A new species of *Admete* (Gastropoda: Cancellariidae: Admetinae) from the Paleocene of eastern Hokkaido, northern Japan

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ABSTRACT

A new cancellariid species, *Admete katsuhiraensis* new species is described from the Paleocene Katsuhira Formation in Urahoro Town, eastern Hokkaido, Japan. This is the oldest record of cancellariid gastropods in Japan and also the oldest record of the genus *Admete* and the subfamily Admetinae worldwide. Although the known fossil record of the genus is very incomplete, occurrence of Paleocene Admetinae in deep sea deposits of the Katsuhira Formation in northern Japan provides an interesting insight into the timing of origin of the present day cold water molluscan fauna in the northern Hemisphere.

INTRODUCTION

Cancellariids consist of a diverse group of mostly warm-water mollusks. Biodiversity estimates for Cancellariidae include 1200 fossil and 300 recent species (Hemmen, 2007), and 124 genera and 1864 recent and fossil species, according to Petit and Harasewych (2005). The oldest geological records of the family date from the Late Cretaceous (Cenomanian) of Texas and the family reached its maximum diversity in the Eocene and Miocene (Stephensen, 1952; Taylor and Morris, 1988; Hemmen, 2007). No Cretaceous cancellariids have been recorded from Japan (see Hayami and Kase, 1977; Kase, 2001). The oldest species from Japan are *Cancellaria*? sp. indet. a, b, c, d from the upper Eocene Kyuragi and Kijima Formations and the lower Oligocene Yamaga Formation in northern Kyushu (Nagao, 1928). However, columellar folding, one of the distinct characteristics of cancellariids, has not been recognized on those Eocene species from Kyushu. These Paleogene species from Kyushu were reexamined by Oyama et al. (1960), and *C.*? sp. indet. a, b from the upper Oligocene Yamaga Formation were reassigned to *Trigonostoma*? (*Scalptia*?) sp. No Paleogene cancellariids have been recorded in Sakhalin, while several cancellariid species have been described and illustrated from the Paleogene deposits of western Kamchatka (Gladenkov et al., 1991).

Specimens of a small cancellariid have been recently collected from the Paleocene (Danian–Selandian) Katsuhira Formation (see Amano and Jenkins, 2014) in eastern Hokkaido. In this paper, we describe these as a new species and discuss its biogeographic significance.

MATERIALS AND METHODS

Two specimens of cancellariid gastropods were collected from dark gray mudstone of the upper part of Katsuhira Formation at the cliff along Urahoro River near Katsuhira, Urahoro Town, eastern Hokkaido (Figure 1). The age of the formation was assigned to the Paleocene (Danian–Selandian), based on the planktonic foraminifera and calcareous nannofossils (Kiminami et al., 1978; Kaiho, 1984; see also Amano and Jenkins, 2014).

Cancellariid specimens from this locality are associated with protobranch bivalves such as *Acila*, *Leionucula*, *Malletia*, and deep-sea arcid *Bentharca steffeni* Amano, Jenkins and Nishida, 2015. Although paleoenvironments of the Katsuhira Formation have not been studied in detail, these bivalves indicate deposition in deep water (Amano and Jenkins, 2014; Amano and Oleinik, 2014; Amano et al., 2015). One institutional acronym used is: JUE, Joetsu University of Education, Joetsu, Niigata Prefecture.

SYSTEMATIC PALEONTOLOGY

Class Gastropoda Cuvier, 1797
Order Neogastropoda Wenz, 1938
Superfamily Cancellarioidea Forbes and Hanley, 1851
Family Cancellariidae Forbes and Hanley, 1851
Subfamily Admetinae Troschel, 1865

Remarks: Admetinae is characterized by thin shell and columella with arched and weak columellar folds (Wilson, 1994). Recent molecular phylogeny work reveals that this subfamily, as it is now understood, is polyphyletic (Modica et al., 2011). The genus *Admetula*

