

Occurrence of a young elasmosaurid plesiosaur skeleton from the Late Cretaceous (Maastrichtian) of Antarctica

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Abstract The most completely articulated fossil skeleton heretofore found on the continent of Antarctica is represented by a juvenile plesiosaur. The specimen was found in the Sandwich Bluff area of Vega Island east of the Antarctic Peninsula from Late Cretaceous (Maastrichtian) marine deposits from the upper Snow Hill Island Formation. The plesiosaur skeleton is represented by a nearly complete torso, partial paddles, and neck and tail sections. Along the ventral margin of the torso are articulated gastralia, some that are unusual in being forked. Numerous small gastroliths are associated within the trunk cavity, indicating that even juveniles ingest gastroliths. Coupled with other known specimens, the skeleton indicates shallow marine environment may have been an area where marine reptiles had their young, and the young remained until reaching maturity prior to facing open marine environments. The morphology of the specimen suggests the skeleton represents a juvenile *Mauisaurus*, an elasmosaurid plesiosaur taxon originally described from New Zealand and endemic to the Weddellian Province of the austral region.

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Introduction

A joint American-Argentine team discovered a well-preserved plesiosaur on Vega Island east of the Antarctic Peninsula (Figure 1). The fossil marine reptile is approximately 70 million years old (Late Cretaceous) and swam the southern ocean when global warmth prevailed (Martin et al., 2005). The second author found the skeleton while working at high elevations on Sandwich Bluff, Vega Island. Dr. Sawyer found vertebrae exposed by wind from argillaceous sandstones near the top of the Snow Hill Island Formation, below the unconformity between the Cape Lamb Member of the Snow Hill Island Formation and the suprajacent Sandwich Bluff Member of the López de Bertodano Formation (see Crame et al., 2004, for stratigraphic relationships). The ensuing two-week excavation revealed a nearly perfectly preserved juvenile skeleton of an elasmosaurid plesiosaur preserved in life position. The specimen was exceedingly difficult to collect owing to over 100kmph winds and temperatures that dropped so much that water would turn to slush before plaster could be mixed to encase the fossil for removal and transportation. The ground was frozen, and finally, a jackhammer had to be carried up to Sandwich Bluff to excavate the specimen. The resulting package of plesiosaur encased in a protective plaster jacket was too large to carry manually, and the Argentine air force kindly brought helicopters to remove the specimen from Sandwich Bluff. Once prepared, the specimen was discovered to be a meter and a half long skeleton of a long-necked (elasmosaurid) plesiosaur. An adult specimen could reach over 8 meters in length (Hiller et al., 2005). The specimen was nearly perfectly articulated in life position, but the skull had been eroded away before the specimen was discovered. Bad weather and lack of

field time prevented further exploration for the eroded skull.

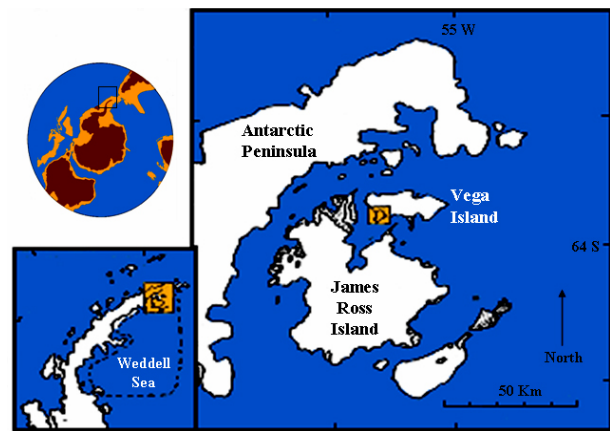


Figure 1. Upper left: position of the Antarctic Peninsula during the Late Cretaceous (~70 Ma) modified from Lawver et al. (1992). Brown areas indicate current land areas, whereas yellow represents former terrestrial areas. Black box indicates area of lower left figure. Lower left: position of Vega Island within the Antarctic Peninsular area. Lower right: area of plesiosaur discovery (Cape Lamb) in yellow of southwestern Vega Island.

Systematics

PLESIOSAURIA de Blainville, 1835

ELASMOSAURIDAE Cope, 1869

MAUISAURUS Hector, 1874

Mauisaurus sp. indet..

Referred specimen

SDSM (South Dakota School of Mines and Technology) 78156 from SDSM locality V2005-03 is represented (Figure 2) by a nearly complete, articulated torso, partial paddles, and neck and tail sections from Maastrichtian deposits of the upper Cape Lamb Member of the Snow Hill Island Formation.

