

NOTA BREVE

Lakumasaurus antarcticus, n. gen. et sp., a new mosasaur (Reptilia, Squamata) from the Upper Cretaceous of Antarctica

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Introduction

Mosasaur were large predatory lizards that typically inhabited warm, epicontinental seas during the last 20 million years of the Mesozoic Era. Evidence of their taxonomic diversity derives mainly from significant finds from Late Cretaceous rocks of North America, Europe, and northern Africa (e.g., Russell, 1967; Lingham-Soliar, 1991, 1992; Bell, 1997). In contrast, the mosasaur record from the Southern Hemisphere is partial and much less informative (e.g., Welles and Gregg, 1971; Wiffen, 1980, 1990; Páramo, 1994; Bell *et al.*, 1998; Caldwell and Bell, 1995; Gasparini *et al.*, 2001). Mosasaur remains from Antarctica are mostly limited to isolated teeth and fragmentary bones (Gasparini and Del Valle, 1981, 1984; Chatterjee and Zinsmeister, 1982), thus restricting their potential implications for mosasaur phylogeny and paleobiogeography. Here we report on a new tylosaurine mosasaur, *Lakumasaurus antarcticus* gen. et sp. nov., discovered in the Late Cretaceous beds of James Ross Island, northeast Antarctic Peninsula. *Lakumasaurus* is the most complete mosasaur yet recorded in Antarctica, thus providing insights on mosasaur diversification in the southern seas. This discovery, together with Late Cretaceous mosasaur remains from New Zealand, suggests that distinctions between Cretaceous marine reptile faunas of the Southern and Northern hemispheres were greater than has been thought.

Abbreviations: IAA, Instituto Antártico Argentino.

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Systematic Paleontology

SQUAMATA Oppel 1811

MOSASAURIDAE Gervais 1853

TYLOSAURINAE (Williston 1895) Williston 1897

Genus *Lakumasaurus* Novas, Fernández, Gasparini, Lirio, Nuñez, and Puerta, n.gen.

Derivatio nominis. *Lakuma*, spirit of the sea in the mythology of the Yamana Indians from Tierra del Fuego (Gusinde, 1986), Southern Patagonia.

Type species. *Lakumasaurus antarcticus* Novas, Fernández, Gasparini, Lirio, Nuñez, and Puerta, n. sp.

Diagnosis. Same as species.

Lakumasaurus antarcticus Novas, Fernández, Gasparini, Lirio, Nuñez, and Puerta, n.sp.
Figures 1.A, B and 2.A, B

Diagnosis. Differs from all known tylosaurines in the following: frontals with external margins almost straight; fronto-parietal suture lacking defined flanges; squamosal-opisthotic-supratemporal articulation dorsoventrally deep; quadrate lateromedially compressed, with articular surface for the squamosal unexposed in lateral view; suprapedial process of the quadrate stout and robust, and with a strong ventromedial projection, and infrastapedial process absent; mandible slender, dorsoventrally shallow, with medial wall of the dentary higher than the lateral wall; coronoid greatly expanded dorsally; teeth lacking posterior carina and anterior carina devoid of serrations.

Derivatio nominis. *Antarcticus*, referring to Antarctica.

Holotype. IAA 2000-JR-FSM-1, specimen consisting of an almost complete and articulated skull with jaws and teeth (figure 1), rib fragments, and isolated vertebrae. The skull and mandibles were found articulated *in situ*, upside down, in an indurated fine sandstone; additional ossifications were recovered from the surface in a linear sequence up to 20 m from the head.

