Paleontological Research

Papers in Press

"Papers in Press" includes peer-reviewed, accepted manuscripts of research articles, reviews, and short notes to be published in Paleontological Research. They have not yet been copy edited and/or formatted in the publication style of *Paleontological Research*. As soon as they are printed, they will be removed from this website. Please note they can be cited using the year of online publication and the DOI, as follows:

Shigeta, Y. and Isukura, M. 2021: Discovery of the heteromorph ammonoid *Amapondella amapondense* in the middle Campanian of Hokkaido, Japan. *Paleontological Research*, doi:10.2517/2021PR008.

Discovery of the heteromorph ammonoid *Amapondella amapondense* in the middle Campanian of Hokkaido, Japan

YASUNARI SHIGETA[1] and MASATAKA IZUKURA[2]

[1]*Department of Geology and Paleontology, National Museum of Nature and Science, 4-1-1 Amakubo, Tsukuba, Ibaraki 305-0005, Japan (e-mail: shigeta@kahaku.go.jp)*

[2]*N28 E21-1-3, Higashi-ku, Sapporo, Hokkaido 065-0028, Japan*

Abstract. The discovery of the heteromorph ammonoid *Amapondella amapondense* (van Hoepen) in the lower middle Campanian in the Urakawa, Biratori and Hidaka areas of Hokkaido, northern Japan, represents the first report of this taxon in the Northwest Pacific region. Because the species flourished in other regions during Santonian to early Campanian time, its final geographic occurrence in Hokkaido suggests that global environmental changes likely had a significant influence on ammonoid biogeography during early middle Campanian time.

Keywords: *Amapondella*, ammonoid, biogeography, Campanian, Cretaceous,

Hokkaido

Introduction

The shell of the monospecific Cretaceous heteromorph ammonoid genus *Amapondella* Klinger and Kennedy, 1997 (type species *Heteroceras amapondense* van Hoepen, 1921) is characterized by its tightly coiled helical phragmocone, which forms a low helix and a body chamber that curves upward until it reaches or slightly exceeds the height of the apex of the helical whorls (Klinger and Kennedy, 2003). The genus was first proposed as a subgenus of the genus *Eubostrychoceras* Matsumoto, 1967, but then was treated as an independent genus (e.g. Klinger *et al.*, 2007). Specimens assigned to the genus are known from the Santonian of Europe, the Middle East, southern Africa, Madagascar, southern USA, Pacific Coast of Canada and the lower Campanian offshore deposits of Madagascar and south of KwaZulu-Natal, southern Africa (Klinger and Kennedy, 2003; Haggart and Graham, 2018).

Coauthor Masataka Izukura recently discovered two specimens referable to *Amapondella amapondense* in the lower middle Campanian in the Biratori and Hidaka areas, south-central Hokkaido, northern Japan (Figure 1). The late Hide Kubota

collected two specimens referable to this species from the lower middle Campanian in the Urakawa area, southern central Hokkaido and the specimens were subsequently donated to the Hobetsu Museum (Mukawa, Hokkaido) by his wife Katsuko Kubota. We herein describe these four specimens and discuss their biogeographical significance.

Notes on stratigraphy

The Upper Cretaceous Chinomigawa Formation of the Yezo Group, which is composed mainly of sandy mudstone and mudstone with sandstone, is widely distributed in the Urakawa area (Matsumoto, 1942; Kanie, 1966; Sakai and Kanie, 1986; Kanie and Sakai, 2002; Shigeta *et al*., 2016), and sporadic outcrops occur in the Niikappu–Biratori–Hidaka areas of south-central Hokkaido (Shigeta *et al*., 2019). These sporadic outcrops were originally described as the Hakobuchi Group in Yoshida *et al*. (1959) and Takahashi and Suzuki (1978, 1986).

The Chinomigawa Formation in the Urakawa area was divided into four members (U2–U5, Sakai and Kanie, 1986), and the lower two members (U2 and U3) are well exposed along the southern coast of Ikantai, 3 km west–northwest of Urakawa (Matsumoto and Kanie, 1982; Wada *et al*., 1992). Member U2 contains *Sphenoceramus*

orientalis (Sokolov, 1914) in the upper part and Member U3 includes *S. schmidti* (Michael, 1899). Both fossils are index inoceramids of early middle Campanian time in the Northwest Pacific region, an age assignment confirmed by both magnetostratigraphy and zircon geochronology (e.g. Kodama, 1990; Shigeta and Tsutsumi, 2018). Outcrops of the portion of the formation yielding *S. orientalis* and *S. schmidti* are exposed in a narrow area in the middle course of the Soushubetsu River in the Biratori area (Yoshida *et al*., 1959) and are widely distributed in the upper course of the Pankeushappu River in the Hidaka area (Takahashi and Suzuki, 1986).

The four *Amapondella amapondense* specimens of the present study were collected from the Chinomigawa Formation in the following areas: two specimens from float calcareous concretions found along the southern coast of Ikantai in the Urakawa area together with *Sphenoceramus orientalis*, one specimen from an exposure along the middle course of the Soushubetsu River in the Biratori area that also contained the early middle Campanian ammonoid *Urakawaites* sp. and one specimen from a float calcareous concretion found in the upper course of the Pankeushappu River in the Hidaka area together with *S. orientalis*.

Paleontological description

Systematic descriptions follow the classification established by Wright *et al*. (1996). Morphological terms in the systematic description are those used in Arkell (1957).

Institution abbreviations.—HMG, Hobetsu Museum, Mukawa.

