

First records of the chondrichthyans *Heslerodus* and *Ossianodus* from the Upper Pennsylvanian LaSalle Limestone (Bond Formation) of northern Illinois

Ricky Gieser^{1*}, Ryan Shell², M. Jared Thomas³ & Mark Davis¹

¹Illinois Natural History Survey, Prairie Research Institute, University of Illinois at Urbana-Champaign, Forbes Natural History Building, 1816 South Oak Street, Champaign, IL 61820, USA

²Department of Vertebrate Paleontology, Cincinnati Museum Center, 1301 Western Avenue, Cincinnati, OH 45203, USA

³Center for Paleontology, Illinois Natural History & State Geological Surveys, Prairie Research Institute, University of Illinois at Urbana-Champaign, Forbes Natural History Building, 1816 South Oak Street, Champaign, IL 61820, USA

*Correspondence: rgieser2@illinois.edu

Abstract: *Heslerodus divergens* and an undetermined species of the genus *Ossianodus* are recorded for the first time from the Upper Pennsylvanian LaSalle Limestone Member of the Bond Formation in northern Illinois. *Ossianodus* is a new record for the state. Four specimens of *H. divergens* and one of *Ossianodus* sp. were recovered, all partially complete teeth. Descriptive and comparative notes are provided. Future studies of the formation may yield additional specimens of other vertebrate species.

Key words: *Heslerodus*, *Ossianodus*, Chondrichthyes, Elasmobranchii, sharks, LaSalle County

Introduction

The shark species *Heslerodus divergens* (Ctenacanthiformes: Heslerodidae) is known from Pennsylvanian deposits across North America and Russia, including teeth, fin spines, and skeletal elements (Ginter 2002). In July of 2020, the senior author collected two teeth at an exposure of the Upper Pennsylvanian LaSalle Limestone Member of the Bond Formation near Oglesby, LaSalle County, Illinois (Figure 1). Subsequent visits to the site yielded several more *H. divergens* teeth and a single tooth assigned to the genus *Ossianodus* (Hybodontiformes: Hybodontidae). These specimens represent the first records of these species from the highly fossiliferous LaSalle Limestone Member and, in addition to being previously unknown from the LaSalle Limestone, this is also the first record of *Ossianodus* from Illinois.

