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Cover picture: Heteromorph ammonoid *Didymoceras hidakense* from a float concretion that most likely weathered out of the lower upper Campanian *Baculites subanceps* beds in the Ribira River area, Hokkaido. The specimen's discovery by Noboru Sasaki alerted us to the presence of upper Campanian strata in the vicinity and provided the opportunity to conduct an intensive investigation of the area's Cretaceous stratigraphy and paleontology.

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Campanian (Late Cretaceous) ammonoids and inoceramids from the Ribira River area, Hokkaido, northern Japan

Yasunari Shigeta[1], Masataka Izukura[2] and Tomohiro Nishimura[3]

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Abstract. Thirty-seven species of Campanian (Late Cretaceous) ammonoids, which includes three newly described species (*Neophylloceras nodosum* sp. nov., *Menuites armatus* sp. nov. and *Parasolenoceras ribiraense* sp. nov.), and four species of inoceramid bivalves are reported from the Urakawa and Chinomigawa formations of the Yezo Group in the Ribira River area, southern central Hokkaido, Japan. As brief summary of the stratigraphy and paleontology of the Urakawa and Chinomigawa formations is provided. Furthermore, seven distinct Campanian ammonoid and inoceramid assemblages are recognized as follows, in ascending order: the lower Campanian *Gaudryceras tenuiliratum* beds, the middle Campanian *Sphenoceramus orientalis* beds, *Sphenoceramus schmidti* beds and *Metaplacenticeras subtilistriatum* beds, and the lower upper Campanian *Baculites pacificus* beds, *Baculites subanceps* beds and *Baculites rex* beds. *Pachydiscus excelsus* is reported from the middle Campanian *Metaplacenticeras subtilistriatum* beds as well as the lower upper Campanian, thus making it the oldest *Pachydiscus* in the Northwest Pacific region. Since *Pachydiscus* flourished in other regions during early Campanian time, its occurrence in the Ribira River area suggests that the genus extended its geographical distribution from other regions to this particular area during middle Campanian time.

Key words: ammonoids, Campanian, Cretaceous, Hokkaido, inoceramids, Ribira River

Introduction

The Cretaceous Yezo Group, distributed in a relatively narrow band running in a north-south direction in central Hokkaido and West Sakhalin Mountains, yields numerous well-preserved fossils from various horizons (Matsumoto, 1954; Vereshchagin, 1977). An ammonoid and inoceramid based biostratigraphic scheme for the upper Albian to middle Campanian of Hokkaido was long ago established (Matsumoto, 1959a, 1977; Toshimitsu *et al.*, 1995). However, occurrences of fossils from the upper Campanian to Maastrichtian are discontinuous and sporadic. Consequently, the biostratigraphic framework for the upper Campanian to Maastrichtian interval is ambiguous in the Yezo Group (Toshimitsu *et al.*, 1995).

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 upper part of the Cretaceous, a complete succession of marine fossil assemblages spanning the Campanian has not yet been found in the western part of the Yezo Basin.

In contrast, fossiliferous mudstone and sandy mudstone facies are still dominant in the upper part of the Cretaceous in the eastern part of the Yezo Basin. Shigeta *et al.* (2016) reported a continuous succession yielding middle Campanian

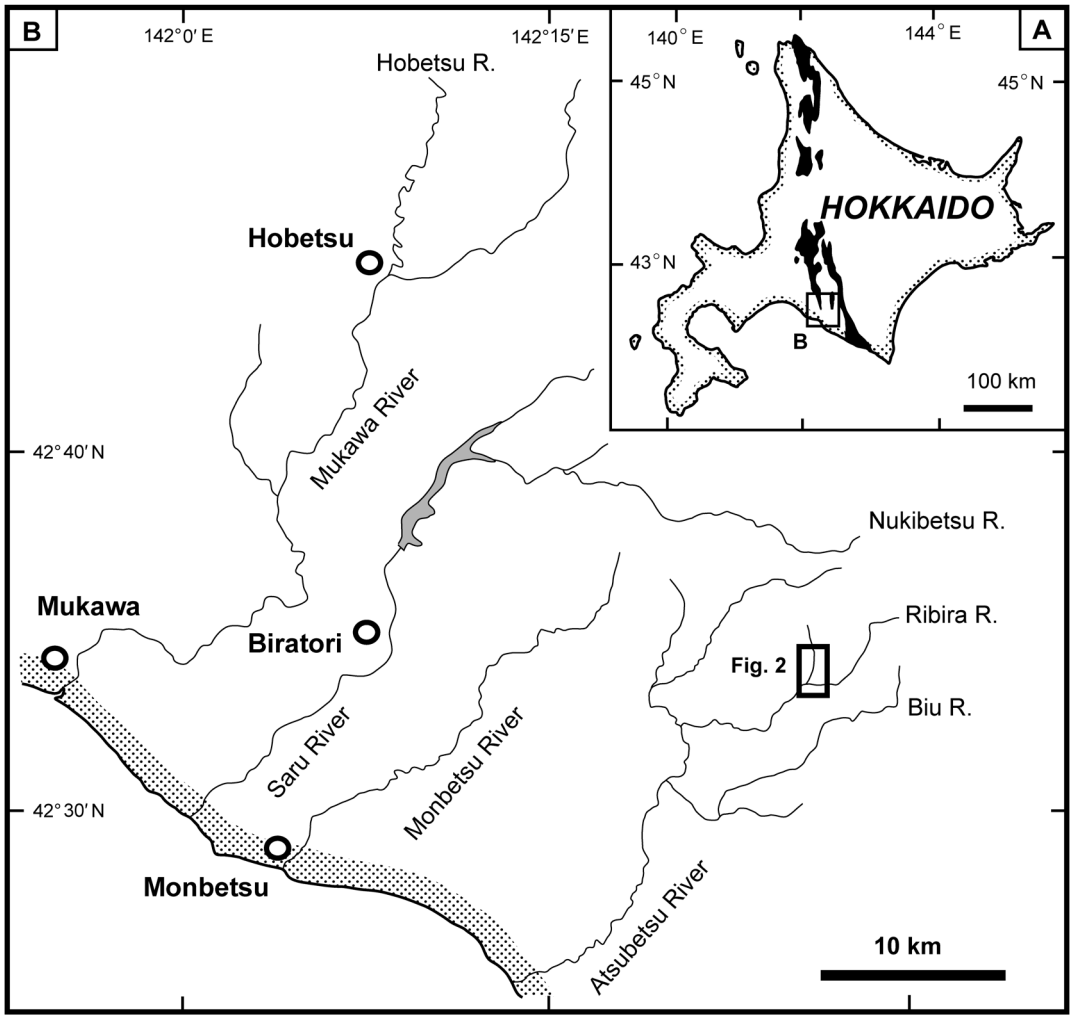

Fig. 1. Index maps showing distribution of the Yezo Group (black area) in Hokkaido (A) and the studied area in the Ribira River area, southern central Hokkaido (B).

Metaplacenticeras subtilistriatum (Jimbo, 1894) and early late Campanian *Baculites subanceps* Haughton, 1925 in the Urakawa area of southern central Hokkaido, located in the southeastern part of the Yezo Basin. The Urakawa area is the one of the better areas for studying the succession of Campanian assemblages, but upper Campanian strata overlying the *B. subanceps*-bearing beds are not known in this area because of a synclinal structure.

We recently discovered a more complete continuous succession yielding Campanian megafossil assemblages in the Ribira River area, southern central Hokkaido, about 50 km northwest of Urakawa (Fig. 1). In this paper, we document the Campanian megafossil assemblages in the Ribira River area and propose a new biostratigraphic zonation scheme for the middle to upper Campanian in the Yezo Group. We also document the oldest record of *Pachydiscus* in the Northwest Pacific area and discuss the evolution of this taxon in the region.

Notes on stratigraphy

The Cretaceous Yezo Group is distributed in a rather narrow band running in a north-south direction in the eastern tributary area of the Wen-

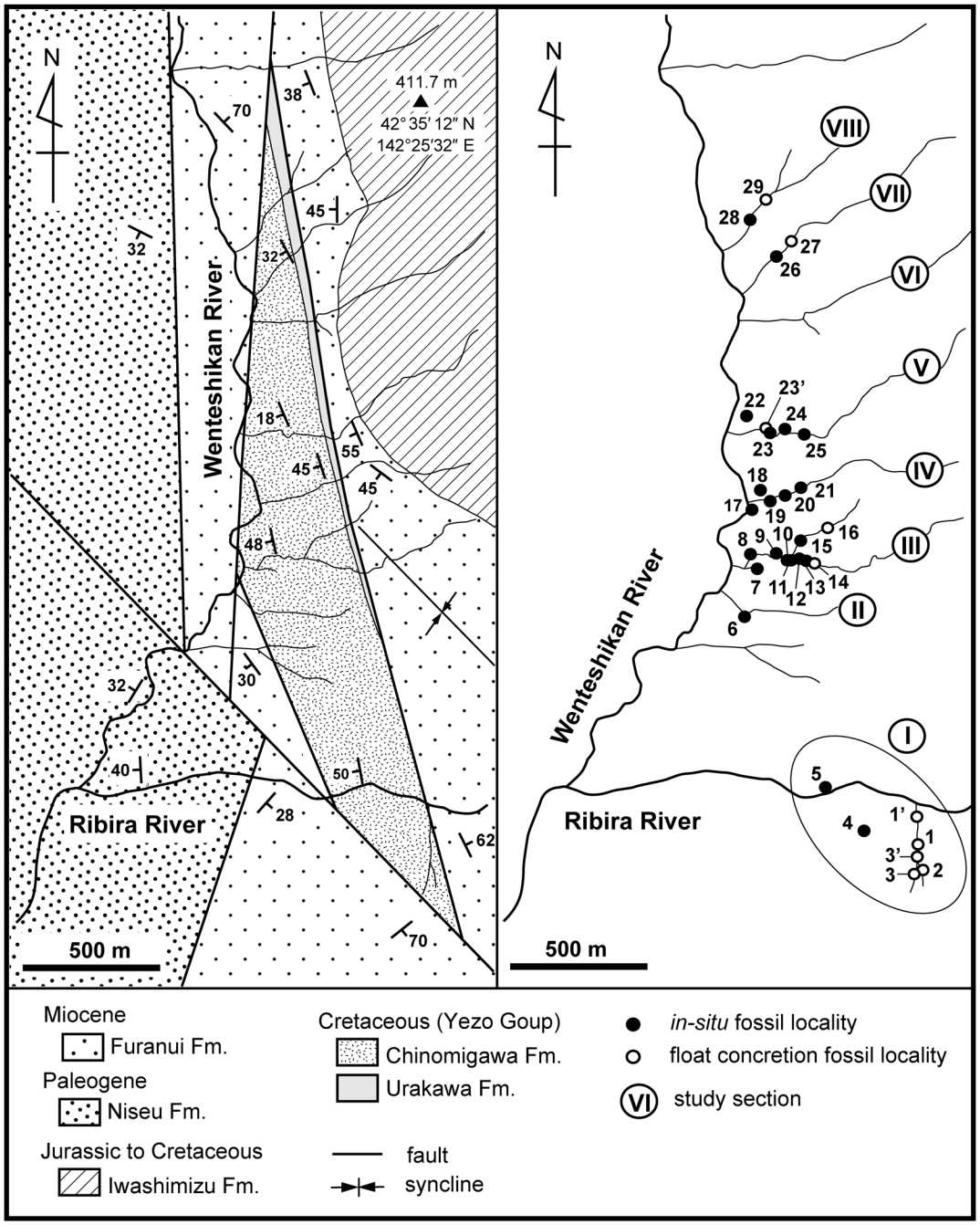

Fig. 2. Geological map and locality map showing study sections (I through VIII) and fossil localities along the Ribira River and Wenteshikan River and their tributaries in the Ribira River area, Hokkaido.

teshikan River and in a very small area of the Ribira River and its tributaries. Fig. 2 provides a geological map of the area and the location of eight studied sections along these various tributaries. All sides of the Yezo Group are in fault contact with the Miocene Furanui Formation, which itself is in fault contact with the Paleogene Niseu Formation on the east side and unconform-

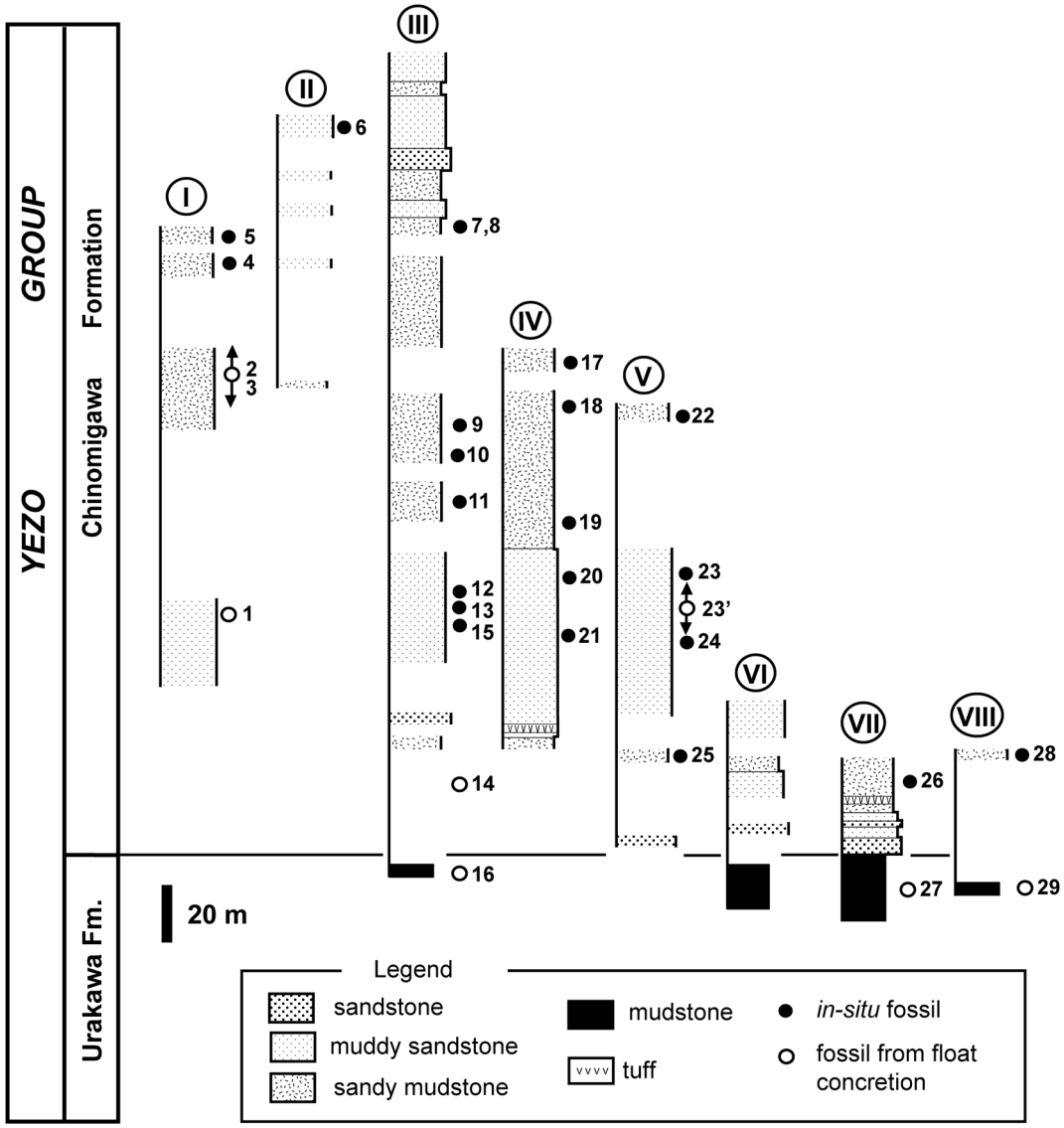

Fig. 3. Columnar sections showing localities from which fossils were collected in the Ribira River area, Hokkaido.

ably covers the Jurassic to Cretaceous Iwashimizu Formation on the west side (Sakai *et al.*, 2000). The Yezo Group, which generally strikes N10–20° westward and dips 20–50° southward, is lithologically similar to strata in the Urakawa area and is divided into the Urakawa and Chinomigawa formations in ascending order (Kanie, 1966; Sakai and Kanie, 1986).

Urakawa Formation

The Urakawa Formation is equivalent to the Kashima Formation in the Oyubari area of south-central Hokkaido (Motoyama *et al.*, 1991; Takashima *et al.*, 2004), the Kotobuki Formation in the Nakatonbetsu area of northern Hokkaido (Osanai *et al.*, 1963, Ando *et al.*, 2001) and the Bykov Formation in southern Sakhalin (Poyarkova, 1987; Shigeta *et al.*, 1999; Kodama *et al.*, 2002; Maeda *et al.*, 2005).

Exposure.—Middle course of the eastern tributaries of the Wenteshikan River (Fig. 2).

Thickness.—Greater than 30 m.

Stratigraphic relationship.—The Urakawa Formation is in fault contact with the Miocene Furanui Formation on the west side and is conformably overlain by the Chinomigawa Formation on the east side.

Lithology.—The formation consists of dark grey, massive mudstone (Fig. 3), but detailed sedimentological features are uncertain because of poor exposures.

Fossils.—Although *in-situ* fossils have not been collected, float concretions containing *Gaudryceras tenuiliratum* Yabe, 1903 and *G. intermedium* Yabe, 1903 have been found within the outcrop area of the Urakawa Formation (Fig. 4).

Chinomigawa Formation

The Chinomigawa Formation is equivalent to the Kamikoma Formation in the Nakatonbetsu area of the northern Hokkaido (Osanai *et al.*, 1963, Ando *et al.*, 2001) and the Krasnoyarka Formation in the southern Sakhalin (Poyarkova, 1987; Shigeta *et al.*, 1999; Kodama *et al.*, 2002; Maeda *et al.*, 2005).

Exposure.—Lower course of the eastern tributaries of the Wenteshikan River, and a very small area of the Ribira River and its tributaries (Fig. 2).

Thickness.—Greater than 280 m.

Stratigraphic relationship.—The Chinomigawa Formation conformably overlies the Urakawa Formation and its upper portion is in fault contact with the Miocene Furanui Formation.

Lithology.—See Fig. 3. The lowermost part of the formation consists of greenish gray, coarse- to medium-grained, poorly sorted bedded or massive sandstone in association with dark gray, bioturbated muddy sandstone beds. It grades upward into a dark gray, intensely bioturbated massive sandy mudstone unit interbedded with thin tuff beds. Higher still, the unit transitions upward into bioturbated muddy sandstone.

The middle part of the formation consists of dark gray, intensely bioturbated massive sandy mudstone. It grades upward into dark gray, bioturbated muddy sandstone in associated with fine- to medium grained sandstone in the upper part of the formation.

Fossils.—See Figs. 4–7. The sandy mudstone beds in the lower part of the formation are fossiliferous. From the lower part of this sequence, the inoceramid bivalves *Sphenoceramus orientalis* (Sokolov, 1914) and *Inoceramus ezoensis* Yokoyama, 1890 were collected from *in-situ* concretions at Loc. 26 together with following ammonoids: *Phyllopachyceras ezoense* (Yokoyama, 1890), *Tetragonites glabrus* (Jimbo, 1894), *Gaudryceras striatum* (Jimbo, 1894), *Damesites* sp., *Eupachydiscus haradai* (Jimbo, 1894) and *Baculites* sp. Float concretions, which probably came from this horizon, contained *Ainoceras kamuy* Matsumoto and Kanie, 1967and *S. pseudosulcatus* (Nagao and Matsumoto, 1940) together with *I. ezoense*. The faunal composition changes toward the upper part of the sequence, and the following fossils were collected from *in-situ* concretions at Loc. 28: the inoceramid bivalve, *Sphenoceramus schmidti* (Michael, 1899) and the following ammonoids: *Tetragonites popetensis* Yabe, 1903, *Gaudryceras mamiyai* Matsumoto and Miyauchi, 1984, *Canadoceras mysticum* Matsumoto, 1954, *Canadoceras* sp., *Parasolenoceras* sp. and *Baculites yezoensis* Matsumoto and Miyauchi, 1984.

Fossils were not found in the lower part of the overlying muddy sandstone beds, but the upper part is fossiliferous. *In-situ* concretions at Locs. 12, 13, 15, 20, 21 and 24 yielded the following ammonoids: *Phyllopachyceras ezoense*, *Tetragonites popetensis*, *Metaplacenticeras subtilistriatum*, *Saghalinites teshioensis* Matsumoto, 1984, *Canadoceras multicostatum* Matsumoto, 1954, *Menuites fascicostatus* Yabe in Yabe and Shimizu (1921), *Didymoceras*? sp. and *Pachydiscus excelsus* Matsumoto, 1979. An *in-situ* concretion from the upper part of the muddy sandstone beds at Loc. 23 contained *Baculites pacificus* Matsumoto and Obata, 1963 and a float concretion, most likely from the same horizon as Loc. 23, contained *Menuites sanadai* Matsumoto, 1984.

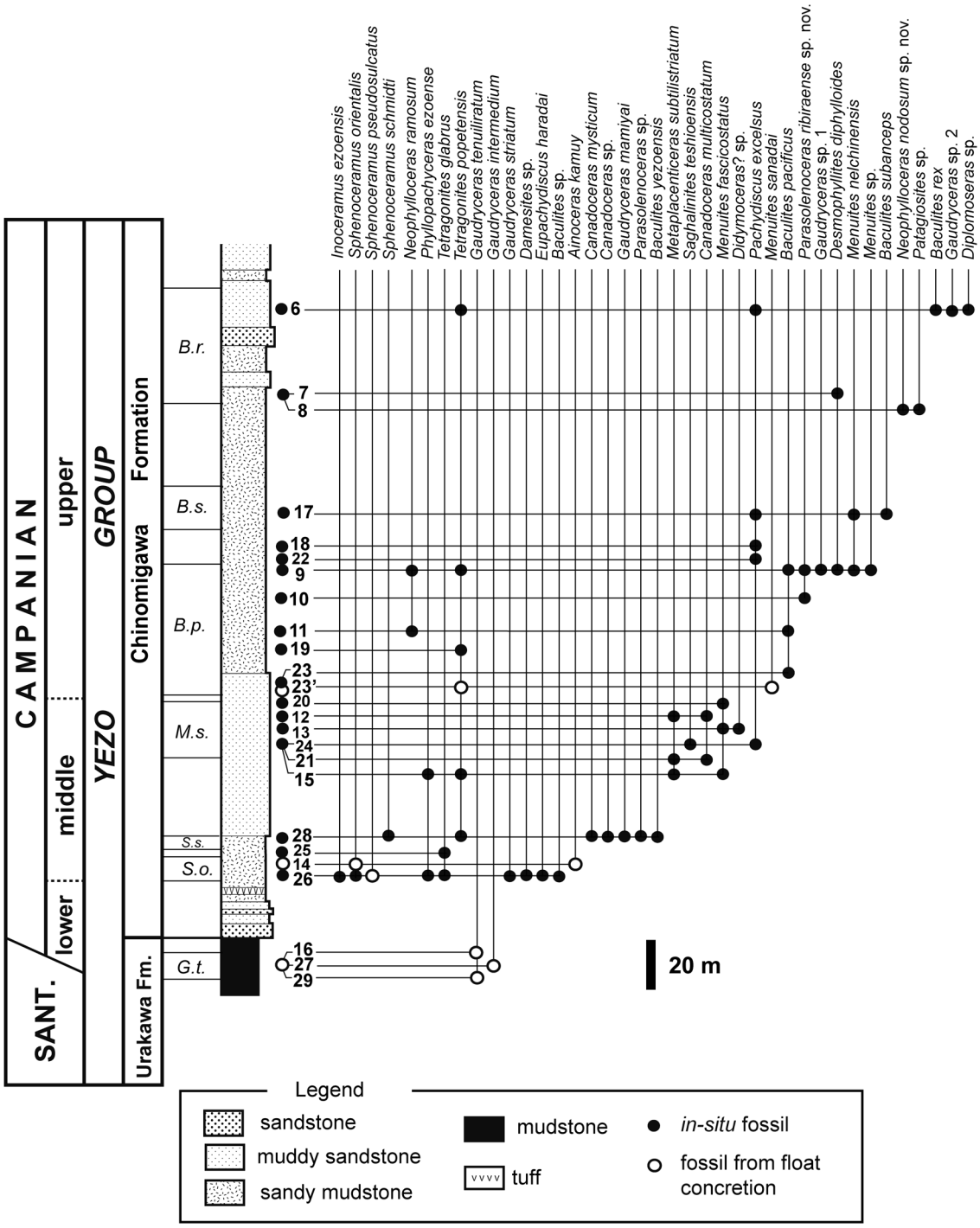

Fig. 4. Stratigraphic occurrence of ammonoids and inoceramid bivalves in the Urakawa and Chinomigawa formations along the Wenteshikan River and its tributaries in the Ribira River area, Hokkaido. Abbreviations: *G.t.* = *Gaudryceras tenuiliratum* beds; *S.o.* = *Sphenoceramus orientalis* beds; *S.s.* = *Sphenoceramus schmidti* beds; *M.s.* = *Metaplacenticeras subtilistriatum* beds; *B.p.* = *Baculites pacificus* beds; *B.s.* = *Baculites subanceps* beds; *B.r.* = *Baculites rex* beds.

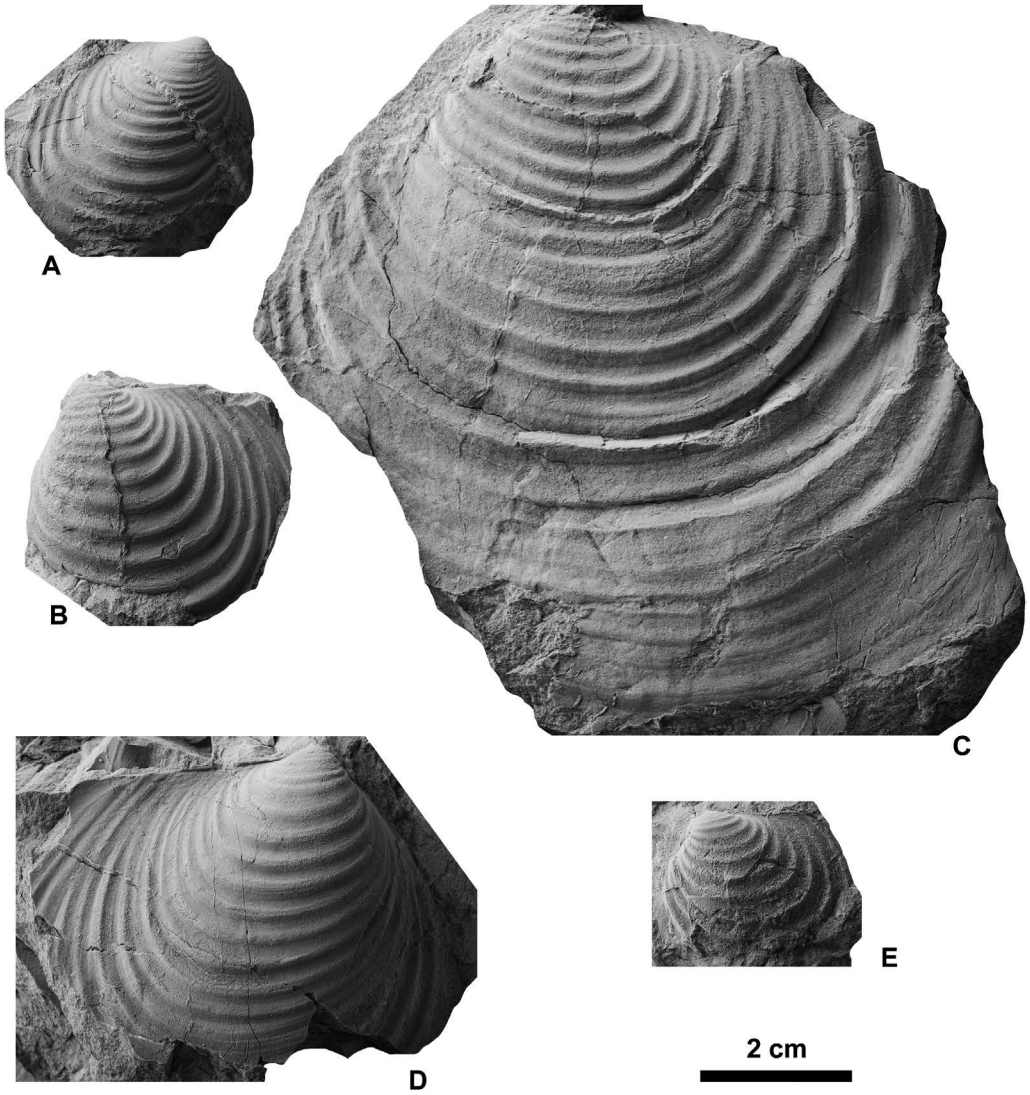

Fig. 5. *Inoceramus ezoensis* Yokoyama, 1890. All from the Chinomigawa Formation at Loc. 26. A, NMNS PM35284; B, NMNS PM35285; C, NMNS PM35286; D, NMNS PM35287; E, NMNS PM35288.

The sandy mudstone beds in the middle part of the formation are also fossiliferous, and the following ammonoids were collected from *in-situ* concretions in the lower part at Locs. 9, 10, 11: *Neophylloceras ramosum* (Meek, 1858), *Tetragonites popetensis*, *Parasolenoceras ribiraense* Shigeta sp. nov., *Pachydiscus excelsus*, *Baculites pacificus*, *Gaudryceras* sp. 1, *Desmophyllites diphylloides* (Forbes, 1846) and *Menuites nelchinensis* Jones, 1963. *Menuites armatus* Shigeta sp. nov. as well as *Baculites pacificus* was collected from a float concretion found at Loc. 3. An *in-situ* concretion from the middle part at Loc. 17 contained *Baculites subanceps*, *Menuites nelchinensis* and *Pachydiscus excelsus*. *Didymoceras hidakense* Shigeta in Shigeta *et al.* (2016) and *Baculites subanceps* were collected from float concretions found at Loc. 2 and 3. *Desmophyllites diphylloides*, *Neophylloceras nodosum* Shigeta sp. nov. and *Patagiosites* sp. were collected from *in-situ* concretions in the upper part at Loc. 8.

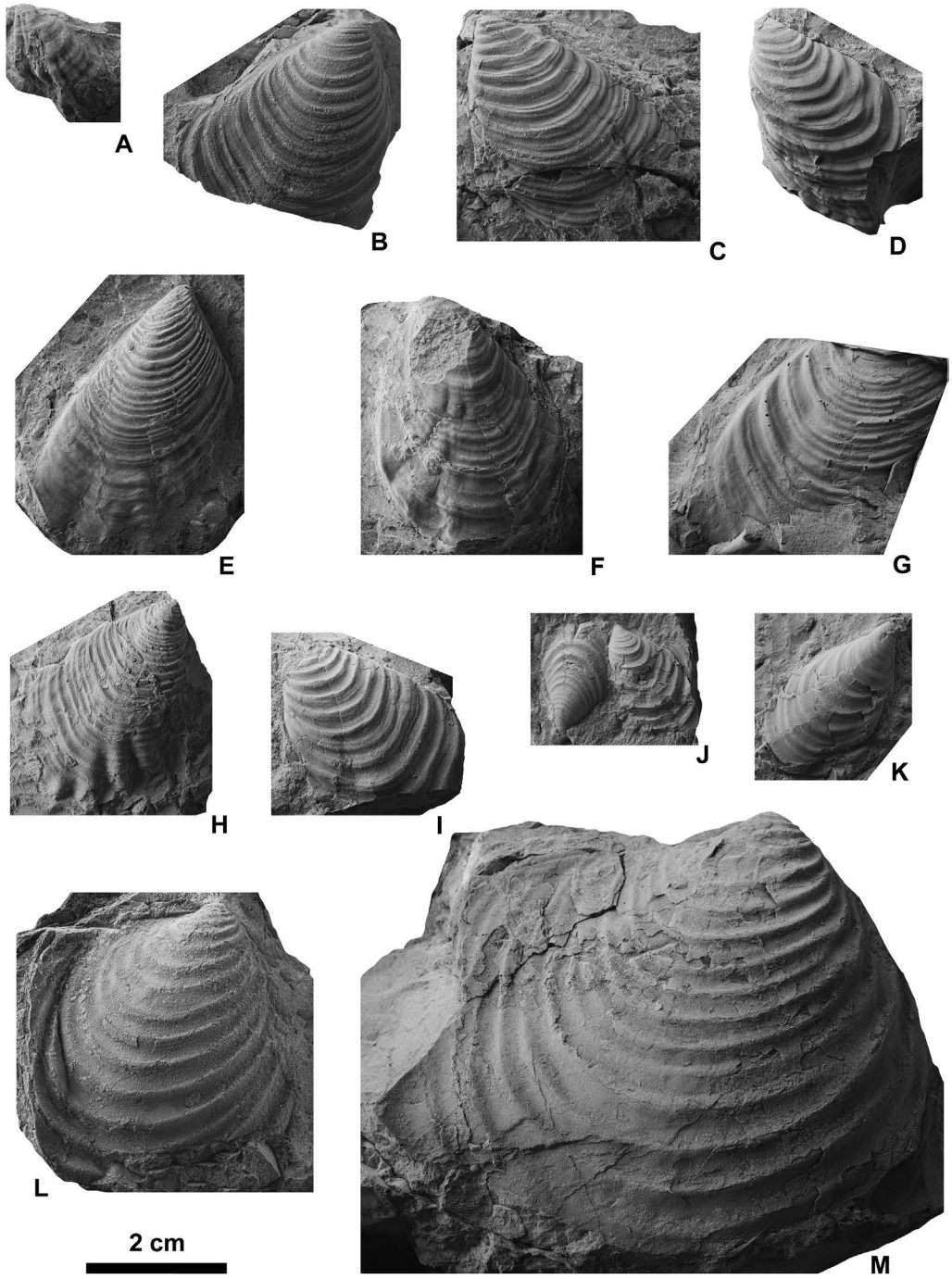

Fig. 6. *Sphenoceramus* and *Inoceramus* from the Chinomigawa Formation. A, *Sphenoceramus pseudosulcatus* (Nagao and Matsumoto, 1940), NMNS PM35294 from Loc. 26; B–K, *Sphenoceramus orientalis* (Sokolov, 1914); B–I from Loc. 26; B, NMNS PM35295; C, NMNS PM35296; D, NMNS PM35297; E, NMNS PM35298; F, NMNS PM35299; G, NMNS PM35300 (rubber cast of outer mold); H, NMNS PM35301, I, NMNS PM35302; J, K, from a float concretion found at Loc. 14; J, NMNS PM35303; K, NMNS PM35304; L, M, *Inoceramus ezoensis* Yokoyama, 1890 from Loc. 26; L, NMNS PM35290; M, NMNS PM35291.

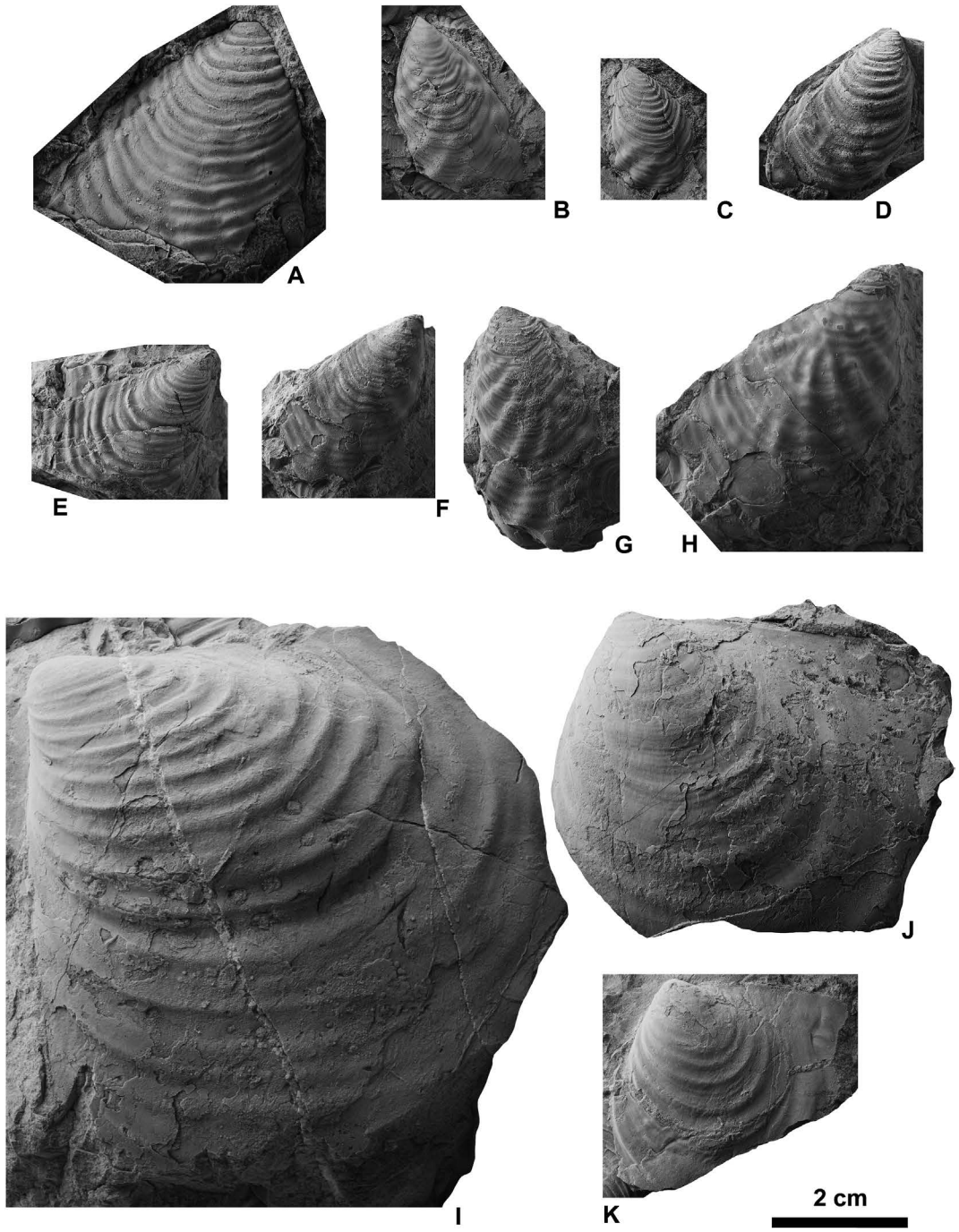

Fig. 7. *Sphenoceramus* and *Inoceramus* from the Chinomigawa Formation. A–H, *Sphenoceramus schmidti* (Michael, 1899) from Loc. 28; A, NMNS PM35305 (rubber cast of outer mold); B, NMNS PM35306; C, NMNS PM35307; D, NMNS PM35308; E, NMNS PM35309; F, NMNS PM35310; G, NMNS PM35311; H, NMNS PM35312; I–K, *Inoceramus ezoensis* Yokoyama, 1890 from Loc. 26; I, NMNS PM35289; J, NMNS PM35292; K, NMNS PM35293.

Even though the upper part of the formation is not as fossiliferous, the following ammonoids were collected from *in-situ* concretions at Loc. 6: *Tetragonites popetensis*, *Pachydiscus excelsus*, *Baculites rex* Anderson, 1958, *Gaudryceras* sp. 2 and *Diplomoceras* sp.

