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A New Actinopterygian Fish from the Cretaceous of North America

BY BOBB SCHAEFFER¹

INTRODUCTION

The single specimen described in the present paper has been in the collection of fossil fishes of the American Museum of Natural History for many years. Unfortunately it was not catalogued at the time of acquisition, and no information is available regarding the locality or the collector. Prior to complete preparation, the dorsal surface was embedded in a block of chalky matrix (fig. 1) framed with two-by-four timbers. Although the frame suggests a collecting technique employed by the Sternbergs for Niobrara fishes, neither Charles nor George Sternberg recalls the specimen.

Through the kindness of Dr. Stuart A. Levinson of the Esso Production Research Company, the coccolith assemblage obtained from matrix samples has been analyzed by Mr. John Beard of the stratigraphic geology division of that company. This assemblage is Upper Cretaceous (Campanian) in age, and it shows a marked resemblance to that of the Gammon Member of the Pierre Formation on the western flank of the Black Hills. The coccoliths further indicate marine, offshore deposition. As the chalky matrix is strongly suggestive of the Niobrara Formation (and not of the Pierre), it is pertinent to note that the Gammon Member interfingers with the upper part of the Niobrara over a

¹ Chairman and Curator, Department of Vertebrate Paleontology, the American Museum of Natural History; Professor of Zoology, Columbia University in the City of New York.



FIG. 1. *Asarotus arcamus*, new genus and species, A.M.N.H. No. 5555, specimen as preserved in original matrix, showing sphenoid, pectoral fins, and general aspect of squamation. *Ca.* $\times \frac{1}{5}$

broad area extending from the Black Hills eastward to the Missouri River Valley (Gill and Cobban, 1961).

Derivation of the specimen from the Niobrara Formation is also indicated by the Foraminifera, which have been studied by Dr. Harry L. Cousminer. The species recovered are common in the Smoky Hill Member of the Niobrara in Kansas, eastern South Dakota, and northern Nebraska. Pelagic forms indicate deposition in rather deep water at some distance from the shore.

Dr. William J. Mapel (personal communication) has noted that "the facies relations indicate to me that the Gammon-like coccoliths might be found in the upper part of the Niobrara Formation along the east side and at the south end of the Black Hills and also further east in outcrops in the Missouri Valley region of South Dakota and Nebraska. They would be less likely in the Niobrara in the northwestern part of the Black Hills or further to the west in Wyoming and Montana."

The above evidence indicates that the specimen came from the upper part of the Niobrara somewhere in Nebraska or South Dakota. The fact that this large, highly distinctive fish has not been reported from the well-collected Kansas Niobrara is difficult to explain. A possible explanation is that it inhabited a different environment within the Niobrara Sea, although such is not actually evident from the lithology.

TAXONOMY AND DESCRIPTION

CLASS OSTEICHTHYES

SUBCLASS ACTINOPTERYGII

INFRACLASS CHONDROSTEI OR HOLOSTEI

ASAROTIFORMES,¹ NEW ORDER

DIAGNOSIS: An actinopterygian of problematical affinity, which differs from other taxa within the subclass Actinopterygii by the following combination of characters: Dermal skull composed of many small polygonal bones and several pairs of relatively large irregular ossifications that are extensively overlapped by smaller, radially arranged elements. Dermal bones ornamented with dentine tubercles. Braincase mostly cartilaginous. Parasphenoid broad anteriorly, deeply forked posteriorly, and with large tooth plate covered with minute closely spaced teeth. Ossified basiptyergoid process absent. Notochord persistent; centra absent. Ribs ossified. Scales rhomboidal, lepidosteoid, ornamented with crenulated bony ridges.

¹ Latin *asarotum*, floor laid in mosaic.

