11
Depth of preoperculum	25
Length of preoperculum	23
Length of vertebra	9
Width of vertebra	5

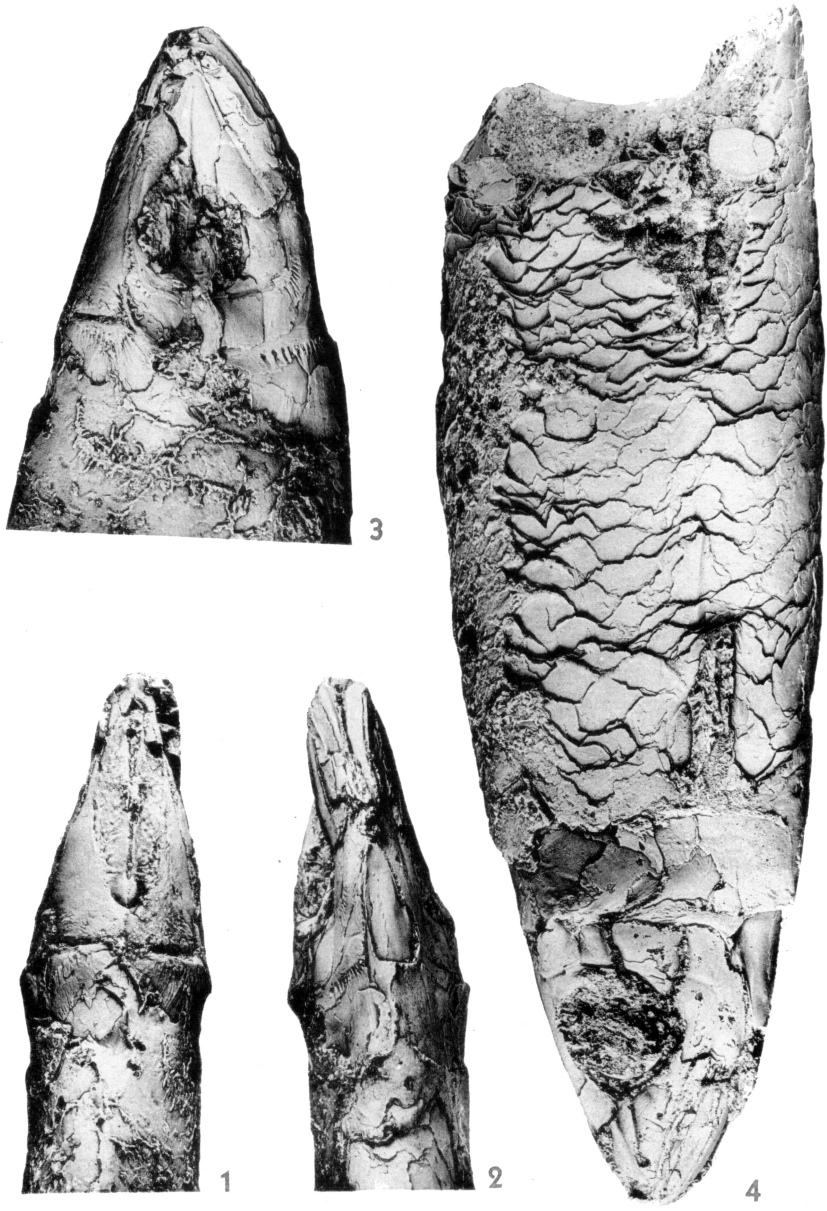

FIG. 1. *Paleoclupea dakotaensis,* n.g., n.sp. Dorsal aspect. Pierre shale, Upper Cretaceous, Oacoma, Lyman County, South Dakota. U. S. Nat. Mus. 16162.
FIG. 2. The same. Ventral aspect.
FIG. 3. The same. Right lateral aspect showing serrated operculum.
FIG. 4. The same. Left lateral aspect. All figures 5/8 natural size.

