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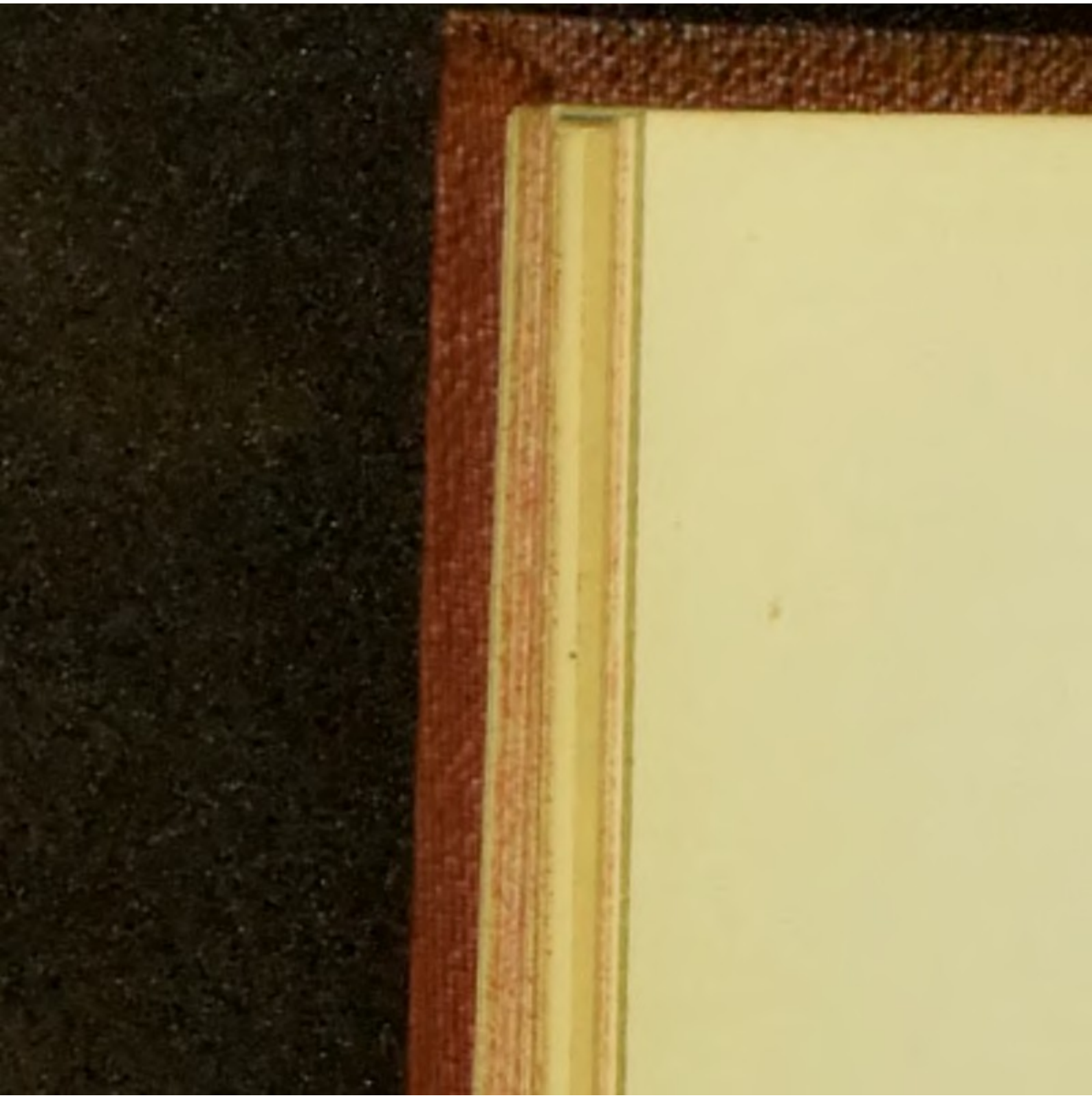
In 1870 the collection of Triassic fishes made by Messrs. W. C. and J. H. Redfield, and generally known as the "Redfield Collection," was presented to the Yale Museum, with the understanding that it should be arranged and placed on exhibition as soon as opportunity served. The gift was acknowledged in the annual report of the Sheffield Scientific School, 1870–71; but for various reasons most of the specimens remained unexamined in the store-rooms of the museum for nearly thirty years. Meanwhile, good material of the same geological age, received from other sources, has greatly enhanced the value of the Yale collections.

