





Museum of Comparative  
Zoology  
DEC 18 1939  
LIBRARY

A NEW ARTHRODIRE  
FROM THE  
CLEVELAND SHALE FORMATION

BY  
DAVID H. DUNKLE  
AND  
PETER A. BUNGART

SCIENTIFIC PUBLICATIONS  
OF THE  
CLEVELAND MUSEUM OF NATURAL HISTORY

Vol. VIII, No. 2, pp. 13-28  
Issued, December 14, 1939  
CLEVELAND, OHIO

e







PLATE III

*Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). Photograph of the shale block containing the greater part of the type specimen. For an explanation see Text Fig. 1. Slightly less than x 3/10.

SCIENTIFIC PUBLICATIONS  
OF THE  
CLEVELAND MUSEUM OF NATURAL HISTORY

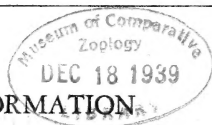
VOL. VIII

ISSUED, DECEMBER 14, 1939

No. 2

70,743

A NEW ARTHRODIRE  
FROM THE CLEVELAND SHALE FORMATION



BY

DAVID H. DUNKLE AND PETER A. BUNGART

INTRODUCTION

The Cleveland Museum of Natural History possesses a collection of fossil fishes numbering some two thousand and two hundred specimens. The collection is comprised of Arthrodiran, shark and Osteichthyian remains collected, during the past seventeen years, exclusively from the exposures of the Upper Devonian Ohio Shales occurring in Cuyahoga, Lorain, Erie, and Huron Counties, Ohio. It is undoubtedly the largest single collection of these fishes from the Devonian of Ohio which has ever been accumulated. Its importance is further enhanced by the facts that nearly all of the known forms from these rocks are represented, and that, in a number of cases, genera are represented by large series of specimens. The collection offers a means, therefore, toward the solution of various taxonomic and phylogenetic problems concerning these early fish groups hitherto only partially answered.

As the initial step in a proposed comprehensive study, a survey of the entire collection has been made. During this rather cursory examination, a number of specimens were observed which we consider belonging to previously unrecognized forms. It has been thought best to describe these new fish separately as time permits. The present paper concerns the remains of a small Arthrodire recovered by one of us (P. A. B.) from fallen shale debris. The specimen consists of a number of bones and impressions of bones displayed in a shale slab, and also several free plates. The series of bones, from the head shield and body carapace, is not complete. Most of the plates are easily identifiable, despite complete disassociation, by comparison with those of other Arthrodiras. There is no doubt but that the entire assemblage of bones is from a single individual.

We wish here to express our grateful appreciation to Mr. Guerdon S. Holden of Cleveland for his kindly interest in this work. Mrs. J. E. Hyde and Mr. Eber Hyde have been most considerate in placing at our disposal the library and notes of the late Professor Jesse Earl Hyde, Curator of Geology at The Cleveland Museum of Natural History from 1922 until 1936, in whose honor the species is named.

### **Gymnotrachelus hydei** gen. et sp. n.

*Type Specimen.* C. M. N. H. Cat. Fos. Fishes No. 5724: a number of disassociated bones and impressions of bones from the head and body armor contained in a shale slab; also several loose bones from the same individual.

*Geological Horizon and Locality.* Cleveland Shale Formation of the Upper Devonian on Townnes Creek, (Oberlin Quadrangle) Lorain County, Ohio.

*Collected* — May 7th, 1928 by Peter A. Bungart.

*Generic Diagnosis.* A comparatively small Arthrodire with broad and somewhat flattened head shield and body carapace. Bones relatively heavy in proportion to the size of the fish, unornamented, and widely overlapping in their contact with each other. Orbits large and forwardly placed; limited in front by a strongly developed pre-orbital process; post-orbital process quite indistinct. Dorsal unarmored space between the Median Basal and Median Dorsal nearly twice as long as wide between the condyles on the Antero-dorsolaterals. Median Basal broader than long; the postero-lateral processes converging forward in approximately a ninety degree angle; postero-medial spine stout. Externo-basal widely overlapped along most of its dorsal margin by the Median Basal; condylar fossa broad and shallow; the glenoid process represented by a weakly developed protuberance. The anterior portion of the Sub-orbital heavy; lateral face of this portion much deepened; as long or longer than the thin expanded posterior portion. The Antero-supra-gnathal roughly triangular and plate-like; a single series of tooth-like tubercles projecting down from the anterior and lateral margins. Postero-supra-gnathal long and slender; a single row of evenly spaced "teeth" project along the entire inferior border. Infero-gnathal long and



comparatively heavy; dorsal margin of the anterior half studded with "teeth" which may be in more than a single longitudinal row; presumably with no high anterior cusp developed.