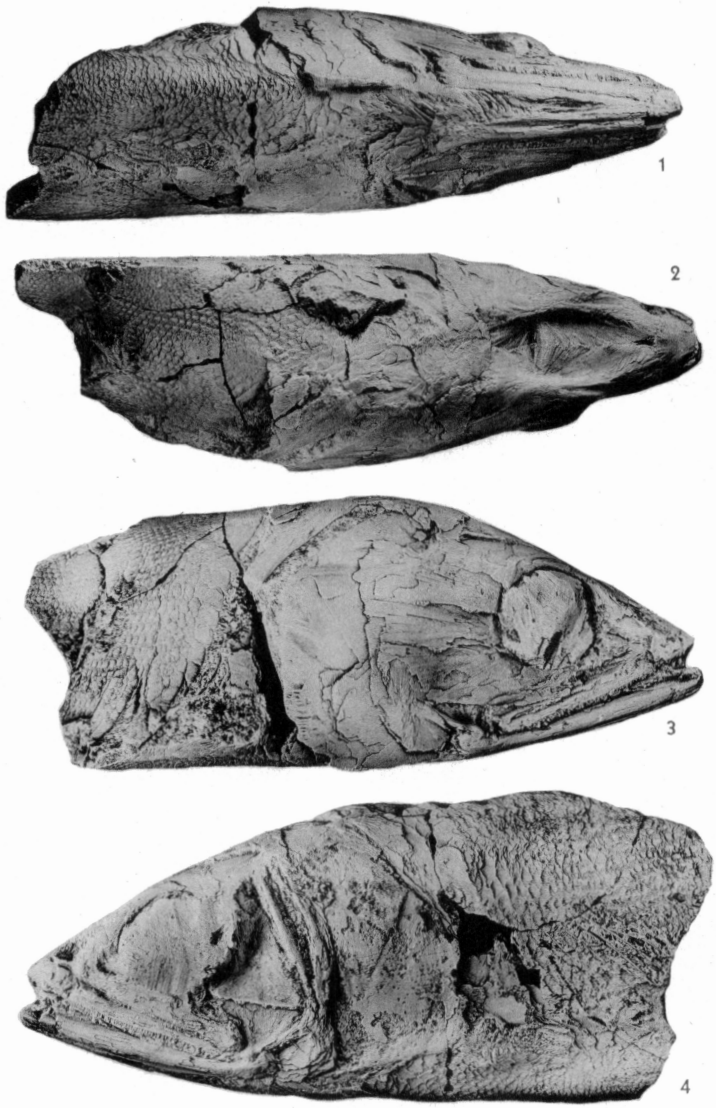

FIG. 1. *Thrissopater intestinalis* Moodie. Ventral aspect. Pecan Gap chalk(?) member of Taylor marl, Upper Cretaceous, Texas. U. S. Nat. Mus. 16161.

FIG. 2. The same. Dorsal aspect.

FIG. 3. The same. Right lateral aspect.

FIG. 4. The same. Left lateral aspect. All figures two-thirds natural size.

Family ELOPIDAE.

Genus THRISSOPATER Woodward.

THRISSOPATER INTESTINALIS Moodie.

Plate II, Figs. 1, 2, 3, 4.

Moodie, R. L., Kan. Univ. Sci. Bull., V, No. 15, 1911, pp. 281-285, Pl. lxi.

This species was established by Moodie on a specimen which showed the outlines of the body and intestine, but with the bones of the head poorly preserved. In the National Museum there is a specimen of *Thrissopater* (U.S.N.M. 16161) consisting of the skull and anterior portion of the body that gives new information concerning the bony structure of the skull. This specimen was received in 1886 as a gift from Dr. R. W. Noble of Barclay, Falls County, Texas. It was found about twenty feet below the surface in a bed of blue shale or marl, four feet from the top of the bed. The exact formation is not known, but from an examination of the Geological Survey maps of this area, it seems to be the Taylor marl of the Upper Cretaceous, probably the Pecan Gap chalk member. The specimen agrees in almost every particular with the preserved portions of *Thrissopater intestinalis* Moodie from the Austin chalk of Texas.

The fossil described by Moodie is embedded in matrix with only parts of the skull preserved. Many of the bones are missing and some are represented only by impressions. In the specimen here described, the skull is free from the matrix and most of the bones are present, although a few are missing or represented only by fragments and impressions. Because of its rarity in the United States, near completeness, and clarity of structure, the fossil seems worthy of description.

The type specimen of *Thrissopater intestinalis* is longer than the specimen here described, and has most of the outline of the body, the ribs, fins, and soft parts present. In the fossil described below, most of the body has been lost. A few ribs and vertebrae are preserved, and the left pectoral fin remains.

The skull is approximately twice as deep as it is broad, slightly deeper than long, and twice as long as wide. The ratio of its length to depth is about three to five. From a lateral view, the head is sharply pointed anteriorly, while in dorsal aspect it tapers to a blunt point. In the type, the skull and

opercular apparatus is longer than in the specimen here described, but at the quadrate the depth of the skull is not as great.

Cranium.—The ethmoid is a flat, angularly rounded bone, as long as it is wide, that bends down on the lateral edges to join the premaxillaries. Posteriorly it unites with the frontals which, on the left side, seem to overlap slightly the edges of the ethmoid, while on the right side they touch without overlapping. The bone is finely punctate on the anterior portion of the outer surface.

The frontals are long, smooth bones running almost one-third the length of the skull. At their anterior end they unite with the ethmoid and are separated from each other by a narrow triangular opening about 6 mm. long. Posteriorly, the frontals connect with the parietals which are covered with scales and cannot be well distinguished. Laterally they rise along the edge into a prominent ridge. This ridge contains a slight groove that commences as a wide, deep depression near the front of the orbit and gradually disappears about the middle of the eye. Centrally the frontals have a deep depression that lies between the two ridges over the orbits. About two-thirds back, the frontals rise in a triangular transverse ridge with a quadrilateral pit behind it. Posteriorly the frontals and pterotics extend over and partially cover the sphenotics.

