
Pennsylvanian (Late Carboniferous) chondrichthyans from the LaSalle Limestone Member (Bond Formation) of Illinois, USA

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With 5 figures


Abstract: Chondrichthyan teeth are common fossils in late Paleozoic rock units worldwide, and potentially useful in biogeographic, biostratigraphic, paleoecological, and taphonomic studies. Here I present a brief description of a newly-discovered chondrichthyan macrofauna from the LaSalle Limestone Member of the Bond Formation (Missourian, Upper Pennsylvanian, Late Carboniferous) of LaSalle County, Illinois. Recent fieldwork has yielded isolated remains of four chondrichthyan tooth taxa (Petalodus ohioensis, Peripristis semicircularis, Helodus cf. simplex, Deltodus angularis), which are briefly described and compared to similar taxa from across the globe. This is the first publication to provide explicit stratigraphic and locality data for a chondrichthyan fauna from Illinois, and raises potential for future discoveries of chondrichthyan tooth and body fossils.

Key words: Chondrichthyes, Petalodontida, Elasmobranchii, Holocephali, Carboniferous, Pennsylvanian, Paleozoic, Illinois, biogeography, biostratigraphy.

1. Introduction

Isolated macroscopic chondrichthyan teeth, spines, and dermal denticles are common fossils in late Paleozoic rock units worldwide. Several Pennsylvanian (Late Carboniferous) chondrichthyan genera were originally described from Illinois (United States) during the early state geological surveys of the late nineteenth century (NEWBERRY & WORTHEN 1866, 1870; ST. JOHN & WORTHEN 1875, 1883; HAY 1885; BRANSON 1905), including teeth and spines of petalodontiform and cochlodontid chondrichthyans. However, as many of these specimens were collected prior to any detailed geological analyses of the Illinois Basin, precise stratigraphic and locality data are missing for most Pennsylvanian chondrichthyans from Illinois. In recent years, much attention has been devoted to the vertebrate faunas of the Desmo-
and includes the type specimens of the holocephalians *Psephodus actus* Branson, 1905; *Deltodus angularis* Newberry & Worthen, 1866; and *Cymatodus oblongus* Newberry & Worthen, 1870, as well as specimens of *Lophodus Romanovsky*, 1864; *Sandalodus Newberry* & Worthen, 1866; *Helodus Agassiz*, 1838; *Acondylacanthus St. John & Worthen*, 1875; *Vaticinodus St. John & Worthen*, 1883; and *Petalodus Owen*, 1840. While these specimens were likely collected from the LaSalle Limestone Member, they were usually described as coming from “the limestone near La Salle, Illinois,” and thus any specific stratigraphic or locality data is unknown.

Recent fieldwork in the LaSalle Limestone has yielded four chondrichthyan tooth taxa (*Petalodus ohioensis* Safford, 1853, *Peripristis semicircularis* Newberry & Worthen, 1866, *Deltodus angularis* Morris & Roberts, 1862, and *Helodus cf. simplex* Agassiz, 1838) as well as isolated fish scales and bone fragments. In general, this assemblage is similar to faunas known from Arizona (Elliott et al. 2004), Colorado (Itano et al. 2003), New Mexico (Lucas & Estep 2000; Zidek & Kietzke 1993), and Ohio (Hansen 1996), and adds another record to the growing list of localities worldwide that preserve comparable late Paleozoic chondrichthyan assemblages.


2. Geological setting

The LaSalle Limestone Member of the Bond Formation crops out frequently in both La Salle and Livingston Counties, where it is extensively mined for Portland cement (Fig. 1). This unit is characterized by thick benches of algal bank limestone alternating with thinner anoxic black shales (Fraser 1991). Fossils are abundant in this unit, and include brachiopods (Brusatte 2004), crinoids (Strimple & Moore 1971), and other invertebrates. Sites visited for this study are located in La Salle County, and include the Buzzi Unichem Quarry (NE ¼, SE ¼ of Sec 36, T33N, R1E La Salle Twp), an outcrop along Orlando Smith Road (SE ¼, SE ¼ of Sec 22, T33N, R1E La Salle Twp), and an abandoned quarry near Bailey Falls (SW ¼ Sec 6, T32N, R2E Vermilion Twp). Rigorous correlations between different measured sections are currently premature, but the Orlando Smith Road outcrop is stratigraphically higher than the Buzzi Unichem outcrops (Brusatte, unpubl. data).

