

Article XX.—THE SYSTEMATIC RELATIONSHIPS OF CERTAIN AMERICAN ARTHRODIRES.

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PLATE XLV.

In studying a natural group of organisms it is of primal importance to ascertain the kind and degree of structural modifications to which the generalized forms have given rise. In the case of the Arthrodira, a group wholly extinct, our knowledge of the interrelationships of the various types is still rather vague, owing partly to the scantiness of materials and partly to the dispersal of these materials in widely separated museums making comparative studies difficult to carry out. The following notes are offered as a small contribution to this subject. They include a discussion of the synonymy of several long-known arthrodires and a description of a new genus and species.

Brachygnathus n. gen.

Type species: *Brachygnathus (Dinichthys) minor* (Newberry).

In 1878 Newberry described an arthrodire, *Dinichthys minor*, on the evidence of three plates—a median occipital, a dorsomedian and a right mandible. These plates were subsequently figured and redescribed in his 'Paleozoic Fishes of North America' in 1889.¹

While studying these specimens recently, I have observed that they differ widely from their homologues in *Dinichthys*, so much in fact, as to require separation into a distinct genus. This genus differs more in appearance and structure from *Dinichthys* than the latter does from *Coccosteus*.

The dorsomedian plate, as already indicated in Newberry's figure, instead of being anteriorly emarginated as is the rule in the Arthrodira,² is drawn out into an elongate cusp (Fig. 1B). From several available specimens in the Newberry Collection at the American Museum, I have been enabled to draw a tolerably accurate restoration of this plate which is here reproduced (Fig. 1A; cf. Fig. 2). The body of the plate is relatively shorter

¹ Monogr. U. S. Geol. Sur., XVI, p. 149, pl. viii, figs. 3-5.

² Cf. a juvenile specimen of apparently this genus recently figured by Prof. Bashford Dean in Amer. Mus. Memoirs, IX, p. 280. A somewhat similar element is also figured by Dr. C. R. Eastman in his 'Devonic Fishes of Iowa,' 1908, p. 206, fig. 32.

and broader than in *Dinichthys*, the posterior process longer and more slender.

It is to be expected from the characters of this dorsomedian that other structural peculiarities will be found when the osteology of this form becomes

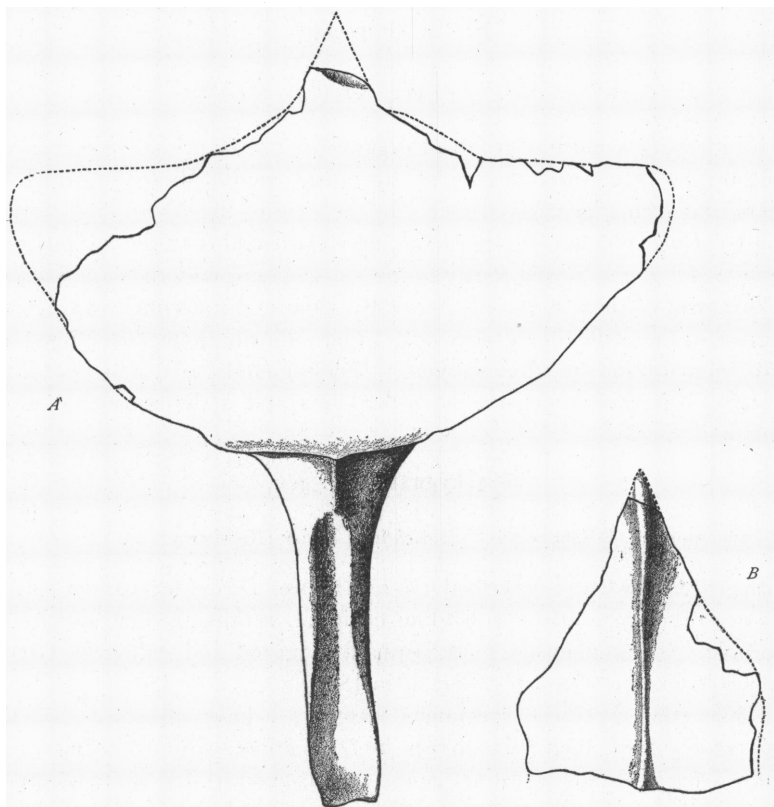


Fig. 1. *Brachygnathus minor* (Newb.). A, Dorsomedian plate. B, Anterior extremity belonging to type dorsomedian. Newberry Collection, Amer. Mus., No. 118. $\times \frac{1}{2}$. Cleveland shale (Upper Devonian): Ohio.

known. This is the case with the other two elements known, the mandible and the median occipital.