Semionotus.

In preparing these Triassic fishes for exhibition, an attempt was made to follow Prof. Newberry's classification, as proposed in his monograph on the Triassic Fishes and Plants.* His arrangement, however, was not found entirely satisfactory. Especially was this the case in regard to the genus *Semionotus (Ischypterus)*, under which some of the specific definitions are uncertain guides in identifying specimens, because of the lack of characters offering any real contrast between the different species named. Fortunately most of Prof. Newberry's types are preserved in the Yale University Museum and in the Columbia University Museum. After a careful study of these and of all other accessible material, the present writer has been enabled to state additional characters to some of the species described in Prof. Newberry's work; while, on the other hand, it still seems advisable to leave many forms in the doubtful list to which they were relegated by Dr. A. Smith Woodward.† Indeed it appears probable that Prof. Newberry's enthusiasm led him to describe more species than are now warranted by the better and larger collections available for study. Well aware of the difficulties he encountered in classifying such imperfect and indistinctly preserved material as the American Triassic fishes, Prof. Newberry himself graciously made easier the task of reducing the number of species by stating that intermediate forms might ultimately make reduction necessary. It is significant that in Dr. Woodward's Catalogue, only two of the American species are deemed worthy of description under the genus *Semionotus* (synonymous with *Ischypterus*), the remainder being merely listed as doubtful and probably

* Mon. U. S. Geol. Surv., No. xiv, 1888.

† Cat. Foss. Fish., British Mus. Nat. Hist., pt. iii.



here some characters of the scales which have not been emphasized by previous writers. The most handsome and complete specimens do not generally show the form of the overlapped portions of the scales. Such details are occasionally to be seen in the dissociated scales of fragmentary specimens. Unfortunately the same conditions which make this possible may also render the specific identification difficult and uncertain. Slightly at variance with Dr. Woodward's statement in regard to the scales,* "the narrow overlapped margin not produced at the angles," most of the American species show the antero-superior angle of the lower flank scales produced to a marked degree, and there is reason to suppose that this character holds good throughout the American division of the genus. Not only is the "peg-and-socket articulation" found in the flank scales generally, the pegs extending upward from the superior border of the scales, but the present writer has prepared for the Yale Museum an example of *Semionotus* from Boonton, N. J., in which the lower flank scales of the ventral region articulate by a second series of pegs and sockets (Plate VI, fig. 3). The antero-inferior angles of these scales bear peg-like processes, similar in size and form to those of the upper border, which lie under the posterior margins of the adjacent scales. The specimen displaying this double articulation is of uncertain specific identity, and it would be quite useless, at present, to speculate upon the prevalence of this character throughout the genus.

Semionotus fultus Agassiz.

Palæoniscus fultus L. Agassiz, 1833, Poiss. Foss., vol. ii, pt. i.
Palæoniscus fultus W. C. Redfield, 1841, This Journal. vol. xli.
Palæoniscus macropterus W. C. Redfield, 1841, ibid.
Ischypterus fultus Sir P. Egerton, 1847, Quart. Jour. Geol. Soc., vol. iii.
Ischypterus fultus J. S. Newberry, 1888, Mon. U. S. Geol. Surv., No. xiv.
Ischypterus macropterus J. S. Newberry, 1888, ibid.
Semionotus fultus A. S. Woodward, 1895, Cat. Foss. Fish., British Mus. Nat. Hist., pt. iii.

