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NOTE

THE FIRST DUCK-BILLED DINOSAUR (FAMILY HADROSAURIDAE) FROM ANTARCTICA

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Duck-billed dinosaurs or hadrosaurs are a very common family of dinosaurs in the Late Cretaceous of North America and Eurasia with rare occurrences in South America. Here, we report the first hadrosaur recovered in Antarctica from sandstones of late Maastrichtian age, Vega Island, Antarctic Peninsula (Fig. 1) during a joint U.S.-Argentinian geological and paleontological field expedition to the island. This discovery supports the hypothesis of a dispersal route between southern South America and Antarctica in the Maastrichtian.

Dinosaurs are extremely rare in the dominantly marine deposits of Late Cretaceous age in Antarctica, so the discovery of a single hadrosaur tooth (Fig. 2) by the third author (DSC) was unexpected. Hadrosaurs are not the first dinosaurs from Late Cretaceous deposits in the James Ross Basin. Theropod, ornithopod, and ankylosaur specimens had been previously recorded (Gasparini et al., 1987; Hooker et al., 1991; Molnar et al., 1996). However, these dinosaur groups represent either cosmopolitan taxa or native Gondwanan taxa, thus the duck-billed dinosaur represents a new immigrant family of dinosaurs into this southernmost continent.

The fossil-bearing deposit occurs at 61°51′S and 53°33′W, at Sandwich Bluff on Cape Lamb, Vega Island, Antarctic Peninsula. The "Reptile Horizon," named for the numerous mosasaur and plesiosaur specimens recovered from this stratigraphic level, is in the upper third of the Sandwich Bluff Member (Crame et al., 1991; Pirrie et al., 1991) or Unit C (Olivero, 1992) of the Lopez de Bertodano Formation. This member is a nearshore marine deposit of composed of fine-grained, ferruginous, loosely consolidated sandstones that are latest Maastrichtian age (approximately 66–68 million years ago), based on correlations of ammonite and palynological taxa (Crame et al., 1991; Pirrie et al., 1991).

In addition to the hadrosaur, at least four different bird species (which can be referred to modern avian orders, including charadriiform and gaviid birds, based on the morphology of their respective tarsometatarsals), have been recovered from this same stratigraphic level. Additionally, numerous specimens of plesiosaurs and mosasaurs were collected from this same horizon, as well as the 5-meter horizon immediately below (Martin et al., 1999a, b). At least five taxa of marine reptiles are represented on Vega Island, and numerous specimens of juvenile individuals were collected, concentrations of which are relatively rare in the North American marine reptile record.

SYSTEMATIC PALEONTOLOGY

REPTILIA

ARCHOSAURIA Cope, 1869
HADROSAURIDAE, Cope, 1869
?HADROSAURINAE Lambe, 1918

Referred Material—MLP (Museo de La Plata, Argentina) MLP 98-I-10-1, cheek tooth; a cast, SDSM C641, resides at the Museum of Geology, South Dakota School of Mines and Technology (SDSM).

Horizon and Locality—Sandwich Bluff Member, Lopez de Bertodano Formation; "Reptile Horizon" on the eastern flank of Sandwich Bluff, Vega Island, Antarctica.

DESCRIPTION

The Antarctic hadrosaur is represented by a single cheek tooth, which based upon morphology, was clearly part of a typical hadrosaur dental battery (Fig. 2). The tooth is conical with a lozenge-shaped enamel face. A central ridge (=medial carina) bisects the enamel face and extends from the crown apex to the crown base. The tooth crown is 20 mm in height and is hexagonal in cross-section, which can be easily seen as the root had been broken off. The diameter across the crown base is 10 mm in both the anteroposterior and labiolingual directions. The enamel face is slightly asymmetrical, is 10 mm at its greatest width, and narrows to 5 mm at the crown base. The medial carina has a maximum height of 3 mm above the surface of the enamel and is relatively uniform in width from the apex to the crown base; however, near the base of the crown, the carina flares. No secondary carinae exist lateral to the primary medial carina. The outer margin of the enamel face is only incipiently ridged around the margin of the enamel face. The marginal ridge has well-worn denticles on both the anterior and posterior margins, resulting in a coarsely serrated appearance. The non-enamelled surface is faintly rugose and bears a broad, vertical facet set just lateral to the transverse plane. This facet represents the interface for an interlocking adjacent cheek tooth.