The mandible is here figured in outer and inner aspects (Fig. 3). It measures 85 mm. in total length. It will be noted that for an arthrodire mandible it is singularly short fore-and-aft, predicating a form much more brachycephalic than either *Dinichthys* or *Coccosteus*. The gape of the mouth is smaller than in these genera. There is no trace of the second

cuspid or "tooth" which in *Diniohthys* follows the first, the cutting edge being a regular knife-like blade. In this regard *Brachygnathus* agrees with *Stenognathus*, though in other characters the two are very different, *Stenognathus* having a long slender mandible suggesting a dolichocephalic form with a wide mouth (*cf.* Figs. 3 and 4). It may be mentioned in passing,

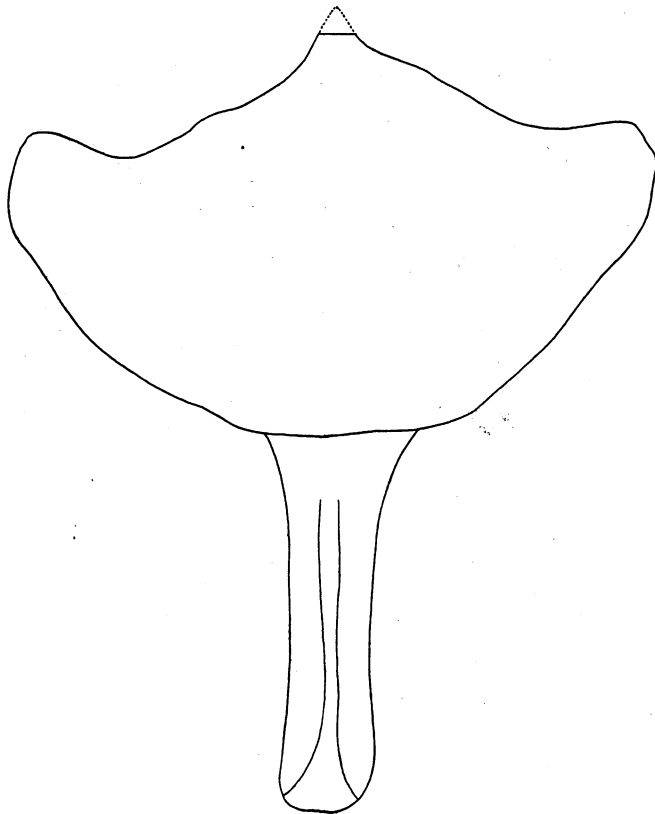


Fig. 2. *Brachygnathus minor* Newb. Dorsomedian, $\times \frac{1}{2}$. (From a field sketch made by the collector, Jay Terrell).

that the mandible of *Brachygnathus* indicates unmistakably the flattened, semicircular posterior process to which the writer has called attention¹ as showing that the arthrodiran mandible was attached to a cartilaginous support rather than articulated posteriorly to a bony pivot.

The median occipital element has already been carefully described and figured by Newberry.² The fact that some half dozen such elements are to

¹ Mem. Amer. Mus. Nat. Hist., IX, 1906, p. 114.

² Monogr. U. S. Geol. Surv., XVI, 1889, p. 149, pl. viii, figs. 3, 4.

be found in the Newberry collection alone goes to show that the genus was abundant in individuals; and probably when more of its history is known, these median occipitals will turn out to represent more than one species. It is rather curious that each of these elements is complete and shows the anterior thinned flange which interlocked with the parts of the head in front.

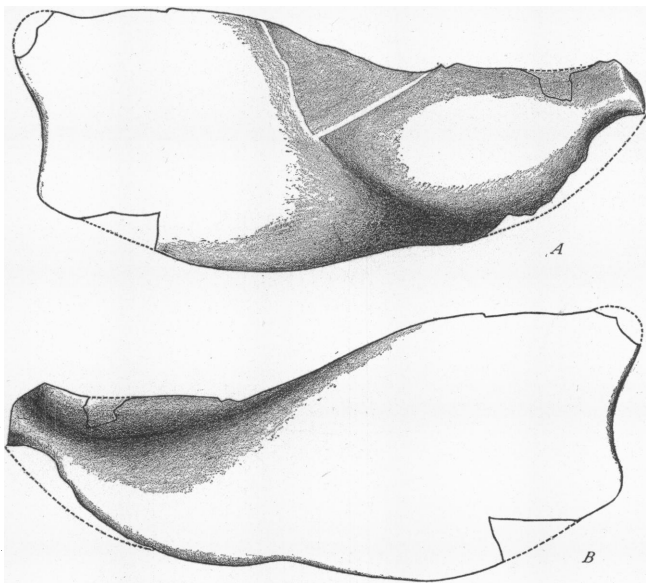


Fig. 3. *Brachygnathus minor* (Newb.). Mandible, natural size, in outer (A), and inner (B), view. Newberry Coll., Amer. Mus. No. 118. Cleveland shale: Ohio.

