

Original Article

Additional specimens of *Pravitoceras sigmoidale* Yabe from the upper Campanian (Upper Cretaceous) of Hokkaido, Japan

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Abstract. *Pravitoceras sigmoidale* Yabe, a heteromorph ammonoid of late Campanian (Late Cretaceous) age, occurs abundantly in the Izumi Group of Southwest Japan, but until now only one specimen had been reported from the Yezo Group in the Hidaka area, Hokkaido, northern Japan. We herein report two newly discovered specimens referable to this species that were collected from float concretions in a small tributary of the Pankeushappu River in the Hidaka area. One specimen consists of a nearly complete phragmocone and the rear part of the body chamber, while the other consists of part of a phragmocone outer whorl and two-thirds of the S-shaped body chamber. The shells are 1.25 times larger than the original Hidaka specimen, but they fit well within the size variation for specimens documented from Southwest Japan.

Key words: ammonoid, Cretaceous, Hidaka, Hokkaido, late Campanian, *Pravitoceras sigmoidale*
(Received 31 October 2017)

Introduction

Pravitoceras sigmoidale Yabe, 1902, a late Campanian nostoceratid ammonite, exhibits a unique shell morphology consisting of a nearly planispiral phragmocone and subsequent S-shaped body chamber that forms a retroversal hook. Because of the taxon's abundance in the Izumi Group on Awaji Island and in the Naruto area, it had long been regarded as an endemic species restricted to Southwest Japan. But then Matsunaga *et al.* (2008)'s discovery of a specimen assignable to *P. sigmoidale* from the Yezo Group in the Hidaka area, Hokkaido, northern Japan demonstrated that this species was distributed in a relatively wide area of the northwestern Pacific realm during the late Campanian. As *P. sigmoidale* is a short-ranging species, its discovery played an important part in the precise biostratigraphic correlation between the Izumi and Yezo groups.

In 2005 and 2011, M. Izukura collected two specimens referable to *Pravitoceras sigmoidale* from float concretions in a small tributary of the Pankeushappu River in the Hidaka area, about 4.5 km northwest of outcrop locality (Sr60) on the right bank

of the Saru River where Matsunaga *et al.* (2008) found the single *P. sigmoidale* specimen (MCM.A1040) (Figure 1). Because *P. sigmoidale* is rare in Hokkaido, we herein document these newly discovered specimens and discuss their biostratigraphic implications for the upper Campanian of Hokkaido.

Notes on stratigraphy

Even through the Upper Cretaceous strata in the Pankeushappu River area are complexly folded and faulted, Takahashi and Suzuki (1986) divided the rocks based on lithostratigraphy into the underlying Upper Yezo Group and overlying Hakobuchi Group. Their lithology correlates well with that in the Urakawa area, situated 80 km southeast of Hidaka, where the stratigraphy has been well studied by numerous workers (Matsumoto, 1942; Kanie, 1966; Sakai and Kanie, 1986; Kanie and Sakai, 2002; Shigeta *et al.*, 2016). For the purpose of this paper, we prefer to use the Urakawa Formation rather than the Upper Yezo Group and the Chinomigawa Formation instead of the Hakobuchi Group.