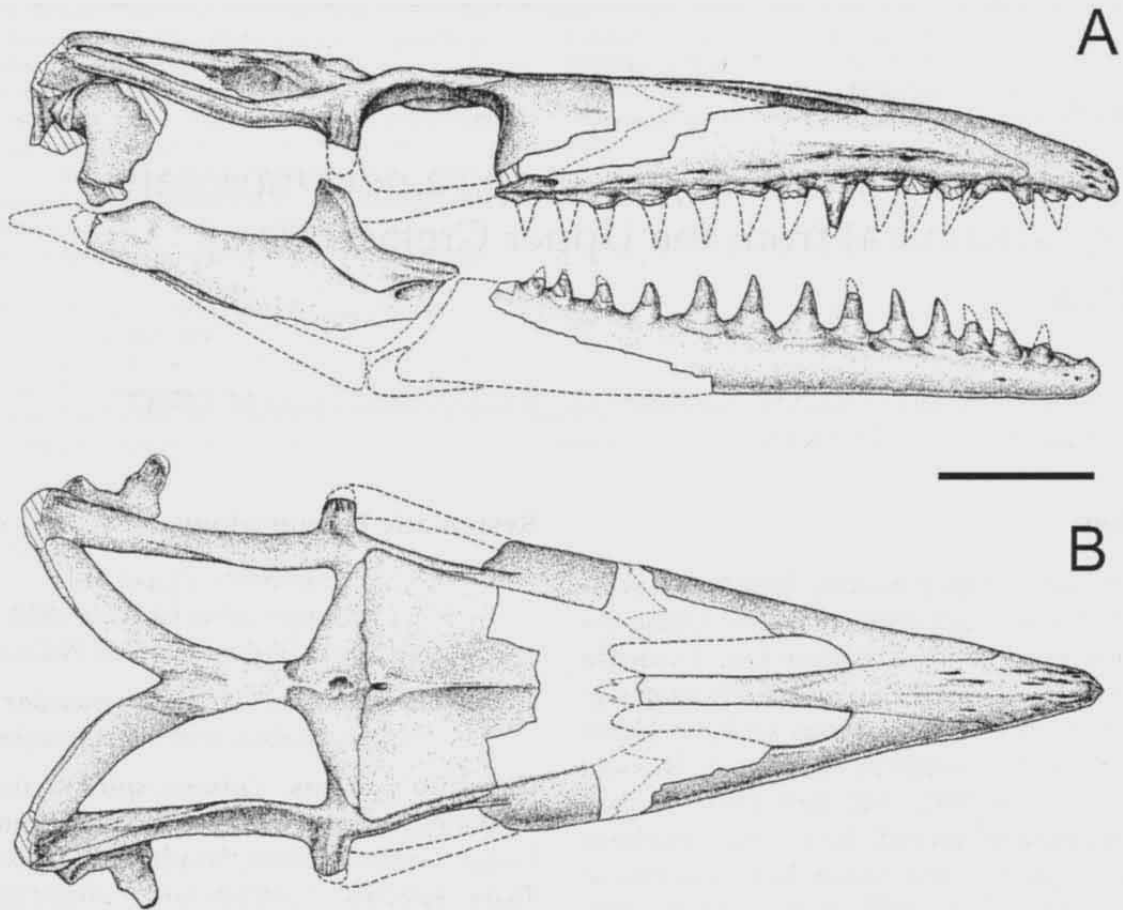


Figure 1. *Lakumasaurus antarcticus*, IAA: 2000-JR-FSM-1 (holotype). Skull in lateral (A) and dorsal (B) views. Scale bar, 10 cm / cráneo en vistas lateral (A) y dorsal (B). Escala, 10 cm.

Locality and horizon. Dinosaurio River, Santa Marta Cove, NW of James Ross Island (Lat. 63° 55' S, 57° 51' W); upper part of Gamma Member of the Santa Marta Formation (Upper Cretaceous, Latest Campanian-Early Maastrichtian; Olivero *et al.*, 1986; Olivero, 1992), lower part of the Marambio Group (Upper Cretaceous-Paleocene). The Santa Marta Formation was deposited in a shallow marine environment (Scasso *et al.*, 1991). The unit yielded a variety of fossil invertebrates (Olivero, 1992), shark teeth (Cione and Medina, 1987), remains of mosasaurs (cf. *Hainosaurus*; Martin *et al.*, in press), plesiosaurs (Gasparini *et al.*, 1984), and an ankylosaurian dinosaur (Olivero *et al.*, 1991). The specimen of *Lakumasaurus* was found in January 2000 by J. M. Lirio, nearly 1100 m to the east from the site where the ankylosaurian dinosaur was recovered, but from a geological horizon located 10 m above the later animal. A tooth of the shark *Notidanodon* (Cione and Medina, 1987) was found within the skull of *Lakumasaurus*.