Fig. 1. Location map and representative stratigraphic section (measured at the Orlando Smith Road Outcrop) of the La Salle Limestone. The general collecting area is denoted by a rectangle.
Fig. 2. Tooth of *Petalodus ohioensis* SAFFORD, 1853 (FMNH PF 14202) in lingual (A) and labial (B) views. Scale bar equals 1 cm.

3. Systematic paleontology

**Chondrichthyes** HUXLEY, 1880

**Petalodontidae** ZANGERL, 1981

**Petalodontidae Newberry & Worthen, 1866**

**Petalodus** OWEN, 1840

*Petalodus ohioensis* SAFFORD, 1853

**Fig. 2A-B**

Material: Nearly complete tooth from the Bailey Falls Section (FMNH PF 14202) and nearly complete crown from the Orlando Smith Road Outcrop (UCRC PV4). A total of 29 crown fragments from the Buzzi Unichem Quarry (UCRC PV4) clearly represent *Petalodus*, and are provisionally referred to *P. cf. ohioensis* based on overall morphology and stratigraphic position (see HANSEN 1985).

Description: FMNH PF 14202 (Fig. 2) is a complete tooth, measuring 58 mm in dorsoventral depth and 50 mm in mesiodistal width. It is labiolingually compressed and slightly sigmoid in mesial view. Lingually, the crown is bordered ventrally by a band of imbricating ridges, which is narrow as is diagnostic for *P. ohioensis* (HANSEN 1985; DALLA VECCHIA 1988). The remaining specimens are highly fragmented. Because of their fragmentary nature, specimens from the Buzzi Unichem Quarry (UCRC PV4) generally do not preserve details of the imbricated ridges, and thus are not clearly diagnostic at the species level. However, based on their general resemblance to *P. ohioensis*, as well as their stratigraphic position in the Pennsylvanian (see below), these specimens are referred to *P. cf. ohioensis*.

Discussion: *Petalodus* is among the most distinctive and common late Paleozoic chondrichthyan tooth genera, and ranges in age from the Meramecian (Late Mississippian) to the Wolfcampian (Early Permian). Although several species have been assigned to this genus based on subtle shape differences, today many of these are regarded as junior synonyms of two widespread species: *P. acuminatus* AGASSIZ 1838, the dominant Late Mississippian (Early Carboniferous) form, and *P. ohioensis*, which is well-known from Pennsylvanian (Late Carboniferous) and Early Permian strata (HANSEN 1985). One notable invalid species is *P. secundus*, a taxon established by HAY (1885) based on specimens found near La Salle, Illinois, and currently regarded as a junior synonym of *P. ohioensis* (HANSEN 1985). Specimens of *Petalodus* are known worldwide, and have been described from Arizona (ELLIOTT et al. 2004), New Mexico (ZIDEK & KETZKE 1993; LUCAS & ESTEP 2000), Kansas (ROBB 2003), Colorado (ITANO et al. 2003), Texas (MCNULTY 1963), Oklahoma (ZIDEK 1973), Ohio (HANSEN 1996), Slovenia (RAMOVSˇ 1997), Italy (DALLA VECCHIA 1988), and other locales in Europe and Asia (HANSEN 1985).

