Proceedings of the Iowa Academy of Science

Volume 81 | Number

Article 6

1974

Occurrence of a Ctenacanthoid Shark Spine from the Upper Devonian of North Central Iowa

Markes E. Johnson

University of Chicago

Occurrence of a Ctenacanthoid Shark Spine from the Upper Devonian of North Central Iowa

MARKES E. JOHNSON[1]

JOHNSON, MARKES E. (Department of the Geophysical Sciences, University of Chicago, Chicago, Illinois 60637). Occurrence of a Ctenacanthoid Shark Spine from the Upper Devonian of North Central Iowa. *Proc. Iowa Acad. Sci.* 81(2): 56-60, 1974.

Although a diverse, invertebrate fauna is characteristic of the Upper Devonian, Lime Creek Formation, in north central Iowa, fossil fish remains are sparse. A detached and incomplete shark spine with ctenacanthoid features is reported and described. The specimen is the best example of the first occurrences of its kind from the Devonian of Iowa. Despite some asymmetry in shape, the spine is interpreted as the cutwater of a dorsal fin. Overall length of the shark is estimated at 1-1.5m.

INDEX DESCRIPTORS: Ichthyodorulite, Lime Creek Formation, Ctenacanthoid Shark Spine.

HISTORY OF DISCOVERIES

Fossil fish remains from the Upper Devonian, Lime Creek Formation, in north central Iowa are considered very sparse. Eastman (1908) states that the only satisfactorily determined fossil fish from the shales of the interval include *Ptyctodus calceolus* (isolated tritors), *Dinichthys pustulosus* (dental plates) and fragments of heavy, coarsely tuberculated plates indistinguishable from those of *Aspidicthys*. Fenton and Fenton (1924) indicate that two species of fossil fish, *Diplodus* (= *Xenacanthus*) *priscus* and *D. striatus*, are referable to the interval, as well as to comparable Upper Devonian shales in the Chicago region. Belanski (1931) reports "10 or 11" species of fossil fish to be characteristic of the *Ptyctodus calceolus* Zonule (in the Hackberry Phase) at the top of the *Douvillina* Zone. *P. calceolus* is mentioned as the most common taxon; no others are listed. Examination of the Belanski Collection at the Repository of the Geology Department, The University of Iowa, in Iowa City, produces the list of taxa for the Lime Creek Formation which is presented in Table 1.

All are found in the *Ptyctodus calceolus* Zonule except 1, 2 and 10. *Aspidicthys* (1) is found in the *Atrypa devoniana* Zonule, 1m above the top of the *Douvillina* Zone; *Ptyctodus ferox* (10) is found in the *Lioclema occidens* Zonule (facies equivalent of the *Ptyctodus calceolus* Zonule), at the top of the *Douvillina* Zone; and *Conchodus* (2) is found in the *Xenocidaris* Zonule, 3.5m below the top of the *Douvillina* Zone. Zonules given reference are all within the Cerro Gordo Member of the Lime Creek Formation. The comparatively more abundant forms range through much of the Lime Creek Formation.

Of the fauna previously reported from the Lime Creek Formation, spinal elements are known only from *Gamphacanthus*. Spines are known from certain species of *Dinichthys*, *Xenacanthus* and *Eczematolepis*, but not from the Upper Devonian species of north central Iowa. In July of 1969 the author collected a large and distinctive spine at the Rockford Brick and Tile Company pit, Rockford, Iowa. Although the precise horizon cannot be established with certainty, it is likely that the specimen came from the lower 1.5-2.5m of the *Spirifer* (= *Cyrtospirifer*) *whitneyi* Zone, which overlies the *Douvillina* Zone. The spine was recovered from talus against the north bench of a newly excavated area, the floor of which approximates the base of the *Cyrtospirifer whitneyi* Zone. C. O. Levorson, collecting extensively from the Lime Creek Formation, has discovered two separate spine fragments of like affinity at the Rockford site. The source horizon given by Levorson (personal communication) corresponds exactly to the inferred stratigraphic position.

