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A new species of *Tanabeceras* (Ammonoidea, Tetragonitidae) from the middle Cenomanian (Upper Cretaceous) of Hokkaido, Japan

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Abstract. ***Tanabeceras nakagawaense* sp. nov. is described from the lower part of the middle Cenomanian (*Cunningtoniceras takahashii* Zone, Upper Cretaceous) in the Nakagawa area, Hokkaido, northern Japan. This new taxon is characterized by having the most compressed shell among all species assigned to *Tanabeceras*, and it also represents the youngest taxon of the genus. The stratigraphic distribution of *Tanabeceras* in Hokkaido suggests that the genus migrated from the Tethyan realm to the Northwest Pacific region during late Albian, evolved and radiated regionally during the late Albian to early middle Cenomanian, and then became extinct during late middle Cenomanian time.**

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Keywords: ammonoid, Cenomanian, Cretaceous, Hokkaido, *Tanabeceras*

Introduction

Tanabeceras Shigeta *et al*., 2012, is a genus belonging to the subfamily Gabbioceratinae Breistroffer, 1953 of the family Tetragonitidae Hyatt, 1900 (Hoffmann, 2015). The comprehensive generic diagnosis is summarized as follows: 1) depressed shell with rounded venter, 2) narrow, deep, funnel-shaped umbilicus with angular or subangular umbilical shoulder, 3) ornamentation with growth lines, fine ribs and constrictions, which are prorsiradiate on inner flank, rectiradiate or slightly rursiradiate on outer flank and exhibiting a concave sinus on the venter, and 4) gaudryceratid type suture line with $ELU_2U_1I_s$ and lateral angulation located in middle of U_2 (Shigeta *et al*., 2012; Hoffmann, 2015).

Tanabeceras probably evolved from *Gabbioceras* Hyatt, 1900 during early Albian time, and subsequently became widely distributed in the Tethyan realm during the early to middle Albian, before eventually disappearing from the realm (Murphy, 1967; Shigeta *et al*., 2012). Late Albian and Cenomanian members of the genus are known only from Hokkaido, northern Japan and Sakhalin, Far Eastern Russia as follows: *T. pombetsuense* Shigeta *et al*. (2012) from the upper Albian, *T. yezoense* (Shigeta, 1996) from the lower Cenomanian (e.g. Yazykova *et al*., 2004; Shigeta and Izukura, 2013), *T. horokanaiense* Shigeta, 2013 from the lower Cenomanian, and *T. mikasaense* (Shigeta, 1996) from the lower Cenomanian.

Our recent examination of specimens assigned to *Gabbioceras yezoense* and *G. mikasaense* by Hayakawa and Nishino (1999, p. 5, pl. 5, figs. a–j) as well as newly collected material from the lower part of the middle Cenomanian in the Nakagawa area, northern Hokkaido, leads us to regard the specimens as a new taxon. We herein describe them as a new species of *Tanabeceras* and discuss the timing of the genus's demise.

Notes on stratigraphy

The Aptian–Campanian Yezo Group in the Nakagawa area is complexly folded and faulted (e.g. Matsumoto, 1942; Osanai *et al*., 1960; Nagao, 1962) and is subdivided into the following ten formations: the Kamiji, Mehoro, Shirataki, Sakotandake, Sakugawa, Saku,

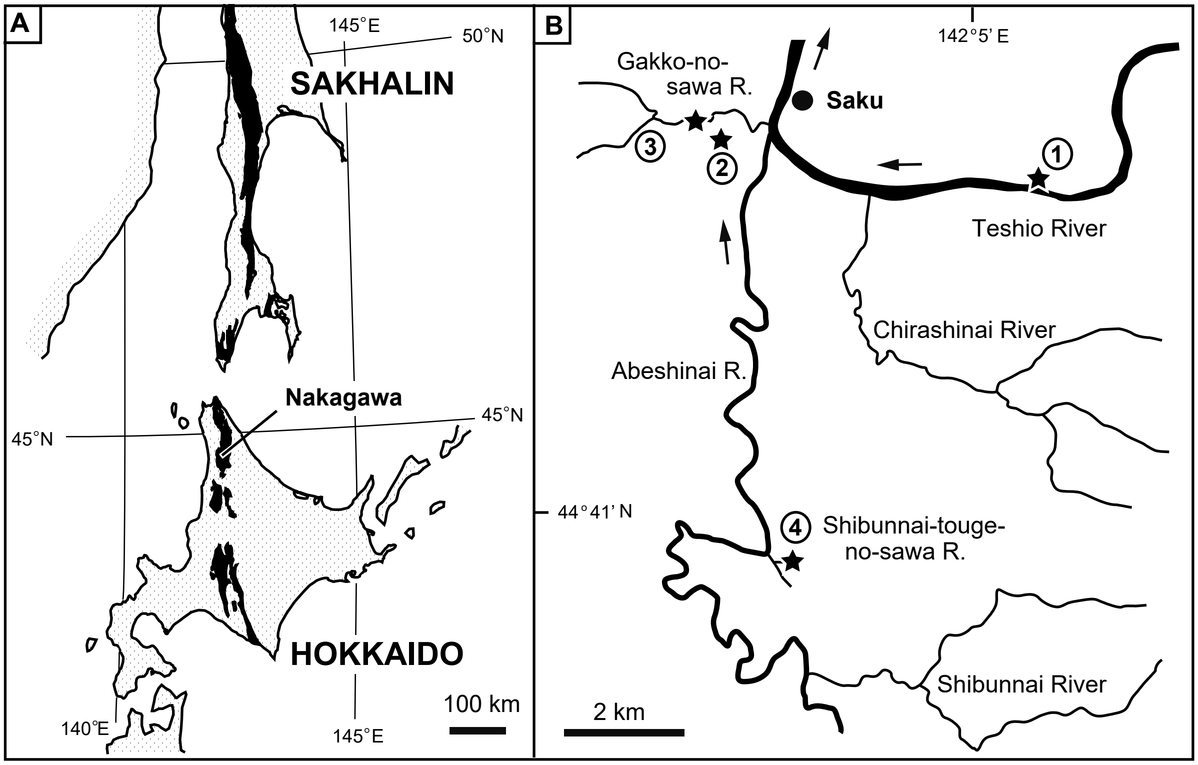

Figure 1. Maps showing distribution of the Cretaceous Yezo Group (black areas) in Hokkaido, Japan and Sakhalin, Russia (**A**), and localities of *Tanabeceras nakagawaense* sp. nov. specimens described (indicated by stars) from the Nakagawa area, Hokkaido (**B**). Locs. 1 and 2 = Locs. T and Y of Hayakawa and Nishino (1999, fig. 1), respectively; Loc. 3 = Loc. T5038 of Matsumoto and Okada (1973, fig. 2).