A number of specimens seeming to Prof. Newberry to offer slight differences in the proportions of length and depth were arranged by him in two species—*Ischypterus fultus* and *I. macropterus*. These specific names had been used previously, their history being as follows: In 1833 *Palæoniscus fultus* was given by Agassiz, in his *Poissons Fossiles*, to small and imperfect specimens from Sunderland, Mass. The species was afterwards placed in the new genus *Ischypterus*, by Sir Philip Egerton.† Meanwhile, the name *Palæoniscus fultus* was applied to specimens from Massachusetts, Connecticut, and

* Loc. cit.

† Quart. Jour. Geol. Soc., vol. iii, 1847.

New Jersey, by W. C. Redfield,* who at the same time gave the name *P. macropterus* to specimens from these localities. It appears that there was some doubt as to the validity of the latter species, for, in 1848, a paper by J. H. Redfield was read before the Association of American Geologists and Naturalists, in which *I. fultus* and *I. macropterus* were discussed and were united under the name *I. fultus*. The late Prof. Newberry, belonging to a school of paleontologists whose practice it was to decide all doubtful cases in favor of new species, again separated the two forms; and finally Dr. Woodward (loc. cit.) reunited *I. macropterus* with *I. fultus*, and placed the latter in the genus *Semionotus*, where it will doubtless remain, for no generic difference has been shown between the American *Ischypterus* and the Old World *Semionotus* established by Agassiz in 1832.

The only character of *Semionotus macropterus*, as described by Prof. Newberry, that separates it from *S. fultus* is its relatively greater depth† of body. Even this the author did not state with much assurance, for after discussing the two species at length without contrasting them, he used the following words: "In most cases, however, there need be no doubt, the fusiform and slender fish standing for *I. fultus*, the broader one for *I. macropterus*." A careful examination of Prof. Newberry's original collection at Columbia University shows that, while one of the specimens (not a type) of *I. macropterus*, in its pressed and flattened condition, is deeper than a type of *I. fultus*, all the others are proportionately more slender. For this reason Dr. Woodward's decision will be adopted, and the specimens in the Yale Museum which have hitherto been labeled *I. fultus* and *I. macropterus* will now be exhibited under the name *Semionotus fultus*. The following description, while not as clear as could be desired, is as detailed as the condition of the fossils permits; and it will serve, at least, to distinguish good examples of *S. fultus* from well-preserved specimens of the other species:

S. fultus, attaining a length of 9 inches and a depth of 2½ inches. Origin of dorsal fin at mid-length.

Origin of anal fin under middle of dorsal fin or somewhat further to the rear, and on the third oblique scale-row in advance of the dorsal fin.

Origin of ventral fins slightly nearer to anal fin than to pectoral fins.

Dorsal fin fulcra about 12, rays about 10 (Plate V, fig. 1).

Anal fin fulcra about 12, rays about 10.

Dorsal and anal fin fulcra long. Apparently 4 dorsal fulcra

* This Journal, 1841.

† Termed "broader" by Newberry.

originate on the dorsal line over basal supports. The 5th dorsal fulcrum has its origin adjacent to that of the 1st ray, and is about equal in length to one-half the anterior margin of the fin.

Pectoral fins show, on the superior surface, about 10 fulcra, long and slender, and not widely divergent from the rays, which are about 10 in number (Plate V, fig. 2).

Ventral fins show, on the superior surface, about 10 fulcra.

Caudal fin has about 15 rays.

The best preserved specimens are a little less than four times as long as deep, the maximum depth being midway between head and dorsal fin, where the oblique scale-row comprises about 20 scales. Horizontal scale-row along lateral line comprises about 33 scales.

The deepest scales are in the 4th row behind the clavicular arch; these are twice as deep as long.* Scales of the anterior caudal region are nearly equilateral. With the exception of the scales of the lateral line, the anterior flank scales generally have the postero-inferior angles slightly rounded (Plate V, fig. 3), and the posterior flank scales have the postero-inferior angles produced into single points (Plate V, fig. 4). In rare and doubtful cases, the posterior borders of the flank scales may be slightly irregular, but never to the extent commonly seen in *S. micropterus*.

Semionotus micropterus Newberry.

Ischypterus micropterus J. S. Newberry, 1888, Mon. U. S. Geol. Surv., No. xiv.

