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A Cretaceous shark tooth in glacial debris of middle Missouri

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Fossil Crow shark teeth, extinct genus *Squalicorax*, are widespread and are reported from the Late Cretaceous of Europe, northern Africa and North America. In the spring of 2011 a fossil tooth of *Squalicorax kaupi* was discovered in glacial debris of north-central Missouri. The tooth is fairly worn. It is about 1.5 cm tall and 1.6 cm at its widest point. Both cutting edges show evidence of heavy serrations though they are preserved well only at the distal notch. Portions of the enamel are missing and the broken edges are worn smooth. There are two likely sources for the fossil shark tooth of this study. It could have arrived in Missouri by fluvial and glacial movements from formations of the Western Interior Seaway of Kansas, Nebraska or Iowa or from the north northwest by glacial movements from the Hudson Seaway. There are no marine deposits of the Late Cretaceous in this part of Missouri, but Late Cretaceous marine formations and fossils are abundant from Kansas and Nebraska and lesser so from Iowa.

Keywords: Squalicorax*, crow shark, Anacoracidae, Late Cretaceous, fossil shark tooth, Western Interior Seaway, Hudson Seaway*

Introduction

In the spring of 2011 an isolated fossil tooth of *Squalicorax kaupi* (Agassiz 1843) was discovered in glacial debris about 25 km northeast of Fayette, Missouri (Fig. 1). The tooth was identified to genus and species by K. Shimada (personal communication 2011). The tooth is housed in the Stephens Museum of Central Methodist University (TSM 2011-1) in Fayette, Missouri, USA. Fayette is in Howard County, in the north-central part of the state. *Squalicorax* teeth are common as fossils in marine Cretaceous deposits around the world, including North America (Cappetta 1987). In the United States, they occur in deposits from the Late Albian to the Late Maastrichtian, especially in deposits of the Western Interior Seaway (WIS) (Cappetta, Duffin and Zidek 1993; Noibhani and Cappetta 1997; and Shimada and Cicimurri 2005) and only occasionally have been reported as reworked material from younger deposits

Figure 1. The state of Missouri showing the Missouri River crossing the state from Kansas City, at the state line on the left, to St. Louis at the state line on the right. The dot in the north-central part of the state is the site where the tooth in this study was collected. The two arrows north of the Missouri River show the generalized direction of flow for pre-Illinoian glaciation.

(Shroud and Winter 1980, Burris 2001). Until now, *Squalicorax falcatus* was the only reported *Squalicorax* tooth in Missouri and was discovered in Paleogene sediments lying directly above Cretaceous deposits in Stoddard County (Shroud and Winter 1980). The tooth described here represents a much longer hiatus, as it was located in Pleistocene sediments, and is the second *Squalicorax* species to be documented from Missouri.

Systematic Paleontology

Chondrichthyes Huxley 1880
Lamniformes Berg 1958
Anacoracidae Casier 1947
Squalicorax Whitley 1939
Squalicorax kaupi Agassiz 1843

Material: TSM 2011-1, an isolated tooth from either the left mandible or right palatoquadrate.

Description: The tooth is approximately 1.5 cm tall (root lobe to cusp apex) and 1.6 cm at its widest point (Fig. 2). The tooth has an overall crescent shape, owing to the distally inclined cusp apex, long distal cutting edge and short mesial cutting edge. The mesial cutting edge is bulbously convex, while the distal cutting edge is nearly vertical, dropping into a distal notch followed by an angled distal heel. Both cutting edges show evidence of heavy serration, though it is only well preserved at the distal notch. The tooth root lacks a lingual nutritive groove. The tooth is fairly worn. In addition to the worn serrations just described, the cusp apex is rounded instead of sharp, the distal root lobe is damaged and partially worn, and the mesial root lobe is worn.

Portions of enamel are missing from the dentine-enamel junction on the labial face of the cusp, but the broken edges are also worn smooth.

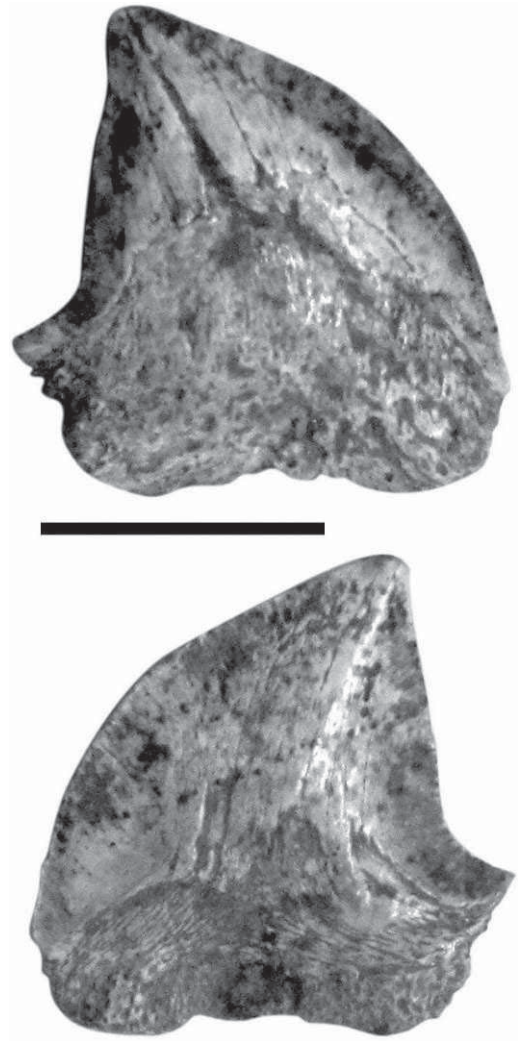

Figure 2. Photos of the ***S. kaupi*** shark tooth (TSM 2011-1) reported herein. The top view is lingual and the bottom view is labial. Scale = 1 cm.