Median Dorsal with a short median and a pair of long lateral anterior processes; ventral keel low and not extending to the anterior limits of the plate; posterior portion of the keel thickened and projecting beyond the rounded posterior margin of the dorsal plate. Antero-dorso-lateral deeper than long; condyle moderately developed; sub-glenoid process weak; anterior margin of the bone extended markedly upward and backward dorsal to the condyle. The Antero-lateral short but indicated to be exceedingly deep.

Sensory canals developed as deep narrow grooves. The externo-basal canal represented by a single pit immediately anterior to the lateral extremity of the condylar fossa. An accessory central canal present. Gape between dorsal and ventral portions of the sub-post-orbital canal wide. Gnathal and sub-post-orbital canals not joined on the sub-orbital plate. Antero-lateral canal not developed on the Postero-dorso-lateral.

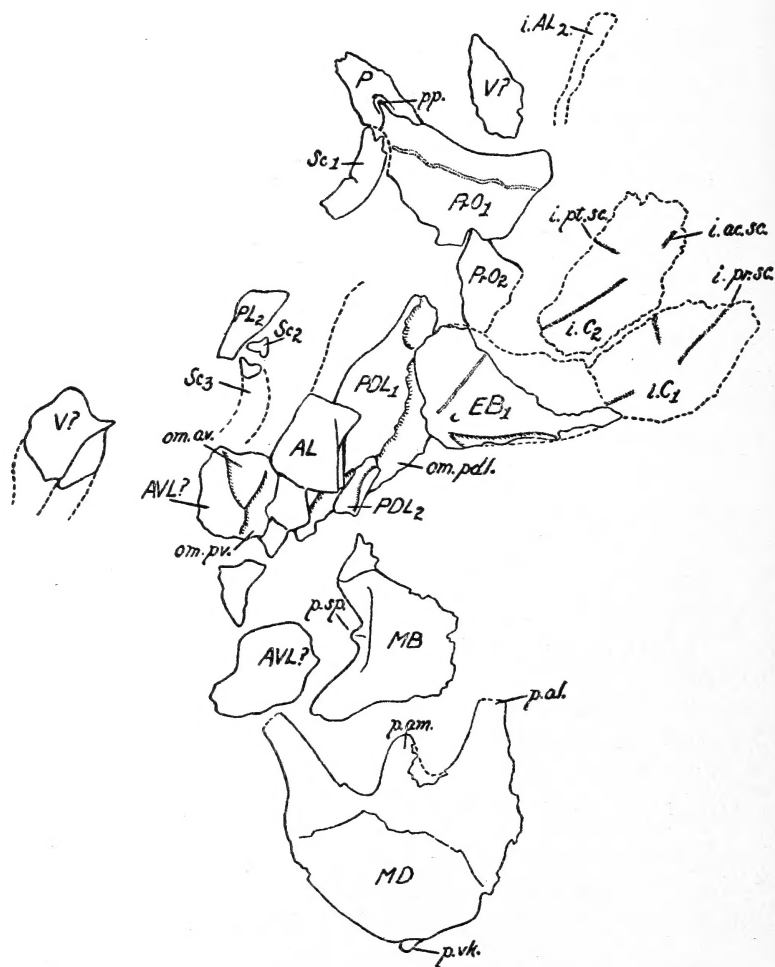
*Specific Diagnosis.* — At this time the same as the generic diagnosis.

## DESCRIPTION

The bones and impressions of bones comprising the type specimen indicate an Arthrodire of small size. In contrast with this small size, the proportionately robust development of the bones is noteworthy. The preservation is generally excellent. Only a slight distortion of the elements by crushing has occurred, a fact due perhaps to the heavy deposits of pyrite laid down within the cell spaces. The external and internal surfaces of the bones do not exhibit any ornamentation and even the radiating lines of ossification are but faintly discernible. The areas of overlap by adjacent bones are exceedingly broad and well defined.