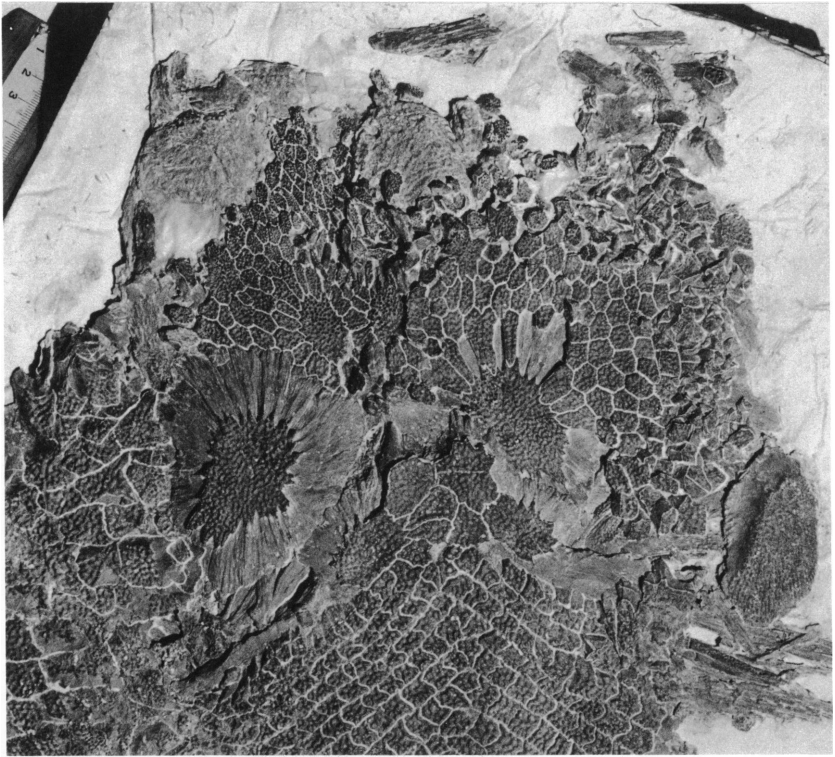


FIG. 2. *Asarotus arcanus*, new genus and species, A.M.N.H. No. 5555, dorsal aspect of skull, sutures emphasized. *Ca.* $\times \frac{1}{3}$.

ASAROTIDAE, NEW FAMILY

DIAGNOSIS: Same as for order.

DISTRIBUTION: Niobrara Formation; Upper Cretaceous (Campanian), central United States.

ASAROTUS, NEW GENUS

TYPE SPECIES: *Asarotus arcanus*,¹ new species.

DISTRIBUTION: Niobrara Formation; Upper Cretaceous (Campanian), central United States.

¹ Latin *arcanus*, mysterious.

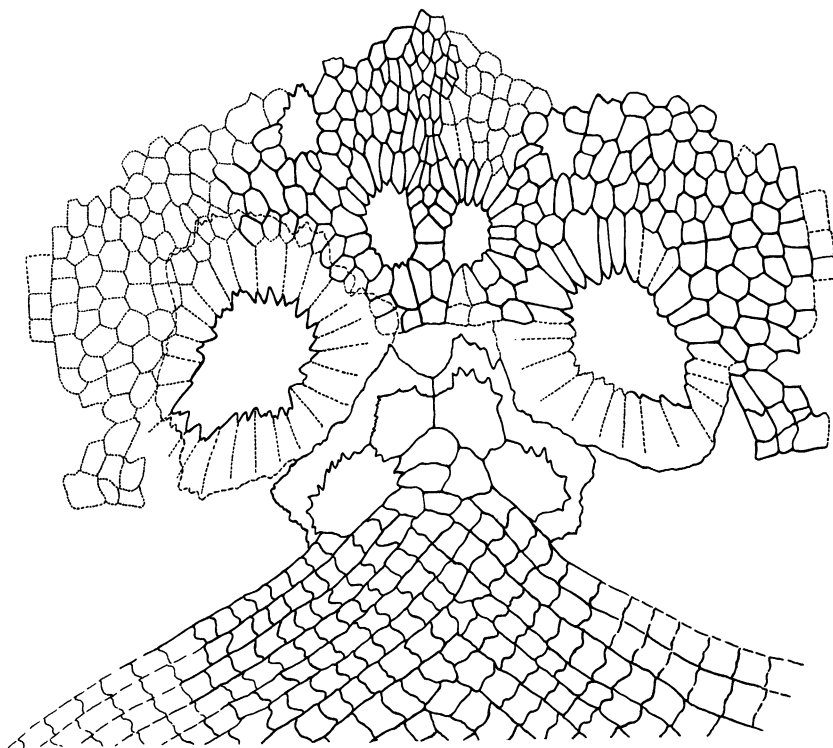


FIG. 3. *Asarotus arcanus*, new genus and species, A.M.N.H. No. 5555, partial reconstruction of skull and anterior squamation in dorsal aspect. Ca. $\times \frac{1}{2}$.

