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CRETACEOUS RESEARCH

The first record of a pliosaurid (Plesiosauria, Pliosauridae) from the Lower Cretaceous of North America

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Abstract

The fragmentary remains of a plesiosaur have been collected from the Haida Formation (Albian, Lower Cretaceous) at Cumshewa Inlet, Queen Charlotte Islands, British Columbia. The specimen is identified as a member of the family Pliosauridae, based on tooth structure. This is the first record of a pliosaurid from the west coast of North America, and the first pliosaurid from the Lower Cretaceous of North America.

Keywords: Lower Cretaceous; Albian; Pliosaurid; Queen Charlotte Islands

1. Introduction

In 1995, the fragmentary remains of a plesiosaur were collected from the Lower Cretaceous Haida Formation in Cumshewa Inlet, Queen Charlotte Islands, British Columbia, Canada (Fig. 1). The specimen is identified as a pliosaurid, based on its tooth structure. Although plesiosaurs were abundant in North America during the Late Cretaceous, this is certainly not true for the Early Cretaceous (Welles, 1962; Russell, 1988). Globally, the known abundance and diversity of plesiosaurs from the Lower Cretaceous is very low, a fact which has been attributed both to extinction events (Bakker, 1993) and to the inadequacy of the fossil record (Bardet, 1994). The specimen reported here is the first record of a pliosaurid from the Lower Cretaceous of the Pacific coast, and one of the very few from North America; indeed, it is the first record of the family Pliosauridae from the Lower Cretaceous of North America.

2. Stratigraphic occurrence

The pliosaurid remains were collected from the intertidal platform southwest of McLellan Island on the north shore of Cumshewa Inlet, Queen Charlotte Islands (Fig. 1). The strata consist of silty fine-grained sandstone and siltstone assigned to the Sandstone Member of the Haida Formation; elsewhere, the Sandstone Member also includes granular sandstone and pebble conglomerate. Haida Formation strata exposed in Cumshewa Inlet are preserved in a NW–SE trending syncline (Sutherland Brown, 1968) and exposures in the vicinity of McLellan Island are found on the eastern limb of the syncline.

Strata assigned to the Sandstone Member of the Haida Formation are distributed widely across Queen Charlotte Islands and range in age from Albian to Cenomanian (Haggart, 1991). Outcrops of the Sandstone Member immediately adjacent to the pliosaurid locality in Cumshewa Inlet, and along the strike (GSC Locality C-196931), have produced the ammonites *Desmoceras* (*Pseudouhligella*) *bearskinense* McLearn, *Anagaudryceras sacya* (Forbes), and *Puzosia skidegatensis* McLearn. *D.* (*P.*) *bearskinense* makes its first appearance in the upper part of the *Cleoniceras* (*Grycia*?) *perezianum* ammonite zone of Queen Charlotte Islands and ranges up through the overlying *Mortoniceras-Desmoceras* (*Pseudouhligella*) *dawsoni* Zone, indicating an age range of late middle–latest Albian (McLearn, 1972; Jeletzky, 1977; Haggart, 1986).

