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Ctenacanthiform Cladodont Teeth from the Lower Permian Wichita Group, Texas, U.S.A.

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ABSTRACT:

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Isolated teeth of *Glikmanius occidentalis* occur in ten vertebrate faunas in the Waggoner Ranch Formation and in one fauna in the underlying Petrolia Formation. They range in size (anteromedial-posterolateral base length) from 1.28 mm to 10.15 mm (n = 12). In addition to the typical teeth, one with an asymmetrical base and one possible posterior tooth (both *G.* ?*occidentalis*), and a questionable symphyseal tooth (*Glikmanius*?), occur in the collection.

Key words: Ctenacanthiform shark teeth, Lower Permian, Artinskian, Texas, USA.

INTRODUCTION

Isolated cladodont teeth were recovered by bulk-sampling of matrix (JOHNSON *& al*. 1994) from various strata in the Wichita Group (mostly Artinskian, the age of the teeth in this study) from Baylor County, north-central Texas. Nearly all of the teeth belong to *Glikmanius occidentalis* (LEIDY, 1859), based on a revision of *Cladodus occidentalis* by GINTER *& al*. (2005). Descriptive abbreviations include am-pl = anteromedial-posterolateral and l-l = labial-lingual. The teeth are reposited in the Shuler Museum of Paleontology, Southern Methodist University (SMU 69375-69394).

DESCRIPTION

***Glikmanius occidentalis* teeth:** The Wichita teeth clearly demonstrate the morphological features of *Glikmanius occidentalis* described by GINTER *& al*. (2005). Besides possessing the typical base-crown morphology of cladodont teeth, they possess a deep basolabial depression at the base of the median cusp; well-separated oral apical buttons and corresponding aboral basal tubercles on the base; a vertical but slightly lingually bent median or principal cusp with a deeply convex lingual side and slightly convex labial side, the two sides separated by a pair of carinae; and a lateral cusp separated from the much larger median cusp by a smaller intermediate cusplet on either side of the median cusp (Text-figs 1, 2). The cusplets define a line labial to one defined by the median and lateral cusps.

There is little to significantly distinguish most of the Wichita *Glikmanius occidentalis* teeth from one another. None are totally complete, as one cusp or another is broken; some are worn from transport. There are minor differences in the cristae patterns in the median cusp (compare Text-figs 1 and 2); each tooth is probably unique in this case. In unworn median cusps, some of the cristae extend all the way to the tip (SMU 69388, 69393). There is more variability than GINTER *& al.* (2005, p. 626) imply, but in general the patterns agree. The intermediate cusplets are sometimes absent (one tooth > ½ complete in SMU 69384, Table 1; and see below), and none of the teeth have more than one pair, which agrees with the GINTER *& al*. (2005, p. 626) assessment. The median