*Bones of the Cranial Roof.* — The Median Basal (MB) is preserved with the dorsal and posterior surfaces exposed for examination. The dorsal surface is gently convex from side to side. Its postero-lateral angles are drawn out into broad extensions which overlap much of

the dorsal edge of the Externo-basals. The greatest width of the Median Basal occurs across the extremities of these postero-lateral processes. The maximum length of the bone is only two-thirds this width. The posterior margin of the plate is thickened and encloses



TEXT FIG. 1. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). Outline sketch of Plate I, showing the arrangement of the disassociated bones and impressions on the shale block. Approx. x 3/10.

an indentation whose outline tapers to a forward angle of approximately ninety degrees. An exceptionally stout median spine projects backward into this indentation from the thickened posterior surface of the bone. The anterior border of the Median Basal is truncated and the width of this margin is less than half the posterior width.

The paired Centrals (C) are represented mainly by the impressions on the shale block of their ventral surfaces. Only small fragments of the actual bones remained, at the time when the specimen was discovered. These plates are large, twice as long as broad, and are indicated to have been of comparatively thin uniform thickness. Their margins are very irregular and appear serrated. As in the cases of many Arthrodires, the courses of the externally grooved sensory canals are marked by corresponding ridges on the internal surfaces of the bones. The presence of the pre-orbital canal, the so-called sub-post-orbital canal extension on the Central, and an accessory central canal, the middle head line of Stensio (1925), are clearly exhibited by the impressed ventral surfaces. The terminations of these canals are widely separated near the center of ossification.

The Pineal (P) is a small plate lying ventrally exposed. The bone tapers to a blunt point in its posterior portion. Anteriorly, although partially covered by the left Pre-orbital, it is quite broad. At about the center of the plate a pronounced elevation encloses the pituitary pit. The character of this elevation is reminiscent of that found in *Stenognathus* except that forward its sides do not appear to diverge as widely. The visible margins of the element surrounding this central structure are flat and thin. Their surfaces are marked by radiating ridges and grooves which indicate a firm overlap of the Pineal on the antero-mesial edges of the Central plates.

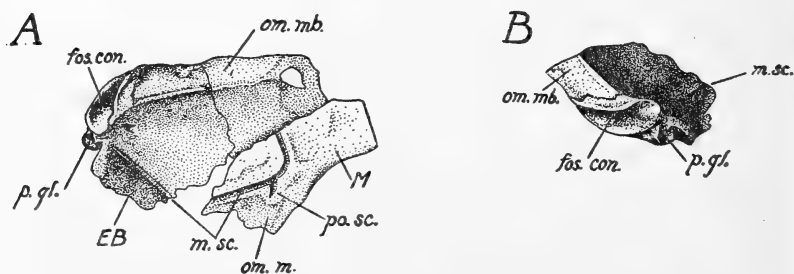
No recognizable Rostral (R) element has been observed.

Portions of both Externo-basal (EB) plates are preserved. The left one is contained in the shale block, lacking a fragment from its inferior margin. The outline of the missing fragment, however, is impressed on the shale. The less complete right Externo-basal is free. These elements are roughly triangular in shape, a rounded posterior edge forming the base of the triangle. The mesial or dorsal margin is almost straight and from immediately above the

condylar region forward, is widely overlapped by the lateral edge of the Median Basal. A prominent ridge limits laterally this depressed area of articulation. At the junction between dorsal and posterior borders the edge is thickened. This thickening is occupied by a broad and shallow condylar fossa. A horizontal line projected across the fossa meets the external contour line of the element in an angle of thirty degrees. The ventral lip of the fossa is more produced than the dorsal one. A small protuberance, the glenoid process, is developed on the lateral edge of the ventral lip. A distinct cleft remains, accommodating the sub-glenoid process of the Antero-dorso-lateral, between the dorso-laterally inclined face of the glenoid process and the external edge of bone which is confluent mesially with the dorsal lip of the fossa. The external surfaces of the plates are marked by the extensions of the marginal sensory canals and by a single pit situated above the condylar margin which presumably represent the externo-basal canals. Internally, the surfaces are without pronounced relief except for wide indented areas in the postero-dorsal portions of the plates, in all probability homologous with the postero-lateral impressions of *Dinichthys* (Heintz, 1932).

Only the postero-ventral angle of the Marginal (M) plate is present. The post-marginal sensory canal traverses the external surface of the fragment. On the inner surface and paralleling the posterior edge, there are several low ridges and shallow grooves on which possibly the post-marginal plate articulated.

The Post-orbital (PtO) plate, which is represented by the posterior portion of the right one crushed down on the right Externo-



TEXT FIG. 2. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). A. Left Externo-basal and Post-orbital plates in lateral aspect. B. Condylar fossa on left Externo-basal in posterior view. Approx. x 6/10.