Nishichirashinai, Omagari, Osoushinai, and Hakobuchi formations in ascending order (Hashimoto *et al*., 1967; Takahashi *et al*., 2003; Taki *et al*., 2011). The 1200 m thick Sakugawa Formation, which occupies the middle part of the Yezo Group, is relatively well exposed along the Teshio River and its tributaries (e.g. Gakko-no-sawa River) and the lower Abeshinai River and its tributaries (Takahashi *et al*., 2003). Consisting mainly of mudstone and sandy mudstone, the Sakugawa Formation contains the lower Cenomanian ammonoids *Stolizikaia japonica* Matsumoto *et al*., 1952 and *Maccarthyites mikasaensis* Matsumoto *et al*., 1991 in Matsumoto, T. (compiled), 1991 in the lower part (Matsumoto *et al*., 2005; Hikida and Nishino, 2017), the middle Cenomanian index ammonoids *Cunningtoniceras takahashii* (Matsumoto, 1975) and *Calycoceras asiaticum* (Jimbo, 1894) in the middle part (Toshimitsu *et al*., 1995; Hayakawa and Nishino, 1999; Matsumoto *et al*., 2005), and the lower Turonian index inoceramid *Inoceramus kamuy* Matsumoto and Asai, 1996 in the upper part (Takahashi *et al*., 2003).

Material and methods

Material

In addition to the single specimen assigned to *Gabbioceras yezoense* (NMA-132 from Loc. 3 in Figure 1B) and the four specimens assigned to *G. mikasaense* (NMA-134–137 from Locs. 1 and 2 in Figure 1B) by Hayakawa and Nishino (1999, p. 5, pl. 5, figs. a–j), 36 newly collected specimens (NMNS PM 45384–45419) referable to *Tanabeceras* were also examined. These new specimens were collected from calcareous concretions in float possibly derived from the *Cunningtoniceras takahashii* Zone of the middle part of the Sakugawa Formation along the first tributary on the right bank of the Shibunnai-touge-no-sawa River (Loc. 4 in Figure 1B).

Methods

All specimens were examined for biometric analysis of shell morphology. A total of 40 specimens was scanned using X-ray computed tomography (inspeXio SMX-225CT FPD HR, Shimadzu) at the National Museum of Nature and Science, Tsukuba with settings of 0.01–0.05 mm resolution, 200–225 kV and 70 μA. Four classic geometric parameters of the shell, i.e., shell diameter (D),

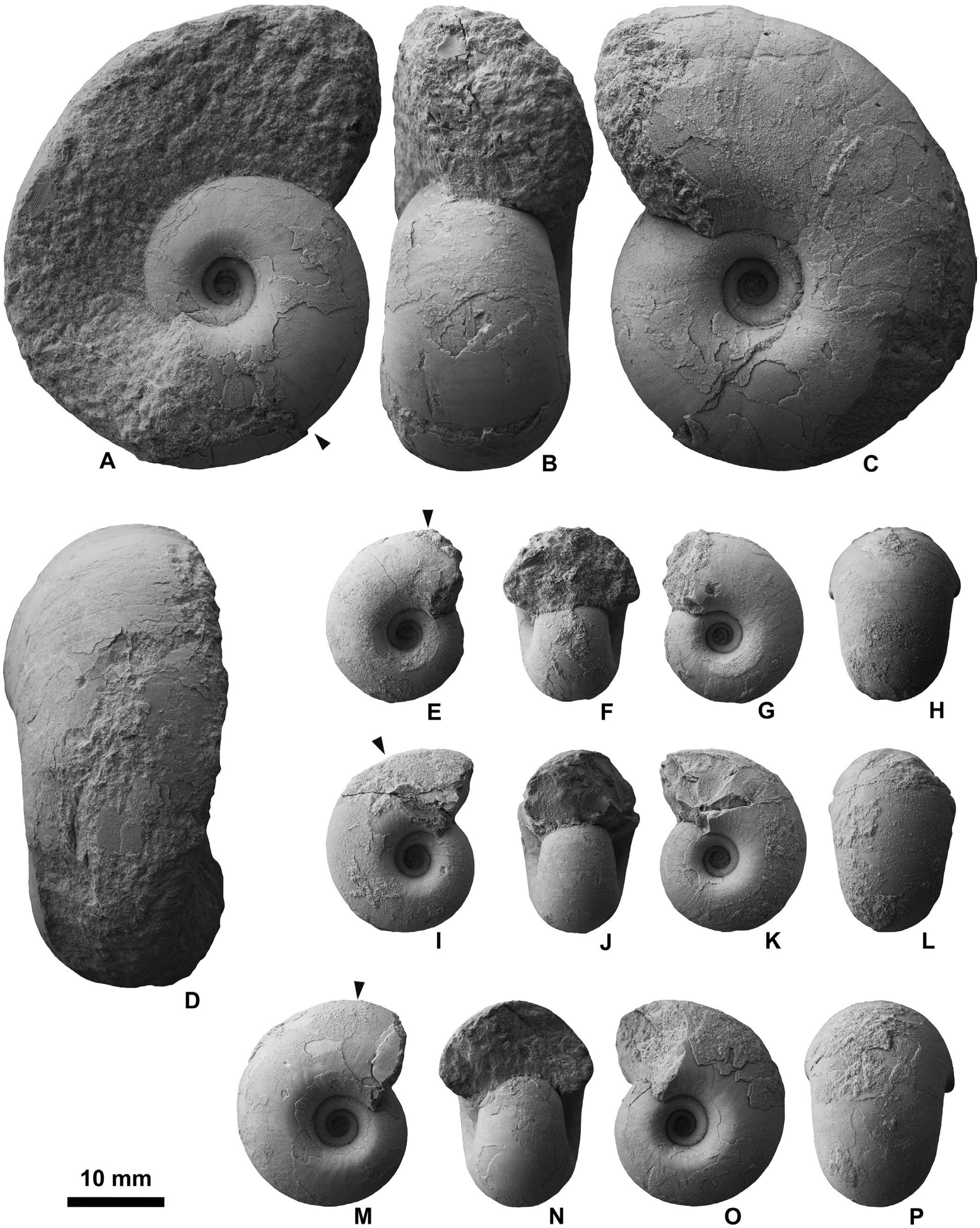

Figure 2. *Tanabeceras nakagawaense* sp. nov. from the Nakagawa area, Hokkaido (Loc. 4 in Figure 1B). **A–D,** NMNS PM 45384 (holotype); **E–H,** NMNS PM 45385 (paratype); **I–L,** NMNS PM 45408 (paratype); **M–P,** NMNS PM 45386 (paratype). A, E, I, M, left lateral views; B, F, J, N, apertural views; C, G, K, O, right lateral views; D, H, L, P, ventral views. Black arrows indicate position of last septum.