Suborder Ancyloceratina Wiedmann, 1966

Superfamily Turrilitoidea Gill, 1871

Family Nostoceratidae Hyatt, 1894

Genus ***Amapondella*** Klinger and Kennedy, 1997

Type species.—*Heteroceras amapondense* van Hoepen, 1921.

Remarks.—*Amapondella* was first proposed as a subgenus of *Eubostrychoceras* by Klinger and Kennedy (1997), but Klinger *et al*. (2007) later elevated the taxon to an independent genus. We herein follow the interpretation of Klinger *et al*. (2007).

Amapondella amapondense (van Hoepen, 1921)

Figures 2–4

Heteroceras amapondense van Hoepen, 1921, p. 17, pl. 4, figs. 1, 2.

Eubostrychoceras (*Amapondella*) *amapondense* (van Hoepen). Klinger and Kennedy, 2003, p. 235, figs. 5, 6, 7A, 8A–D, 9A–C (with synonymy).

Amapondella amapondense (van Hoepen). Klinger *et al*., 2007, p. 101, figs. 5A–C, 10I–J, 11, 12B–I, 13A–E, M (with synonymy); Schaffert and Larson, 2021, p. 31, figs. 43–49.

Amapondella cf. *amapondense* (van Hoepen). Haggart and Graham, 2018, fig. 5.

Type.—The holotype, figured by van Hoepen (1921, p. 17, pl. 4, figs. 1, 2), from the upper Santonian or lower Campanian of the Mzamba Formation at the Mzamba River Estuary, Pondoland, Eastern Cape Province, South Africa, is curated in Ditsong Museum of Natural History, Pretoria.

Material examined.—HMG-2014 was extracted from a calcareous concretion found in the middle course of the Soushubetsu River (42°39′17.85″N, 142°25′12.44″E), in the Biratori area. HMG-2015 was extracted from a float calcareous concretion found 5.25 km upriver from the mouth of the Pankeushappu River (42°54′52.05″N, 142°25′15.17″E), a branch of the Saru River, in the Hidaka area. HMG-2016 and

HMG-2017 were extracted from float calcareous concretions found along the southern coast of Ikantai in the Urakawa area.

Description.—HMG-2014 (Figure 2A–F), consisting of almost half of 60 mm diameter helical phragmocone. Earliest whorls, less than about 5 mm in diameter, not preserved. Preserved initial three whorls (about 30 mm in diameter) helically and tightly coiled dextrally, forming apical angle of approximately 95°. As shell grows, apical angle becomes lower, 112° on the fourth whorl (about 60 mm in diameter). Whorl cross section nearly circular. Shell surface ornamented with dense, regularly spaced, normal ribs and strong, highly elevated, flared ribs occurring between every 2–3 normal ribs. Ribs slightly oblique, narrowly raised with slightly concave interspaces, and symmetrical in cross section with respect to adoral direction.

HMG-2016 (Figure 2G–I), consisting of a fragment of a phragmocone and a part of the body chamber. Coiling helical and dextral, forming low apical angle with whorls touching. Whorl cross section nearly circular. Shell surface ornamented with dense, regularly spaced, normal ribs and flared ribs occurring every 5–6 normal ribs. Ribs slightly oblique, narrowly raised with slightly concave interspaces, and symmetrical in cross section with respect to adoral direction.

HMG-2015 (Figure 3), consisting of a phragmocone with a diameter of about 60

mm and a fragment of body chamber with length of about 300°. Early whorls, less than about 15 mm in diameter, not preserved. Middle whorls (phragmocone), 15–60 mm in diameter, helically and tightly coiled dextrally, forming low apical angle of approximately 150°. Body chamber gradually grows downward and is located below in contact with the previous whorls. Whorl cross section nearly circular. Shell surface ornamented with dense, regularly spaced, normal ribs and flared ribs occurring between every 4–5 normal ribs. Ribs slightly oblique on phragmocone and early part of body chamber, but rursiradiate on lower whorl face on the remaining body chamber, narrowly raised with slightly concave interspaces, and symmetrical in cross section with respect to adoral direction.

HMG-2017 (Figure 4), consisting of a phragmocone with a diameter of 68 mm and a part of the body chamber with length of about 210°. Early whorls, less than about 15 mm in diameter, not preserved. Middle whorls (phragmocone), 15–68 mm in diameter, helically and tightly coiled dextrally, forming low apical angle of approximately 150°. Because the body chamber is broken at 90° from last septum, the ensuring part not in contact with the previous whorls. Whorl cross section nearly circular. Shell surface ornamented with dense, regularly spaced, normal ribs and flared ribs occurring every 3–7 ribs. Ribs slightly oblique, narrowly raised with slightly

concave interspaces, and symmetrical in cross section with respect to adoral direction.

Remarks.—Klinger and Kennedy (2003, Figs. 6, 7A) illustrated a complete specimen of *Amapondella amapondense* from the lower Campanian of South Africa. The body chamber of their specimen, which begins at about 60 mm in diameter, is about 440° long and ends with the aperture facing upward. The body chambers of HMG-2015 and HMG-2017 begin at about 60 mm and 68 mm in diameter, but their lengths are about 300° and 210° respectively, suggesting that the last third and half of their respective body chambers are not preserved.

Occurrence.—Santonian of Europe (France, Austria), the Middle East (Israel), southern Africa, Madagascar, southern USA (Mississippi) and Canadian Pacific Coast (British Columbia), lower Campanian of Madagascar and South Africa, and lower middle Campanian (*Sphenoceramus orientalis* Zone) of Hokkaido.