Description

The skull of *Lakumasaurus*, 72 cm long, is dorsoventrally depressed and triangular in dorsal view (figure 1). It possesses several tylosaurine features (Bell, 1997): premaxillary rostrum very large,

medial dorsal keel on frontal well developed, parietal foramen small, prefrontal overlapped laterally by postorbitofrontal, quadrate stapedial pit elongate and very narrow, quadrate ala thick, and dentary anterior projection long. However, *Lakumasaurus* is interpreted as a basal member of Tylosaurinae because it lacks the following derived features shared by the remaining tylosaurs: internarial bar wide, slightly narrower than the rostrum, premaxillary internarial bar with dorsally keeled, and tooth carinae serrated.

The premaxilla of *Lakumasaurus* projects anteroventrally from the end of a curved snout. As in the remaining tylosaurines, the predental rostrum of the premaxilla is elongate, the outer surface of which is decorated by large foramina. A strong, crescent-shaped ridge on the ventral surface of the premaxilla compares well to an "osseous lip" that precedes the teeth. The premaxillary rostrum is V-shaped in dorsal view, a condition resembling that in the mosasaurine *Clidastes* (Russell, 1967; Bell, 1997). Relative to conditions in *Tylosaurus*, the external nares of *Lakumasaurus* are caudally retracted. The broad and nearly triangular frontals bear a sharp dorsal midline keel. The external margins of the frontals are almost straight, rather than sigmoid as in most mosasaurs, and are excluded from the orbital margin by the contact of the postorbitofrontal with the prefrontal. As seen from above, the parietals are

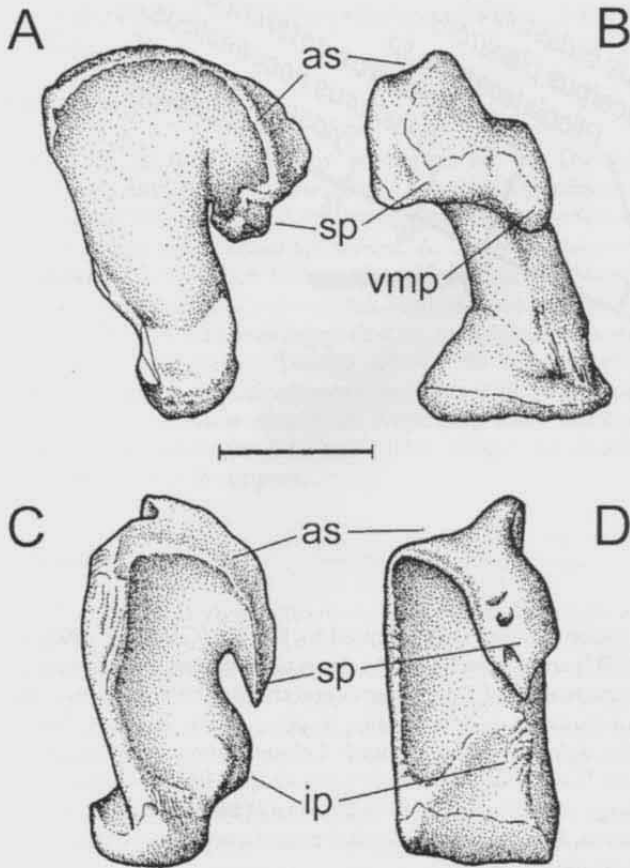


Figure 2. Left quadrates of *Lakumasaurus antarcticus*, IAA: 2000-JR-FSM-1, holotype (A, B), and *Tylosaurus proriger* (redrawn from Russell, 1967) (C, D), in lateral (A, C) and posterior (B, D) views. Abbreviations: as, articular surface for the squamosal; ip, infrastapedial process; sp, suprastapedial process; vmp, ventromedial projection of suprastapedial process. Scale bar, 5 cm / Cuadrados izquierdos de *Lakumasaurus antarcticus*, IAA: 2000-JR-FSM-1, holotipo (A, B) y *Tylosaurus proriger* (redibujado de Russell, 1967) (C, D), en vistas lateral (A, C) y posterior (B, D). Abreviaturas: as, superficie articular del escamoso; ip, proceso infraestapedia; sp, proceso supraestapedia; vmp, proyección ventromedial del proceso supraestapedia. Escala, 5 cm.