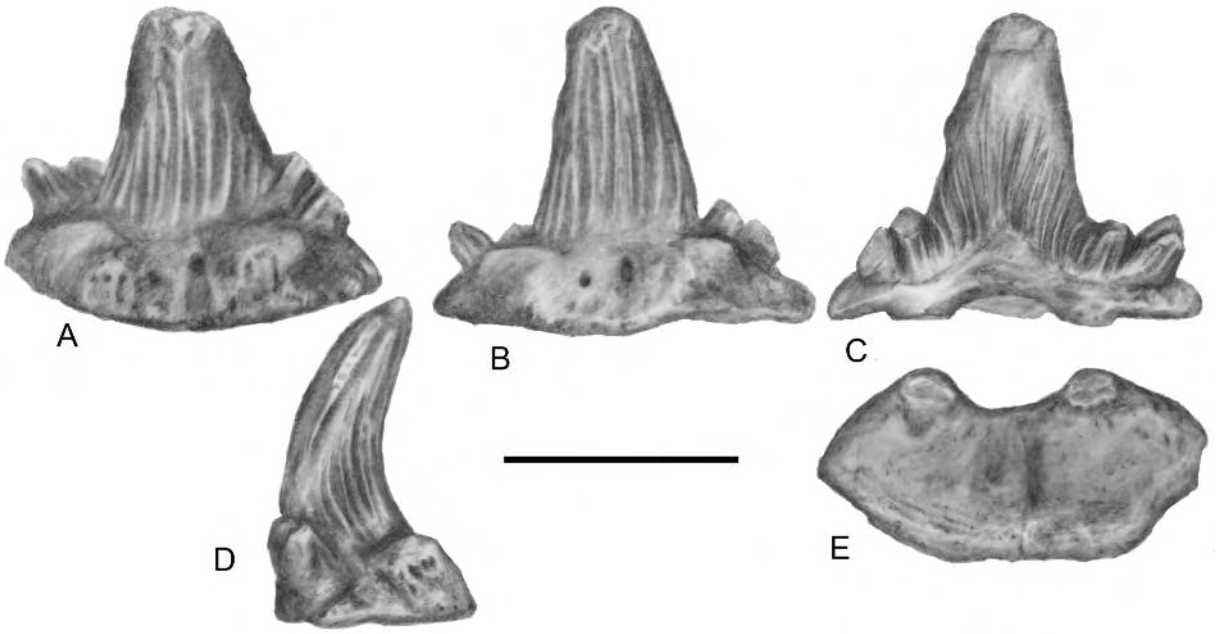

Fig. 1. *Glikmanius occidentalis* tooth (SMU 69378) from the Brushy Creek C fauna, upper Petrolia Formation; A – lingual-occlusal, B – lingual, C – labial, D – anterior/posterior, and E – aboral (concave surface, labial margin at top) views. Part of the lingual margin of the base is visible below the labial margin in C; one lateral cusp and both intermediate cusplets are broken. Scale bar = 5 mm

cusp may be nearly straight, but is usually bent lingually (Fig. 1D); in one tooth (SMU 69388, Table 1), it is slightly sigmoidal.

The bases of the Wichita teeth are concave on their aboral side. They have a reniform shape where a determination can be made, with two exceptions described below. Apical buttons are lingually marginal and may be prominent or subdued.

Measurements: Teeth with complete bases were measured using a camera lucida. The maximum l-l measurement includes the most extended part of the

Formation and fauna (SMU locality no.)	Comments (number of teeth, most ≥½ complete*)
l. upper Waggoner Ranch Formation	
Tit Butte/ac* (344)	SMU 69388 (1), 69389 (2), 69393 (1)
middle Waggoner Ranch Formation	
Mitchell Creek B/ac (160)	SMU 69384 (6), 69392 (2)
Mitchell Creek A (353)	SMU 69385 (1)
Bluff Creek A (356)	SMU 69387 (1); *Glikmanius*? symphyseal?; Text-fig. 4
Spring Creek B/ac (357)	SMU 69380 (1)
Spring Creek A/ac (359)	SMU 69381 (1), 69382 (5), 69390 (3)
Old Military Crossing (361)	SMU 69386 (1); *G.* ?*occidentalis* (asymmetrical base)
l. middle Waggoner Ranch Formation	
West Franklin Bend C (286)	SMU 69379 (2), 69394 (1)
West Franklin Bend C/ac (286)	SMU 69375 (1; Text-fig. 2), 69376 (1; *G.* ?*occidentalis* posterior?; Text-fig. 3), 69377 (2)
West Franklin Bend A/ac (363)	SMU 69383 (4), 69391 (1)
upper Petrolia Formation	
Brushy Creek C (377)	SMU 69378 (1; Text-fig. 1)

*fragments and cusps included but not counted; ac = sample obtained from acid-treated rock; l. = lower

Table 1. Stratigraphic distribution of *Glikmanius occidentalis* teeth in the Lower Permian Wichita Group of Texas, U.S.A.

lingual margin to the greatest labial projection of the basal tubercles, projected onto a line perpendicular to the am-pl dimension. The results are shown in Table 2. The mean dimensions are 4.88 mm (am-pl) x 2.48 mm (l-l), n = 12. They are smaller than the teeth illustrated by GINTER & *al*. (2005, figs 1A-E, 2A-B), largely reflecting the effects of bulk-sampling.

