

New Mosasaur remains from the Upper Cretaceous of Mississippi

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ABSTRACT - New discoveries of fossil teeth from mosasaurid reptiles are reported from Late Cretaceous strata in northeastern Mississippi, USA. The new material is attributed to the mosasaurine *Mosasaurus hoffmannii* and the rüsselosaurines *Tylosaurus* sp., *Plioplatecarpus* sp. nov., and cf. *Platecarpus*. Fossil specimens originate from the Campanian of Lee and Prentiss Counties and the Maastrichtian of Union County.

Keywords: Mississippi, Late Cretaceous, Campanian, Maastrichtian, Mosasaur, Paleobiogeography

INTRODUCTION

Mosasaurids were secondarily aquatic marine reptiles that inhabited the oceans and seas during the last 25 million years of the Late Cretaceous. Returning to sea during the Cenomanian-Turonian, the ancestors of mosasaurids quickly diversified to take advantage of a variety of marine predator niches (Everhart, 2005). Unique and highly adapted tooth morphologies indicate that some mosasaurids specialized in predation on specific prey items (Massare, 1987; Harrell Jr and Perez Huerta, 2015).

First reported in the Gulf Coast region of the United States by Gibbes (1850), mosasaur remains are common fossil occurrences in Mississippi and Alabama (Cope, 1869; Renger, 1935; Russell, 1967; Thurmond and Jones, 1981;

Bell and Sheldon, 1986; Daly, 1992; Ikejiri et al., 2013). Remains consist predominantly of isolated teeth and vertebrae, although partial skeletons have been recovered (Moffitt, 2020).

Here, we report the discovery of new mosasaur finds, namely isolated teeth, from northeastern Mississippi. Fossil specimens were recovered by amateur fossil hunters sifting through creek beds in Lee, Prentiss, and Union Counties. The new material includes a Maastrichtian occurrence of the mosasaurine *Mosasaurus hoffmannii*, and Campanian occurrences of the rüsselosaurines *Tylosaurus* sp., *Plioplatecarpus* sp. nov., and cf. *Platecarpus*.

GEOLOGIC SETTING

Cretaceous deposits crop out in the northeastern corner of Mississippi between Alcorn and Noxubee Counties. From oldest to

youngest, they are: the Tuscaloosa Group, the McShan Formation, the Eutaw Formation and its Tombigbee Sand Member, the Mooreville Chalk, the Coffee Sand Formation, the Demopolis Chalk and its “Frankstown Sand,” the Ripley Chalk and its Chiwapa Sandstone Member, and Prairie Bluff Chalk and Owl Creek Formation (Mancini et al., 1996; Schweitzer et al., 2019) (Figure 1). These strata were laid down in a shallow sea between approximately the middle Cenomanian and the late Maastrichtian.

Frankstown fossil site: The Frankstown fossil site is located in Twenty Mile Creek at the crossroads of Highway 30 and I-45, approximately 8 km north of Baldwin, Mississippi. The site was popularized in the summer of 1990 during construction of the Highway 45 Bypass at Frankstown when a highway cut uncovered an abundance of shark teeth and other vertebrate fossils from the unconformable Coffee Sand/Demopolis contact (Dockery, 1997).

The Frankstown locality is rich in marine remains. Shark and mosasaur fossils originate from a < 1 meter thick sand bed informally referred to as the “Frankstown Sand.” Historically interpreted as an unnamed layer at the base of the Demopolis Chalk (Manning and Dockery, 1992), sediment in this layer is early Late Campanian in age and consists of a light brown, well-sorted sand with traces of crab and shrimp burrows. Teeth from the lamniform chondrichthyans *Scapanorhynchus texanus* and *Squalicorax* sp. are particularly abundant in this layer. Immediately overlying the “Frankstown Sand” is an oyster bed rich in *Exogyra ponderosa* and *Pycnodonte convexa* (Manning and Dockery, 1992).

On May 6, 1995, a portion of the Frankstown fossil site was dedicated as the W. M. Browning Cretaceous Fossil Park, and the site became

Mississippi’s first roadside park dedicated to paleontology (Dockery, 1997). Today, fossils are found in gravel layers that alternate with sand layers in the creek beds and along sandbars of Alcorn, Prentiss, and Lee Counties.