fan-shaped and rostrally expanded, and their suture with the frontals is transversely straight. The parietal foramen is small and located well behind the frontoparietal suture.

Bones involved in jaw suspension of *Lakumasaurus*, morphologically depart from the ancestral tylosaur condition (figures 1, 2): the posterolateral corner of the temporal fenestra (formed by the conjunction of the paraoccipital process, the squamosal, and the supratemporal) is dorsoventrally deep, thus creating a wall that bounds the quadrate from behind. A cup-shaped excavation on the ventral surface of the squamosal receives an unusually large ventromedial projection emerging from the suprastapedial process of the quadrate. Interestingly, the peculiar configuration of the temporal bones displaces the articulation with the quadrate more rostrally than in other mosasaurs, a position indicated by the morphology of the postdentary bones of the jaw. The quadrate is also unusual (figure 2) due to its

lateromedial compression, the transverse growth of the suprastapedial process, and the lateral curvature of its proximal end.

The mandible of *Lakumasaurus* differs from those of other mosasaurs in being slender and dorsoventrally shallow. In contrast, the coronoid process is unusually high. As in the remaining tylosaurines, the edentulous projection of the dentary is elongate. Thirteen, slightly striated teeth are present on the jaw; the absence of a posterior carina and unserrated anterior carina differs from teeth in other mosasaurs.

The cervical vertebrae of *Lakumasaurus* have slightly depressed articular condyles, as in other tylosaurines. Caudal vertebrae also have tylosaurine features, such as craniocaudally short centra that are unfused to the haemal arches (Bell, 1997).

Discussion

Antarctica has yielded a number of mosasaur remains since their presence was originally documented two decades ago (e.g., Gasparini and Del Valle, 1981, 1984; Chatterjee and Zinsmeister, 1982). Recovered materials consist of isolated vertebrae, teeth and skull and jaw fragments, referred to mosasaurines, plioplatacarpines and tylosaurines (Martin *et al.*, 1999, in press). At least five taxa have been identified in the Late Cretaceous units of the Marambio Group: *Leiodon*, *Plioplatacarpus*, *Mosasaurus* cf. *lemmonieri*, cf. *Hainosaurus*, and cf. *Moanasaurus* (Martin *et al.*, 1999). Phylogenetic analysis conducted for this paper depicts *Lakumasaurus* as a basal member of Tylosaurinae (figure 3), clearly distinguishable from other northern and southern mosasaurs by its set of autapomorphic features.

Aside from Antarctica, New Zealand has provided outstanding material of southern, Late Cretaceous marine reptiles (e.g., Welles and Gregg, 1971; Wiffen, 1980, 1990; Bell *et al.*, 1998). *Moanasaurus* and *Taniwasaurus* are among the most conspicuous mosasaur taxa recorded in the Maastrichtian Tahora Formation from New Zealand (Wiffen, 1980, 1990). The former is a member of Mosasaurinae, a clade different from the branch to which *Lakumasaurus* belongs. *Taniwasaurus*, however, is a tylosaurine presumably related to derived forms such as *Hainosaurus* (Bell *et al.*, 1998). *Lakumasaurus* differs from *Taniwasaurus* by its digitated fronto-parietal suture and polygonal-shaped frontals in dorsal aspect. However, both southern tylosaurines share a slender jaw with a high lingual wall.