This indicates that the median occipital became readily extricated in the dissolution of the creature. But whether it prove that the exoskeleton of the genus was only partially ossified with the plates embedded in the softer parts, as supposed by Newberry,¹ it would be idle to speculate.

***Brachygnathus minor* (Newberry).**

1878. *Dinichthys minor* NEWBERRY, Ann. N. Y. Acad. Sci., I, p. 191.

1889. *Dinichthys minor* NEWBERRY, Paleoz. Fishes, p. 149, pl. viii, figs. 1-5.

1908. *Dinichthys minor* NEWB., HUSSAKOF, Bull. Amer. Mus., XXV, p. 12.

An imperfectly definable species of arthrodire known at present only from three dermal plates: a dorsomedian, a median occipital and a right

¹ Monogr. U. S. Geol. Surv., XVI, p. 149.

mandible. Specific characters of these plates comprised in the generic description above. Plates ornamented superficially with crape-like wrinklings.

Type specimen from the Cleveland shale (Upper Devonian) of Ohio. Newberry collection, Amer. Mus., No. 118.

***Stenognathus corrugatus* (Newberry).**

1889. *Dinichthys corrugatus* NEWBERRY, Paleoz. Fishes, p. 151, pl. vii, figs. 3, 3a.

1893. *Dinichthys gracilis* CLAYPOLE, Amer. Geologist, XII, p. 279, fig.

1897. *Stenognathus corrugatus* NEWBERRY (DEAN), Trans. N. Y. Acad. Sci., XVI, p. 30, pl. xxiv, figs. 27, 28.

A cast of Claypole's type of *Dinichthys gracilis* is preserved in the American Museum. On comparing it with Newberry's type of *Steno-*



Fig. 4. *Stenognathus corrugatus* (Newb.). Mandible, $\times \frac{1}{2}$. Cleveland shale (Upper Devonian): Ohio.

gnathus corrugatus, no doubt is left that the two forms are identical. Newberry's two specimens are the front halves of mandibles, lacking the posterior blade portions, while Claypole's is a complete mandible (Fig. 4).

It may here be recalled that the diagnostic characters of this genus as given by Newberry are the very slender form of the mandible and the absence of the second cusp, or "tooth,"—the one which in *Dinichthys* follows the main upturned fang. The entire functional portion of the upper margin of the mandible is therefore one uninterrupted cutting edge. In this regard *Stenognathus* resembles *Brachygnathus*.

***Mylostoma variabile* Newberry.**

1883. *Mylostoma terrelli* NEWBERRY, Trans. N. Y. Acad. Sci., II, p. 147.

1889. *Mylostoma terrelli* NEWBERRY, Paleoz. Fishes, p. 164, pl. xiv, figs. 1, 2.

1906. *Mylostoma terrelli* NEWB., EASTMAN, Bull. Mus. Comp. Zool., L, p. 23, pl. iii, fig. 21.

1908. *Mylostoma variabile* NEWB., HUSSAKOF, Bull. Amer. Mus., XXV, p. 17.

In the catalogue of the types of fossil fishes in the American Museum (Bull. Amer. Mus. Nat. Hist., XXV, pp. 16, 17), I have indicated that I regard

M. terrelli as a synonym of *M. variable*. This conclusion was the result of a careful comparison of practically all the originals preserved — those at the American Museum, the Harvard Museum and the Oberlin College Museum. It remains here to give the reasons for this opinion.

Mylostoma terrelli was founded by Newberry upon a single specimen of a left mandible.¹ The reasons for differentiating it from *M. variable*² appear to have been, first, its larger size, and, secondly the belief at the time it was described that it came from a lower horizon (Huron shale) than *M. variable* (Cleveland shale). The latter point, however, appears to have been an error. Many of the first finds from the same locality (Sheffield Township, Lorain Co., Ohio), were originally labeled by Newberry as from the Huron shale. Subsequent geologic work, however, proved this determination of the horizon erroneous, and on many original labels in the Newberry Collection, we find the words *Huron shale* stricken out and *Cleveland shale* substituted in Newberry's own hand.