Biostratigraphic subdivisions

Carefully controlled bed by bed sampling has permitted the recognition of seven distinct Campanian ammonoid and inoceramid assemblages in the studied area (Figs. 4, 8, 9). Although this much higher resolution significantly adds to our knowledge of the area's biostratigraphy (Figs. 8, 9), it would be premature to introduce formal zones because fossil occurrences are not stratigraphically continuous. Our knowledge of Campanian ammonoid and inoceramid assemblages in the Yezo Group is still somewhat inadequate. Hence, we provisionally use the word "beds" to describe the following sequence of local assemblages in ascending order.

Gaudryceras tenuiliratum beds

This subdivision, which is well documented in the Urakawa Formation, contains *Gaudryceras tenuiliratum*, a common ammonoid of the Santonian and lower Campanian in the Yezo Group of Hokkaido and Sakhalin (Matsumoto, 1995). These beds probably include the Santonian *Inoceramus amakusensis* and lower Campanian *Inoceramus japonicus* zones (Toshimitsu *et al.*, 1995).

Sphenoceramus orientalis beds

This assemblage is characterized by the occurrence of *Sphenoceramus orientalis* as well as *Ainoceras kamuy*. An identical assemblage is known from the Nakagawa, Nukibetsu and Urakawa areas in Hokkaido (Matsumoto and Kanie, 1967; Kanie and Kawashita, 1981) and the Aridagawa area in Southwest Japan (Misaki and Ohara, 2011). Although *A. kamuy* has not yet been reported, the *S. orientalis*-bearing beds are known from many sections in Kyushu (Noda *et al.*, 1996), Hokkaido and Sakhalin (Nagao and Matsumoto, 1940; Zonova *et al.*, 1993). Shigeta and Tsutsumi (2018) reported that the age of the tuff bed immediately below the *S. orientalis*-bearing beds of the Osoushinai Formation in the Nakagawa area, northern Hokkaido is 80.2 ± 0.8 Ma (95% conf.), which suggests an earliest middle Campanian age.

Sphenoceramus schmidti beds

These beds are characterized by the occurrence *Sphenoceramus schmidti*, which is common in the Upper Cretaceous of the Yezo Group in Hokkaido (Nagao and Matsumoto, 1940), Sakhalin (Zonova *et al.*, 1993) and Southwest Japan (Noda *et al.*, 1996; Misaki and Maeda, 2009). An identical assemblage that includes *Canadoceras mysticum* is known from the Cape Soya and Nakagawa areas in Hokkaido (Matsumoto and Miyauchi, 1984; Takahashi *et al.*, 2003).

Kodama (1990) correlated the *Sphenoceramus schmidti*-bearing beds of the Izumi Group, Southwest Japan with the uppermost part of polarity chron C33r. Tsutsumi *et al.* (2014) reported that the age of a tuff bed in the *S. schmidti*-bearing beds of the Himenoura Group, Southwest Japan is 79.7 ± 0.7 Ma (95% conf.). Shigeta and Tsutsumi (2018) stated that the age of a tuff bed immediately below the *S. orientalis*-bearing beds of the Osoushinai Formation in the Nakagawa area is 80.2 ± 0.8 Ma (95% conf.). Taken together, this evidence suggests that the *S. schmidti*-bearing beds correlate with the lower middle Campanian.

Metaplacenticeras subtilistriatum beds

This subdivision contains *Metaplacenticeras subtilistriatum* as well as *Canadoceras multicostatum* and *Menuites fascicostatus*. An identical assemblage is known from the Teshio Mountains, Cape Soya and Urakawa areas (Matsumoto, 1984; Matsumoto and Miyaushi, 1984; Shigeta *et al.*, 2016). Although *M. subtilistriatum* has not yet been reported from Sakhalin, a similar assemblage is known from the Naiba and

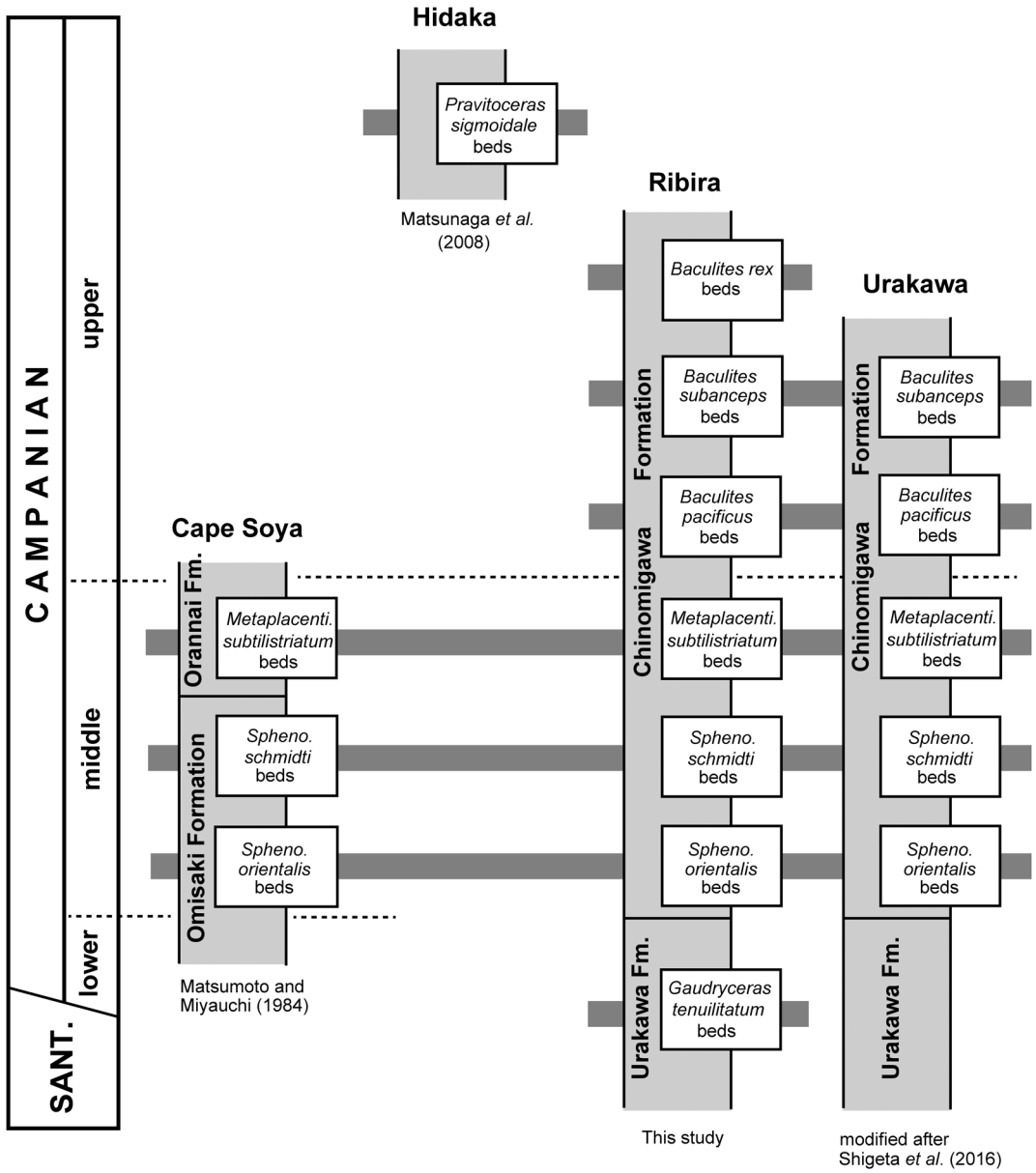

Fig. 8. Diagram showing biostratigraphic correlation between middle and upper Campanian deposits in Hokkaido.

Makarov areas (Kodama *et al.*, 2002; Maeda *et al.*, 2005). Beds containing *M. subtilistriatum* are also known in the Asan Mountains, Southwest Japan (Morozumi, 1985).

***Baculites pacificus* beds**

These beds are characterized by the occurrence of *Baculites pacificus*. Shigeta *et al.* (2016) assigned 17 specimens to *Baculites subanceps* from Unit U6 of the Chinomigawa Formation in the Urakawa area, but seven of the specimens from Locs 1 and 7 lack crescentic nodes on their flanks and are identical to *B. pacificus*. Shigeta *et al.* (2016) reported that the age of a tuff bed immediately below the *B. pacificus*-bearing beds is 76.0 ± 1.3 Ma (95% conf.) to 75.1 ± 0.9 Ma

(95% conf.), which infer an early late Campanian age. Therefore, the *B. pacificus* beds should be correlated with the lower upper Campanian.

***Baculites subanceps* beds**

This subdivision contains *Baculites subanceps* as well as *Didymoceras hidakense*. Although *D. hidakense* has not been found with *B. subanceps* at Loc. 17, the two taxa have been found together in float concretions at Locs. 2 and 3 along a small tributary of the Ribira River (see Fig. 2). An identical assemblage is known from the Urakawa area (Shigeta *et al.*, 2016). Because *D. hidakense* closely resembles *Didymoceras* sp. A of Morozumi (2007), the *B. subanceps* beds probably correlate with the lower part of the *Didymoceras* sp. Zone of Morozumi (1985) in the Asan Mountains, Southwest Japan. *Baculites subanceps* is known from the upper middle to lower upper Campanian in the western coastal region of North America (Ward *et al.*, 2012).

***Baculites rex* beds**

The bed yielding *Baculites rex* is well documented at Loc. 6, and a bed that yields *Neophylloceras nodosum* sp. nov. at Loc. 8 most likely should be included in the *Baculites rex* beds, because the taxa often occur together in the Hidaka area, Hokkaido (Shigeta, unpublished data). *Baculites rex* is known from the lower upper Campanian of the western coastal region of North America (Ward *et al.*, 2012).

Discussion

Biostratigraphic implication

The following three middle Campanian ammonoid and inoceramid assemblages have been recognized in the Yezo Group, in ascending order: *Sphenoceramus orientalis*, *S. schmidti* and *Metaplacenticeras subtilistriatum* (Fig. 9).

Upper Campanian strata of the Izumi Group of Southwest Japan yield numerous well-preserved fossils from various horizons, and the following four ammonoid zones are recognized, in ascending order: *Didymoceras* sp., *D. awajiense*, *Pravitoceras sigmoidale* and *Pachydiscus awajiensis* (Morozumi, 1985). In contrast, the biostratigraphic framework of the upper Campanian in the Yezo Group is still ambiguous (Shigeta *et al.*, 1999), because a continuous succession of marine fossil assemblages spanning the late Campanian–Maastrichtian has not yet been found.

Shigeta *et al.* (2016) discovered a continuous succession yielding middle Campanian *Metaplacenticeras subtilistriatum*, early late Campanian *Baculites pacificus* and *B. subanceps* in the Urakawa area of Hokkaido. A similar succession occurs in the Ribira River area. Because *Baculites pacificus* is somewhat similar to *B. kotanii*, it is possible that the *B. pacificus* beds may be correlated with the *B. kotanii* Zone overlying the *M. subtilistriatum* Zone in the Izumi Group (Fig. 9). *Didymoceras hidakense* from the *B. subanceps* beds closely resembles *Didymoceras* sp. of the Izumi Group, and this similarity suggests that the *B. subanceps* beds are probably a correlative of the *Didymoceras* sp. Zone (Shigeta *et al.*, 2016). Upper Campanian strata overlying the *B. subanceps* beds are not known to occur in the Urakawa area because of a synclinal structure. As reported herein, a more complete succession of late Campanian assemblages occurs in the Ribira River area, and it includes an additional fossil assemblage, the *Baculites rex* beds that overlap the *B. subanceps* beds. Because *Baculites rex* is known from the lower upper Campanian of the coastal region of western North America (Ward *et al.*, 2012), the three assemblages from the *Bacilites pacificus* to the *B. rex* beds can be correlated with the lower upper Campanian.

The fossil assemblages overlying the *Baculites rex* beds are not recorded in the Ribira River area because of fault contact with the Miocene Furanui Formation. The uppermost Campanian *Pachydiscus awajiensis* Zone has not been recognized in the Yezo Group, but *Pravitoceras sigmoidale*, an index ammonoid of the second zone from the top of Campanian is found in the Hidaka area (Matsunaga *et al.*, 2008; Shigeta and Izukura, 2018a). Because a detailed stratigraphic study of upper Campanian strata has not been

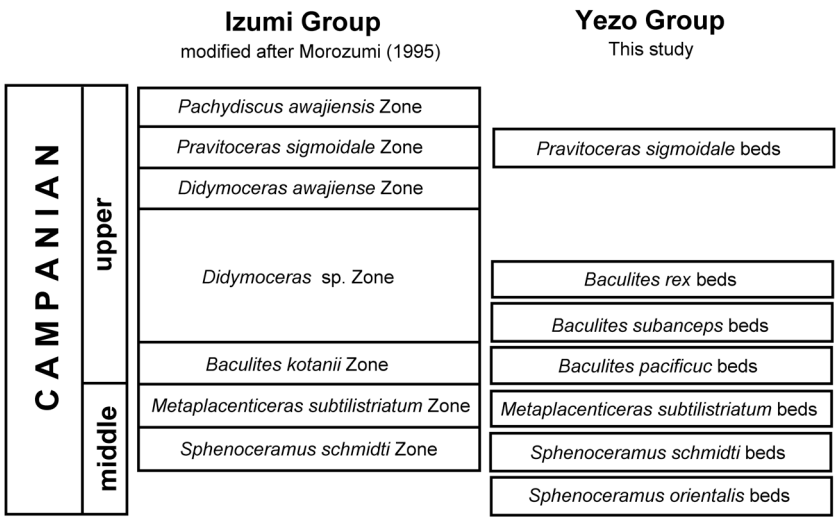

Fig. 9. Diagram showing biostratigraphic correlation between middle and upper Campanian deposits in the Izumi Group, Southwest Japan and the Yezo Group, Hokkaido.

conducted in the Hidaka area, fossil assemblages below and above the *Pravitoceras sigmoidale*-bearing beds are not well known. However, the occurrence of *Inoceramus shikotanensis* Nagao and Matsumoto, 1940, an uppermost Campanian–lowest Maastrichtian index fossil, suggests that the *Pravitoceras sigmoidale* beds in the Yezo Group are much higher stratigraphically than the *Baculites rex* beds. Furthermore, the fact that U–Pb age of the lower part of the *Didymoceras awajiense* Zone of the Sotoizumi Group, Southwest Japan is 72.4 ± 0.8 Ma (95% conf.), inferring a late late Campanian age, suggests that the zone is also probably higher stratigraphically than the *Baculites rex* beds (Shigeta *et al.*, 2017).

A complete succession of marine fossil assemblages spanning the middle to late Campanian has not been found in the Yezo Group, but the fossil record in the Ribira River area provides an important key for the establishment of a precise biostratigraphic framework for the middle to lower part of the upper Campanian in Hokkaido and Sakhalin. Recently, Shigeta and Izukura (2018a, b) reported the occurrence of the *Canadoceras multicostatum* and *Pravitoceras sigmoidale* assemblages in the Hidaka area. Although a detailed stratigraphic study of the Cretaceous has not yet been conducted in this area, it is anticipated that further geological and paleontological work may provide a complete succession of marine fossil assemblages spanning the middle to late Campanian.

Paleobiogeography of *Pachydiscus*

Matsumoto and Miyauchi (1984) described *Pachydiscus soyaensis* from the middle Campanian in the Soya area, but the distinctive features of the moderately involute shell with tubercles above the umbilical shoulder enable us to assign it to *Menuites*. All the specimens examined by Matsumoto and Miyauchi (1984) are at least slightly deformed and a few are very badly distorted. As Shigeta and Izukura (2018b) earlier pointed out, this preservation may have led them to believe that the shell was originally more slender, and similar in shape to *Pachydiscus*. Furthermore, the missing shell material from most of the specimens they examined makes the elongated base of the umbilical tubercle appear somewhat similar to the umbilical bullae of *Pachydiscus*.

Pachydiscus is known worldwide from the Campanian and Maastrichtian, but Campanian members are best known from Europe, where the oldest taxon occurs in the lower Campanian, and

several species occur in the higher Campanian (e.g. Kennedy and Summesberger, 1984; Kennedy, 1986). In contrast, two Campanian species of *Pachydiscus*, *P. excelsus* from Hokkaido and *P. awajiensis* from Southwest Japan, have until now only been reported from the upper Campanian in the Northwest Pacific region (Matsumoto, 1979; Morozumi, 1985), but the discovery of *P. excelsus* in the *Metaplacenticeras subtilistriatum* beds in the Ribira River area demonstrates that *Pachydiscus* first appears in the middle Campanian in this particular region.

It is well known that some ammonoid taxa, e.g. *Pseudophyllites*, *Desmophyllites*, *Saghalinites* and *Metaplacenticeras* probably originated in other regions and extended their geographical distribution to the North Pacific region during the middle Campanian (Shigeta, 1992). In other words, much of the middle Campanian ammonoid fauna of the Northwest Pacific region may have been formed by adding "foreign taxa" that migrated from other regions and joined the existing indigenous ammonoid fauna. Indeed, *Pachydiscus* may be one of these "foreign taxa", and the Ribira River area occurrence suggests that it extended its geographical distribution from other areas to the Northwest Pacific region during middle Campanian time.

Paleontological description

(by Y. Shigeta)

Morphological terms are those used in Arkell (1957). Quantifiers used to describe the shape of ammonoid shell replicate those proposed by Matsumoto (1954, p. 246) and modified by Haggart (1989, table 8.1).

Abbreviations for shell dimensions.—*D* = shell diameter; *U* = umbilical diameter; *H* = whorl height; *W* = whorl width.

Institution abbreviations.—BMNH = Natural History Museum, London; CAS = California Academy of Sciences, San Francisco; GK = Department of Earth and Planetary Sciences, Kyushu University, Fukuoka; HMG = Hobetsu Museum, Mukawa; LSJU = Stanford University, Stanford, California; NMNS = National Museum of Nature and Science, Tsukuba; UMUT = University Museum, University of Tokyo; USNM = United State National Museum, Washington, D. C.

Suborder Phylloceratina Arkell, 1950
Superfamily Phylloceratoidea Zittel, 1884
Family Phylloceratidae Zittel, 1884
Genus ***Neophylloceras*** Shimizu, 1934

Type species.—*Ammonites* (*Scaphites*?) *ramosus* Meek, 1858.

Remarks.—*Neophylloceras* has been regarded as either a synonym of *Hypophylloceras* Salfeld, 1924, a subgenus of *Hypophylloceras* or *Phylloceras* Suess, 1865, or as an independent genus. We herein follow the interpretation of Murphy and Rodda (2006) and treat *Neophylloceras* as an independent genus.

Neophylloceras nodosum Shigeta sp. nov.

Fig. 10A–E

Holotype.—HMG-1848, consisting of a phragmocone and fragment of the body chamber, was collected from Loc. 8.

Diagnosis.—*Neophylloceras* with single row of nodes at mid-flank.

Etymology.—Species name refers to nodes, from the Latin word: *nodus*.

Description.—Very involute, very compressed shell with elliptical whorl section, arched venter, rounded ventral shoulders and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus narrow and deep with moderately high, vertical wall and rounded shoulders. Ornamentation consists of broad undulations on inner flank, single row of nodes at mid-flank, and fine, dense lirae, which arise at umbilical seam, sweep gently forward across inner flank, and then strengthen and become rectiradiate at mid-flank before passing straight across venter.

Measurements.—Taken at *D* = 23.0 mm of HMG-1848, *U* = 2.0 mm, *H* = 12.5 mm, *W* = 7.0 mm, *U/D* = 0.09, *W/H* = 0.56.

Comparison.—Compared with all known spe-

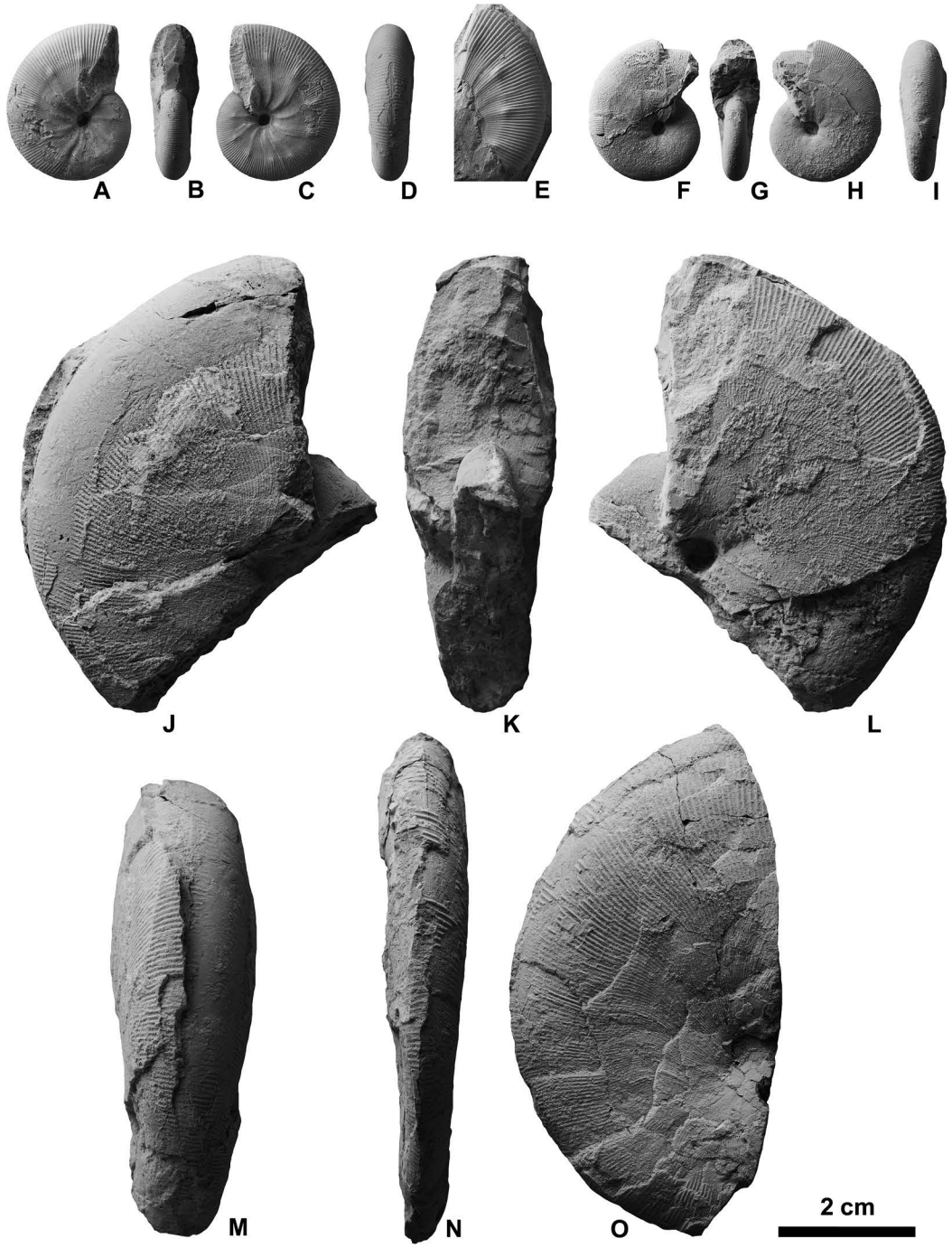

Fig. 10. *Neophylloceras* from the Chinomigawa Formation. A–E, *Neophylloceras nodosum* Shigeta sp. nov., HMG-1848, (holotype) from Loc. 8; F–O, *Neophylloceras ramosum* (Meek, 1858); F–I, HMG-1850 from Loc. 9; J–M, HMG-1851 from Loc. 11; N, O, HMG-1849 from a float concretion found at Loc. 3.

cies of *Neophylloceras*, *N. nodosum* sp. nov. is closer to *N. hetonaiense* Matsumoto, 1942d with its broad undulations on the inner flank and rectiradiate lirae on the outer flank, but differs by having a single row of nodes at mid-flank.

Occurrence.—Described specimen was collected from the lower upper Campanian *Baculites rex* beds in the Chinomigawa Formation at studied section III.

Neophylloceras ramosum (Meek, 1858)

Fig. 10F–O

Ammonites (*Scaphites*?) *ramosus* Meek, 1858, p. 45.

Ammonites velledae Michelin. Schmidt, 1873, p. 10, pl. 1, figs. 3, 4.

Phylloceras velledae (Michelin). Yokoyama, 1890, p. 177, pl. 19, fig. 1.

Phylloceras? *ramosus* (Meek). Meek, 1876, p. 371, pl. 5, fig. 1.

Phylloceras cf. *ramosus* (Meek). Yabe, 1927, p. 31, pl. 9, fig. 3.

Phylloceras ramosum (Meek). Anderson, 1958, p. 181, pl. 40, fig. 4.

Phylloceras (*Neophylloceras*) *ramosum* (Meek). Henderson and McNamara, 1985, p. 40, pl. 1, figs. 1–3, text-fig. 2c; Ward and Kennedy, 1993, p. 15, fig. 17.2, 17.5, 17.6.

Phylloceras (*Hypophylloceras*) *ramosum* (Meek). Stinnesbeck, 1986, p. 189, pl. 7, figs. 1, 2, text-figs. 16a, 17b.

Phylloceras subramosum Shimizu, 1935, p. 165.

Neophylloceras ramosum (Meek). Usher, 1952, p. 49, pl. 1, figs. 4, 5; Matsumoto, 1959b, p. 1, pl. 1, fig. 1, pl. 2, fig. 2, pl. 8, fig. 1; Jones, 1963, p. 22, pl. 6, figs. 1–8, text-fig. 7; Henderson, 1970, p. 5, pl. 1, fig. 3, text-fig. 2a; Matsumoto, 1984, p. 9, pl. 1, fig. 1; Matsumoto and Miyauchi, 1984, p. 37, pl. 10, fig. 5; Yazykova, 1992, p. 195, pl. 107, fig. 4, pl. 108, fig. 2, pl. 109, fig. 2; Zonova *et al.*, 1993, p. 144, pl. 75, fig. 4, pl. 79, fig. 3, pl. 101, fig. 3; Yazykova, 1994, p. 287, pl. 1, fig. 9, 10; Alabushev and Wiedmann, 1997, p. 6, pl. 1, figs. 1, 2, pl. 2, fig. 1 right.

Neophylloceras aff. *ramosum* (Meek). Matsumoto and Miyauchi, 1984, p. 37, pl. 10, fig. 2, pl. 23, fig. 1.

Neophylloceras subramosum (Shimizu). Matsumoto, 1942d, p. 675, text-fig. 1a$_1$, b$_1$; Matsumoto *et al.*, 1963, p. 29, pl. 45, fig. 1 (= Yokoyama, 1890, pl. 19, fig. 1); Wani, 2001, figs. 2A, 3B, 4, 7A, B.

Hypophylloceras ramosum (Meek). Vereshchagin *et al.*, 1965, p. 46, pl. 45, figs. 1–4; Poyarkova *et al.*, 1987, pl. 25, fig. 9.

Hypophylloceras (*Neophylloceras*) *ramosum* (Meek). Takahashi *et al.*, 2007, pl. 5, fig. 1; Salazar *et al.*, 2010, p. 184, fig. 4a–d, m.

Hypophylloceras (*Neophylloceras*) *subramosum* (Shimizu). Kurihara and Kano, 2006, pl. 1, fig. 1; Kurihara *et al.*, 2007, pl. 3, fig. 4; Takahashi *et al.*, 2007, pl. 1, fig. 1.

Hypophylloceras subramosum (Shimizu). Kawabe, 2000, pl. 7, fig. 4; Shigeta, 2001, pl. 56, figs. 3, 4.

Holotype.—USNM 12451, figured by Meek (1876, p. 371, pl. 5, fig. 1), from "Komooks", Vancouver Island. According to Usher (1952, p. 50), the type locality may be Hornby Island, British Columbia, Canada. Holotype was not figured by Meek (1857, p. 45).

Material examined.—One specimen, HMG-1849, from a float concretion found at Loc. 3; one specimen, HMG-1850, from Loc. 9; one specimen, HMG-1851 from Loc. 11.

Description.—Very involute shell with very compressed elliptical whorl section, arched venter, rounded ventral shoulders and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus narrow and deep with moderately high, vertical wall and rounded shoulders. Ornamentation consists of fine, dense, slightly sinuous, prorsiradiate lirae, which arise at umbilical seam, strengthen and become slightly sigmoidal at mid-flank before passing straight across venter.

Remarks.—Shimizu (1935, p. 165) proposed *Phylloceras subramosum* based on a specimen illustrated as *P.* cf. *ramosum* by Yabe (1927, pl. 7, fig. 3), which was collected from the "Urakawa" series (= Coniacian–lower Campanian) of Hokkaido. Numerous authors subsequently attributed many specimens to *P. subramosum*, *Neophylloceras subramosum* or *Hypophylloceras subramosum* from the Yezo Group in Hokkaido, but all are assignable to *Neophylloceras ramosum*.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificus* beds in the Chinomigawa Formation at study section III. Float concretion found at study section I probably came from the same bed. *Neophylloceras ramosum* is also

known to range from the Turonian to upper Campanian in Japan, Northeast Russia and California, and upper Campanian–Maastrichtian in Alaska, Vancouver Island, southern Argentina, Chile, the Antarctic Peninsula, western Australia, New Zealand and northern Spain.

Genus ***Phyllopachyceras*** Spath, 1925

Type species.—*Ammonites infundibulum* d'Orbigny, 1841.

Phyllopachyceras ezoense (Yokoyama, 1890)

Fig. 11

Phylloceras ezoense Yokoyama, 1890, p. 178, pl. 19, fig. 2; Yabe and Shimizu, 1921, p. 54, pl. 8, fig. 2.

Phyllopachyceras ezoense (Yokoyama). Shimizu, 1934, fig. 35 (= Yokoyama, 1890, pl. 19, fig. 2); Matsumoto *et al.*, 1963, p. 29, pl. 45, fig. 2 (= Yokoyama, 1890, pl. 19, fig. 2); Vereshchagin *et al.*, 1965, p. 54, pl. 64, figs. 1, 2; Matsumoto and Miyauchi, 1984, p. 38, pl. 10, figs. 3, 4; Poyarkova *et al.*, 1987, pl. 26, fig. 7; Zonova *et al.*, 1993, p. 146, pl. 75, figs. 1–3, pl. 83, fig. 3; Alabushev and Wiedmann, 1997, p. 6, pl. 1, figs. 3–5; Wani, 2001, fig. 8A–C; Ando *et al.*, 2001, pl. 1, figs. 4–7; Shigeta, 2001, pl. 56, figs. 7, 8; Maeda *et al.*, 2005, p. 60, fig. 24.5–24.11; Takahashi *et al.*, 2007, pl. 1, fig. 2; Jagt-Yazykova, 2011, pl. 10, figs. 7, 8.

Holotype.—The holotype, figured by Yokoyama (1890, p. 178, pl. 19, fig. 2), from the Yezo Group in the Urakawa area, Hokkaido, is reposited in Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany. Its exact collection locality and horizon are unknown.

Material examined.—Two specimens, NMNS PM35191, 35192, from a float concretion found at Loc. 1; one specimen, NMNS PM35193, from a float concretion at Loc. 3; three specimens, HMG-1852–1854, from Loc. 15; two specimens, HMG-1855, NMNS PM35194, from Loc. 26.

Description.—Very involute, fairly depressed shell with sub-circular whorl section, arched venter, rounded ventral shoulders and convex flanks with maximum whorl width at mid-flank. Umbilicus very narrow, deep and funnel-shaped. Ornamentation consists of very fine, dense, prorsiradiate lirae, which curve slightly forward on the ventral shoulder and pass over venter in a broad convex arch. As shell grows, low, rounded ribs appear on middle and outer flank and extend across venter.

Remarks.—Mature whorls of *Phyllopachyceras ezoense* exhibit frequent, strong, rounded ribs (Matsumoto and Miyauchi, 1984). The lack of such ribs suggests that the described specimens are immature shells.

Occurrence.—Described *in-situ* specimens were collected from the middle Campanian *Sphenoceramus orientalis* and *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study sections III and VII. Float concretions collected at study section I most likely came from the same beds and possibly the lower upper Campanian *Baculites pacificus* beds. *Phyllopachyceras ezoense* is abundant and ranges from the Turonian to Campanian of the Yezo Group in Hokkaido and Sakhalin.

Suborder Lytoceratina Hyatt, 1889

Superfamily Tetragonitoidea Hyatt, 1900

Family Tetragonitidae Hyatt, 1900

Genus ***Saghalinites*** Wright and Matsumoto, 1954

Type species.—*Ammonites cala* Forbes, 1846.

Saghalinites teshioensis Matsumoto, 1984

Fig. 12A

Saghalinites teshioensis Matsumoto, 1984, p. 27, pl. 9, figs. 1–3; Matsumoto, 1988, p. 179, pl. 51, fig. 1; Maeda *et al.*, 2005, p. 90, fig. 45.1–45.9; Takahashi *et al.*, 2007, pl. 5, figs. 6, 7; Shigeta *et al.*, 2016, p. 331, fig. 7A–C; Shigeta and Izukura, 2018b, p. 13, fig. 2A.

Holotype.—GK. H5971, figured by Matsumoto (1984, p. 27, pl. 9, fig. 1), from the *Metaplacenticeras subtilistriatum* Zone (middle Campanian) in the Uttsu River area, Teshio Mountains, northern Hokkaido.

Material examined.—One specimen, HMG-

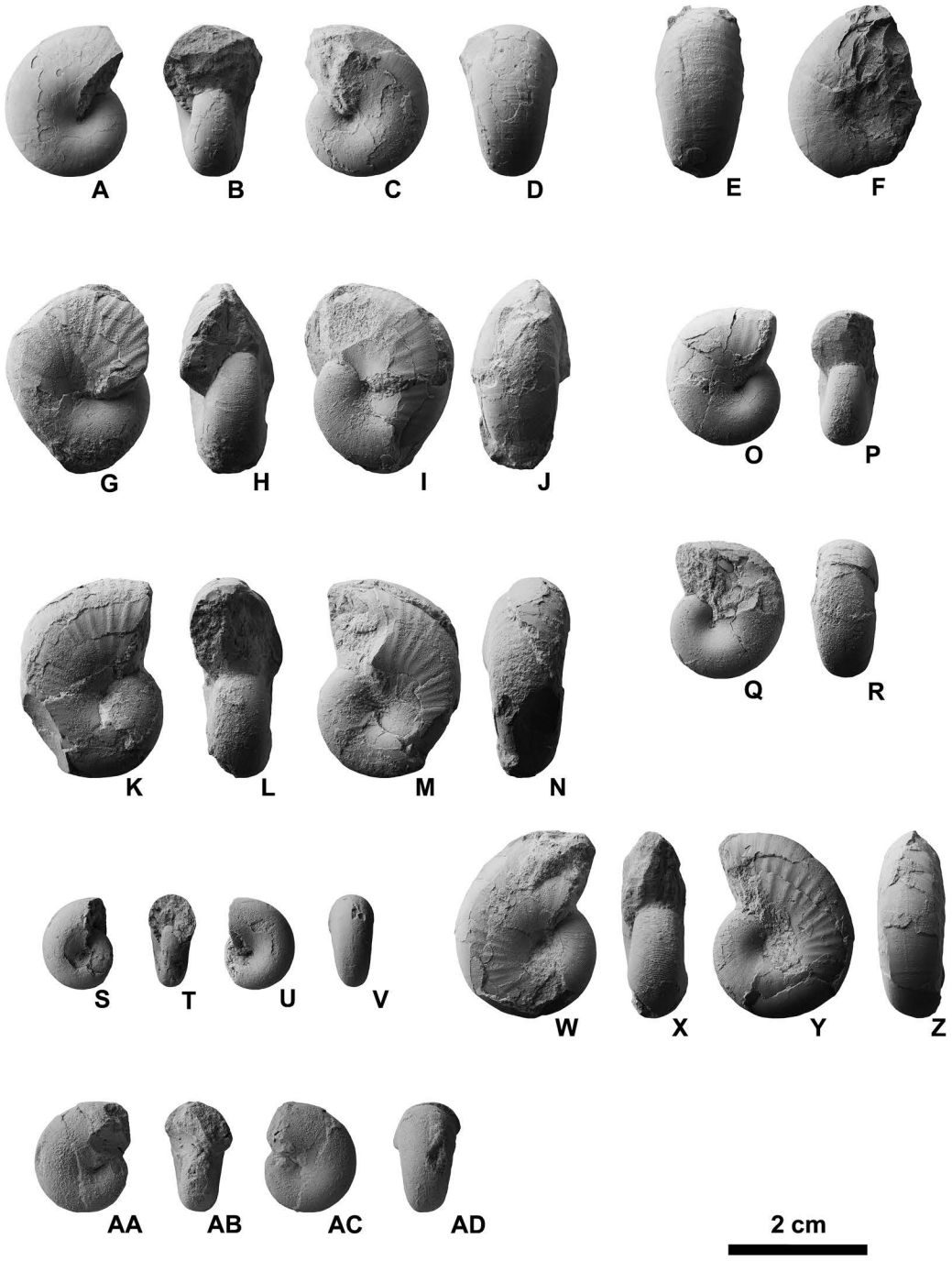

Fig. 11. *Phyllopachyceras ezoense* (Yokoyama, 1890) from the Chinomigawa Formation. A–D, HMG-1855 from Loc. 26; E, F, NMNS PM35194 from Loc. 26; G–J, HMG-1852 from Loc. 15; K–N, HMG-1853 from Loc. 15; O–R, HMG-1854 from Loc. 15; S–V, NMNS PM35191 from a float concretion found at Loc. 1; W–Z, NMNS PM35192 from a float concretion found at Loc. 1; AA–AD, NMNS PM35193 from a float concretion found at Loc. 3.

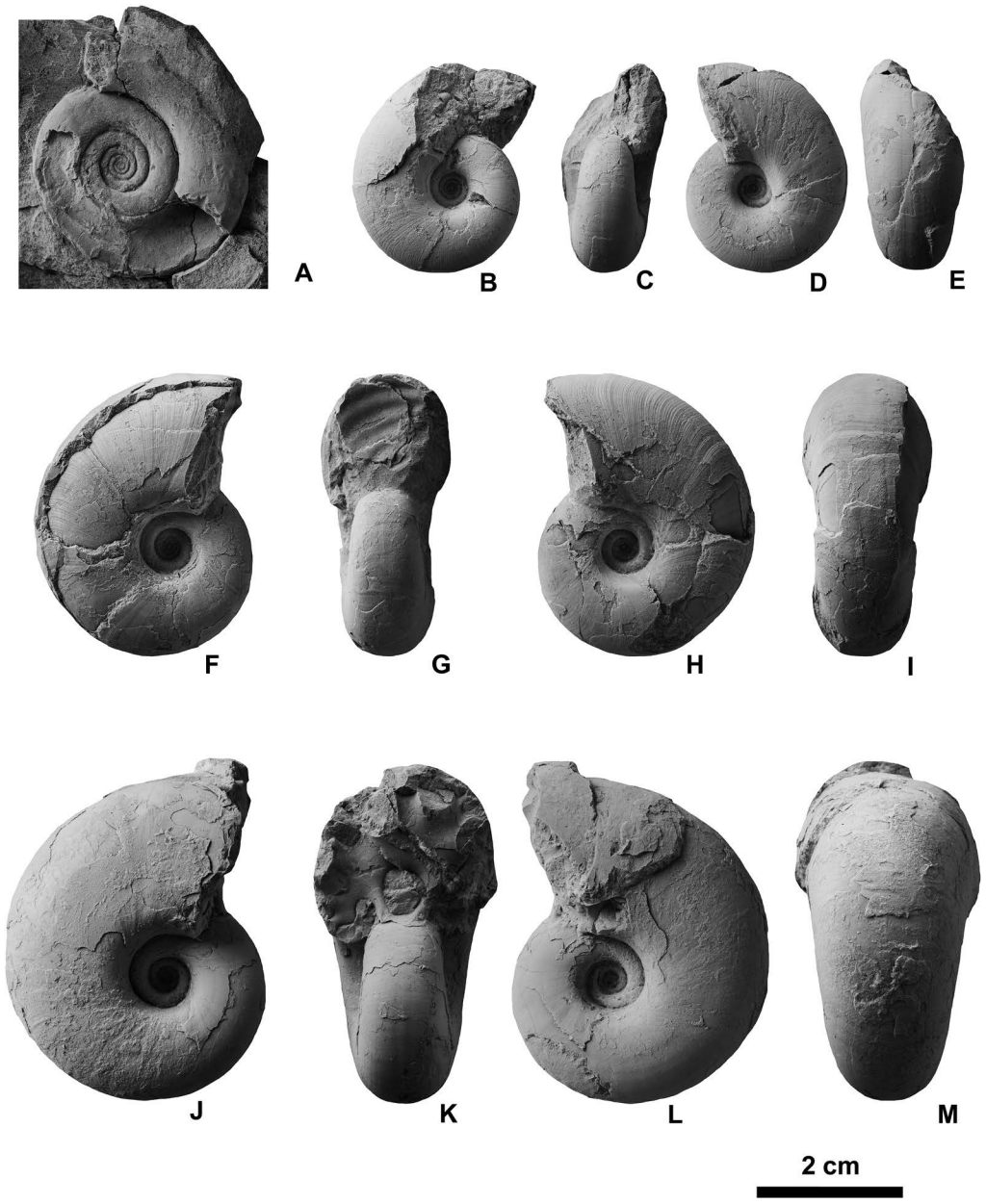

Fig. 12. *Saghalinites* and *Tetragonites* from the Chinomigawa Formation. A, *Saghalinites teshioensis* Matsumoto, 1984, HMG-1856 from Loc. 24; B–M, *Tetragonites glabrus* (Jimbo, 1894); B–E, HMG-1858 from Loc. 26; F–I, HMG-1859 from Loc. 26; J–M, HMG-1857 from Loc. 25.