Description

SDSM 78156 (Figure 2) is the body section of a juvenile individual, approximately 1.5m long. The cervical vertebrae are mostly articulated, the trunk vertebrae are well articulated, and many articulated caudal vertebrae occur, but the tip of the tail was not preserved. Neither the transverse processes nor the neural arches are fused to the vertebral centra, indicating the juvenile condition. Pectoral and pelvic girdles are well preserved and mostly articulated as in life. The scapula and coracoid are obvious in ventral view, although the scapula is obscured. The coracoids are characterized by a conical mid-ventral process (Figure 2). The quadratic-hexagonal pubis is well exposed, but the ischium is obscured distally by the right rear paddle that was folded under the body at the time of death and remains partially articulated. The remaining three paddles were not so well preserved. Portions of the propodials (humeri and femura) were recovered, and all exhibit rounded proximal ends, particularly the femura. Most bones of the plesiosaur had not developed distinct ends and were poorly ossified, indicating the youth of the individual.

Spectacular preservation of the stomach area was discovered following preparation. Articulated gastralia were found along the ventral abdomen, and although most were long straight rods like those of most plesiosaurs, one was forked into two prongs and another into three. A medial set of gastralia interdigitates with what appears to be two lateral sets. One of the gastralia, which possesses three prongs, occurs in a distal, medial position and interdigitates with two typical rod-like gastralia on the left side (Figure 2). Moreover, numerous small (~1 cm in diameter) rounded, polished stomach stones (gastroliths) were found concentrated within the abdominal cavity, indicating that stomach stones were ingested, even by juvenile plesiosaurs.

Discussion

The juvenile plesiosaur appears to be related to an elasmosaurid first discovered in New Zealand (Hector, 1874). The plesiosaur, *Mauisaurus* (as recognized by Welles and Gregg (1971)), has been diagnosed by a rounded end of the femur and conical mid-ventral process of the coracoid, among other characters (Hiller et al., 2005). Moreover, Hector (1874) illustrated forked gastralia. Therefore, SDSM 78156 is referred to *Mauisaurus*, but specific determination is not possible until skulls from New Zealand and Antarctica are better known. Because the comparison of a juvenile with the adult condition could be equivocal, the Antarctic skeleton was compared with a partial juvenile specimen from New

Zealand, C.M. (Canterbury Museum) zfr. 103, that was considered a species of *Mauisaurus* by Welles and Gregg (1971). A great similarity occurs between the specimens, suggesting they are congeneric; specific identities require more completely preserved specimens. Overall, the Antarctic juvenile specimen represents one of the most complete skeletons of *Mauisaurus*, a taxon confined to the Weddellian Province (Gasparini et al., 2003), and represents the best articulated fossil skeleton recovered from Antarctica.

The juvenile was found in lithologies associated with marine invertebrates that suggest a shallow-water environment of deposition during the Late Cretaceous. Volcanism may have directly or indirectly caused the death of the plesiosaur. Volcanic ash beds (bentonites) are found interbedded with the marine sandstone, although no bentonite layers were directly associated with the plesiosaur. However, chunks of ash associated with the skeleton were found with plant material inside. The occurrence of plant debris enclosed within the ash suggests the possibility of a major volcanic blow-down of vegetation, such as that observed when Mt. St. Helens erupted in North America in 1980. Therefore, either the blast or ash dumped into the seaway may have contributed to the demise of the young plesiosaur. Moreover, the silica released through devitrification of the ash contributed to the spectacular preservation of the skeleton.

Antarctic expeditions to the Cape Lamb area since 1998 have secured numerous isolated elements of juvenile plesiosaurs and mosasaurs (Martin, 2002) as well as other partially associated juvenile skeletons. Therefore, this specimen reinforces the contention that the region east of the Antarctic Peninsula during the Late Cretaceous may have represented a shallow, protected area where marine reptiles came to have their young and where the young remained until they were of sufficient size and ability to survive in open marine waters.

Summary

A juvenile skeleton of a long-necked (elasmosaurid) plesiosaur represents the most completely articulated fossil skeleton found on the southernmost continent, Antarctica. The preserved skeleton, SDSM 78156, is approximately 1.5 m long (compared to an adult that may be greater than 8 m). All major bones are poorly ossified, particularly their articulating surfaces, indicating the youth of the individual. Rows of articulated gastralia occur along the ventral margin of the torso; some gastralia are unusual in being forked. Numerous small gastroliths (stomach stones) were found within the trunk cavity, indicating that gastroliths commonly found in adult specimens are ingested at a relatively young ontological age. The morphology of the coracoids, gastralia, and femura indicates that the plesiosaur skeleton represents a species of *Mauisaurus*, originally described from New Zealand by Hector (1874). This occurrence adds to the evidence for the endemism of the plesiosaur genus in the