**Elasmobranchii** Bonaparte, 1838

**Pristodontidae** Woodward, 1889

**Peripristis** St. John, 1870

**Peripristis semicircularis** Newberry & Worthen, 1866

**Fig. 3A**

Material: One nearly complete tooth (UCRC PV5) from the Orlando Smith Road Outcrop.
Description: The lone recovered specimen (Fig. 3A) is relatively complete, but eroded on one margin. It is approximately 18 mm wide mesiodistally, and 11 mm deep dorsoventrally. Labially, the crown is divided into five triangular, lobate cusps that decrease in size toward the mesial and distal margins, as is characteristic of *P. semicircularis* (HANSEN 1985). As the specimen is imbedded in a block of limestone, only the labial surface is exposed. Thus, the unique lingual shelf and pit that characterizes *P. semicircularis* and other pristodontids is not visible. However, it is evident that the specimen lacks a distinct series of labial imbricating ridges, as in all pristodontids.

Discussion: As with *Petalodus*, *Peripristis* is a common North American late Paleozoic fossil that ranges in age from the Late Mississippian to the Early Permian. Along with a range of other forms, *Peripristis* belongs to the Pristodontidae, a group of petalodontiform chondrichthyans characterized by lobate teeth with a prominent lingual shelf and pit (ZANGERL 1981; HANSEN 1985). Specimens of *Peripristis* have been reported from several Pennsylvanian units, including locales in Colorado (ITANO et al. 2003), New Mexico (ZIDEK & KIETZKE 1993), and Ohio (HANSEN 1996). It has not been reported outside North America.

**Holocephali** BONAPARTE, 1832

Peripristiformes PATTERTON, 1965

Pristodontidae PATTERTON, 1965

*Helodus* AGASSIZ, 1838

*Helodus* cf. *simplex* AGASSIZ, 1838

**Cochliodontiformes** OBRUCHEV, 1953

Cochliodontidae OWEN, 1867

*Deltodus* MORRIS & ROBERTS, 1862

*Helodus* Agassiz, 1838

*Helodus* cf. *simplex* Agassiz, 1838

**Deltodus angularis** NEWBERRY & WORTHEN, 1866

Fig. 4A-B

Material: One nearly complete tooth from the Buzzi Unichem Quarry (UCRC PV6).

Description: The single collected tooth (Fig. 3B) measures 9 mm in mesiodistal width and 20 mm in labiolingual length. The crown is finely punctate, and rises at its center into a low, bulbous projection. The mesial and distal edges are both marked by fine raised lineations that may have formed an articulation with adjacent teeth. This morphology is diagnostic of *Helodus*, but specific characters of *H. simplex* are not apparent, although the overall morphology of this specimen closely matches published figures of *H. simplex* (e.g., STAHL 1999). Thus, this tooth is referred to *Helodus* cf. *simplex*.

Discussion: This genus is known from Devonian-Early Permian units worldwide (STAHL 1999), and is especially common in the Mississippian of the Midwestern United States. Teeth of *Helodus* *simplex* are very similar to those of *Psephodus*, a genus reported from the La Salle area by BRANSON (1905).

Material: Thirty-six tooth plate fragments (UCRC PV7) from the Buzzi Unichem Quarry.

Description: The material consists of several crown fragments in a variable state of preservation. Some specimens are noticeably fragmented, while others are nearly complete. The crowns are convex, with a surface that is generally smooth but finely punctate. Some specimens are marked with a distinct convex ridge running along the long axis of the tooth, and faint depressions and wear facets are visible on some of the tooth plates. One specimen shows faint
radial zonations, which may represent growth lines, while two fragments preserve a portion of the root, which is slightly inset relative to the crown. The small size, teardrop to triangular shape, and lack of transverse corrugations are diagnostic of *D. angularis* relative to other species of *Deltodus* (e.g., *D. sublaevis*: see Stahl 1999; Stahl & Hansen 2000; Elliott et al. 2004).