During the Late Cretaceous, there was a continuous seaway from the Antarctic Peninsula to Alaska. Yet, there appears to have existed a strong faunal provincialism between Northern and Southern hemispheres. For example, many of the well-preserved

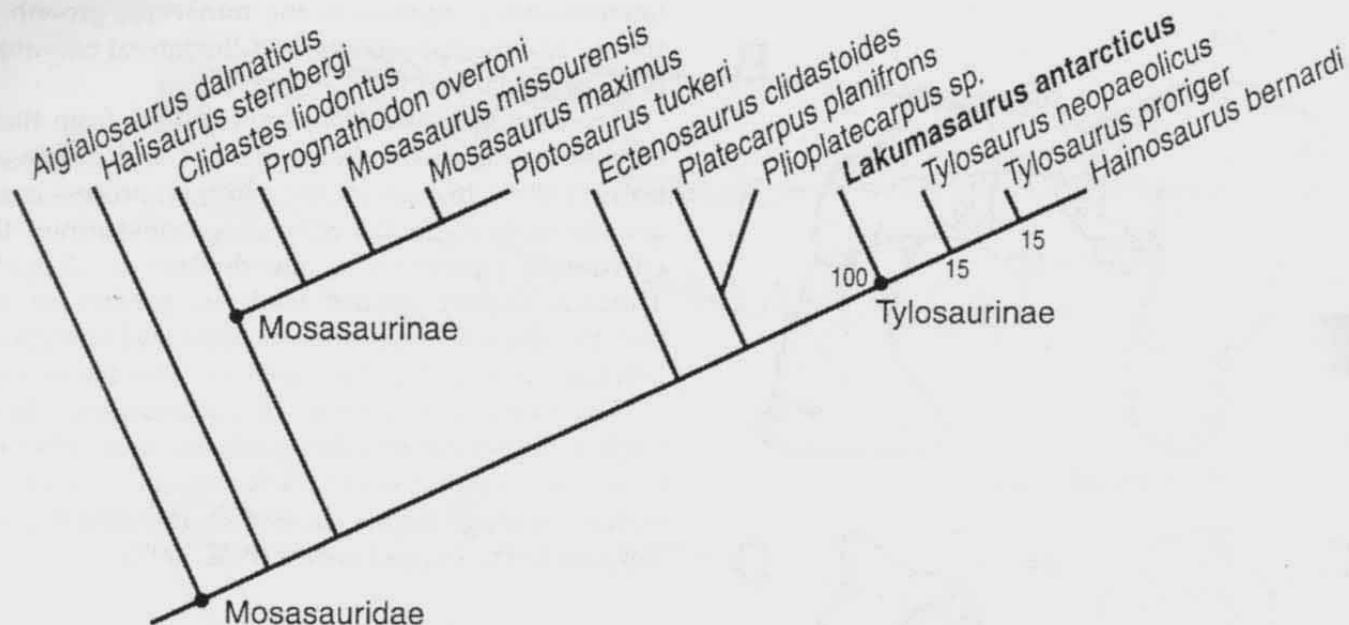


Figure 3. Phylogenetic relationships of *Lakumasaurus antarcticus*. Most parsimonious tree generated by NONA (Goloboff, 1993) using exact solutions ($L=172$, $Ci=0.58$; $Ri=0.67$). Characters and taxa from Bell (1997) and Caldwell (2001). Trees were rooted with *Aigialosaurus dalmaticus* and *Halisaurus sternbergi* as outgroups. Due to the incomplete preservation of *Taniwasaurus* and the lack of direct observations on the specimens of *Moanasaurus*, we opted to exclude these two relevant Southern taxa from the present cladistic analysis. Numbers correspond to relative Bremer support values (Goloboff and Farris, 2001) / *Relaciones filogenéticas de Lakumasaurus antarcticus*. Árbol más parsimonioso generado por NONA (Goloboff, 1993) usando soluciones exactas. Caracteres y taxones tomados de Bell (1997) y Caldwell (2001). Los árboles fueron enraizados con *Aigialosaurus dalmaticus* y *Halisaurus sternbergi* como grupos externos. Debido a la incompleta preservación de *Taniwasaurus* y la falta de observaciones directas de los especímenes de *Moanasaurus*, hemos optado por excluir estos dos relevantes taxones sureños del presente análisis cladístico. Los números corresponden a los valores relativos del soporte Bremer.