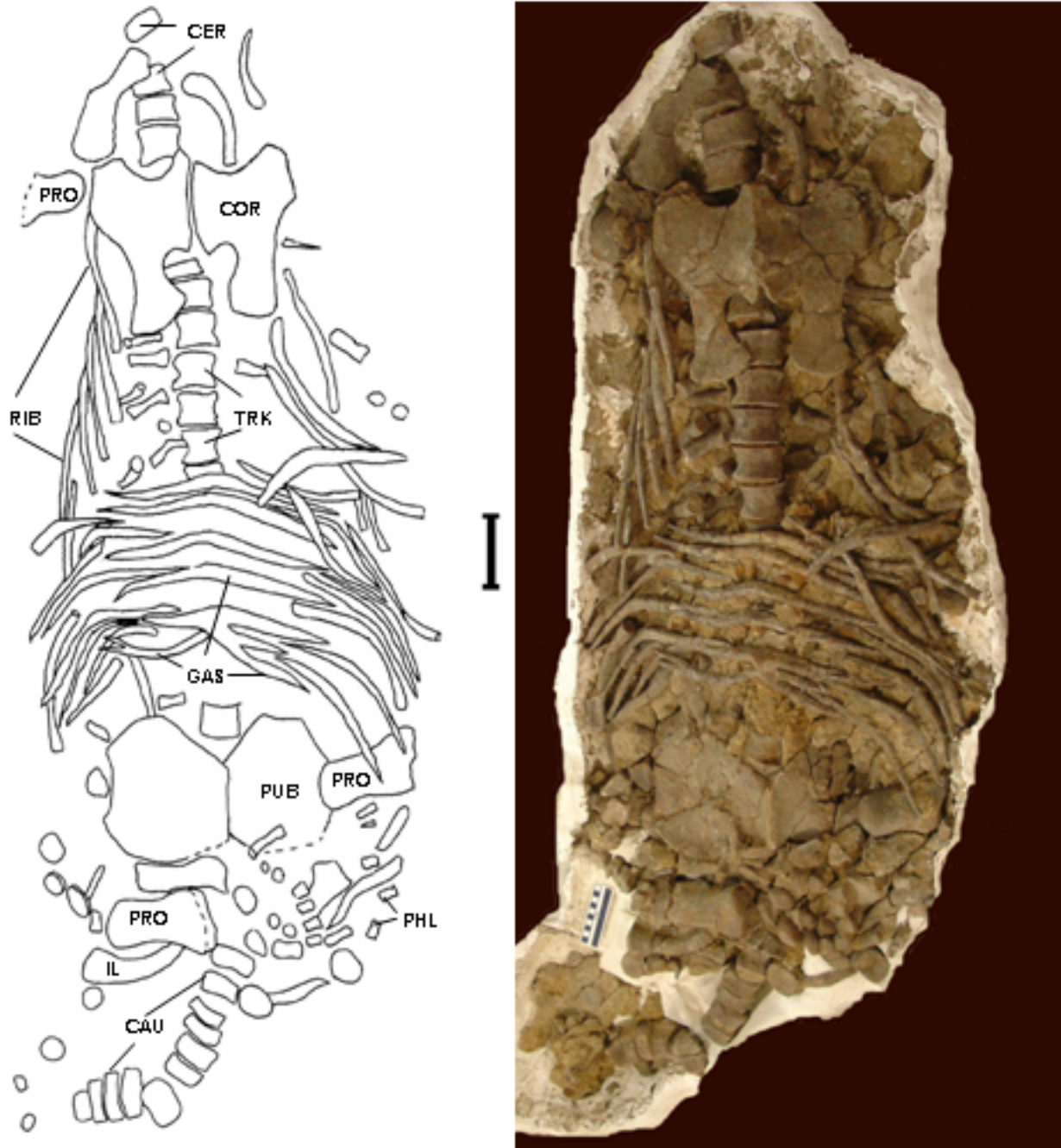


Figure 2. SDSM 78156, juvenile plesiosaur skeleton, ventral view. Anterior is at top of figure. Abbreviations: **CAU**-caudal vertebrae; **CER**-cervical vertebrae; **COR**-coracoid; **GAS**-gastralia; **IL**-ilium; **PHL**-phalanges; **PRO**-propodial; **PUB**-pubis; **RIB**-ribs; **TRK**-trunk vertebrae. Scales equal 10 cm.

Weddellian Province of the austral region (Gasparini et al., 2003; Hiller et al., 2005). The juvenile skeleton was discovered in the Sandwich Bluff area of Vega Island from Late Cretaceous (Maastrichtian) marine deposits from the upper Cape Lamb Member of the Snow Hill Island Formation. From the same area, relatively numerous juvenile marine vertebrates were previously collected. These specimens, in conjunction with the articulated juvenile plesiosaur, indicate the shallow marine environment may have been a protected area

where marine reptiles had their young. These young remained in the shallows until attaining size and behavioral maturity to face the dangers of open marine environments.

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