One of the fishes placed by Dr. Woodward in his list of doubtful species is *S. micropterus*. It is encouraging to find that good specimens, not accessible when his Catalogue was compiled, now make it possible to describe this species more fully and to separate it from other forms by the characters of its fins and scales, and not solely by its contour. This species may be described as follows:

S. micropterus, attaining a length of 10 inches and a depth of 3 inches.

Relative position and size of fins about the same as in *S. fultus*.

Dorsal fin fulcra about 14, rays about 9 (Plate V, fig. 13).

Anal fin fulcra about 14, rays about 9.

Dorsal and anal fin fulcra relatively shorter than in *S. fultus*. Apparently 3 dorsal fulcra originate on the dorsal line over basal supports. The 5th dorsal fulcrum has its origin on the anterior margin of the 1st ray, at a point considerably removed

*These and similar measurements refer to the exposed portion of the scales, not to actual dimensions.

from the origin of that ray, and is about equal in length to one-third the anterior margin of the fin.

Pectoral fins show, on the superior surface, about 17 fulcra, which are shorter than in *S. fultus* and other species (Plate V, fig. 6).

The last scale of the anterior dorsal ridge has its posterior end slightly produced into a point (Plate V, fig. 11).

The best preserved specimens are a little more than three times as long as deep, and have a more strongly convex outline in the pectoral region than *S. fultus*.

In the majority of specimens, the flank scales, especially those below the lateral line, show a tendency to become bi- or tri-dentate on the postero-inferior angle (Plate V, figs. 7 and 8). Although this character is not always present, it may serve to identify the species in question, when the dorsal and pectoral fins are not preserved. No other species shows scales thus strongly dentate.

In reference to these dentate scales of *S. micropterus*, it is interesting to note that a specimen of this species, showing this character highly developed, but having the anterior dorsal ridge (characteristic of the genus) concealed, was labeled by Prof. Newberry "*Catopterus Redfieldi*." This error may have been caused by the presence of the "one or more posterior teeth" of the scales, given by Prof. Newberry as a character of *C. Redfieldi*, and also by the form of the pectoral fin fulcra, which offer a slight resemblance to those of *Catopterus*.

Semionotus Marshi W. C. Redfield.

Ischypterus Marshii W. C. Redfield, 1856, Proc. Am. Assoc. Adv. Sci. (Name only).

Ischypterus Marshii J. S. Newberry, 1888, Mon. U. S. Geol. Surv., No. xiv.

The Redfield Collection contains an imperfect fish about 12 inches long, from Sunderland, Mass., bearing the name *Ischypterus Marshii*. No description of this fish was published by the Redfields, although the name is found in a paper by W. C. Redfield entitled "On the Relations of the Fossil Fishes of the Sandstone of Connecticut, and other Atlantic States, to the Liassic and Jurassic Periods" (Proc. Am. Assoc. Adv. Sci., 1856). Prof. Newberry's monograph contains a plate and a description of this species, the credit for which is generously given to W. C. Redfield. Three other specimens from Sunderland, undoubtedly belonging to the same species as the above mentioned fish, are in the collection of the American Museum of Natural History in New York. According to the statement of Prof. Whitfield of that museum, their labels, bearing the name *I. Agassizii*, were written at the dictation of Prof. Newberry, when the latter was asked to identify them. This

incident is of especial interest in connection with the discussion of *I. Agassizii* in Prof. Newberry's monograph, where he writes "I have seen no such fishes as these anywhere except at Boonton. * * * At Sunderland occurs another species (*I. Marshii*) which in form and general aspect resembles those under consideration, but it is narrower, with less strong dorsal and anal fins, with thicker and relatively broader scales, which form more oblique rows on the sides. For these reasons I have thought it wise to regard it as distinct."

So far as comparison can be made, the three fishes at the American Museum of Natural History, labeled *I. Agassizii*, agree with the type of *S. Marshi* in size and form of body, size, form, and obliquity of scales, and relative position and structure of fins. The specific description here offered is based upon these specimens jointly with the type at Yale:

Semionotus Marshi, attaining a length of 12½ inches and a depth of 3½ inches.