The Urakawa Formation consists primarily of

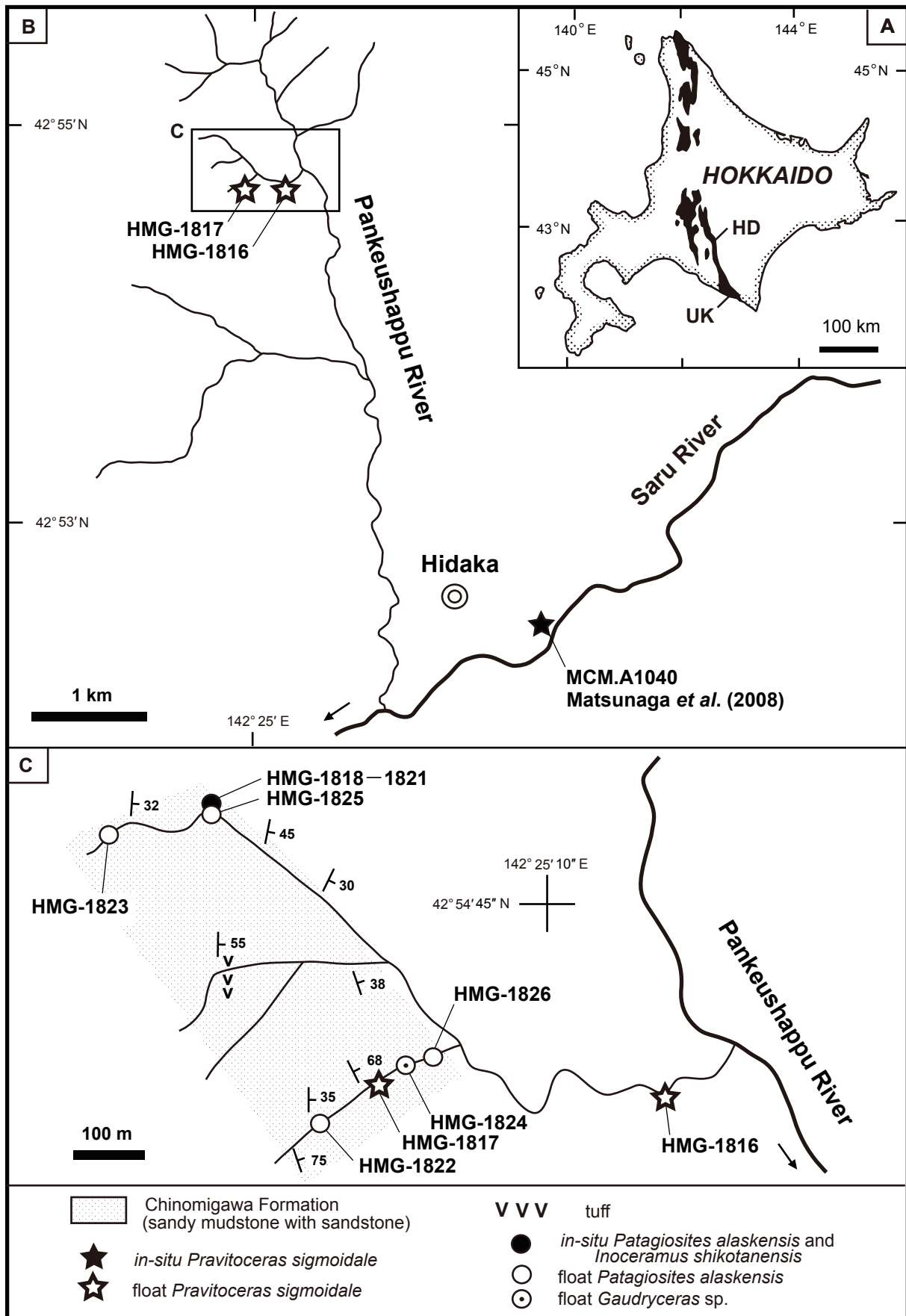


Figure 1. Index map showing distribution of the Yezo Group (black areas) in Hokkaido (A), collection localities of *Pravitoceras sigmoidale* Yabe, 1902 specimens in the Hidaka area (B) and geological map along a small tributary of the Pankeushappu River in the Hidaka area (C). HD, Hidaka; UK, Urakawa.



Figure 2. Late Campanian ammonoids from float concretions found in a small tributary of the Pankeushappu River of the Hidaka area, Hokkaido (white circles in Figure 1C). **A–D**, *Patagiosites alaskensis* Jones, 1963; **A, B**, HMG-1825; **C, D**, HMG-1826.



Figure 3. Late Campanian ammonoids from float concretions found in a small tributary of the Pankeushappu River in the Hidaka area, Hokkaido (white circles in Figure 1C). A–H, *Patagiosites alaskensis* Jones, 1963; A–D, HMG-1822; E–H, HMG-1823; I–K, *Gaudryceras* sp., HMG-1824.

mudstone while the overlying Chinomigawa Formation is composed mainly of sandy mudstone with sandstone. The early middle Campanian index inoceramid *Sphenoceras schmidtii* (Michael, 1899) is abundant in the Chinomigawa Formation in the upper reaches of the Pankeushappu River (Takahashi and Suzuki, 1986).