Discussion

It is plausibly assumed that *Amapondella amapondense* evolved from the early Coniacian taxon *Eubostrychoceras auriculatum* (Collignon, 1965) of Madagascar (Klinger and Kennedy, 1997), and then during Santonian time, extended its distribution

to the Canadian Pacific Coast (British Columbia), southern USA, Europe, the Middle East, southern Africa and Madagascar (e.g. Klinger, 1976; Summesberger, 1979, 1980; Lewy, 1983; Kennedy and Cobban,1991; Kennedy *et al*., 1995; Haggart and Graham, 2018; Figure 5). However, by early Campanian time, its distribution had decreased to just southern Africa and Madagascar (Collignon, 1969; Klinger, 1976; Klinger *et al*., 2007; Figure 5), and then by the early middle Campanian, it had completely disappeared from the middle southern latitudes, leaving only the Hokkaido occurrence of the present study (Figure 5).

The Cretaceous Yezo Group in Hokkaido and Sakhalin, Far Eastern Russia yields numerous well-preserved fossils from various horizons (e.g. Matsumoto, 1954; Vereshchagin, 1977). Nevertheless, in spite of extensive search efforts, specimens assignable to *Amapondella amapondense* have not yet been discovered in Santonian to lower Campanian deposits (e.g. Tanabe *et al*., 1977; Toshimitsu, 1988; Okamoto *et al*., 2003; Aiba *et al*., 2017), which strongly suggests that the species did not exist in the Northwest Pacific during this time interval, and most likely extended its geographical distribution from the middle southern latitudes into the Northwest Pacific region during early middle Campanian time.

It is well known that some ammonoid taxa, e.g. *Pseudophyllites* Kossmat, 1895,

Desmophyllites Spath, 1929, *Pachydiscus* Zittel, 1884, *Saghalinites* Wright and Matsumoto, 1954, *Metaplacenticeras* Spath, 1926 and *Didymoceras* Hyatt, 1894 probably originated in other regions and extended their geographical distribution to the Northwest Pacific region during late middle Campanian time (Shigeta, 1992; Shigeta *et al*., 2019). In contrast, some ammonoid species, e.g. *Tetragonites popetensis* Yabe, 1903 are widely distributed in the Upper Cretaceous successions in this particular region (e.g. Shigeta, 1989; Maeda *et al*., 2005). As Shigeta *et al.* (2016) earlier pointed out, the resultant late middle Campanian ammonoid faunas of the Northwest Pacific region may have been supplemented by the addition of "foreign taxa" that migrated from other regions into the existing indigenous ammonoid population.

Amapondella amapondense was probably one of these "foreign taxa" in the Northwest Pacific region during early middle Campanian time. Although the reason for the extinction of *A. amapondense* in other regions and its subsequent migration to the Northwest Pacific region are unknown, the final geographic occurrence of the species in Hokkaido suggests that global environmental changes likely had a significant influence on ammonoid biogeography during early middle Campanian time as well as late middle Campanian time.

A similar fluctuating pattern of geographical distribution is also known for the

Albian–Cenomanian ammonoid *Tanabeceras* Shigeta *et al*., 2012 of the family Gaudryceratidae Spath, 1927, which was widely distributed in California and the Mediterranean area during early to middle Albian time, but disappeared from both areas, and late Albian to Cenomanian members are known only from Hokkaido and Sakhalin (Shigeta *et al*., 2012). Iba and Sano (2007, 2008) discussed the existence of a vicariance event which separated the North Pacific region from the Tethyan biotic realm during Albian time, and then Shigeta *et al*. (2012) stated that this Albian vicariance event and related chain episodes may have influenced the evolution of *Tanabeceras*.

It is unclear what type of global environmental changes affected ammonoid biogeography during middle Campanian time, but the changing pattern of geographical distribution for various ammonoid taxa may provide an important key for understanding the global environmental changes that occurred during middle Campanian time.

Acknowledgements

We thank Akihiro Misaki (Kitakyushu Museum of Natural History and Human History, Kitakyushu), Herbert Klinger (Iziko South African Museum, Cape Town) and Kazushige Tanabe (University Museum, The University of Tokyo) for valuable

comments on the first draft. We are grateful to Katsuko Kubota (Sapporo, Hokkaido) for donating the specimens and providing locality information. Thanks are extended to Jim Jenks (West Jordan, Utah) for his helpful suggestions and improvement of the English text. This study was financially supported by the National Museum of Nature and Science project, Chemical Stratigraphy and Dating as a Clue for Understanding the History of the Earth and Life.

References

Aiba, D., Yamato, H., Kurihara, K. and Karasawa, T., 2017: A new species of *Eubostrychoceras* (Ammonoidea, Nostoceratidae) from the lower Campanian in the northwestern Pacific realm. *Paleontological Research*, vol. 21, p. 255–264.

Arkell, W. J., 1957: Introduction to Mesozoic Ammonoidea. *In*, Arkell, W. J., Furnish, W. M., Kummel, B., Miller, A. K., Moore, R. C., Schindewolf, O. H., Sylvester-Bradley, P. C. and Wright, C. W. *eds*., *Treatise on Invertebrate Paleontology*, *Part L*, *Mollusca 4*, *Cephalopoda*, *Ammonoidea*, p. L81–129. Geological Society of America, New York and University of Kansas Press, Lawrence.

Collignon, M., 1965: *Atlas des fossiles caractéristiques de Madagascar (Ammonites). Fascicle XIII (Coniacien)*, 88 p. Service Geologique, Tananarive.