Relative position and size of fins about the same as in *S. fultus*.

Dorsal fin fulcra about 14, rays about 9.

Anal fin fulcra about 14, rays about 9.

Apparently 4 dorsal fin fulcra originate on the dorsal line over basal supports, the 5th being nearly equal in length to one-half the anterior margin of the fin.

Pectoral fin fulcra about 14, rays about 12.

Ventral fin fulcra about 12.

The flank scales usually have the postero-inferior angles a little less pointed than in *S. fultus* (Plate V, figs. 5 and 12), and have the antero-superior angles continued forward as distinct processes under the overlapping scales (Plate V, fig. 9; Plate VI, fig. 2). The deepest scales are in the 3rd or 4th oblique row behind the clavicular arch; these are about twice as deep as long. Scales near the lateral line under the dorsal fin are equilateral.

The maximum depth is midway between the pectoral and ventral fins, where the oblique rows comprise about 19 scales. Horizontal row along lateral line comprises about 34 scales.

The last scale of the anterior dorsal ridge has its posterior end produced into a fine point (Plate V, fig. 10).

Semionotus tenuiceps Agassiz.

Eurynotus tenuiceps L. Agassiz, 1835, Poiss. Foss., vol. ii, pt. i.
Eurynotus tenuiceps J. H. Redfield, 1837, Ann. Lyc. Nat. Hist. N. Y., vol. iv.
Palæoniscus latus J. H. Redfield, 1837, ibid.
Ischypterus tenuiceps J. S. Newberry, 1888, Mon. U. S Geol. Surv., No. xiv.
Semionotus tenuiceps A. S. Woodward, 1895, Cat. Foss. Fish., British Mus. Nat. Hist., pt. iii.

This is one of the two American species of *Semionotus* approved by Dr. Woodward. Except in its young form it may be

easily distinguished from other species by the peculiar development of the scales of the anterior dorsal ridge. Dr. Woodward describes his type in the collection of the Geological Society of London as follows:

"A species attaining a length of about 0·2 [m]. Trunk with a considerably arched dorsal border, the depth of the caudal pedicle more than one-third as great as the maximum depth of the abdominal region. Length of head with opercular apparatus less than the maximum depth of the trunk, and contained four times in the total length of the fish. Fins as in *S. fultus*. Scales smooth and not serrated, those of the middle of the flank in part twice as deep as broad; dorsal ridge-scales large and conspicuous, comparatively obtuse in large specimens."

To this may be added that the last scale of the anterior dorsal ridge has its posterior end blunt and not produced, while the scale on the ventral line immediately in front of the anal fin has its posterior end notched. The ribs are more strongly developed than in other species.

Semionotus ovatus W. C. Redfield.

Palæoniscus ovatus W. C. Redfield, 1841, This Journal, vol, xli.
Ischypterus ovatus Sir P. Egerton, 1850, Quart. Jour. Geol. Soc., vol. vi.
Ischypterus ovatus J. S. Newberry, 1888, Mon. U. S. Geol. Surv., No. xiv.

Several specimens are to be found bearing this name, but, as far as the writer can ascertain, only one, the type at Columbia University, is so well preserved as to afford specific distinction. The only character given hitherto in which this species differs from others is the greater proportionate depth of body midway between the head and dorsal fin. The type specimen, however, shows another character which will probably be found more reliable, viz., a greater number of dorsal and anal fin fulcra than is found in the other American species of this genus.

S. ovatus, length 11 inches, depth $3\frac{3}{4}$ inches.

Position and size of fins about the same as in *S. fultus*.

Dorsal fin fulcra 21, actually preserved.

Anal fin fulcra 19, actually preserved.

Apparently 5 dorsal fin fulcra originate on the dorsal line, and the 6th is equal in length to a little less than one-half the anterior margin of the fin (Plate VI, fig. 5).