1856, from Loc. 24.

Description.—Very evolute shell with rounded whorl section, arched venter, rounded ventral shoulders and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus fairly wide with nearly vertical wall and rounded shoulders. Ornamentation consists only distant constrictions and very fine growth lines, which are prorsiradiate on flanks, but become slightly sinuous at ventral shoulder before crossing over venter with shallow concave arch.

Remarks.—See Shigeta *et al.* (2016) for a

recent discussion of *Saghalinites teshioensis*.

Occurrence.—Described specimen was collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study section V. *Saghalinites teshioensis* occurs in the middle Campanian *Metaplacenticeras subtilistriatum* Zone in the Cape Soya area and the Teshio Mountains, Hokkaido and the lower upper Campanian *Baculites pacificus* Zone in the Urakawa area, Hokkaido. It also occurs together with *Menuites soyaensis* of the middle Campanian in the Naiba and Makarov areas, Sakhalin and the Hidaka area, Hokkaido.

Genus ***Tetragonites*** Kossmat, 1895

Type species.—*Ammonites timotheanus* Pictet, 1847.

Tetragonites glabrus (Jimbo, 1894)

Fig. 12B–M

?*Lytoceras* sp. Yokoyama, 1890, p. 181, pl. 19, fig. 4.
Lytoceras glabrum Jimbo, 1894, p. 180, pl. 22, fig. 2.
Lytoceras sphaeronotum Jimbo, 1894, p. 181, pl. 22, fig. 4.
Lytoceras crassum Jimbo, 1894, p. 181, pl. 22, fig. 5.
Tetragonites glabrus (Jimbo). Yabe, 1903, p. 43, pl. 7, figs. 2, 5; Matsumoto, 1959b, p. 149, pl. 39, figs. 2, 3, text-figs. 72, 73; Matsumoto, 1963, p. 44, pl. 65, fig. 2 (= Jimbo, 1894, pl. 22, fig. 2), fig. 4 (= Jimbo, 1894, pl. 22, fig. 4); Tanabe and Kanie, 1978, p. 8, pl. 1, fig. 2; Shigeta, 1989, p. 334, figs. 12.1, 12.2; Nishida *et al.*, 1995, pl. 4, fig. 1; Nishida *et al.*, 1996, pl. 40, fig. 1; Zonova and Yazykova, 1998, pl. 10, fig. 12; Nishida *et al.*, 1998, pl. 7, fig. 2, pl. 8, fig. 1; Wani, 2001, figs. 4, 6; Copper, 2003, p. 96, figs. 3F, G, 5E, F; Maeda *et al.*, 2005, p. 84, fig. 42.1–42.4; Kurihara and Kano, 2006, pl. 3, fig. 1; Kurihara *et al.*, 2007, pl. 4, fig. 4 (= Kurihara and Kano, 2006, pl. 3, fig. 1).
Tetragonites cf. *glabrus* (Jimbo). Nishida *et al.*, 1995, pl. 3, fig. 2.
?*Tetragonites* cf. *glabrus* (Jimbo). Matsumoto *et al.*, 1963, p. 29, pl. 45, fig. 4 (= Yokoyama, 1890, pl. 19, fig. 4).
Tetragonites crassus (Jimbo). Matsumoto, 1963, p. 44, pl. 65, fig. 5 (= Jimbo, 1894, pl. 22, fig. 5).
Tetragonites sphaeronotus (Jimbo). Yabe, 1903, p. 45, pl. 7, fig. 1.
Tetragonites epigonus Kossmat. Yazykova, 1994, p. 294, pl. 5, fig. 1.
Tetragonites cf. *epigonus* Kossmat. Yabe, 1903, p. 49, pl. 7, fig. 3; Yazykova *et al.*, 2004, fig. 9.7.
Epigoniceras glabrum (Jimbo). Vereshchagin *et al.*, 1965, p. 48, pl. 48, figs. 2, 3; Poyarkova *et al.*, 1987, pl. 26, fig. 1.
Epigoniceras glabrum var. *problematica* Matsumoto, 1942c, p. 672, fig. 1.
Epigoniceras epigonum (Kossmat). Alabushev and Wiedmann, 1997, p. 8, pl. 1, figs. 8–11, text-fig. 1.

Holotype.—UMUT MM7513, figured by Jimbo (1894, p. 180, pl. 22, fig. 2), from the Upper Cretaceous of Ikandai in the Urakawa area, Hokkaido.

Material examined.—One specimen, HMG-1857, from Loc. 25; two specimens, HMG-1858, 1859, from Loc. 26.

Description.—Fairly involute, fairly depressed shell with sub-rounded to sub-quadrate whorl section, rounded venter, rounded ventral shoulders, and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus fairly narrow and deep with high, nearly vertical wall and rounded shoulders. Ornamentation consists of very fine growth lines, which are prorsiradiate on flanks, but become slightly sinuous at ventral shoulders before crossing venter with very shallow concave arch.

Remarks.—See Maeda *et al.* (2005) for a discussion of *Tetragonites glabrus*.

Occurrence.—Described specimens were collected from the middle Campanian *Sphenoceramus orientalis* beds in the Chinomigawa Formation at study section V and VII. *Tetragonites glabrus* is abundant from the Turonian to lower Campanian of the Yezo Group in Hokkaido and Sakhalin. The species is also known from the Santonian to Campanian of northern Kamchatka, Northeast Russia.

Tetragonites popetensis Yabe, 1903

Figs. 13–18

Ammonites timotheanus Pictet. Schmidt, 1873, p. 14, pl. 2, figs. 7–11.
Tetragonites popetensis Yabe, 1903, p. 48, pl. 7, figs. 4, 6; Matsumoto and Miyauchi, 1984, p. 52, pl. 23, fig. 3; Matsumoto, 1988, p. 178, pl. 50, figs. 3, 4; Zonova *et*

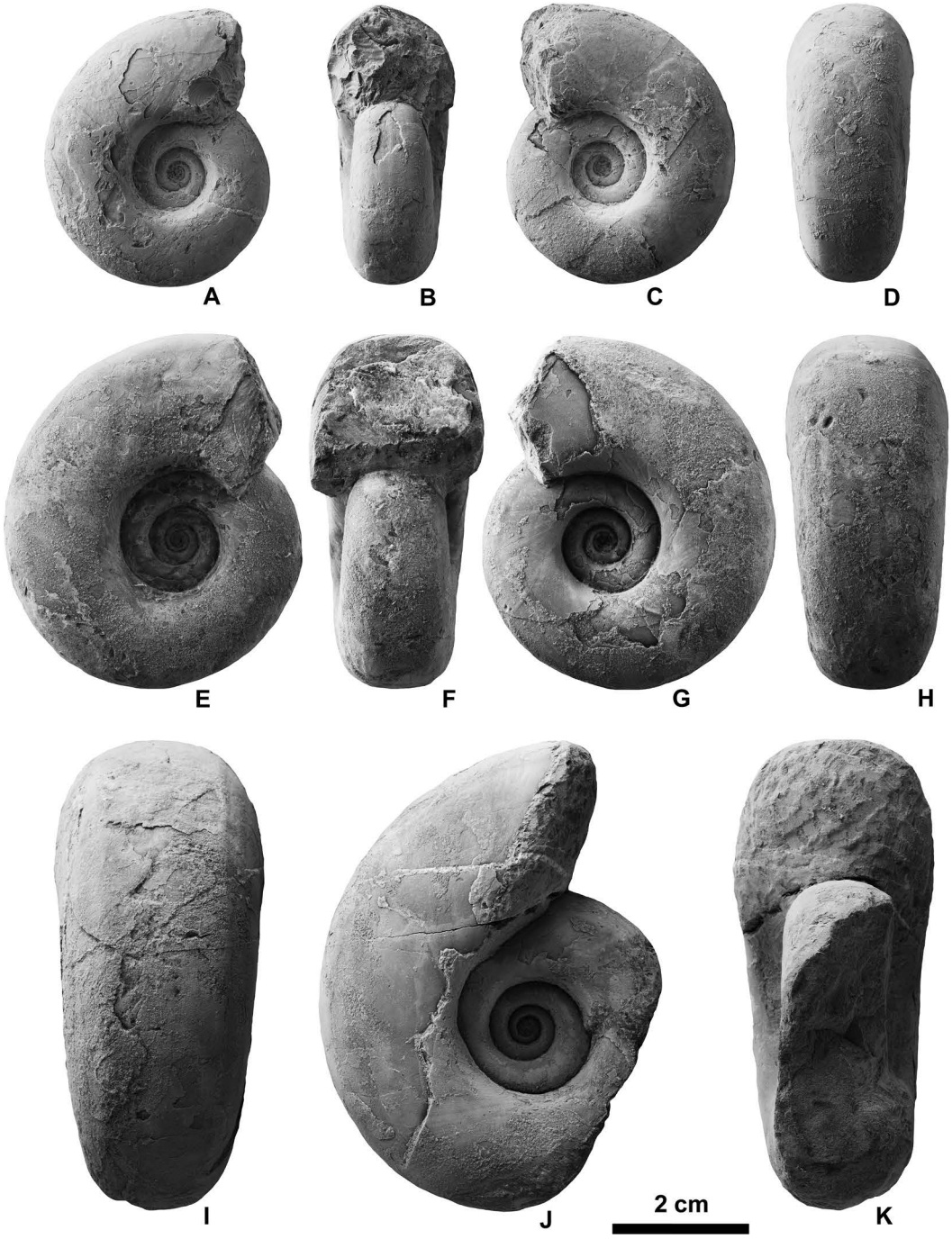

Fig. 13. *Tetragonites popetensis* Yabe, 1903 from Loc. 28 in the Chinomigawa Formation. A–D, HMG-1866; E–H, HMG-1867; I–K, NMNS PM35202.

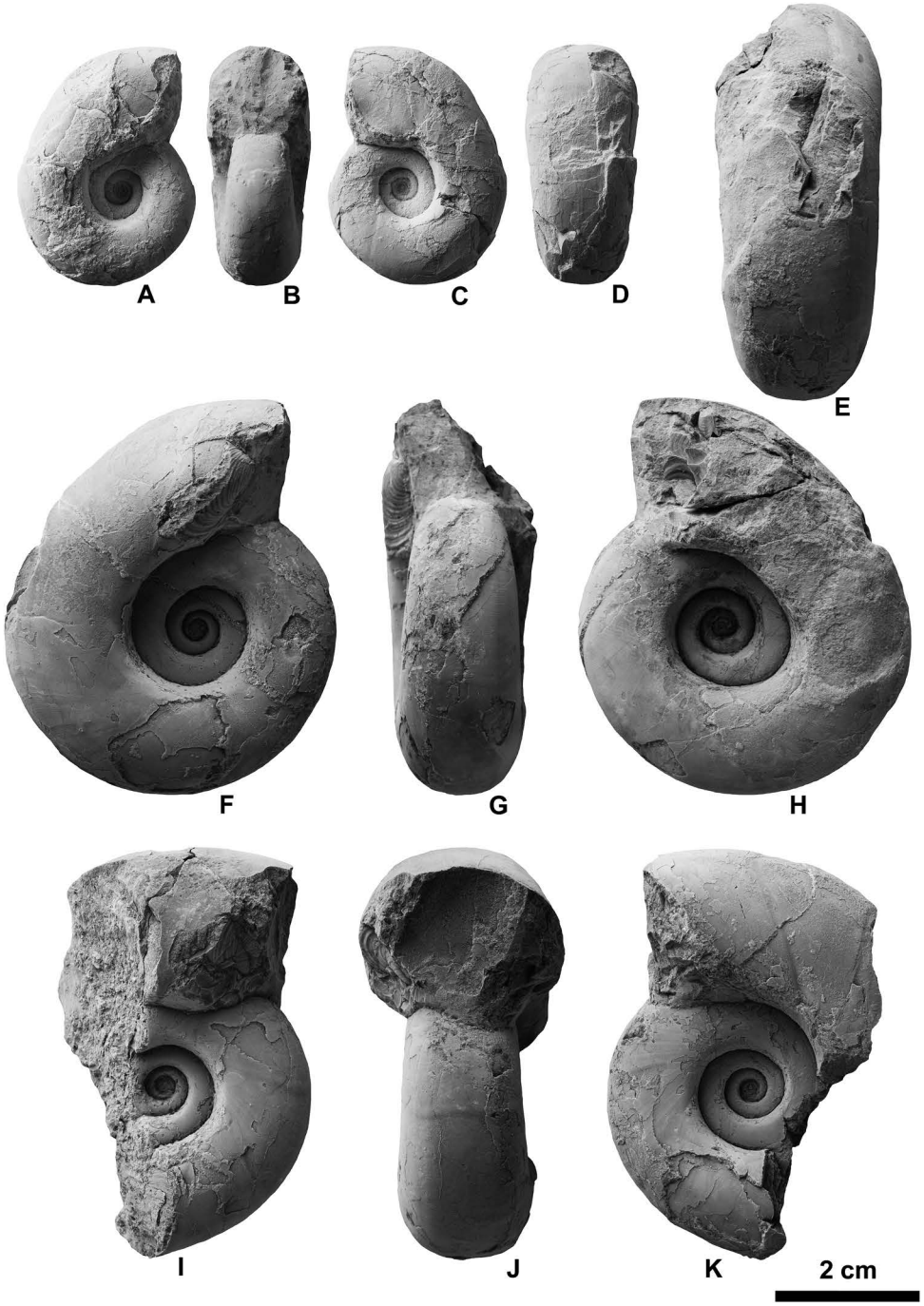

Fig. 14. *Tetragonites popetensis* Yabe, 1903 from Loc. 28 in the Chinomigawa Formation. A–D, NMNS PM35205; E–H, NMNS PM35203; I–K, NMNS PM35204.

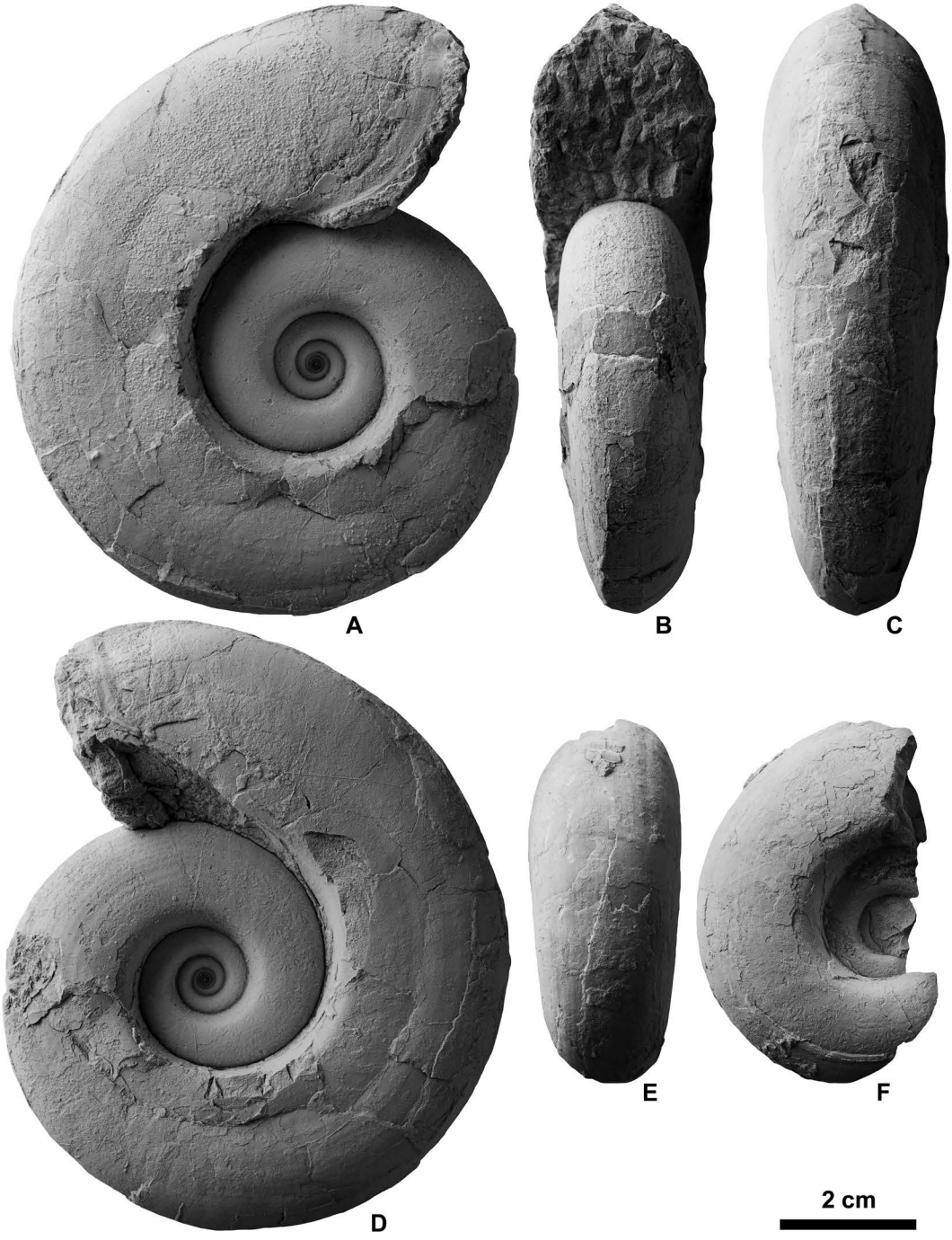

Fig. 15. *Tetragonites popetensis* Yabe, 1903 from float concretions found at Loc. 3. A–D, HMG-1860; E, F, NMNS PM35196.

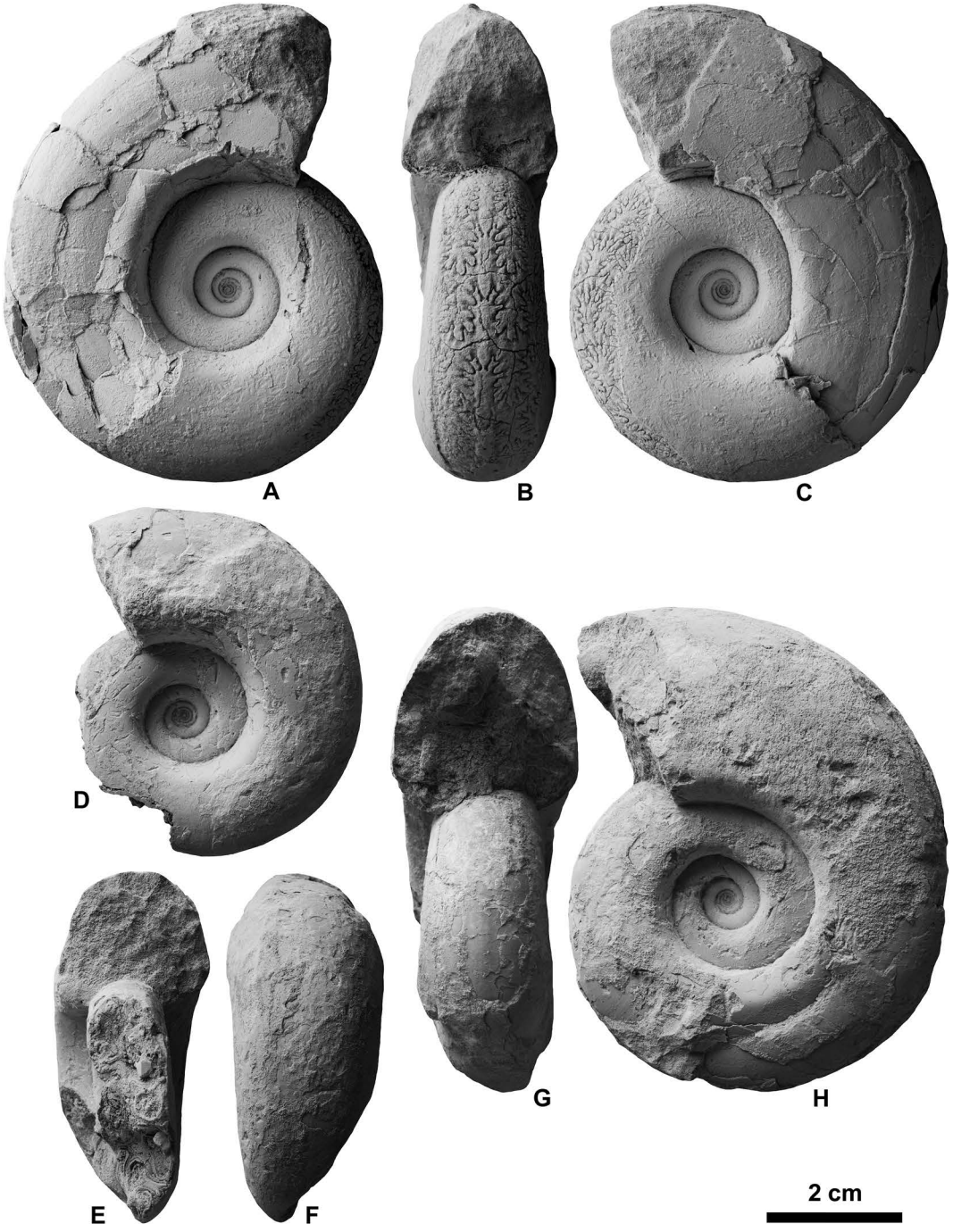

Fig. 16. *Tetragonites popetensis* Yabe, 1903 from float concretions found at Loc. 3. A–C, HMG-1861; D–F, NMNS PM35197; G, H, NMNS PM35198.

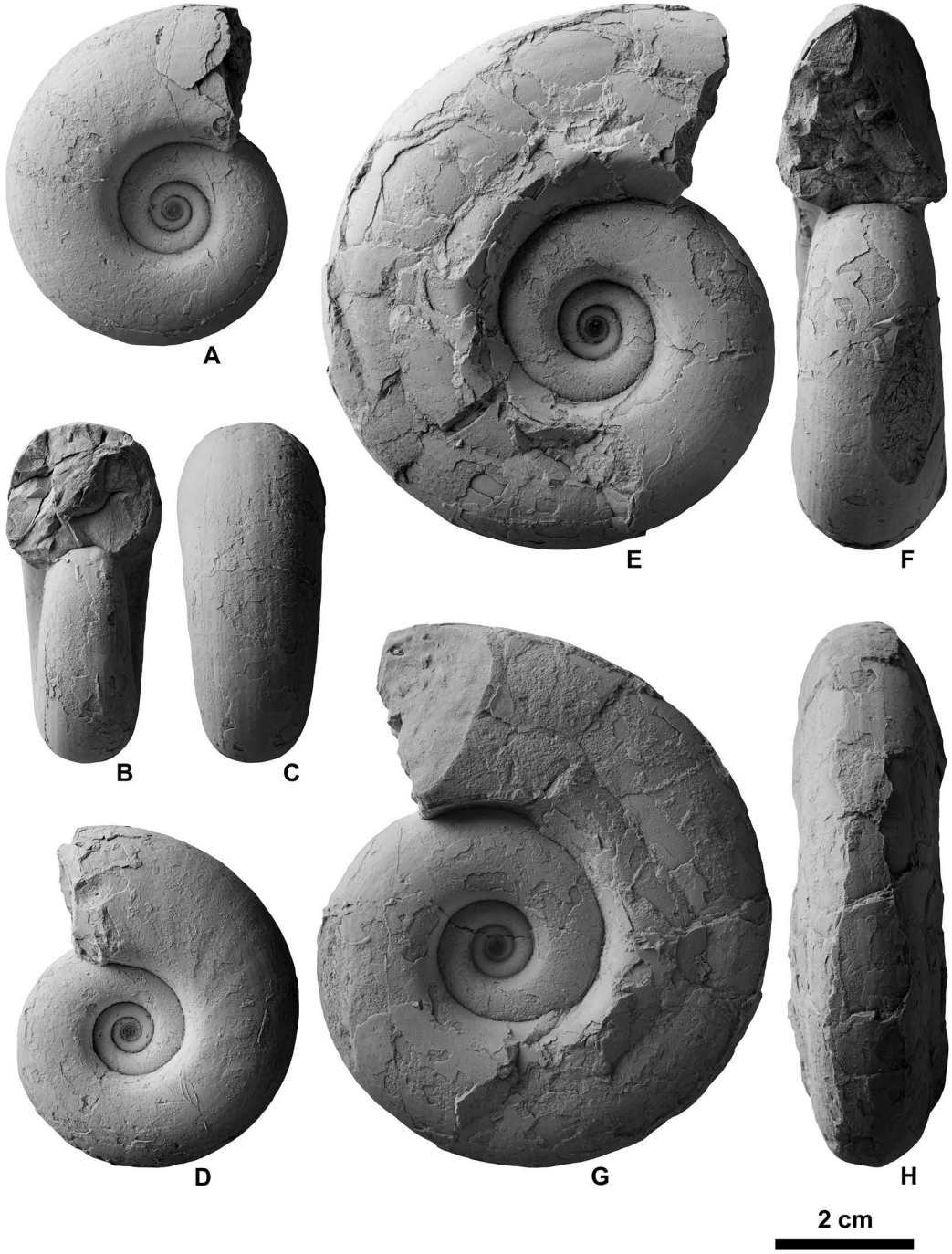

Fig. 17. *Tetragonites popetensis* Yabe, 1903 from Loc. 4 in the Chinomigawa Formation. A–D, HMG-1862; E–H, HMG-1863.

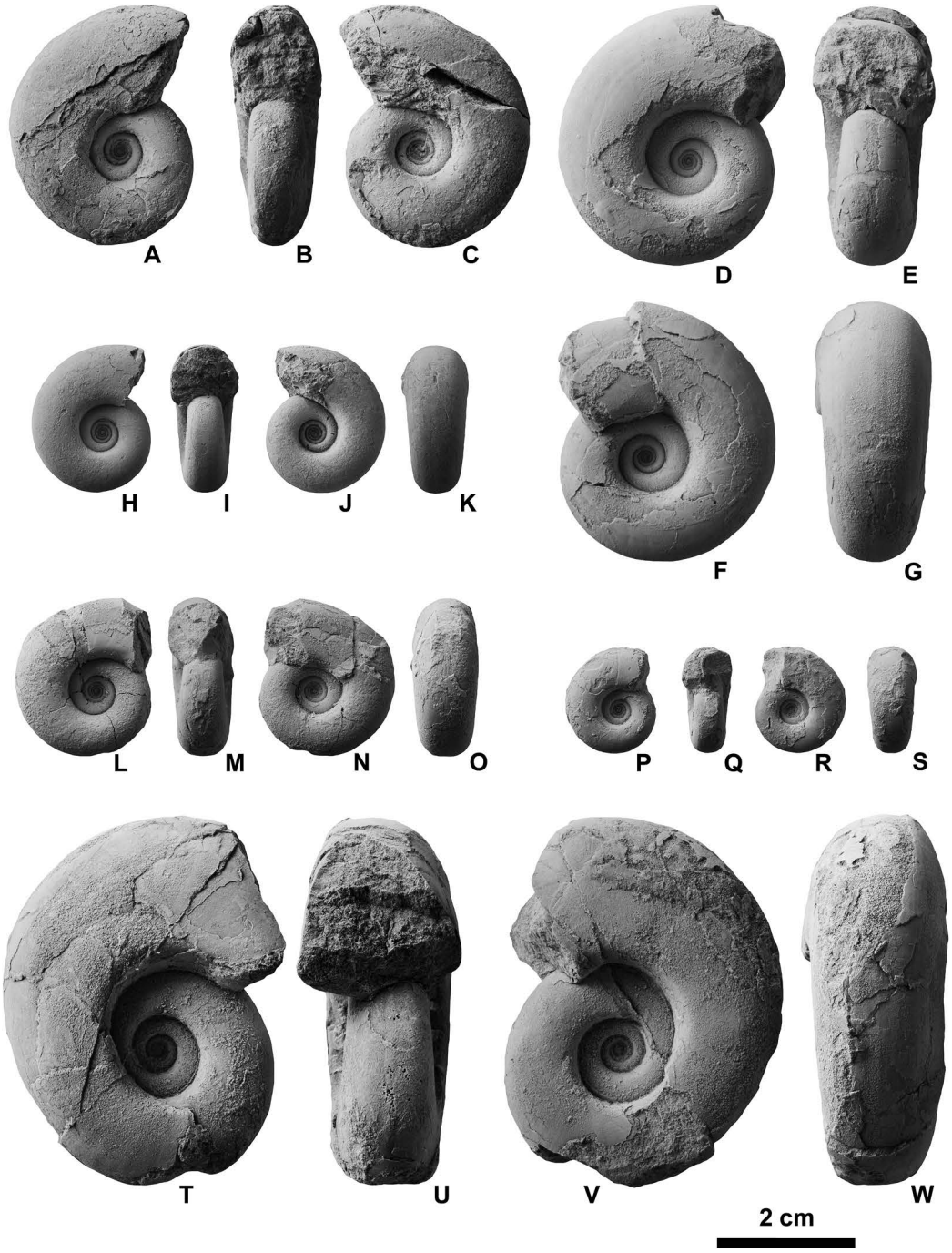

Fig. 18. *Tetragonites popetensis* Yabe, 1903 from the Chinomigawa Formation. A–C, NMNS PM35199 from Loc. 6; D–G, HMG-1864 from Loc. 9; H–K, HMG-1865 from Loc. 19; L–O, NMNS PM35201 from a float concretion found at Loc. 23'; P–S, NMNS PM35195 from a float concretion found at Loc. 1; T–W, NMNS PM35200 from Loc. 15.

al., 1993, p. 155, pl. 87, fig. 2; Yazykova, 1994, p. 293, pl. 3, fig. 1 (= Zonova *et al.*, 1993, pl. 87, fig. 2); Naruse *et al.*, 2000, fig. 3.4; Ando and Ando, 2002, pl. 2, figs. 4, 5; Maeda *et al.*, 2005, p. 88, figs. 38.9–38.11, 38.14, 38.15, 42.5–42.11, 43, 44; Kurihara and Kano, 2006, pl. 3, fig. 2; Takahashi *et al.*, 2007, pl. 1, fig. 4; Misaki and Maeda, 2009, fig. 8E, F; Shigeta *et al.*, 2016, p. 333, figs. 7D-H, 8D, E, 24A, B; Shigeta *et al.*, 2017, p. 26, figs 18–21.

Epigoniceras epigonum (Kossmat). Usher, 1952, pl. 2, figs. 6, 7, pl. 3, fig. 1.

Lytoceras (*Tetragonites*) *henleyense* Anderson, 1958, p. 185, pl. 12, fig. 5, pl. 41, fig. 7.

Tetragonites superstes (Hoepen). Matsumoto and Miyauchi, 1984, p. 52, pl. 23, fig. 2.

Tetragonites glabrus (Jimbo). Shigeta, 1989, p. 334, fig. 12.4–12.7.

Saghalinites maclurei (White). Haggart, 1989, p. 186, pl. 8.1, figs. 7–11.

Saghalinites cala (Forbes). Zonova *et al.,* 1993, p. 155, pl. 209, figs. 3, 4.

Holotype.—UMUT MM7460, figured by Yabe (1903, p. 48, pl. 7, fig. 4), from the Upper Cretaceous "*Pachydiscus*-beds" along the Sanushube (Sanushibe) River in the Hobetsu area, Hokkaido.

Material examined.—One specimen, NMNS PM35195, from a float concretion found at Loc. 1; five specimens, HMG-1860, 1861, NMNS PM35196–35198 from float concretions found at Loc. 3; two specimens, HMG-1862, 1863, from Loc. 4; one specimen, NMNS PM35199, from Loc. 6; one specimen, HMG-1864, from Loc. 9; one specimen, NMNS PM35200, from Loc. 15; one specimen, HMG-1865, from Loc. 19; one specimen, NMNS PM135201, from a float concretion found at Loc. 23'; six specimens, HMG-1866, 1867, NMNS PM35202–35205, from Loc. 28.

Description.—Moderately evolute, fairly depressed shell (early growth stages) to fairly compressed shell (later growth stages) with subquadrate whorl section, broadly rounded venter, rounded ventral shoulders, and slightly convex flanks with maximum whorl width near umbilical shoulder. Umbilicus moderately wide with moderately high, nearly vertical wall and rounded shoulders. Ornamentation consists only of very fine, growth lines, which are prorsiradiate on flanks, but become slightly sinuous at ventral shoulders before crossing venter with very shallow concave arch. Specimen NMNS PM35204 (Fig. 14I–K) exhibits conspicuous rib-like elevations and constrictions, which are parallel to growth lines. Suture line typical tetragonitid-type with trifid major saddles and bifid lateral lobs (Fig. 16B).

Remarks.—See Shigeta and Izukura (2017) for a recent discussion of *Tetragonites popetensis*.

Occurrence.—Described *in-situ* specimens were collected from the middle Campanian *Sphenoceramus schmidti* and *Metaplacenticeras subtilistriatum* beds and the lower upper Campanian *Baculites pacificus* and *B. rex* beds in the Chinomigawa Formation at study sections I, II, III, IV and VIII. Float concretions found at study sections I and V most likely came from these same beds. *Tetragonites popetensis* is abundant from the Santonian to the lower Maastrichtian of the Yezo Group in Hokkaido and Sakhalin, and it is also known from the middle Campanian of Wakayama, Southwest Japan. The species also ranges from the Coniacian to Campanian in California, Washington and Vancouver Island.

Family Gaudryceratidae Spath, 1927
Genus ***Gaudryceras*** Grossouvre, 1894

Type species.—*Ammonites mitis* Hauer, 1866.

Gaudryceras tenuiliratum Yabe, 1903
Figs. 19–22

Lytoceras sacya Forbes. Yokoyama, 1890, p. 178, pl. 18, figs. 12, 13.

Gaudryceras tenuiliratum Yabe, 1903, p. 19, pl. 3, fig. 4; Yabe, 1927, pl. 7, fig. 5; Shimizu, 1934, fig. 37; Matsumoto, 1941, fig. 2b; Matsumoto, 1942b, fig. 1; Matsumoto *et al.*, 1963, p. 29, pl. 44, figs. 12, 13 (= Yokoyama, 1890, pl. 18, figs. 12, 13); Hirano, 1975, p. 185, pls. 24–26; Matsumoto and Miyauchi, 1984, text-fig. 8; Matsumoto, 1995a, p. 116, figs. 1, 61A (= Yokoyama, 1890, pl. 18, fig. 13), 61B, 61C (= Yokoyama, 1890, pl. 18, fig. 12), 62 (= Matsumoto and Miyauchi, 1984, text-fig. 8), 63–66, 67A–D; Matsumoto, 1995b, p. 67, fig. 2A; Alabushev and Wiedmann,

Fig. 19. *Gaudryceras tenuiliratum* Yabe, 1903 from float concretions found at Loc. 16. A–C, HMG-1868; D–F, NMNS PM35206; G–J, NMNS PM35207; K, L, NMNS PM35208.

Fig. 20. *Gaudryceras tenuiliratum* Yabe, 1903 from a float concretion found at Loc. 29. A–C, HMG-1869; D–F, HMG-1870.

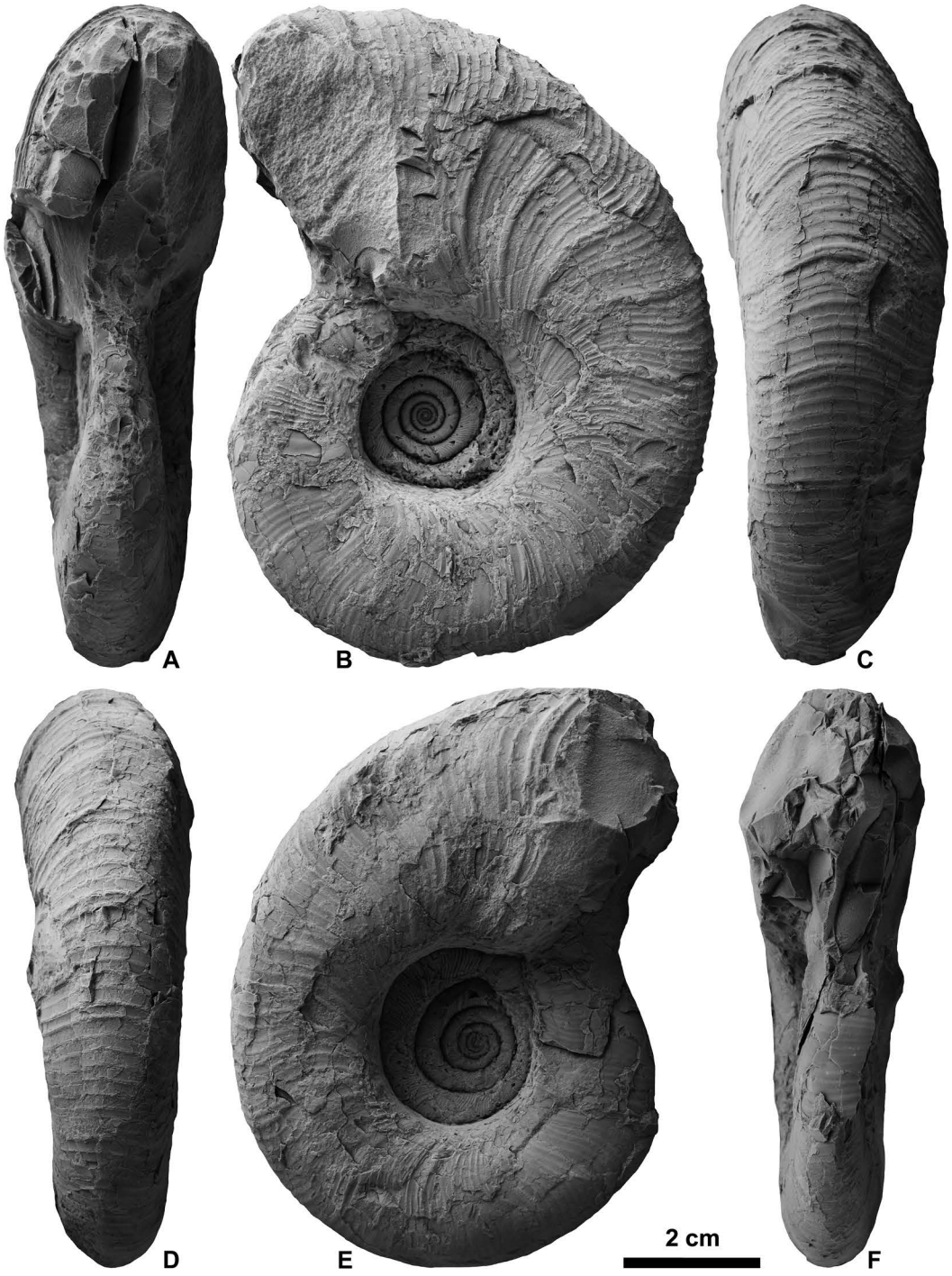

Fig. 21. *Gaudryceras tenuiliratum* Yabe, 1903 from a float concretion found at Loc. 29. A–C, HMG-1871; D–F, HMG-1872.