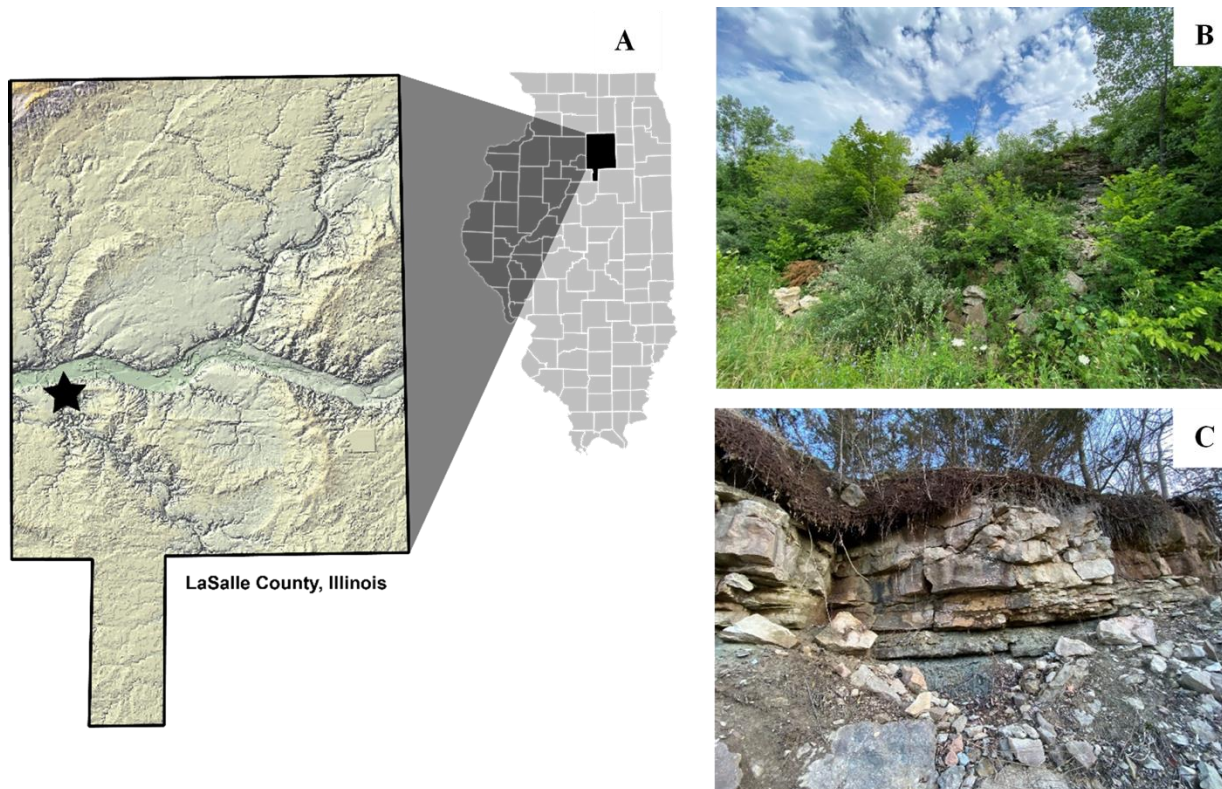


Figure 1. Roadside exposure from which specimens were collected: **A**, map showing the location of LaSalle County within Illinois and the location of the exposure (star); **B**, view of the locality; **C**, the exposure of the LaSalle Limestone Member, Bond Formation. All teeth were collected from the talus at the base of the exposure. Photos by RG.

The Bond Formation lies within the Missourian Stage of the Upper Pennsylvanian (Hatch & Affolter 2002) (Figure 2) and comprises a heterolithic sequence of limestones and clastic rocks. Aside from the well-studied Mazon Creek Lagerstätte, information regarding Paleozoic vertebrate assemblages of the Illinois Basin is generally lacking, and chondrichthyan diversity has not been extensively investigated. Only four chondrichthyan species have been previously reported from the Bond Formation (Brusatte 2007), namely: *Deltodus angularis* (Cochliodontidae); *Helodus* cf. *simplex* (Helodontidae); *Peripristis semicircularis* (Pristodontidae); and *Petalodus ohioensis* (Petalodontidae).

Material and Methods

Five partial teeth preserved in limestone: INHS-P5079, P5080, P5082, P5083, and P5092, deposited in the Center for Paleontology at the Prairie Research Institute, University of Illinois at Urbana-Champaign, USA. The fossils collected were visible on the surface of limestone blocks collected by RG from the talus slope immediately beneath the exposure. The specimens were prepared using dental explorers and insect pins under a stereomicroscope. A soft bristled paintbrush was used to apply Paraloid B72 thinned with acetone to reattach the main cusp of INHS-P5083. Images were obtained using a Canon EOS 5D Mark IV DSLR with a Canon MPE-65 mm macro lens mounted on a Stackshot macro rail. Z-stacked images were taken using Helicon Remote 3.9.10 and stacked in Helicon Focus 7. Final image editing and scale bar additions were completed in Adobe Photoshop CC.