umbilical diameter (*U*), whorl height (*H*) and whorl width (*W*), were measured every half whorl using an X-ray CT image of the cross section and then the two ratios, relative umbilical size (*U*/*D*) and relative whorl thickness (*W*/*H*), were calculated. For one particular cross-sectioned specimen (NMNS PM 45419), four parameters (*D*, *U*, *H*, *W*)

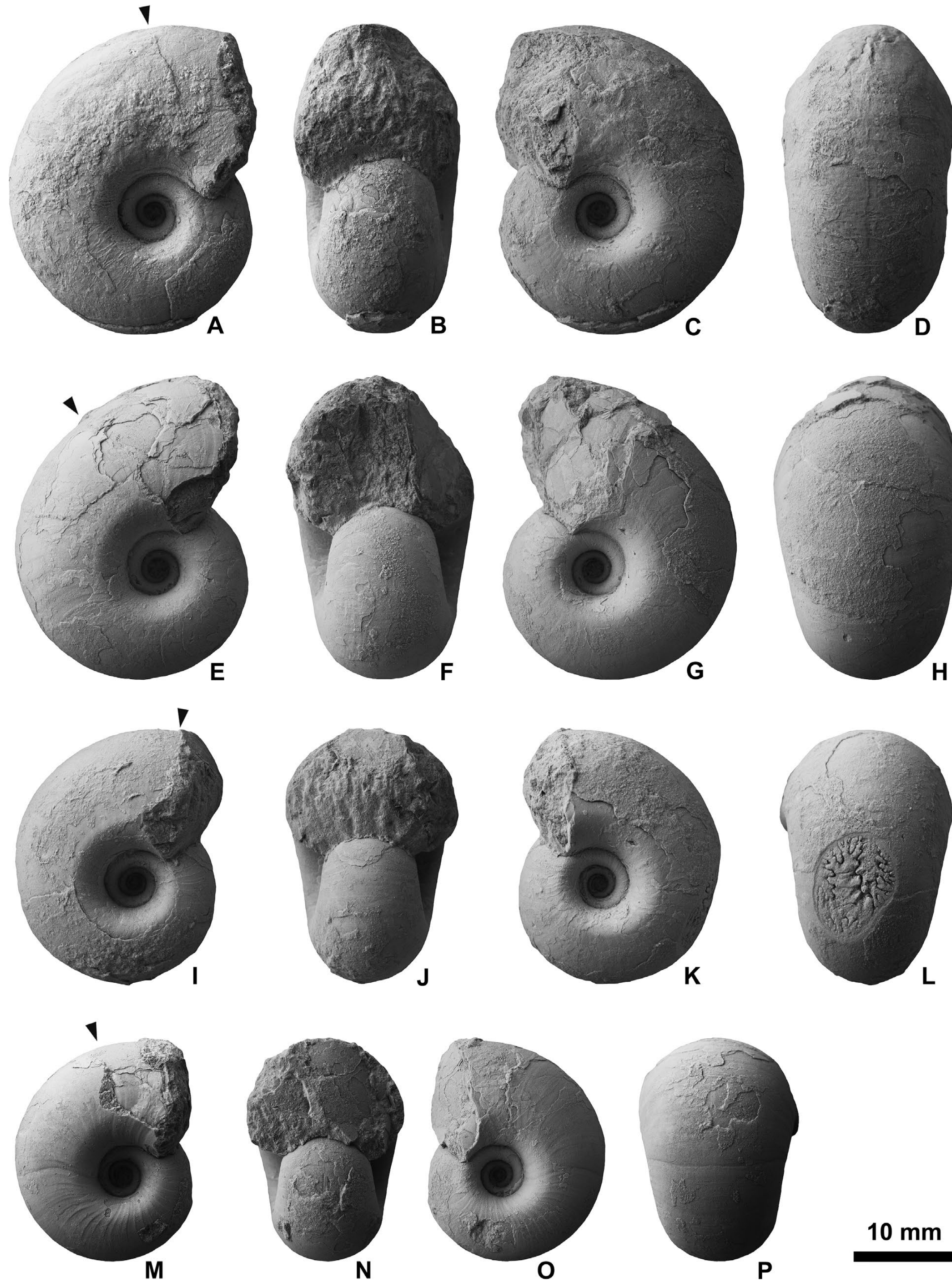

Figure 3. *Tanabeceras nakagawaense* sp. nov. from the Nakagawa area, Hokkaido (Loc. 4 in Figure 1B). **A–D,** NMNS PM 45387 (paratype); **E–H,** NMNS PM 45388 (paratype); **I–L,** NMNS PM 45389 (paratype); **M–P,** NMNS PM 45390 (paratype). A, E, I, M, left lateral views; B, F, J, N, apertural views; C, G, K, O, right lateral views; D, H, L, P, ventral views. Black arrows indicate position of last septum.

were measured every half whorl using a digital micrometer (accuracy, ± 0.001 mm) attached to a profile projector (Nikon Model V-20B), after which two ratios (*U*/*D*, *W*/*H*), were calculated.

