A LATE CRETACEOUS MOSASAUR FROM NORTH-CENTRAL NEW MEXICO

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Abstract—We describe a partial vertebral column of a mosasaur identified as cf. *Tylosaurus* sp. from the lower Niobrara interval of the Mancos Shale south of Galisteo in Santa Fe County, New Mexico. Invertebrate fossils collected from the same horizon include the inoceramids cf. *Inoceramus* (*Cremnoceramus*) *deformis* and cf. *Inoceramus* (*Platyceramus*) *platinus* and dense growths of the oyster *Pseudoperna congesta*. They suggest a Coniacian age. This is the oldest documented mosasaur from New Mexico.

INTRODUCTION

Mosasaurs were marine lizards of the Late Cretaceous that first appeared during the Cenomanian (Russell, 1967, 1993). Although marine Upper Cretaceous strata are widely exposed in New Mexico, the fossil record of mosasaurs from the state is limited to a handful of documented occurrences (Lucas and Reser, 1981; Hunt and Lucas, 1993). Here, we add to this limited record notice of incomplete remains of a mosasaur from Santa Fe County, north-central New Mexico. In this article, NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque.

PROVENANCE

The mosasaur reported here was collected by P. Bircheff at NMMNH locality 1350 about 15 km south of Galisteo and just east of NM-41, in the SE 1/4 NE 1/4 SW 1/4 sec. 13, T12N, R9E, Santa Fe County, New Mexico (UTM 3902400N, 415000E, zone 13). The fossil locality is in a grayish orange to yellowish gray, ripple-laminated litharenitic sandstone that is part of a succession of fossiliferous sandstones overlying typical gray laminar shale of the Mancos Shale (Fig. 1).

IDENTIFICATION

The mosasaur fossil, NMMNH P-22142, is a partial vertebral column consisting of 17 articulated vertebrae and six associated proximal ends of ribs (Fig. 2A-C; Hunt and Lucas, 1993, fig. 10). The anterior 12 vertebrae bear processes for rib articulation, whereas the posterior five lack such processes. Therefore, we locate the vertebrae as the 12 posterior dorsal (presacral) vertebrae followed by five pygal (sacral) vertebrae. Measurements of the vertebrae, from anterior to posterior (L/W in mm) are: ?/65, 83/68, 94/72, 93/74, 93/70, 92/73, 88/70, 103/70, 96/78, 111/76, 110/70, 100/?, 111/80, 105/83, 90/77, 94/72, and 104/70. The entire length of the preserved vertebral column is about 160 cm, thus indicating a relatively large mosasaur, about 11% longer than the 7-m-long *Tylosaurus* skeleton illustrated by Williston (1898, pl. 72).

Bell (1993) systematically revised the Mosasauroidea as part of a doctoral dissertation at the University of Texas at Austin. In so doing, he listed one character relevant to discussion here. Bell (1993) recognized a new subfamily, which includes the genus *Tylosaurus*, in part diagnosed by "posterior trunk vertebrae without sharp-edged, anteriorly precipitous ridge connecting distal synapophysis/zygopophysis" (Bell, 1993, p. 184). Comparison of this trait, published mosasaur descriptions by Russell (1967, p. 78), and plates of Williston (1898, pls. 42, 54, 72) with NMMNH P-22142 indicate that the Santa Fe County specimen exhibits this condition. The synapophyses on NMMNH P-22142 are rounded, not sharp-ridged, across their dorsal aspect and retain a constant, posteriorly-subhorizontal attitude. This places NMMNH 22142 in Bell's new subfamily, which contains the genera *Tylosaurus*, *Ectenosaurus*, *Platecarpus* and *Plioplatecarpus*. This subfamily encompasses Russell's (1967) Tylosaurinae and Plioplatecarpinae, excluding the genera *Halisaurus*, *Prognathodon*, and "*Clidastes* " *sternbergii*.

In addition to Bell's work, we compared NMMNH P-22142 to the vertebral descriptions of Russell (1967). The synapophyses throughout the preserved posterior trunk vertebrae are constant in size and shape, matching the description of *Tylosaurus* in Russell (1967, p. 78). Furthermore, comparison of NMMNH P-22142 to Williston's (1898) plates shows that in *Tylosaurus* the rib articulations on the dorsal vertebrae are large, dorsally positioned and circular in cross section. NMMNH P-22142 is also very similar to specimens of *Tylosaurus proriger* illustrated by Williston (1898, pls. 62, 65, 72) in that no traces of a zygosphene-zygantrum articulation can be seen on any of the vertebrae, and the neural spines are very long antero-posteriorly so that their edges almost meet. However, strictly speaking, the specimen is not diagnostic at the genus level using the taxonomy of Russell (1967) and Bell (1993). Therefore, we identify NMMNH P-22142 as cf. *Tylosaurus* sp.