There is much confusion about the localities ascribed to the American species of *Semionotus*. For example, the two imperfect specimens to which Agassiz applied the name *S. fultus* were found at Sunderland, Massachusetts, and specimens in the Redfield Collection, whose original labels were *S. fultus*, have proved to be *S. tenuiceps* from Massachusetts and *S.*

micropterus from Connecticut. It is certain, however, that Prof. Newberry's types of *S. fultus* and *S. macropterus*, illustrated in his monograph, are from Boonton, New Jersey, and that all the specimens in the Redfield Collection which agree with these types are from New Jersey also; indeed it is possible that *S. fultus* of Newberry should be rightly considered as limited to that state.

S. micropterus is known only from Connecticut.

S. Marshi probably occurs in Massachusetts, Connecticut, and New Jersey.

S. tenuiceps is a Massachusetts species which is doubtfully from Connecticut.

S. ovatus (type) is from Boonton, New Jersey.

The other species of *Semionotus* described by Prof. Newberry in his monograph must remain of doubtful validity until their claims for distinction are better supported. Indeed the difficulty of the situation cannot be better shown than by quoting Dr. Woodward's sweeping statement: "Nearly complete fishes, variously crushed and distorted and sometimes imperfectly preserved, have been described from the Trias of North America under the following names. They may be conveniently referred to the genus *Semionotus*, and doubtless represent much fewer species than are here enumerated." Then follows a list of all the American species except *S. fultus* and *S. tenuiceps*. It is the present writer's hope that these notes may serve to reëstablish three of the species thus lately discredited, and may place the classification of this genus on a firmer basis.

Catopterus J. H. Redfield.

This genus is represented in the Yale Collection by J. H. Redfield's type of *C. gracilis* and by a remarkably good series of specimens from the Trias of New Jersey and of the old Connecticut River valley, which probably belong under the type species, as they agree in the main with the characters of that species given by Dr. Woodward. The only addition to the knowledge of the structure of this genus is the determination that the flank scales were interlocked by a single peg-and-socket articulation. From the superior margins of these scales arise pegs similar to those which characterize the superior margins of the flank scales of *Semionotus*; but no articulating processes have been found projecting from the antero-inferior angles. As flank scales can be seen in the closely allied genus *Dictyopyge*, which articulate in a like manner, it is evident that the single peg-and-socket articulation is characteristic of the Catopteridæ.

Yale University, February 24, 1903.

EXPLANATION OF PLATES.