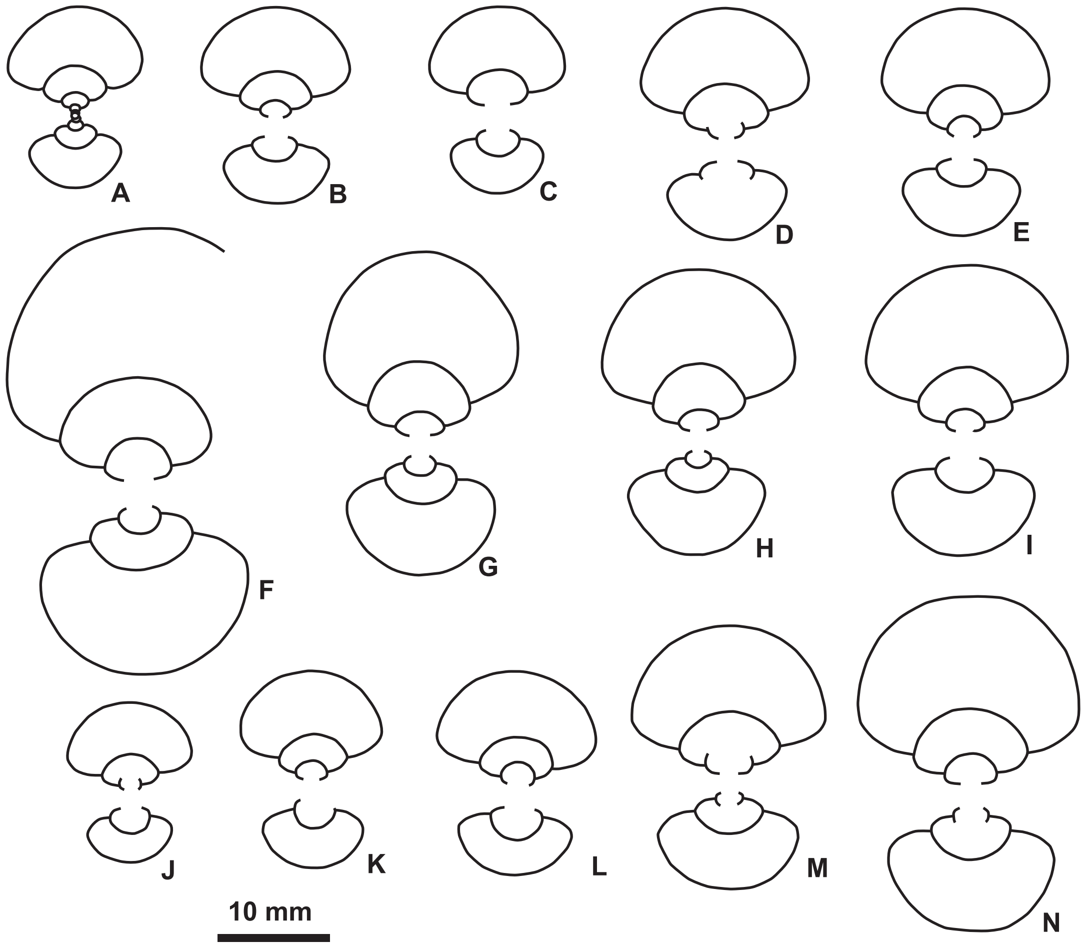

Figure 4. Whorl cross sections of *Tanabeceras nakagawaense* sp. nov. from the Nakagawa area, Hokkaido. **A,** NMNS PM 45419 (paratype); **B,** NMNS PM 45385 (paratype); **C,** NMNS PM 45408 (paratype); **D,** NMNS PM 45386 (paratype); **E,** NMNS PM 45388 (paratype); **F,** NMNS PM 45384 (holotype); **G,** NMNS PM 45387 (paratype); **H,** NMNS PM 45389 (paratype); **I,** NMNS PM 45390 (paratype); **J,** NMA-135; **K,** NMA-136; **L,** NMA-132; **M,** NMA-134; **N,** NMA-137. All except for A were drawn from X-ray CT images.

Paleontological description

Systematic descriptions basically follow the classification of the Lytoceratidae established by Hoffmann (2015). Morphological terms in the systematic description are those used by Arkell (1957) for Mesozoic Ammonoidea. Quantifiers used to describe the shape of ammonoid shell are those proposed by Matsumoto (1954, p. 246) and modified by Haggart (1989, table 8.1).

Abbreviations for shell dimensions.—See Methods Subchapter.

Institution abbreviations.—MCM, Mikasa City Museum, Mikasa; NMA, Nakagawa Museum of Natural History; NMNS, National Museum of Nature and Science, Tsukuba; TKD, Institute of Geoscience, University of Tsukuba, Tsukuba.

Superfamily Lytoceratoidea Neumayr, 1875
Family Tetragonitidae Hyatt, 1900
Subfamily Gabbioceratinae Breistroffer, 1953
Genus ***Tanabeceras*** Shigeta *et al*., 2012

Type species.—*Gabbioceras yezoense* Shigeta, 1996.

Tanabeceras nakagawaense sp. nov.

Figures 2–7

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Gabbioceras yezoense Shigeta. Hayakawa and Nishino, 1999, p. 5, pl. 5, figs. i, j.
Gabbioceras mikasaense Shigeta. Hayakawa and Nishino, 1999, p. 5, pl. 5, figs. a–h.