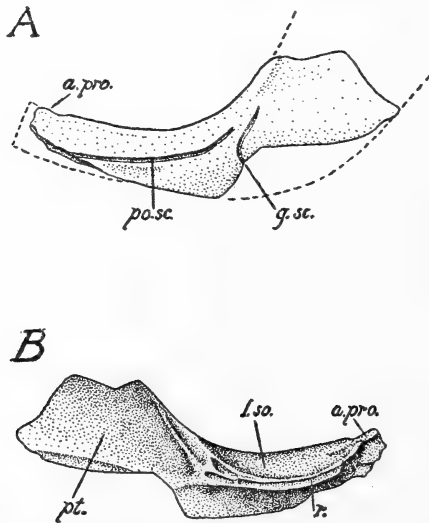
basal, is long, thin, and narrow. The lateral edge is gently concave and this concavity is only slightly interrupted by the projection of the indistinct post-orbital process. Seen from the inner surface, a weakly developed longitudinal ridge extends back a short way from the region of the post-orbital process. This ridge forms the mesial limits of the sub-orbital notch into which the antero-dorsal angle of the Sub-orbital plate abuts. The irregular posterior margin of the Post-orbital shows a depressed area for the overlap by the Marginal. The mesial edge of the plate is convex. From the contour of this edge and of the lateral one we can assume that the plate is more narrow in its anterior portion than behind. Externally, the marginal sensory canal extends forward from the postero-mesial corner of the plate and passes in a right angle curve inward onto the Central. A low ridge partially obstructs the complete junction between this canal and the short marginal portion of the sub-post-orbital canal.

The Pre-orbital (PrO) plates are crescentic elements fully as large as the Centrals. The entire left plate is exposed in dorsal aspect on the shale block. It tapers to a postero-lateral, finger-like extremity. The marginal contour of the plate, laterally, is concave, forming the dorsal and anterior borders of the orbits. The pre-orbital process is strongly developed. The extent of the free antero-inferior margin can not be accurately determined, but a concave portion of this edge, mesial to the pre-orbital process, perhaps indicates this dimension. The mesial margin is convex and is very irregular in outline. A distinct pre-orbital sensory canal traverses the length of the bone, paralleling the orbital border.

*Bones of the Cheek and Visceral Skeleton.* — The Sub-orbital (SO) plate is of the usual Arthrodiran type with a narrow infra-orbital handle and an expanded post-orbital portion. Only the left one was recovered with the specimen and it lacks fragments from the dorsal and inferior margins. A portion of the posterior margin, however, is entire, and from this it may be observed that the anterior handle is as long or longer than the posterior expanded portion of the plate. On the inner side of the handle the bone becomes gradually thickened from the thin dorsal edge ventrally, forming a longitudinal ridge, which continues the post-orbital border forward in a perfect arc. The dorso-mesially inclined surface between this ridge and the thin dorsal margin is concave in both transverse and frontal sections,

and serves as a lateral sub-orbital shelf. A comparatively broad shallow groove extends along the crest of the thickened ridge. That portion of the laterally deepened face of the handle ventral to the ridge is thin, and thus, appears sharply set off from the thickened portion in mesial view. Posteriorly, the inner ridge indistinctly bifurcates and becomes generally spread out into the expanded post-orbital portion of the Sub-orbital. One axis of the indistinct bifurcation follows the orbital margin and the other extends back to the posterior limits of the plate. Parts of both the sub-post-orbital and marginal sensory canals are exhibited on the lateral surface of the bone. These canals are not joined and neither approaches very closely the dorsal margin of the plate.

The Sclerotic (Sc) plates are represented by one well preserved element, a fragment and impression of another, and a fragment of a third. The plates are long, narrow, and quite thin. On either end of a plate, the slightly concave margin is produced into short pointed processes. The visceral surface of the one complete element exhibits striae which converge from the convex margin toward a center situated near the middle of the concave margin.



