A mosasaur from the Lewis Shale (Upper Cretaceous), northwestern New Mexico

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New Mexico Geology, v. 3, n. 3 pp. 37-40, Print ISSN: 0196-948X, Online ISSN: 2837-6420.
https://doi.org/10.58799/NMG-v3n3.37
Download from: https://geoinfo.nmt.edu/publications/periodicals/nmg/backissues/home.cfml?volume=3&number=3

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Mosasaurs are an extinct group of giant marine lizards that flourished during the Late Cretaceous. Their fossilized remains are known from all the continents except Antarctica; the largest and best known collections come from the Niobrara Formation in Kansas. Although marine sediments of Late Cretaceous age are exposed throughout large areas of New Mexico, only three mosasaur specimens have previously been reported from the state. These specimens were found in south-central New Mexico in the Jornada del Muerto region (Cope, 1871a) and in northeastern New Mexico in the Raton Mesa region (Lee, 1917). Late Cretaceous marine deposits in other parts of New Mexico, including extensive exposures of the Lewis Shale in and around the San Juan Basin, until recently have failed to produce mosasaur remains. The discovery of a mosasaur in the Lewis Shale as reported herein is the fourth report of a mosasaur from New Mexico (fig. 1) and the first report of a mosasaur from the Lewis Shale. This discovery extends the geographic range of the mosasaurs into that part of the sea that covered northwestern New Mexico during the Late Cretaceous.

The following abbreviations are used in the text: AMNH—Department of Vertebrate Paleontology, American Museum of Natural History, New York; UNM—Department of Geology, University of New Mexico, Albuquerque; YPM—Peabody Museum of Natural History, Yale University, New Haven.

**Lewis Shale and its fauna**

The Lewis Shale was named by Cross and others (1899) for exposures around Fort Lewis, an old army post in the La Plata River valley in southwest Colorado. Primarily composed of dark-gray to greenish-gray shale with some sandy layers, limestone, and calcareous nodules, the Lewis Shale has been mapped throughout a large area in northwestern New Mexico and southwestern Colorado (Reeside, 1924; Dane, 1936; O’Sullivan and others, 1972). The Lewis Shale was deposited offshore in the regressing seaway that covered this region during the Late Cretaceous (Fassett and Hinds, 1971; Mannhard, 1976).

The fauna of the Lewis Shale is mainly a diverse assemblage of marine bivalves, gastropods, and cephalopods (Reeside, 1924; Dane, 1936; Cobban and others, 1974; Mannhard, 1976). Worm burrows and other trace fossils (for example, Ophiomorpha) also are present. The only vertebrates previously reported from the Lewis Shale are shark’s teeth (for example, Lamna sp.) and bony fish scales (Mannhard, 1976).

**Systematic paleontology**

Class REPTILIA

Order SAURIA

Subfamily PLIOPLATECARPINAE (Dollo, 1884)

Tribe PLIOPLATECARPINI (Dollo, 1884)

Genus PLATECARPUS Cope, 1869

*cf. Platecarpus* sp.

REFERRED SPECIMEN—UNM-LK-1; a partial skeleton consisting of 46 vertebrae (14 dorsals, (?7 pygals, and 27 caudals) of variable preservation, two nearly complete thoracic ribs and fragments of others, and assorted lower (?) jaw and tooth fragments.

**Locality**—UNM-V-070; in the NE 1/4 SW 1/4 sec. 9, T. 30 N., R. 1 E. on the Jicarilla Apache Indian Reservation southeast of Dulce, New Mexico (figs. 1-2).

**Collectors**—Originally discovered by Adolph Julian and Darrell Paiz, members of the Jicarilla Apache Indian Tribe; collected by the authors.

**Discussion**—The taxonomy of mosasaurs, like many groups of reptiles, is based heavily on cranial characters (Russell, 1967). The absence of any cranial remains of UNM-LK-1 other than jaw and tooth fragments thus renders difficult a precise identification of the specimen. Fortunately, subfamilies and tribes of mosasaurs can be diagnosed largely on the basis of vertebral characters (Russell, 1967). In addition, the tooth and jaw fragments of UNM-LK-1 aid in a tentative assessment of its generic identity.