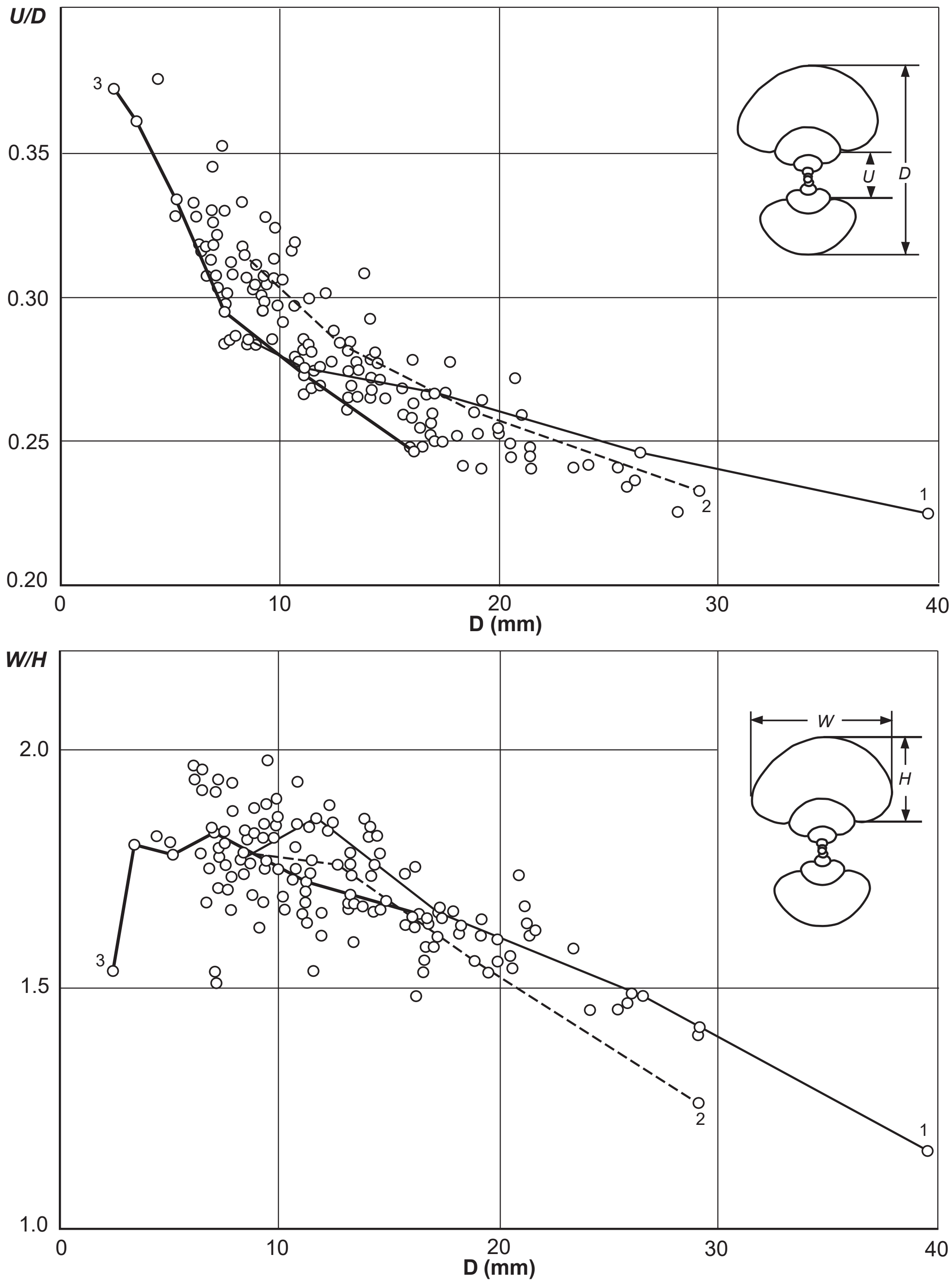

Figure 5. Scatter diagrams showing the relationships between umbilical diameter/shell diameter (*U*/*D*) versus shell diameter (*D*) and whorl width/whorl height (*W*/*H*) versus shell diameter (*D*) for *Tanabeceras nakagawaense* sp. nov. specimens. Each diagram plots 136 data points from 41 specimens (See Material and methods section). Ontogenetic variation is also shown for three selected specimens. 1, NMNS PM 45384 (holotype; thin line); 2, NMNS PM 45387 (paratype; dotted line); 3, NMNS PM 45419 (paratype; thick line).

Type specimens.—Holotype, NMNS PM 45384 (Figures 2A–D, 4F), measuring about 48.0 mm in shell diameter, from a calcareous concretion in float found in the first tributary on the right bank of the Shibunnai-tougeno-sawa River in the Nakagawa area (Loc. 4 in Figure 1B). Specimen consists of the phragmocone and body

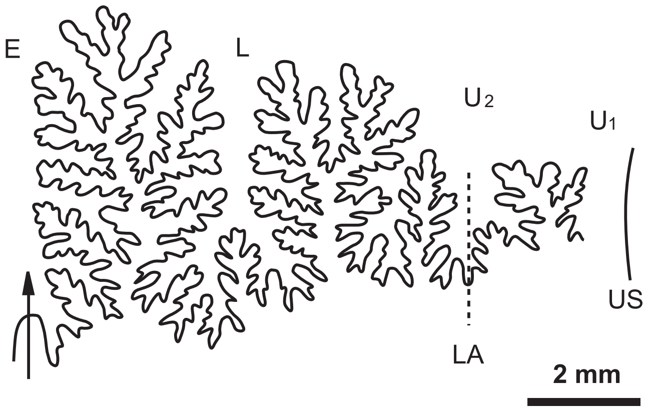

Figure 6. Suture line of *Tanabeceras nakagawaense* sp. nov., NMNS PM 45395 (paratype), from the Nakagawa area, Hokkaido, at D = 15 mm. Arrow indicates position of the siphuncle. Solid line and dotted line indicate position of umbilical seam (US) and lateral angulation (LA). E, external lobe; L, lateral lobe; U_1, first umbilical lobe; U_2, second umbilical lobe.

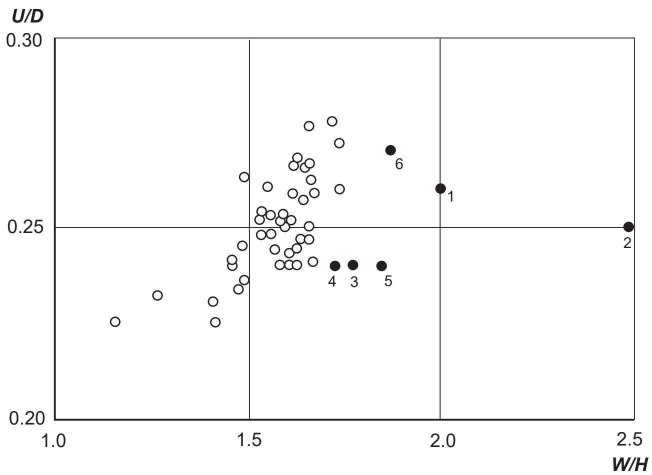

Figure 7. Scatter diagram of umbilical diameter/shell diameter (U/D) versus whorl width/whorl height (W/H) for 42 data points from 33 specimens of *Tanabeceras nakagawaense* sp. nov. (open circles, see Appendix) and six selected type specimens with a shell diameter 15 mm to 30 mm of various species of *Tanabeceras* from Hokkaido (solid circles). Number accompanying each solid circle corresponds as follow. 1, *T. pombetsense*, holotype, MCM M0184; 2, *T. yezoense*, paratype, NMNS PM 8299; 3, *T. horokanaiense*, holotype, TKD3051; 4–6, *T. mikasaense*; 4, holotype, MCM A397; 5, paratype, MCM A398; 6, paratype, MCM A400. Measurement data for type specimens are from Shigeta (1996, 2013) and Shigeta *et al*. (2012).

chamber, which begins at a diameter of about 26.5 mm and occupies nearly three-fourths of the outer whorl. Paratypes, 35 specimens (NMNS PM 45385–45419; Figures 2E–P, 3, 4A–E, G–I) from float calcareous concretions found in the same river as the holotype. Of these 35 specimens, 17 (NMNS PM 45402–45418) were extracted from the same calcareous concretion.

Material examined.—In addition to the holotype and paratypes, five specimens (NMA-132 from Loc. 3, NMA-134 from Loc. 2, NMA-135–137 from Loc. 1 in Figure 1B), described as *Gabbioceras* by Hayakawa and Nishino (1999) were also utilized in the following description.

Diagnosis.—*Tanabeceras* with sub-globular shell form and a fairly narrow, deep umbilicus with a subangular to rounded umbilical shoulder, and ornamentation characterized by fine lirae.

Etymology.—Named after the Nakagawa area, northern Hokkaido.

Description.—Very involute, very depressed shell characterized by a depressed sub-globular whorl section with rounded venter and convex flanks gradually converging from umbilical shoulders to venter. Maximum whorl width occurs on umbilical shoulders at one third to one fourth of whorl height. Umbilicus fairly narrow, deep and funnel-shaped with high, gently convex umbilical wall and subangular to rounded umbilical shoulder. As shell grows, relative umbilical size gradually decreases and whorl section becomes slightly compressed (Figure 5). Ornamentation consists only of fine lirae, which arise at umbilical seam, curve backwards on umbilical shoulder, become slightly rursiradiate, and cross venter in a broad, slightly concave arch. Lirae are sometimes prominent on inner flank. Suture consists of early gaudryceratid-type characters with bipartite lateral saddles (Figure 6). Lateral angulation located in middle of second umbilical lobe (U_2).