Discussion

Identification: The tooth described here, however, is firmly within the morphological range of *S. kaupi*; it has a bulbously convex mesial cutting edge and the distal cutting edge is nearly vertical, dropping into a distal notch. *Squalicorax falcatus* tends to have a straighter distal cutting edge, a more acute cusp apex and the outer face of the crown overhangs the tooth base (Cappetta 1973; Schwimmer, Stewart, and Williams 1997). *Squalicorax pristodontus* is similar in morphology to *S. kaupi*, but lacks the distal notch (Gottfried, Rabarison and Randriamiarimanana 2001). *Squalicorax curvatus* lacks the vertical distal edge and tends to have a more acute notch (Williston 1900).

Occurrence: The exact origin of the tooth is not known. We propose the primary scenario is that the tooth originated in the WIS of Kansas or Nebraska, or possibly western Iowa (Witzke 1981). A second possibility could be the Hudson Seaway, which connected the Labrador Sea to the WIS via Manitoba, Saskatchewan and Minnesota (White, Wizke and Ludvigson 2000). Fluvial and/or glacial action then moved the tooth from its point of fossilization to the location in Howard County, Missouri, where it was discovered in glacial debris (Fig. 1).

The only Cretaceous deposits in Missouri are located in Stoddard and Scott Counties in the southeastern corner, while the non-Cenozoic outcrops in Howard County are Carboniferous (Lamar and Sutton 1930, Unklesbay and Vineyard 1992). In Missouri Illinoian glacial debris is deposited only a few km north of St. Louis in a small area immediately west of the present day Mississippi River (Whitfield 1995). Aside from this one minor exception, the glacial debris of northern Missouri is of pre-Illinoian glaciation, approximately 2.5 Ma to 500,000 years ago (Guccione 1983, Mickelson and Attig 1999, Roy et al. 2004).

By the 1960s a consensus was reached by glaciologists studying in Missouri that the southern boundary of pre-Illinoian glaciation is nearly the same as the modern Missouri River Valley (Heim 1961). This consensus has endured to the present (Middendorf 2003). The eastern side of the state has well defined glacial debris north of the Missouri River, with a few widely scattered erratics immediately south of the river (Heim 1961). The western side of the state has a distinct southern limit immediately south of the Missouri River. It is generally agreed that the present day Missouri River is a good approximation for the southern limit of glaciation in Missouri with the exception of the middle part of the state, where, at one point, the Missouri River is about 30 km north of the southern limit of glaciation (Heim 1961; Middendorf 2003). Another way to look at Missouri's approximate southernmost glacial debris would be to use present day Interstate 70, which extends across Missouri from Kansas City to St. Louis. Howard County lies immediately to the north of Interstate 70 and the Missouri River and was entirely glaciated (Middendorf, 2003). Pre-Illinoian glacial advancement was in the south southeast direction, which may have contributed to transport from either the WIS or the Hudson Seaway (Guccione 1983, fig. 1).

During the Pleistocene the advancing ice also reshaped the land and formed new stream channels and buried others. Before the Pleistocene the ancestral Missouri River was a lesser tributary to the larger Kansas (also known as the Kaw) River. After glaciation the Kansas River became a major tributary to the Missouri River (Bayne et al. 1971). The Kansas River currently drains the northern half of Kansas as well as the southern part of Nebraska and much of eastern Colorado (Colby et al. 1956). Since the ancestral form of the Kansas River originated in the sediments of the WIS, this could have been the likely route the tooth took to end up in Howard County, Missouri. As local glacial advances retreated, flood waters of the southern termination of these glaciers created the present day Missouri River Valley from Montana to Kansas City (Trimble 1980).

Alternative transport scenario: There is a remote possibility that the tooth could have been transported to the Howard County site by a Native American. There has been only one fossil shark tooth discovered on a recognized archaeological site in Missouri, the Bridgeton Site in St. Louis County. This large tooth was of *Carcharodon*, an ancient great white shark, and was undoubtedly brought to the site by a Native American (M. Fuller, personal communication 2011). In the late 1940s, several large shark teeth were excavated from Mound 34 of the Cahokia Site on the Illinois side of the St. Louis area. All of these teeth were also from *Carcharodon*, ancient great white sharks, and all were nearly 2 in (5 cm) from tip-to-base and serrations were unworn

(Perino 1953). The large size and relatively unworn, large serrations make these teeth distinctly different from the *S. kaupi* tooth of this study. Based on these differences, and the extent and characteristics of wear, it is an unlikely scenario that a Native American brought the tooth of this study to Howard County.

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