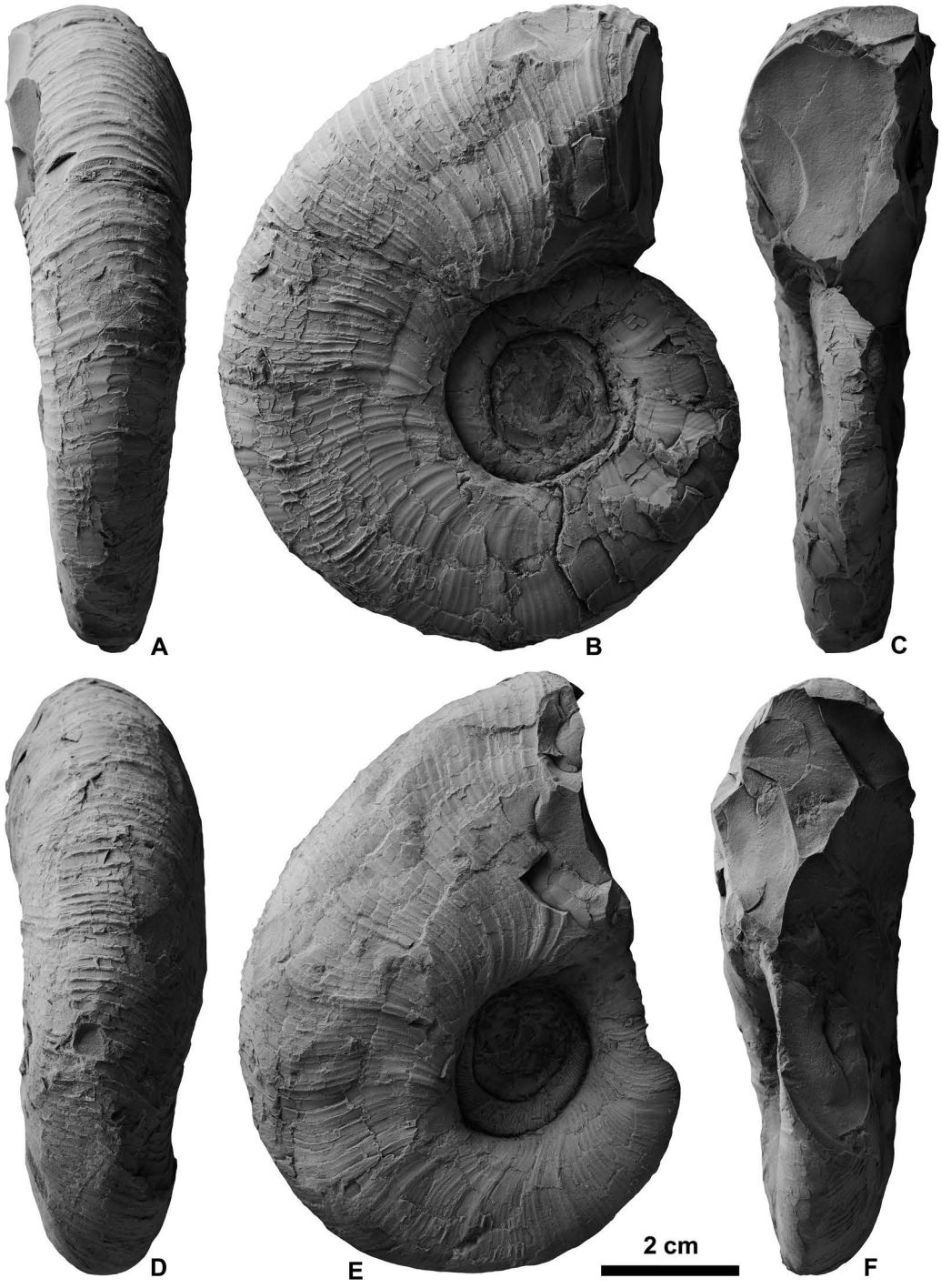

Fig. 22. *Gaudryceras tenuiliratum* Yabe, 1903 from a float concretion found at Loc. 29. A–C, NMNS PM35209; D–F, NMNS PM35210.

1997, pl. 1, figs. 13, 14; Shigeta, 2001, pl. 52, fig. 1; Wani, 2001, fig. 2B; Wani, 2003, fig. 4C; Takahashi *et al.*, 2007, pl. 1, fig. 5.

Gaudryceras tenuiliratum var. *ornate* Yabe, 1903, p. 24, pl. 3, fig. 2; Vereshchagin *et al.*, 1965, p. 49, pl. 50, fig. 1, 2, pl. 51, fig. 1.

Gaudryceras tenuiliratum ornate Yabe. Poyarkova *et al.*, 1987, pl. 25, fig. 5; Zonova *et al.*, 1993, p. 152, pl. 75, figs. 5, 6.

non *Gaudryceras tenuiliratum* Yabe. Yabe, 1903, pl. 3, fig. 3 (= *Gaudryceras intermedium*); Kobayashi, 1931, p. 639, pl. 10 (= *Gaudryceras izumiense*); Jones, 1963, p. 26, pl. 9, figs. 1–3 (= *Gaudryceras denmanense*), pl. 10, figs. 1, 2, text-fig. 12 (= *Gaudryceras hobetsense*); Yazykova, 1992, p. 196, pl. 104, fig. 3, pl. 108, fig. 3 (= *Gaudryceras denseplicatum*); Zonova *et al.*, 1993, p. 151, pl. 71, fig. 2 (= *Gaudryceras denseplicatum*); Alabushev and Wiedmann, 1997, pl. 1, fig. 12 (= *Gaudryceras denseplicatum*); Zonova and Yazykova, 1998, pl. 9, fig. 13, pl. 10, figs. 10 (= Zonova *et al.*, 1993, pl. 71, fig. 2), 11 (= Yazykova, 1992, pl. 104, fig. 2) (= *Gaudryceras denseplicatum*); Yazykova *et al.*, 2004, fig. 9.8 (= *Gaudryceras denseplicatum*).

Gaudryceras denseplicatum var. *tenuiliratum* Yabe. Hirano, 1978, pl. 33, fig. 2; Hirano, 1979, pl. 1, fig. 3 (= Hirano, 1975, pl. 26, fig. 14).

Gaudryceras mamiyai Matsumoto and Miyauchi. Alabushev and Wiedmann, 1997, pl. 2, fig. 1.

Lectotype.—Specimen designated independently by Matsumoto *et al.* (1963, p. 29) and Jones (1963, p. 28) is the original of Yokoyama (1890, pl. 18, fig. 12) from Efue (= Ibui) of the Urakawa area, Hokkaido. Its repository is the Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany.

Material examined.—Four specimens, HMG-1868, NMNS PM35206–35208, from float concretions found at Loc. 16; six specimens, HMG-1869–1872, NMNS PM35209, 35210, from a float concretion found at Loc. 29.

Description.—Early whorls (up to 30 mm in diameter): Very evolute, slightly depressed shell with rounded whorl section, arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width below mid-flank. Umbilicus wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of very fine, dense lirae, which arise at umbilical seam and approach a sigmoidal pattern before passing over the venter in a broad convex arch. Intercalation of lirae occurs on umbilical shoulder to inner flank. Each whorl has variable dense but distinct, rounded, collar-like ribs, running parallel to lirae.

Middle whorls (30–50 mm in diameter): As shell grows, whorl section becomes more compressed, while umbilical width becomes progressively smaller. Lirae gradually develop into slightly more distant, narrowly raised ribs, which increase in strength as diameter increase.

Later whorls (over 50 mm in diameter): As shell grows larger, whorl section becomes even more compressed. Ribs become much coarser and more distant and collar-like ribs become more frequent. These ribs tend to become more sinuous as diameter increases.

Remarks.—See Matsumoto (1995a) for a discussion of *Gaudryceras tenuiliratum*. Specimens assigned to *G. tenuiliratum* from Sakhalin by Yazykova (1992), Zonova *et al.* (1993), Alabushev and Wiedmann (1997), Zonova and Yazykova (1998) and Yazykova *et al.* (2004) are identical to *Gaudryceras denseplicatum*. The specimen from Sakhalin assigned to *G. mamiyai* by Alabushev and Wiedmann (1997) closely matches the juvenile shell of *G. tenuiliratum*. As Shigeta and Nishimura (2013) pointed out, the specimen assigned to *G. tenuiliratum* by Jones (1963, pl. 10, figs. 1–3) from the lower Maastrichtian of Alaska is identical to *G. hobetsense* Shigeta and Nishimura, 2013.

Occurrence.—Described specimens were collected from float concretions that probably came from the lower Campanian *Gaudryceras tenuiliratum* beds in the Urakawa Formation at study sections III and VIII. *Gaudryceras tenuiliratum* is abundant and ranges from the Coniacian to the lower Campanian of the Yezo Group in Hokkaido and Sakhalin.

Gaudryceras intermedium Yabe, 1903

Fig. 23

Gaudryceras tenuiliratum var. *intermedia* Yabe, 1903, p. 27, pl. 3, fig. 1.

Fig. 23. *Gaudryceras intermedium* Yabe, 1903, HMG-1873, from a float concretion found at Loc. 27.

Gaudryceras tenuiliratum Yabe. Yabe, 1903, pl. 3, fig. 3.
Gaudryceras denseplicatum var. *intermedium* Yabe. Hirano, 1978, pl. 33, fig. 3, pl. 34, fig. 2, pl. 35, fig. 1; Hirano, 1979, pl. 1, fig. 2 (= Hirano, 1978, pl. 35, fig. 1).
Gaudryceras denseplicatum var. *intermedium* Yabe. Matsumoto, 1959, p. 143.
non *Gaudryceras tenuiliratum intermedia* Yabe. Poyarkova *et al.*, 1987, pl. 25, fig. 4 (= *Gaudryceras denseplicatum*).
Gaudryceras intermedium Yabe. Matsumoto, 1995a, p. 104, figs. 53B, 54 (= Yabe, 1903, pl. 3, fig. 1), 55–60; Takahashi *et al.*, 2007, pl. 1, fig. 8.

Lectotype.—Specimen designated by Matsumoto (1959b, p. 143), UMUT MM7471, is the original of Yabe (1903, pl. 3, fig. 1) from the Upper Cretaceous "Upper Ammonite-beds" along the Sanushube (Sanushibe) River in the Hobetsu area, Hokkaido.

Material examined.—One mostly crushed specimen, HMG-1873, from a float concretion found at Loc. 27.

Description.—Very large, fairly involute shell with arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width slightly below mid-flank. Umbilicus fairly narrow with high, vertical wall and rounded shoulders. Ornamentation consists of slightly sinuous, narrowly raised ribs and distinct, rounded, collar-like ribs, which are markedly prorsiradiate on inner flank, turn and cross to mid-flank in a gently rursiradiate arc, and then turn gently forward on outer flank to cross venter in a broad convex arch. Intercalation of ribs occurs between umbilical shoulder and mid-flank.

Remarks.—See Matsumoto (1995a) for a discussion of *Gaudryceras intermedium*.

Occurrence.—Described specimen was collected from a float concretion that most likely came from the lower Campanian *Gaudryceras tenuiliratum* beds in the Urakawa Formation at study section VII. *Gaudryceras intermedium* commonly occurs in the Santonian to lower Campanian of the Yezo Group in Hokkaido and Sakhalin.

Gaudryceras striatum (Jimbo, 1894)

Fig. 24E–P

Ammonites sacya var. *sachalinensis* Schmidt, 1873, p. 15, pl. 2, figs. 1–6.
Lytoceras striatum Jimbo, 1894, p. 181, pl. 22, fig. 6.
Gaudryceras striatum (Jimbo). Yabe, 1903, p. 31, pl. 4, fig. 5; Yabe, 1909, figs. 1, 2; Shimizu, 1934, fig. 38; Matsumoto, 1941, fig. 2d, e; Matsumoto, 1963, p. 44, pl. 65, fig. 6 (= Jimbo, 1894, pl. 22, fig. 6); Haggart, 1989, p. 189, pl. 8.2, figs. 1–11; Shigeta, 2001, pl. 51, fig. 2; Maeda *et al.*, 2005, p. 62, fig. 25.1–25.3; Kurihara and Kano, 2006, pl. 2, fig. 2.
Gaudryceras striatum var. *pictun* Yabe, 1903, p. 33, pl. 4, fig. 6.
Gaudryceras striatum var. *paucistriata* Matsumoto, 1941, fig. 2c.
non *Gaudryceras* aff. *striatum* (Jimbo). Morozumi, 1985, p. 25, pl. 8, fig. 1 (= *Patagiosites laevis*)

Holotype.—UMUT MM7493, figured by Jimbo (1894, p. 181, pl. 22, fig. 6), from the Upper Cretaceous in the Nakagawa area, Hokkaido. Its exact collection locality and horizon are unknown.

Material examined.—Three specimens, HMG-1874–1876, from Loc. 26.

Description.—Very evolute, slightly depressed shell with rounded whorl section, arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width below mid-flank. Umbilicus wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of very fine, dense lirae, which arise at umbilical seam and approach a sigmoidal pattern before passing over the venter in a broad convex arch. A few fine lirae are intercalated on inner flank. Rounded, variable dense but distinct, collar-like ribs, running parallel to lirae, occur on all whorls.

Remarks.—See Maeda *et al.* (2005) for a discussion of *Gaudryceras striatum*. The large fragmentary specimen assigned to *Gaudryceras* aff. *striatum* from the Izumi Group of Southwest Japan by Morozumi (1985) closely matches the adult shell of *Patagiosites laevis* Morozumi, 1985 in having a subquadrate whorl section and thick major ribs.

Occurrence.—Described specimens were col-

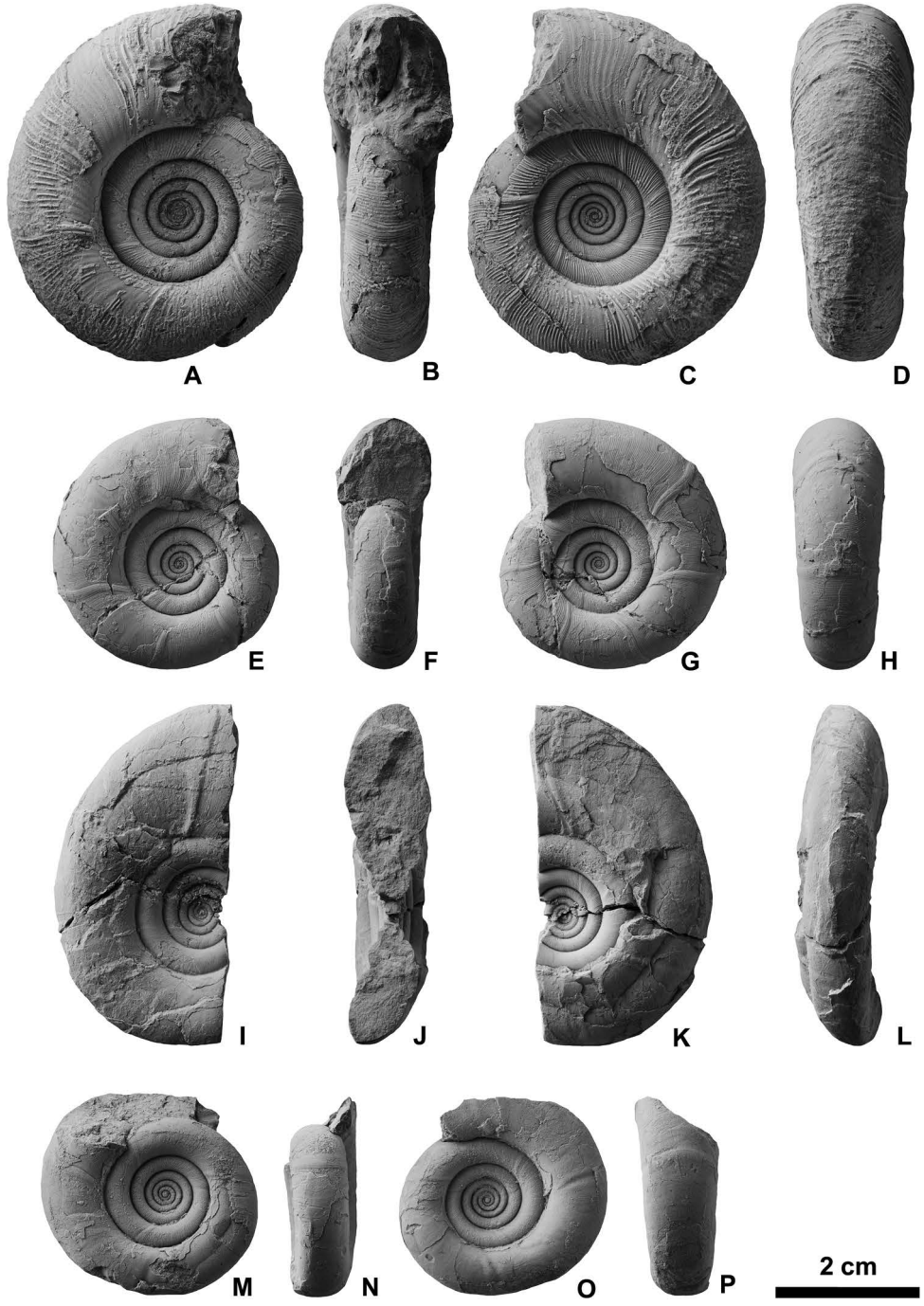

Fig. 24. *Gaudryceras* from the Chinomigawa Formation. A–D, *Gadryceras mamiyai* Matsumoto and Miyauchi, 1984, NMNS PM35211 from Loc. 28; E–P, *Gaudryceras striatum* (Jimbo, 1894) from Loc. 26; E–H, HMG-1874; I–L, HMG-1875; M–P, HMG-1876.

lected from the middle Campanian *Sphenoceramus orientalis* beds in the Chinomigawa Formation at study section VII. *Gaudryceras striatum* is abundant in the *S. orientalis* and *S. schmidti*-bearing beds (= middle Campanian) of the Yezo Group in Hokkaido and Sakhalin. This species is also known from the *S. schmidti*-bearing beds in Vancouver Island.

Gaudryceras mamiyai
Matsumoto and Miyauchi, 1984
Fig. 24A–D

Gaudryceras mamiyai Matsumoto and Miyauchi, 1984, p. 55, pl. 24, fig. 1; Maeda *et al.*, 2005, p. 64, fig. 26.1, 26.2.

non *Gaudryceras mamiyai* Matsumoto and Miyauchi. Alabushev and Wiedmann, 1997, pl. 2, fig. 1.

Holotype.—GK. H5974, figured by Matsumoto and Miyauchi (1984, p. 55, pl. 24, fig. 1), from the middle Campanian in the Cape Soya area, Hokkaido.

Material examined.—One specimen, NMNS PM35211, from Loc. 28.

Description.—Very evolute, slightly depressed shell with arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width below mid-flank. Umbilicus fairly wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of fine, dense, slightly sinuous lirae, which arise at umbilical seam and pass over venter in a broad convex arch. Intercalation of lirae occurs between umbilical shoulder and lower flank. Each whorl has variable dense or distant, rounded, collar-like ribs, running parallel to lirae. Lirae gradually develop into more distant, narrowly raised ribs, which increase in strength as diameter increases.

Remarks.—The described specimen is a juvenile shell, but it closely matches the inner whorls of *Gaudryceras mamiyai* described by Matsumoto and Miyauchi (1984) and Maeda *et al.* (2005). It is somewhat similar to a specimen described as *Gaudryceras* sp. from a float concretion that also contained *Menuites soyaensis* in the Hidaka area, Hokkaido (Shigeta and Izukura, 2018b), but it is clearly distinguished from the latter by its coarser ribs.

Occurrence.—Described specimen was collected from the middle Campanian *Sphenoceramus schmidti* beds in the Chinomigawa Formation at study section VIII. The holotype of *Gaudryceras mamiyai* was found in a concretion among a pile of dredged rocks immediately northeast of the fishing harbor of Kiyohama-II in the Cape Soya area, Hokkaido. Obviously, the exact horizon from which the concretion came is uncertain, but judging from its lithology, it probably came from the *Sphenoceramus schmidti* or *Menuites soyaensis* beds. This species is also known from the *Sphenoceramus schmidti*-bearing bed in the Makarov area, Sakhalin.

Gaudryceras sp. 1
Figs. 25, 26A–X

Gaudryceras sp. Shigeta *et al.*, 2016, p. 335, fig. 9.

Material examined.—Four specimens, HMG-1877–1879, NMNS PM35212, from float concretions found at Loc. 3; one specimen, HMG-1880, from Loc. 4; six specimens, HMG-1881–1886, from Loc. 9.

Description.—Very evolute, slightly depressed shell with rounded whorl section, arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of very fine, dense, slightly sinuous lirae, which arise at umbilical seam and pass over the venter in a broad convex arch. Flanks and venter covered by extremely fine, dense lirae that result from intercalation of main lirae, which occur on umbilical shoulder to inner flank. Each whorl has variable dense but distinct, rounded, collar-like ribs, running parallel to lirae.

Remarks.—The described specimens closely match the inner whorls of *Gaudryceras* sp. described by Shigeta *et al.* (2016) from a float concretion that probably came from the *Baculites pacificu*s-bearing bed in the Urakawa area.

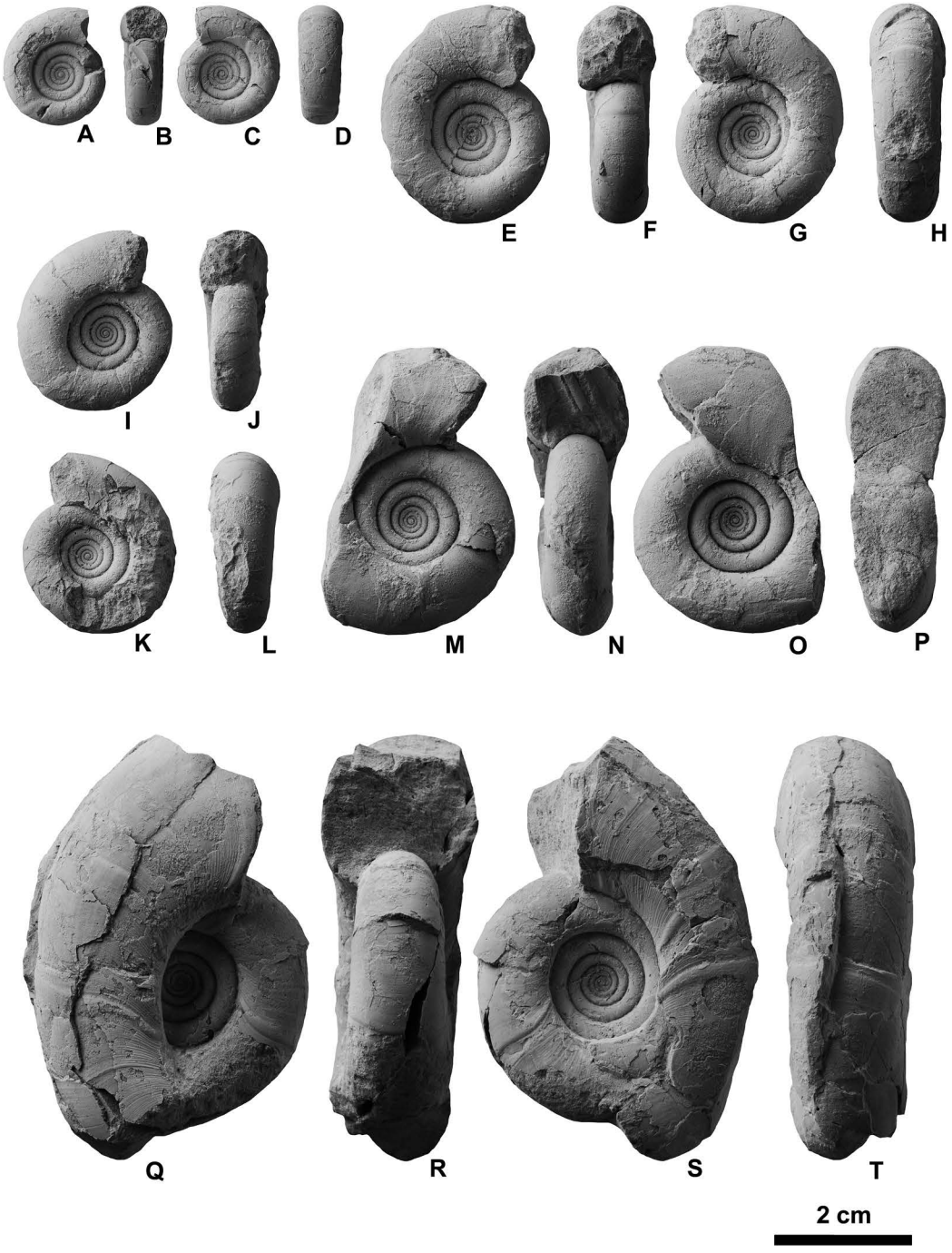

Fig. 25. *Gaudryceras* sp. 1 from the Chinomigawa Formation. A–D, HMG-1880 from Loc. 4; E–T, from float concretions found at Loc. 3; E–H, HMG-1877; I–L, HMG-1878; M–P, HMG-1879; Q–T, NMNS PM35212.

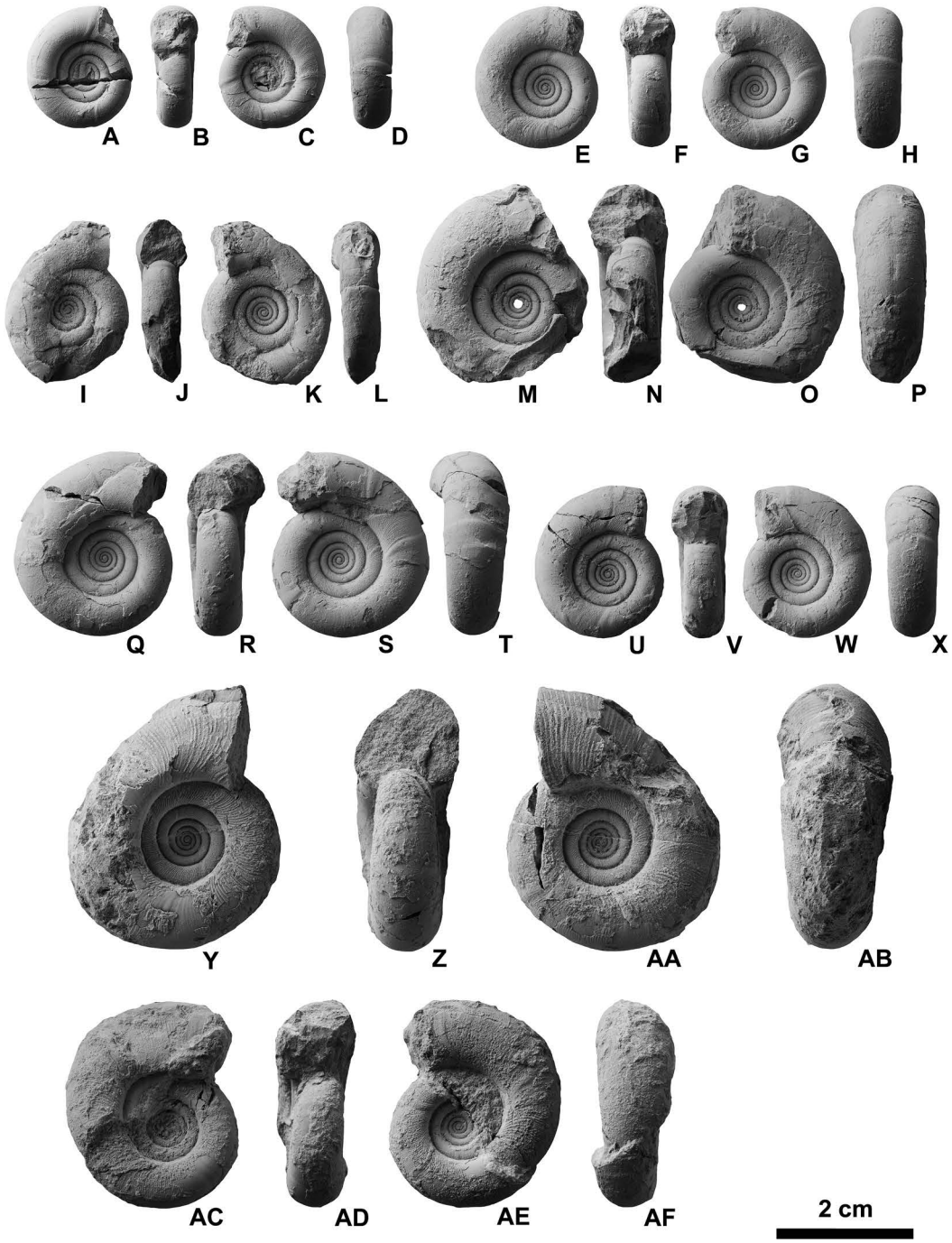

Fig. 26. *Gaudryceras* from the Chinomigawa Formation. A–X, *Gaudryceras* sp. 1 from Loc. 9; A–D, HMG-1881; E–H, HMG-1882; I–L, HMG-1883; M–P, HMG-1884; Q–T, HMG-1885; U–X, HMG-1886; Y–AF, *Gaudryceras* sp. 2 from Loc. 6; Y–AB, NMNS PM35213; AC–AF, NMNS PM35214.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificu*s beds in the Chinomigawa Formation at study section I and III. Float concretions from study section I probably came from the same beds.

Gaudryceras sp. 2

Fig. 26Y–AF

Material examined.—Two specimens, NMNS PM35213, 35214, from Loc. 6.

Description.—Fairly evolute, slightly depressed shell with arched venter, indistinct ventral shoulders, and slightly convex flanks with maximum whorl width below mid-flank. Umbilicus moderately wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of fine, dense, slightly sinuous lirae, which arise at umbilical seam and pass over venter in a broad convex arch. Intercalation of lirae occurs between umbilical shoulder and lower flank. Each whorl has variable dense or distant, rounded, collar-like ribs, running parallel to lirae. Lirae gradually develop into more distant, narrowly raised ribs, which increase in strength as diameter increases.

Remarks.—The described specimen is somewhat similar to the inner whorl of *Gaudryceras mamiyai*, but differs by its more involute shell. The lack of adult shell feature precludes a definitive species assignment.

Occurrence.—Described specimens were collected from the lower upper Campanian *Baculites rex* beds in the Chinomigawa Formation at study section II.

Suborder Ammonitina Hyatt, 1889
Superfamily Desmoceratoidea Zittel, 1895
Family Desmoceratidae Zittel, 1895
Genus ***Damesites*** Matsumoto, 1942a

Type species.—*Desmoceras damsi* Jimbo, 1894.

Damesites sp.

Fig. 27

Material examined.—Ten specimens, HMG-1887–1892, NMNS PM35215–35218, from Loc. 26.

Description.—Very involute, fairly compressed shell with elliptical whorl section, rounded venter with very weak keel, rounded ventral shoulders, and nearly flat flanks with maximum whorl width at ventral shoulders. Umbilicus deep and very narrow with vertical wall and rounded shoulders. Ornamentation consists of distant constrictions and very fine, prorsiradiate growth lines, which arise at umbilical seam, become slightly sigmoidal on flank and project sharply forward on ventral shoulder before passing over venter in a narrow, convex arch.

Remarks.—The described specimens represent juvenile shells of *Damesites*, and the lack of adult features precludes a definitive species assignment.

Occurrence.—Described specimens were collected from the middle Campanian *Sphenoceramus orientalis* beds in the Chinomigawa Formation at study section VII.

Genus ***Desmophyllites*** Spath, 1929

Type species.—*Desmoceras lartei* Seunes, 1891.

Desmophyllites diphylloides (Forbes, 1846)

Figs. 28, 29

Ammonites diphylloides Forbes, 1846, p. 105, pl. 8, fig. 8.

Desmophyllites diphylloides (Forbes). Matsumoto and Obata, 1955, p. 121, pl. 24, figs. 1, 5, pl. 30, fig. 1; Matsumoto, 1959b, p. 9, pl. 3, fig. 3, text-fig. 2; Howarth, 1965, p. 388, pl. 11, fig. 3; Matsumoto, 1984a, p. 12, pl. 1, fig. 2; Henderson and McNamara, 1985, p. 54, pl. 4, figs. 1–4; Haggart, 1989, p. 193, pl. 8.4, figs. 1–13; Kennedy and Henderson, 1992, p. 405, pl. 6, figs. 1–9, pl. 16, figs. 1–3, 7, 8, pl. 17, figs. 4–7, text-fig. 3F; Alabushev and Wiedmann, 1997, p. 22, pl. 6, figs. 3–5; Ando and Ando, 2002, pl. 3, fig. 4; Ifrim *et al*., 2004, p. 1594, text-fig. 9F; Maeda *et al.*, 2005, p. 104, fig. 53.7–53.14; Takahashi *et al.*, 2007, pl. 5, figs.

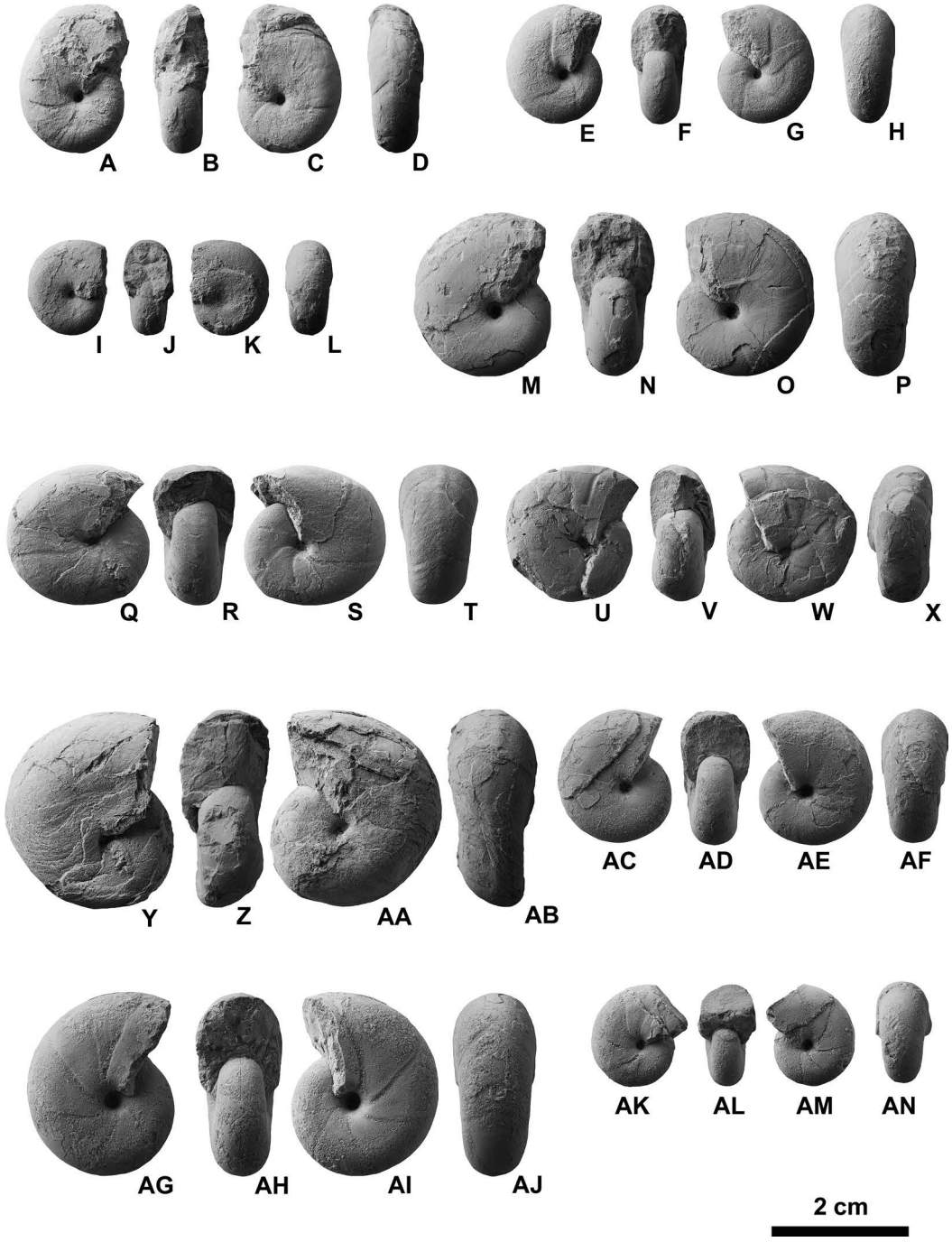

Fig. 27. *Damesites* sp. from Loc. 26 in the Chinomigawa Formation. A–D, HMG-1887; E–H, HMG-1888; I–L, NMNS PM35215; M–P, HMG-1889; Q–T, NMNS PM35216; U–X, NMNS PM35217; Y–AB, NMNS PM35218; AC–AF, HMG-1890; AG–AJ, HMG-1891; AK–AN, HMG-1892.