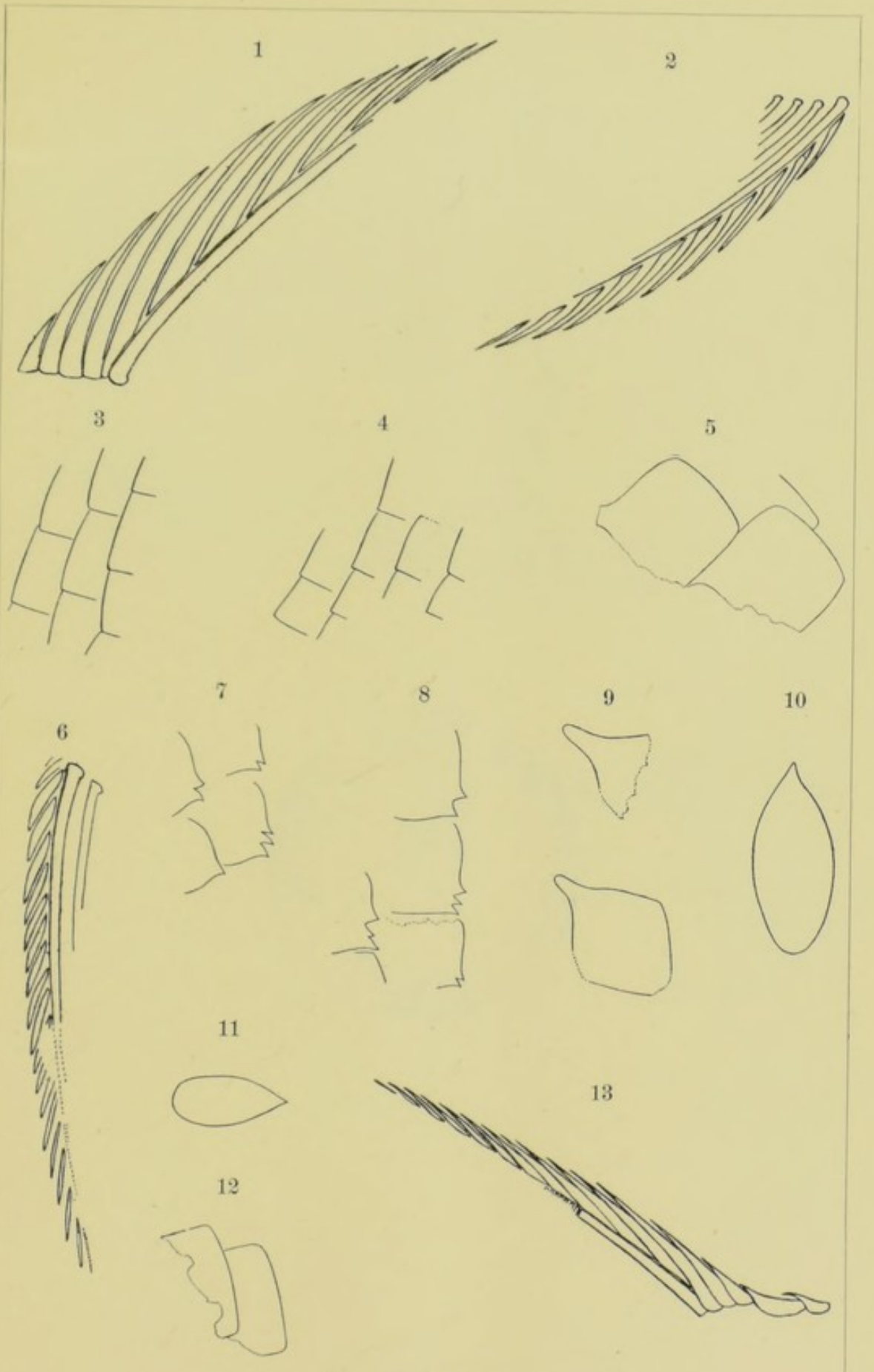
Plate V.

Figure 1.—*Semionotus fultus;* dorsal fin.
Figure 2.—*S. fultus;* pectoral fin.
Figure 3.—*S. fultus;* anterior flank scales.
Figure 4.—*S. fultus;* posterior flank scales.
Figure 5.—*S. Marshi;* scales from 12th oblique row, a little below lateral line.
Figure 6.—*S. micropterus;* pectoral fin.
Figure 7.—*S. micropterus;* anterior flank scales.
Figure 8.—*S. micropterus;* posterior flank scales.
Figure 9.—*S. Marshi;* posterior flank scales.
Figure 10.—*S. Marshi;* last scale of anterior dorsal ridge.
Figure 11.—*S. micropterus;* last scale of anterior dorsal ridge.
Figure 12.—*S. Marshi;* scales of 7th and 8th oblique rows, immediately below lateral line.
Figure 13.—*S. micropterus;* dorsal fin.

All the figures are twice natural size.

Plate VI.

Figure 1.—*S. Marshi;* head; natural size.
Fr., frontal; *Pa.*, parietal; *S.t.*, supratemporal; *Sq.*, squamosal; *P.or.*, postorbital; *Op.*, operculum; *P.op.*, preoperculum; *I.op.*, interoperculum; *S.op.*, suboperculum.
Figure 2.—*S. Marshi;* lower flank scale, showing articular process; natural size.
Figure 3.—*Semionotus*, sp.; lower flank scales, showing double articulation; four times natural size.
Figure 4.—*Semionotus*, sp.; premaxillæ; natural size.
Figure 5.—*S. ovatus*; dorsal fin; twice natural size.



TRIASSIC FISHES.