The two specimens of *Pravitoceras sigmoidale* reported herein were collected from float concretions found in a small tributary of the Pankeushappu River, where the Chinomigawa Formation is widely

distributed (Figure 1). Although float concretions with late Campanian ammonoids (Figures 2–4) are numerous, *in-situ* concretions containing age-diagnostic ammonoids or inoceramids are extremely rare. We collected only one *in-situ* concretion from the area, and it contained a late Campanian ammonoid *Patagiosites alaskensis* Jones, 1963 and an inoceramid bivalve *Inoceramus shikotanensis* Nagao and Matsumoto, 1940 (Figure 4).

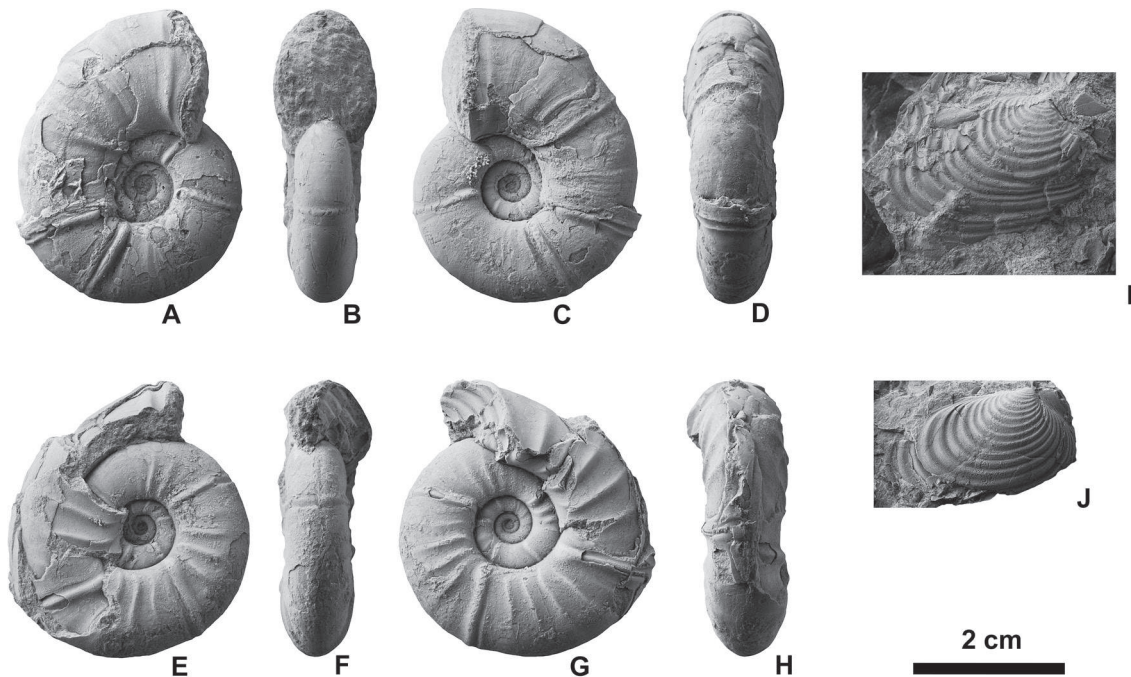


Figure 4. Late Campanian ammonoids and inoceramid bivalves from an *in-situ* concretion found in bank along a small tributary of the Pankeushappu River in the Hidaka area, Hokkaido (solid black circle in Figure 1C). **A–H**, *Patagiosites alaskensis* Jones, 1963; A–D, HMG-1818; E–H, HMG-1819; **I, J**, *Inoceramus shikotanensis* Nagao and Matsumoto, 1940; I, HMG-1820; J, HMG-1821.

Paleontological description

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

Institution abbreviations.—HMG = Hobetsu Museum, Mukawa; MCM = Mikasa City Museum; UMUT = University Museum, University of Tokyo.

Suborder Ancyloceratina Wiedmann, 1966

Superfamily Turrilitoidea Gill, 1871

Family Nostoceratidae Hyatt, 1894

Genus *Pravitoceras* Yabe, 1902

Type species.—*Pravitoceras sigmoidale* Yabe, 1902.