The only legitimate reason for differentiating *Mylostoma terrelli* from *M. variable*, therefore, appears to be that of size; and this is not a valid ground for specific separation. In general form and in the possession of the tubercle, the type specimen — the only one known — agrees entirely with a typical mandible of *M. variable*. Its greater size, worn-down tubercle and general flattened and triturated oral face, indicate that it belonged to a very old individual. Recalling that in the closely related genus *Dinichthys* very large worn mandibles are known, indicative of the good old age reached by this arthrodire, it is not surprising to find a similar instance of senility among the mylostomids.

***Dinognathus ferox* n. gen., n. sp.**

An imperfectly definable genus and species of arthrodire known at present only from a single dental plate. Form of dental plate as shown in figure 5; bilaterally symmetrical, the lower third formed into two dinichthyid-like "teeth" of about the size of the "premaxillaries" in *Dinichthys intermedius*. These "teeth" functional, as indicated by the lines of wear. Near upper margin of functional face, an oval boss occupying about one-third the width of the element at its widest part; this boss apparently not functional. Reverse side of dental element smooth, and comparable with the reverse or inserted surface of a mylostomid palatal plate. Lateral faces smooth, slightly oblique, the inserted surface being slightly broader than the functional one — as in a mylostomid pavement plate. Maximum thickness about one-third the width of the element at its middle.

The type specimen was discovered by Mr. Peter A. Bungart of Lorain Co., Ohio,

¹ Trans. N. Y. Acad. Sci., II, 1883, p. 147.

² *Ibid.*, p. 146.

in whose private collection it is preserved. I am indebted to him for the privilege of examining it.

This extraordinary element differs from all arthrodire dental plates now known. Its perfect symmetry and clean-cut lateral faces preclude any idea of its being a malformed element due to the fusing of the extremities of a pair of mandibular or upper "teeth." Its symmetry and the fact that the tips of the fangs point away from each other suggest that the element was set in the median line of the jaw. Its resemblance to a mylostomid palatal plate suggests, furthermore, that it was embedded in cartilage by its

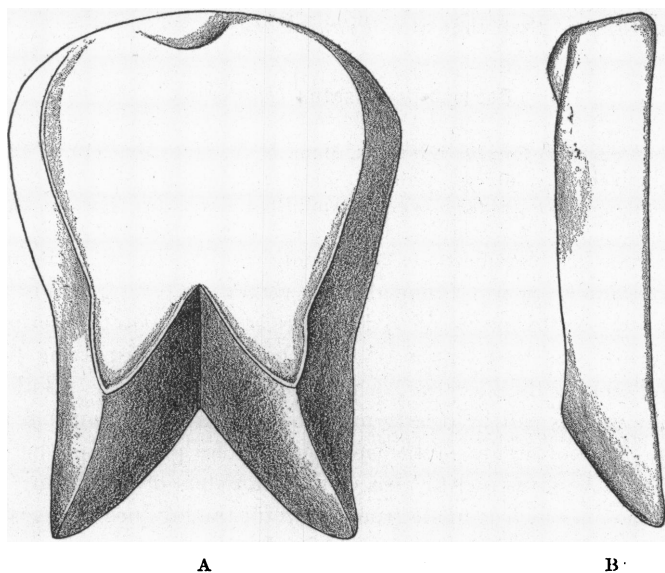


Fig. 5. *Dinognathus ferox* n. gen., n. sp. Dental element in oral (A), and lateral (B), view. Type. $\times 1$. Cleveland shale (Upper Devonic): Ohio.

reverse, or smooth, side. But whether it represents the fused "premaxillaries" or is a premandibular placed at the symphysis, cannot at present be decided.

To students of the Arthrodira an alternative interpretation will perhaps occur which may here be briefly noticed. In the early days of arthrodire discoveries in Ohio, Newberry, Claypole and others believed that the deep groove in the mandible of *Titanichthys* was set with a few strong teeth, and that future discoveries would bring these teeth to light. Newberry, in fact, figured a small plate which he interpreted as such a tooth; but excepting this — which was an error in identification¹ — no evidence for

¹ Monogr. U. S. Geol. Surv., XVI, pl. xliii, fig. 4. The element here figured is one of a pair of small plates placed on either side of the pineal on the ventral aspect of the cranial shield.

teeth in *Titanichthys* has been forthcoming. It is probable therefore, that the dental element here discussed will be declared by some paleichthyologist to be one of the long-looked-for "teeth" of *Titanichthys*.