As reviewed by Eastman (1908), the term "Ichthyodorulites" ("fish-spine-stone"—Incertae Sedis) relates to all isolated, dermal spines and tubercles of cartilaginous fish. De La Beche (1822) was the first to report the occurrence of such fossils. Buckland (1836) was among the earliest to use the term. Subsequently, Agassiz (1833-43) applied the term to all fossil spines of Elasmobranch and Chimaeroid fishes, regardless of correlation with teeth. The term was

TABLE 1: VERTEBRATE TAXA LISTED FROM THE BELANSKI COLLECTION OF THE LIME CREEK FORMATION (DEVONIAN) (Geology Department Repository, The University of Iowa, Iowa City)

	Example	Catalog Number
Aspidicthys?	Single fragmentary dermal plate	SUI 73358
Conchodus	Single dental plate	SUI 73430
Dinichthys pustulosis	Single dermal plate	SUI 53408
Dinichthys?	Single dermal plate	SUI 54416
Diplodus (= *Xenacanthus*)	Single tritor	SUI 73837
Heteracanthus (= *Gamphacanthus*)	Several dermal spines	SUI 73361
Palaeomylus (= *Eczematolepis*)	Single dermal plate	SUI 73514
Ptyctodus calceolus	Four tritors	SUI 73406
Ptyctodus compressus	Three fragmentary tritors	SUI 73359
Ptyctodus ferox	Single tritor	SUI 74116
Rhynchodus excavatus	Several fragmentary tritors	SUI 73357

[1] Department of the Geophysical Sciences, University of Chicago, Chicago, Illinois 60637.

later restricted by A. S. Woodward (1885) to those detached spines or tubercles which exhibit the microscopic structure of vasodentine, but whose precise systematic position cannot be determined. Illustrated by Schäfer (1972), the dorsal fin spine of the recent shark, *Squalus acanthias,* is structurally comparable to some fossil Ichthyodorulites.

SYSTEMATIC PALEONTOLOGY

Class	CHONDRICHTHYES
Subclass	ELASMOBRANCHII
Order	CLADOSELACHII (PLEUROPTERYGII)
Family	?CTENACANTHIDAE
Genus	?CTENACANTHUS

Material and Occurrence

A single specimen of a ctenacanthoid shark spine, collected by the author and deposited in the Repository of the Geology Department, The University of Iowa, in Iowa City, catalog SUI 37247, was discovered at the Rockford Brick and Tile Company pit, Rockford, SE¼ NW¼ Sec. 16, T95N, R18W, Floyd County, Iowa. Occurrence of the Ichthyodorulite is from the upper Cerro Gordo Member, probably the lower 1.5-2.5m of the *Cyrtospirifer whitneyi* Zone, Lime Creek Formation, Upper Devonian.

Description

The specimen is a detached and incomplete, somewhat asymmetrical spine lacking the posterior margin, the distal portion, about 80mm above the line of insertion and a smaller proximal portion about 35mm below the line of insertion. Total length of the preserved specimen is about 115mm. Maximum width is 40mm, measured perpendicular to the proximal-distal axis and parallel to the anterior-posterior plane at the approximate mid-section of the spine. Maximum thickness of the spine is 18mm, measured perpendicular to the proximal-distal axis and anterior-posterior plane at the juncture of insertion through the integument. Minimum thickness of the spine is 5mm, measured in the same way at the most distal extremity of the specimen. Both the maximum and minimum thicknesses are reflected close to the anterior margin of the spine, which diminishes in thickness longitudinally in both directions from the line of insertion. Overall thickness of the spine remains relatively even at the juncture of insertion, but tapers to a progressively thinner anterior margin distally. The anterior margin is essentially straight in the proximal-distal axis, beginning to curve gently to the posterior about 45mm above the line of insertion. The surface of the exposed, distal portion is completely covered on the anterior margin and lateral sides with longitudinal ridges, or costae, which become narrower and less distinctly ornamented toward the posterior margin. As many as 50 parallel, subequal ridges crowd each of the two lateral sides. The *more distal ridges* trace the gentle curvature of the anterior margin. In detail, ornamentation along the ridges is "cone-in-cone" at some spots, beaded at others and pectinate at still other spots, with ridges phasing into rounded, loosely spaced tubercles which pinch out between adjacent ridges distally. The line of insertion is well preserved on the right side, and is almost perpendicular to the proximal-distal axis. Preservation is not as exact on the left side but the line of insertion diverges from 2 to 7mm from that of the right side, migrating approximately 5 to 10 degrees distally.