The following considerations justify assignment of UNM-LK-1 to the Plioplatecarpine as defined by Russell (1967): 1) UNM-LK-1 was a mosasaur of moderate size, probably about 6 m in overall length, based on comparison of the length of its incomplete dorsal series with vertebral and body lengths of various mosasaurs given by Russell (1967, tables 2-3). All plioplatecarpines are moderate-sized mosasaurs (Russell, 1967); UNM-LK-1 is well within the size range of all plioplatecarpine specimens in the YPM collections. Although undue emphasis should not be placed on size as a diagnostic character in reptiles (animals with indeterminate growth), no evidence exists to suggest that UNM-LK-1 was a particularly young individual; that it is just a small representative of one of the giant mosasaurs like *Mosasaurus* or *Tylosaurus* seems unlikely. 2) All caudal vertebrae of
UNM-LK-1 have unfused haemal arches (fig. 3, C-E). The haemal peduncles are subcircular, centrally pitted, posterodorsally directed, and located near the posterior end of the centrum lateral to the ventral midline. This condition is seen in the plioplatecarpines but not in the mosasaurines in which the haemal peduncles typically are fused to the caudal centra (Russell, 1967). 3) Other vertebrae of UNM-LK-1 correspond well to those of plioplatecarpines, although by themselves they are not sufficient to diagnose the group. A typical median dorsal vertebra (fig. 3, J-L) has the synapophysis located on the anterodorsal aspect of the centrum, an anterior articular cup that is wider than tall, and a posterior articular ball that is likewise transversely oval. This vertebra closely resembles median dorsal vertebrae of Platecarpus (Cope, 1875, pl. 20, figs. 5M-N). Most of the dorsal vertebrae of UNM-LK-1 are not as well preserved as this one; typically, the neural arch and spine is no longer present. No evidence of a zygosphene-zygantrum can be discerned on any of the vertebrae, but almost all of the vertebrae are so badly damaged that ascertaining whether or not at least a small zygosphene-zygantrum articulation was present at some point on the dorsal vertebral column is impossible. 4) As Russell (1967, p. 54) has pointed out, the marginal teeth of mosasaurs are "often generally diagnostic." Among the tooth and jaw fragments of UNM-LK-1 is a nearly complete tooth (fig. 3, A-B) that is long, slender, and has a pointed tip that is posteromedially recurved. This tooth has a subcircular cross section near the base of the crown and bears distinct anterior and posterior carinae that run the vertical length of the crown. The buccal aspect of this tooth bears six vertical facets whereas the lingual aspect bears numerous thin vertical striations.

FIGURE 3—SELECTED ELEMENTS OF UNM-LK-1, A PARTIAL SKELETON OF CF. PLATECARPUS SP.; buccal (A) and lingual (B) views of a lower (?) tooth; ventral (C), left lateral (D), and posterior (E) views of an anterior caudal vertebra; (F) anterior view of a thoracic rib; anterior (G), left lateral (H), and posterior (I) views of an anterior dorsal vertebra; ventral (J), left lateral (K), and posterior (L) views of a median dorsal vertebra. Black bars are 3 cm long (one scale for A and B; one for C, D and E; one for F; and one for G, H, I, J, K, and L).
nated dark-gray shale suggestive of an offshore environment of relatively deep and quiet water. The anterior and medial dorsal vertebral column was found articulated, though slightly twisted in the middle. The posterior dorsal, pygal, and caudal vertebrae are nearly all disarticulated; they were probably less tightly bound together by bony processes, axial muscles, tendons, and ligaments than the more anterior parts of the vertebral column. The degree of disarticulation of UNM-LK-1 suggests a fairly long period of decomposition before final burial in the sediment. This decomposition may have occurred in part as the dead animal floated in the water column, but most decomposition probably occurred as the animal lay on the bottom, since the disarticulated bones show a preferential northwest-southeast alignment shared by the still articulated portion of the vertebral column. Mixed among the disarticulated vertebrae are invertebrate shell fragments, shark's teeth, and bony fish scales that could represent either gut contents of the mosasaur or organic debris present in the sediment where the dead animal came to rest, or both.

The orientation of most of the bones (a notable exception is the rib in the lower left hand corner of fig. 5) suggests the presence of a distinct, though most likely slight, bottom current probably flowing predominately to the northwest because most of the bones are scattered in this direction. The absence of the skull and cervical vertebrae of UNM-LK-1 may be because the anterior end of the animal first was exposed in an arroyo (fig. 5): these elements, if they were fossilized, have long since eroded away. The girdles and appendages, on the other hand, may have been removed in a number of ways.