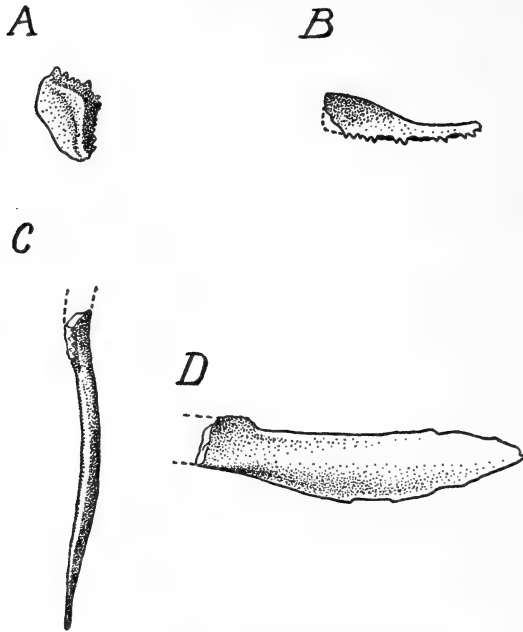
TEXT FIG. 3. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). A. Left Sub-orbital plate in lateral view. B. The same plate in mesial view. Approx.  $\times 6/10$ .

A fragment of bone, exhibiting a thickening on its inner surface similar to the thickening on the internal surface of a Dinichthyid Post-sub-orbital plate, was discovered with the specimen. Because of this structure, the fragment has been identified as the Post-sub-orbital of the present form. The bone is indicated to be of roughly triangular shape. Externally, it possesses a crescentic posterior exposed portion and an anteriorly directed flange which the postero-dorsal edge of the Sub-orbital plate overlapped. The thickening in the center of the inner surface is composed of an elevated ridge encircling a central depression.

Both right and left Antero-supra-gnathal (ASG) plates are preserved. In dorsal aspect these elements present a triangular appearance. The main body of each has the form of a thin horizontal plate. A heavy dorsally projecting ridge is developed along the anterior and lateral margins of this plate. The ridge is most produced near the angle of junction between the anterior and lateral faces and diminishes in height both mesially and posteriorly. A single row of twelve tooth-like tubercles project down from the inferior margin of this ridge. The "teeth" are very uneven in size and also in spacing. The ventral surfaces of these gnathal elements could not be prepared but from the thinness of the horizontal plate we may, perhaps, safely assume that it is quite flat.

The Postero-supra-gnathal (PSG) elements are long and thin. The right one, alone preserved in its entirety and with the inner side exposed, is most deep anteriorly and becomes reduced to a very low posterior termination. The dorsal margin of this plate is concave and seems to coincide with the contour of the inferior border of the sub-orbital ridge. The oral border of the Postero-supra-gnathal is almost straight and a single series of some eighteen tubercles are developed here.

Our knowledge of the Infero-gnathal (IG) is limited to the blade portion and the most posterior of the functional portion of the left element. The blade is only moderately expanded and is quite thick. Its posterior extremity is pointed. The tubercles on the oral margin are large and appear to be in a double irregular series. They project above the level of the dorsal edge of the blade portion, even with the perpendicular lateral surface of the bone. The dorsal margin of the element is thicker in this region than the base of the tubercles,



TEXT FIG. 4. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). A. The right Antero-supra-gnathal from above and slightly anteriorly. B. Inner surface of the right Postero-supra-gnathal. C. & D. Dorsal and lateral views respectively of the left Infero-gnathal. Approx.  $\times 6/10$ .

and consequently an interno-dorsal longitudinal shelf results. Assuming that the combined lengths of the two supra-gnathal elements equals approximately the length of the functional portion of the Infero-gnathal, we have restored the missing anterior portion of this latter plate. If correct, the blade and functional portions each occupy half the total length of the bone. It seems doubtful, because of the plate-like nature of the Antero-supra-gnathal, that any anterior cusp development existed.

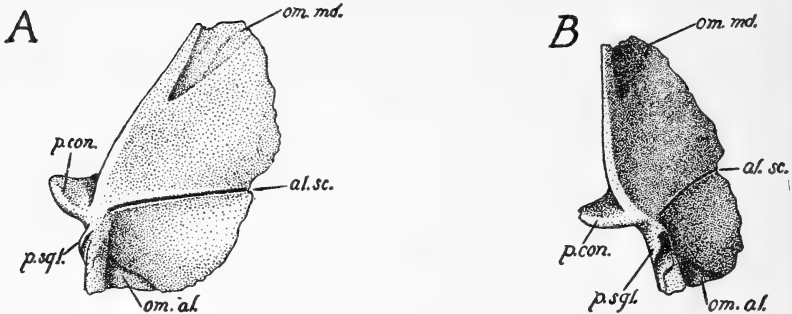
*Bones of the Body Carapace.* — The Median Dorsal (MD) is longer than wide. Its anterior margin bears three processes; a short median one, and a pair of long lateral ones. The posterior margin is broadly rounded. Ventrally, a low median keel is developed only in the posterior half of the plate. This keel becomes gradually heavier from front to back and terminates in a dorsally grooved process



which projects beyond and below the rounded margin of the dorsal plate.