Remarks

Considering the likelihood that quite different kinds of sharks may have been able to produce superficially similar fin spines, (Zangerl, personal communication), the wide embrace of Family Ctenacanthidae and Genus Ctenacanthus is questionable. Although there is little in the way of recent work, a review of the pertinent literature is instructive.

According to Romer (1966), the range of *Ctenacanthus* in North America is from Upper Devonian to Lower Permian; slightly varying ranges are known from Europe, Asia and South America. Hay (1929) catalogs over 50 species of the genus in North America. Of these, at least a score have been figured and/or described from the Mississippian of southeast Iowa and vicinity, e.g., Eastman (1902). Only 6 of the species cataloged by Hay are truly Devonian in age. Most of these can be placed in relative stratigraphic position based on conodont zonation (Fig. 1); two others may be included: that of an indeterminate species and of a species reported from the Berea Sandstone, marginally Devonian-Mississippian in position. No additional species have been reported from the Devonian of North America since the compilation of Hay's catalog. To the author's knowledge, ctenacanthoid spines have not been reported previously from the Devonian of Iowa. Surface ornamentation of the specimen here reported compares best with *Ctenacanthus angustus* Newberry, 1889 (Hussakof 1908, Fig. 19), although according to Newberry's original description the size of the spine and number of longitudinal ridges are not as great. The flattened form of *C. compressus* Newberry, 1878 (Newberry 1889, p. 168, pl. 23), is similiar in size and shape, although details of surface ornamentation differ. About the same size, *C. wrighti* Newberry, 1884 (p. 206, pl. 16), differs primarily in possessing an anterior margin which is unusually straight. While *C. clarkii* Newberry, 1889 (p. 168, pl. 26), approaches the same shape, it is not as compressed in cross section and possesses a line of insertion which is far from perpendicular to the proximal-distal axis. Furthermore, the size of the spine and number of longitudinal ridges are not as great. The source of *C. angustus* is the Berea Sandstone of Ohio; *C. compressus* and *C. clarkii* are from the Cleveland Shale of Ohio; and *C. wrighti* is from the Moscow Shale of New York.

Morphologic Implications

The asymmetry of the specimen, distinguished by an irregular line of insertion, raises interpretive alternatives. Was the spine a support for a dorsal fin or a support for one of two paired fins on the belly of the shark? Definitely, the spine is in marked contrast to examples of other detached spines, as exhibited by *Ctenacanthus clarkii,* in which the line of insertion sweeps evenly back at an angle to the proximal-distal axis. Such an angle persuasively suggests implantation at a posterior inclination on the back of the shark. To consider the paired fins interpretation, the detail of the insertion line would imply that the spine acted as a cutwater for the right ventral fin. Although intriguing, all prior evidence tends to disprove the supposition. Moy-Thomas (1939) produces a line drawing reconstruction of *C. costellatus,* Pennsylvanian in age. The reconstruction shows the shark with two dorsal fins, the anterior (first dorsal) fin spine making a smaller angle with the long axis of the animal than the posterior (second dorsal). The anterior fin spine is characterized as longer and more gracefully curved than the posterior fin spine. This interpretation of