The sphenotics are obtuse triangular-shaped bones which dorsally lie under the lateral edges of the frontals and ventrally are partially covered by the supra- and postorbital bones. The pterotics are quadrilateral-shaped bones which are half covered by scales and most of their details are thus obscured.

The parietals, epiotics, and other bones of the roof of the skull are covered by scales so that details cannot be made out. The lacrimals are missing except for a tiny scrap on the right side.

The orbit is large and is contained two and one-half times in the length of the jaw. The preorbitals are represented by two small patches of bone. The supraorbitals join laterally and slightly cover the frontals and posteriorly cover the edges of the squamosal. The suborbitals form a wide band connecting with the supramaxillary, and with the postorbitals form a broad sheath entirely covering the bone underneath.

Upper Jaw.—The upper jaw is composed of the premaxillaries, maxillaries, and supramaxillaries. The maxillaries are

broken away at each end where they join the premaxillaries and also where they approach close to the quadrate. The teeth are small, pointed, and shallower than those farther back.

Most of both premaxillaries are missing as the end of the snout has been broken off. However, what remains shows a stout bone as wide as the maxillary reaching from near its junction with the maxillary to the end of the ethmoid, a distance of about 10 mm. The bone is also finely punctate. There is one supramaxillary present lying on top of the maxillary.

Lower jaw.—The lower jaw consists of three elements: the dentary, angular, and articular. The large V-shaped dentary extends almost the entire length of the jaw. Only one tooth is exposed. In the type, the mandible is longer, the depth at the cotylus twice as great, but the teeth are only three-fifths the length of those in the present specimen.

The articular fits into the long end of the dentary. It is about 13 mm. long and bends upward into a thickened club-shaped head for articulation with the quadrate. The angular rests in a depression along the posterior ventral edge of the articular. It is shaped like an acute triangle.

The quadrate is a triangular bone and heavily ossified at its articular end. This bone sends posteriorly a splint-like process that lies in a groove in the preoperculum. There seems to be a trace of the symplectic bone.

The metapterygoid is a quadrilateral-shaped bone, lying between the quadrate and preoperculum, that seems to sink downward into a pit near the posterior end of the orbit and then rises again dorsally. It lies on top of the quadrate and may partially cover the symplectic. The posterior end of the bone is missing.

Opercular apparatus.—The preoperculum consists of a J-shaped bone which at the top is divided into two branches —28 by 2 mm. and 32 by 3 mm. respectively—that are 3 mm. apart at their widest place. About even with the junction of the quadrate and metapterygoid, the two branches join to form a thick bone which extends ventrally and anteriorly against the quadrate.

The operculum is mostly missing but traces of it remain to show it was a long, deep, smoothly striated bone about one-half the length of the skull. The sub- and interopercular bones cannot be distinguished from the operculum. In both this and the type specimen, the width of the opercular apparatus is the same.

There are twenty-four branchiostegals lying between the jaws and the operculi. They are thin, flat bones about 2 mm. wide, the largest exposing over 12 mm. of its length.

Fragments of the posttemporal, supracleithrum, and cleithrum are to be found. There are the remains of the left pectoral fin which was so mashed that not much can be made of it. It is thus not as wide as that in the type specimen. A few rays and actinosts may be picked out but their exact positions in the fin cannot be determined.

A few vertebrae and about eleven ribs show through the left side. The scales have the cross striations of the typical elopid scale but do not seem to have the lines radiating from the center.

The following measurements are shown with some of those of the type specimen:

	U. S. N. M. No. 16161	Type specimen
Length of specimen	..	290 mm.
Greatest depth	65 mm.	90
	(head)	(body)
Length of skull with opercular apparatus	92 "	97 "
Width of skull at snout	15 "	..
Width of skull at parietals	35 "	..
Depth of skull at quadrate	50 "	48 "
Length of mandible	54 "	60 "
Depth of mandible at cotylus	5 "	10 "
Length of tooth	2.5 "	1.5 "
Width of opercular apparatus	30 "	30 "
Depth of opercular apparatus	56 "	..
Length of pectoral fin	19 "	..

Bibliography.

1. Pictet, F. J.: 1858, Foss. Terrain Néocom. Voirons., Paleont. Suisse, Pt. iii, p. 18, Pl. ii, iv, Figs. 1-6.
2. Cope, E. D.: 1875, Vert. Cret. Form. West. (Report U. S. Geol. Survey Terr. ii), pp. 180-81.
3. Woodward, A. S.: 1901, Catalogue Fossil Fishes, iv, p. 129.
   Pictet and Humbert: 1866, Nouv. Rech. Pois. Foss. Mt. Liban, p. 32.
4. Von der Marck, W.: 1858, Zeitschr. deutsch. geol. Ges. x, p. 245.
   Woodward, A. S.: 1901, Catalogue Fossil Fishes, iv, p. 131.
5. Cope, E. D.: 1877, Bull. U. S. Geol. Survey Terr., iii, p. 808.
6. Kner, R.: 1863, Sitzungsb. k. Akad. Wiss. math-naturw. Cl. xlviii, Pt. i. p. 132, Pl. 2.

Washington, D. C.