Union County site: The Owl Creek Formation and Prairie Bluff Chalk are chronostratigraphically equivalent formations formed on the eastern side of the Mississippi Embayment during the late Maastrichtian (Schweitzer et al., 2019).

The Prairie Bluff Chalk is an approximately 3.5-meter thick phosphatic chalk that contains grayish-black sandy glauconitic, fossiliferous clay (Bergquist et al., 1943). The Prairie Bluff Chalk extends from Sumter County, Alabama, in a northwest direction into Mississippi through Kemper, Noxubee, Oktibbeha, Clay, Chickasaw, Pontotoc and Union Counties (Stephenson and Monroe, 1937).

The Owl Creek Formation is a non-chalky, fine, argillaceous, glauconitic sand and sandy clay (Stephenson and Monroe, 1937). It runs through Pontotoc, Union, and Tippah Counties, and briefly extends into Hardeman County, Tennessee, before being overlain by the Midway Group. The Owl Creek Formation later reemerges near Crowley’s Ridge in southeastern Missouri (Sohl, 1960).

In Union County, Mississippi, the Prairie Bluff Chalk is replaced by the Owl Creek Formation. The formations are separated by a calcareous muddy fine quartz sand facies, called the Nixon Beds (Phillips, 2010). Both formations overlie the highly lithified Chiwapa Sandstone Member of the Ripley Formation. A close faunal relationship exists between the Prairie Bluff Chalk and its equivalent Owl Creek Formation (Stephenson and Monroe, 1937). Vertebrate fossils expose from the Prairie Bluff Chalk and Owl Creek

Formation and collect in lag deposits in close proximity to their presumed stratigraphic origins (Farke and Phillips, 2017).