In answer to this possible interpretation the writer would say that such a view does not seem to him to be warranted by the character of the present dental plate. Its form is not suggestive of having been set in a titanichthid mandible. From the analogy of other arthrodires the teeth in the mandible should all point approximately in the same direction, whereas in the present element the two teeth point in opposite directions (*cf.* Fig. 5 A). Its surface texture, by reason of its density, is more suggestive of a dinichthid or a mylostomid dental than that of a *Titanichthys*.

***Coccosteus fossatus* (Eastman).**

1907. *Protitanichthys fossatus* EASTMAN, Mem. N. Y. State Mus., 10, p. 144, pl. 10, fig. 2, and text fig. 30.

1908. *Protitanichthys fossatus* EASTMAN, Ann. Rept. Geol. Surv. Iowa, p. 201, fig. 30.

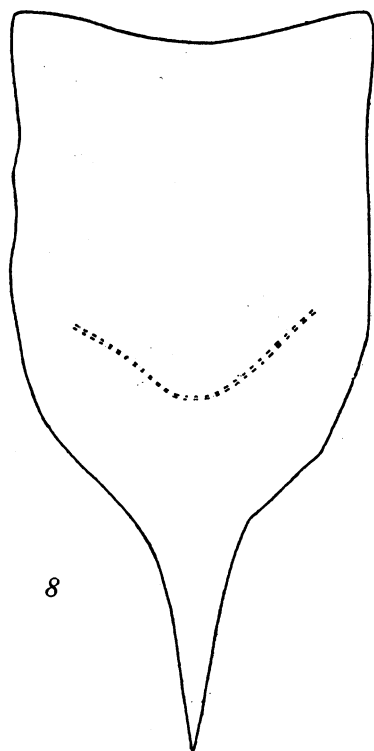
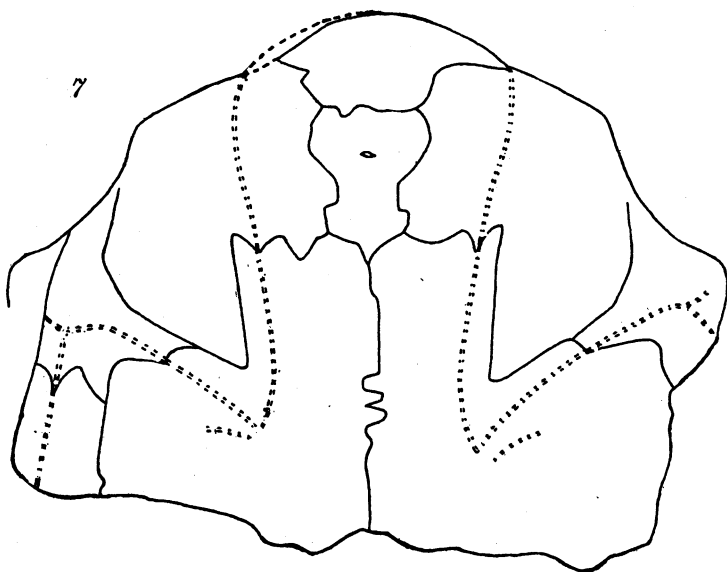
The writer has elsewhere ¹ called attention to the fact that the proposed genus *Protitanichthys* was founded upon rather doubtful grounds. In the following remarks it is proposed to deal more at length with this matter.

The genus was based upon a single head shield displaying the inner aspect and lacking the posterior, or median occipital, region. Both sensory canals and sutures can be clearly made out owing to the unusual mode of preservation and fracture of the specimen. The photograph here reproduced (Pl. XLV) gives a clear idea of the characters of this form; and the outline (Fig. 7), which is made from a careful tracing, presents graphically the result of a close study of the original. It may be noted in passing that this outline differs considerably from that by Dr. Eastman ² accompanying the original description.

The character upon which Dr. Eastman laid most stress in the original description, and which influenced him in selecting the generic name, was the supposed presence of a short-and-broad pineal element — a feature which he regarded as suggestive of titanichthid affinities. But there can be no doubt, I believe, after a close scrutiny of the specimen, that the pineal is not really of that form, but rather elongated fore-and-aft as in typical coccosteids. A transverse flexure across the middle of the pineal (clearly shown in the photograph as a transverse shadow) was apparently taken by Dr. Eastman for the posterior suture of the plate. The specimen clearly

¹ Science, N. S., XXVIII, 1908, p. 312.