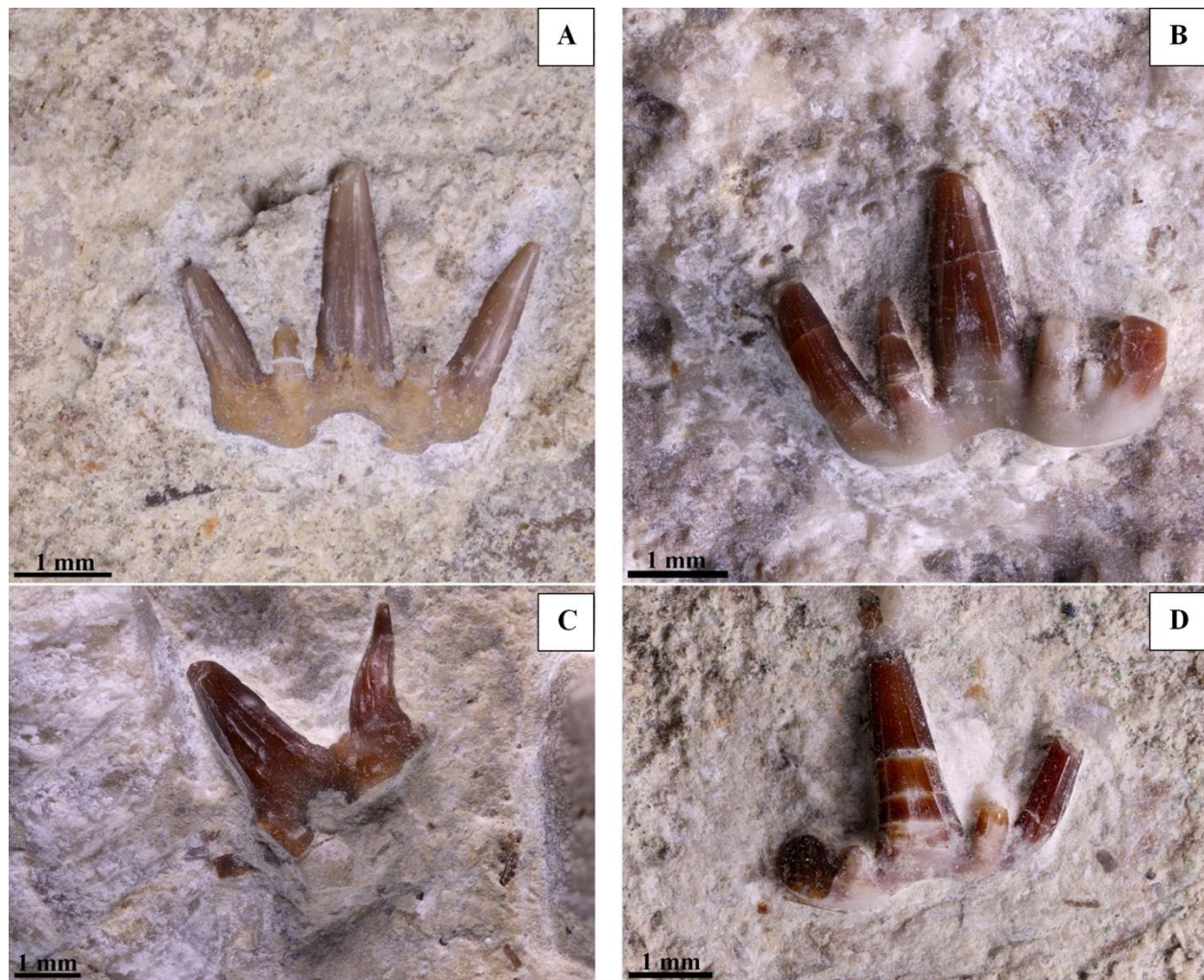


Figure 3. *Heslerodus divergens* teeth in labial view: **A**, INHS-P5092; **B**, INHS-P5080; **C**, INHS-P5082; **D**, INHS-P5079. All teeth were collected from the same site. Photos by MJT.

and width to the main cusp. While each tooth would have had three cusps of similar length, the central cusp would have projected somewhat further than the rest of the tooth on account of a deep, U-shaped basolabial depression that sets the central part of each tooth around 0.1 mm higher than the rest of the crown. Both lateral portions of each tooth do not project outward parallel to the central crown but instead project a few degrees outward from the central crown. The size, basolabial depression relative to cusplet sizes, and divergence of the lateral and central cusps in P5079 and P5080, are also consistent with P5082, though the latter is more poorly preserved than the former. These specimens are typical of the rest of the *H. divergens* specimens from this locality.