The left Antero-dorso-lateral (ADL) plate is preserved, lacking portions of its posterior and inferior margins. The element is peculiarly developed and exhibits the features which contribute to the remarkably long unarmored nuchal space referred to in the generic diagnosis. The bone is much deeper than long. The lateral surface may be divided into dorsal and ventral portions, above and below the horizontal level of the condyle. The antero-lateral sensory canal extends across the plate at approximately this level. The anterior margin of the ventral portion is much thickened. The face of this portion is inclined dorso-laterally at an angle of 25 degrees from the vertical when the condyle is horizontal. As usual, this face is overlapped in part by the Antero-lateral plate from below. Only a small portion of this overlapped portion is preserved on the present plate. However, from evidences on the inner surface of the Antero-lateral, the ventral overlapped margin of the Antero-dorso-lateral is extensive. Dorsal to the horizontal level of the condyle, the lateral surface of the plate is inclined at an angle of 35 degrees from the vertical. The anterior margin of the dorsal portion extends rather sharply backwardly, and dorso-mesially. A V-shaped depression, accommodating the overlapping antero-lateral process of the Median Dorsal occurs on the postero-dorsal expansion of the plate. The Median Dorsal overlap is not as extensive as in *Dinichthys*, and certain other of the Cleveland Shale Arthrodira. Comparatively, therefore, the free anterior margin of this plate dorsal to the condyle is long. The condyle is moderately developed. The weak sub-glenoid process projects from the anterior margin of the plate below the base of the condyle. Its articular face is inclined ventro-mesially. The inner surface of the entire bone is generally smooth.

The left Postero-dorso-lateral (PDL) element is embedded, with a fragment of the right one, in the shale, partially covered by the Externo-basal and Antero-lateral plates. The visible margins reveal a bone of approximately the same size as Antero-dorso-lateral; much deeper than long. The broad areas of the plate overlain by the Median Dorsal, Antero-dorso-lateral, and Postero-lateral are clearly defined. There is no evidence that the antero-lateral sensory canal is extended back on this bone.



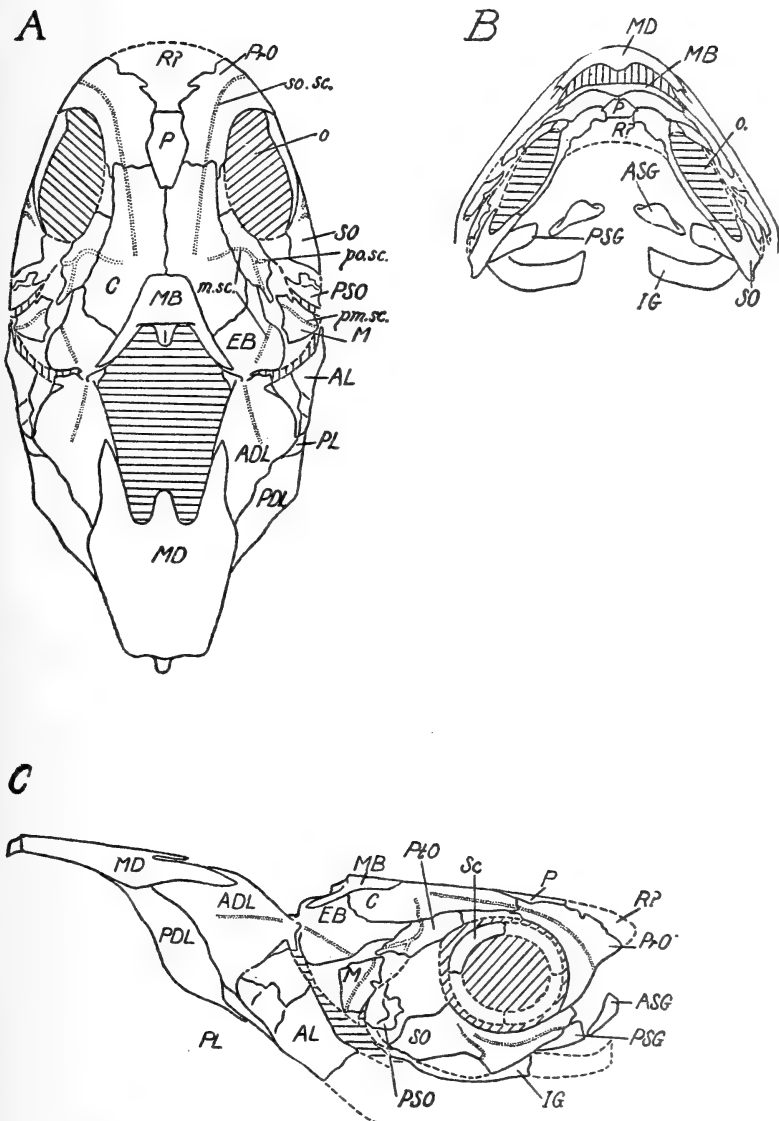
TEXT FIG. 5. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724).  
A. Left Antero-dorso-lateral in lateral view. B. The same plate in  
anterior view. Approx.  $\times 6/10$ .