Pravitoceras sigmoidale Yabe, 1902

Figures 5, 6

Pravitoceras sigmoidale Yabe, 1902, p. 3, pl. 1, figs. 2–4; Yabe, 1915, p. 19, pl. 2, figs. 1–4, pl. 3, fig. 1; Matsumoto *et al.*, 1981, p. 169, pl. 22, fig. 1, pl. 23, figs. 1, 2, pl. 24, figs. 1–3, pl. 25, figs. 1, 2, pl. 26, fig. 1, text-figs. 1, 3; Morozumi, 1985, p. 42, pl. 18, figs. 1, 2; Matsunaga *et al.*, 2008, p. 313, figs. 2, 4, 5; Misaki *et al.*, 2014, figs. 2, 6, 9, 10; Yoshino and Matsuoka, 2016, figs. 5A–H, 7A–C, 8.

Lectotype.—UMUT MM7479, figured by Yabe (1902, p. 3, pl. 1, fig. 3), from the Izumi Group near Minato along the western coast of Awaji Island, here designated as a lectotype. Specimen is an internal mold of a planispiral phragmocone.

Material.—HMG-1816 (42°54'36.66"N, 142°25'20.44"E) and HMG-1817 (42°54'35.29"N, 142°24'57.12"E) were extracted from float concretions found in a small tributary of the Pankeushappu River in the Hidaka area, Hokkaido (Figure 1).

Description.—HMG-1817 consists of a nearly complete phragmocone and rear part of the body chamber. The longer diameter (vertical length in Figure 5A) is about 175 mm. Early whorls are partly preserved and show tight, helical and dextral coiling with a nearly circular whorl section (Figure 6A). Succeeding phragmocone is nearly planispiral and very evolute with circular whorl section. Whorl is slightly in contact with previous whorl, but there is no overlap. Body chamber initially follows the coiling of the phragmocone for a half whorl, then separates tangentially from the coiling part. Shell surface is ornamented with numerous rectiradiate ribs with ventrolateral tubercles which appear on every third to fifth rib.

HMG-1816 consists of a part of the outer whorl of a phragmocone and two-thirds of the S-shaped



Figure 5. *Pravitoceras sigmoidale* Yabe, 1902 from float concretions found in a small tributary of the Pankeushappu River in the Hidaka area, Hokkaido (white stars in Figure 1C). **A, B**, HMG-1817; **A**, lateral view; **B**, back view; **C, D**, HMG-1816; **C**, lateral view; **D**, frontal view. Arrow indicates position of last septum.