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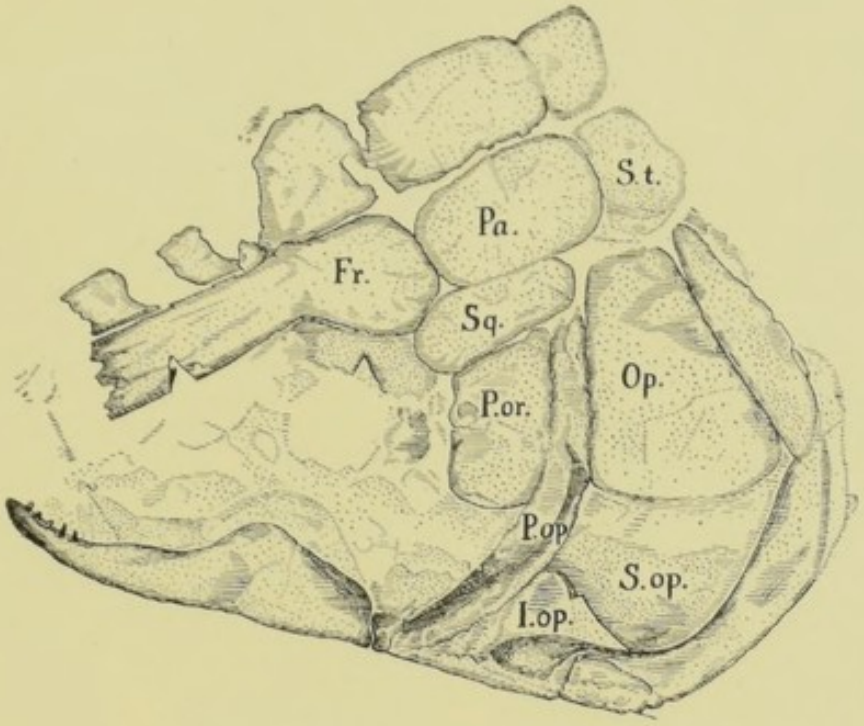

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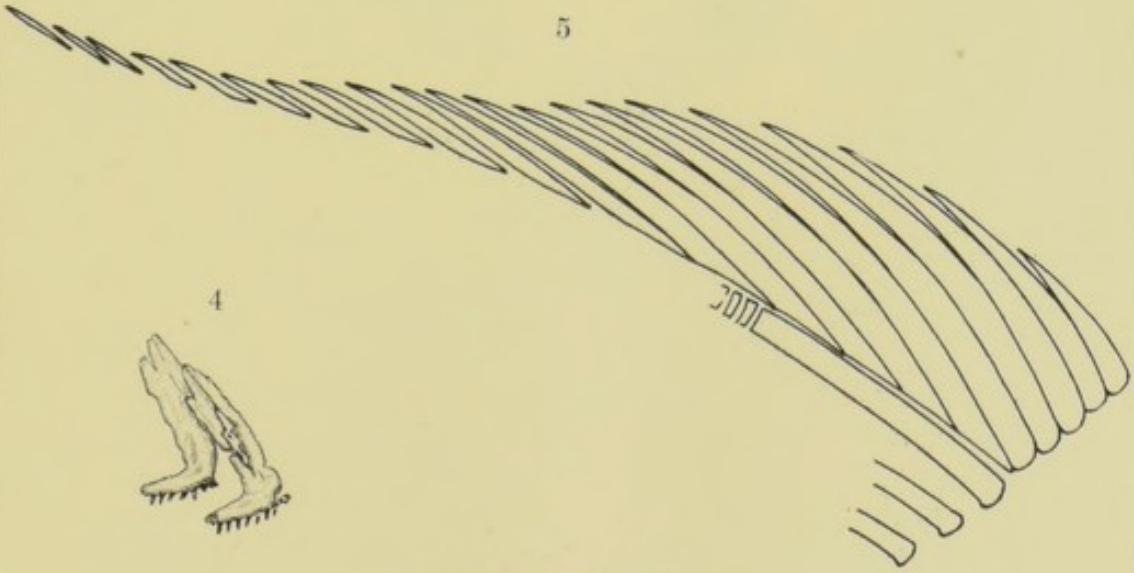

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TRIASSIC FISHES.