Remarks. The size of these teeth, coupled with the number of cusps, their relative sizes to one another, and the way the cusps diverge from one another, is consistent with other known examples of *H. divergens* such as MWGUY/Ps/6/1 which is housed at the University of Warsaw, Poland, and figured by Ginter *et al.* (2010). Similar ctenacanthiform species, such as members of the genus *Glinkmanius*, can also be found in Upper Carboniferous (Pennsylvanian) rocks, and possessed teeth with deep basolabial depressions (Ginter *et al.* 2010). However, the smallest species of *Glinkmanius*, *G. mayachkovensis*, had teeth that are



Figure 4. *Ossianodus* sp. tooth in lingual view: INHS-P5083. Photo by MJT.

approximately twice the size of typical *Heslerodus* teeth and, while the projection of its lateral cusplets also diverged from the central cusp, their lengths were much less than that of the main cusp (Ginter 2002; Ginter *et al.* 2010).

Teeth of *H. divergens* were once placed in the genus *Phoebodus*. However, no other known *Phoebodus* teeth have basolabial depressions similar to those of *Heslerodus* which has since been found to be closer in morphology to ctenacanthiforms such as *Glikmanius* (Ginter 2002; Ginter *et al.* 2010). Other similarities between *Glikmanius* teeth and those of *Heslerodus*, plus the fact that they often co-occur, led Ossian (1974) to propose that the two tooth types belonged to the same heterodont species. However, partially articulated examples of *Heslerodus* (see Williams 1985) and *Glikmanius* (see Hodnett *et al.* 2022) have shown that the two tooth forms belong to distinct species (see also Ginter *et al.* 2010).

Order Hybodontiformes Patterson, 1966

Family Hybodontidae Owen, 1846

Genus *Ossianodus* Ginter, 2016

Ossianodus sp.

Figure 4

Material studied. A single, near-complete tooth: INHS-P5083.

Locality. Roadside exposure off Illinois Route 351 near Oglesby, LaSalle County, Illinois, USA.

Descriptive notes. The crown of INHS-P5083 has a single, elongate central cusp that appears to have been twice the length of the rest of the crown prior to weathering. On either side of this cusp are three pairs of lateral cusplets. While only the lingual portion of the specimen is exposed, it is clear that all of the cusps and cusplets are ornamented with vertical, subparallel crista. The crown-root junction is arcuate, as is the overall shape of the base of the tooth. The root is perforated by numerous pores, which would have allowed for an anaulacorhize style of vascularization.

Remarks. Anaulacorhize vascularization patterns and arcuate bases on Paleozoic chondrichthyan teeth are known to be hybodontiform traits (Ginter *et al.* 2010). Furthermore, the general shape of this tooth, its cusplets, and its crown ornamentation are consistent with known examples of Upper Carboniferous hybodontiforms and are consistent with the holotype of *Ossianodus nebraskensis* Ginter, 2016 (specimen CM 44547b in the collection of Carnegie Museum of Natural History, Pittsburg, USA). However, given the age of our specimen, which is older than that of the type species, and the inability to view the labial side, we herein refrain from placing the specimen definitively in *O. nebraskensis* until additional material can confirm its identity.

Discussion

The teeth reported herein represent the first documented occurrence of *Heslerodus divergens* and of the genus *Ossianodus* from the LaSalle Limestone Member and the Bond Formation as a whole. Although *H. divergens* has been previously recorded from the Excello Shale Member of the Carbondale Formation of northern Illinois (Williams 1985), to our knowledge, the species has never been reported from other deposits in the state. *Ossianodus* was hitherto unknown from Illinois, though specimens have been recovered in Nebraska (Ginter 2016) and Ohio (Cline 2022). Both *H. divergens* and *Ossianodus* likely went undetected due to the miniscule nature of their teeth, as the teeth of both species measure mere millimeters in size. All of the specimens reported herein were already at least partially exposed when discovered, so dissolving the limestone with acid may yield yet more specimens. The LaSalle Limestone Member appears to represent an ecosystem containing a rich diversity of chondrichthyans, and since *Heslerodus* and *Ossianodus* have only just been discovered in the unit, further collecting is likely to yield other previously undocumented species.