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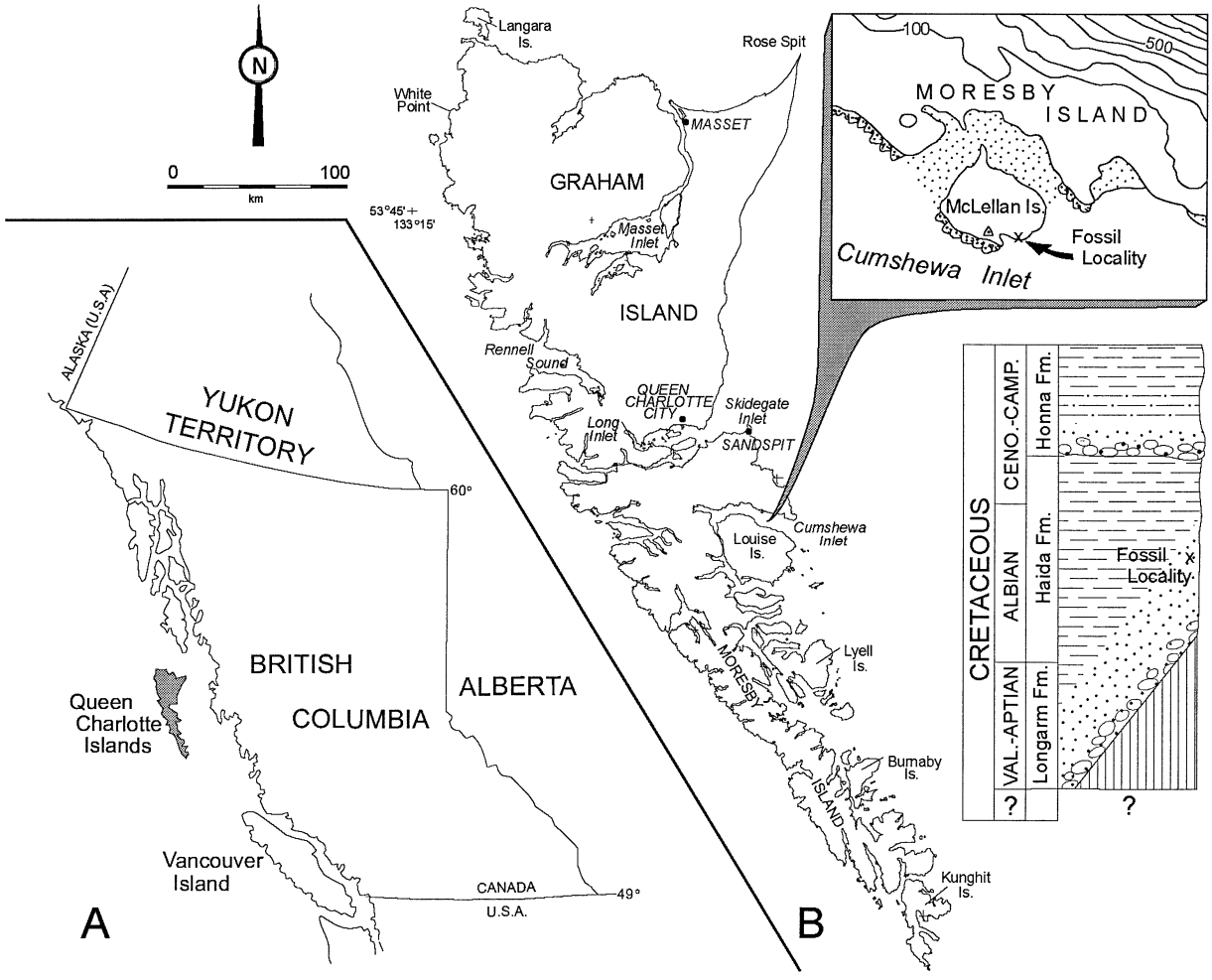

Fig. 1. Map showing location of pliosaur fossil locality, Cumshewa Inlet, Queen Charlotte Islands, British Columbia. Stratigraphic column shows position of fossil locality within Cretaceous succession of Queen Charlotte Islands.

Puzosia skidegatensis appears to be restricted to the *M.-D.* (*P.*) *dawsoni* Zone on the islands (McLearn, 1972; Haggart, unpubl. data), suggesting the locality may be further restricted in age to late Albian.

3. Systematic paleontology

The specimen reported here is in the collections of the Royal Tyrrell Museum of Palaeontology at Drumheller, Alberta (TMP). Additional locality data are available from the Geological Survey of Canada (GSC), Vancouver, British Columbia. Material was prepared from the bulk matrix using modified Chicago Pneumatic and Desouter air scribes.

Order: Plesiosauria De Blainville, 1835
Family: Pliosauridae Seely 1874, emended Tarlo, 1960

3.1. Referred specimen

TMP 95.78.1. Isolated tooth, distal fragment of a propodial, phalanges, vertebral centrum, isolated neural arch, rib fragments (Figs. 2 and 3).

3.2. Description

Twelve phalanges are preserved; they are partially articulated and represent the remains of three digits. They are indicative of a large plesiosaurian, but cannot be identified further.

The centrum lacks any indication of a rib articulation, and is therefore probably from the mid-dorsal region of the vertebral column. It has a length of 82.8 mm along the mid-ventral line. The anterior articular face has a height of 107.3 mm and a width of 94.8 mm. This results in vertebral indices of 83,129:114 (Welles, 1952).

The tooth is distinctive. The crown (Fig. 3) has been damaged, so it is not possible to obtain a shape index. A mould of the tooth, preserved in the matrix, retains a considerable amount of original detail. The crown is slightly recurved, and there is no evidence of carinae. The enamel is heavily striated with ridges of varying length. All ridges start from the same level at the base of the crown. Primary ridges are thick, extend the length of the preserved crown and are uniformly spaced.