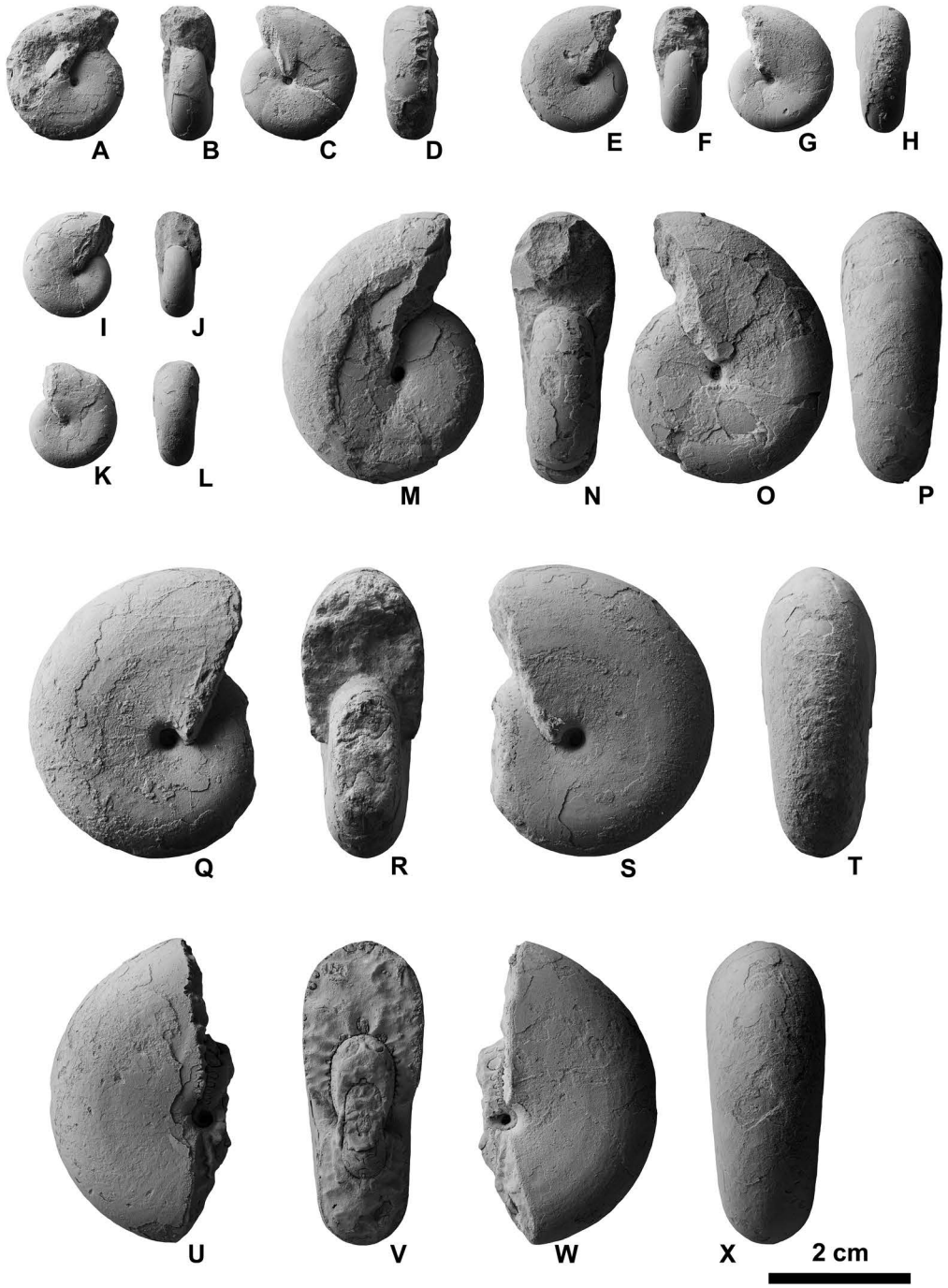

Fig. 28. *Desmophyllites diphylloides* (Forbes, 1846) from the Chinomigawa Formation. A–D, NMNS PM35219 from a float concretion found at Loc. 1; E–T, from float concretions found at Loc. 3; E–H, HMG-1893; I–L, HMG-1894; M–P, HMG-1895; Q–T, HMG-1896; U–X, HMG-1897 from Loc. 4.

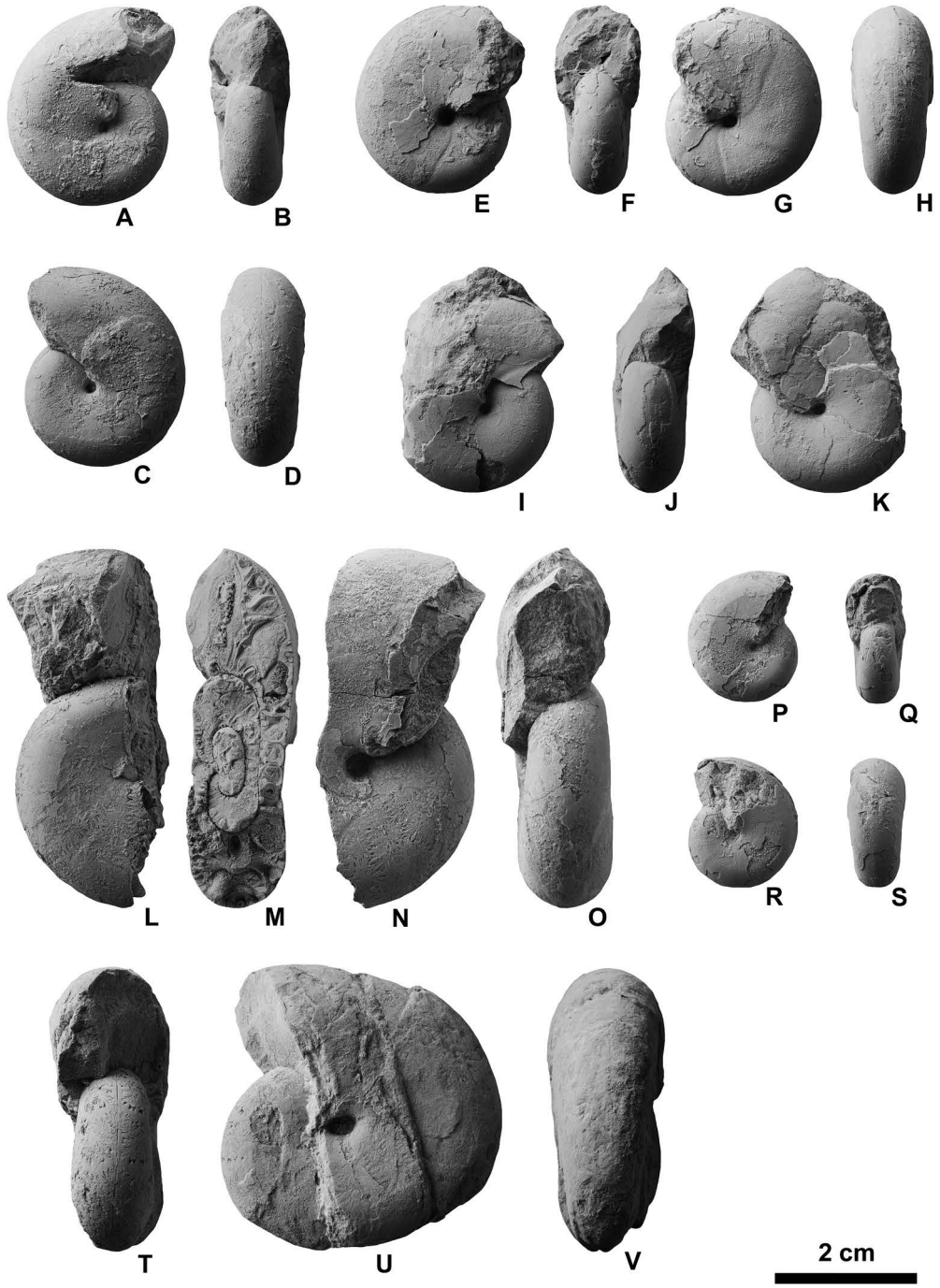

Fig. 29. *Desmophyllites diphylloides* (Forbes, 1846) from the Chinomigawa Formation. A–S, from Loc. 9; A–D, HMG-1898; E–H, HMG-1899; I–K, NMNS PM35220; L–O, NMNS PM35221; P–S, NMNS PM35222; T–V, NMNS PM35223 from Loc. 7.

4, 5; Misaki and Maeda, 2009, fig. 8I–L; Shigeta *et al.*, 2016, p. 335, figs. 8F, G, 10, 11; Shigeta and Izukura, 2018b, p. 16, fig. 3D–Y.

non. *Desmophyllites diphylloides* (Forbes). Matsumoto and Obata, 1955, p. 121, pl. 24, figs. 2–4, text-fig. 1.

Lectotype.—Specimen designated by Matsumoto and Obata (1955, p. 122), is BMNH C22682, the original of Forbes (1846, p. 105, pl. 8, fig. 8) from the Maastrichtian? of Pondicherry, southern India.

Material examined.—One specimen, NMNS PM35219, from a float concretion found at Loc. 1; four specimens, HMG-1893–1896, from float concretions found at Loc. 3; one specimen, HMG-1897, from Loc. 4; one specimen, NMNS PM35223, from Loc. 7; five specimens, HMG-1898, 1899, NMNS PM35220–35222, from Loc. 9.

Description.—Very involute, fairly compressed shell with elliptical whorl section, rounded venter, rounded ventral shoulder, and nearly flat flanks with maximum whorl width at ventral shoulder. Umbilicus deep and very narrow with vertical wall and rounded shoulders. Ornamentation consists of very fine, prorsiradiate growth lines and distant constrictions, which arise at umbilical seam, become slightly sigmoidal on flank and project sharply forward on ventral shoulder before passing over venter in a narrow, convex arch.

Remarks.—See Shigeta *et al.* (2016) for a recent discussion of *Desmophyllites diphylloides*.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificus* and *Baculites rex* beds in the Chinomigawa Formation at study sections I and III. Float concretions found a study section I probably came from the middle Campanian *Metaplacenticeras subtilistriatum* bed and the lower upper Campanian *Baculites pacificus* and *B. subanceps* beds. *Desmophyllites diphylloides* is known from the Santonian to upper Maastrichtian in southern India, Western Australia, northeastern Mexico and Angola, but it has been reported only from the middle to upper Campanian interval in Hokkaido, southern Sakhalin, Vancouver Island and from the middle Campanian in Wakayama, Southwest Japan.

Family Pachydiscidae Spath, 1922
Genus ***Eupachydiscus*** Spath, 1922

Type species.—*Ammonites isculensis* Redtenbacher, 1873.

Eupachydiscus haradai (Jimbo, 1894)

Fig. 30

Pachydiscus haradai Jimbo, 1894, p. 29, pl. 2, fig. 2, 2a, b; Whiteaves, 1895, p. 132, pl. 3, fig. 6.

Pachydiscus perplicatus Whiteaves, 1903, p. 346, pl. 48, fig. 1.

Parapachydiscus (*Mesopachydiscus*) *haradai* (Jimbo). Yabe, 1927, pl. 10, fig. 10a, b.

Parapachydiscus haradai (Jimbo). Kawasaki, 1934, pl. 10, fig. 20.

Neopachydiscus naumani (Yokoyama). Kawasaki, 1934, pl. 11, fig. 23.

Pachydiscus (= *Eupachydiscus*?) *haradai* (Jimbo). Usher, 1952, p. 73, pl. 12, figs. 2–4, pl. 13, figs. 1–3, pl. 31, fig. 6.

Pachydiscus perplicatus Whiteaves. Usher, 1952, p. 77, pl. 12, fig. 1, pl. 13, figs. 4–6, pl. 14, figs. 1–3, pl. 15, figs. 1, 2, pl. 31, fig. 5.

Eupachydiscus haradai (Jimbo). Collignon, 1938, p. 78, pl. 4, fig. 4, 4a; Matsumoto, 1954, p. 281, pl. 8, fig. 2a, b, pl. 9, figs. 1, 2, 3a, b, pl. 10, figs. 1a, b, 2, 3, text-figs. 14–1; Collignon, 1955, p. 44, pl. 9, fig. 1, 1a, b; Matsumoto, 1963, p. 43, pl. 61, fig. 2, 2a, b (= Jimbo, 1894, pl. 2, fig. 2, 2a, b); Shikama, 1964, pl. 57, fig. 2a, b; Vereshchagin *et al.*, 1965, p. 50, pl. 55, fig. 1, pl. 57, fig. 1; Poyarkova, 1987, pl. 27, fig. 1a, b; Haggart and Higgs, 1989, pl. 1, figs. 7a, b, 8; Yazykova, 1992, p. 199, pl. 103, fig. 2a, b; Zonova *et al.*,1993, p. 171, pl. 76, fig. 1a, b; Alabushev and Wiedmann, 1997, p. 26, pl. 10, figs, 2–6; Shigeta *et al.*, 1999, pl. 2, fig. 1; Shigeta, 2001, pl. 29, fig. 1; Takahashi *et al.*, 2007, pl. 3, figs. 5, 6.

Fagesia klamathensis Anderson, 1958, p. 248, pl. 28, fig. 3, 3a.

Eupachydiscus cf. *haradai* (Jimbo). Matsumoto, 1980, p. 287, pl. 45, fig. 4a, b.

Menuites (*Neopachydiscus*) *naumanni* (Yokoyama). Jagt-Yazykova, 2011, pl. 5, figs. 1–8, pl. 7, figs. 1–4.

Eupachydiscus lamberti Collignon. Takahashi *et al.*, 2007, pl. 3, fig. 3.

non *Eupachydiscus haradai* (Jimbo). Jagt-Yazykova, 2011, pl. 6, fig. 1–7 (?= *Menuites naumanni*).

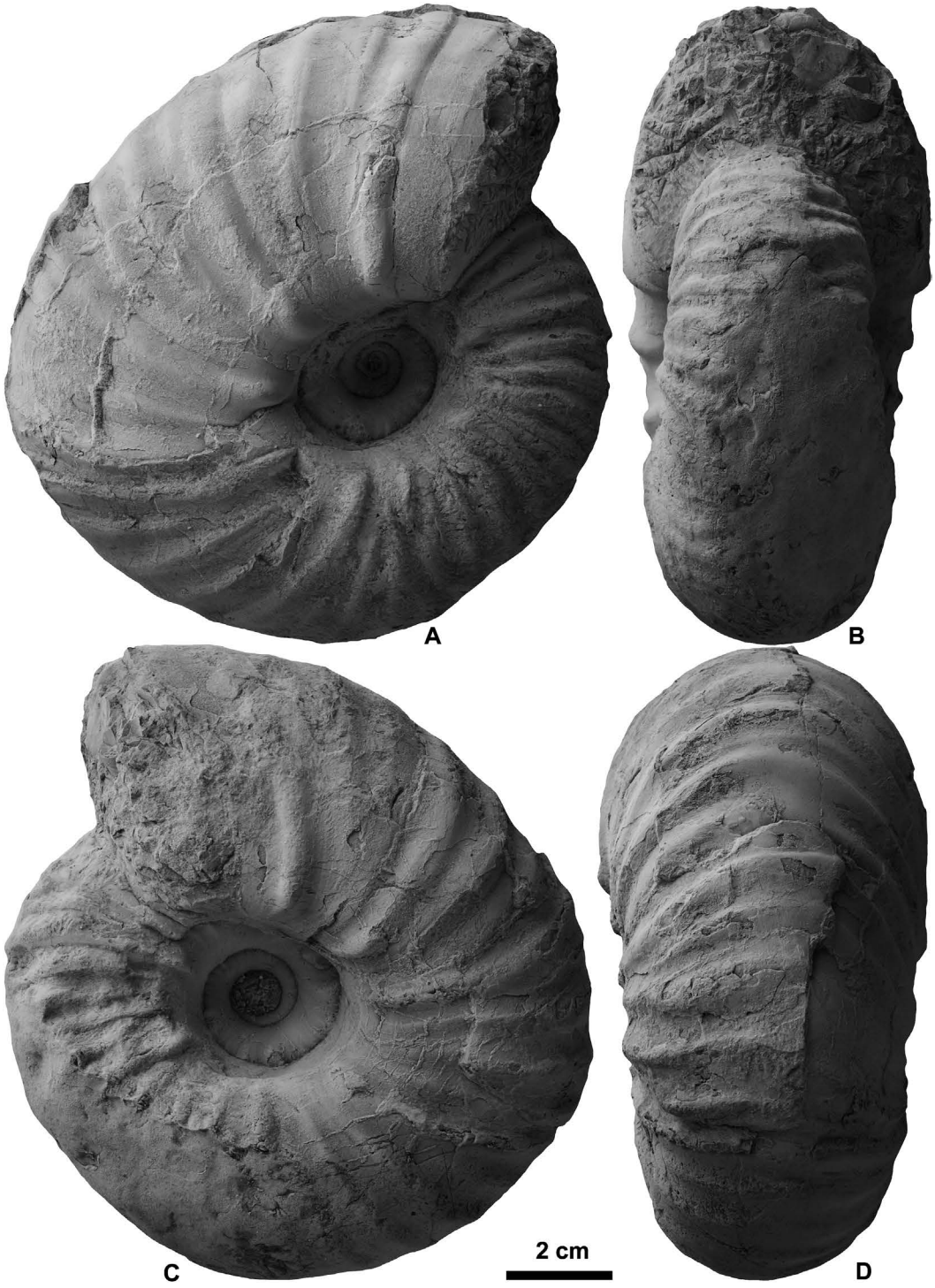

Fig. 30. *Eupachydiscus haradai* (Jimbo, 1894) from Loc. 26 in the Chinomigawa Formation. A–D, HMG-1900.

Lectotype.—Specimen designated by Matsumoto *et al.*, (1963, p. 43), UMUT MM7498 (=GT I-100), is the original of Jimbo (1894, p. 30, pl. 3, fig. 1, 1a, b) from a float calcareous concretion found in the Abeshinai area, northern Hokkaido. Although the exact horizon from which the concretion originated is uncertain, judging from the aragonitic preservation of the shell, it almost certainly came from the sandy mudstone in the upper part of the Osoushinai Formation of the Yezo Group, which is correlated with the Lower Campanian (Takahashi *et al.*, 2003, 2007).

Material examined.—One specimen, HMG-1900, from Loc. 26.

Description.—Fairly involute, fairly depressed shell with subcircular whorl section and convex flanks gradually converging to an arched venter from rounded umbilical shoulders. Umbilicus fairly narrow and fairly deep with moderately high, gently convex, sub-vertical wall. Ornamentation consists of strong, rounded, prorsiradiate major ribs, arising from tubercles on the umbilical shoulder and two or three minor ribs intercalated between all major ribs, arising just above umbilical shoulder or on lower flank. Ribs cross flank and then bend gently forward on ventrolateral shoulders, before crossing venter in a convex arch. No constrictions visible.

Remarks.—Shell of described specimen is more involute and depressed than that of the lectotype of *Eupachydiscus haradai* (UMUT MM7498), but this species exhibits a large variation in shell form and ornamentation (Matsumoto, 1954). The present specimen fits within the variation of *E. haradai.*

Matsumoto (1959b) discussed *Eupachydiscus haradai* extensively and, we agree with his interpretation that *Pachydiscus perplicatus* and *Fagesia klamathensis* are synonym of the present species. The taxon closely resembles *Menuites naumanni* (Yokoyama, 1890) at middle to later growth stages with its depressed shell and strong, rounded, prorsiradiate ribs. However, *E. haradai* is more slender than *M. naumanni* at the middle growth stage. Furthermore, both genera can be easily distinguished by features exhibited by their younger shells: *E. haradai* is characterized by its more slender shell with numerous ribs crossing over the venter, while *M. naumanni* has a more depressed shell with less numerous ribs disappear near the venter. Specimens illustrated as *E. haradai* by Jagt-Yazykova (2011, pl. 6) are probably assignable to *M. naumanni*, and those illustrated as *M. naumanni* by Jagt-Yazykova (2011, pl. 5) to *E. haradai*.

Occurrence.—Described specimen was collected from the middle Campanian *Sphenoceramus orientalis* beds in the Chinomigawa Formation at study section VII. *Eupachydiscus haradai* is known from the Santonian to middle Campanian of Japan and Russian Far East, the Santonian of the Pacific Coast of Canada and USA, and from the Lower Campanian of Madagascar.

Family Pachydiscidae Spath, 1922

Genus ***Canadoceras*** Spath, 1922

Type species.—*Ammonites newberryanus* Meek, 1876.

Canadoceras mysticum Matsumoto, 1954

Figs. 31E–X, 32

Canadoceras mysticum Matsumoto, 1954, p. 307, pl. 31, fig. 2, pl. 35, figs. 1, 2, text-figs. 75, 76; Matsumoto, 1959b, p. 59, pl. 15, figs. 2, 3; Matsumoto and Miyauchi, 1984, p. 48, pl. 19, figs. 2, 3, pl. 20, fig. 3.

?*Canadoceras minimum* Matsumoto and Miyauchi, 1984, p. 50, pl. 19, fig. 1, pl. 20, fig. 1, pl. 21, figs. 1, 2.

Holotype.—GK. H5184, figured by Matsumoto (1954, p. 307, pl. 31, fig. 1), from the *Sphenoceramus schmidti* Zone in the Nakagawa area, Hokkaido. The exact collection locality and horizon are unknown.

Material examined.—Nine specimens, HMG-1902–1910, from Loc. 28.

Description.—Early whorls (up to 20 mm in diameter): Fairly involute, slightly depressed shell with elliptical whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-

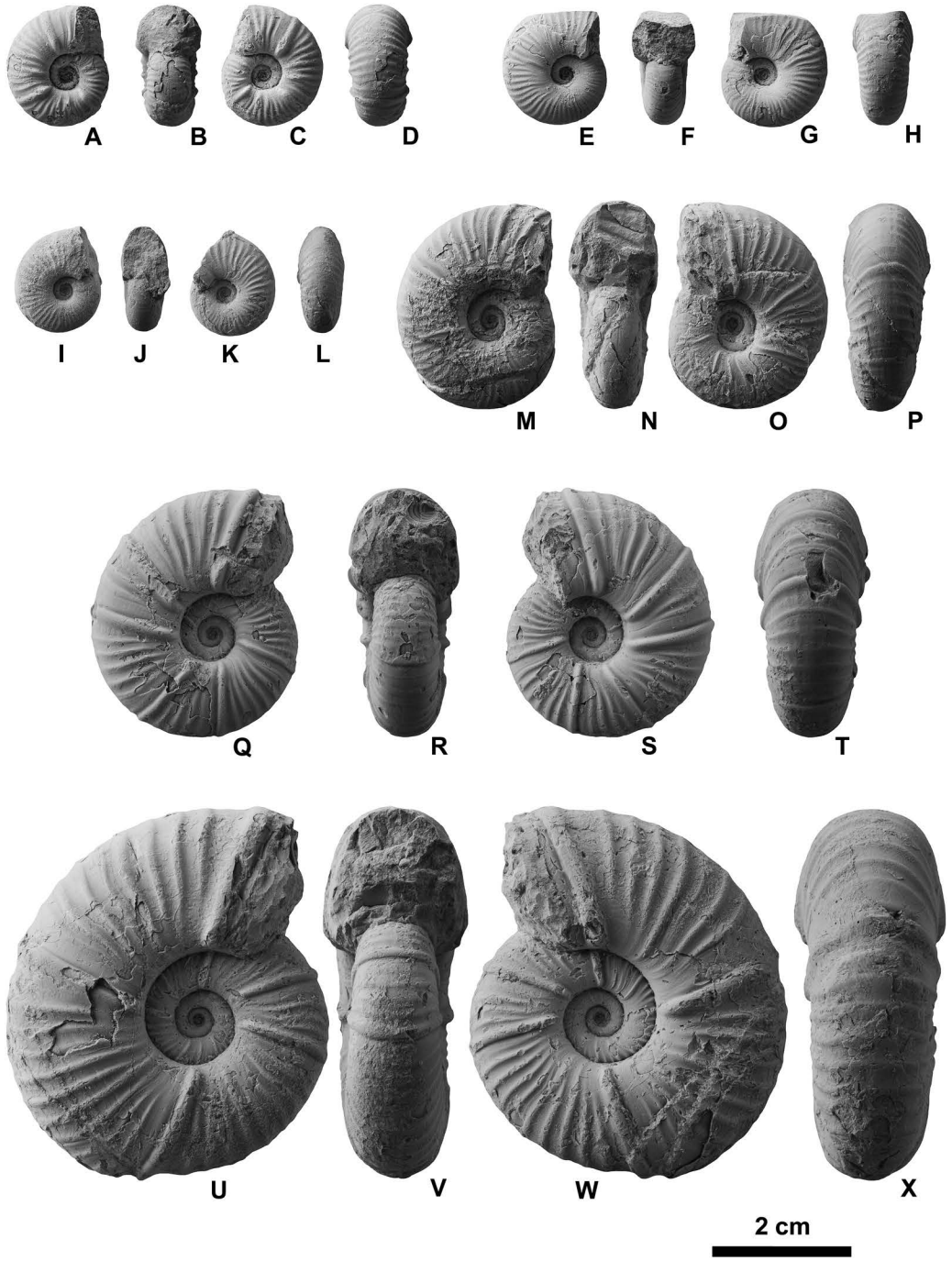

Fig. 31. *Canadoceras* from Loc. 28 in the Chinomigawa Formation. A–D, *Canadoceras* sp., HMG-1901; E–X, *Canadoceras mysticum* Matsumoto, 1954; E–H, HMG-1902; I–L, HMG-1903; M–P, HMG-1904; Q–T, HMG-1905; U–X, HMG-1906.

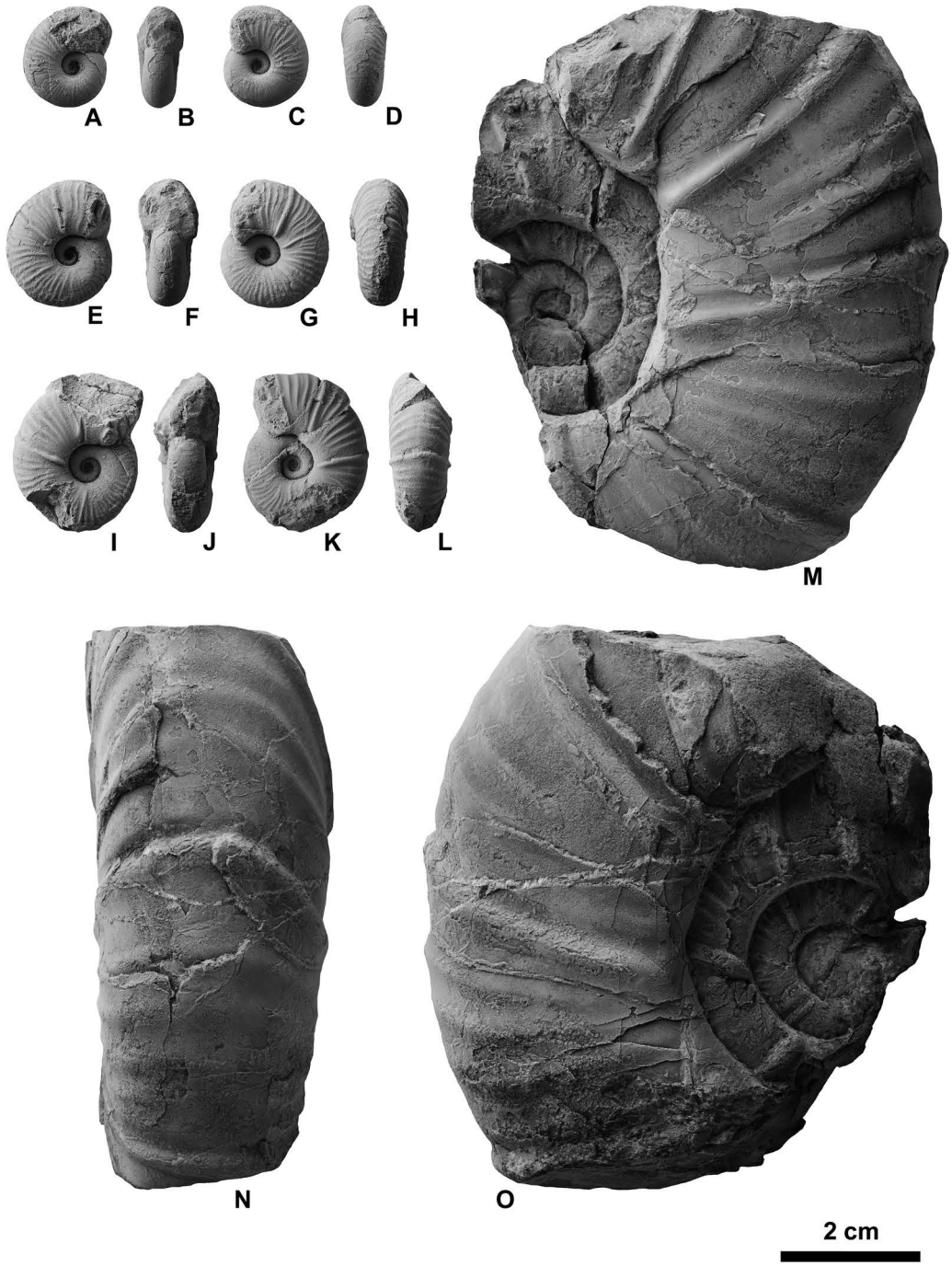

Fig. 32. *Canadoceras mysticum* Matsumoto, 1954 from Loc. 28 in the Chinomigawa Formation. A–D, HMG-1907; E–H, HMG-1908; I–L, HMG-1909; M–O, HMG-1910.

flank. Umbilicus fairly narrow with moderately high, vertical wall and rounded shoulders. Ornamentation consists of numerous, prorsiradiate ribs as well as prominent major ribs arising from very weak umbilical bullae, and shallow constrictions followed immediately by major ribs. Intercalation occurs between inner and mid-flank. Ribs cross flank and then bend gently forward on ventrolateral shoulders, before crossing venter in a convex arch.

Middle to later whorls (over 20 mm in diameter): As shell grows, whorl section becomes more compressed. Ribs become much stronger and more distant. Major ribs arising from prominent umbilical bullae increase in strength and frequency.

Remarks.—The inner whorls of mature *Canadoceras mysticum* shell (and juvenile shells) are similar to the holotype and paratypes of *C. minimum* Matsumoto and Miyauchi, 1984. In terms of morphology, these smaller *C. mysticum* shells are slightly less involute and have a somewhat wider umbilicus (Matsumoto and Miyauchi, 1984), but the ornamentation is very similar to *C. minimum*, with its in fine, dense, numerous ribs and less prominent major ribs arising from very weak umbilical bullae. Both species are possibly conspecific, but a study of the variation in shell form of a large sample of each species is required in order to make this determination.

Occurrence.—Described specimens were collected from the middle Campanian *Sphenoceramus schmidti* beds in the Chinomigawa Formation at study section VIII. *Canadoceras mysticum* occurs together with *S. schmidti* in the middle Campaanian of Hokkaido and Sakhalin.

Canadoceras multicostatum Matsumoto, 1954

Figs. 33, 34

Canadoceras multicostatum Matsumoto, 1954, p. 304, pl. 34, figs. 1, 2, text-fig. 28; Matsumoto, 1984, p. 18, pl. 3, figs. 1–3; Matsumoto and Miyauchi, 1984, p. 47, pl. 18, figs. 1, 2, pl. 20, fig. 2; Maeda *et al.*, 2005, fig. 12.3, 12.4; Takahashi *et al.*, 2007, pl. 5, figs. 9, 10; Shigeta *et al.*, 2016, p. 339, fig. 15; Shigeta and Izukura, 2018b, p. 18, fig. 4.

Mesopuzosia densicostata Matsumoto. Matsumoto, 1984, p. 13, pl. 2, figs. 1, 2.

Holotype.—UMUT MM9118, figured by Matsumoto (1954, p. 304, pl. 34, fig. 1), from the Upper Cretaceous in the Togushi (= Gorbusha) area of the Nishinotoro (= Kril'on) Peninsula, southern Sakhalin.

Material examined.—One specimen, HMG-1911, from Loc. 12; one specimen, NMNS PM35224, from Loc. 21.

Description.—Moderately evolute, fairly compressed shell with elliptical whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-flank. Umbilicus moderately wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of numerous, prorsiradiate ribs as well as distinct constrictions followed immediately by major ribs arising from umbilical tubercles. Intercalation occurs between inner and mid-flank. Ribs cross flank and then bend gently forward on ventrolateral shoulders, before crossing venter in a convex arch.

Remarks.—See Shigeta *et al.* (2016) for a recent discussion of *Canadoceras multicostatum*.

Occurrence.—Described specimens were collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study sections III and IV. *Canadoceras multicostatum* is known from the middle Campanian in the Urakawa and Hidaka areas, Teshio Mountains and Cape Soya areas in Hokkaido, and the Naiba and Makarov areas in southern Sakhalin.

Canadoceras sp.

Fig. 31A–D

Material examined.—One specimen, HMG-1901, from Loc. 28.

Description.—Fairly involute, fairly depressed shell with semicircular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-flank. Umbilicus moderately wide with

Fig. 33. *Canadoceras multicostatum* Matsumoto, 1954 from Loc. 12 in the Chinomigawa Formation. A–D, HMG-1911.

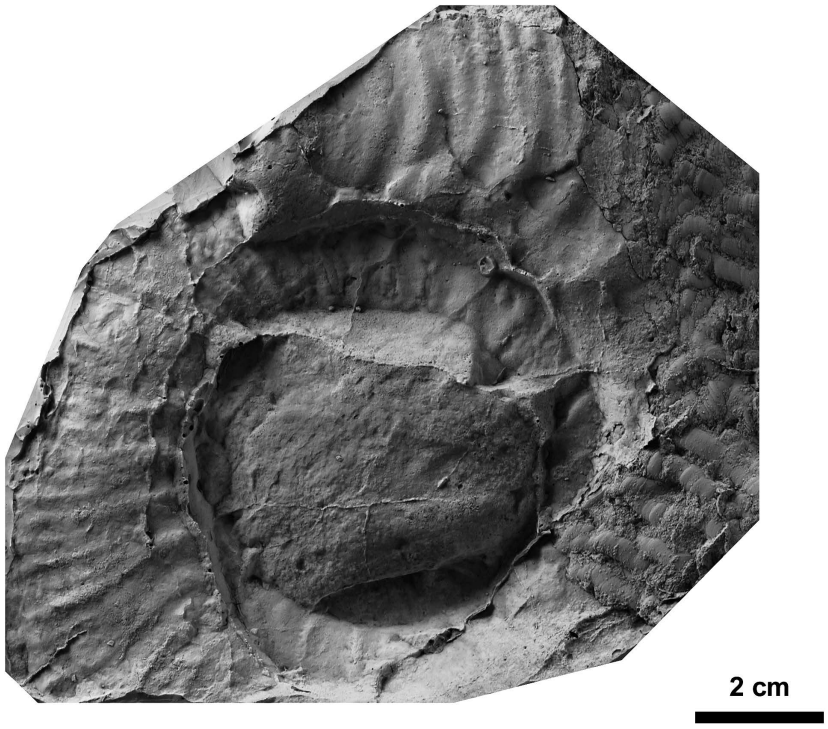

Fig. 34. *Canadoceras multicostatum* Matsumoto, 1954, NMNS PM35224 (rubber cast of outer mold), from Loc. 21 in the Chinomigawa Formation.

moderately high, vertical wall and rounded shoulders. Ornamentation consists of numerous, prorsiradiate ribs as well as prominent major ribs arising from umbilical bullae, and shallow constrictions followed immediately by major ribs. Intercalation occurs between inner and mid-flank.

Remarks.—The described specimen clearly differs from the juvenile shell or inner whorls of *Canadoceras mysticum* and *C. minimum* by its fairly depressed shell and prominent ribs arising from the umbilical bullae. It is very similar to the inner whorls of *C. yokoyamai* (Jimbo, 1894) and *C. kossmati* Matsumoto, 1954, but no definitive species assignment can be made.

Occurrence.—Described specimen was collected from the middle Campanian *Sphenoceramus schmidti* beds in the Chinomigawa Formation at study section VIII.

Family Pachydiscidae Spath, 1922
Genus ***Menuites*** Spath, 1922

Type species.—*Ammonites menu* Forbes, 1846.

Menuites sanadai Matsumoto, 1984
Fig. 35

Menuites sanadai Matsumoto, 1984, p. 17, pl. 5, fig. 1, text-fig. 1; Takahashi *et al.*, 2007, pl. 6, fig. 4.

Holotype.—GK. H5969, figured by Matsumoto (1984, p. 17, pl. 5, fig. 1), from the middle Campanian *Metaplacenticeras subtilistriatum* Zone in the Teshio Mountains, Hokkaido.

Material examined.—One specimen, HMG-1912, from a float concretion that probably came from Loc. 23.

Description.—Moderately involute, fairly depressed shell with circular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width

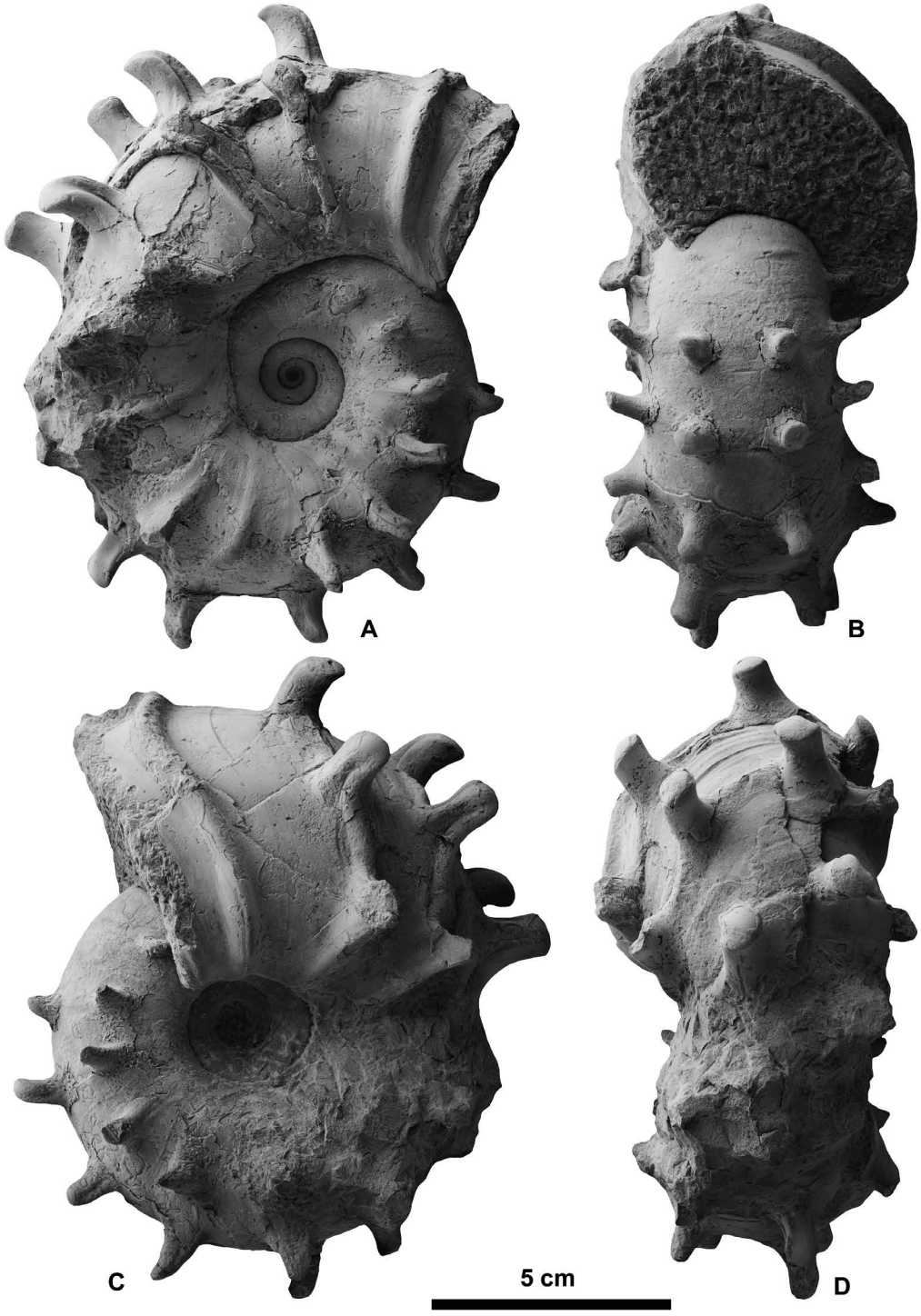

Fig. 35. *Menuites sanadai* Matsumoto, 1984 from a float concretion found at Loc. 23'. A–D, HMG-1912.