Measurements.—See Appendix.

Comparison.—*Tanabeceras nakagawaense* sp. nov. is characterized by having the most compressed shell among all those species assigned to *Tanabeceras* with a shell diameter in excess of 15 mm (Wiedmann, 1962; Murphy, 1967; Shigeta, 1996, 2013; Shigeta *et al*., 2012; Figure 7). This new species is closest to *T. pombetsense*, *T. mikasaense* and *T. horokanaiense*, but differs by its more compressed whorls and rounded venter. The new taxon exhibits fine lirae like *T. horokanaiense*, while the latter possesses constrictions in addition to fine lirae. The phragmocone of *T. pombetsense* is somewhat similar to this new species, but its whorls are more depressed and its umbilical wall is slightly concave. The adult body chamber of *T. pombetsense* is ornamented with flat-topped, band-like or low fold-like, broad major ribs.

Occurrence.—The holotype and paratypes were collected from float calcareous concretions in the first tributary on the right bank of the Shibunnai-touge-no-sawa River in the Nakagawa area. Although the exact stratigraphic horizon from which the concretions came is uncertain,

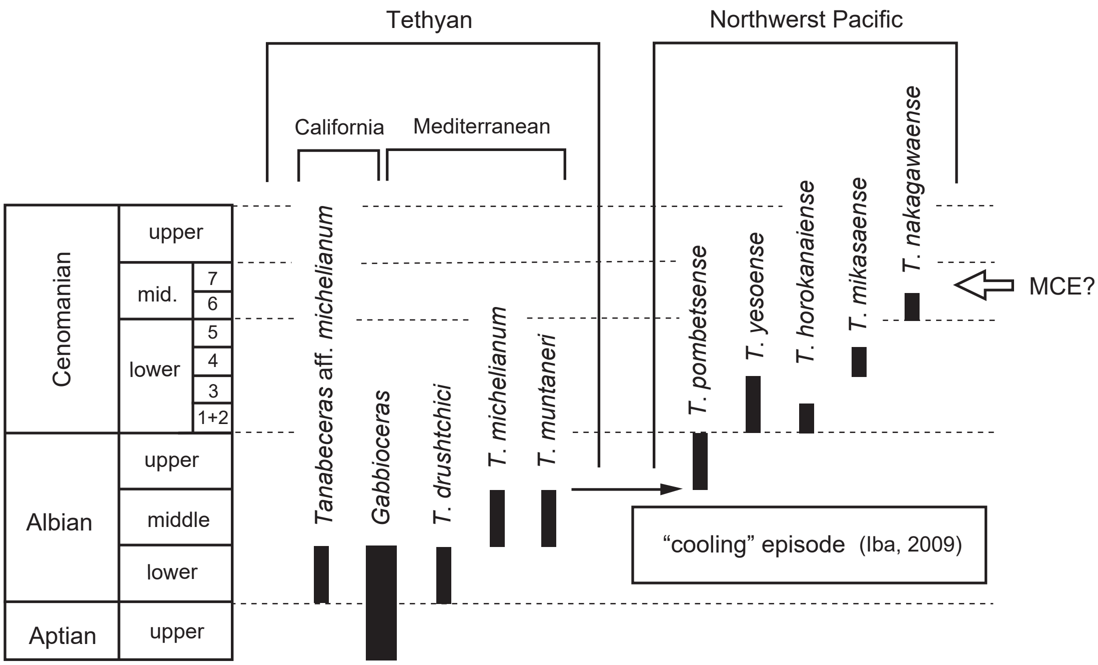

Figure 8. Stratigraphic distribution of *Gabbioceras* and *Tanabeceras* in the Tethyan realm and the Northwest Pacific region (Murphy, 1967; Shigeta, 1996, 2013; Shigeta *et al*., 2012; Shigeta and Izukura, 2013). MCE, Mid-Cenomanian Event. 1, *Graysonites wooldridgei* Zone; 2, *Stoliczkaia japonica* Assemblage Zone; 3, *Mantelliceras saxbii* Zone; 4, *Mantelliceras japonicum* Zone; 5, *Acompsoceras renevieri* Zone; 6, *Cunningtoniceras takahashii* Zone; 7, *Calycoceras asiaticum* Zone. Biostratigraphic zonation in the Cenomanian is based on Toshimitsu *et al*. (1995) and Matsumoto *et al*. (2003, 2004).

judging from their location, there is very little doubt they came from the mudstone of the *Cunningtoniceras takahashii* Zone (= lower middle Cenomanian; Toshimitsu *et al*., 1995) in the middle part of the Sakugawa Formation. Specimens NMA-134–137 were collected from outcrops of the *Cunningtoniceras takahashii*-bearing beds of the Sakugawa Formation in the Nakagawa area (Hayakawa and Nishino, 1999).

Discussion

Late Albian and Cenomanian-aged *Tanabeceras* were previously known only from Hokkaido and Sakhalin, with four species described from this region (Shigeta, 1996, 2013), i.e., *T. pombetsense* from the upper Albian, *T. yezoense* and *T. horokanaiense* from the lowest Cenomanian, and *T. mikasaense* from the middle lower Cenomanian (*Mantelliceras japonicum* Zone). Among them, *T. horokanaiense* exhibits forms that are intermediate between *T. yezoense* and *T. mikasaense*. This evidence suggests that *Tanabeceras* evolved and radiated in the Northwest Pacific region during the early Cenomanian (Shigeta, 2013). However, phylogenetic relationships between these taxa, i.e., whether *T. mikasaense* evolved from *T. yezoense* via *T. horokanaiense*, or *T. mikasaense* and *T. yezoense* evolved independently from *T. horokanaiense*, are unresolved (Shigeta, 2013). Because the shell morphology and ornamentation of *T. nakagawaense* sp. nov. and *T. mikasaense* are very similar and both occur in younger horizons, it follows that *T. nakagawaense* sp. nov. is considered to have originated from *T. mikasaense* during late early Cenomanian or earliest middle Cenomanian time.

The Cretaceous Yezo Group in Hokkaido and Sakhalin yields numerous well-preserved fossils from various horizons (e.g. Matsumoto, 1954; Vereshchagin, 1977). Nevertheless, in spite of extensive search efforts, specimens assignable to *Tanabeceras* have not yet been discovered in the upper middle Cenomanian (*Calycoceras asiaticum* Zone) and younger deposits, which strongly suggests that *Tanabeceras* became extinct during late middle Cenomanian time.