***Asarotus arcanus*, new species**

TYPE: A.M.N.H. No. 5555, partial skull and anterior portion of body.

HORIZON AND LOCALITY: On the basis of the coccolith, foraminiferal, and regional stratigraphic evidence, the specimen came from the upper part of the Smoky Hill Member of the Niobrara Formation, probably in South Dakota or Nebraska.

SPECIFIC DIAGNOSIS: Same as for order.

DESCRIPTION

BODY FORM: As preserved, the skull and incomplete body are crushed dorsoventrally. The angle formed by the crossing scale rows in the flank region is fairly high, suggesting a cross-sectional outline similar to that of *Amia* or *Lepisosteus* (Breder, 1947). The known dimensions indicate that the complete body was more than 80 cm. in length.

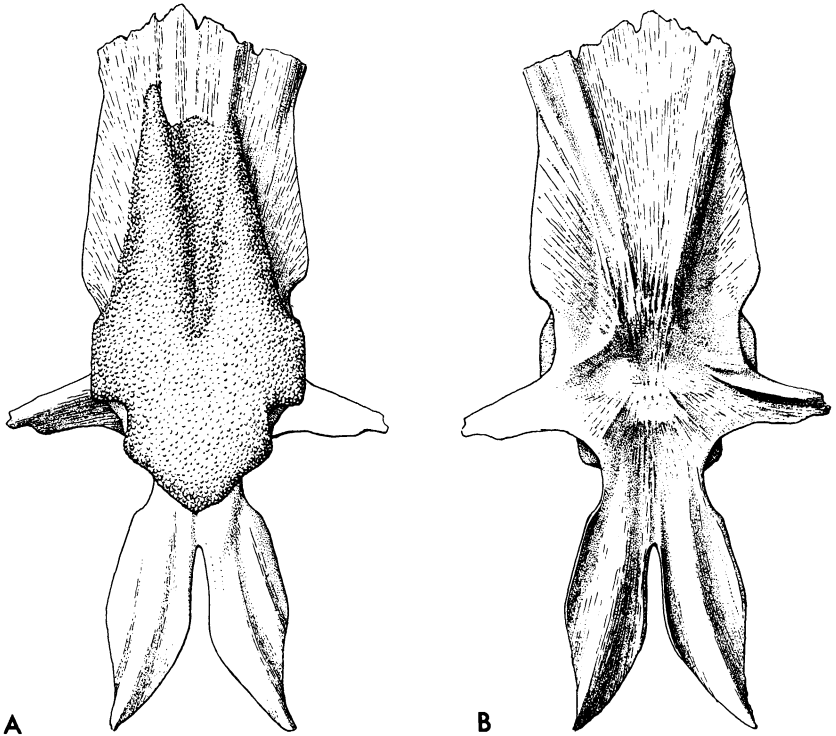


FIG. 4. *Asarotus arcanus*, new genus and species, A.M.N.H. No. 5555, parasphenoid. A. Ventral aspect. B. Dorsal aspect. *Ca.* $\times \frac{2}{3}$.

SKULL: It is impossible to determine how much of the dermal skull is missing in the snout and cheek regions. The polygonal elements that comprise most of the roof and presumably the cheek have vertical sides and average 3 to 5 mm. in thickness. They become generally smaller anteriorly, and the dentine tubercles on the upper surface become more closely spaced. In contrast with these elements, the several large, paired ossifications have broad, sloping borders covered with a ring of frequently narrow and elongated bones. The massive, tightly articulated elements at the back of the skull roof also have sloping anterior margins that must have been covered with smaller ossifications (figs. 2 and 3). Thin sections of the polygonal elements demonstrate that they are composed entirely of cancellous bone.

The position of the orbits is not evident, and no jaw or branchial arch elements can be positively identified.