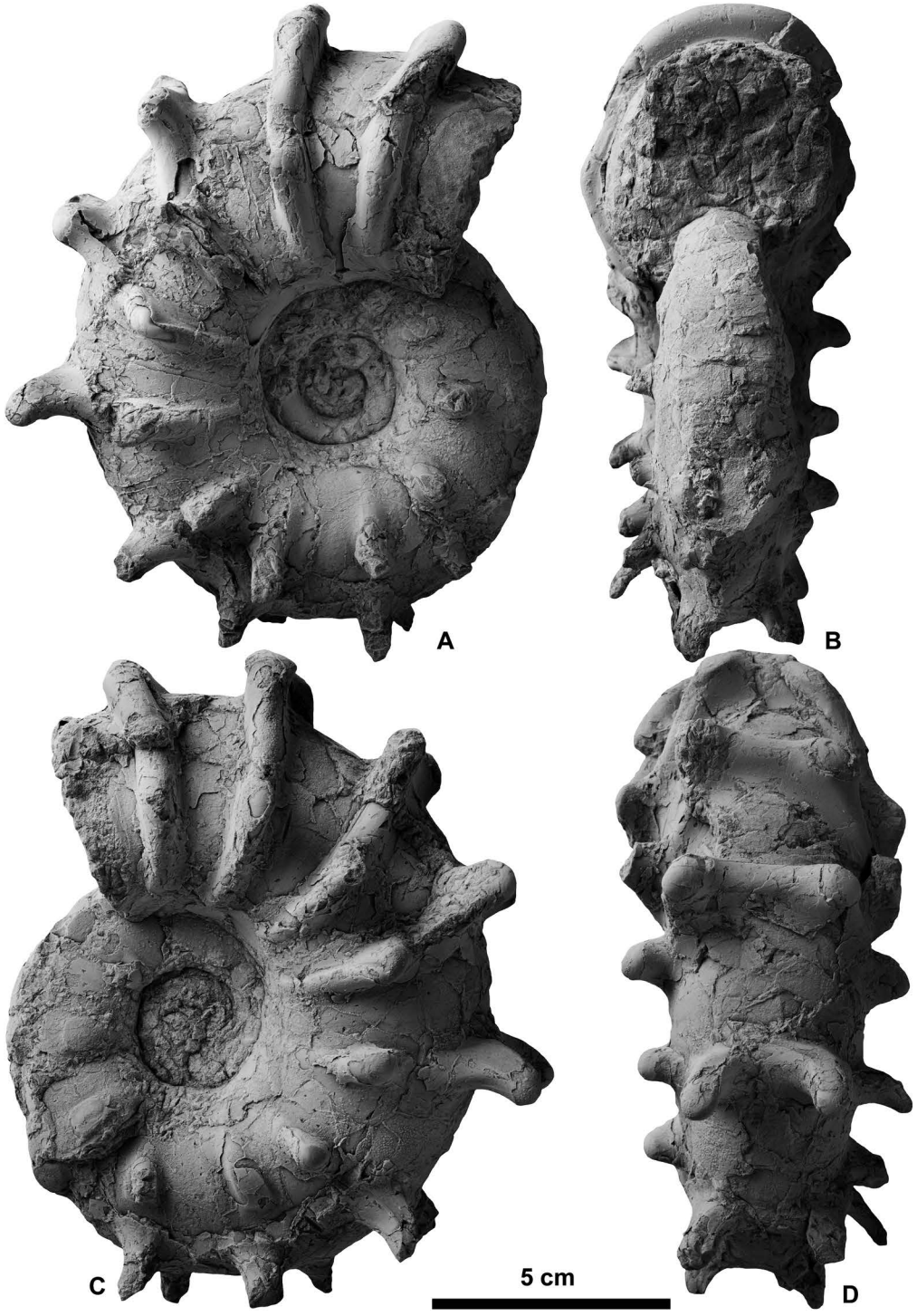

Fig. 36. *Menuites armatus* Shigeta sp. nov. from a float concretion found at Loc. 3. A–D, HMG-1913.

at mid-flank. Umbilicus fairly narrow with high, convex wall and rounded shoulders. Complex ornamentation includes long, robust umbilical and ventrolateral spines on last part of phragmocone and main part of body chamber. Outer portion of spines tends to project slightly backward. Distant, prorsiradiate ribs arising from umbilical seam, from which both spines arise, develop on last quarter whorl of body chamber and pass over venter in a convex arch. Ribs become much stronger near apertural part of body chamber, while spines either become much weaker or fade completely.

Remarks.—As indicated by Matsumoto (1984), the phragmocone of this species closely resembles the immature shell of *Menuites fascicostatus*. It is possible that both taxa may represent a dimorphic pair, but the intensive study required to support such a hypothesis is beyond the scope of this work.

Occurrence.—Described specimens were collected from a float concretion that most likely came from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study section V. *Menuites sanadai* is known from the middle Campanian *M. subtilistriatum* Zone in the Teshio Mountains and Cape Soya area in Hokkaido.

Menuites armatus Shigeta sp. nov.

Fig. 36

Pseudomenuites sp. Shigeta *et al.*, 1999, pl. 5, figs. 1, 2; Ando and Ando, 2002, pl. 2, figs. 13.
Menuites sp. Shigeta *et al.*, 2016, p. 339, figs. 12–14.

Holotype.—HMG-1913 was collected from a float concretion, which also contained *Baculites pacificus* at Loc. 3.

Diagnosis.—*Menuites* characterized by moderately involute, fairly depressed shell with moderately wide umbilicus and very strong ribs with umbilical and ventrolateral spines on last quarter whorl of body chamber. Ribs tend to become stronger near apertural part of body chamber, while spines simultaneously become weaker or fade completely.

Etymology.—Species name refers to “armed”, from the Latin word: *armatus*.

Description.—Moderately involute, fairly depressed shell with circular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-flank. Umbilicus moderately wide with high, convex wall and rounded shoulders. Complex ornamentation includes long, robust umbilical and ventrolateral spines on last part of phragmocone and main part of body chamber. Outer portion of spines tends to project slightly backwards. Distant, prorsiradiate ribs arising from umbilical seam, from which both spines arise, develop on last quarter whorl of body chamber and pass over venter in a convex arch. Ribs become stronger near apertural part of body chamber, but spines simultaneously become weaker or completely disappear.

Measurements.—Taken at $D = 125.4$ mm of HMG-1913, $U = 37.2$ mm, $H = 47.4$ mm, $W = 45.2$ mm, $U/D = 0.29$, $W/H = 0.95$.

Comparison.—*Menuites armatus* sp. nov. differs from *M. sanadai* from the *Metaplacenticeras subtilistriatum* Zone in the Teshio Mountains and Cape Soya area by its more evolute shell, wider umbilicus and much stronger ribs on last quarter whorl of body chamber. Specimens described as *Menuites* sp. by Shigeta *et al.* (2016, figs. 12–14) from the Campanian in the Urakawa area, Hokkaido are identical to *M. armatus* sp. nov. Specimens illustrated as *Pseudomenuites* sp. by Shigeta *et al.* (1999, pl. 5, figs. 1, 2) and Ando and Ando (2002, pl. 2, figs. 1–3) from the Campanian in Sakhalin and Hokkaido are very close to *M. armatus* sp. nov., and may be identical.

Occurrence.—Described specimens were collected from a float concretion that probably came from the lower upper Campanian *Baculites pacificus* beds in the Chinomigawa Formation at study section I. *Menuites armatus* sp. nov. is also known from the *Baculites pacificus*-bearing beds in the Urakawa area, Hokkaido.

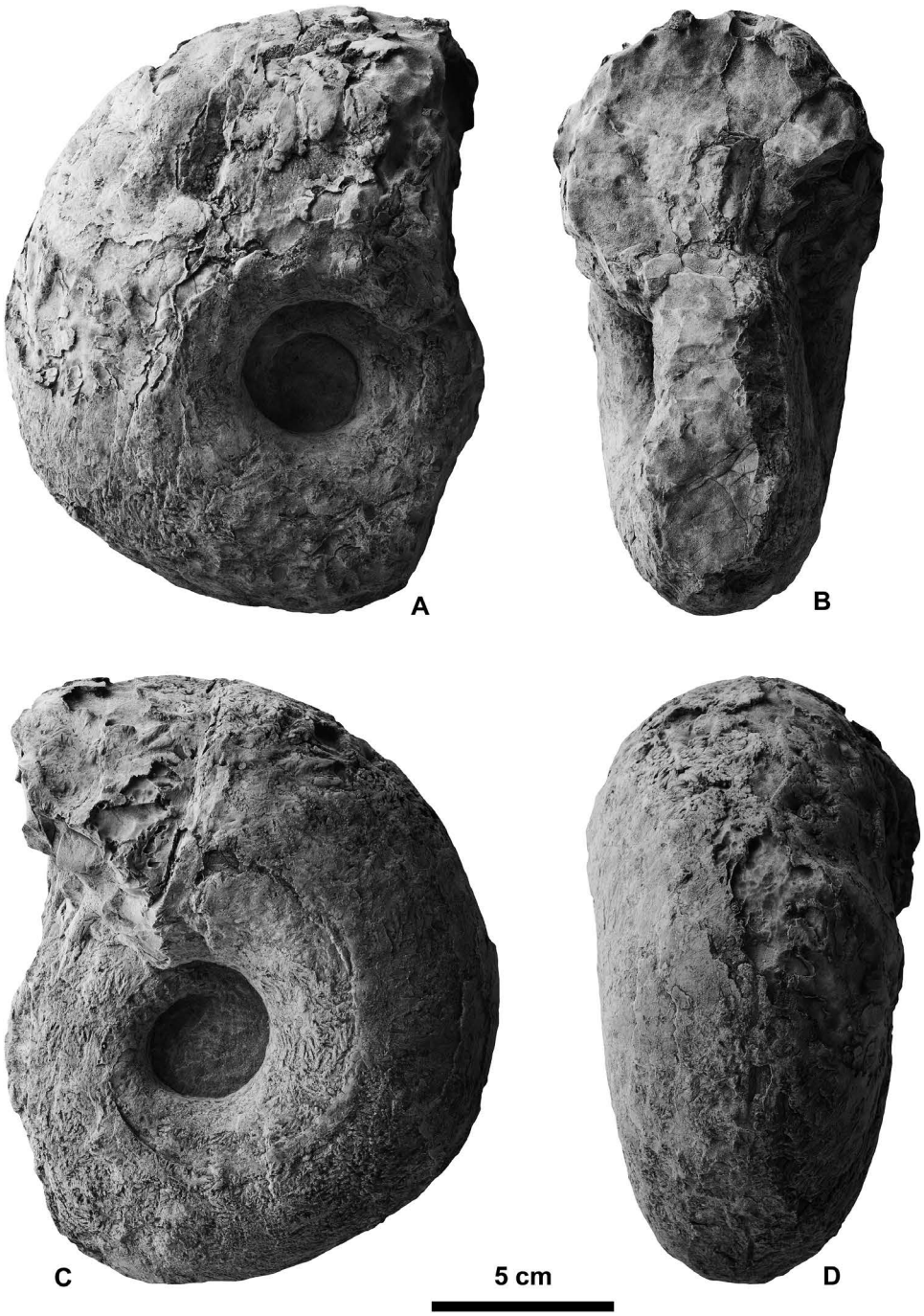

Fig. 37. *Menuites fascicostatus* (Yabe in Yabe and Shimizu, 1921) from Loc. 15 in the Chinomigawa Formation. A–D, inner whorls of NMNS PM35225 (Fig. 38).

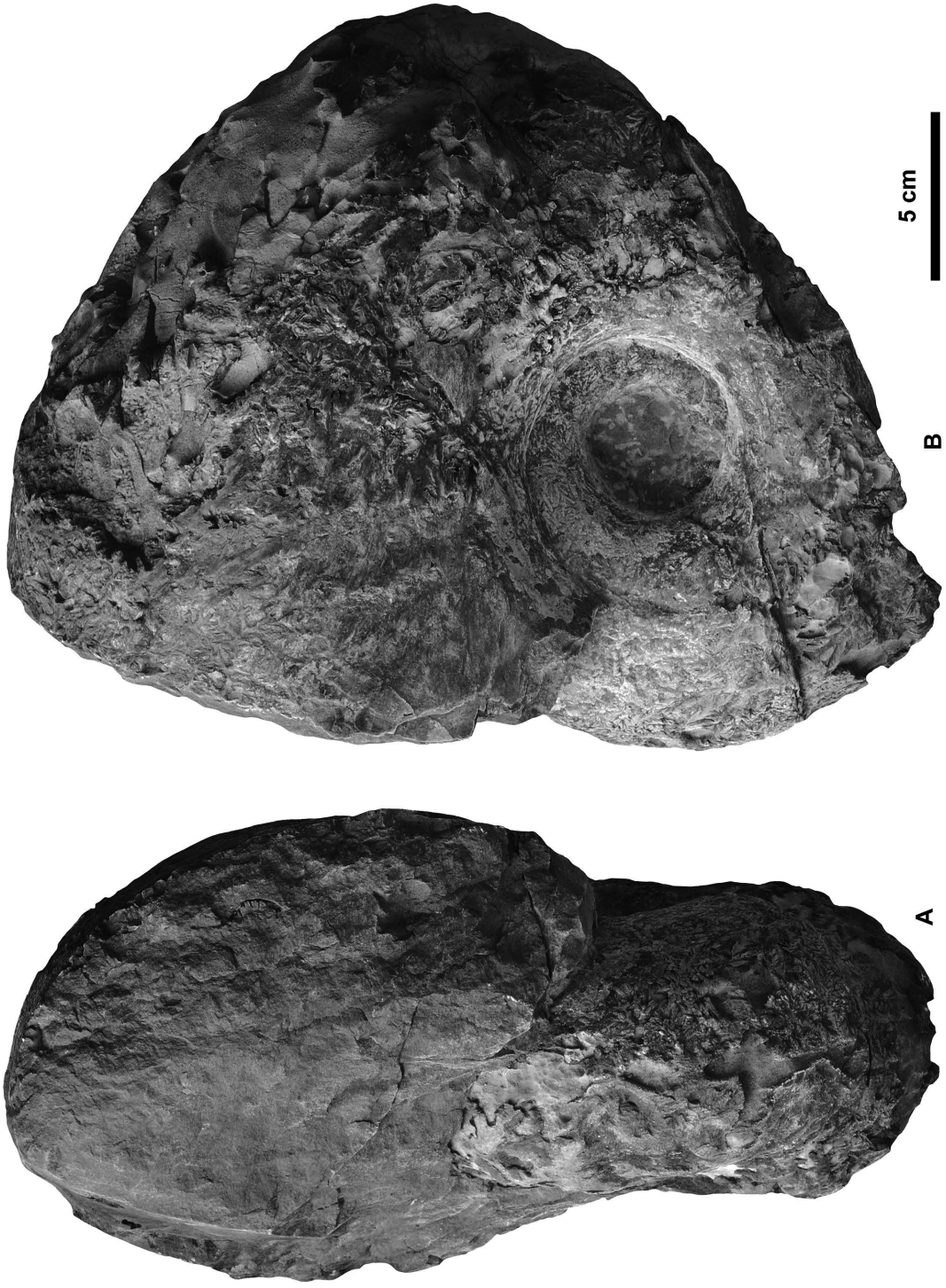

Fig. 38. *Menuites fascicostatus* (Yabe in Yabe and Shimizu, 1921) from Loc. 15 in the Chinomigawa Formation. A, B, NMNS PM35225.

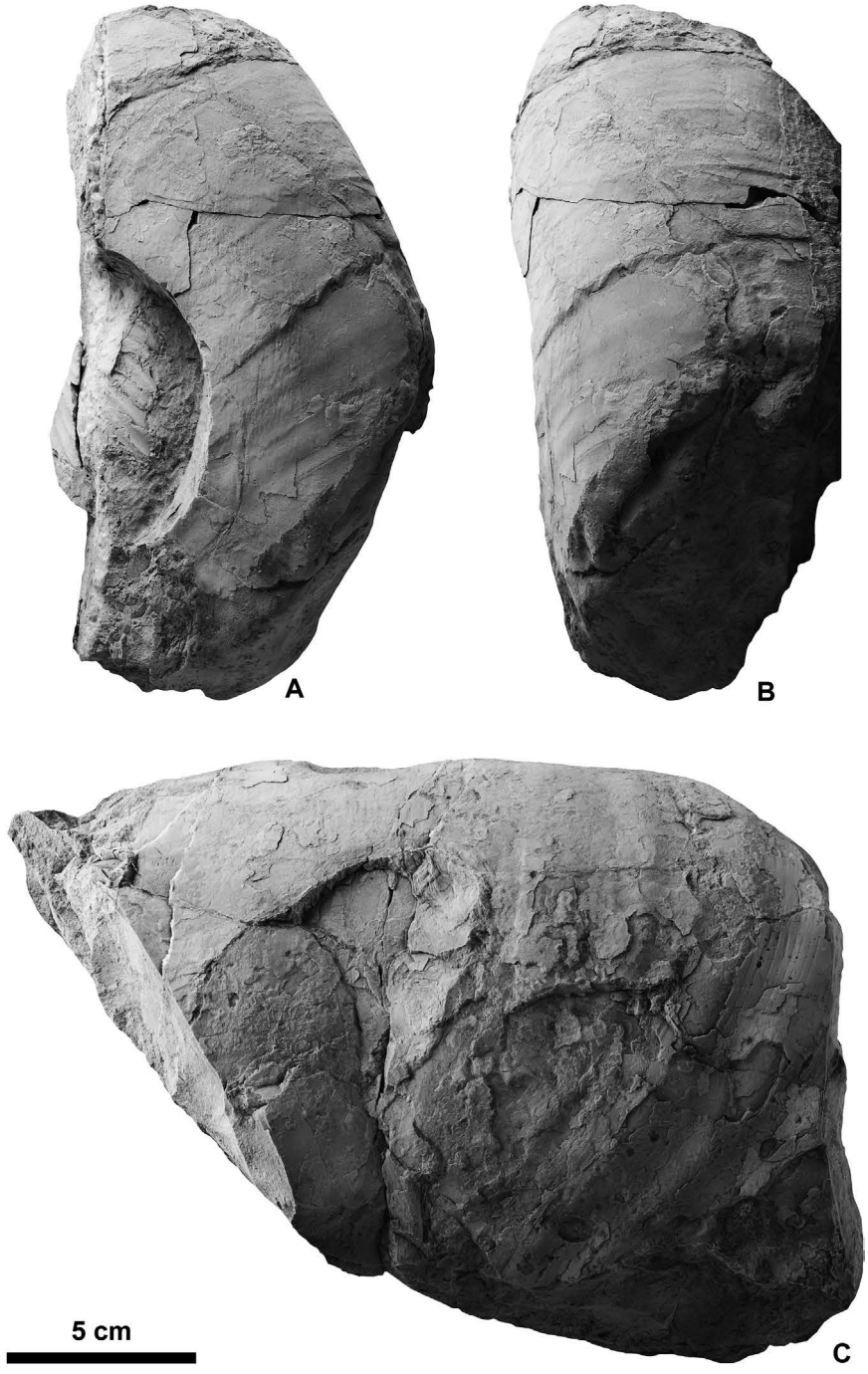

Fig. 39. *Menuites fascicostatus* (Yabe in Yabe and Shimizu, 1921) from Loc. 13 in the Chinomigawa Formation. A–C, NMNS PM35227.

Fig. 40. *Menuites fascicostatus* (Yabe in Yabe and Shimizu, 1921) from Loc. 20 in the Chinomigawa Formation. A, B, HMG-1914.

Fig. 41. *Menuites fascicostatus* (Yabe in Yabe and Shimizu, 1921) from Loc. 15 in the Chinomigawa Formation. A, B, NMNS PM35226.

Menuites fascicostatus
(Yabe in Yabe and Shimizu, 1921)
Figs. 37–41

Pachydiscus (*Parapachydiscus*) *fascicostatum* Yabe in Yabe and Shimizu, 1921, p. 57, pl. 8, fig. 5, pl. 9, figs. 2–5.
Anapachydiscus fascicostatus (Yabe). Matsumoto, 1954, p. 273, pl. 23, fig. 3, text-fig. 13; Matsumoto, 1984, p. 14, pl. 4, figs. 1, 2, pl. 5, fig. 2, pl. 8, fig. 7, text-fig. 4.
Anapachydiscus cf. *fascicostatus* (Yabe). Matsumoto and Miyauchi, 1984, p. 45, pl. 22, fig. 3.
Menuites fascicostatus (Yabe). Takahashi *et al.*, 2007, pl. 6, fig. 5.
Pachydiscus (*Pachydiscus*) *soyaensis* Matsumoto and Miyauchi. Takahashi *et al.*, 2007, pl. 6, fig. 56.

Holotype.—UMUT. MM6764, figured by Yabe in Yabe and Shimizu (1921, p. 57, pl. 8, fig. 5, pl. 9, figs. 2–5.), from the Upper Cretaceous, most likely came from the middle Campanian *Metaplacenticeras subtilistriatum* Zone, along the Tan-no-sawa, a tributary of the Abeshinai River, in the Nakagawa area, Hokkaido.

Material examined.—One specimen, NMNS PM35227, from Loc. 13, two specimens, NMNS PM35225, 35226, from Loc. 15; one specimen, HMG-1914, from Loc. 20.

Description.—Fairly involute with fairly depressed shell with circular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-flank. Umbilicus fairly narrow, with high, convex wall and rounded shoulders. Ornamentation consists of umbilical bullae-like elevations and fine, numerous, prorsiradiate ribs, which curve slightly forward on the ventral shoulder and pass over venter in a broad convex arch. As shell grows, ribs become much coarser and more distant. Suture line typical pachydiscid-type with deep trified lobes and bifid saddles.

Remarks.—Well preserved specimens of *Menuites fascicostatus* that retain most of their shell material are characterized by spinose umbilical tubercles that extend vertically from the umbilical shoulder. The missing shell material on the present specimens makes the elongated base of the umbilical tubercles appear to be somewhat similar to umbilical bullae. These umbilical bullae-like elevations observed on the inner molds are almost certainly the base of umbilical tubercles.

Occurrence.—Described specimens were collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study section III and IV. *Menuites fascicostatus* is known from the middle Campanian *M. subtilistriatum* Zone in the Teshio Mountains and Cape Soya area in Hokkaido.

Menuites nelchinensis (Jones, 1963)
Figs. 42–46

Anapachydiscus nelchinensis Jones, 1963, p. 44, pl. 34, figs. 1–3, pl. 35, figs. 4, 7–9, text-fig. 23.

Holotype.—USNM 131212, figured by Jones (1963, p. 44, pl. 34, figs. 4, 7, 9.), from the Campanian at USGS Mesozoic loc. 24217, Matanuska Valley–Nelchina area, southern Alaska.

Material examined.—Three specimens, HMG-1916–1918, collected by N. Sasaki, from float concretions found at Loc. 3; one specimen, HMG-1915, from Loc. 9; one specimen, NMNS PM35228, from Loc. 17.

Description.—Moderately involute, fairly depressed shell with circular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at mid-flank. Umbilicus fairly narrow, with high, convex wall and rounded shoulders. As size increases, whorl section becomes more compressed and umbilicus becomes narrower. Ornamentation consists of very weak, low, umbilical bullae-like elevations and very weak, fine, prorsiradiate ribs, which pass over venter in a broad convex arch. Suture line typical pachydiscid-type with deep trified lobes and bifid saddles.

Remarks.—Immature shells of this species closely resemble the inner whorls of *Menuites armatus* sp. nov. It is possible that both taxa represent a dimorphic pair, but the intensive study required to support such a hypothesis is beyond the scope of this work.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian

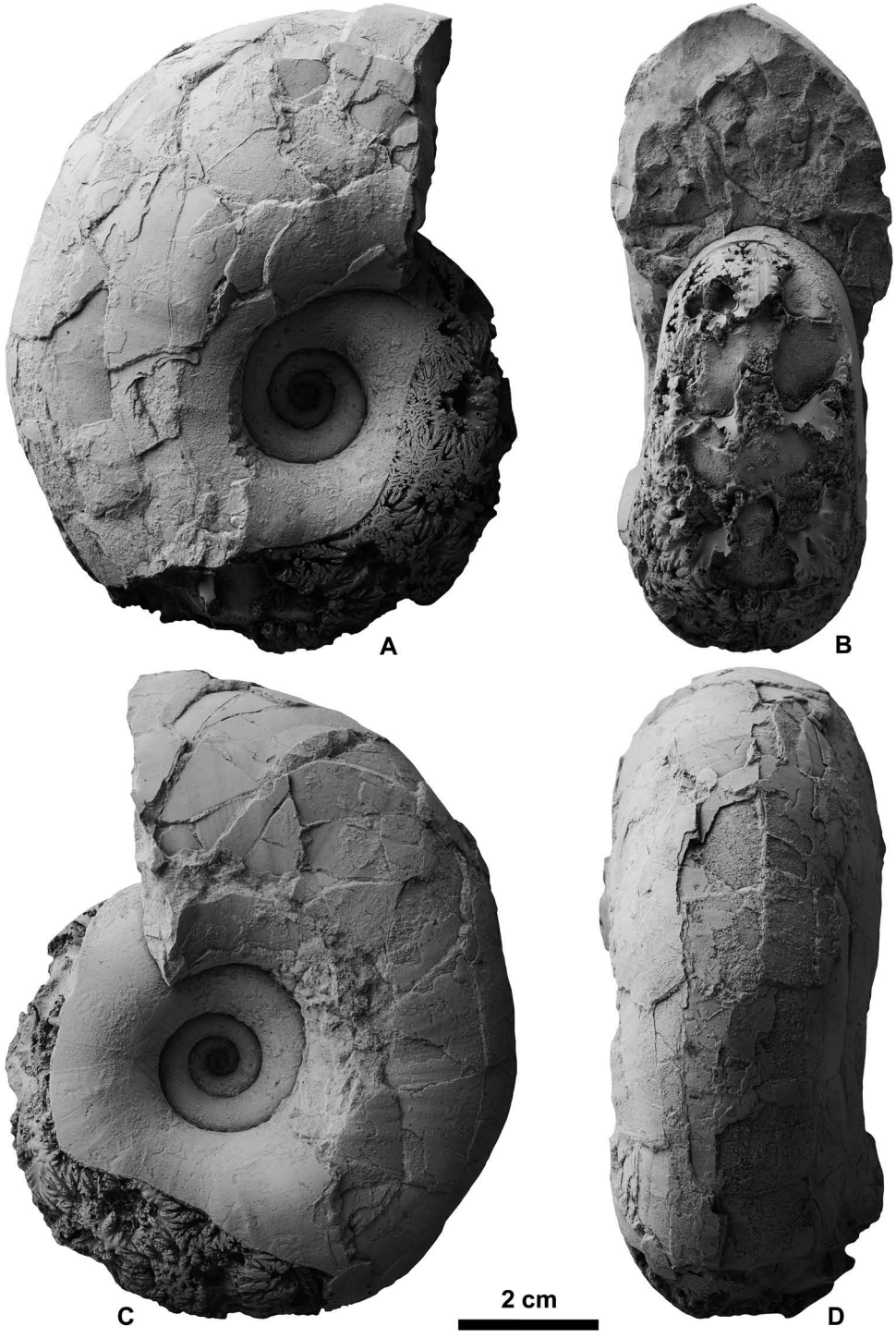

Fig. 42. *Menuites nelchinensis* (Jones, 1963) from Loc. 9 in the Chinomigawa Formation. A–D, HMG-1915.

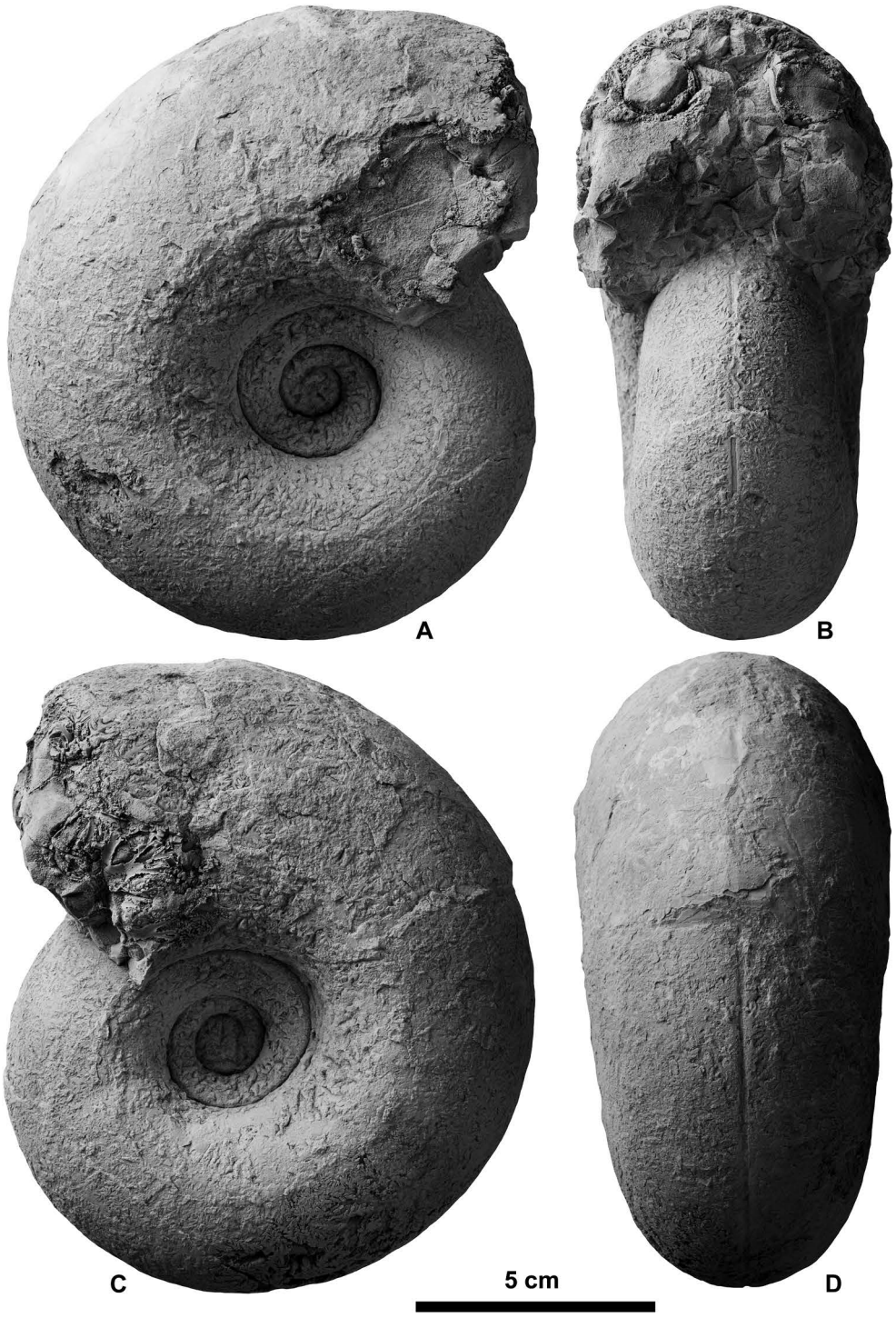

Fig. 43. *Menuites nelchinensis* (Jones, 1963) from a float concretion found at Loc. 3. A–D, HMG-1916.

Fig. 44. *Menuites nelchinensis* (Jones, 1963) from a float concretion found at Loc. 3. A–D, HMG-1918.

Fig. 45. *Menuites nelchinensis* (Jones, 1963) from a float concretion found at Loc. 3. A–C, HMG-1917.

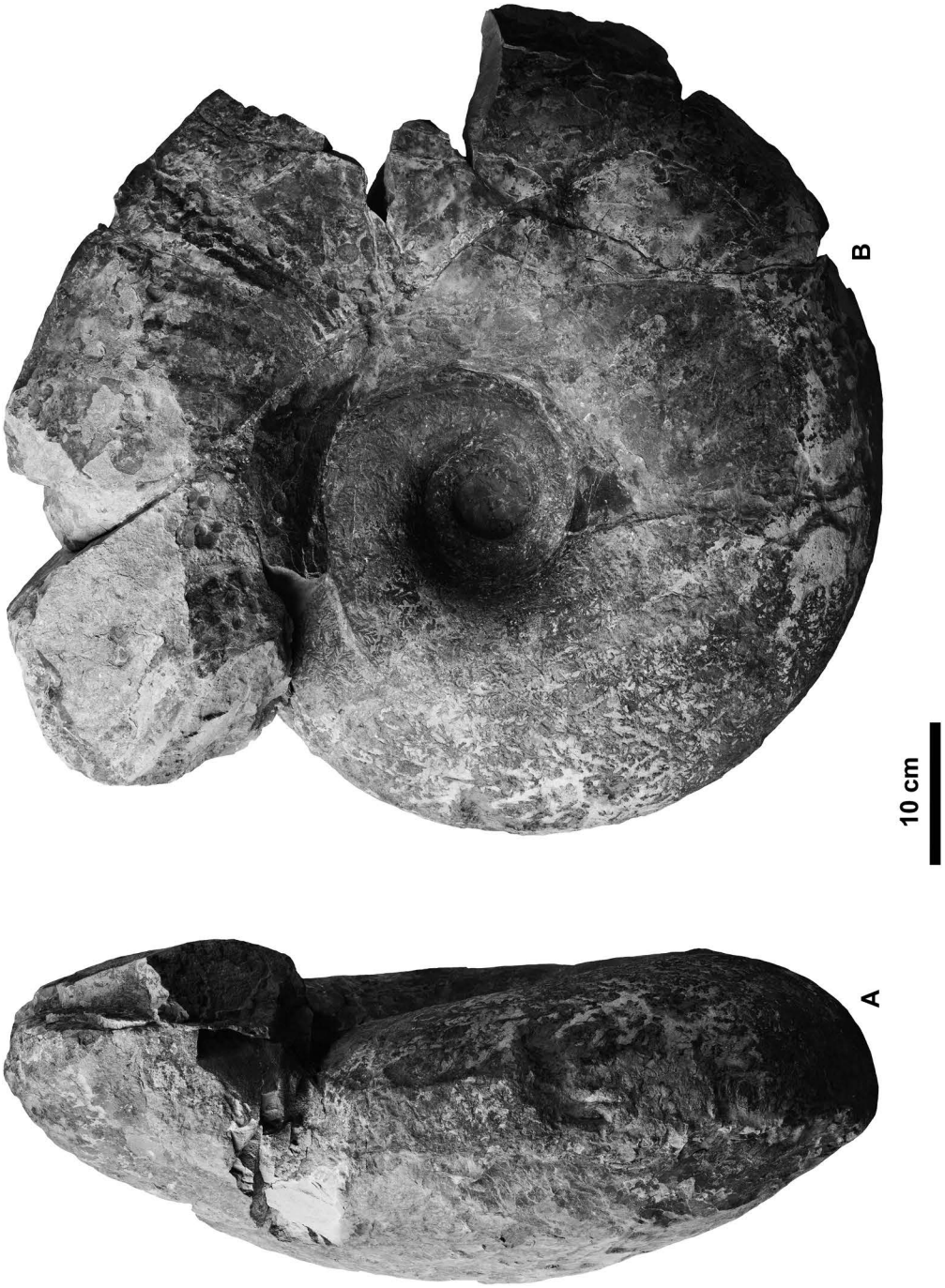

Fig. 46. *Menuites nelchinensis* (Jones, 1963) from Loc. 17 in the Chinomigawa Formation. A, B, NMNS PM35228.

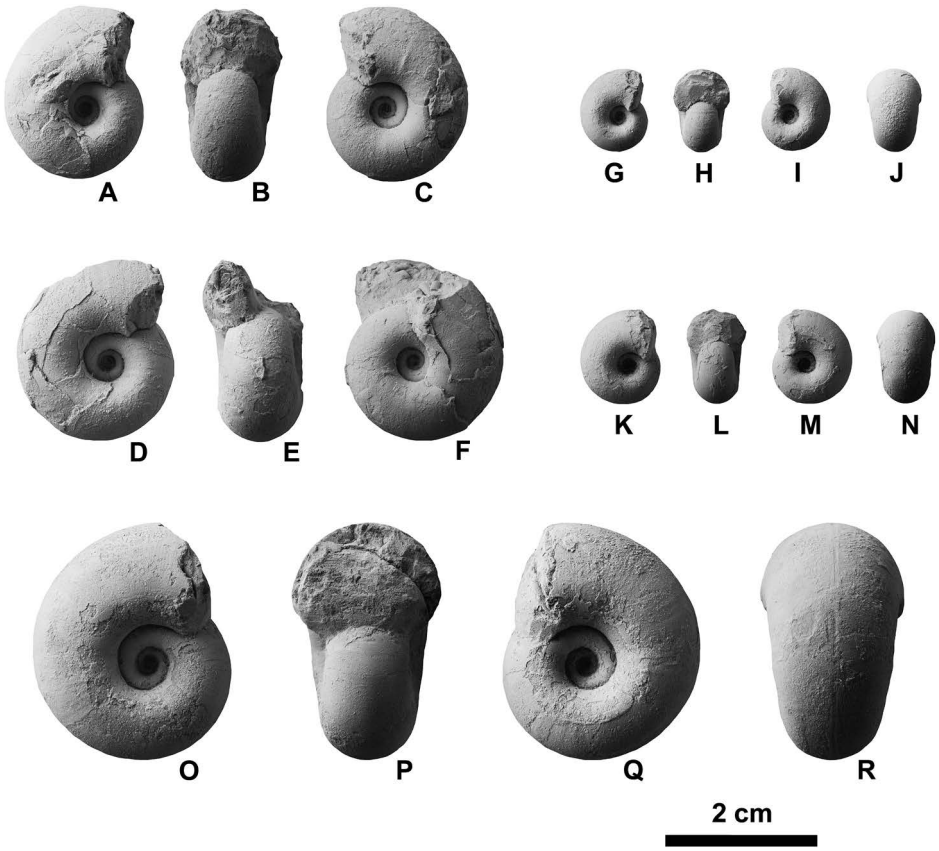

Fig. 47. *Menuites* sp. from the Chinomigawa Formation. A–F, from a float concretion found at Loc. 3; A–C, HMG-1919; D–F, HMG-1920; G–R, from Loc. 9; G–J, HMG-1921; K–N, HMG-1922; O–R, HMG-1923.

Baculites pacificus and *Baculites subanceps* beds in the Chinomigawa Formation at study sections III and IV. Float concretions found at study section I probably came from the same beds. *Menuites nelchinensis* is known from the Campanian of southern Alaska.

Menuites sp.

Fig. 47

Material examined.—Two specimens, HMG-1919, 1920, found together with *Baculites pacificus* in a float concretion at Loc. 3; three specimens, HMG-1921–1923, from Loc. 9.

Description.—Fairly involute, fairly depressed shell with circular whorl section, rounded venter, indistinct ventral shoulders, and gently convex flanks with maximum whorl width at umbilical shoulder. Umbilicus fairly narrow, with high, convex wall and rounded shoulders. Ornamentation consists of very weak, umbilical bullae and very fine, prorsiradiate lirae, which pass over venter in a broad convex arch.

Remarks.—A definitive species assignment cannot be made because the specimens may in fact represent the juvenile whorls of *Menuites armatus* sp. nov. or *M. nelchinensis*.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificus* in the Chinomigawa Formation at study section III. Float concretion found at loc. 3 most likely came the same beds.