Thus, we propose the following evolutionary scenario for *Tanabeceras* (see Figure 8). *Tanabeceras* probably evolved from *Gabbioceras* during the early Albian and subsequently became widely distributed in the Tethyan realm during early to middle Albian time, but this distribution did not extend into the Northwest Pacific region.

During the early Albian, *T. drushtchici* (Wiedmann, 1962) was distributed in the Mediterranean area and *T.* aff. *michelianum* (d'Orbigny, 1850) in California, while in the middle Albian, *T. michelianum* and *T. muntaneri* (Wiedman, 1962) were distributed in the Mediterranean area (Murphy, 1967). It is speculated that the "cooling" episode that occurred in the Northwest Pacific region during this interval (Iba, 2009) may have prevented *Tanabeceras* from extending its distribution to the region. After the "cooling" episode, *Tanabeceras* did extend its distribution into the Northwest Pacific region, but the reason for its eventual disappearance from the Tethyan realm is not known. *Tanabeceras pombetsense* from the upper Albian of Hokkaido differs from other species of *Tanabeceras* in having broad major ribs on its body chamber, but the phragmocone resembles *T. muntaneri*, by its globular whorl section, rounded venter and slightly concave umbilical wall (Wiedmann, 1962, fig. 6; Shigeta *et al*., 2012, fig. 2). These similarities suggest that *T. muntaneri* is probably an ancestor of *T. pombetsense*. *Tanabeceras* evolved and radiated in the Northwest Pacific region during late Albian to early middle Cenomanian time, but then became extinct during the late middle Cenomanian.

The Mid-Cenomanian Event (MCE), which is often referred to as a precursor of the Oceanic Anoxic Event 2 that marked a major turnover of foraminifers and radiolarians, was recognized globally during the middle Cenomanian (e.g. Coccioni and Galeotti, 2003). In Hokkaido, benthic foraminiferal assemblages exhibit a stepwise extinction after the MCE (Kaiho and Hasegawa, 1994) and radiolarian abundance also decreased during the same interval (Taketani, 1982). At least five endemic ammonoid genera (*Tanabeceras*; *Miogaudryceras* Matsumoto, 1995; *Microdesmoceras* Matsumoto and Muramoto in Matsumoto *et al*., 1972; *Eomadrasites* Matsumoto, 1955; *Mikasaites* Matsumoto, 1956), whose paleogeographic distributions were restricted to the North Pacific region became extinct during the middle Cenomanian. Furthermore, according to a database of Japanese Cretaceous ammonoids by Toshimitsu and Hirano (2000), the species diversity of ammonoids declined sharply between the middle and late Cenomanian. Although detailed studies of paleoclimate during the Cenomanian have not been conducted, the extinction of endemic ammonoid genera as well as the decline of species diversity during the middle Cenomanian suggests that the ammonoid fauna in the Northwest Pacific region was also affected by the MCE or its chained episode (Figure 8).

Acknowledgments

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Author contributions

T. S and H. F. collected fossils and contributed to the geological aspect of the study. Y. S. conducted the taxonomic study. All authors contributed to the writing of paper.

Appendix. Measurements (in mm) of herein studied specimens of *Tanabeceras nakagawaense* sp. nov. *D*, shell diameter; *U*, umbilical diameter; *H*, whorl height; *W*, whorl width; <H>, holotype; <P>, paratype.

register number	*D* (mm)	*U* (mm)	*H* (mm)	*W* (mm)	*U*/*D*	*W*/*H*
NMNS PM 45384<H>	8.43	2.41	3.37	6.02	0.29	1.79
	11.81	3.25	4.82	8.92	0.28	1.85
	17.11	4.58	7.95	13.25	0.27	1.67
	26.51	6.51	12.29	18.31	0.25	1.49
	39.76	8.76	18.55	21.69	0.22	1.69
NMNS PM 45385<P>	7.92	2.44	3.28	6.32	0.31	1.93
	11.60	3.12	5.20	9.20	0.27	1.77
	17.28	4.32	7.84	13.04	0.25	1.66
NMNS PM 45386<P>	14.33	3.90	6.19	10.89	0.27	1.76
	21.22	5.50	9.40	15.75	0.26	1.68
NMNS PM 45387<P>	8.31	2.62	3.54	6.31	0.32	1.78
	12.62	3.58	5.54	9.76	0.28	1.76
	18.92	4.92	8.46	13.23	0.26	1.56
	29.08	6.77	13.69	17.23	0.23	1.26
NMNS PM 45388<P>	6.55	2.07	2.41	4.60	0.32	1.91
	9.20	2.76	4.02	6.78	0.30	1.69
	20.69	5.06	9.54	15.06	0.24	1.58
NMNS PM 45389<P>	6.93	2.40	3.07	5.60	0.35	1.82
	11.60	3.27	5.20	8.00	0.28	1.54
	17.07	4.27	7.60	12.13	0.25	1.60
	25.47	6.13	11.73	17.20	0.24	1.47
NMNS PM 45390<P>	11.30	3.19	4.93	8.41	0.28	1.71
	16.96	4.35	7.68	12.61	0.26	1.64
	25.94	6.09	12.17	17.97	0.23	1.48
NMNS PM 45391<P>	8.38	2.67	3.62	6.29	0.32	1.74
	12.38	3.43	5.24	9.90	0.28	1.88
	18.10	4.57	8.48	13.71	0.25	1.62
NMNS PM 45392<P>	8.96	2.54	3.88	6.57	0.28	1.69
	13.13	3.43	5.67	9.55	0.26	1.68
	19.25	4.63	8.81	14.18	0.24	1.61
	29.10	6.57	13.73	19.40	0.23	1.41
NMNS PM 45393<P>	14.35	4.00	6.35	11.53	0.28	1.82
	21.41	5.29	9.76	16.00	0.25	1.64
NMNS PM 45394<P>	9.06	2.82	3.76	6.12	0.31	1.63
	13.29	3.65	5.76	9.76	0.27	1.69
	20.00	5.06	9.12	14.59	0.25	1.60
NMNS PM 45395<P>	7.57	2.52	3.01	5.53	0.33	1.84
	11.36	3.40	4.85	8.45	0.30	1.74
	16.80	4.47	7.48	12.23	0.27	1.64
NMNS PM 45396<P>	9.62	3.16	3.80	7.47	0.33	1.97
	13.92	4.30	5.95	11.01	0.31	1.85
	20.89	5.70	9.37	16.33	0.27	1.74
NMNS PM 45397<P>	9.89	3.21	4.00	7.37	0.32	1.84
	14.42	4.00	6.32	11.26	0.28	1.78
	21.47	5.16	9.79	15.79	0.24	1.61
NMNS PM 45398<P>	9.43	2.87	3.91	7.36	0.30	1.88
	14.14	3.79	6.32	11.49	0.27	1.82
	21.61	5.29	10.00	16.21	0.24	1.62
NMNS PM 45399<P>	7.26	2.57	2.74	5.31	0.35	1.94
	10.62	3.36	4.51	7.79	0.32	1.73
	15.84	4.25	6.90	11.24	0.27	1.63
NMNS PM 45400<P>	7.60	2.16	3.28	5.60	0.28	1.71
	11.12	2.96	4.88	8.00	0.27	1.64
	16.08	3.92	7.28	11.68	0.24	1.60
NMNS PM 45401<P>	7.59	2.29	3.08	5.41	0.30	1.76
	11.05	3.16	4.74	7.82	0.29	1.65
	16.54	4.21	7.59	11.65	0.25	1.53
NMNS PM 45402<P>	6.96	2.30	2.81	5.26	0.33	1.87
	9.93	3.11	3.93	7.26	0.31	1.85
	14.15	4.15	6.07	11.11	0.29	1.83
NMNS PM 45403<P>	6.96	2.22	2.74	5.04	0.32	1.84
	10.15	3.11	4.30	7.19	0.31	1.67
	14.44	4.00	6.22	10.37	0.28	1.67
NMNS PM 45404<P>	10.80	3.45	4.37	8.05	0.32	1.84
	16.09	4.48	7.24	12.68	0.28	1.75
NMNS PM 45405<P>	6.37	2.03	2.42	4.73	0.32	1.95
	9.12	2.86	3.96	6.92	0.31	1.75
	13.67	3.63	6.04	9.67	0.27	1.60
	20.56	5.11	9.22	14.22	0.25	1.54
NMNS PM 45406<P>	7.29	2.35	2.94	5.29	0.32	1.80
	10.71	3.18	4.47	8.00	0.30	1.79
	16.12	4.24	7.41	11.06	0.26	1.49
	24.35	5.88	10.94	15.88	0.24	1.45
NMNS PM 45407<P>	6.71	2.06	2.65	4.47	0.31	1.69
	9.18	2.71	3.76	6.82	0.30	1.81
	13.29	3.53	5.88	9.88	0.27	1.68
	20.00	5.06	9.06	14.12	0.25	1.56
NMNS PM 45408<P>	7.78	2.22	3.13	5.35	0.29	1.71
	11.01	3.03	4.85	8.18	0.28	1.69
	16.67	4.14	7.68	12.02	0.25	1.57
NMNS PM 45409<P>	6.12	2.04	2.43	4.76	0.33	1.96
	8.93	2.72	3.83	6.99	0.30	1.83
	13.11	3.69	5.53	9.71	0.28	1.76
	19.61	4.95	9.03	13.88	0.25	1.54
NMNS PM 45410<P>	7.97	2.28	3.35	5.82	0.29	1.74
	11.39	3.23	4.81	8.86	0.28	1.84
	17.09	4.43	7.85	12.66	0.26	1.61