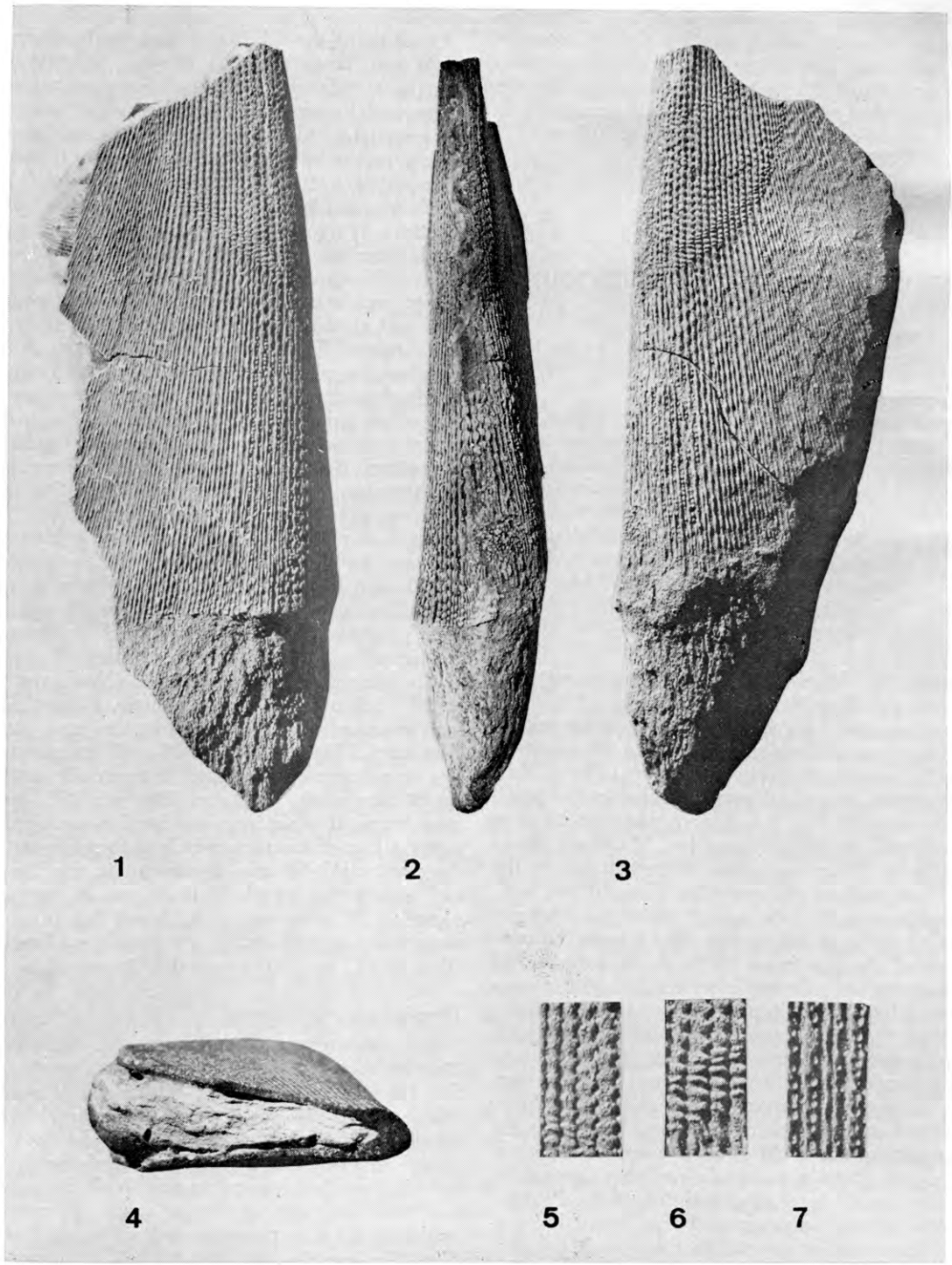

Plate 1. Figures 1-7. Ichthyodorulite: ctenacanthoid shark spine (SUI 37247). 1. Right lateral view. 2. Anterior margin view. 3. Left lateral view. 4. Distal cross section. 5. "Cone-in-cone" ornamentation. 6. Beaded ornamentation. 7. Pectinate ornamentation, pinched out. Figures 1-4, 1x; Figures 5-7, 3x.