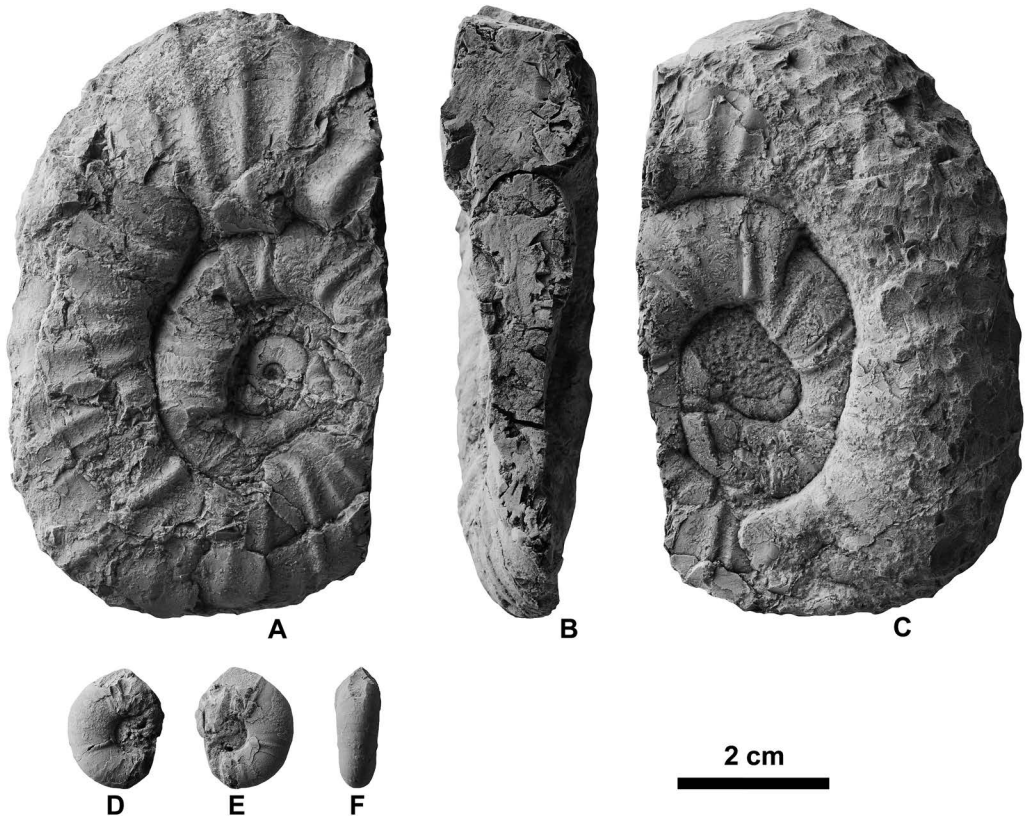

Fig. 48. *Patagiosites* sp. from the Chinomigawa Formation. A–C, HMG-1924 from a float concretion found at Loc. 3; D–F, HMG-1925 from Loc. 8.

Genus ***Patagiosites*** Spath, 1953

Type species.—*Ammonites patagiosus* Schlüter, 1867.

Patagiosites sp.

Fig. 48

Material examined.—One specimen, HMG-1924, from a float concretion found at Loc. 3; one specimen, HMG-1925, from Loc. 8.

Description.—Very evolute, fairly compressed shell with elliptical whorl section, arched venter, rounded ventral shoulders, and slightly convex flanks with maximum whorl width at mid-flank. Umbilicus moderately wide with moderately high, vertical wall and rounded shoulders. Ornamentation consists of numerous, prorsiradiate ribs as well as prominent major ribs arising from umbilical bullae, and shallow constrictions followed immediately by major ribs. Intercalation occurs on inner flank.

Remarks.—The present specimens undoubtedly represent shells of *Patagiosites*, but the crushed preservation of the larger specimens and the exceedingly small size of the other precludes a definitive species assignment.

Occurrence.—Described *in-situ* specimen HMG-1925 was collected from the lower upper Campanian *Baculites rex* in the Chinomigawa Formation at study section III. Float concretions collected at Loc. 3 probably came from the lower upper Campanian *B. pacificus* or *B. subanceps* beds at study section I.

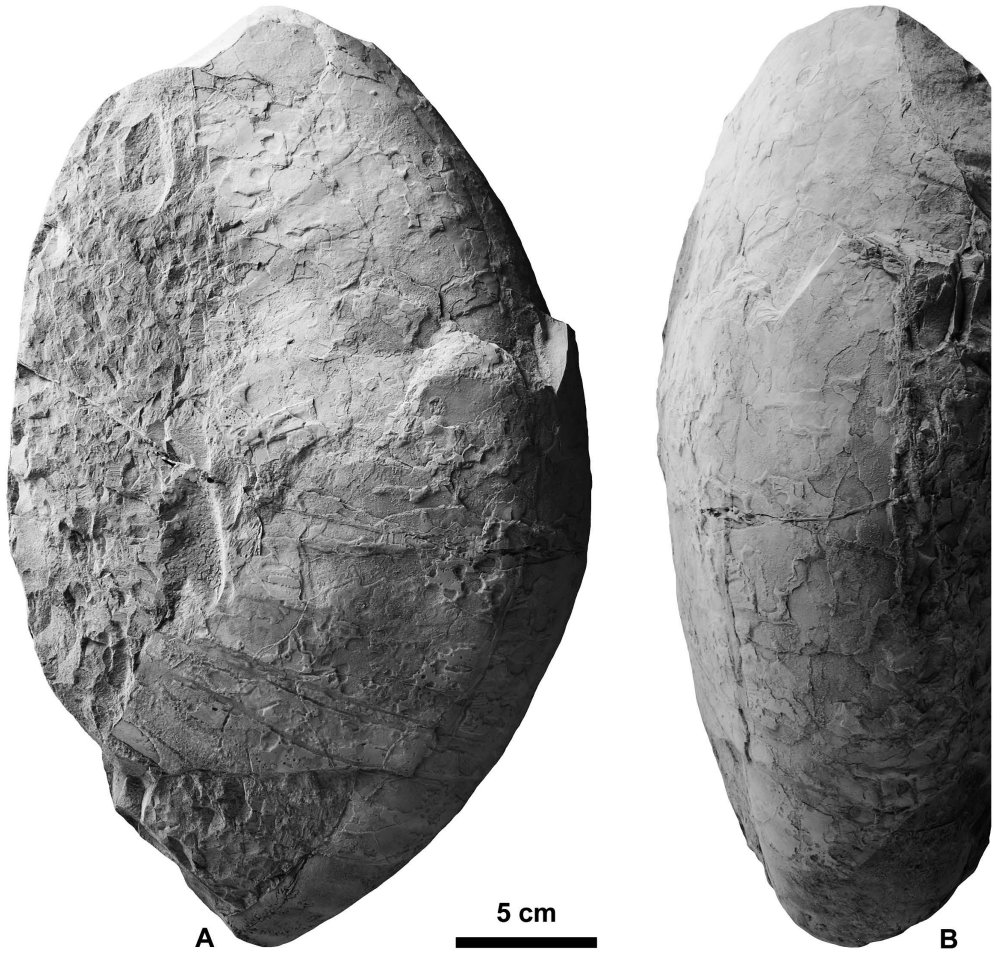

Fig. 49. *Pachydiscus excelsus* Matsumoto, 1979 from Loc. 5 in the Chinomigawa Formation. A, B, NMNS PM35230.

Genus ***Pachydiscus*** Zittel, 1884

Type species.—*Ammonites neubergicus* Hauer, 1858.

Pachydiscus excelsus Matsumoto, 1979

Figs. 49–56

Pachydiscus excelsus Matsumoto, 1979, p. 50, pl. 8, fig. 1, text-fig. 2; Shigeta *et al.*, 2016, p. 343, fig. 16.

Holotype.—GK. H5895, figured by Matsumoto (1979, p. 50, pl. 8, fig. 1), from the lower part of the Hakobuchi Formation (probably upper Campanian), along the Sanushupe (Sanushibe) River in the Hobetsu area, Hokkaido.

Material examined.—Three specimens, HMG-1926 (collected by N. Sasaki), 1927, NMNS PM35229, from float concretions found at Loc. 3; one specimen, NMNS PM35230, from Loc. 5; three specimens, NMNS PM35231–35233, from Loc. 6; one specimen, NMNS PM35234, from Loc. 17; one specimen, NMNS PM35235, from Loc. 18; two specimens, NMNS PM35236, HMG-1928, from Loc. 22; one specimen, HMG-1929, from Loc. 24.

Description.—Early whorls (up to 30 mm in diameter): Moderately involute, fairly compressed shell with elliptical whorl section, arched venter, rounded ventral shoulders, and slightly convex flanks with maximum whorl width at

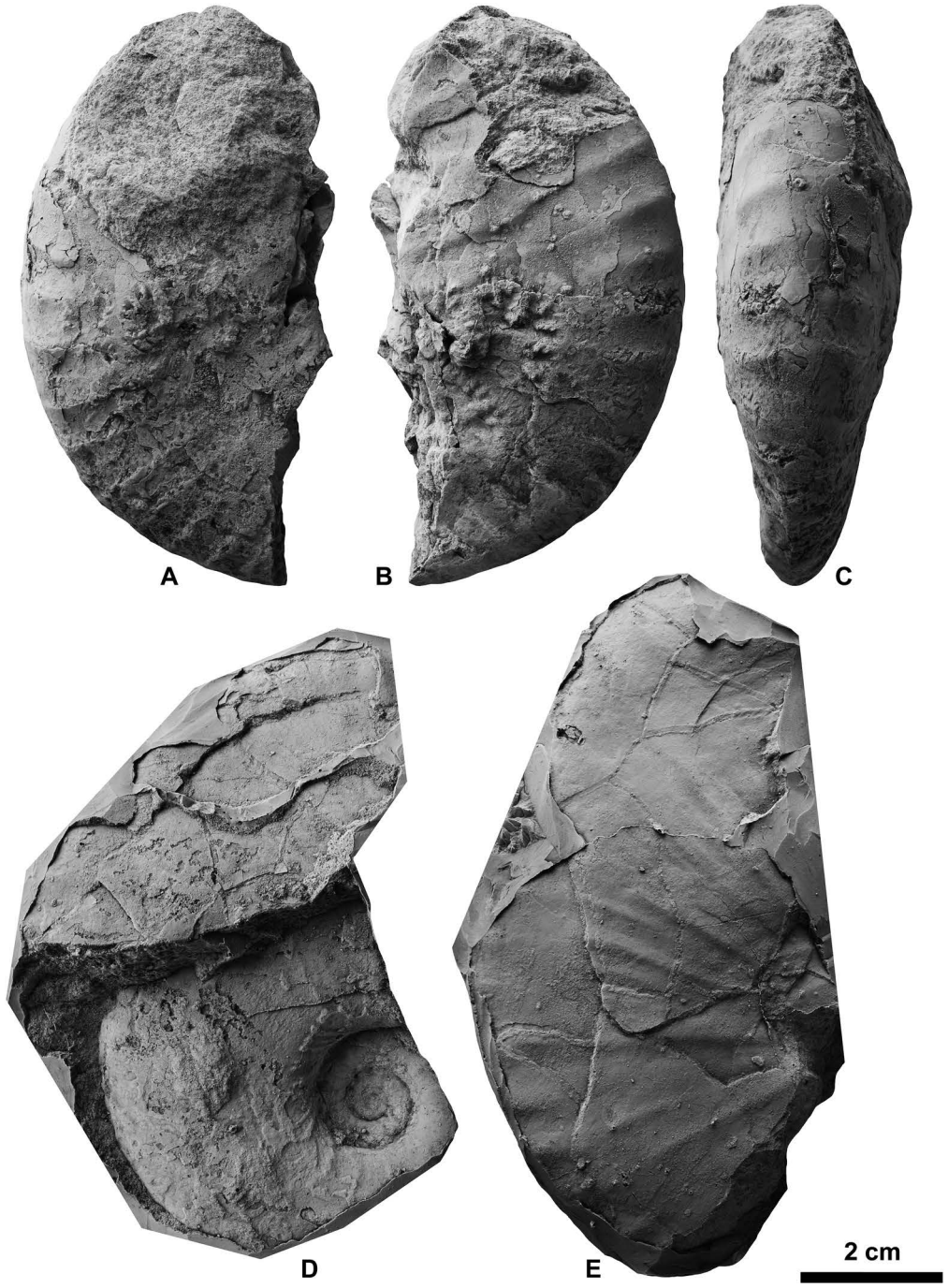

Fig. 50. *Pachydiscus excelsus* Matsumoto, 1979 from the Chinomigawa Formation. A–E, HMG-1929 from Loc. 24. D, E, rubber casts of outer molds.

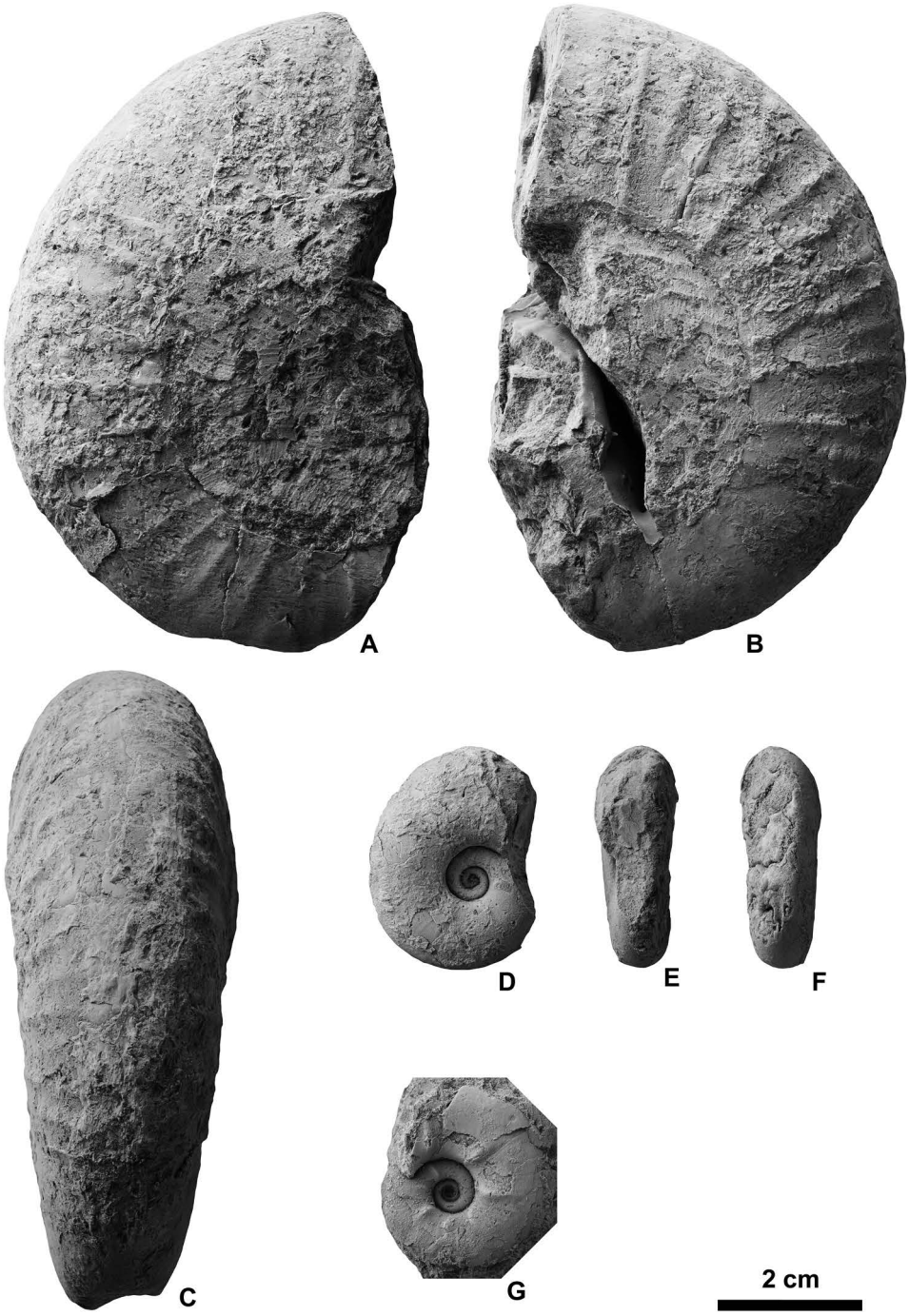

Fig. 51. *Pachydiscus excelsus* Matsumoto, 1979 from Loc. 6 in the Chinomigawa Formation. A–C, NMNS PM35231; D–F, NMNS PM35232; G, NMNS PM35233.

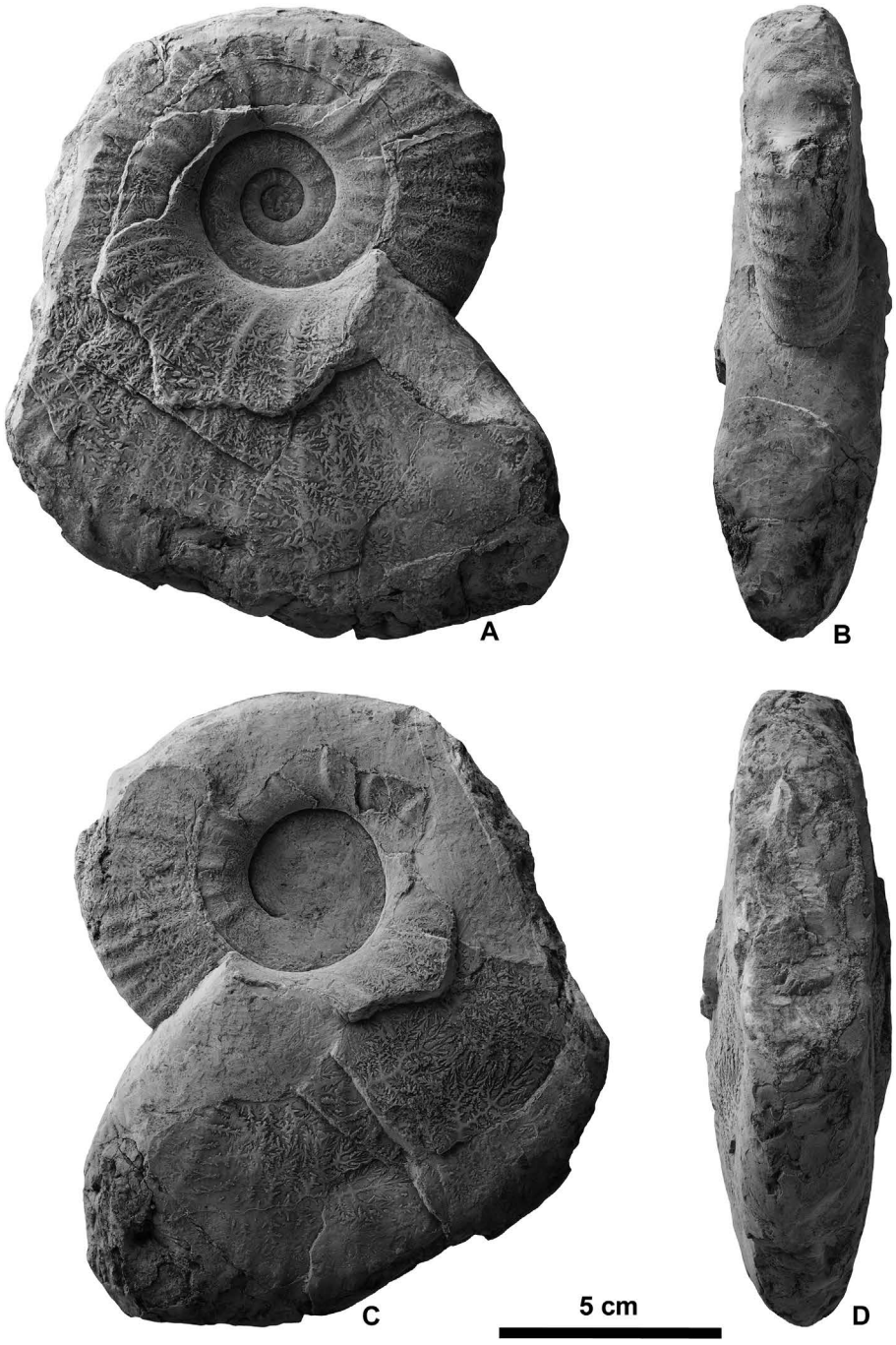

Fig. 52. *Pachydiscus excelsus* Matsumoto, 1979 from Loc. 17 in the Chinomigawa Formation. A–D, NMNS PM35234.

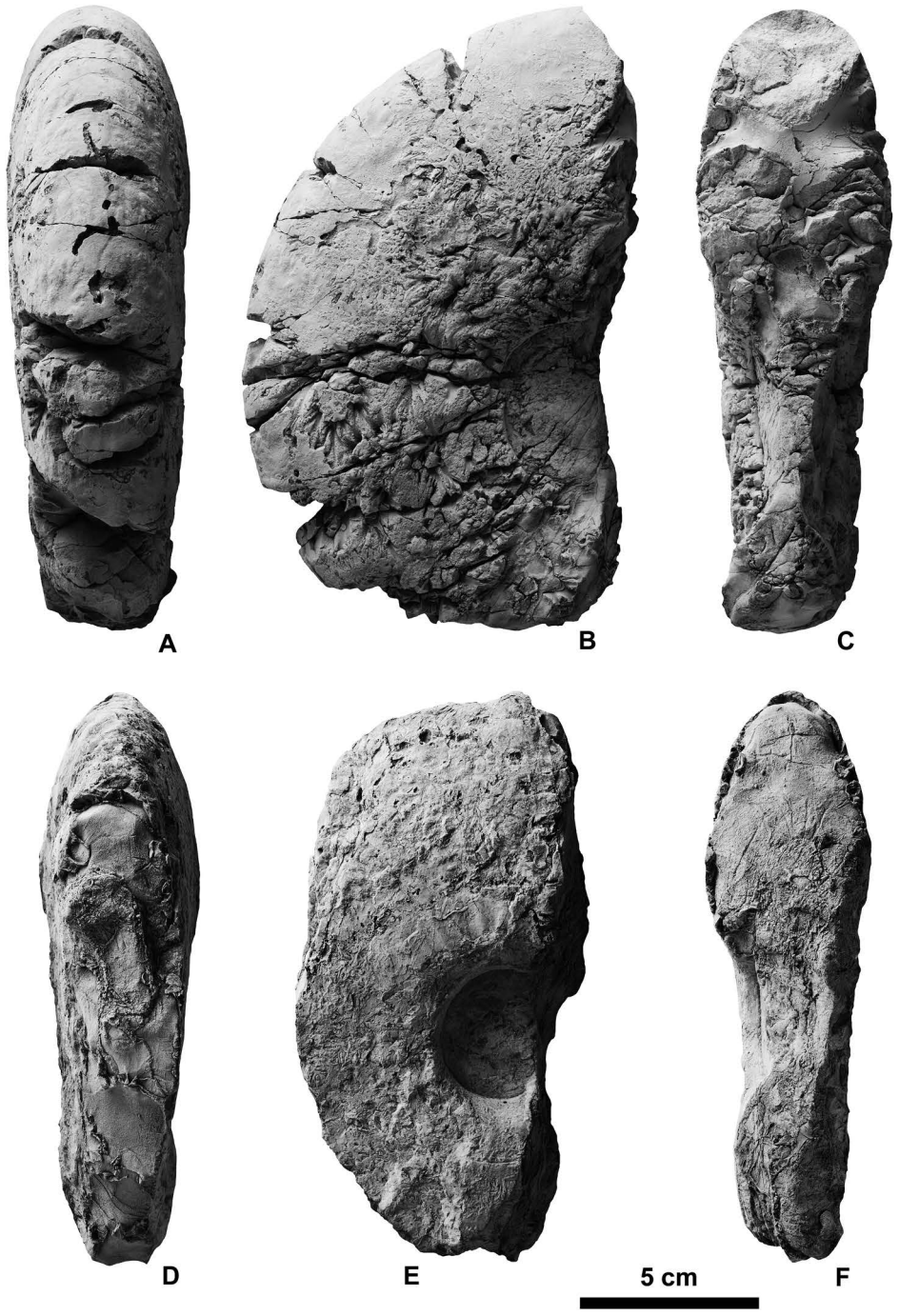

Fig. 53. *Pachydiscus excelsus* Matsumoto, 1979 from the Chinomigawa Formation. A–C, NMNS PM35235 from Loc. 18; D–F, NMNS PM35229 from a float concretion found at Loc. 3.

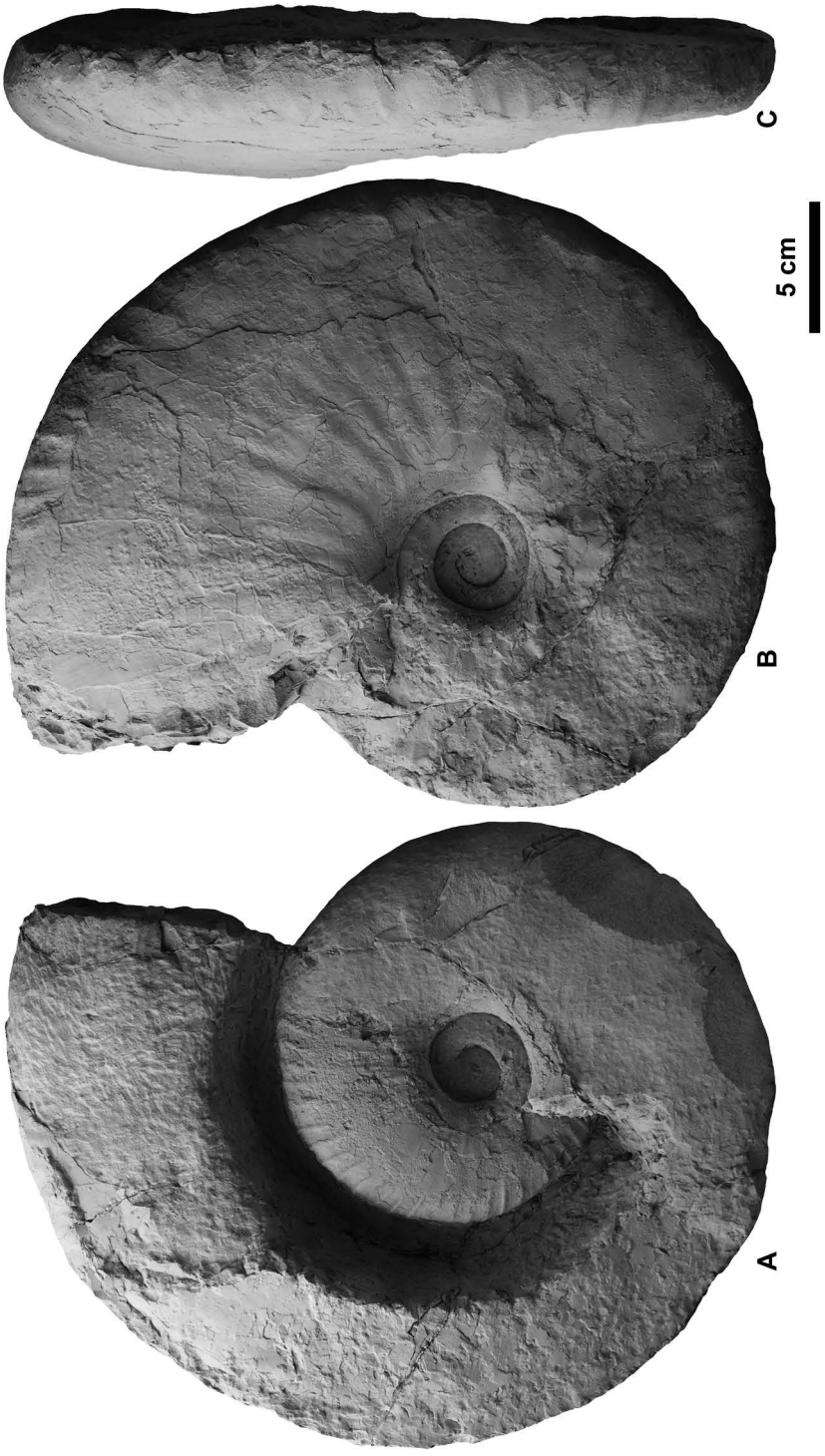

Fig. 54. *Pachydiscus excelsus* Matsumoto, 1979 from a float concretion found at Loc. 3; A–C, HMG-1926.

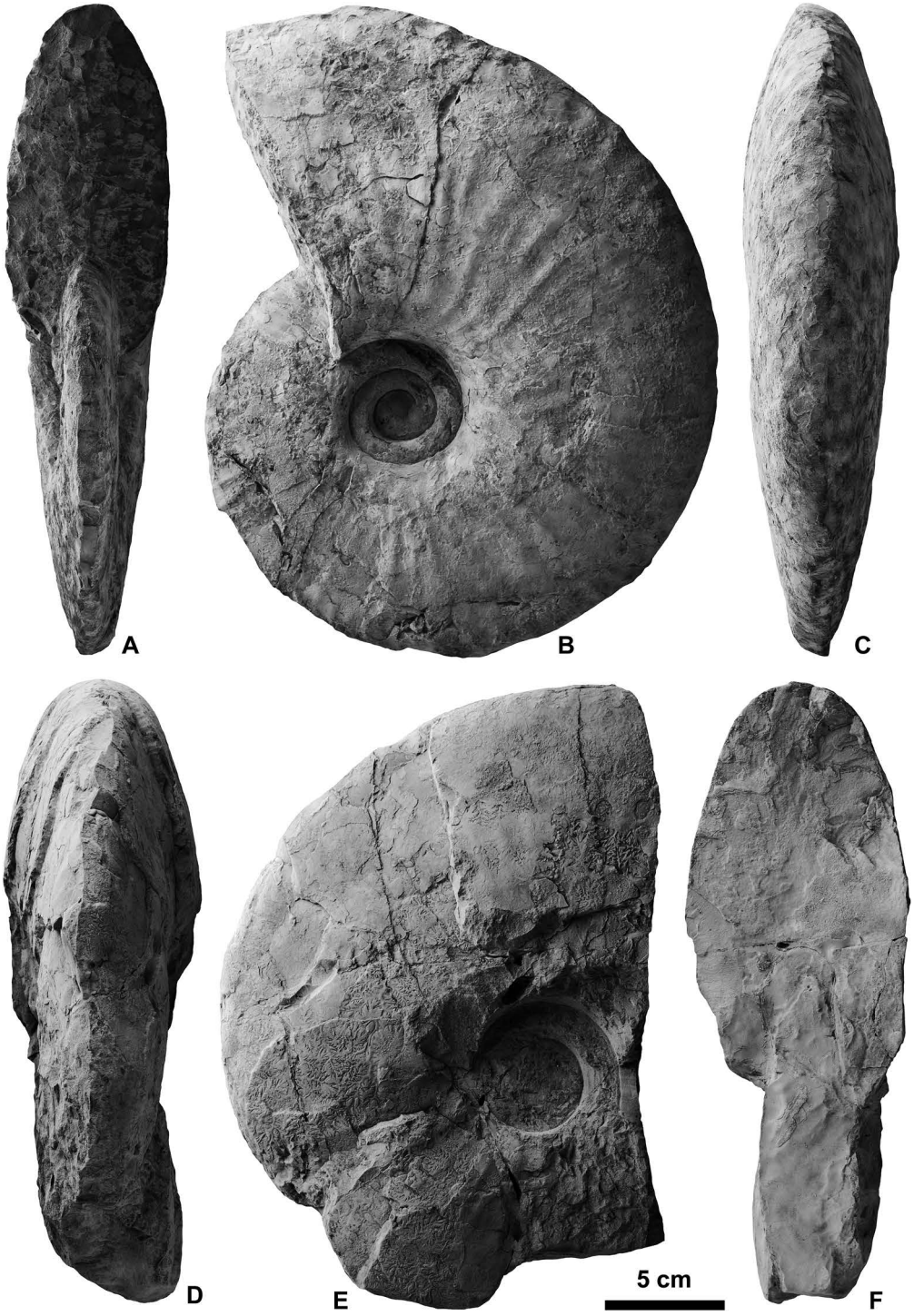

Fig. 55. *Pachydiscus excelsus* Matsumoto, 1979 from the Chinomigawa Formation. A–C, HMG-1927 from a float concretion found at Loc. 3; D–F, NMNS PM35236 from Loc. 22.

Fig. 56. *Pachydiscus excelsus* Matsumoto, 1979 from Loc. 22 in the Chinomigawa Formation. A–C, HMG-1928.

mid-flank. Umbilicus fairly narrow with moderately high, vertical wall and rounded shoulders. Ornamentation consists of moderately distant, bullate umbilical ribs fading away on flank.

Middle to late whorls (over 30 mm in diameter): As size increases, whorl section becomes more compressed and umbilicus becomes narrower. Ornamentation consists of numerous, weakly prorsiradiate, ribs arising fairly high on umbilical shoulder, crossing flank in a more or less straight line and then crossing venter in diminished strength. Intercalation occurs on mid-flank.

Occurrence.—Described *in-situ* specimens were collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds and the lower upper Campanian *Baculites pacificus* and *B*. *rex* beds in the Chinomigawa Formation at study sections I, II, IV and V. Float concretions collected at Loc. 3 probably came from the lower upper Campanian *B*. *pacificus* and *B*. *subanceps* beds at study section I. *Pachydiscus excelsus* is known from sediments of probably late Campanian age in the Hobetsu and Urakawa areas.

Superfamily Hoplitoidea Douvillé, 1890
Family Placenticeratidae Hyatt, 1900
Genus ***Metaplacenticeras*** Spath, 1926

Type species.—*Placenticeras pacificum* Smith, 1900.

Metaplacenticeras subtilistriatum (Jimbo, 1894)
Fig. 57

Placenticeras subtilistriatum Jimbo, 1894, p. 171, pl. 1, fig. 1.

Metaplacenticeras (*Paraplacenticeras*) *subtilistriatum* (Jimbo). Matsumoto, 1953, p. 140, pl. 13, figs. 1–4, text-figs. 1–9.

Metaplacenticeras subtilistriatum (Jimbo). Matsumoto, 1963, p. 42, pl. 60, fig. 1 (= Jimbo, 1894, pl. 1, fig. 1); Matsumoto, 1984, p. 21, pl. 6, figs. 1, 2, pl. 7, figs. 1–4; Matsumoto and Miyauchi, 1984, p. 51, pl. 22, figs. 1, 2; Bando and Hashimoto, 1984, pl. 1, figs. 1–6, pls. 2, 3; Tashiro *et al.*, 1993, pl. 1, figs. 4, 6; Ando and Ando, 2002, pl. 3, fig. 3; Wani, 2006, figs. 4, 5; Takahashi *et al.*, 2007, pl. 5, figs. 2, 3, 8; Shigeta *et al.*, 2016, p. 343, fig. 17.

Lectotype.—Specimen designated by Matsumoto (1984, p. 21), is UMUT MM7502, original of Jimbo (1894, pl. 1, fig. 1) from the Wembetsu-Rubeshibe River in the Teshio Mountains.

Material examined.—One specimen, HMG-1930, from a float concretion found at Loc. 1; one specimen, HMG-1931, from Loc. 12; three specimens, HMG-1932–1934, from Loc. 15; two specimens, HMG-1935, 1936, from Loc. 21.

Description.—Very involute, very compressed shell with elongated trapezoidal cross section, narrow, bicarinate venter, and slightly convex flanks with maximum whorl width near umbilical shoulders. Umbilicus narrow with low, steeply inclined wall and angular shoulders. Ornamentation consists of fine, prorsiradiate, sigmoidal ribs, lirae and umbilical tubercles.

Occurrence.—Described *in-situ* specimens were collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study sections III and IV. Float concretion found at Loc. 1 probably came from the same beds. *Metaplacenticeras subtilistriatum* is known from the Teshio Mountains, Cape Soya, Soya Hill and Urakawa areas in Hokkaido and the Asan Mountains, Shikoku, Southwest Japan.

Suborder Ancyloceratina Wiedmann, 1966
Superfamily Turrilitoidea Gill, 1871
Family Nostoceratidae Hyatt, 1894
Genus ***Ainoceras*** Matsumoto and Kanie, 1967

Type species.—*Ainoceras kamuy* Matsumoto and Kanie, 1967.

Ainoceras kamuy Matsumoto and Kanie, 1967
Fig. 58

Ainoceras kamuy Matsumoto and Kanie, 1967, p. 351, pl. 20, figs. 1–6; Takahashi *et al.*, 2007, pl. 4, fig. 1; Misaki and Ohara, 2012, p. 242, fig. 2D–G.

Holotype.—GK. H5575, figured by Matsumoto and Kanie (1967, p. 351, pl. 20, fig. 1), from the *Sphenoceramus orientalis* Zone (= lowest middle Campanian) along the third tributary

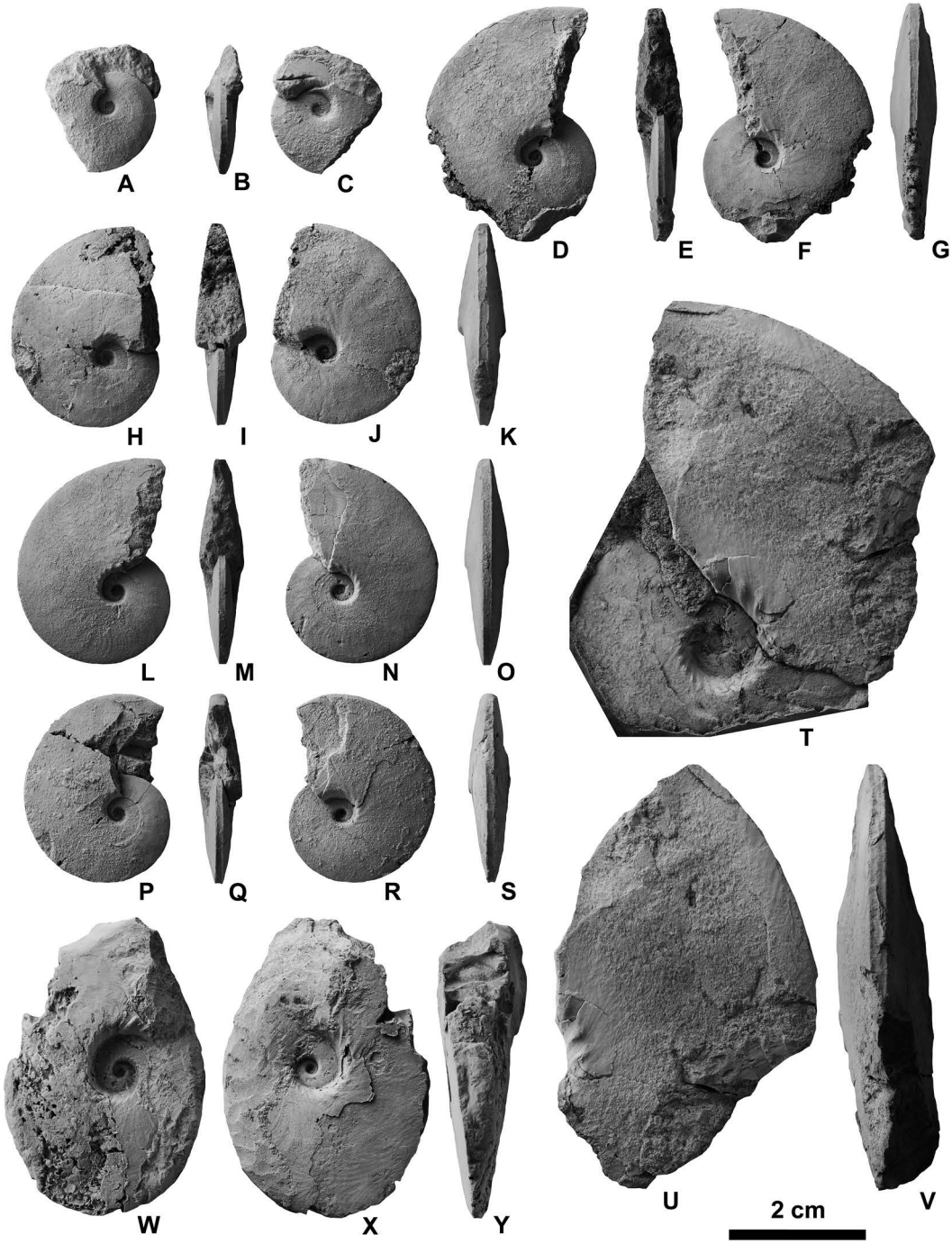

Fig. 57. *Metaplacenticeras subtilistriatum* (Jimbo, 1894) from the Chinomigawa Formation. A–C, HMG-1931 from Loc. 12; D–G, HMG-1932 from Loc. 15; H–K, HMG-1933 from Loc. 15; L–O, HMG-1934 from Loc. 15; P–S, HMG-1935 from Loc. 21; T–V, HMG-1936 from Loc. 21; W–Y, HMG-1930 from a float concretion found at Loc. 1.