Collignon, M., 1969: *Atlas des fossiles caractéristiques de Madagascar (Ammonites). Fascicle XV (Campanien inférieur)*, 216 p. Service Geologique, Tananarive.

Gill, T., 1871: Arrangement of the families of mollusks. *Smithsonian Miscellaneous Collections*, vol. 227, p. 1–49.

Haggart, J. W. and Graham, R., 2018: The crinoid *Marsupites* in the Upper Cretaceous Nanaimo Group, British Columbia: Resolution of the Santonian–Campanian boundary in the North Pacific Province. *Cretaceous Research*, vol. 87, p. 277–295.

Hoepen, E. C. N. van, 1921: Cretaceous Cephalopoda from Pondoland. *Annals of the Transvaal Museum*, vol. 8, p. 1–48.

Hyatt, A., 1894: Phylogeny of an acquired characteristic. *Proceedings of the American Philosophical Society*, vol. 32, p. 349–647.

Iba, Y. and Sano, S., 2007: Mid-Cretaceous step-wise demise of the carbonate platform biota in the Northwest Pacific and establishment of the North Pacific biotic province. *Palaeogeography*, *Palaeoclimatology*, *Palaeoecology*, vol. 245, p. 462–482.

Iba, Y. and Sano, S., 2008: Paleobiogeography of the pectinid bivalve *Neithea*, and its pattern of step-wise demise in the Albian Northwest Pacific. *Palaeogeography, Palaeoclimatology, Palaeoecology*, vol. 267, p. 138–146.

Kanie, Y., 1966: The Cretaceous deposits in the Urakawa district, Hokkaido. *Journal of the Geological Society of Japan*, vol. 72, p. 315–328. (*in Japanese with English abstract*)

Kanie, Y. and Sakai A., 2002: *Geology of the Urakawa District*, *Scale 1:50,000*, 43 p. Geological Survey of Japan, Tsukuba. (*in Japanese with English abstract)*

Kennedy, W. J., Bilotte, M. and Melchior, P., 1995: Ammonite faunas, biostratigraphy and sequence stratigraphy of the Coniacian–Santonian of the Corbières (NE Pyrènèes). *Bulletin du Centre de Recherches Elf Exploration Production*, vol. 19, p. 377–499.

Kennedy, W. J. and Cobban, W. A., 1991: Upper Cretaceous (Upper Santonian) *Boehmoceras* fauna from the Gulf Coast region of the United States. *Geological Magazine*, vol. 128, p. 167–189.

Klinger, H. C., 1976: Cretaceous heteromorph ammonites from Zululand. *Geological Survey of South Africa Memoir*, no. 69, p. 1–142.

Klinger, H. C. and Kennedy, W. J., 1997: On the affinities of *Madagascarites*

andimakensis Collognon, 1966, and allied Upper Cretaceous heteromorph ammonites. *Annals of the South African Museum*, vol. 105, p. 227–247.

Klinger, H. C. and Kennedy, W. J., 2003: Cretaceous faunas from Zululand and Natal, South Africa. The ammonite families Nostoceratidae Hyatt, 1894 and Diplomoceratidae Spath, 1926. *Annals of the South African Museum*, vol. 110, p. 219–336.

Klinger, H. C., Kennedy, W. J. and Grulke, W. E., 2007: New and little-known Nostoceratidae and Diplomoceratidae (Cephalopoda: Ammonoidea) from Madagascar. *African Natural History*, vol. 3, p. 89–115.

Kodama, K., 1990: Magnetostratigraphy of the Izumi Group along the Median Tectonic Line in Shikoku and Awaji Islands, Southwest Japan. *Journal of the Geological Society of Japan*, vol. 96, p. 265–278. (*in Japanese with English abstract*)

Kossmat, F., 1895: Untersuchungen über die Südindische Kreideformation. Teil 1. *Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients*, Band 9, p. 97–203.

Lewy, Z., 1983: A well-preserved Upper Santonian heteromorph ammonite from Israel. *Geological Survey of Israel*, *Current Research 1982*, p. 24–27.

Maeda, H., Shigeta, Y., Fernando, A. G. S. and Okada, H., 2005: Stratigraphy and fossil

assemblages of the Upper Cretaceous System in the Makarov area, southern Sakhalin, Russian Far East. *National Science Museum Monographs*, vol. 31, p. 25–120.

Matsumoto [= Matumoto], T., 1942: Fundamentals in the Cretaceous stratigraphy of Japan, Part 1. *Memoirs of the Faculty of Science*, *Kyushu Imperial University*, *Series D*, *Geology*, vol. 1, p. 129–280.

Matsumoto, T., 1954: *The Cretaceous System in the Japanese Islands*, 324 p. Japan Society for the Promotion of Science, Tokyo.

Matsumoto, T., 1967: Evolution of the Nostoceratidae (Cretaceous heteromorph ammonoids). *Memoirs of the Faculty of Science*, *Kyusyu University*, *Series D*, *Geology*, vol. 18, p. 331–347.

Matsumoto, T, and Kanie, Y., 1982: On three Cretaceous keeled ammonites from the Urakawa area, Hokkaido. *Science Report of the Yokosuka City Museum*, no. 29, p. 9–22.

Michael, R., 1899: Üeber Kreidefossilien von der Insel Sachalin. *Jahrbuch der Königlich Preussischen Geologischen Landsanstalt und Bergakademie zu Berlin*, Band. 18, p. 153–164.

