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An Early Albian Arctic-type ammonite *Arcthoplites* from Hokkaido, northern Japan, and its paleobiogeographic and paleoclimatological implications

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ABSTRACT

An Early Albian Arctic-type ammonite *Arcthoplites* was discovered from the Kamiji Formation of the Yezo Group in the Nakagawa area, northern Hokkaido, northern Japan. This is the first reliable record of a hoplitid ammonite from Japan and clearly indicates the distribution of an Arctic fauna in the middle latitudes of the North Pacific at that time. Synchronously with the appearance of this Arctic-type ammonite, the tropical Tethyan biota (Mesogean taxa) disappeared from Hokkaido and elsewhere in the Northwest Pacific. These biogeographic changes suggest the existence of a "cooling" episode in the Early Albian North Pacific.

1. Introduction

The Cretaceous period was generally characterized by warm climate. Mid-Cretaceous (Aptian–Turonian) in particular was a well-documented greenhouse period of global importance during the Earth's history and associated with higher atmospheric CO_2 levels (Bice and Norris, 2002). Marine long-term oxygen isotope records suggest that a significant global warming trend during mid-Cretaceous and its optimum occurred largely in the Turonian (e.g., Jenkyns et al., 1994; Clarke and Jenkyns, 1999; Huber et al., 2002; Wilson et al., 2002; Steuber et al., 2005). On the other hand, evidence for cooler episodes exists, particularly in the Early Cretaceous (e.g., Kemper, 1987; Price, 1999; Price et al., 2000).

Abundant ammonite shells preserved in Cretaceous marine deposits are particularly useful for reconstruction of the paleobiogeography and marine paleoenvironments of this period (e.g., Cecca, 1998; Bengtson and Kakabadze, 1999). Some Albian ammonite genera (e.g., *Leymeriella*, *Brancoceras*, *Arcthoplites*, *Hoplites*, and *Mortoniceras*) have also been utilized for paleogeographic, paleobiogeographic and paleoclimatological purposes, although mainly in Europe (e.g., Owen, 1973, 1996; Baraboshkin, 1996). The distribution of *Arcthoplites*, a typical Arctic ammonite, was restricted to the Early Albian Arctic–Boreal regions (Imlay, 1961; Jones and Grantz, 1967; Birkelund and Håkansson, 1983; Wright et al., 1996; Baraboshkin, 1992, 1996; Casey, 1999; Baraboshkin and Mikhailova, 2005), and this genus is regarded as a good indicator for cool climatic conditions. *Arcthoplites* has been subdivided into two phylogenetically related subgenera *Arcthoplites* s.s. and *Subarcthoplites* (Baraboshkin, 1992; Baraboshkin and Mikhailova, 2005). Both subgenera are known to occur from the Lower Albian (*Leymeriella tardefurcata* Zone), and in general, *Subarcthoplites* occurs in slightly younger strata than *Arcthoplites* s.s. (e.g., Baraboshkin, 1996, 2004). In this paper I report a new specimen of *Arcthoplites* from the Yezo Group of northern Hokkaido (Fig. 1), that represents the first reliable hoplitid ammonite from Japan located at middle latitudes of the Cretaceous Northwest Pacific. This finding indicates the existence of a "cooling" episode in the Albian North Pacific.

2. Geological settings

The Yezo Group is represented by a thick clastic sedimentary sequence, about 8000 m in total thickness, deposited in the Aptian–Paleocene fore-arc basin of the East Asian active margin that extended from southern Hokkaido to Sakhalin Island (Far East Russia) (e.g., Okada, 1983; Takashima et al., 2004). The Upper Cretaceous part of the Yezo Group contains abundant macro- and microfossils at various horizons (e.g., Matsumoto, 1942, 1943; Toshimitsu et al., 1995; Takashima et al., 2004; Shigeta and Maeda, 2005) and is a reference marine Cretaceous succession in the circum-North Pacific regions. In contrast to the Upper Cretaceous part, the Lower Cretaceous part of the Yezo Group is extremely scarce in macrofossils.