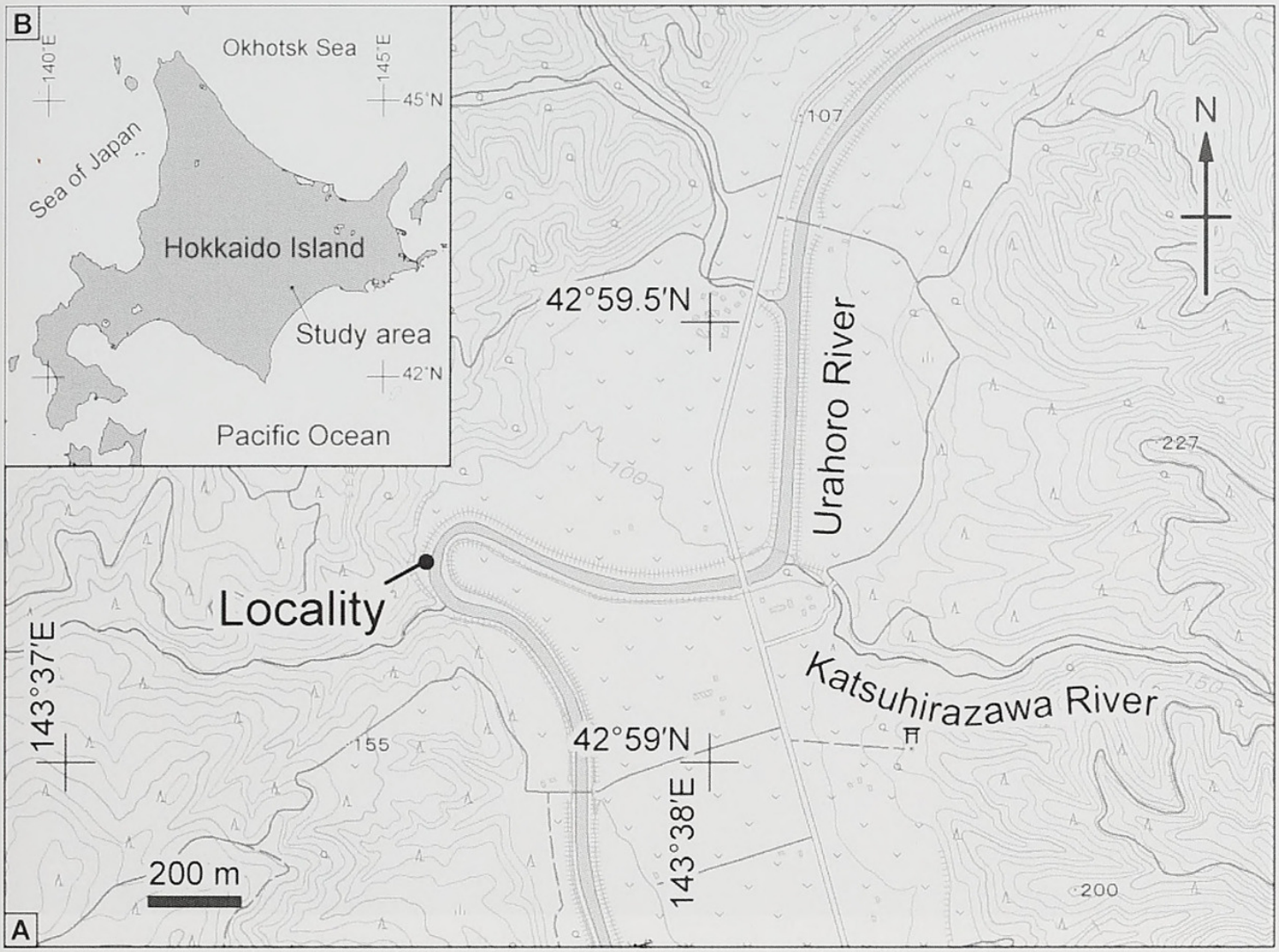


Figure 1. Locality map of *Admete katsuhiraensis* new species. (Base map is from "Katsuhira", scale 1: 25,000; topographical map published by the Geospatial Information Authority of Japan).

Cossmann, 1899 is considered as a separate from Admetinae clade. This classification was used by Harzhauser and Landau (2012) when they revised the Neogene cancellariids of the Paratethys. They also treated *Bonellitia* Jousseaume, 1887 as the *Admetula* clade, despite of lack of molecular data.