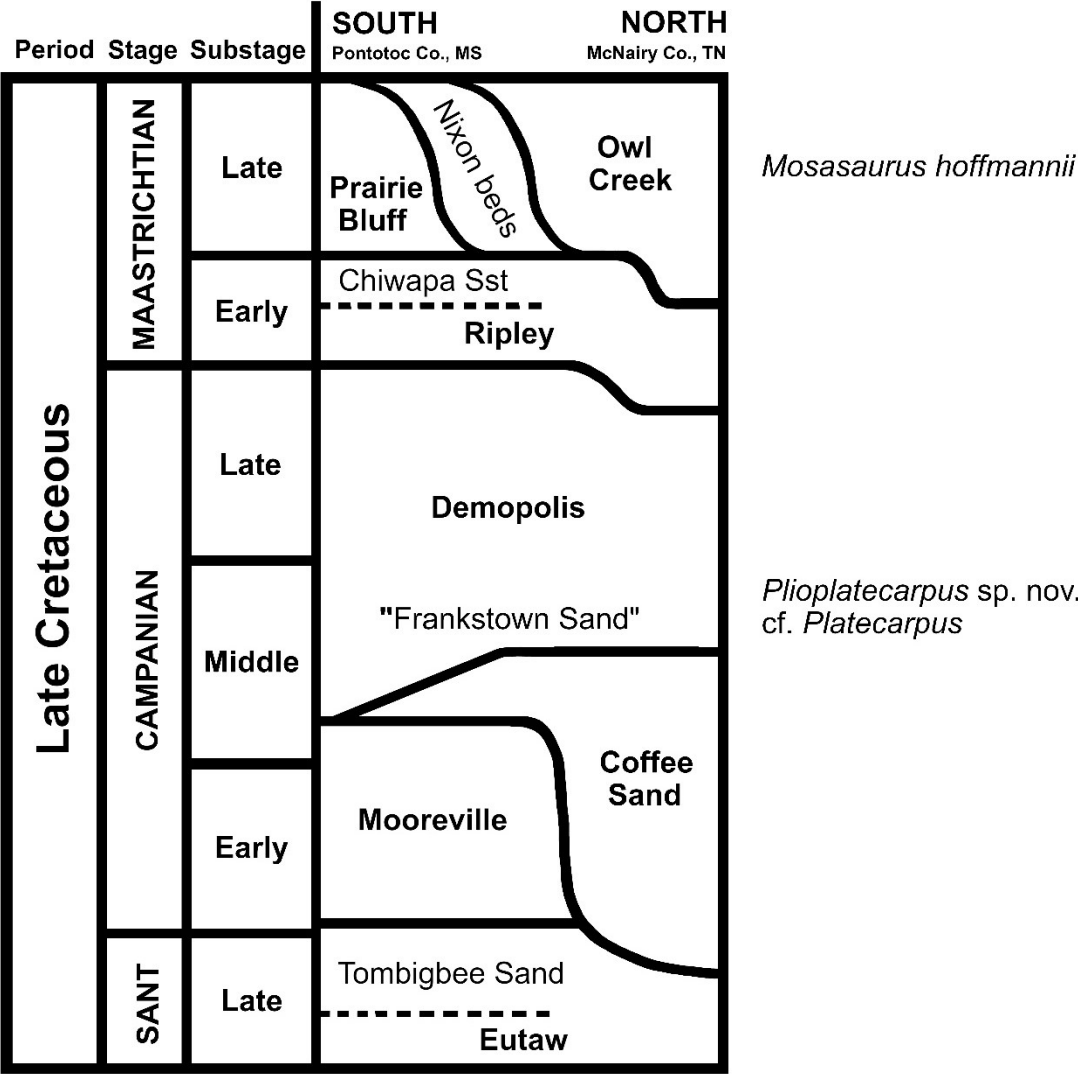


Figure 1. Stratigraphic chart of Late Cretaceous deposits in northeast Mississippi. Based on Stephenson and Monroe, 1937, Mancini et al., 1996, and Schweitzer et al., 2019.

MATERIALS AND METHODS

Photographs were taken using a Panasonic LUMIX FZ80 4K Digital Camera. Figures were prepared using GIMP 2.10.20. Anatomical terminology follows Russell, 1967, with dental terminology following Hornung and Reich, 2015. Material examined for this study is retained in the first author's collection (abbreviated REMPC). Resin casts of the fossil material are available at the Cranbrook History Centre (Cranbrook, British Columbia, Canada), and 3D-scans of *Mosasaurus hoffmannii*, *Tylosaurus* sp., and cf. *Platecarpus* teeth are available online as downloadable models at sketchfab.com.

RESULTS

Systematic Paleontology

Order SQUAMATA Oppel, 1811

Family MOSASAURIDAE Gervais, 1853

Subfamily MOSASAURINAE Gervais, 1853

Genus *Mosasaurus* Conybeare, 1822

Mosasaurus hoffmannii Mantell, 1829

Material and occurrence. REMPC M0190, marginal tooth crown, upper Maastrichtian, Owl Creek Formation/Prairie Bluff Chalk, Union County, Mississippi (Figure 2).

Description. The tooth measures 50 mm high, 26 mm long, and 23 mm wide. The apex of the crown curves medially (labiolingually) towards

the center of the jaw. Two well-defined carinae divide the tooth into subequal labial and lingual faces. The labial surface is reduced due to the posterior carina swinging laterally at a 240° occlusal angle from the anterior carina. Lingually, the crown is convex and inflated. This results in a D-shaped basal cross-section. The carinae bear minute crenulations. The enamel texture consists of fine, vermiculate sculpturing. The tooth bears three prism faces labially and an indistinguishable number of facets lingually.

Remarks. The genus *Mosasaurus* is characterized by teeth possessing well-defined carinae, medial curvature, a flattened labial surface and convex lingual surface, a D-shaped basal cross-section, and enamel decorated by prism faces and facets. Differences in facet counts differentiate the teeth of the various *Mosasaurus* species (Bardet et al., 2004). In *M. hoffmannii*, marginal teeth bear 2-3 labial prism faces and at least 5 lingual facets, although facets are often faded to the point of being uncountable (Rempert et al., 2022b).

M. hoffmannii is well known from Maastrichtian deposits in the Atlantic and Gulf coastal plains of North America (Russell, 1967; Farke and Phillips, 2017; Moffitt, 2020), with historical occurrences often listed under the junior synonym *M. maximus* (Russell, 1967). The species had a transatlantic paleobiogeographical distribution between paleolatitudes 25°N and 50°N (Rempert et al., 2022b).