Appendix. *Continued.*

register number	D (mm)	U (mm)	H (mm)	W (mm)	U/D	W/H
	26.20	6.20	12.03	17.97	0.24	1.49
NMNS PM 45411<P>	8.45	2.82	3.50	6.41	0.33	1.83
	12.23	3.69	5.15	9.42	0.30	1.83
	17.86	4.95	7.77	12.91	0.28	1.66
NMNS PM 45412<P>	7.80	2.44	3.39	5.67	0.31	1.67
	11.97	3.23	5.20	8.35	0.27	1.61
	16.93	4.25	7.40	11.81	0.25	1.60
NMNS PM 45413<P>	9.84	3.02	3.97	7.54	0.31	1.90
	14.60	3.97	6.67	11.19	0.27	1.68
NMNS PM 45414<P>	6.08	2.00	2.48	4.80	0.33	1.94
	8.96	2.72	3.84	7.20	0.30	1.88
	13.36	3.60	5.84	10.16	0.27	1.74
NMNS PM 45415<P>	5.12	1.68	2.04	3.68	0.33	1.80
	7.52	2.24	3.20	5.76	0.30	1.80
	10.88	3.04	4.64	8.24	0.28	1.78
	16.08	4.16	7.28	12.00	0.26	1.65
NMNS PM 45416<P>	6.83	2.14	2.83	4.97	0.31	1.76
	10.14	2.97	4.28	7.25	0.29	1.69
	14.83	3.93	6.55	11.03	0.27	1.68
NMNS PM 45417<P>	7.17	2.21	3.24	4.90	0.31	1.51
	10.00	2.97	3.86	6.76	0.30	1.75
	13.66	3.79	5.93	10.00	0.28	1.69
NMNS PM 45418<P>	4.52	1.70	1.70	3.11	0.38	1.83
	6.52	2.07	2.74	4.89	0.32	1.78
	9.41	2.81	3.85	7.11	0.30	1.85
	13.85	3.81	6.15	10.30	0.28	1.67
NMNS PM 45419<P>	2.41	0.90	0.89	1.37	0.37	1.54
	3.49	1.26	1.35	2.43	0.36	1.80
	5.07	1.69	2.10	3.75	0.33	1.79
	7.51	2.22	3.18	5.67	0.30	1.78
	11.04	3.02	4.83	8.33	0.27	1.72
	16.16	4.00	7.34	12.13	0.25	1.65
NMA-132	7.05	2.30	3.11	4.75	0.33	1.53
	8.52	2.62	3.61	6.56	0.31	1.82
	12.46	3.60	5.41	10.00	0.29	1.85
	18.36	4.43	8.52	14.26	0.24	1.67
NMA-134	10.84	3.01	4.70	9.04	0.28	1.92
	15.78	4.10	7.11	12.41	0.26	1.75
	23.49	5.66	10.84	17.23	0.24	1.59
NMA-135	7.09	2.15	2.66	5.06	0.30	1.90
	9.75	2.78	4.18	7.59	0.29	1.82
	14.30	3.80	6.33	11.01	0.27	1.74
NMA-136	8.48	2.41	3.42	6.08	0.28	1.78
	11.90	3.29	5.32	8.86	0.28	1.67
	17.59	4.68	7.59	12.53	0.27	1.67
NMA-137	9.25	2.84	3.88	6.87	0.31	1.77
	13.13	3.73	5.52	9.85	0.28	1.78
	19.25	5.07	8.66	14.33	0.26	1.65
	29.10	6.72	13.58	19.10	0.23	1.41