Genus *Admete* Krøyer in Möller, 1842

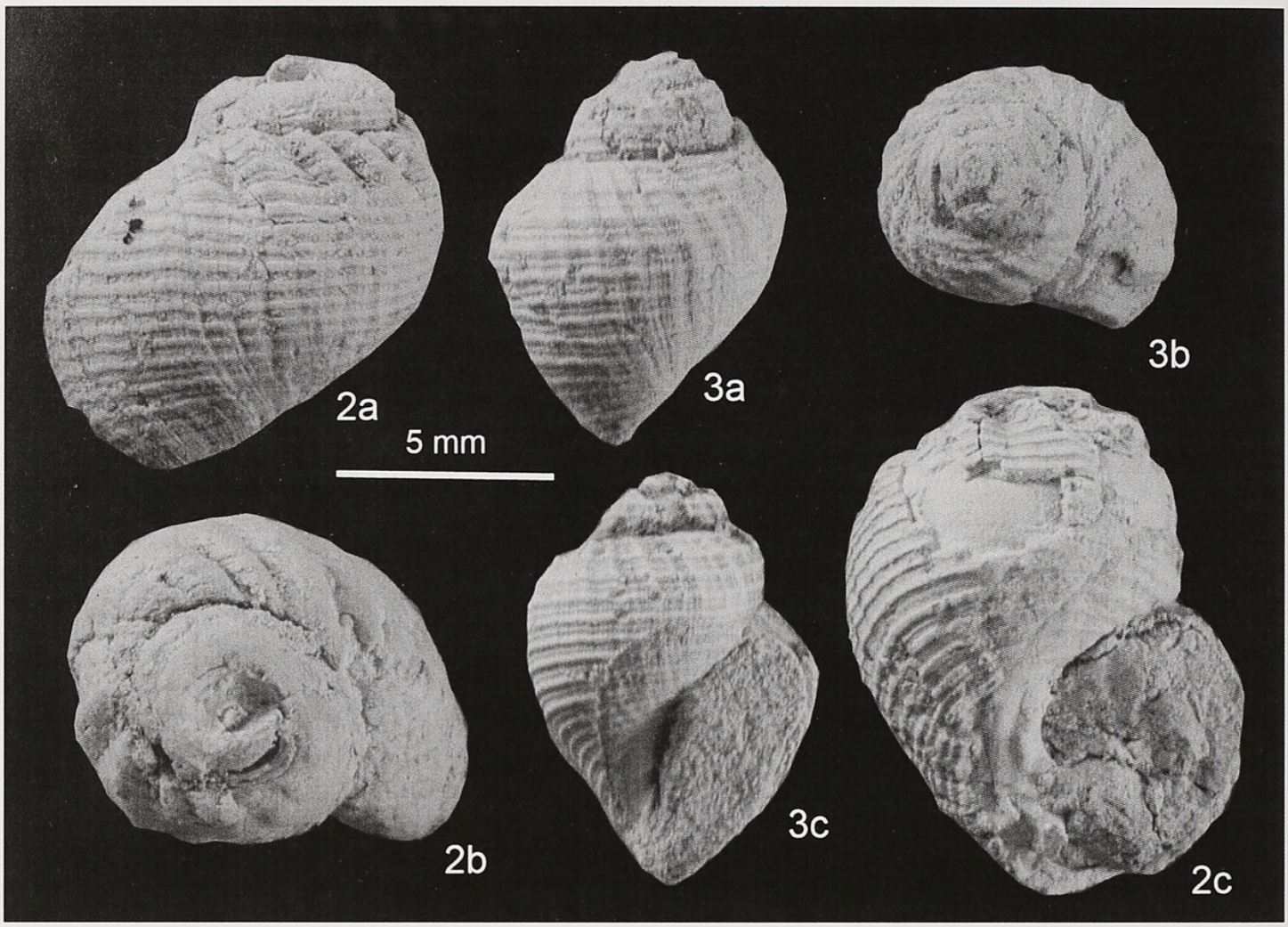
Type Species: *Admete crispa* Möller, 1842 (= *Tritonium viridulum* Fabricius, 1780) by monotypy.

Remarks: The genus *Admete* is characterized by a rather thin shell with large last whorl, deep sutural groove, narrow shoulder and by having a straight collumella with two weak folds and narrow umbilicus or slit (Harasewych and Petit, 1986: 86; this study). *Neadmete* Habe, 1961 can be separated from the genus *Admete* by having a higher spire and rather straight collumella with three folds. *Zeadmete* Finlay, 1926 differs from *Admete* by a fine cancellate sculpture on entire surface. Genera *Admetula* and *Bonellitia* have a thick crenulated outer lip, three strong columellar folds and lack umbilicus or slit. The American Cretaceous genus *Admetopsis* Meek, 1873 including *Admete*? *gregaria* Meek, 1873, *A.*? *subfusiformis* and *A.*? *rhomboides* Meek, 1873 can be clearly separated from *Admete* by having rounded whorls without shoulder, a significantly higher spire, an anteriorly thickened calcareous callus, by weaker or absent of collumellar folds, and lack of an umbilicus or slit. It is presently not clear if *Admetopsis* belongs to Admetinae or not. Another American Cretaceous genus *Paladmete* Gardner, 1916 can be easily distinguished from *Admete* by having a smooth collumella without folds. Stephenson (1941) established family Paladmetidae based on this genus.