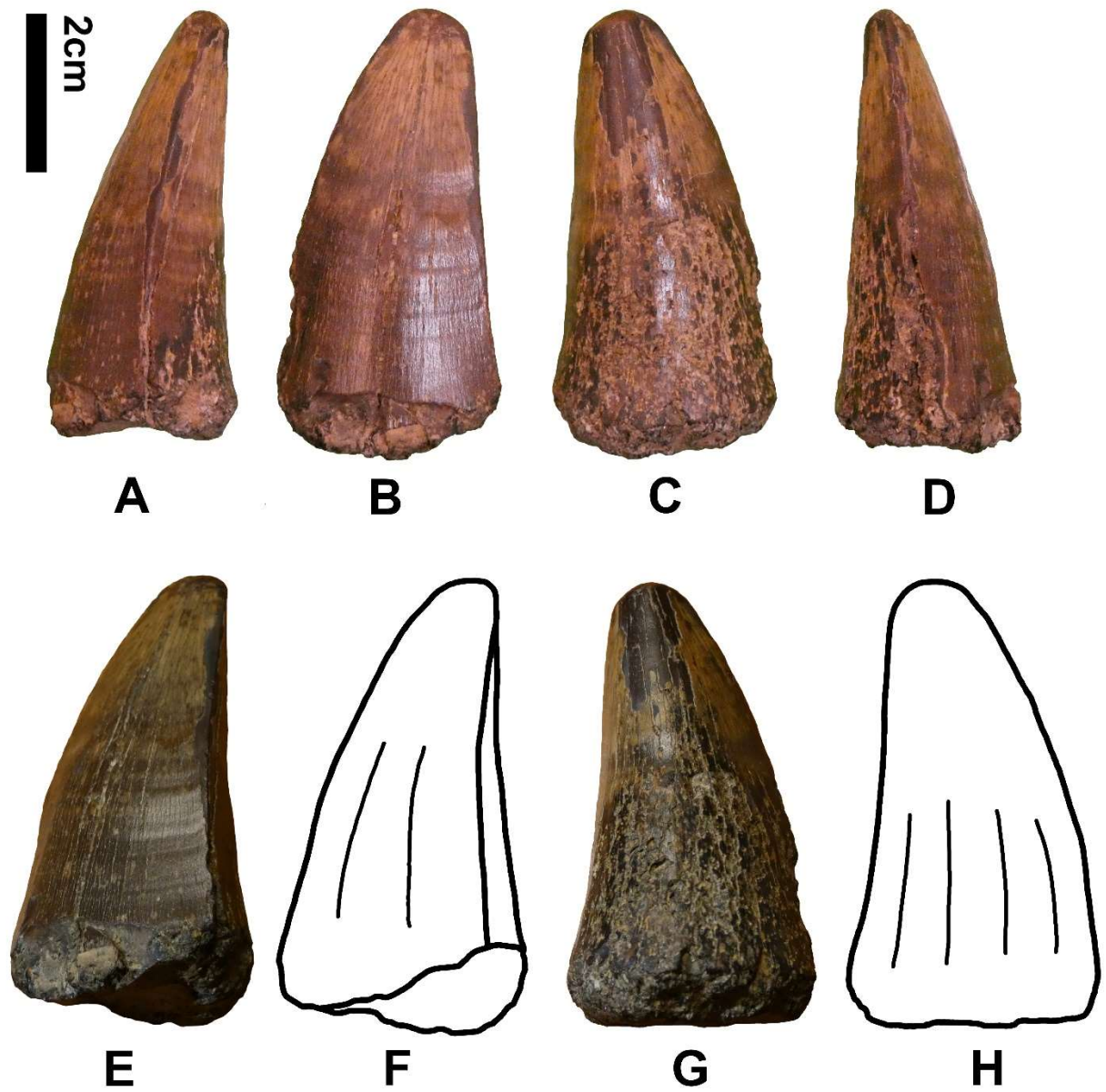


Figure 2. *Mosasaurus hoffmannii*, REMPC M0190, marginal tooth crown, (A) posterior view; (B) labial view; (C) lingual view; (D) anterior view; (E) oblique view showing labial prisms; (F) trace of prisms; (G) oblique view showing lingual facets; (H) trace of facets.