Acknowledgments

We thank Ben Riegler for site information and advice, Jacob Spangler for assistance in the field, and Jordyn Chace for her support and encouragement. We also thank two anonymous reviewers for their constructive comments.

References

- Bonaparte, C.L. 1838. Synopsis vertebratorum systematis. *Nuovi Annali della Scienze Naturali, Bologna* 11: 105–133.
- Brusatte, S.L. 2007. Pennsylvanian (Late Carboniferous) chondrichthyans from the LaSalle Limestone Member (Bond Formation) of Illinois, USA. *Neues Jahrbuch für Geologie und Paläontologie – Abhandlungen* 244: 1–8.

- Cline, D.A. 2022. *Vertebrate assemblages of the Skelley Limestone (Conemaugh Group: Carboniferous, Gzhelian) in Noble and Muskingum Counties, Ohio*. M.S. Thesis, Wright State University, Dayton, Ohio, 78 pp.
- Ginter, M. 2002. Taxonomic notes on “*Phoebodus heslerorum*” and *Symmorium reniforme* (Chondrichthyes, Elasmobranchii). *Acta Palaeontologica Polonica* 47: 547–555.
- Ginter, M. 2016. The heterodonty in euselachian sharks from the Pennsylvanian of Nebraska. *Acta Geologica Polonica* 66: 299–312.
- Ginter, M., Hampe, O. & Duffin, C. 2010. *Chondrichthyes: Paleozoic Elasmobranchii: Teeth. Handbook of Palaeoichthyology, Volume 3D*. Dr. Friedrich Pfeil Publishers, Munich, Germany, 168 pp.
- Glikman, L.S. 1964. *Sharks of the Paleogene and their stratigraphic significance*. Nauka Press, Moscow, Soviet Union (in Russian), 229 pp.
- Hatch, J.R. & Affolter, R.H. 2002. Resource assessment of the Springfield, Herrin, Danville, and Baker coals in the Illinois Basin. *U.S. Geological Survey Professional Paper* 1625-D: 1–230.
- Huxley, T.H. 1880. On the application of the laws of evolution to the arrangement of the Vertebrata and more, particularly the Mammalia. *Proceedings of the Zoological Society of London* 1880: 649–662.
- Hodnett, J.P.M., Tweet, J.S. & Santucci, V.L. 2022. The occurrence of fossil cartilaginous fishes (Chondrichthyes) within the parks and monuments of the National Parks Service. *New Mexico Museum of Natural History and Science Bulletin* 90: 183–208.
- Maisey, J. 2010. Heslerodidae (Chondrichthyes, Elasmobranchii), a new family of Paleozoic phalacanthous sharks. *Kirtlandia* 57: 13–21.
- Ossian, C. 1974. *Paleontology, paleobotany and facies characteristics of a Pennsylvanian delta in southeastern Nebraska*. Ph.D. Thesis, University of Texas, Austin, Texas, 393 pp.
- Owen, R. 1846. *Lectures on the comparative anatomy and physiology of the vertebrate animals, delivered at the Royal College of Surgeons of England in 1844 and 1846. Part 1. Fishes*. Longman, London, UK, 308 pp.
- Patterson, C. 1966. British Wealden sharks. *Bulletin of the British Museum (Natural History)* 11: 283–350.
- Trautschold, H. 1879. Die Kalchbrüche von Mjatschkowa. Eine Monographie des oberen Bergkalks. *Nouveau Mémoires de la Société Impériale des Naturalistes de Moscou* 14: 3–82.
- Williams, M.E. 1985. The “cladodont level” sharks of the Pennsylvanian black shales of North America. *Palaeontographica* 190: 83–158.