Admete katsuhiraensis new species

(Japanese vernacular name: Katsuhira-koromogai)
(Figures 2, 3)

Diagnosis: Shell small with cancellate sculpture consisting of 15 to 21 spiral cords and 19 to 23 axial ribs.



Figures 2, 3. *Admete katsuhiraensis* new species. **2**. Paratype, JUE no. 15940; **2a**, adapertural view; **2b**, apical view; **2c**, apertural view. **3.** Holotype, JUE no. 15939; **3a**, apical view, **3b**, adapertural view; **3c**, apertural view.

Four whorls with rather deep sutural groove; spire low, 1/8 of shell height. Columella nearly straight with two weak folds; inner lip broadly covered by thin calcareous callus; siphonal canal short with very weak fasciole and very narrow umbilical slit.

Description: Shell small, attaining 11.4 mm in height, thin, fusiform, with four whorls. Sutural groove rather deep; very narrow shoulder present in holotype. Last whorl large, occupying approximately 7/8 of the height of shell; spire very low; protoconch poorly preserved, half of smooth volution remaining. Surface of last whorl sculptured by 19 to 23 rounded axial ribs that become obsolete toward base, separated by equal or narrower interspaces, more distinct near suture. Spiral sculpture of last whorl consisting of 15 to 21 flat cords sometimes with one weak cord in between. Sculpture of penultimate whorl consisting of 20 fine axial ribs and five spiral cords in holotype. Outer lip thin and not crenulated; columella nearly straight with two weak folds; inner lip broadly covered by thin calcareous callus; siphonal canal short with very weak fasciole and very narrow umbilical slit recognized in paratype specimen.

Type Material: Holotype, JUE no. 15939 (Shell height, 8.0 mm; Diameter, 6.0 mm); Paratype, JUE no. 15940 (Shell height, 11.4 mm; Diameter, 9.9 mm)

Type Locality: The cliff along Urahoro River at 750 m downstream from the mouth of Katsuhirazawa River, Urahoro Town, eastern Hokkaido. Danian to Selandian Katsuhira Formation.

Remarks: *Admete viridula* (Fabricius, 1780) is the only species of *Admete* recorded from the upper Miocene to Pleistocene deposits in Japan as *A. couthouyi* (Jay, 1839) (Amano, 1983; Baba, 1990). According to Sneli and Stockland (1986), the latter name is a junior synonym of *A. viridula*. This species differs from *A. katsuhiraensis* new species by its larger size (more than 20 mm in height), a rounded shoulder, very faint columellar plaits and more strongly curved columella.

Admete katsuhiraensis new species is similar to *Admete profundicola* (Okutani, 1964) which lives at 1500 m depth off Sagami Bay, central Honshu. Both species share small shell size (*A. profundicola*; shell height, 7.8 mm; diameter, 5.0 mm), angulated shoulder,

very narrow umbilicus, two columellar folds and similar number of spiral cords (15 in the last whorl of *A. profundicola*). The new species is different from *A. profundicola* in having a lower spire and more numerous axial ribs (17–19 in the last whorl of *A. profundicola*).

The new species resembles *A. californica* Dall, 1908 (found around 1103 meters in the Gulf of California) by having a similar number of spiral cords and axial ribs (both 20 in the last whorl of *A. californica*). However, the new species can be separated from *A. californica* by having a larger shell (16 mm in height of *A. californica*), lower spire and very narrow umbilical split.

The new species differs from the Miocene *A. kamtschatica* Sinelnikova in Gladenkov and Sinelnikova, 1990 from the Ilyinskaya Formation, western Kamchatka by its smaller size, more compressed shell, with less whorls, a more inflated and larger (7/8 of the total shell height) last whorl, and a deep sutural groove.

Cancellaria globulosa Holzapfel, 1888, from the Cretaceous of western Germany, has a similar outline of shell and two columellar folds. However, it differs from the new species by its thick shell with multiple crenulations inside the outer lip, lack of a deep suture, and lack of an umbilical slit.

Etymology: The new species is named for the location where the type material was collected.

Distribution: Known only from the type locality, Paleocene Katsuhira Formation, Danian to Selandian, Urahoro Town, eastern Hokkaido.