Subfamily TYLOSAURINAE Williston, 1897

Genus *Tylosaurus* Marsh, 1872

Tylosaurus sp.

Material and occurrence. REMPC M0191, marginal tooth crown, exact origin unknown, Mississippi (Figure 3).

Description. The tooth measures 30 mm high, 20 mm long, and 17 mm wide. The crown is moderately curved in the posterior and medial directions. The apex of the crown has been abraded away, seemingly from wear during life. Had the tooth not been worn, it would have had a crown height of approximately 35 mm. Anterior and posterior carina are poorly defined due to wear. Crenulations are perceptible near the apex on the posterior carina. The labial and lingual surfaces are convex and striated. The crown is sub-circular in basal cross-section.

Remarks. Striated enamel is diagnostic of rasselosaurine mosasaurs: the

plioplatecarpinae and tylosaurinae. Large size and crenulations on the carinae indicate this tooth was from a tylosaurine mosasaur (Russell, 1967). Compared to other tylosaurinae, the tooth lacks the labiolingual compression present in marginal teeth of *Hainosaurus* and *Taniwhasaurus* (Rempert et al., 2022a). Based on the sub-circular cross-section, medial curvature, and moderately defined, crenulated carinae, REMPC M0191 bears closest resemblance to *Tylosaurus* and is attributed to that genus.

This tooth was found by an amateur fossil hunter somewhere near Monroe County, Mississippi. The fossil hunter lost track of where he was at the time of finding the tooth and its exact origin is unknown. The umber black coloration of the tooth is typical preservation of the Demopolis Formation and seemingly indicates an origin further north in Lee County (Manning and Dockery, 1992). However, this is purely speculative and by not indicative of provenance.

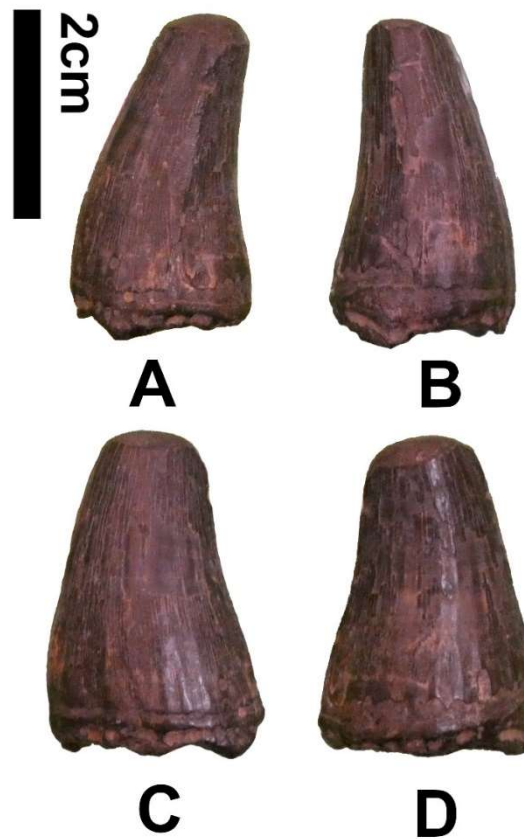


Figure 3. *Tylosaurus* sp., REMPC M0191, marginal tooth crown, (A) posterior view; (B) anterior view; (C) labial view; (D) lingual view.

Subfamily: Plioplatecarpinae Dollo, 1882

Genus: *Plioplatecarpus* Dollo, 1882

Plioplatecarpus sp. nov.

Material and occurrence. REMPC M0192, marginal tooth crown, middle Campanian, “Frankstown Sand,” lower Demopolis Chalk, Lee/Prentiss Counties, Mississippi (Figure 4A-B).

Description. The tooth measures 17 mm tall, 12 mm long, and 9 mm wide. It is strongly recurved in both posterior and medial directions. Anteriorly, a barely perceptible carina runs from

the apex to the crown base. A posterior carina, similarly poorly defined, runs from the apex down one-third of the crown height before terminating. Neither carina is crenulated. The enamel surface is marked by numerous primary and tertiary striations. The crown is elliptical in basal cross-section.