The tooth from Antarctica is taller than wide, a characteristic that distinguishes hadrosaur teeth from those of other ornithopods (Ryan and Vickaryous, 1997). The crown of the tooth is relatively diamond-shaped, rather than elongate, a characteristic that separates hadrosaurines from lambeosaurines according to Horner (1990). The crown morphology of the Antarctic hadrosaur cheek tooth is very reminiscent of that of North American hadrosaurs, especially that of *Edmontosaurus.* The tooth is relatively symmetrical, somewhat short, has only a single medial carina which is nearly straight, and possesses coarse, poorly formed denticles. Although these features might suggest that the tooth belongs to a hadrosaurine, the root is broken from the Antarctic specimen so the crown-root angulation cannot be determined, another characteristic which can be used to separate the two hadrosaur subfamilies (Lull and Wright, 1942; Horner, 1990). Therefore, additional specimens must be obtained before greater taxonomic precision can be obtained; nevertheless, the tooth clearly represents a species of the Hadrosauridae and probably that of a hadrosaurine.

DISCUSSION

Hadrosaurs are known from North America, beginning in the latest Albian to earliest Cenomanian with the first occurrence being dated by 40Ar/39Ar method at 98.3 Ma (Cifelli et al., 1997). The family is a very diverse group with at least thirteen genera having been described within two subfamilies, depending upon taxonomic grouping, and hundreds of specimens collected along the western margin of the epicontinental seaway which lay across the midland of North America. Specimens have been collected from New Mexico to Alaska in the Cordilleran region, and hadrosaurs are known from the Atlantic and Gulf coastal plains in the east and westerly to California and Baja California (Horner, 1979; Weishampel and Horner, 1990). Hadrosaurs are less diverse and more rare from the Late Cretaceous deposits of Europe and eastern Asia (Weishampel and Horner, 1990), and in the Late Creta-

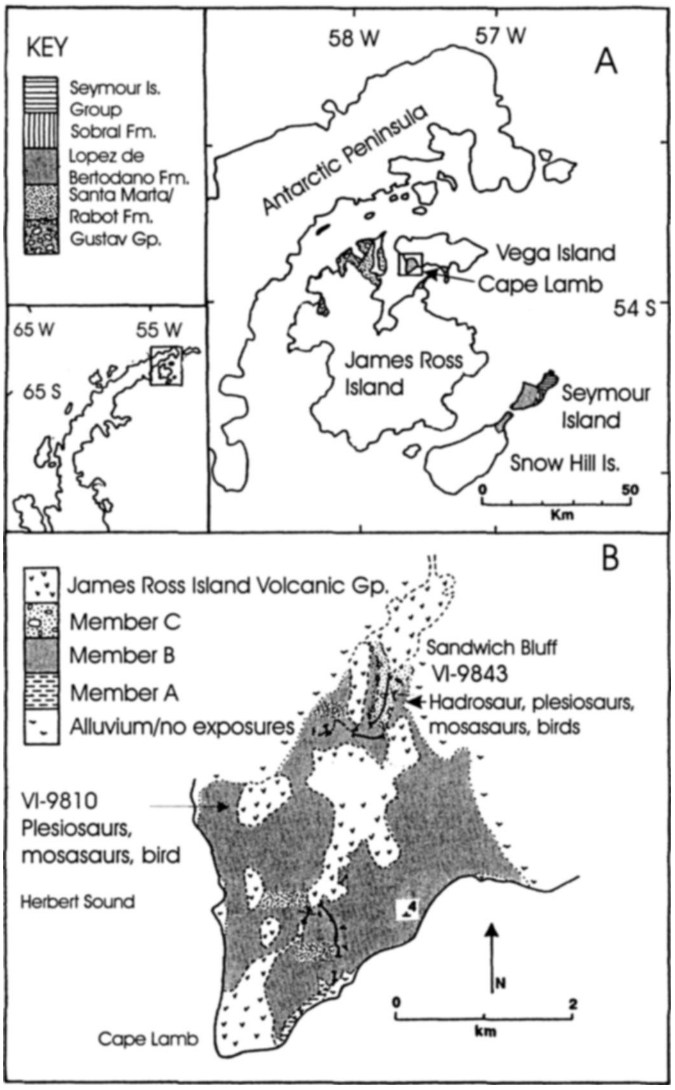

FIGURE 1. Maps of the Cape Lamb area of Vega Island and the important fossil vertebrate localities. **A**, map of Vega Island illustrating its position in relationship to James Ross Island and the Antarctic Peninsula. The upper inset is a key to the stratigraphical rock units in the area, whereas the lower inset places the study area in the geographical context of the Antarctic Peninsula. **B**, Cape Lamb area of Vega Island with indications of important vertebrate fossils which were recovered from west of Leal Bluff in Member B and recovered from Sandwich Bluff in Member C. The hadrosaur tooth was collected from Sandwich Bluff.