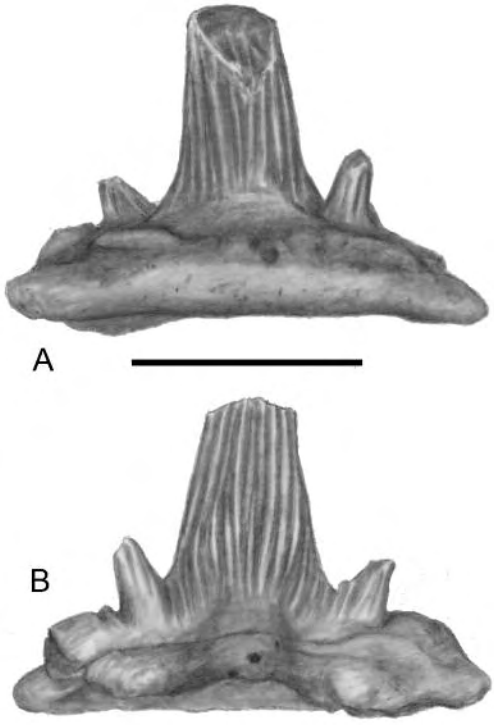

Fig. 2. *Glikmanius occidentalis* tooth (SMU 69375) from the West Franklin Bend C/ac fauna, lower middle Waggoner Ranch Formation; A – lingual and B – labial views. Part of one of the basal tubercles appears below the margin of the base in A; the other one does not because the view is from slightly left of center. The lingual margin of the aboral side of the base is visible below the labial margin in B; the lateral cusps are broken. Scale bar = 5 mm

Fig. 4. *Glikmanius*? symphyseal? tooth (SMU 69387) from the Bluff Creek A fauna, middle Waggoner Ranch Formation. A – lingual, and B – labial views; intermediate cusplets are absent. Scale bar = 2 mm

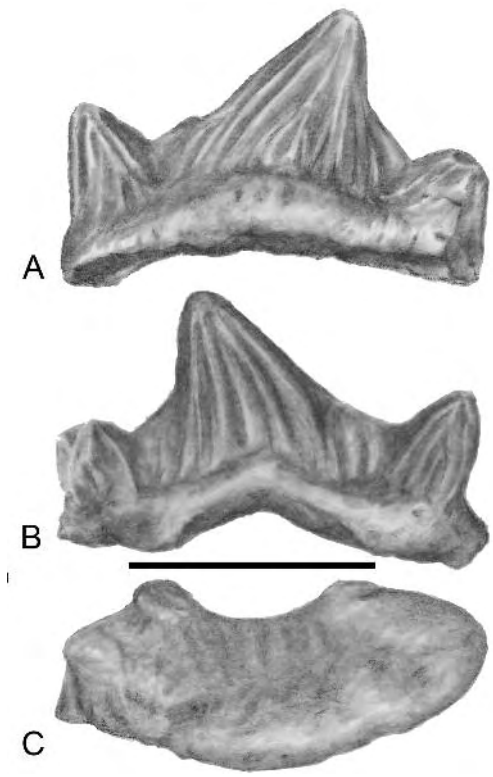

Fig. 3. *Glikmanius* ?*occidentalis* posterior? tooth (SMU 69376) from the West Franklin Bend C/ac fauna, lower middle Waggoner Ranch Formation; A – lingual, B – labial, and C – aboral (labial margin at top) views. Intermediate cusplets and apical buttons are absent; lingual margin and aboral surface of base are covered by a film of matrix. The basal tubercles in B are partly obscured by matrix; the left (posterior? in B) end is broken. Although the aboral side of the base is concave, its lingual margin in B is not quite visible (compare with Text-fig. 1C). Scale bar = 2 mm

Locality	SMU no.	am-pl, mm	l-l, mm
344	69393	6.92	3.23
160	69392	2.35	1.34
		3.36	1.83
357	69380	1.47	0.89
359	69390	4.29	2.20
		3.10	1.79
		3.06	1.94
361	69386	1.28	0.75
286	69394	4.77	2.46
286	69375	9.85	5.23
363	69391	10.15	4.15
377	69378	8.00	4.00

Table 2. Measurements of *Glikmanius occidentalis* tooth bases from the Lower Permian Wichita Group of Texas, U.S.A., in stratigraphic order (youngest at top; see Table 1). am-pl = anteromedial-posterolateral length, l-l = labial-lingual width

Occurrence: The stratigraphic distribution of the teeth is given in Table 1 (compare with JOHNSON 1981, fig. 3; 1999, table 1; 2003, table 1). The faunas in this part of the Wichita Group contain marine, nonmarine, and terrestrial vertebrates (JOHNSON 1979). This complements the marine Lower Permian distribution of *Glikmanius occidentalis* in the U.S.A. provided by GINTER & *al*. (2005).