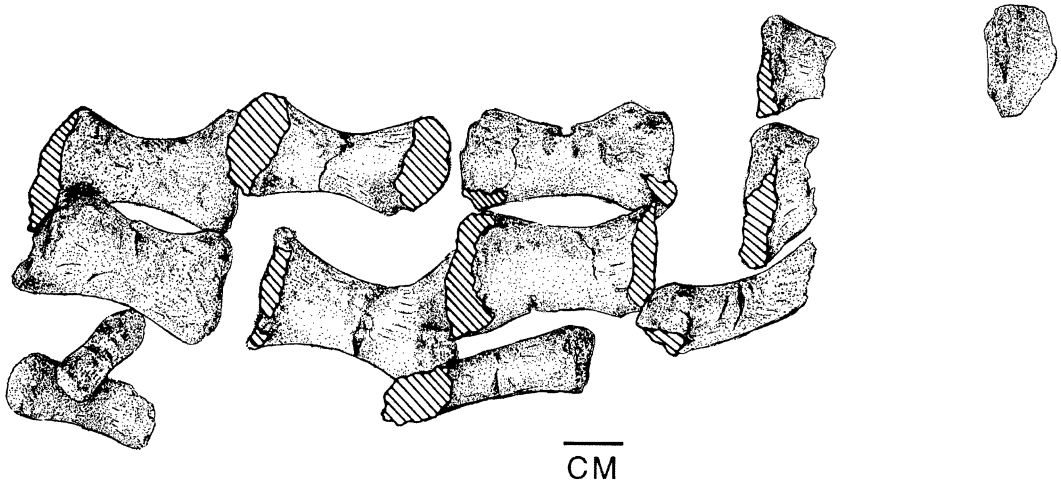

Fig. 2. Illustration of paddle of TMP 95.78.1, Pliosauridae, gen. et sp. indet. Scale bar represents 10 mm.

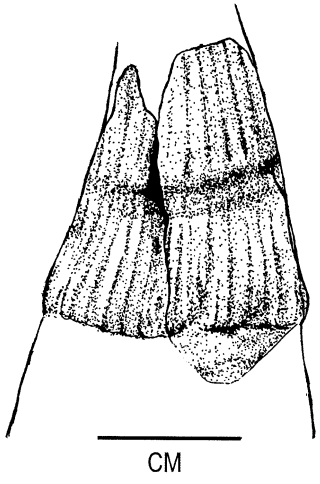

Fig. 3. Illustration of tooth of TMP 95.78.1, Pliosauridae, gen. et sp. indet., crown and root of tooth, lingual view. Scale represents 5 mm.

Secondary ridges are much finer. They are interspersed among the primary ridges and extend only a short way up the crown. Secondary ridges are not of uniform length and are not evenly spaced. There is usually one secondary ridge between each primary ridge; occasionally, two secondary ridges occur. The striations are present around the entire circumference of the preserved tooth, although they are more widely spaced on the labial side of the crown. About half way along the preserved height of the crown, there is a wrinkle in the enamel around the circumference.

4. Discussion

Most of the material is too incomplete to be identified below the level of Plesiosauria. The vertebral centrum is unusual in that the height of the articular face exceeds its width. While this character is recorded in *Pistosaurus* (Sues, 1987) and some of the more primitive sauropterygians (Rieppel, 1994), it is not known in other plesiosaurs. It is possible that the centrum of TMP 95.78.1 has been crushed, although this is not apparent in the specimen. Not too much weight should be placed on this character, however, as dorsal vertebrae are not as diagnostic as cervical vertebrae, and proportions of vertebral centra have been shown to vary, both with ontogeny and with relative position along the vertebral column (Welles, 1952, Brown, 1981). It is certain, however, that the centrum of TMP 95.78.1 lacks the very wide articular face seen in some elasmosaurs (Welles, 1943, 1952).

Tarlo (1960), Welles (1962), Persson (1963), and Brown (1981) all used the presence of stout, heavily striated teeth as one of the distinguishing characters of the Pliosauroidea, or short-necked plesiosaurs. The Pliosauroidea of Welles (1943) is no longer recognized, however, as the short necked Cretaceous polycotylids have been shown to be more closely related to the Cretaceous elasmosaurs (Carpenter, 1996; Druckenmiller, 1998; Bardet & Godefroit, 1998; O'Keefe, 2001). Consequently, we agree with Carpenter (1996, 1998) that the term 'pliosaur' should not be used to refer to any short-necked plesiosaur. In this paper, we use the term 'pliosaurid,' and restrict it to members of the family Pliosauridae.