Only the dorsal half of the left Antero-lateral (AL) plate is preserved. Fortunately, the outline of the posterior edge of the missing portion is impressed on the shale, and the full ventral extent of the bone can be observed. The bone, thus revealed, is remarkably deep, and comparatively short. The posterior margin appears to have been almost straight. The anterior margin of the preserved portion is thickened and this thickening is occupied by a groove. The inner surface of the plate exhibits a vertical ridge and parallel grooves which indicates the area overlapping the ventral extension of the Antero-dorso-lateral.

The Postero-lateral (PL) is a small triangular plate. The right element is preserved and shows distinctly the margins overlapped by the Antero-dorso-lateral and the Antero-lateral plates.

No trace of the Spinal or Intero-lateral plates has been found.

Little can be said of the ventral body armor. Of the four remaining plates associated with the specimen, two are so fragmentary as to preclude discussion. The other two are thin, paired, cleaver-shaped elements, which we have tentatively identified as the Antero-ventro-lateral (AVL) plates. On the inner surface of each bone there are two pronounced depressions, interpreted as the areas overlain by the Antero-median-ventral and the Postero-median-ventral. A shaft-like process is extended backwardly. The dorsal surface of this portion is somewhat rugose and suggests a contact with the ventral surface of a Postero-ventro-lateral.



TEXT FIG. 6. *Gymnotrachelus hydei* (CMNH. Cat. Fos. Fishes No. 5724). Attempted reconstruction of the head shield and body carapace in (A) dorsal, (B) anterior, and (C) lateral views. Approx. x 3/10.

## DISCUSSION

Several genera of Cleveland Shale Arthrodira have been previously described, which possess with *Gymnotrachelus* a small size. A relationship is suggested between the present form and *Trachosteus* by the similar structure of the Median Dorsal plates and by the presence in both of tuberculated gnathal elements. The development of these bones differs markedly in detail, however, between the two genera. Further, the bones of *Gymnotrachelus* are unornamented, the sclerotic plates are proportionately longer and narrower, and the structure of the Sub-orbital is dissimilar by comparison with the corresponding bones of *Trachosteus*, as figured by Dean (1909).

An affinity is hinted, again by the common possession in *Gymnotrachelus*, *Stenosteus*, and *Selenosteus* of tuberculated gnathal elements. In *Stenosteus* the length of the tuberculated functional portion of the Infero-gnathal is proportionately greater than in *Gymnotrachelus*. The form of the Antero-supra-gnathals differ widely between the two forms, as do also the general contours of the Antero-dorso-lateral, the Sub-orbital, and the Sclerotic plates. In *Selenosteus* the length of the functional portion of the Infero-gnathal is proportionately less than that of *Gymnotrachelus*. As in *Stenosteus*, the contours of the Antero-dorso-lateral, the Sub-orbital, and the Sclerotic plates, as well as those of the Median Dorsal, the Median Basal, and the Externo-basal plates of *Selenosteus* vary widely from the corresponding plates in *Gymnotrachelus*. The plate-like Antero-supra-gnathal of *Gymnotrachelus* is suggestive of the Mylostomid condition. In our present limited knowledge only two additional characters seem to further support this suggested relationship between *Mylostoma* and the present form; namely, the similar development of the Median Basal and Antero-dorso-lateral plates.