mosasaur remains from South America (Páramo, 1994), Antarctica (*Lakumasaurus*), and New Zealand (e.g., Welles and Gregg, 1971; Wiffen, 1980, 1990; Bell *et al.*, 1998) represent genera that are different from those of the Northern Hemisphere (Russell, 1967; Nicholls and Russell, 1990). Moreover, at least some of these southern mosasaurs (e.g., *Moanasaurus*) seem to represent endemics absent in the boreal seas (Bell *et al.*, 1998). This implies that, contrary to expectations, mosasaur faunas were not taxonomically uniform throughout Cretaceous oceans. There may be some kind of latitudinal barrier between northern and southern faunas. Although we do not dismiss the possibility that some taxa (e.g., *Tylosaurus*, *Hainosaurus*, *Mosasaurus*) could have been present in both hemispheres (Martin *et al.*, 1999), available evidence suggests that the paleobiogeography of marine reptiles was more complex than previously thought. Because of their relative geographic isolation, southern marine reptile faunas may have followed evolutionary pathways different from those of their northern counterparts.

Convincing evidence (e.g., Zinsmeister, 1982; Macellari, 1985; Huber and Watkins, 1992) suggests that by Late Cretaceous times a number of shallow-water, cool-temperature marine organisms (e.g., foraminifers, bivalves, gastropods, ammonites) were endemic for Patagonia, Antarctic Peninsula, Southeast Australia, and New Zealand. This region and its fauna are known as the Weddellian Province

(e.g., Zinsmeister, 1982). Marine vertebrate members of this single, broad paleobiogeographic unit include bizarre elasmosaurids such as the Patagonian *Aristonectes* and its close Antarctic relative, *Morturneria* (Chatterjee and Small, 1989). The peculiar mosasaurs *Lakumasaurus*, *Taniwasaurus*, and *Moanasaurus* may also be considered part of this unique faunal assemblage.

By the end of the Cretaceous the Antarctic seas were populated by a diverse array of mosasaurs (presumably six different genera), including large predators with strongly built mandibles (e.g., *Leiodon*) and slender tylosaurines (e.g., *Lakumasaurus*) that probably fed on smaller prey. An equally diverse assemblage of mosasaurs has been documented from Late Cretaceous strata in New Zealand. Comparison of Antarctic mosasaur faunas with those from North America (e.g., Nicholls and Russell, 1990) particularly those from equivalent high northern paleolatitudes ($\sim 65^\circ$ N), indicates that diversity of genera was higher near the Southern Pole: in northern North America (e.g., Anderson River) only one mosasaur genus (*Platecarpus*) is recorded for the Campanian. In contrast, the diversity of Campanian-Maastrichtian mosasaurs from Antarctica resembles more that of lower northern paleolatitudes (e.g., from Pembina, $\sim 50^\circ$ N), where four mosasaur taxa are recorded (e.g., *Platecarpus*, *Clidastes*, *Tylosaurus* and *Hainosaurus*).

This suggests that Late Cretaceous mosasaur fau-

nas from the Antarctic seas do not completely conform to the coeval northern paleogeographic pattern.

Acknowledgements

Fieldwork in Antarctica was supported by the Dirección Nacional del Antártico and Instituto Antártico Argentino. We thank L. Reiner who assisted P. Puerta in specimen preparation, J. Martín for access to mosasaur specimens, A. Cione for determining shark teeth, D. Russell, S. Chatterjee, A.M. Báez and E. Nicholls for cleaver comments and suggestions. Figures were executed by J. González. This research was supported by the Agencia Nacional de Promoción Científica y Técnica (PIDCT 99 6678 to FEN), Consejo Nacional de Investigaciones Científicas y Técnicas (to ZG and MF), and Instituto Antártico Argentino and Dirección Nacional del Antártico (to JML and HJN). Akapol SA (Buenos Aires) offered technical support.

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Recibido: 21 de noviembre de 2001.

Aceptado: 4 de abril de 2002.