Remarks. The combination of striated enamel and unserrated carinae indicates the tooth is from a plioplatecarpine mosasaur. The tooth is proportionally shorter than those of *Platecarpus tympaniticus*, “*Platecarpus*” *somenensis*, *Plesioplatecarpus planifrons*, *Ectenosaurus* spp.,

Latoplatecarpus spp. and *Selmasaurus* spp. The Mississippi tooth is also notable for being posteriorly recurved to a higher degree than is seen in teeth of *Angolasaurus*, *Ectenosaurus*, *Gavialimimus*, *Latoplatecarpus*, *Platecarpus*, *Plesioplatecarpus*, and *Selmasaurus*. Abrupt posterior recurvature at half the crown height and a medially curving pointed apex are all characters typical of *Plioplatecarpus*.

This tooth originates from an as of yet unnamed species of plioplatecarpine mosasaur from the Demopolis Chalk (Burnham, 1991). This species

is remarkable for having teeth shorter and more posteriorly curved than *Plioplatecarpus marshi* and less robust than teeth of *Plioplatecarpus primaevus* (Dollo, 1882; Russell, 1967). This species is unique for bearing teeth with extremely prominent striations, far more prominent than on teeth on any comparably sized mosasaur. Teeth from this species are abundant; typically, they are the most common mosasaur remains recovered by amateur fossil hunters. A near complete skull of this mosasaur is available at the University of New Orleans under collection number UNO 8611-2.

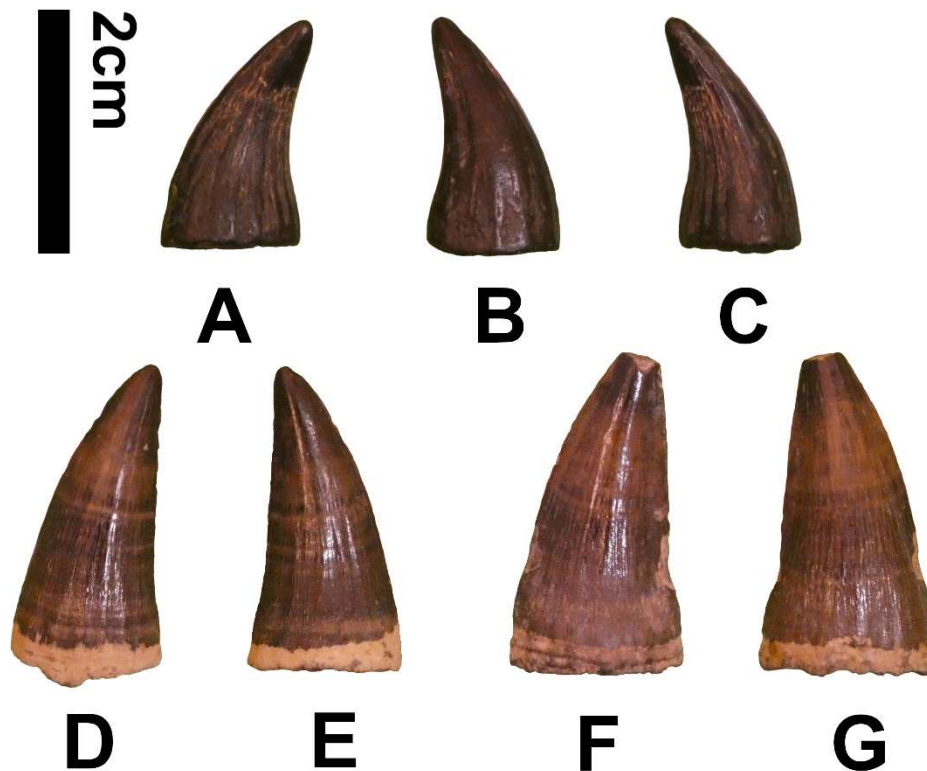


Figure 4. *Plioplatecarpus* sp. nov., REMPC M0192, marginal tooth crown, (A) anterior view; (B) labial view; (C) posterior view. cf. *Platecarpus*, REMPC M0193, marginal tooth crown, (D) labial view; (E) lingual view. cf. *Platecarpus*, REMPC M0194, marginal tooth crown, (F) lingual view; (G) labial view.