Okamoto, T., Matsunaga, T. and Okada, M., 2003: Restudy of the Upper Cretaceous

stratigraphy in the Haboro area, northwestern Hokkaido. *Journal of the Geological Society of Japan*, vol. 109, p. 363–382. (*in Japanese with English abstract*)

Sakai, A. and Kanie, Y., 1986: *Geology of the Nishicha District, Scale 1:50,000*, 92 p. Geological Survey of Japan, Tsukuba. (*in Japanese with English abstract)*

Schaffert, A. and Larson, N., 2021: *The Heteromorph Ammonite Family Nostoceratidae. A Number of Observations and A Systematic Review*, 262 p. The Tethys Ocean Project, Inc., Waterford.

Shigeta, Y., 1989: Systematics of the ammonite genus *Tetragonites* from the Upper Cretaceous of Hokkaido. *Transactions and Proceedings of the Palaeontological Society of Japan*, *New Series*, no. 156, p. 319–342.

Shigeta, Y., 1992: A record of *Pseudophyllites indra* (Lytoceratina, Tetragonitidae) from the Upper Cretaceous of Hokkaido and Sakhalin. *Transactions and Proceedings of the Palaeontological Society of Japan*, *New Series*, no. 166, p. 1157–1163.

Shigeta, Y., Futakami, M. and Hoffmann, R., 2012: Two new ammonoid genera of the subfamily Gabbioceratinae from the Upper Albian (Lower Cretaceous) of Hokkaido, Japan. *Paleontological Research*, vol. 16, p. 208–218.

Shigeta, Y., Izukura, M. and Nishimura, T., 2019: Campanian (Late Cretaceous)

ammonoids and inoceramids from the Ribira River area, Hokkaido, northern Japan. *National Museum of Nature and Science Monographs*, no. 50, p. 1–139.

Shigeta, Y., Izukura, M., Nishimura, T. and Tsutsumi, Y., 2016: Middle and late Campanian (Late Cretaceous) ammonoids from the Urakawa area, Hokkaido, northern Japan. *Paleontological Research*, vol. 20, p. 322–366.

Shigeta, Y. and Tsutsumi, Y., 2018: U–Pb age of the *Sphenoceramus schmidti* Zone (middle Campanian, Cretaceous) in Hokkaido, northern Japan. *Bulletin of the National Museum of Nature and Science*, *Series C*, vol. 44, p. 13–18.

Smith, A. G., Smith, D. G. and Funnel, B. M., 1994: *Atlas of Mesozoic and Cenozoic Coastlines*, 99 p. Cambridge University Press, Cambridge.

Sokolov, D. V., 1914: Cretaceous *Inoceramus* of Russian Sakhalin. *Trudy Geologicheskogo komityeta*, *Novaya Seriya*, vol. 83, p. 1–95. (*in Russian and German; original title translated*)

Spath, L. F., 1926: On new ammonites from the English Chalk. *Geological Magazine*, vol. 63, p. 77–83.

Spath, L. F., 1927: Revision of the Jurassic cephalopod fauna of Kachh (Cutch), part 1. *Memoirs of the Geological Survey of India*, *Palaeontologia Indica*, *New Series*, vol. 9, memoir 2, p. 1–71.

Spath, L. F., 1929: Corrections of cephalopod nomenclature. *Naturalist*, vol. 871, p. 269–271.

Summesberger, H., 1979: Eine obersantone Ammonitenfauna aus dem Becken von Gosau (Oberösterreich). *Annalen des Naturhistorischen Museums in Wien*, Band 82, p. 109–176.

Summesberger, H., 1980: Neue Ammoniten aus der Sandkalkbank der Hochmoosschichten (Obersanton: Gosau, Österreich). *Annalen des Naturhistorischen Museums in Wien*, Band 83, p. 275–283.

Takahashi, K. and Suzuki, M., 1978: *Explanatory Text of the Geological Map of Japan, Scale 1:50,000 Iwachishi (Sapporo-45)*, 46 p. Geological Survey of Hokkaido, Sapporo. (*in Japanese with English abstract)*

Takahashi, K. and Suzuki, M., 1986: *Explanatory Text of the Geological Map of Japan, Scale 1:50,000 Hidaka (Sapporo-34)*, 44 p. Geological Survey of Hokkaido, Sapporo. (*in Japanese with English abstract)*

Tanabe, K., Hirano, H., Matsumoto, T. and Miyata, Y., 1977: Stratigraphy of the Upper Cretaceous deposits in the Obira area, northwestern Hokkaido. *Science Reports, Department of Geology, Kyushu University*, vol. 12, p. 181–202. (*in Japanese with English abstract*)

Toshimitsu, S., 1988: Biostratigraphy of the Upper Cretaceous Santonian stage in northwestern Hokkaido. *Memoirs of the Faculty of Science*, *Kyushu University*, *Series D*, *Geology*, vol. 26, p. 125–192.

Vereschagin, V. N., 1977: The Cretaceous System of Far East. *Trudy Vsesoyunogo Nauchno-Issledovatel'skogo Geologicheskogo Instituta (VSEGEI)*, *New Series*, vol. 245, p. 1–207. (*in Russian*; *original title translated*)

Wada, N., Takahashi, K., Watanabe, J. and Kanie, Y., 1992: *Explanatory Text of the Geological Map of Japan, Scale 1:50,000 Mitsuishi (Kushiro-65)*, 73 p. Geological Survey of Hokkaido, Sapporo. (*in Japanese with English abstract)*

Wiedmann, J., 1966: Stammesgeschichte und System der posttriadischen Ammonoideen, ein Überblick (2. Teil). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, Band 127, p. 13–81.