**Discussion:** One of the most characteristic Late Paleozoic chondrichthyan genera, *Deltodus*, is known from several deposits worldwide, including those in Arizona (Elliott et al. 2004), Colorado (Itano et al. 2003), West Virginia (Lund et al. 1979), Ohio (Hansen 1996), Oklahoma (Zidek 1973), and Wyoming (Branson 1916), as well as locales in Thailand, France, England, Ireland, Belgium, Russia, and Australia (Stahl 1999). This genus is commonly represented by isolated and fragmentary tooth plates, which indicate a durophagous diet.

### 4. Other vertebrate fossils

Additional vertebrate fossils recovered from the LaSalle Limestone include several indeterminate osteichthyan scales and a possible three-dimensional chondrichthyan braincase (FMNH PF 8744) (Fig. 5). This specimen clearly preserves prismatic calcified cartilage, a feature of chondrichthyans, and has an outline consistent with that of a braincase, but few other details are evident. Tetrapod material has been reported, including several long bones discovered in a lens deposit and a complete femur discovered during a prospecting trip led by the Earth Science Club of Northern Illinois, but is not available for study.

### 5. Discussion and conclusions

This paper is the first published description of the chondrichthyan tooth fauna of a particular Pennsylvanian unit in Illinois. While other descriptions of Illinois chondrichthyan fossils have been published (e.g. Newberry & Worthen 1866, 1870; St. John & Worthen 1875, 1883; St. John 1885; Branson 1905), none include detailed stratigraphic and locality data. These omissions hinder any attempts to determine precise stratigraphic and geographic ranges for chondrichthyan taxa in Illinois, and thus make reliable comparisons to similar faunas difficult. As shark teeth are common fossils in many late Paleozoic deposits, they are potentially useful in biogeographic, biostratigraphic, paleoecological, and taphonomic studies. Hansen (1985) suggested that petalodont teeth from the mid-continental United States may permit biostratigraphic zonation to at least the series level, but then lamented the lack of detailed locality and stratigraphic data for most taxa. This problem has been addressed in a handful of recent studies, including those of Lucas & Estep (2000), Itano et al. (2003), and Elliott et al. (2004), which have described Pennsylvanian chondrichthyan tooth faunas within a stratigraphic context. But, the fact that this note is the first such attempt to carefully describe a late Paleozoic tooth fauna from Illinois strongly attests that much work remains to be done.

Comparison of the LaSalle Limestone chondrichthyan fauna with other global assemblages is currently difficult, as only preliminary fieldwork has been conducted in Illinois. Thus, detailed comparisons of...
the diversity and relative abundance of taxa between the LaSalle Limestone and other formations is not possible at the moment. However, the LaSalle Limestone shares chondrichthyan tooth taxa with similar-age formations from across the United States, as well as Europe and Asia (e.g., Hansen 1985; Stahl 1999; Lucas & Estep 2000; Itano et al. 2003; Elliott et al. 2004). This adds to growing evidence for the cosmopolitan nature of chondrichthyan faunas during the Pennsylvanian (Late Carboniferous). However, some regional differences in faunas are apparent. For example, although Petalodus and Deltodus are known from across North America and from sites in Europe and Asia, Peripristis has not been reported outside North America.

In addition to yielding the fossils described in this note, fieldwork in the LaSalle Limestone Member has revealed potential for future vertebrate discoveries. The anoxic black shales that alternate with the more prominent limestone beds are similar in lithology to the fossiliferous Mecca and Logan Quarry Shales, which have produced a diverse assemblage of well-preserved chondrichthyan body fossils (Williams 1985). Additionally, although most Pennsylvanian tetrapods are found within fluvial-deltaic and lake deposits (DiMichele & Hook 1992), the discovery of isolated tetrapod remains within the LaSalle Limestone Member suggests a potential for future discoveries. As paleontological studies of the LaSalle Limestone Member have so far been limited, additional fieldwork is sure to uncover new specimens.

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References


Fig. 5. Indeterminate chondrichthyan braincase (FMNH PF 8744). Scale bar equals 1 cm.


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