	Middle Devonian (part)	Upper Devonian		System
	Givetian	Frasnian	Famennian	Stage
C. angustus			x?	RELATIVE STRATIGRAPHIC POSITION OF DEVONIAN CTENACANTHS
C. clarkii			x	
C. compressus			x	
C. vetustus			x	
C. chemungensis			x-?-x	
C. wrighti	x	x		
C. sp. indet.		x		
Iowa find (this report)		x		

Figure 1. Relative stratigraphic position of known Devonian occurrences of the genus *Ctenacanthus* based on conodont zonation. Under each species, the first reference cited provides parent stratigraphic horizon; the second reference gives age of that stratum according to the conodont zonation. *Ctenacanthus nodocostatus* Hussakof and Bryant, 1919, is excluded for lack of sufficient stratigraphic data. The Berea Sandstone (*C. angustus* Newberry, 1889) is positioned with question at the Devonian-Mississippian boundary (Sandberg, Streel and Scott, 1972). The Cleveland Shale (*C. clarkii* Newberry, 1889; *C. compressus* Newberry, 1878; and *C. vetustus* Newberry, 1873) is at the top of the Famennian (Hass, 1947). Canadaway and Conneaut Groups (*C. chemungensis* Calypole, 1885) are lower Famennian (Rickard and Fisher, 1970). *Ctenacanthus wrighti* occurs in the Moscow Shale (Newberry, 1884) which is Givetian (Rickard and Fisher, 1970) and in the North Evans Limestone (= conodont bed; Hussakof and Bryant, 1919) of lower Frasnian age (Klapper et al., 1971). Romer (1966) did not recognize the Middle Devonian (Givetian) lower range extension of *Ctenacanthus*, which is based on the Moscow Shale occurrence. The North Evans Limestone is the source of *C.* sp. indet. (Hussakof and Bryant, 1919). Finally, the Cerro Gordo Member of the Lime Creek Formation (this report) is upper Frasnian (Klapper et al., 1971).

C. costellatus was first given credibility by Traquair (1884) in a description of a remarkable specimen capturing the entire shape of the shark. A Devonian specimen of *C. clarkii* (Dean 1909, Figure 43) from the Cleveland Shale has also been reported. This specimen includes preservation of the soft, mid-portion of the shark and clearly lacks spines in association with the ventral fins. In view of the evidence, it seems most likely that the spine in question functioned as a support for the second dorsal fin of the animal. The asymmetry of the spine can be accounted for by pelomorphic deformation and/or life injury. The size of the specimen suggests that it belonged to a shark of estimated length 1-1.5m.

Occurrence of the ctenacanthoid shark spine adds a significant aspect to the picture of faunal diversity from the Upper Devonian, Lime Creek Formation.

ACKNOWLEDGMENTS

Gratitude is warmly expressed to several individuals at the Geology Department of The University of Iowa in Iowa City. The Ichthyodorulite was unearthed from the author's collection of Rockford fossils by W. M. Furnish, who encouraged the preparation of this report. H. A. Semken stimulated thought on the interpretation of the specimen and kindly aided with much appreciated counsel at numerous stages of investigation. The author is indebted to G. Klapper for discussing conodont biostratigraphy pertinent to the placement of the Devonian ctenacanth spines in relative sequence. H. L. Strimple, curator of the Department's Repository, helped with access to the Belanski Collection. D. B. Johnson graciously assisted with the photography. G. D. Schrimper, curator of the University of Iowa Museum of Natural History, cooperated in the molding of casts. Experience with the Lime Creek Formation was cordially shared by C. O. Levorson of Riceville, Iowa. R. Zangrel, Chief Curator of Geology at the Field Museum of Natural History in Chicago, Illinois, offered highly valued criticism and permitted examination of museum collections.

LITERATURE CITED

AGASSIZ, L. 1833-43. Recherches sur les poissons fossiles. Tome III: 1-590 -Atlas. Neuchatel (Suisse).

BELANSKI, C. H., *in* C. L. FENTON. 1931. Evolution of the genus spirifer. *Wagner Free Institute Sci.* 2:1-6.

BUCKLAND, W. 1836. Geology and mineralogy considered with reference to natural theology. *Bridgewater Treatise* 6(1):1-596, (2):1-128.

CLAYPOLE, E. W. 1885. On *Ctenacanthus* and *Gyracanthus* from the Chemung of Pennsylvania. *Amer. Assoc. Adv. Sci. Proc.* 33:489-490.