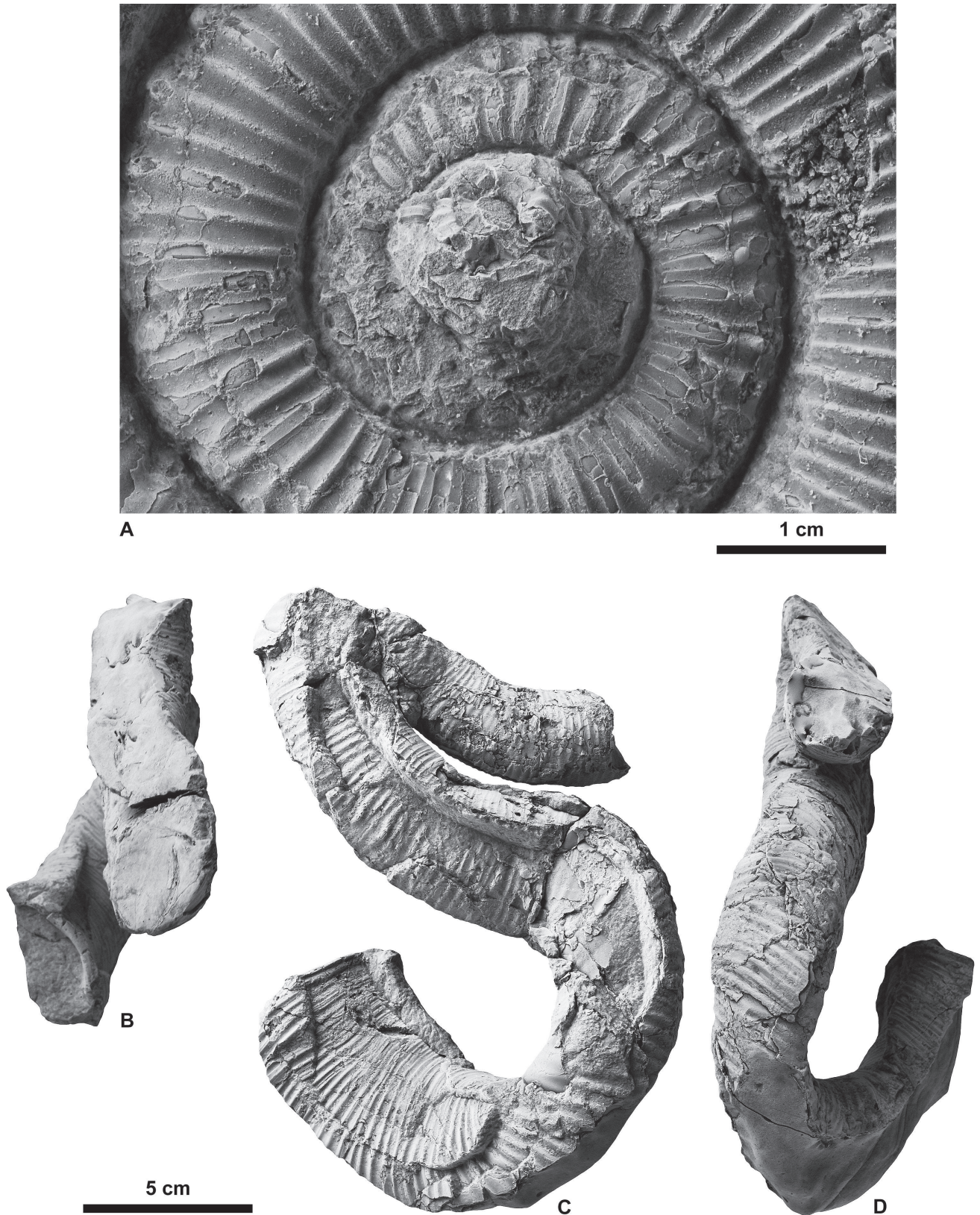


Figure 6. *Parvitoceras sigmoide* Yabe, 1902 from float concretions found in a small tributary of the Pankeushappu River in the Hidaka area, Hokkaido. (white stars in Figure 1C). A, early whorls of HMG-1817; B–D, HMG-1816; B, upper view; C, lateral view; D, back view.

body chamber. Coiling is dextral, but twisted and apparently sinistral. Longer diameter (vertical length in Figure 5C) is about 185 mm. Body chamber lacks the rear part, but it twists in a reverse direction to form a retroversal hook with a U-shape. Rectiradiate ribs become rursiradiate on retroversal hook. Two rows of ventrolateral tubercles shift in accordance with twisting of the shell. Apertural margin thickens.

Remarks.—Shell size of the planispiral part of HMG-1817 and retroversal hook of HMG-1816 are 1.25 times larger than MCM.A1040 from the Saru River (Matsunaga *et al.*, 2008), but they fit well within the size variation of *Pravitoceras sigmoidale* documented by Matsumoto *et al.* (1981) from Southwest Japan.

Misaki *et al.* (2014) reported that specimens of *Pravitoceras sigmoidale* from Awaji Island are frequently encrusted by sessile anomiid bivalves, which are found on both sides and ventral peripheries of the ammonoid shells and then become predominant on the body chamber. No such bivalve encrustation is present on the shells of the Hidaka specimens.

Occurrence.—*Pravitoceras sigmoidale* occurs in the upper Campanian on Awaji Island, the Naruto area in Shikoku, and the Hidaka area in Hokkaido.

Discussion

Various horizons of the Izumi Group of Southwest Japan are well known for their rich late Campanian ammonoid faunas. Indeed, the following four ammonoid zones are recognized, in ascending order: *Didymoceras* sp., *D. awajiense*, *Pravitoceras sigmoidale* and *Pachydiscus awajiensis* (Morozumi, 1985). Although the discovery of *P. sigmoidale* in Hokkaido has resulted in a much more precise biostratigraphic correlation between the Izumi and Yezo groups (Matsunaga *et al.*, 2008), other zonal-index ammonoids, i.e., *D. awajiense* (Yabe, 1901) and *P. awajiensis* Morozumi, 1985, have not yet been found in the Yezo Group.