AGE

The geology of the area from which these mosasaur remains were collected has not been mapped, nor has the stratigraphy been studied,

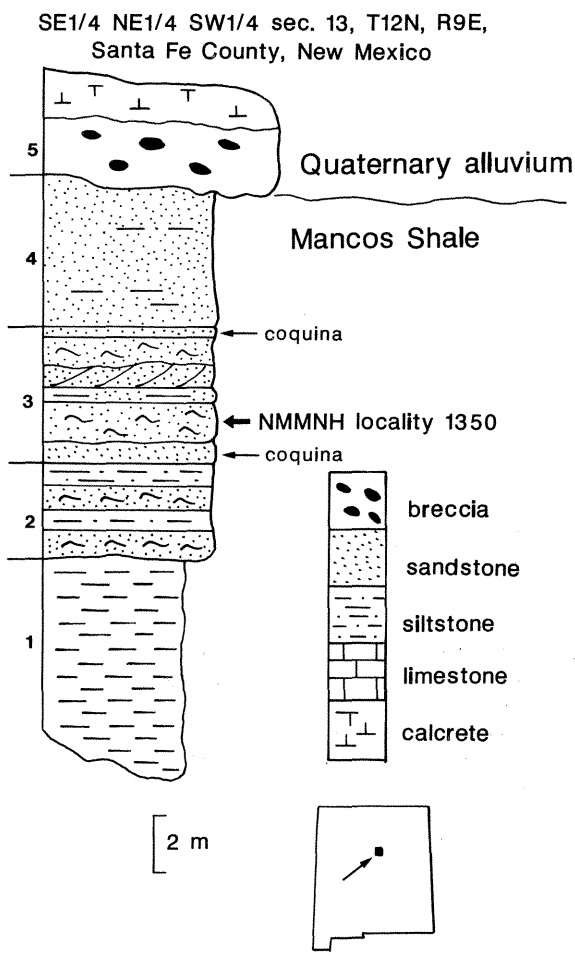

FIGURE 1. Measured stratigraphic section at mosasaur locality. See appendix for description of stratigraphic units.