A single ovoid bone that may be the opercular or subopercular is

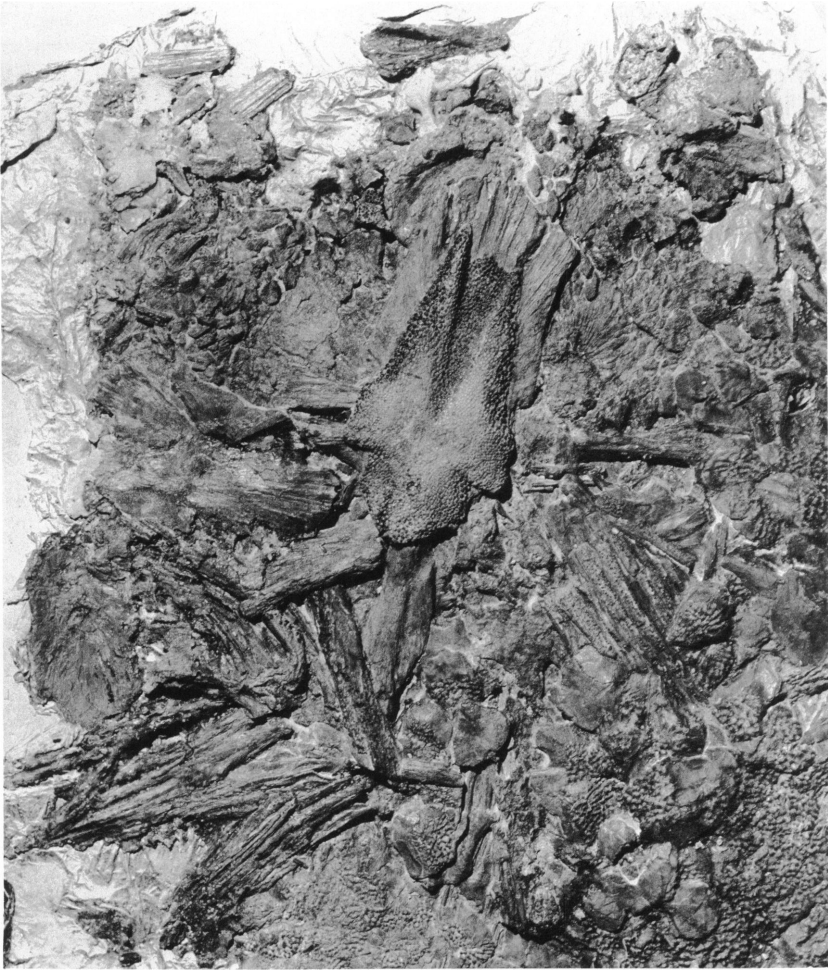


FIG. 5. *Asarotus arcanus*, new genus and species, A.M.N.H. No. 5555, head region in ventral aspect, showing parasphenoid, part of palate, and pectoral fins. *Ca.* $\times \frac{1}{2}$.

preserved on the right side. It may have been overlapped anteriorly by a missing preopercular or by cheek ossicles. If we assume that this element should be rotated about 90 degrees from its present position, so that the overlap border faces anteriorly, then it is evident that much of the cheek in front of this border is missing. There is no indication of a longitudinal separation between the skull roof and the cheek.

The parasphenoid (figs. 4 and 5) is exceptionally broad in front of the ascending processes and flares laterally at its anterior end. Deeply separated posterior processes diverge as they taper to pointed terminations. Basipterygoid processes involving the parasphenoid are absent. The large, parasphenoid tooth plate (fig. 4A) consists of tiny, closely spaced teeth that have rounded crowns composed of orthodentine. A longitudinal, V-shaped depression extends from the anterior border of the plate to its widest portion at the anterior border of the ascending processes. Presumably the basibranchial tooth plate had a ridge that more or less opposed this depression. Tooth wear is evident immediately behind the apex of the depression. Sharp ridges and furrows on the dorsal surface of the parasphenoid (fig. 4B) indicate that this surface was firmly fixed to the cartilaginous basicranium. There is no hypophyseal foramen.

Part of the palate may be represented by a mass of relatively flat bone situated on the right side of the parasphenoid, but positive identification of individual elements has not been possible. The hyomandibular or possibly the ceratohyal is preserved on each side of the parasphenoid. Other components of the visceral skeleton are not definitely present. Barlike elements on the left side of the parasphenoid, originally thought to be parts of the gill skeleton, are now regarded as ornamented rays of the left pectoral fin.