A number of grooves and scratches on vertebrae and rib fragments of UNM-LK-1 may indicate scavenging, a plausible mechanism by which the girdles and appendages may have been removed. However, the specimen is so damaged by weathering and the roots of recent plant growth that we hesitate to support such a conclusion firmly. The girdles and appendages simply may have floated away once they became detached from the vertebral column or may have fallen off elsewhere when the decomposing animal was floating in the water column.

Most difficult to explain is how the jaw fragments came to be buried beneath the mixed-up posterior dorsal, pygal, and caudal vertebrae. Either the jaw of the animal fell first and the rest of the carcass fell on top of it, or the jaw broke up and was carried northward by bottom currents where it mixed with the vertebrae and sank deeper into a soft bottom than did the vertebrae. The former explanation is simpler, but the varied aspects of the disarticulated vertebrae exposed on the quarry surface (fig. 6) suggest tumbling and sinking at various angles into a soft bottom and might support the later explanation. A third possibility is that the jaw fragments are those of a different individual than the vertebrae and ribs. We see no clear way to decide among these three possibilities. Although nothing about the size and morphology of the Lewis Shale mosasaur remains to suggest that they belonged to more than one individual, this chastening possibility must always be entertained when dealing with fossil material in a state of disarticulation or incompleteness.

**Summary of marine reptiles in New Mexico**

Among the Reptilia three main groups adapted to life in the marine realm: ichthyosaurs, plesiosaurs, and mosasaurs. Some representatives of other reptile groups, notably turtles and crocodiles, have also invaded marine niches, but are not considered here.

Ichthyosaurs were a widespread group of fishlike marine reptiles during the Mesozoic. Although their remains have been found in Triassic, Jurassic, and Cretaceous deposits of western North America (McGowan, 1978), to our knowledge no ichthyosaurs have been reported yet from New Mexico.

Plesiosaur remains, on the other hand, have been reported from two localities in New Mexico. Cope (1887) described plesiosaur remains from what he termed the “Fox Hills bed of New Mexico.” He assigned the following taxonomic names to these remains: Piptomerus megaloporus new genus and species, P. microporus new species, P. hexagonus new species, and Orophosaurus pauciporus new genus and species. Williston (1903, p. 11) later listed these taxa and summarized their supposed diagnostic characters. Welles (1952), in a revision of North American plesiosaurs, considered all of Cope's taxa to be based on indeterminate material and thus declared them to be nomina vana (vain or void names). The locality from which these plesiosaurs were collected was not given by Cope and the Fox Hills Formation is not present in New Mexico, being currently restricted to strata in North...
Cope's type specimen of _L. dyspelor_ was collected by W. B. Lyon, a surgeon stationed at Fort McRae, an old army post that was just east of the present site of Elephant Butte Reservoir in south-central New Mexico (Cope, 1871b). In his final description of this specimen, Cope (1875, p. 167) explained that it came "from the yellow beds of the Niobrara epoch of the Jornada del Muerto, near Fort McRae, New Mexico." Cope probably was referring to beds of the Mancos Shale that are exposed in the Jornada del Muerto region (Kelley and Silver, 1952) and are, in part, a correlative of the Niobrara Formation.

Lee (1917, p. 46-47) can be credited with the other two previous reports of mosasaurs from New Mexico. He listed _Mosasaurus_ sp. (sic) from two localities in the Raton Mesa region: 1) "North wall of Cimarron Canyon, about 4 mi northwest of Cimarron; 100 ft below top of Pierre Shale and 2) "Van Bremmer Canyon, New Mexico, a mile from its mouth, in slide rock; at base of Trinidad Sandstone." Unfortunately, Lee did not describe or illustrate any specimens so their assignment to _Mosasaurus_ remains unverified.

Acknowledgments—We are greatly indebted to numerous members of the Jicarilla Apache Indian Tribe for their aid, interest, and enthusiasm which enabled the collection of the specimen described here. We specifically thank Leonard Atole, Tribal President, under whose auspices the work was done; Joe Muniz, Director of Tourism, who enthusiastically pursued the investigation and authorized an extended loan of the specimen to the University of New Mexico; and Adolph Julian and Darrell Paiz whose sharp eyes first found the specimen. Barry Kues, Niall Mateer, and Robert Sullivan reviewed an earlier draft of this paper; their comments have improved its content and clarity. Barry Kues was especially helpful in pointing out obscure references to New Mexico's marine reptiles.

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