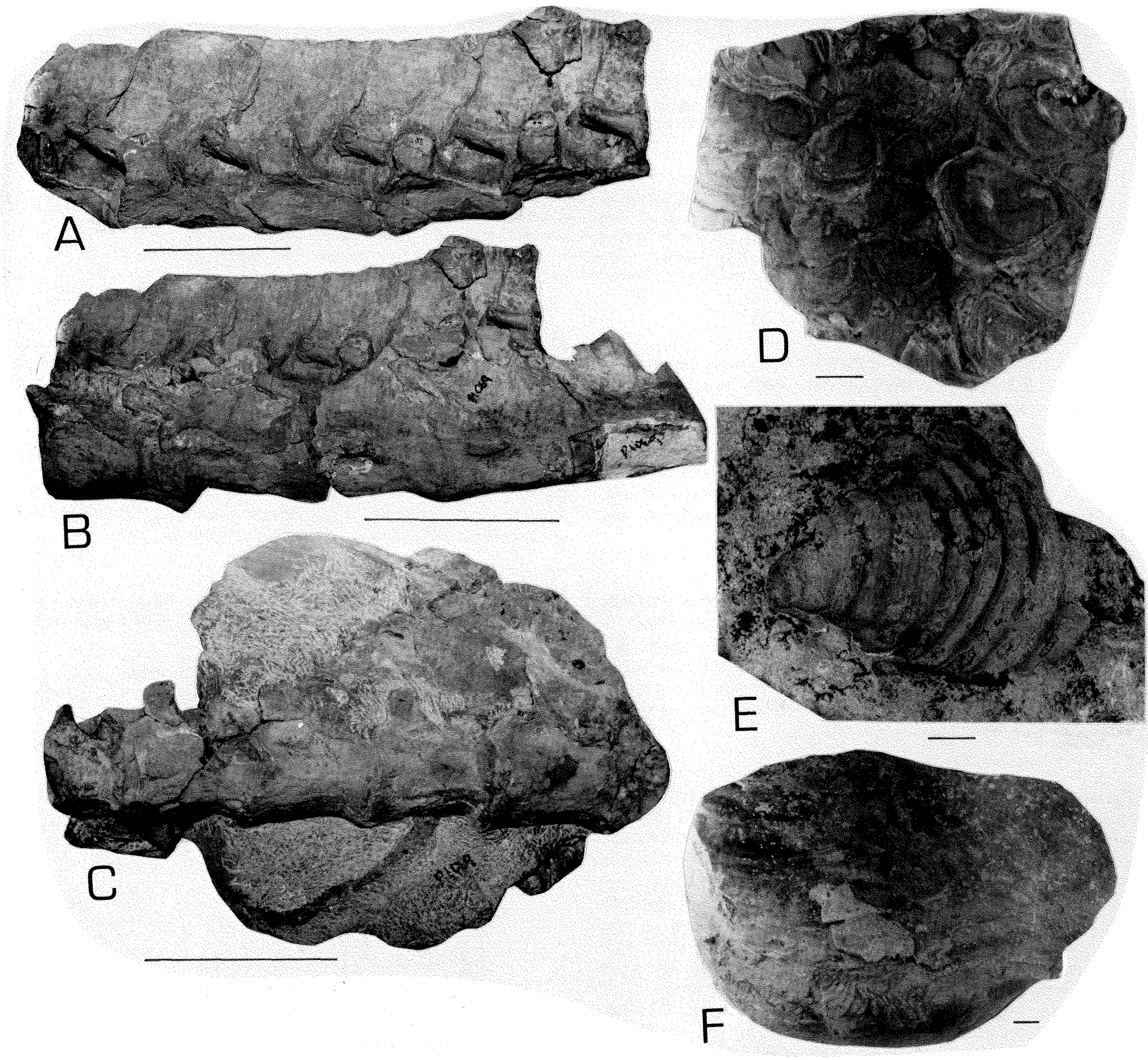

FIGURE 2. Mosasaur and bivalves from NMMNH locality 1350. A–C, cf. *Tylosaurus* sp., NMMNH P–22142, lateral views of dorsal vertebrae (A–B) and ventral view of pygal vertebrae (C). D, *Pseudoperna congesta*, NMMNH P-25042. E, species group of *Inoceramus* (*Cremnoceramus*) *deformis*, NMMNH P-25043. F, cf. *Inoceramus* (*Platyceramus*) *platinus*, NMMNH P–25044. Bar scales for A–C are 10 cm long; those for D–F are 1 cm long.

since the reconnaissance work of Stearns (1953a,b). At present, field observations of the stratigraphy do not permit precise placement of the mosasaur horizon within the Upper Cretaceous sequence exposed in the area, but utilization of the generalized geological map of Stearns (1953a, p. 1) and examination of a small collection of bivalves from the mosasaur locality allow a reasonably accurate determination of the mosasaur's age. The locality is approximately at the boundary between the units mapped as middle and upper Mancos by Stearns (1953a), about 150 m above the top of the Juana Lopez Member (upper Turonian), and well above the base, though still within the lower part, of the Niobrara interval of the Mancos Shale.

Invertebrate fossils collected with the mosasaur remains consist of fragmentary inoceramids representing two species, and dense growths of the oyster *Pseudoperna congesta* (Conrad) occurring as epizoans on several large inoceramid shell fragments (P-25042) (Fig. 2D). The smaller inoceramid species, represented by NMMNH P-25043, exceeds 80 mm in maximum height, possesses high, relatively narrow and widely-spaced, regular concentric growth folds from the dorsal to ventral margins, and appears to belong to the species group of *Inoceramus* (*Cremnoceramus*) *deformis* Meek (Fig. 2E). The second inoceramid species is represented only by shell fragments, none of which provide an indication of the original shape of the valves. These fragments indicate a very large species; a portion of the ventral margin and central portion of one valve is 20 cm long (Fig. 2F). These shell fragments are of low convexity, and are ornamented with low, muted, irregular concentric folds that fade to obscurity along the length of the valve, and by much finer growth lirae. The size, shape and ornamentation of these fragments suggest *Inoceramus* (*Platyceramus*) *platinus* Logan or a closely related species.