Wright, C. W., Calloman, J. H. and Howarth, M. K., 1996: *Treatise on Invertebrate Paleontology*, *Part L*, *Mollusca 4*, *Revised*, *vol. 4*, *Cretaceous Ammonoidea*, 362 p. Geological Society of America, Boulder and University of Kansas Press, Lawrence.

Wright, C. W. and Matsumoto, T., 1954: Some doubtful Cretaceous ammonites genera from Japan and Saghalien. *Memoirs of the Faculty of Science*, *Kyushu University*,

Series D, *Geology*, vol. 4, p. 107–134.

Yabe, H., 1903: Cretaceous Cephalopoda from the Hokkaido. Part 1: *Lytoceras, Gaudryceras*, and *Tetragonites*. *Journal of the College of Science*, *Imperial University of Tokyo*, vol. 18, p. 1–55.

Yoshida, T., Matsuno, K., Satoh, H. and Yamaguchi, S., 1959: *Explanatory Text of the Geological Map of Japan*, *Scale 1:50,000 Biu (Sapporo-56)*, 55 p. Geological Survey of Hokkaido, Sapporo. (*in Japanese with English abstract)*

Zittel, K. A., 1884: Cephalopoda. *In*, Zittel, K. A. *ed*., *Handbuch der Palaeontologie*, *Band 1*, *Abt. 2*, *Lief 3*, p. 329–522. Oldenbourg, Munich and Leipzig.

Author contributions

M. I. collected fossils and contributed to the geological aspect of the study. Y. S. conduced taxonomic study. Both authors contributed to the writing of the paper.

Figure caption

Figure 1. Index map showing distribution of the Yezo Group (black area) in Hokkaido (**A**) and collection localities of *Amapondella amapondense* specimens in the Hidaka, Biratori and Urakawa areas (indicated by stars, **B, C**).

Figure 2. *Amapondella amapondense* (van Hoepen, 1921). **A–F,** HMG-2014, from outcrop of the Chinomigawa Formation exposed along the middle course of the Soushubetsu River in the Biratori area. A, B, apical views; C, D, lateral views; E, F, basal views; **G–I,** HMG-2016, from a float calcareous concretion found along the southern coast of Ikantai in the Urakawa area; G, apical view; H, basal view; I, lateral view. Arrowheads indicate position of last septum.

Figure 3. *Amapondella amapondense* (van Hoepen, 1921), HMG-2015, from a float calcareous concretion found in the upper course of Pankeushappu River in the Hidaka area. **A, B,** apical views; **C, D,** lateral views; **E, F,** basal views. Arrowheads indicate

position of last septum.

Figure 4. *Amapondella amapondense* (van Hoepen, 1921), HMG-2017, from a float calcareous concretion found along the southern coast of Ikantai in the Urakawa area. **A,** apical views; **B,** oblique apical view rotated 45° from A; **C,** lateral view rotated 90° from A; **D,** basal view; **E,** lateral view rotated 90° from D. Arrowheads indicate position of last septum.

Figure 5. Paleogeographical (**A**) and stratigraphical (**B**) distribution of *Amapondella amapondense* (van Hoepen, 1921) during Santonian to middle Campanian time. Paleomap from Smith *et al*. (1994). 1, British Columbia (Haggart and Graham, 2018); 2, Mississippi (Kennedy and Cobban, 1991); 3, France (Kennedy *et al*., 1995); 4, Austria (e.g. Summesberger, 1979); 5, Israel (Lewy, 1983); 6, South Africa (e.g. Klinger and Kennedy, 2003); 7, Madagascar (e.g. Klinger *et al*., 2007); 8, Hokkaido (this study).