POSTCRANIAL SKELETON: Well-ossified ribs and haemal spines are exposed at one place along the body. Neural arches have not been observed. Centra are absent, and the notochord must have been unreduced.

Elements of the shoulder girdle, presumably the cleithra, are evident behind the skull in dorsal aspect. Partly dissociated pectoral fins include only the proximal, unsegmented portion of the fin rays. The robust, anterior rays are ornamented with tubercles.

SQUAMATION: The scales are relatively large, thick, and rhombic. They are ornamented with crenulated, bony ridges of varying length that may have a more or less radial arrangement, particularly along their anterior border. Some dentine tubercles are present on the scales immediately behind the skull. In thin section the scales show well-defined bone lamellae in the basal half. Cell lacunae are abundant on the boundaries between the lamellae, but decrease in number toward the upper surface. Abundant vertical tubules with openings on the upper or lower scale surface terminate in flat arborizations situated either above or below a tubule-free zone (presumably the scale nucleus) in the middle of the scale, or at progressively greater distances away from this zone. These canals are apparently lepidosteoid tubules as described by Kerr (1952) and Moss (1964). Well-spaced branching vascular canals are present

throughout the scales. Densely packed, very fine, oblique tubules that presumably contained connecting collagen bundles extend from the nucleus area to the lower scale surface.

DISCUSSION

The persistence of the notochord, the absence of centra, the mostly cartilaginous braincase, the broad parasphenoid with its large tooth plate and posterior wings, the pattern of the excessively subdivided dermal skull, and the lepidosteoid squamation represent a peculiar combination of characters that do not seem to be duplicated in any other known actinopterygian. *Asarotus* is not related to any of the Late Mesozoic teleost groups, and it shows no evident affinity to taxa of holostean or chondrosteian level that possess some of these characters. The nearly rectangular anterior expansion of the parasphenoid is apparently unknown among non-teleostean actinopterygians. Likewise, the large and distinctively shaped parasphenoid tooth plate cannot be closely compared with that of any known Cretaceous chondrosteian or holostean. The dermal skull is distinctive in the extent of its subdivision, in the essentially polygonal shape of nearly all the dermal elements, and in the radial pattern associated with the largest bones. Although there is no basis for estimating variability in the subdivisions of the *Asarotus* dermal skull, it is evident that the total pattern is unlike that of *Acipenser* (Jarvik, 1948, fig. 19), *Chondrosteus* (Lehman, 1966, fig. 114), or pycnodonts of the *Mesturus* type (Lehman, 1966, fig. 164). In fact, the closest approach to the polygonal arrangement that I have noted is in the cheek region of *Lepisosteus*, which obviously has no systematic significance.

The fact that *Asarotus* and *Aspidorhynchus* (Schultze, 1966) have a similar lepidosteoid scale histology is simply additional evidence that this scale must have evolved numerous times independently. In terms of its complete squamation, *Asarotus* can be excluded from the chondrosteiform-acipenseriform complex (Lehman, 1966), but neither the form nor the structure of the scales necessarily implies affinity with any known group at the holostean level.

Additional information on the dermal skull, including the rostral area, the orbits, and the opercular complex, together with data on the feeding mechanism and the fins, might aid significantly in resolving the affinities of *Asarotus*. I suspect, however, that our present knowledge of this curious genus is sufficient to indicate its systematic isolation. The large parasphenoid tooth plate suggests that the feeding mechanism was distinctive, but further speculation on this point or on presumed feeding habits is

presently futile. Unless the caudal fin were also specialized in some unexpected way, which seems improbable, it could do little more than help to indicate the evolutionary level that *Asarotus* attained within the Actinopterygii.

Assigning *Asarotus* to any known actinopterygian order would be, at best, arbitrary and, in my opinion, hardly compatible with the tenets of phylogenetic classification. The only way to express taxonomically the probability that this genus is the sole known representative of a lineage that evolved independently from some unknown actinopterygian stock is to place it in an order of its own. Similarly, the order Polypteriformes is recognized for the genera *Polypterus* and *Calamoichthys*.

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