DEAN, B. 1909. Studies on fossil fishes (sharks, chimaeroids, and arthrodires). *Amer. Mus. Nat. Hist. Mem.* 9:211-248.

DE LA BECHE, H. T. 1822. Remarks on the geology of the south coast of England from Bridport Harbour, Dorset, to Babbacome Bay, Devon. *Trans. Geol. Soc. London* (2)1:40-47.

EASTMAN, C. R. 1902. Some carboniferous cestraciont and acanthodian sharks. *Mus. Comp. Zool. Bull.* 39(3):53-99.

———. 1908. Devonian fishes of Iowa. *Iowa Geol. Surv. Ann. Rpt.* 18:29-386.

FENTON, C. L., and M. A. FENTON. 1924. Stratigraphy and fauna of the Hackberry Stage of the Upper Devonian. *Michigan Univ. Mus. Geol. Contrib.* 1:1-260.

HASS, W. H. 1947. Conodont zones in Upper Devonian and Lower Mississippian Formations of Ohio. *Jour. Paleontology* 12:131-141.

HAY, O. P. 1929. Second bibliography and catalogue of the fossil vertebrata of North America. *Carnegie Inst. Washington Publ.* 390:1-2003.

HUSSAKOF, L. 1908. Catalogue of types and figured specimens of fossil fishes. *Amer. Mus. Nat. Hist. Bull.* 25:1-103.

HUSSAKOF, L., and W. L. BRYANT. 1919. Catalogue of the fossil fishes in the museum of the Buffalo Society of Natural Sciences. *Buffalo Soc. Nat. Sci. Bull.* 12:1-346.

KLAPPER, G., G. A. SANDBERG, C. COLLINSON, J. W. HUDDLE, R. W. ORR, L. V. RICKARD, D. SCHUMACHER, G. SEDDON and T. T. UYENO. 1971. North American Devonian conodont Biostratigraphy, *in* W. C. Sweet and S. M. Bergström (eds.). Symposium on conodont biostratigraphy. *Geol. Soc. Amer. Mem.* 127:285-316.

MOY-THOMAS, J. A. 1939. The early evolution and relationships of the elasmobranchs. *Biol. Rev.* 14:1-26.

NEWBERRY, J. S. 1873. Descriptions of fishes of the carboniferous system, Section 2. *Ohio Geol. Surv.* 1(2):325-355.

———. 1878. Descriptions of new palaeozoic fishes. *Annals N.Y. Acad. Sci.* 1:191-192.

———. 1884. Note. *N.Y. State Mus.* 35:206.

———. 1889. The paleozoic fishes of North America. *U.S. Geol. Surv. Mon.* 16:1-340.

RICKARD, L. V., and D. W. FISHER. 1970. Geological map of New York, Niagara Sheet. *N.Y. State Mus. and Sci. Ser.*

ROMER, A. S. 1966. *Vertebrate paleontology.* 3rd. ed., Univ. Chicago Press, 1-468.

SANDBERG, C. A., M. STREEL, and R. A. SCOTT. 1972. Comparison between conodont zonation and spore assemblages at the Devonian-Carboniferous boundary in western and central United States and Europe. *Septième Congrès International de Stratigraphie et de Géologie du Carbonifère.* Krefeld, 23-28 Aug. 1971, Compte Rendu 1:179-203.

SCHAFER, W. 1972. *Ecology and palaeoecology of marine environments.* English ed., Univ. Chicago Press, 1-568.

TRAQUAIR, R. H. 1884. Description of a fossil shark (*Ctenacanthus costellatus*) from the lower carboniferous rocks of Eskdale, Dumbriesshire. *Geol. Mag.* (3)1:3-8.

WOODWARD, A. S. 1885. Chapters on fossil sharks and rays. *Sci. Gossip* 21:270-272.

ZANGERL, R., and E. S. RICHARDSON, JR. 1963. The paleoecological history of two Pennsylvanian black shales. *Fieldiana Geol. Mem.* 4:1-352.