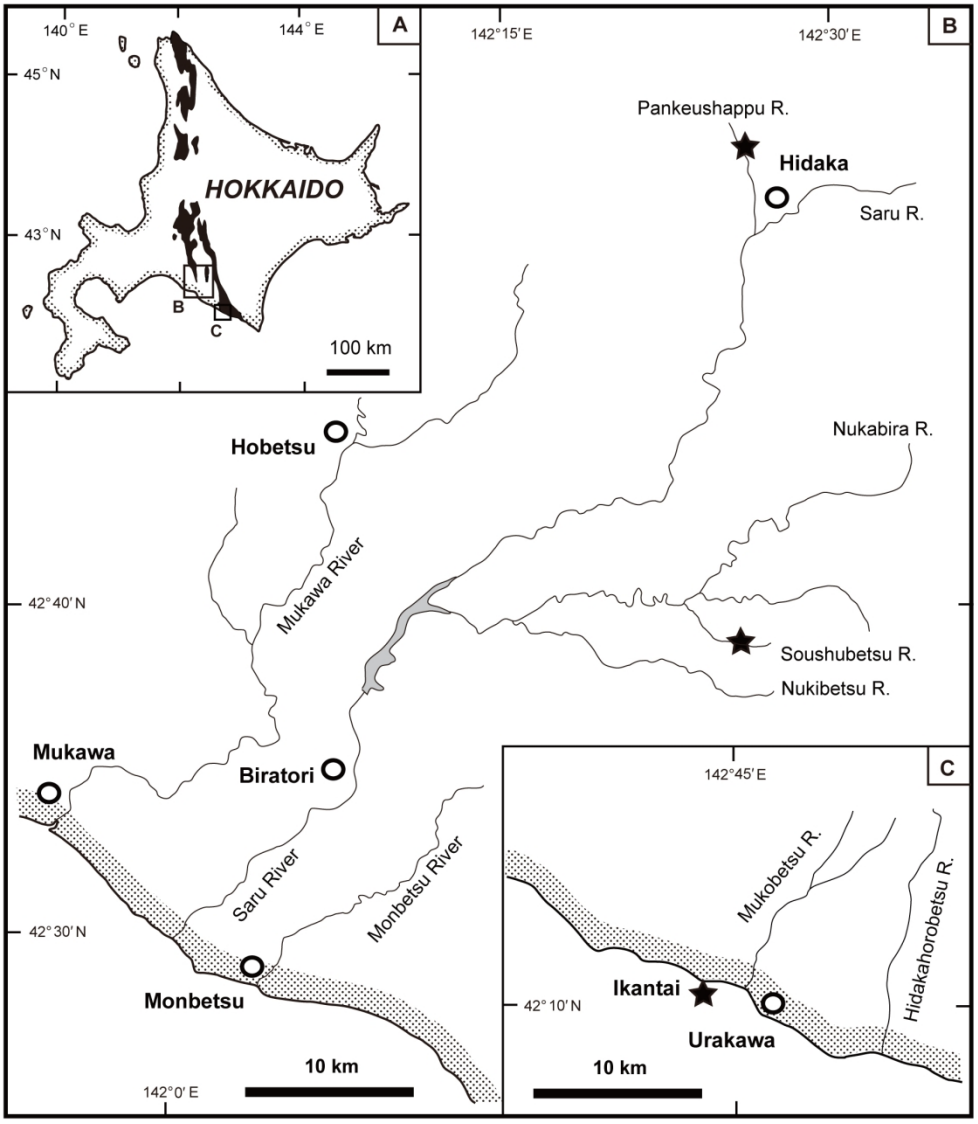


Figure 1. Index map showing distribution of the Yezo Group (black area) in Hokkaido (A) and collection localities of *Amapondella amapondense* specimens in the Hidaka, Biratori and Urakawa areas (indicated by stars, B, C).

165x187mm (300 x 300 DPI)

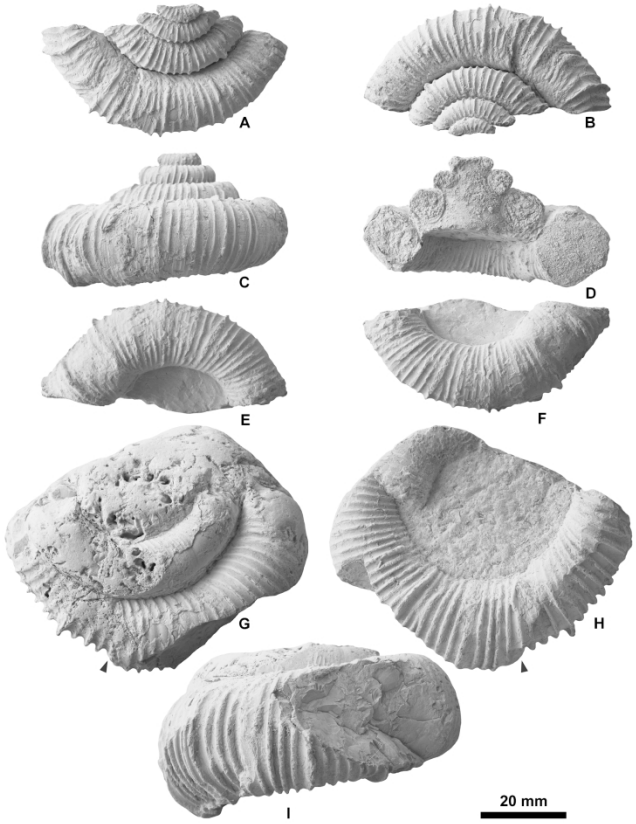


Figure 2. *Amapondella amapondense* (van Hoepen, 1921). A–F, HMG-2014, from outcrop of the Chinomigawa Formation exposed along the middle course of the Soushubetsu River in the Biratori area. A, B, apical views; C, D, lateral views; E, F, basal views; G–I, HMG-2016, from a float calcareous concretion found along the southern coast of Ikantai in the Urakawa area; G, apical view; H, basal view; I, lateral view. Arrowheads indicate position of last septum.

214x279mm (300 x 300 DPI)

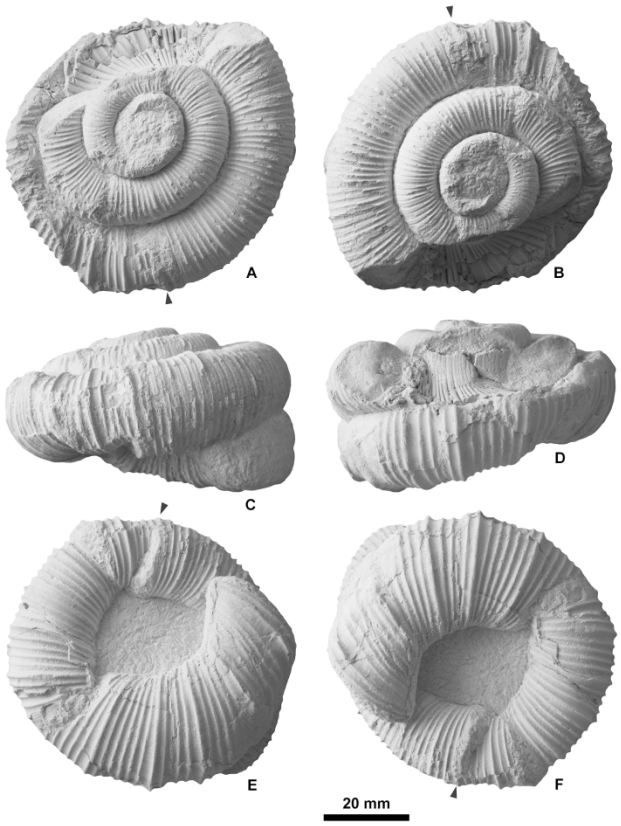


Figure 3. *Amapondella amapondense* (van Hoepen, 1921), HMG-2015, from a float calcareous concretion found in the upper course of Pankeushappu River in the Hidaka area. A, B, apical views; C, D, lateral views; E, F, basal views. Arrowheads indicate position of last septum.