Genus: *Platecarpus* Cope, 1869

cf. *Platecarpus*

Material and occurrence. REMPC M0193 and M0194, two marginal tooth crowns, middle Campanian, “Frankstown Sand,” lower Demopolis Chalk, Lee/Prentiss Counties, Mississippi (Figure 4D-G).

Description. REMPC M0193 measures 25 mm tall, 14 mm long, and 11 mm wide. REMPC M0194 measures 24 mm tall, 12 mm long, and 10 mm wide. The teeth are tall and straight, with only a minimal amount of medial curvature. Uncrenulated anterior and posterior carinae extend from the apex to the base of the crown. The carinae point approximately anteroposteriorly, dividing the tooth into nearly equal labial and lingual surfaces. The enamel surface is decorated by primary and tertiary striations. The crowns are labiolingually compressed and elliptical in basal cross-section.

Remarks. The slender profile, elliptical cross-section, and striated enamel indicate these teeth are from a member of the plioplacarpinae. The teeth, however, lack the abrupt posterior recurvature seen in marginal teeth of *Plioplacarpus* and *Latoplacarpus*. Furthermore, the teeth are less robust than those of *Angolasaurus*, *Gavialimimus*, and “*Platecarpus*” *somenensis*. While most mosasaurids can be differentiated to the generic and even specific level based on isolated tooth morphology, members of the plioplacarpine genera *Selmasaurus*, *Platecarpus*, and *Plesioplacarpus* retain a level of convergence that obfuscates identification (Rempert pers. obs.). Temporal and geographic range can be used in a limited capacity to exclude

Plesioplacarpus, as this taxon was restricted to the Coniacian and Santonian (Russell, 1967).

Tooth morphology is consistent with *Platecarpus tympaniticus* of the middle Santonian to lower Campanian of Mississippi, Alabama, and Kansas, and *Selmasaurus russelli* from the early Campanian of Alabama. Given the uncertainty of generic identification, open taxonomy is used.

DISCUSSION

Similar mosasaur faunal occurrences are observed in analogous stratigraphic formations of Late Cretaceous age (Nicholls and Russell, 1990). With respect to the mosasaur associations of Mississippi, the faunal composition is most consistent with the upper Cretaceous deposits of the North Atlantic coastal plain of Delaware, New Jersey, and Maryland. Both regions are characterized by the presence of *Mosasaurus*, *Plioplacarpus*, and *Clidastes* in their Campanian and Maastrichtian strata, with the former genus predominating in Maastrichtian layers and the latter two predominating in Campanian ones (Russell, 1967; Gallagher, 2005).

Tylosaurus in Mississippi is frequently found in the Tombigbee Sand and Mooreville Chalk of Mississippi. *Tylosaurus* is well known from the Santonian and Early Campanian of Kansas and the Dakotas; however, the genus was on the decline by the time of the Late Campanian when the Demopolis Chalk was being laid down (Martin, 2007; Russell, 1967).

During the Maastrichtian, the mosasaur *Mosasaurus hoffmannii* was nearly ubiquitous in Atlantic marine deposits. The occurrence of *M. hoffmannii* in Mississippi is part of a wide

geographic range extending from the Western Interior Sea along the Atlantic Coastal Plain and across the Atlantic into Europe and North Africa (Gallagher, 2005; Lingham-Soliar, 1992).

CONCLUSION

Isolated teeth from the Late Cretaceous of Mississippi indicate multiple different mosasaur taxa once inhabited the region. These taxa include *Mosasaurus hoffmannii* in the Maastrichtian and *Tylosaurus* sp., *Plioplatecarpus* sp. nov., and cf. *Platecarpus* in the Campanian. Diverse tooth morphologies indicate a wide variety of tooth functions, such as macropredatory cutting (*Mosasaurus hoffmannii*), smashing (*Tylosaurus* sp.), and piscivory (*Plioplatecarpus* sp. nov. and cf. *Platecarpus*).

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Author Disclosures.

The authors declare no conflicts of interest.

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