² Mem. N. Y. State Mus., 10, 1907, fig. 30.



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Head shield, dorsomedian and mandible of probably the same species of coccostean. Natural size. Delaware limestone (Mid. Devon.): Delaware, Ohio.

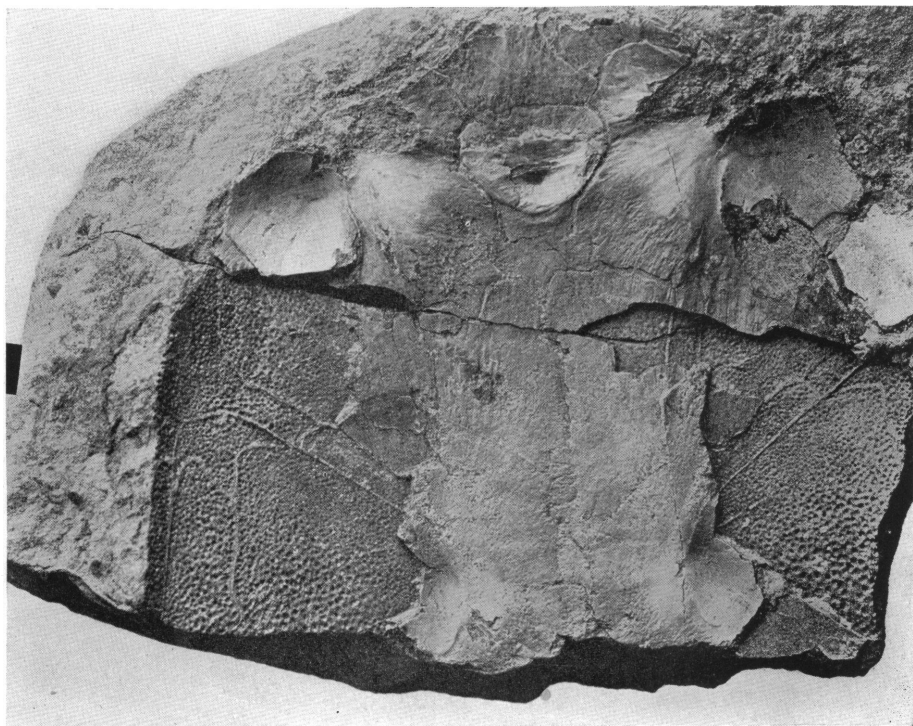
Fig. 6. "*Liognathus*" *spatulatus* Newb. Right mandible, inner view. Newberry Coll., Amer. Mus. No. 325.

Fig. 7. *Coccosteus* (*Protitanichthys*) *fossatus* (Eastman). Head shield. Original in Museum of Comparative Zoölogy, Harvard University.

Fig. 8. *Coccosteus occidentalis* Newb. Dorsomedian, outer view. Newberry Coll., Amer. Mus. No. 313.

shows the outline of the pineal to be that indicated in Figure 7; in fact its lateral sutures are partially brought out in Plate XLV and can be clearly seen in the original photograph. Hence the pineal of this head shield shows no anomalous characters. Except for trivial details it is like that of other coccosteans.

In other regards, such as size, shape of the several elements, direction of the sensory canals and ornamentation, the specimen is typically coccostean. Moreover, it was found in a formation (Delaware limestone) from which remains of two other coccosteids have been described — *Coccosteus occidentalis* (dorsomedian Fig. 8, and median ventral) and *Liognathus spatulatus* (mandible, Fig. 6); indeed, the tubercular ornamentation of the cranial shield of *Protitanichthys* is indistinguishable from that of the dorsomedian of *Coccosteus occidentalis*. It seems reasonably certain therefore, that all these fragments, which have received different names, represent one species; at any rate *Protitanichthys* and *C. occidentalis* appear to belong together. But in default of demonstrative evidence of such specific identity it is expedient to retain the several specimens under different specific names. But certainly it would be unjustifiable to refer the newly discovered head shield to a distinct genus.



HEAD SHIELD OF *Coccosteus fossatus* (EASTMAN). $\times 1\frac{1}{4}$.

Original in the Museum of Comparative Zoölogy, Cambridge, Mass.; kindly loaned by
Dr. C. R. Eastman.