214x279mm (300 x 300 DPI)

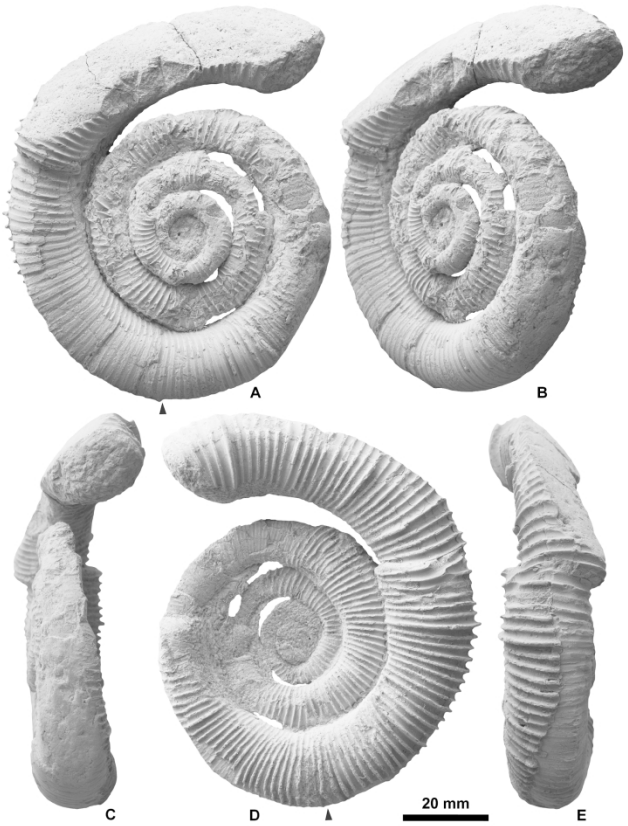
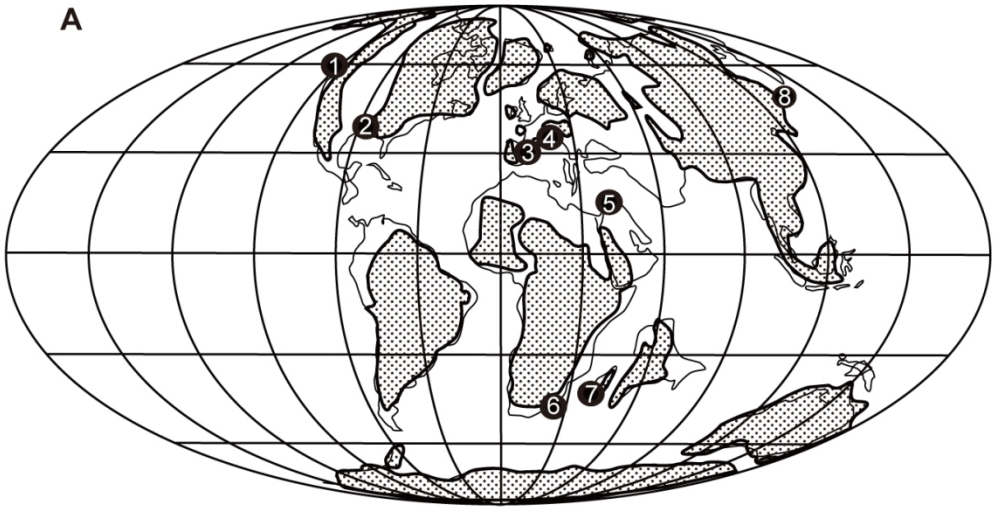


Figure 4. *Amapondella amapondense* (van Hoepen, 1921), HMG-2017, from a float calcareous concretion found along the southern coast of Ikantai in the Urakawa area. A, apical views; B, oblique apical view rotated 45° from A; C, lateral view rotated 90° from A; D, basal view; E, lateral view rotated 90° from D. Arrowheads indicate position of last septum.

214x279mm (300 x 300 DPI)



B

		1	2	3	4	5	6	7	8
Campanian	late								
	middle								●
	early						●	●	
Santonian		●	●	●	●	●	●	●	

Figure 5. Paleogeographical (A) and stratigraphical (B) distribution of *Amapondella amapondense* (van Hoepen, 1921) during Santonian to middle Campanian time. Paleomap from Smith et al. (1994). 1, British Columbia (Haggart and Graham, 2018); 2, Mississippi (Kennedy and Cobban, 1991); 3, France (Kennedy et al., 1995); 4, Austria (e.g. Summesberger, 1979); 5, Israel (Lewy, 1983); 6, South Africa (e.g. Klinger and Kennedy, 2003); 7, Madagascar (e.g. Klinger et al., 2007); 8, Hokkaido (this study).

115x94mm (300 x 300 DPI)