The above comparisons are by necessity broad and obvious. It must be remembered that the genera referred to may be grouped as the rarest of the Cleveland Shale Arthrodira and are in most cases inadequately known. It is, therefore, perhaps excusable that we do not make any definite statement concerning the affinities of *Gymnotrachelus* until our current study of the Cleveland Museum Collection is further advanced.

REFERENCES

- Branson, E. B.** Notes on the Ohio Shales and Their Faunas. Univ. Missouri Bull., II, No. 2, pp. 23-32, Pls. i-iii, 1911.
- Dean, B.** On Two New Arthrodires from the Cleveland Shale of Ohio. Mem. N. Y. Acad. Sci., II, Pt. III, pp. 87-100, Pls. ii-vi, 2 text figs., 1901.
- On the Characters of *Mylostoma* Newberry. Mem. N. Y. Acad. Sci., II, Pt. III, pp. 101-109, Pls. vii-viii, 8 text figs., 1901.
- On the Arthrodire *Trachosteus clarki* Newberry. Mem. Amer. Mus. Nat. Hist., IX, Pt. V, pp. 272-276, Pl. xli, Figs. 56-57, 1909.
- Heintz, A.** The Structure of *Dinichthys*, a Contribution to our Knowledge of the Arthrodira. B. Dean Mem. Vol., Art. IV, pp. 115-224, Pls. i-ix, 91 text figs., 1932.
- Hussakof, L.** Notes on Some Upper Devonian Arthrodira from Ohio, U. S. A., in the British Museum (Natural History). Geol. Mag., (5), VIII, pp. 123-128, Pl. viii, 3 text figs., 1911.
- Stensiö, E. A.** On the Head of the Macropetalichthyids. Field Mus. Nat. Hist., Geol., IV, pp. 89-198, Pls. xix-xxxi, 26 text figs., 1925.

EXPLANATION OF THE LETTERING USED  
IN THE TEXT FIGURES

- AL.** Antero-lateral
- al. sc.** Antero-lateral sensory canal
- a. pro.** Articular surface for the pre-orbital process
- ASG.** Antero-supra-gnathal
- AVL.** Doubtful Antero-ventro-lateral
- EB<sub>1</sub>.** Left Externo-basal
- fos. con.** Condylar fossa
- g. sc.** Gnathal sensory canal
- i. ac. sc.** Impression of the middle head line
- i. AL<sub>2</sub>.** Impression of the right Antero-lateral
- i. C<sub>1-2</sub>.** Impressions of the left and right Centrals respectively
- IG.** Infero-gnathal

- i. pr. sc.** Impression of the pre-orbital sensory canal  
**i. pt. sc.** Impression of the sub-post-orbital sensory canal  
**l. so.** Lateral sub-orbital shelf  
**M.** Marginal  
**MB.** Median Basal  
**MD.** Median Dorsal  
**m. sc.** Marginal sensory canal  
**o.** Orbit  
**om. al.** Antero-lateral overlap area on the Antero-dorso-lateral  
**om. av.** Overlap margin for the Antero-median-ventral  
**om. m.** Marginal overlap area on the Post-orbital  
**om. mb.** Median Basal overlap area on the Externo-basal  
**om. md.** Median Dorsal overlap area on the Antero-dorso-lateral  
**om. pdl.** Overlap margin of the Postero-dorso-lateral  
**om. pv.** Overlap margin for the Postero-median-ventral  
**P.** Pineal  
**p. al.** Antero-lateral process of the Median Dorsal  
**p. am.** Antero-median process of the Median Dorsal  
**p. con.** Condylar process  
**PDL<sub>1-2</sub>.** Left and right Postero-dorso-lateral, respectively  
**p. gl.** Glenoid process  
**PL.** Postero-lateral  
**pm. sc.** Post-marginal sensory canal  
**po. sc.** Sub-post-orbital sensory canal  
**pp.** Pituitary pit  
**PrO<sub>1-2</sub>.** Left and right Pre-orbitals, respectively  
**PSG.** Postero-supra-gnathal  
**p. sgl.** Sub-glenoid process  
**PSO.** Post-sub-orbital  
**p. sp.** Postero-median spine of the Median Basal  
**pt.** Posterior expanded portion of the Sub-orbital  
**p. vk.** Keel of the Median Dorsal  
**R?.** Restored Rostral  
**r.** Internal ridge on the Sub-orbital  
**Sc<sub>1-2-3</sub>.** Sclerotics  
**SO.** Sub-orbital  
**so. sc.** Pre-orbital sensory canal  
**V?.** Doubtful ventral plates