ceous of South America, hadrosaur remains are even more rare. A single species of hadrosaur, *Kritosaurus australis* (Bonaparte et al., 1984) is known from the Los Alamitos Formation (late Campanian, ca. 75 Ma) of Patagonia and *Secernosaurus koerneri,* from the Laguna Palacios Formation (early Campanian), also from Patagonia (Brett-Surman, 1979). However, Bonaparte (1996) commented that the ilium of *Secernosaurus* appears to have been deformed during or after preservation and thus is the earliest known specimen of *Kritosaurus* in South America. Specimens of *Kritosaurus* were previously known from North America and have been collected from Alberta to New Mexico (Brown, 1919; Parks, 1920; Horner, 1992). The dispersal of hadrosaurs from North America to South America probably occurred during the early to mid-Campanian, in order for *K. australis* to appear in Patagonia by the late Campanian. A dispersal event of terrestrial vertebrates (in this case, a species of hadrosaur) between North and South America during the Campanian would coincide with a hypothesis of marsupial mammal

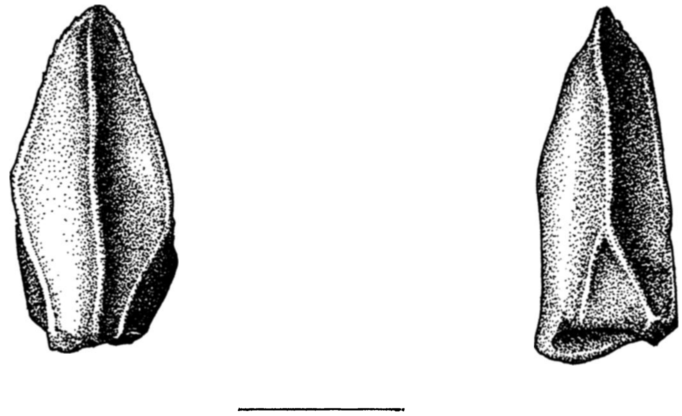

FIGURE 2. Hadrosaur tooth, MLP 98-I-10-1 in occlusal view (left) and side view (right). Scale equals 10 mm.

dispersal from North America to South America in the late Campanian, as well, so that marsupials could continue their dispersal into Antarctica and then onto Australia by the end of the Maastrichtian to the earliest Tertiary (Woodburne and Case, 1996).

Other dinosaurs have been recorded from Late Cretaceous deposits on islands along the eastern coast of the Antarctic Peninsula (Fig. 1). A nodosaurid ankylosaur was found in the Santa Marta Formation (Santonian to Campanian) on James Ross Island only 15 km from the hadrosaur site on Vega Island (Gasparini et al., 1987). This partially complete specimen of a single individual included a mandible with teeth, assorted vertebrae, ribs, girdle elements, podials, and dermal armor (Gasparini et al., 1996). Also from James Ross Island, but further to the north from the nodosaur locality, the distal portion of a theropod (=carnosaur) tibia was recovered from older deposits (i.e., the Hidden Lake Formation) of Coniacian to Santonian Age (Molnar et al., 1996). A hypsilophodontid was the first dinosaur collected from Vega Island (Hooker et al., 1991). This dinosaur was recovered from the late Campanian to early Maastrichtian "*Gunnarites*" Zone of the Cape Lamb Member (=Unit B) of the Lopez de Bertodano Formation. This dinosaur site on the eastern slope of Leal Bluff is only three kilometers from the hadrosaur site at Sandwich Bluff.

The nodosaurid, theropod and hypsilophodontid belong to groups of dinosaurs which have a long geological history with origins in the Early Jurassic to Early Cretaceous and a broad geographical distribution. The hypsilophodontids are nearly cosmopolitan with species having been described from North America, Europe, Africa, Australia, and of course Antarctica (Fastovsky and Weishampel, 1996). Nodosaurs are known from the Early Cretaceous in both Europe and North America, whereas later forms appeared in Australia and Antarctica (Molnar, 1980; Gasparini et al., 1996). The theropod most closely resembles plesiomorphic allosauroids or megalosaurs, both of which are biogeographically widespread (Europe, Africa, and Australia) and may have their origins in the Early or Middle Jurassic (Hammer and Hickerson, 1994; Molnar et al., 1996). The theropod and nodosaurid should be regarded as part of the resident dinosaur fauna existing in Gondwana, and hypsilophodontids and nodosaurids were in Australia by the end of the Early Cretaceous (Molnar, 1980). However, hadrosaurs are a "Northern Hemisphere group," as their earlier record is North American and Eurasian, with subsequent dispersal to South America. Consequently, the discovery of a hadrosaur in the Maastrichtian of Antarctica represents a late dispersal event of the taxon into Antarctica.

The dispersal of hadrosaurs into Antarctica from South America, infers a connection, either an island chain or an isthmus, between Patagonia and the Antarctic Peninsula. Similar geological histories between these two areas on either side of the Drake Passage suggest the existence of a connection between southern South America and Antarctica from the Late Cretaceous to the beginning of the Oligocene (Lawver et al., 1992; Shen, 1995). The dispersal of hadrosaurs into Antarctica by the Maastrichtian may coincide with and provide additional support for a predicted first wave of marsupials from South America to Antarctica (Case et al., 1996; Woodburne and Case, 1996; Goin et al., 1999).

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