The Yezo Group exhibits a lateral change of litho- and biofacies, which infers an eastward-deepening setting for the “Yezo Basin” (Matsumoto and Okada, 1971; Tanaka, 1977). Because regressive deltaic facies become predominant in the uppermost part of the Yezo Group, a complete succession of marine fossil

assemblages spanning the Campanian–Maastrichtian is not recorded in the western part of the Yezo Basin (Matsumoto, 1954; Maeda, 1986). In contrast, fossiliferous mudstone and sandy mudstone facies are dominant in the uppermost part of the Cretaceous in the eastern part of the Yezo Basin, and faunal successions are observable toward the top of the sequence (Shigeta *et al.*, 1999; Maeda *et al.*, 2005; Shigeta *et al.*, 2016). Therefore, it is possible that the late Campanian zonal-index ammonoids, *Didymoceras awajiense* and *Pachydiscus awajiensis* will eventually be found in the eastern part of the Yezo Basin.

Recently, Shigeta *et al.* (2016) discovered a continuous succession yielding middle Campanian *Metaplacentoceras subtilistriatum* (Jimbo, 1894) and early late Campanian *Baculites subanceps* Haughton, 1925 together with *Didymoceras hidakense* Shigeta (in Shigeta *et al.*, 2016) in the Chinomigawa Formation in the Urakawa area of Hokkaido. Because *D. hidakense* closely resembles *Didymoceras* sp. of the Izumi Group, the zone containing *D. hidakense* is probably a correlative of the *Didymoceras* sp. Zone (Shigeta *et al.*, 2016). Since upper Campanian strata overlying the *D. hidakense*-containing beds are not known to occur in the area near Urakawa where Shigeta *et al.* (2016) worked because of a synclinal structure, it would be highly unlikely to find a complete succession of late Campanian fossil assemblages in the area.

The discovery of additional specimens of *Pravitoceras sigmoidale* strongly suggests that upper Campanian strata crop out along the Pankeushappu River in the Hidaka area. Although a detailed stratigraphic study of the Yezo Group has not been conducted in this immediate area, it is anticipated that further geological and paleontological work may therefore provide an important key for the establishment a precise biostratigraphic framework for the upper Campanian of Hokkaido.

Acknowledgments

We are very grateful to Tomohiro Nishimura (Hobetsu Museum, Mukawa) for his co-operation in the field. We thank Jim Jenks (West Jordan, Utah) for his helpful suggestions and improvement of the English text.