Unusual teeth: One tooth (SMU 69386, Tables 1 and 2), has an asymmetrical base. It also lacks intermediate cusplets, but otherwise is normal with apical buttons, basal tubercles, and median and lateral cusps. Slightly greater than half the base is wider than in typically reniform teeth, partly because of a medial lingual protuberance (included in the Table 2 measurements), where the am-pl : l-l ratio is only 1.7 compared to the more typical ratio of ≈ 2. The lingual margin on one side of the protuberance tapers off toward the am/pl rounded tooth end at an angle of ≈ 45° to the am-pl axis. The entire labial margin is normal except the labial depression is not nearly as great as shown in Text-fig. 1E. This unusual combination of base asymmetry, lack of cusplets, and shallow labial depression probably reflects position in the dental arcade, but for the present its identity is questioned (Table 1).

A second tooth (SMU 69376, Table 1) lacks intermediate cusplets and the median cusp leans posteriorly (Text-fig. 3). Although it has well-separated basal tubercles (Text-fig. 3B, C), it lacks apical buttons (Text-fig. 3A) with only a highly subdued lingual ridge (obscured by matrix) in their place. The presence of basal tubercles precludes it from being a hybodont; there is little doubt that it is a cladodont and that it belongs to *Glikmanius*. It may be a posterior tooth, but its identity is questioned (Table 1) because teeth with this morphology have not previously been recognized in *G. occidentalis*. Its lack of secondary cusps is comparable to xenacanth posterior teeth (JOHNSON 1999); however, because the lateral cusps are divergent, its position in the dental arcade is uncertain.

The most unusual tooth (SMU 69387, Table 1) is presumably water-worn by transport, because the cristae on the median cusp are absent except at its base and it has a polished appearance (Text-fig. 4). However, prominent sharp carinae are present on the median cusp which leans lingually and is slightly recurved. Intermediate cusplets are absent and the lateral cusps are reduced in size. It has a highly reduced base [3.25 mm (am-pl length) × 1.87 mm (l-l width)], relative to the size of the median cusp, with apical buttons fused to the median cusp (Text-fig. 4A) with a deep groove between them. This groove contains a relatively large lingually-facing matrix-filled foramen (Text-fig. 4A) and continues on the aboral surface of the base to the labial side where it appears as a notch on the labial margin (Text-fig. 4B). The aboral surface of the right side (Text-fig. 4A) of the base was apparently broken away prior to transport and wear. The labial side lacks a medial depression on both the base and and base of the median cusp; instead, there is a downward-sloping labial shelf below the cusps (Text-fig. 4B). One basal tubercle is highly reduced and the other is absent as a result of the presumed breakage and wear from transport. Although much smaller, SMU 69387 somewhat resembles teeth assigned to *Cladodus robustus* and *C. micropus* by NEWBERRY & WORTHEN (1866; considered to be variants of *Stethacanthus* by M. GINTER, pers. com., November 2007; see also DUFFIN & GINTER 2006, p. 265). *Cladodus micropus* teeth may possess only one pair of accessory cusps, which agrees more closely with the Wichita tooth. The *Cladodus* species are from the Mississippian, which would require the Permian Wichita tooth to have been reworked considerably more than just by simple transport. Its assignment to *Glikmanius* is questioned, assuming its age is Permian, although this doubt may be negated if it should indeed be a symphyseal tooth.

CONCLUSIONS

The presence of cladodont teeth, of which nearly all can be confidently assigned to *Glikmanius occidentalis*, is confirmed to be present in eleven mixed marine and nonmarine faunas in the Lower Permian Wichita Group of Texas. They tend to be smaller in average size than specimens from elsewhere, probably reflecting their acquisition by bulk-sampling of matrix.

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