Carpenter (1996, 1998) recognized three families of short-necked plesiosaur: the Brachaucheniidae, Pliosauridae and Polycotylidae. The first two families are differentiated from all other plesiosaurs by the heavy striations on the teeth, and by the structure of the pterygoids, which are folded into a flange along the ventral midline. The family Brachaucheniidae is monotypic; the single genus, *Brachauchenius*, differs from other plesiosaurs only in minor variations in the pattern of the heavy tooth striations. This striation pattern is not

diagnostic at the generic level, however, as Taylor (1992) has shown that in *Rhomaleosaurus zetlandicus* striation pattern can change with ontogeny, and position in the jaw. Consequently, we refer *Brachauchenius* to the family Pliosauridae. It is noteworthy that the polycotylids, like the elasmosaurs, have high, slender teeth, with a subdued ornamentation of fine striations. It is only the pliosaurids which have the heavily striated dentition.

The tooth of TMP 95.78.1 is thus diagnostic of the family Pliosauridae. The heavy tooth crown, with its distinctive longitudinal striations is found only in the pliosaurids. All other families of plesiosaurs have slender teeth, with a more subdued and irregular ornamentation of fine striations (Brown, 1981).

This is the first record of a pliosaurid plesiosaur from the Lower Cretaceous of North America. The only pliosaurids recorded previously from North America are *Polyptychodon hudsoni* Welles & Slaughter, 1963 and *Brachauchenius lucasi* Williston, 1903, both Turonian in age. The teeth of TMP 95.78.1 differ from those of *Polyptychodon* in that the short striations of TMP 95.78.1 are not uniformly spaced, and there is a slight wrinkling in the enamel. They differ from the teeth of *Brachauchenius* in that the short striations never bifurcate off of the larger striations. Carpenter (1996, 1998) referred *Plesiopleurodon wellesi* to the Pliosauridae and stated that it is from the Lower Cretaceous. However, the specimen comes from the Belle Fourche Shale, which is Cenomanian in age (Carpenter, 1996). The teeth of *Plesiopleurodon* lack the coarse striations present in the teeth of other pliosaurids, and its pterygoid structure is unknown (Carpenter, 1996). Consequently, its referral to the Pliosauridae (Carpenter, 1998) must be considered questionable. The Queen Charlotte Islands specimen also extends the palaeogeographical range of the Pliosauridae to the Pacific coast. All other plesiosaurs from the west coast of North America are elasmosaurs (Welles, 1943, 1952).

In contrast to the abundant record of plesiosaurs from the Late Cretaceous of North America, the record of Early Cretaceous plesiosaurs is sparse. The only well-preserved specimen is *Edgarosaurus muddi* Druckenmiller, 2002. This specimen, from the Thermopolis Shale (Albian) of Montana, consists of a skull, cervical vertebrae and the paddle, and is a polycotylid (Druckenmiller, 2002). Plesiosaurs have recently been found in the Clearwater Formation (Aptian/Albian) at the Syncrude mine north of Fort MacMurray, Alberta. These are currently being prepared and are under study at the Tyrrell Museum of Palaeontology. All other North American Early Cretaceous plesiosaur material is very fragmentary. Tozer & Thorsteinsson (1964) reported fragments of both a polycotylid and an elasmosaurid from the Christopher Formation (Aptian/Albian) of the Queen Elizabeth Islands. Isolated vertebrae from the Kiowa Formation (Albian) were described as *Plesiosaurus gouldi* and *Plesiosaurus mudgei* by Cragin (1894) and Williston (1903). They are unidentifiable and considered *nomina dubia* (Welles, 1962, Schultze et al., 1985).

The Sandstone Member of the Haida Formation consists of shallow-marine sandstone and siltstone which reflect sediment accumulation in the neritic regions of an Early Cretaceous fore-arc basin located west of an active magmatic arc (Haggart, 1991). A diverse assemblage of shallow-marine ammonites, bivalves, and gastropods is found in the member throughout the extent of its outcrop, and attests to its shallow-water nature. The Cretaceous fore-arc basin deepened to the west and was open to the Pacific Ocean. The magmatic arc was part of a complex orogenic belt that separated the Pacific coast regions of North America from the more central Western Interior Seaway throughout Cretaceous time (Jeletzky, 1977). Marine connections between the Interior Seaway and the Pacific Coast were thus highly restricted, both geographically and temporally, and marine faunas in the two regions are significantly different in biogeographic composition. Plesiosaurs of the Pacific coast region are thus expected to be distinct from those occurring in the Western Interior region.

The pliosaurid from Queen Charlotte Islands adds to our very scanty knowledge of the distribution of Early Cretaceous plesiosaurs. It is the first record of the family Pliosauridae from the Lower Cretaceous of North America, and extends the palaeogeographic range of the family to the west coast of North America.

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