DISCUSSION

The oldest fossil specimens identified as *Admete*? were recorded from the Cretaceous in North America. However, as noted above, these species belong to a distinct genus, *Admetopsis*. *Admete* (*Bonellitia*) *funigera* described by Staadt in Cossmann, 1913 (202–203, pl. 7, figs 212–9), from the Paleocene of France, possesses strong collumella folds, and lack a sutural groove and umbilical slit. These morphologic features suggest that *A. funigera* should be classified as *Bonellitia* as was originally proposed by the author. Kollmann and Peel (1983: 93, fig. 209) described and figured an *Admete* from the Paleocene (Selandian) Sonja Member of the Agatdal Formation in central Nûgssuaq of western Greenland. Schnetler and Petit (2010: 22) reexamined these gastropods and allocated that species to *Eocantharus* Clark, 1938 (family Buccinidae). One more species of *Admete* was recorded from the Paleocene (early Selandian) of Greensand at Sundkrogen, Copenhagen, Denmark. The following species from these deposits were described as *Cancellaria* by von Koenen (1885: 8–12): *C. latesulcata*, *C. conoidea*, *C. tricarinata*, and *C. curta*; Ravn (1939) placed them in "*Admete*?." However, the former three species were later allocated respectively to *Admetula*, *Kroisbachia* and *Brocchinia* by Schnetler (2001). Although that author eliminated the question mark from *A.*? *curta*, it is difficult to decide whether to allocate it to *Admete* because of its very small shell size (3.7 mm; Ravn, 1939: 86, pl. 3, figs 20a, b) and relatively large protoconch, indicative of a juvenile individual. The genera *Kroisbachia*, *Brocchinia*, *Admetula*, and *Unitas* are known from the lower Paleocene (Luzanovka beds) of Ukraine (Makarenko, 1976). *Bonellitia* (*Admetula*) *paucivaricata* (Gabb, 1864) was illustrated from the Paleocene (Danian) Getkilninskaya Formation by Gladenkov et al. (1997: pl. 33, fig. 33). *Admete ornata* Ilyina, 1955 was described from the Paleogene of the Ústiurt region (vicinity of the Aral Sea) (Ilyina, 1955: 78, pl. 30, fig. 16). However, that species has strong axial ribs and lack sutural groove which is not characteristic of the genus *Admete*. Although the family Cancellariidae is present in the Paleocene deposits of Europe, Greenland and Kamchatka, no proven records of the subfamily Admetinae are known to date from Paleogene deposits anywhere in the world. Thus, *Admete katsuhiraensis* new species from the Danian to Selandian Katsuhira Formation is not only the oldest record of cancellariid in Japan, but also constitutes the oldest record of the genus *Admete* and the subfamily Admetinae.

The genus *Admete* Krøyer in Möller, 1842, today is restricted to cold waters and considered to be an Arcto-Boreal taxon (Kantor and Sysoev, 2006; Thorson, 1944; Macpherson, 1971; Golikov and Scarlato, 1977; Golikov, 1995; Golikov and Sirenko, 1998, 2004; Gulbin, 2004). Occurrences of the genus *Admete* in the Southern Hemisphere and subantarctic waters (Powell, 1951, 1958; Knudsen, 1964) have yet to be investigated. Some of these have been already reassigned to different genera, the taxonomic status of other species have to be adjusted after the study of soft parts morphology. Arctic and Antarctic mollusks are well known for the convergence in shell morphology, which makes their identification based on the shell morphology alone uncertain at best.

Paleocene marine isotopic records do not indicate a significant departure in sea-surface temperature values from the Late Cretaceous and do not indicate the existence of a significant thermocline (Bralower et al., 2002; Dutton et al., 2005), but there are some indications of warm global temperatures (Adatte et al., 2002) during the early Paleocene. These paleoceanographic conditions, coupled with continuous extended shallow shelf around the rim of the North Pacific, facilitated the dispersal of molluscan faunas, which resulted in general similarity between the northeastern and northwestern Pacific Paleocene molluscan faunas. The majority of faunas appears to be of warm to warm-temperate affinities (Oleinik, 2001), lacking cold-water taxa found in the North Pacific today. Fauna of the Katsuhira Formation, which was previously virtually unknown, shows a departure from this general pattern in having a very high degree of endemism and the appearance of new genera, such as the buccinid *Urahorosphaera* (Amano and Oleinik, 2014), new species such as the aporrhaid, *Kangillioptera inouei* (Amano and Jenkins, 2014), or the first appearance of the modern day cold water genus *Admete* described herein. Since there are no true Paleocene *Admete* species or even

subfamily Admetinae records anywhere in the northern hemisphere, the occurrence of *Admete katsuhiraensis* new species has interesting implications on the history of the formation of cold water molluscan faunas known today in the Arctic and boreal regions. As noted above, the lithology and faunal assemblage of the Katsuhira Formation, from which *Admete katsuhiraensis* new species was found, are indicative of relatively deep water deposits. That not only makes this locality unique among the North Pacific shallow-marine Paleocene deposits, but also may suggest a deep water origin of some modern day Arcto-Boreal taxa in the early part of the Paleogene in the North Pacific.

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