References

- 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.
- Gill, T., 1871: Arrangement of the families of mollusks. *Smithsonian Miscellaneous Collections*, vol. 227, p. 1–49.
- Haughton, S. H., 1925: Notes on some Cretaceous fossils from Angola (Cephalopoda and Echinoidea). *Annals of the South African Museum*, vol. 22, p. 263–288.
- Hyatt, A., 1894: Phylogeny of an acquired characteristics. *Proceedings of the American Philosophical Society*, vol. 32, p. 349–647.
- Jimbo, K., 1894: Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaido. *Palaeontologische Abhandlungen Neue Folge*, Band 2, p. 1–48.
- Jones, D., 1963: Upper Cretaceous (Campanian and Maastrichtian) ammonites from southern Alaska. *U. S. Geological Survey Professional Paper*, no. 432, p. 1–53.
- 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)
- Maeda, H., 1986: Stratigraphy and fossil molluscan fauna of the Upper Cretaceous System in the Bibai area, Hokkaido, north Japan. *Journal of the Geological Society of Japan*, vol. 92, p. 135–153. (in Japanese with English abstract)
- 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*, no. 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., Morozumi, Y., Bando, Y., Hashimoto, H. and Matsuoka, A., 1981: Note on *Pravitoceras sigmoidale* Yabe (Cretaceous heteromorph ammonite). *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, no. 123, p. 168–178.
- Matsumoto, T. and Okada H., 1971: Clastic sediments of the Cretaceous Yezo Geosyncline. *Memoirs of the Geological Society of Japan*, vol. 6, p. 61–74.
- Matsunaga, T., Maeda, H., Shigeta, Y., Hasegawa, K., Nomura, S., Nishimura, T., Misaki, A. and Tanaka, G., 2008: First discovery of *Pravitoceras sigmoidale* Yabe from the Yezo Supergroup in Hokkaido, Japan. *Paleontological Research*, vol. 12, p. 309–319.
- Michael, R., 1899: Über Kreidefossilien von der Insel Sachalin. *Jahrbuch der Königlich Preussischen Geologischen Landesanstalt und Bergakademie zu Berlin*, Band 18, p. 153–164.
- Misaki, A., Maeda, H., Kumagae, T. and Ichida, M., 2014: Commensal anomiid bivalves on Late Cretaceous heteromorph ammonites from south-west Japan. *Palaeontology*, vol. 57, p. 77–95.
- Morozumi, Y., 1985: Late Cretaceous (Campanian and Maastrichtian) ammonites from Awaji Island, Southwest Japan. *Bulletin of the Osaka Museum of Natural History*, no. 39, p. 1–58.
- Nagao, T. and Matsumoto, T., 1940: A monograph of the Cretaceous *Inoceramus* of Japan, Part 2. *Journal of the Faculty of Science, Hokkaido Imperial University, Series 4, Geology and Mineralogy*, vol. 6, p. 1–64.
- 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)
- 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., Maeda, H., Uemura, K. and Solov'yov, A. V., 1999: Stratigraphy of the Upper Cretaceous System in the Kurl'on Peninsula, South Sakhalin, Russia. *Bulletin of the National Science Museum, Series C*, vol. 25, p. 1–27.
- Takahashi, K. and Suzuki, M., 1986: *Explanatory Text of the Geological Map of Japan, Scale 1:50,000 Hidaka*, 92 p. Geological Survey of Hokkaido, Sapporo (in Japanese with English abstract)
- Tanaka, K., 1977: Cretaceous System. In, Tanaka, K. and Nozawa, T. eds., *Geology and Mineral Resources of Japan*, p. 182–206. Geological Survey of Japan, Kawasaki.
- Wiedmann, J., 1966: Stammesgeschichte und System der posttriadischen Ammonoiten, ein Überblick (2. Teil). *Neues Jahrbuch fuer Geologie und Palaeontologie, Abhandlungen*, Band 127, p. 13–81.
- Wright, C. W., Callomon, J. H. and Howarth, M. K., 1996: *Treatise on Invertebrate Paleontology, Part L, Mollusca 4, Revised, Volume 4: Cretaceous Ammonoidea*, 362 p. Geological Society of America, New York and University of Kansas Press, Lawrence.
- Yabe, H., 1901: Note on three Upper Cretaceous ammonites from Japan, outside of Hokkaido. *Journal of the Geological Society of Tokyo*, vol. 8, p. 1–4.
- Yabe, H., 1902: Note on three Upper Cretaceous ammonites from Japan, outside of Hokkaido (continued). *Journal of the Geological Society of Tokyo*, vol. 9, p. 1–7.
- Yabe, H., 1915: Note on some Cretaceous fossils from Anaga on the island of Awaji and Toyajo in the province of Kii. *Science Report, Tohoku Imperial University, Second Series*, vol. 4, p. 13–24.
- Yoshino, K. and Matsuoka, A., 2016: Mode of occurrence and taphonomy of the heteromorph ammonite *Pravitoceras sigmoidale* Yabe from the Upper Cretaceous Izumi Group, Japan. *Cretaceous Research*, vol. 62, p. 74–85.

Yasunari Shigeta and Masataka Izukura, 2018. Additional specimens of *Pravitoceras sigmoidale* Yabe from the upper Campanian (Upper Cretaceous) of Hokkaido, Japan. *The Bulletin of the Hobetsu Museum*, **33**, 1–10.

重田康成・伊豆倉正隆, 2018. 北海道のカンパニアン階上部（上部白亜系）から産出した *Pravitoceras sigmoidale* Yabe の追加標本. むかわ町穂別博物館研究報告, **33**, 1–10.

(要 旨)

カンパニアン期後期（白亜紀後期）の異常巻きアンモナイト *Pravitoceras sigmoidale* Yabe は、西南日本に分布する和泉層群から多産し、北海道・日高地域に分布する蝦夷層群からも 1 標本の産出が報告されている。本論文では、新たに日高地域のパンケウシャップ川支流から転石として採集された 2 標本を報告する。1 つ目の標本は気房部と住房の後方部よりなり、2 つ目の標本は気房部の一部と後方部を欠くが S 字状の住房部の 2 / 3 部分よりなる。これらの殻サイズは、日高地域から見つかった第一標本よりも 1.25 倍大きい。西南日本で報告されている本種の標本の変異幅の中に入る。