The association of inoceramids of this type, with *P. congesta* densely covering the valves of large shells, is typical of the Fort Hays and Smoky Hill members of the Niobrara Chalk in western Kansas (e.g., Frey, 1972; Hattin, 1982), and of the lower Niobrara Formation in northeastern New Mexico (Scott et al., 1986). Both are typical Coniacian species that appear to be confined to that stage (e.g., Kauffman et al, 1978). *Tylosaurus* is confined to the Niobrara vertebrate "age" of Russell (1993), which is of late Cenomanian to early Campanian age, so its possible occurrence at the Santa Fe County locality does not contradict a Coniacian age assignment. Assignment of a more precise age within the Coniacian must await more detailed stratigraphic work and collection of additional invertebrates, especially ammonites, from the mosasaur horizon.

DISCUSSION

Mosasaur fossils are not well known from New Mexico, and published reports are only of fragmentary and incomplete specimens, like that described here. The oldest published report of a "New Mexican" mosasaur is Cope (1871), who named the species "*Liodon dyspelor* " for a series of vertebrae "from the yellow beds of the Niobrara epoch of the Jornada del Muerto, near Fort McRae, New Mexico" (Cope, 1875, p. 167). This specimen, however, actually is from Kansas (D. Parris, written commun., 1994). The Fort McRae mosasaur, previously the geologically oldest mosasaur from New Mexico, thus can be replaced with the Coniacian mosasaur reported here. Other New Mexico mosasaurs are of late Campanian or Maastrichtian age and come from the San Juan and Raton basins (Lucas and Reser, 1981; Sealey and Lucas, 1991; Hunt and Lucas, 1993).

The mosasaur reported here thus is the oldest record from New Mexico. It also indicates that more mosasaur material may be present in the relatively unstudied Cretaceous outcrops of Santa Fe County.

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APPENDIX: MEASURED SECTION

Section measured 28 September, 1988, by S. G. Lucas in the SE¼NE¼SW¼ sec. 13, T12N, R9E, Santa Fe County, New Mexico.

unit	lithology	thickness (m)
Quaternary deposit:		
5.	Ortiz volcanic gravel debris with pedogenic calcrete further up slope. Volcanic gravel is a muddy conglomerate to very coarse, muddy sandstone; clasts are weathered/altered volcanics that are pinkish gray (5YR8/1), well-rounded, and 2-4 mm in diameter; matrix is medium light gray (N6) to greenish gray (5GY6/1) mudstone; weathers to yellowish gray (5Y8/1); very calcareous.	not measured
unconformity		
Mancos Shale		
4	Sandstone and minor siltstone; variegated bands of dark yellowish orange (10YR6/6) and very pale orange (10YR8/2); sandstones are fine grained, well-sorted, subangular to angular litharenites; siltstones are same colors as sandstones and slightly sandy; very calcareous.	5.0
3f	Sandstone with numerous shells; dark yellowish orange (10YR6/6) fresh, weathering to light olive gray (5Y5/2) and olive gray (5Y4/1) with black (N1) spots; medium- to coarse-grained, moderately well-sorted, subangular sublitharenite; numerous bivalves as well as many sharks' teeth; calcareous.	0.2
3e	Sandstone; grayish orange (10YR7/4); fine-grained well sorted subrounded litharenite; ripple laminated; some shells and bioturbation; calcareous; smells petroliferous when acid tested.	1.1
3d	Sandstone; yellowish gray (5Y7/2) to grayish orange (10YR7/4); fine-grained, well-sorted, subangular litharenite; massive; very low angle trough crossbeds; very calcareous.	0.9
3c	Sandstone and interbedded limestone; sandstone is dark yellowish orange (10YR6/6); fine- to very fine-grained, moderately well-sorted, subrounded litharenite, limestone is medium light gray (N6) micrite; sandstone is very calcareous.	0.4
3b	Sandstone; grayish orange (10YR7/4) to yellowish gray (5Y7/2); fine grained, well-sorted subangular to subrounded litharenite; calcareous; ripple laminated; NMMNH locality 1350.	1.4
3a	Sandstone with finely comminuted shell hash; grayish orange (10YR7/4) to yellowish gray (5Y7/2); fine-grained, well-sorted, subrounded sublitharenite; calcareous; massive, bedded; weathers in massive, rounded blocks.	0.6
2	Interbedded sandstone and siltstone; pale yellowish brown (10YR6/2) to pale yellowish orange (10YR8/6); sandstones are fine-grained, moderately well-sorted, subangular litharenites; ripple laminated; calcareous.	3.4
1	Laminar shale; medium light gray (N6) and light gray (N7), stained grayish orange (10YR7/4); slightly silty; calcareous.	7.6+