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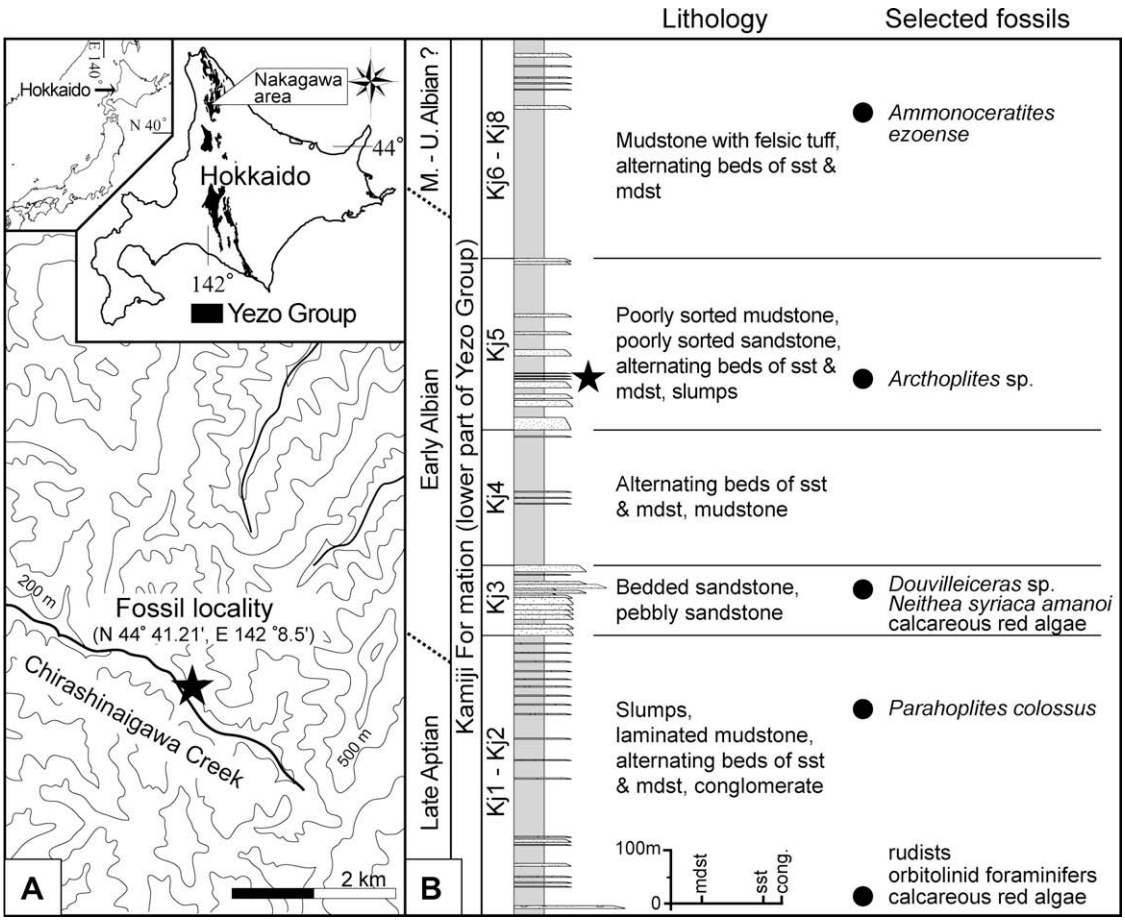

Fig. 1. Locality (A) and horizon (B) of the *Arcthoplites* specimen examined (indicated by stars). The columnar section is mainly based on fieldwork and observations of the exposure along the Chirashinaigawa Creek.

The Yezo Group in the Nakagawa area, northern Hokkaido is subdivided into nine formations; the Kamiji, Mehoro, Shirataki, Sakotandake, Sakugawa, Saku, Nishichirashinai, Omagari, Osoushinai formations in ascending order (Kawaguchi, 1997; Takahashi et al., 2003). The Kamiji Formation stratigraphically represents the lowest of the Yezo Group in this area. The formation consists mainly of mudstone and alternating beds of sandstone and mudstone, and is subdivided into eight members (Kj1 to Kj8 in ascending order) by Hashimoto et al. (1967) (Fig. 1). Representative fossils of Tethyan biota (e.g., rudists, *Orbitolina* (*Mesorbitolina*) *parva* and calcareous red algae) are abundant in the limestone clasts of the conglomeratic beds of the Kj1 Member. They indicate Late Aptian age (Iba and Sano, 2006, 2007). A Late Aptian ammonite *Parahoplites colossus* was reported from the Kj2 Member (Matsumoto, 1984). Iba and Sano (2007) reported an Early Albian ammonite, *Douvilleiceras* sp., calcareous red algae, and *Neithea syriaca amanoi* (a Tethyan non-rudist bivalve *sensu* Dhondt, 1992) from the Kj3 Member. In addition, an Albian ammonite *Ammonoceratites ezoense* was recorded from the Kj7 Member (Hayakawa, 1999). This species is common in the Lower–Middle Albian of the Yezo Group (Hayakawa, 1999). The horizons of these selected fossils are shown in Fig. 1B.

3. Occurrence of *Arcthoplites* from the Kamiji Formation in northern Hokkaido

A single specimen of the hoplitid ammonite *Arcthoplites* was recovered from mudstone of the Kj5 Member of the Kamiji Formation in the Nakagawa area, northern Hokkaido, at the exposure along the Chirashinaigawa Creek (Figs. 1 and 2), together with an assemblage consisting of other ammonites (i.e., *Brewericeras*?, *Tetragonites*, and *Cleoniceras*?), a belemnitid *Neohibolites*, and inoceramid bivalves. The Kj5 Member is more than 200 m thick in this section and consists of poorly sorted massive mudstone and alternating beds of sandstone and mudstone. Sandstone beds represent fine-grained turbidite facies. In this member, ammonites are very rare and embedded with their lateral sides parallel to the bedding plane. Upper flanks of ammonites are often dissolved away and/or deformed during diagenesis, but no fragmentation of shells was observed. These observations indicate that ammonite shells were not transported over a long-distance after death of animals.

Previous works have shown that *Arcthoplites* is restricted in occurrence to the Lower Albian (Baraboshkin, 1996, 2004; Casey, 1999). It seems likely that the Kj5 Member might also be attributed to the Early Albian. This assumption agrees with the proposed age of overlying and underlying strata (see above). The specimen of *Arcthoplites* is reposited in the University Museum, University of Tokyo (UMUT).

4. Systematic paleontology

Superfamily: Hoplitoidea H. Douvillé, 1890.
Family: Hoplitidae H. Douvillé, 1890.
Subfamily: Gastroplitinae Wright, 1952.
Genus: *Arcthoplites* Spath, 1925.
Subgenus: *Subarcthoplites* Casey, 1954.
Arcthoplites (*Subarcthoplites*) sp.