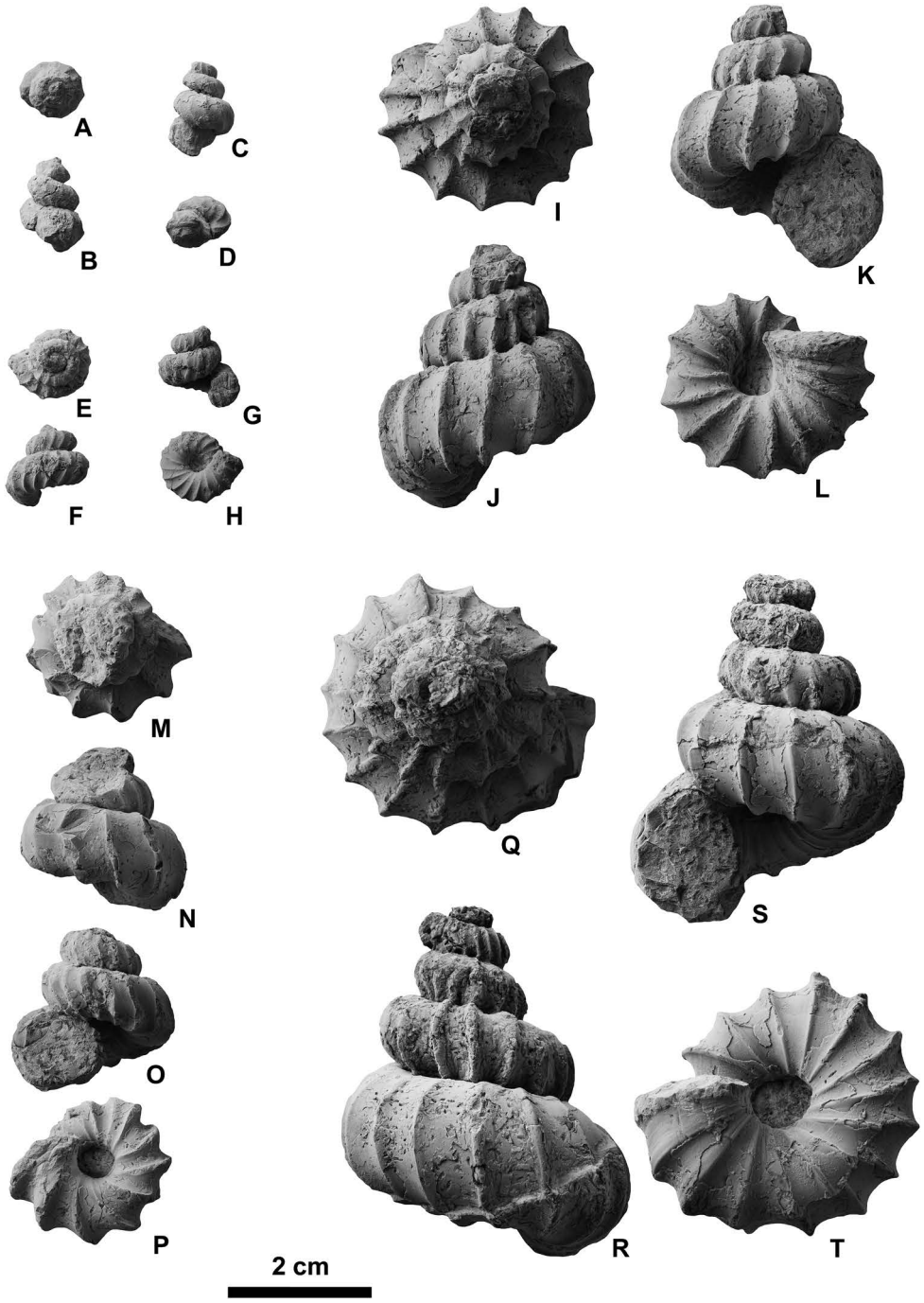

Fig. 58. *Ainoceras kamuy* Matsumoto and Kanie, 1967 from float concretions found at Loc. 14. A–D, HMG-1949; E–H, HMG-1950; I–L, HMG-1951; M–P, HMG-1952; Q–T, HMG-1953.

of the Nio-no-sawa River, Abeshinai-Saku area, Nakagawa, northern Hokkaido.

Material examined.—Five specimens, HMG-1949–1953, from float concretions found at Loc. 14.

Description.—Earliest whorls, less than 2 mm in diameter, not preserved. Preserved whorls helically and tightly coiled dextrally or sinistrally, forming apical angle of approximately 50°. Whorl cross section nearly circular. Shell surface ornamented with distant, sharp-crested, prominent, slightly flared ribs. Mature loosely coiled planispiral whorls not preserved.

Occurrence.—Described specimens were collected from float concretions that also contained *Sphenoceramus orientalis* at study section III. *Ainoceras kamuy* is known from the *S. orientalis* Zone in the Nakagawa, Nukibetsu and Urakawa areas, Hokkaido and the Aridagawa area, Wakayama, Southwest Japan.

Genus ***Didymoceras*** Hyatt, 1894

Type species.—*Ancyloceras*? *nebrascense* Meek and Hayden, 1856.

Didymoceras hidakense
Shigeta in Shigeta *et al.*, 2016
Figs. 59–77

Didymoceras sp. Shigeta, 2001, pl. 40, fig. 1.
Didymoceras hidakense Shigeta in Shigeta *et al.*, 2016, p. 346, figs. 18–23, 24C–E.

Holotype.—HMG-1660, figured by Shigeta in Shigeta *et al.* (2016, p. 346, figs. 19, 20), from the lower upper Campanian *Baculites subanceps* Zone in the Urakawa area, southern central Hokkaido.

Material examined.—Two specimens, HMG-1937, 1938, from float concretion found at Loc. 1'; five specimens, HMG-1939–1943, from float concretions found at Loc. 2; eight specimens, HMG-1944, 1945, NMNS PM35237–35242, from float concretions found at Loc. 3; three specimens, HMG-1946–1948, from float concretions found at Loc. 3'. HMG-1943 was collected by N. Sasaki.

Description.—Earliest whorls including initial chamber and ammonitella, less than 7 mm in diameter, not preserved. Preserved initial whorl loosely coiled in a plane. Middle whorls, 10–100 mm in diameter, helically coiled dextrally or sinistrally, not in contact. Apical angle initially 65–75°, but decreases to 30–50° as shell grows. Later whorls, over 100 mm in diameter, uncoiled with recurved hook-like body chamber that ends with aperture facing upward. Whorl cross section nearly circular. Shell surface ornamented with dense, oblique ribs and two rows of tubercles. Distant but strong, highly elevated ribs followed by a shallow constriction, occur periodically among narrowly raised ribs. Ribs rursiradiate on lower and outer whorl faces, but curve forward on upper face and cross over dorsum in a slight convexity. Ribs on all growth stages become less intense as they cross dorsum. Two rows of tubercles appear rather irregularly on every second to fourth rib: upper row situated on mid-line of outer whorl face, on or near siphuncle, or slightly below, and lower row on ventrolateral shoulder. As shell grows, ribs increase in strength and tubercles and constrictions become weaker or obscure. Peristome characterized by deep constriction followed immediately by a strong rib.

Remarks.—Misaki *et al.* (2014) reported that the uppermost Campanian heteromorph ammonoid *Pravitoceras sigmoidale* from the Seidan Formation of the Izumi Group in Southwest Japan is frequently encrusted by sessile anomiid bivalves, and suggested that this encrustation occurred not on post-morterm floating or sunken carcasses but rather on live conchs. Misaki *et al.* (2014) also observed such anomiid colonization on *Didymoceras awajiense*, which is considered to be the closely related ancestral species of *P. sigmoidale*. Misaki *et al.* (2014) further stated that this anomiid-heteromorph ammonoid commensal relationship may have continued to persist in the descendants of these heteromorph ammonoids during the course of their evolution.

Anomiid encrustation is also observed on *Did-*

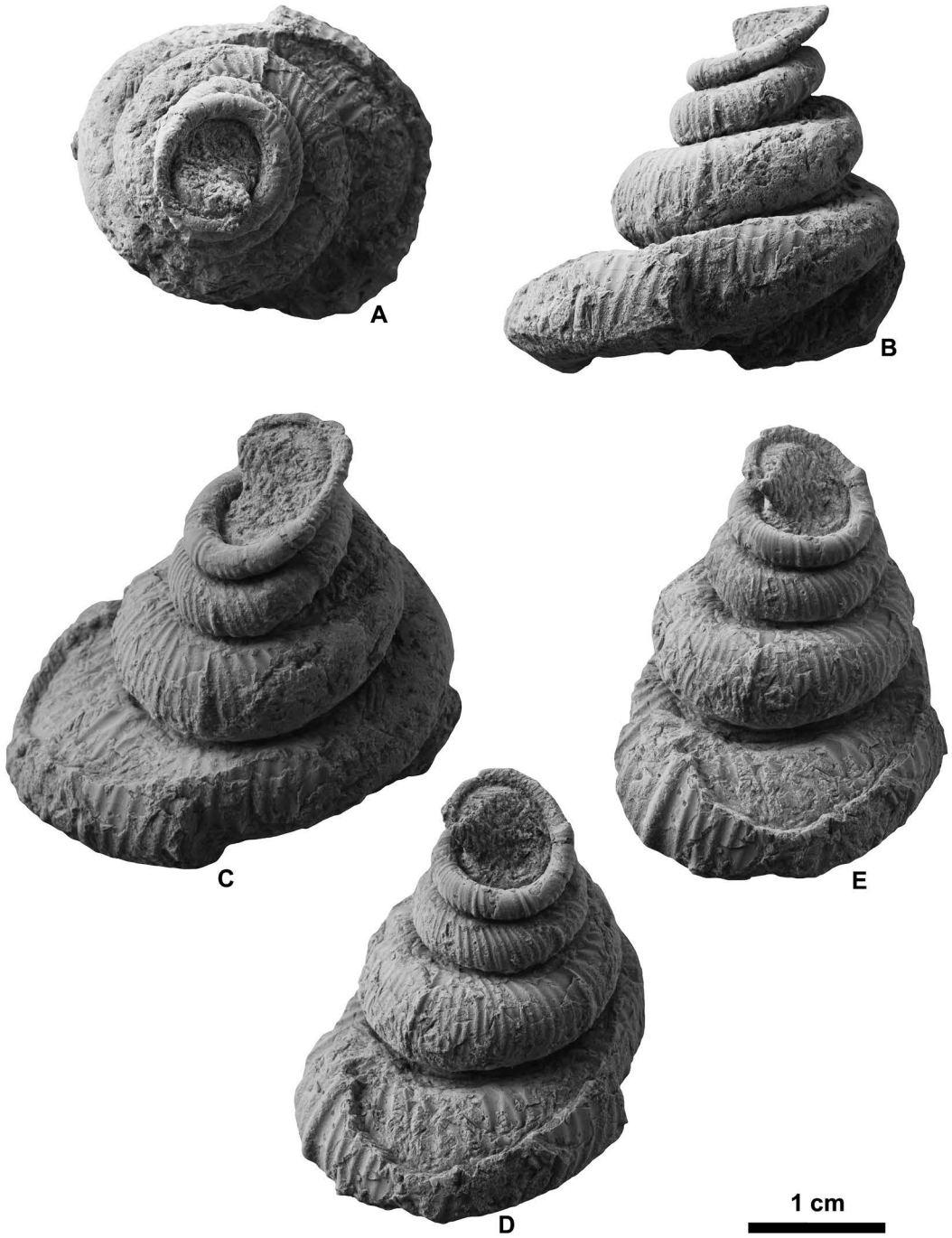

Fig. 59. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A–E, HMG-1939.

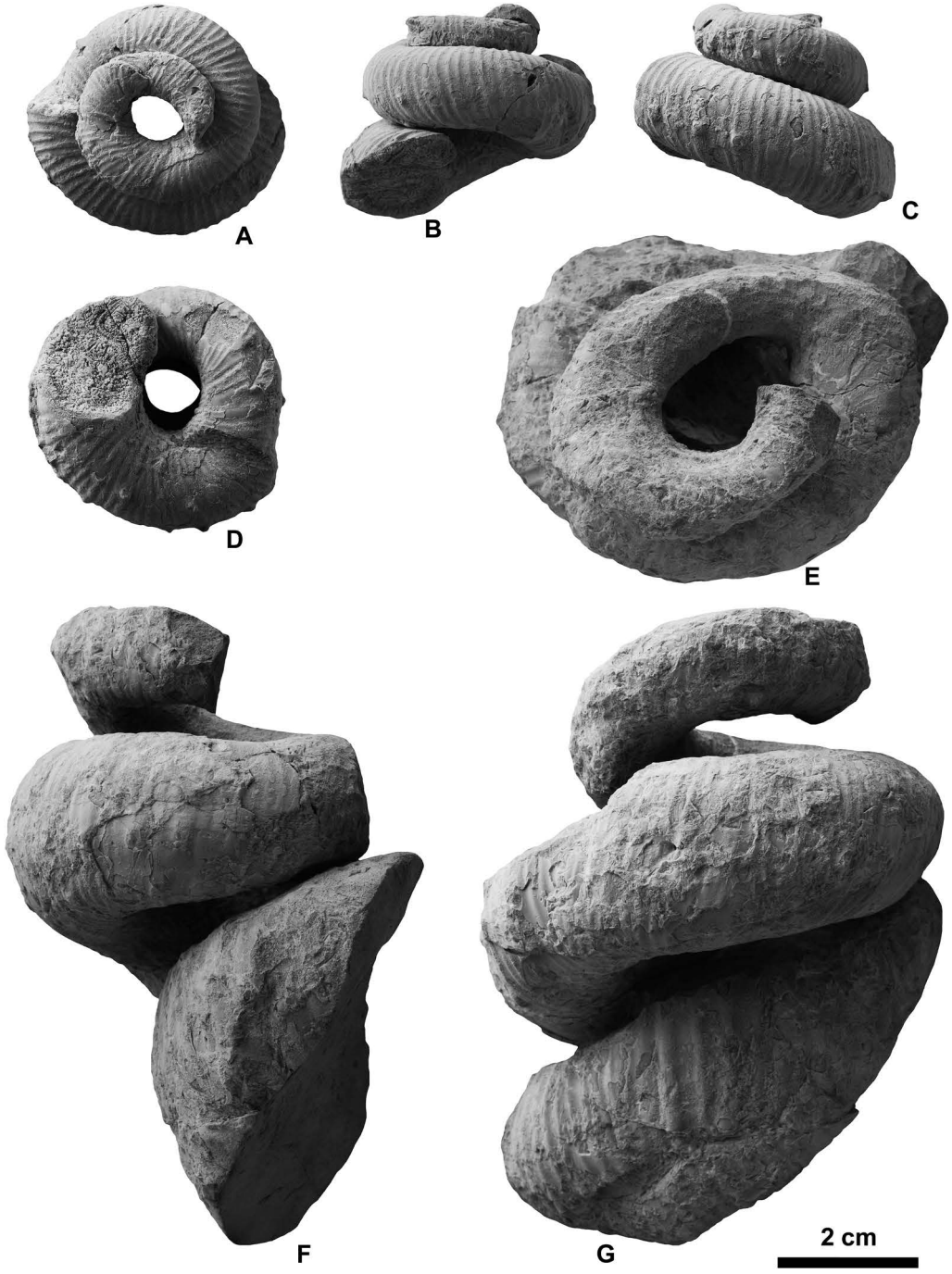

Fig. 60. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016. A–D, HMG-1946 from a float concretion found at Loc. 3'; E–G, NMNS PM35237 from a float concretion found at Loc. 3.

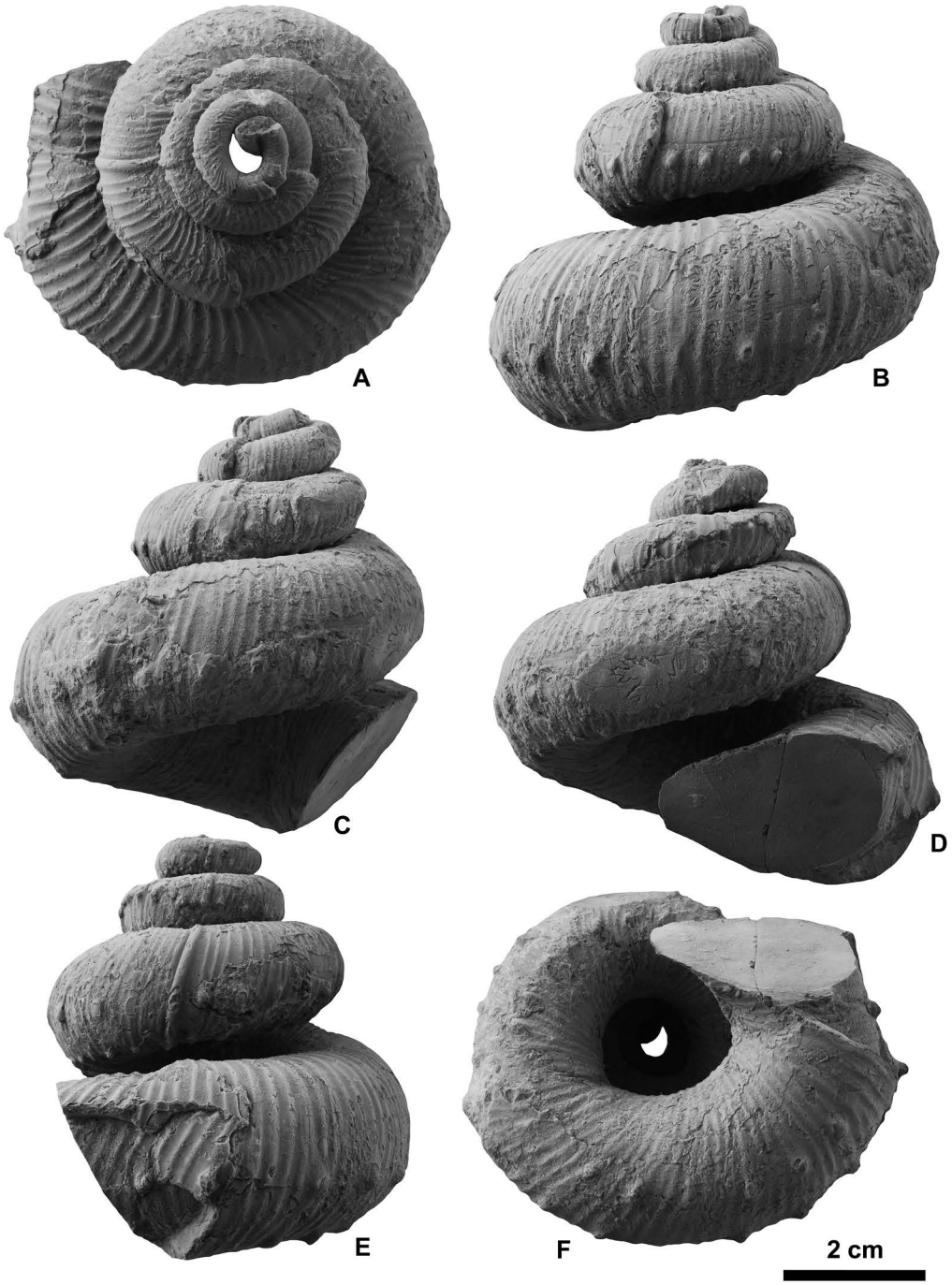

Fig. 61. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 1'. A–F, HMG-1937.

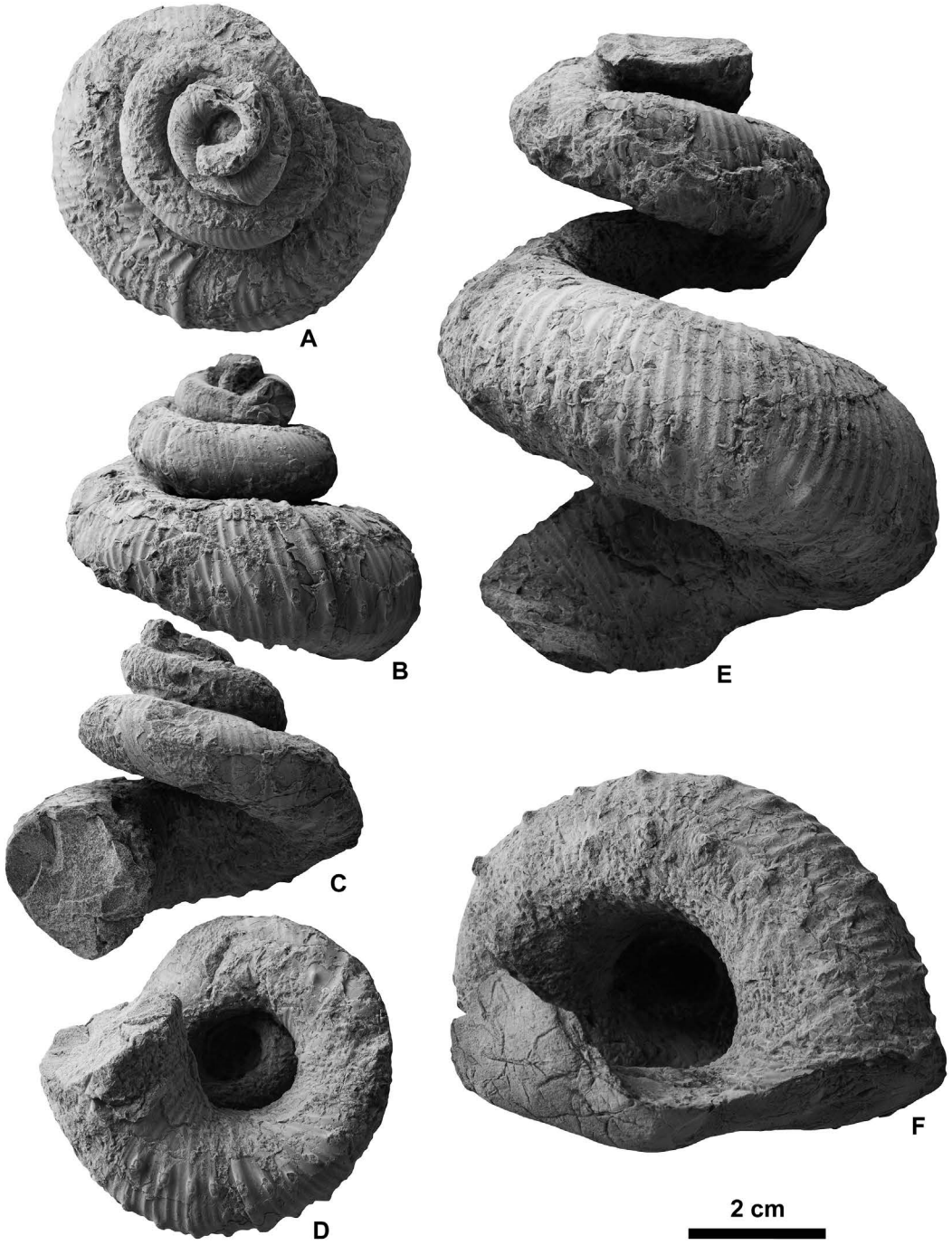

Fig. 62. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from float concretions found at Loc. 3. A–D, NMNS PM35238; E, F, NMNS PM35239.

Fig. 63. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A–C, HMG-1944.

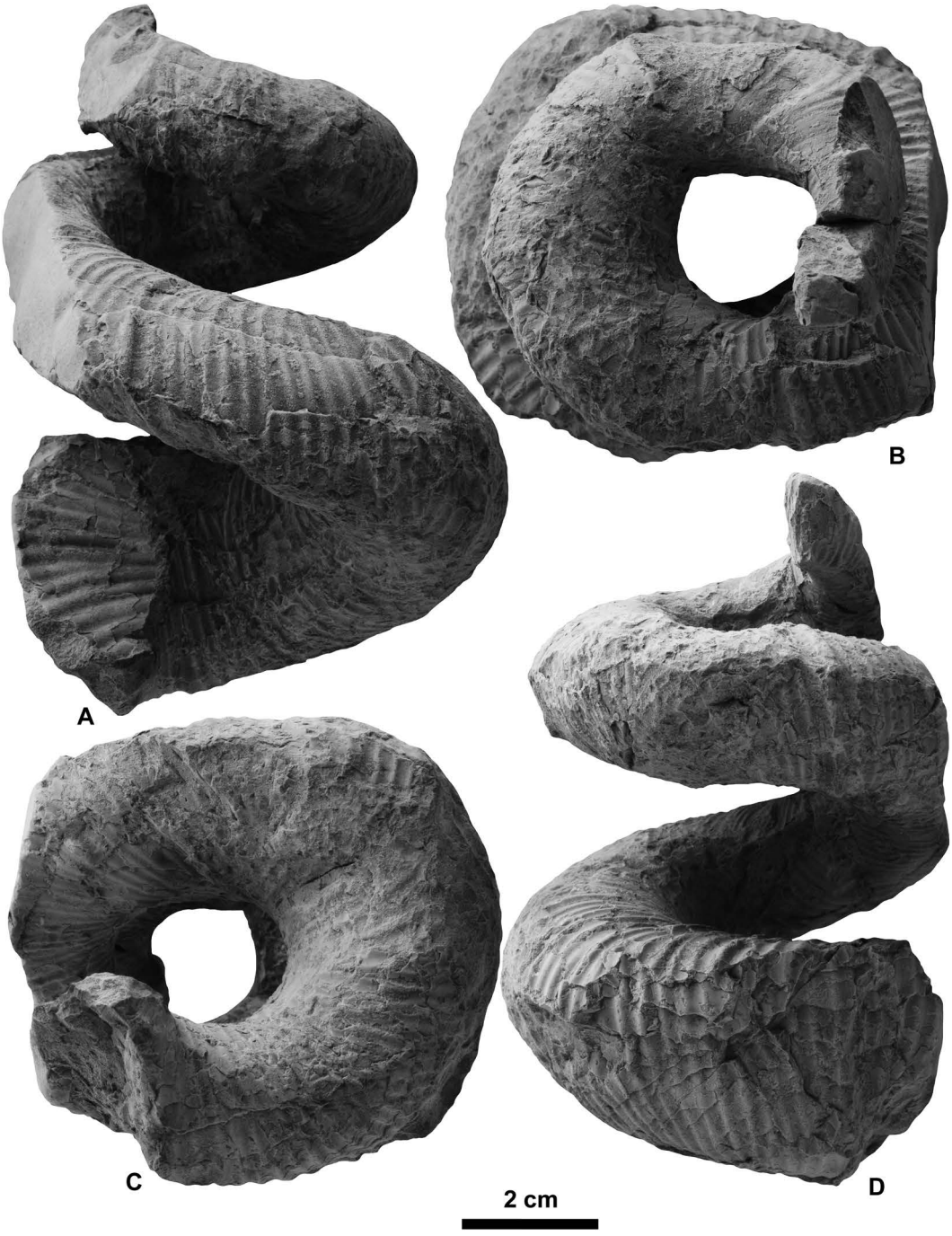

Fig. 64. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A–D, NMNS PM35240.

Fig. 65. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A–C, NMNS PM35241.

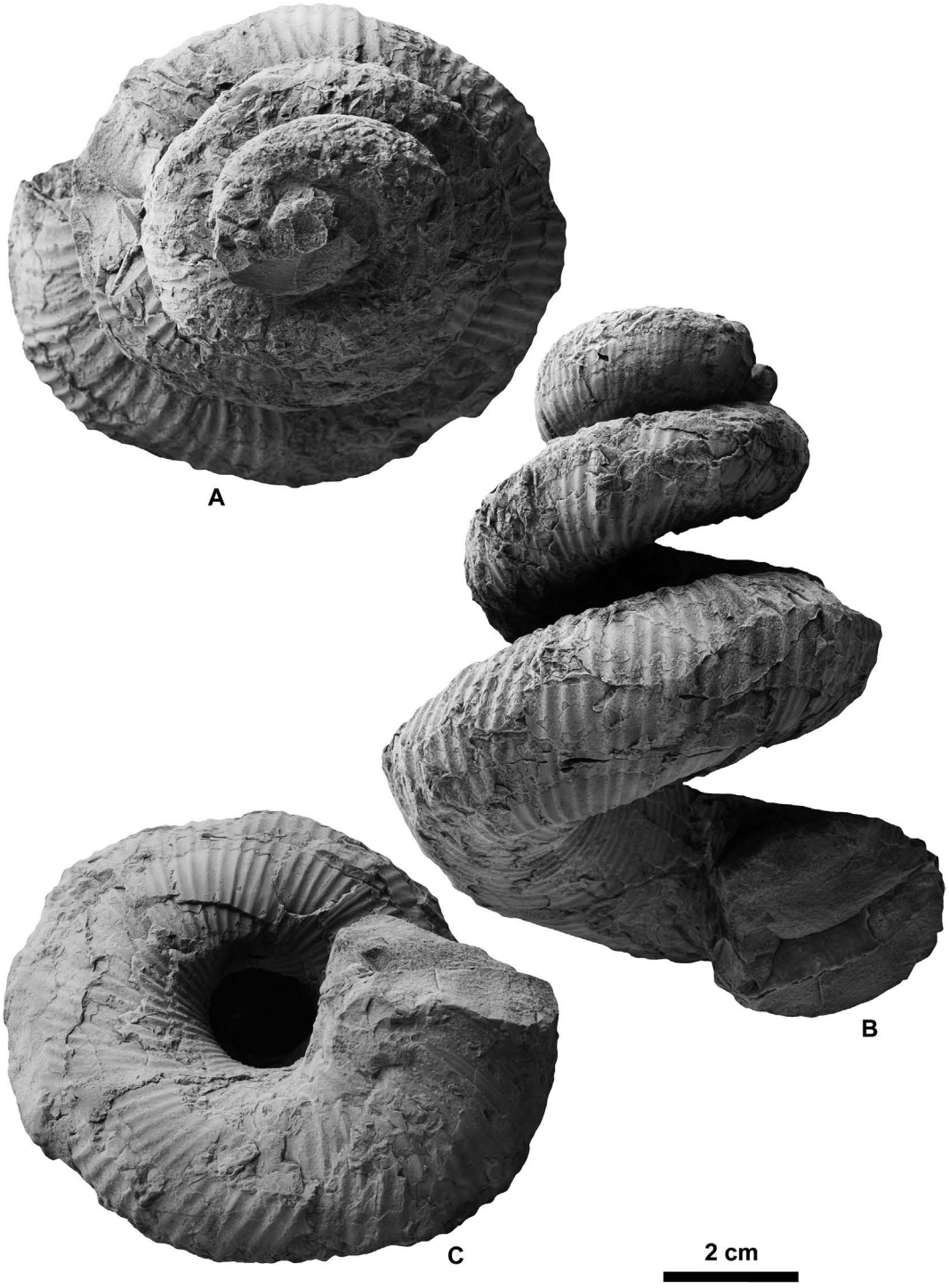

Fig. 66. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A–C, NMNS PM35242.

Fig. 67. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A–C, HMG-1940.

Fig. 68. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A, B, HMG-1945.

Fig. 69. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3. A, B, HMG-1945.

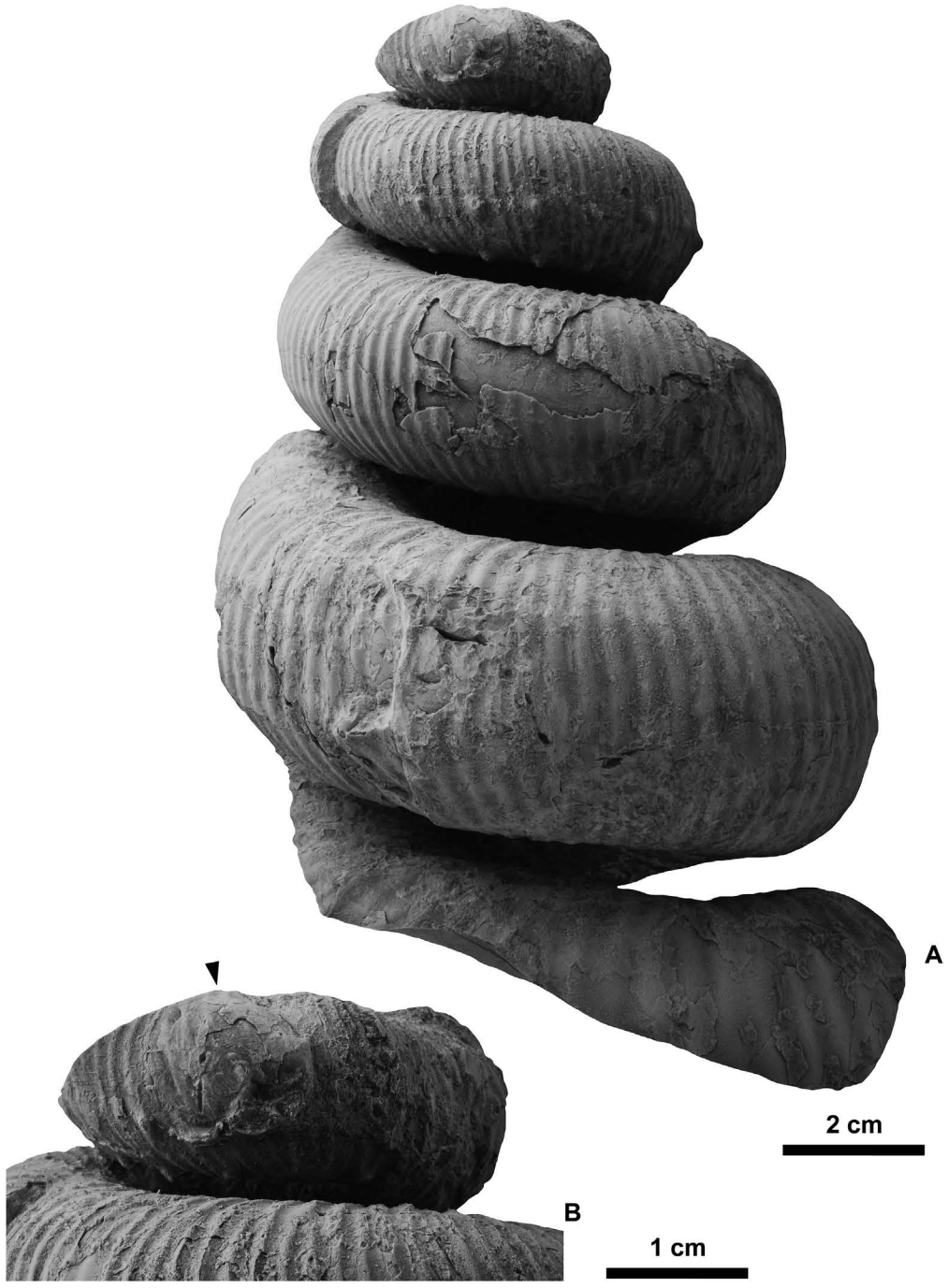

Fig. 70. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 1'. A, HMG-1938; B, close-up of A. Note an anomiid bivalve (indicated by arrow in B) on the shell surface.

Fig. 71. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A, B, HMG-1941.

Fig. 72. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3'. A–D, HMG-1947.

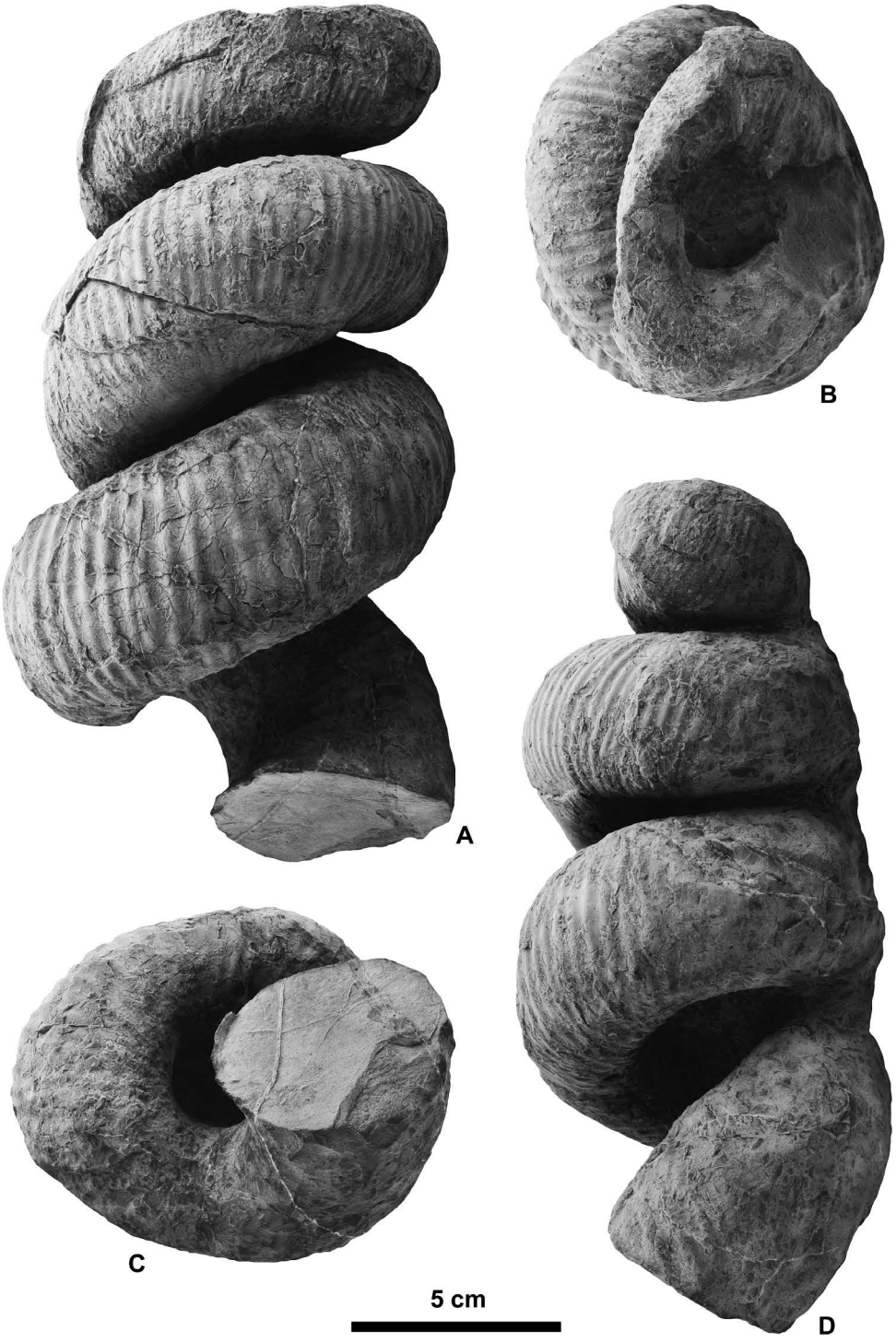

Fig. 73. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 3'. A–D, HMG-1948.

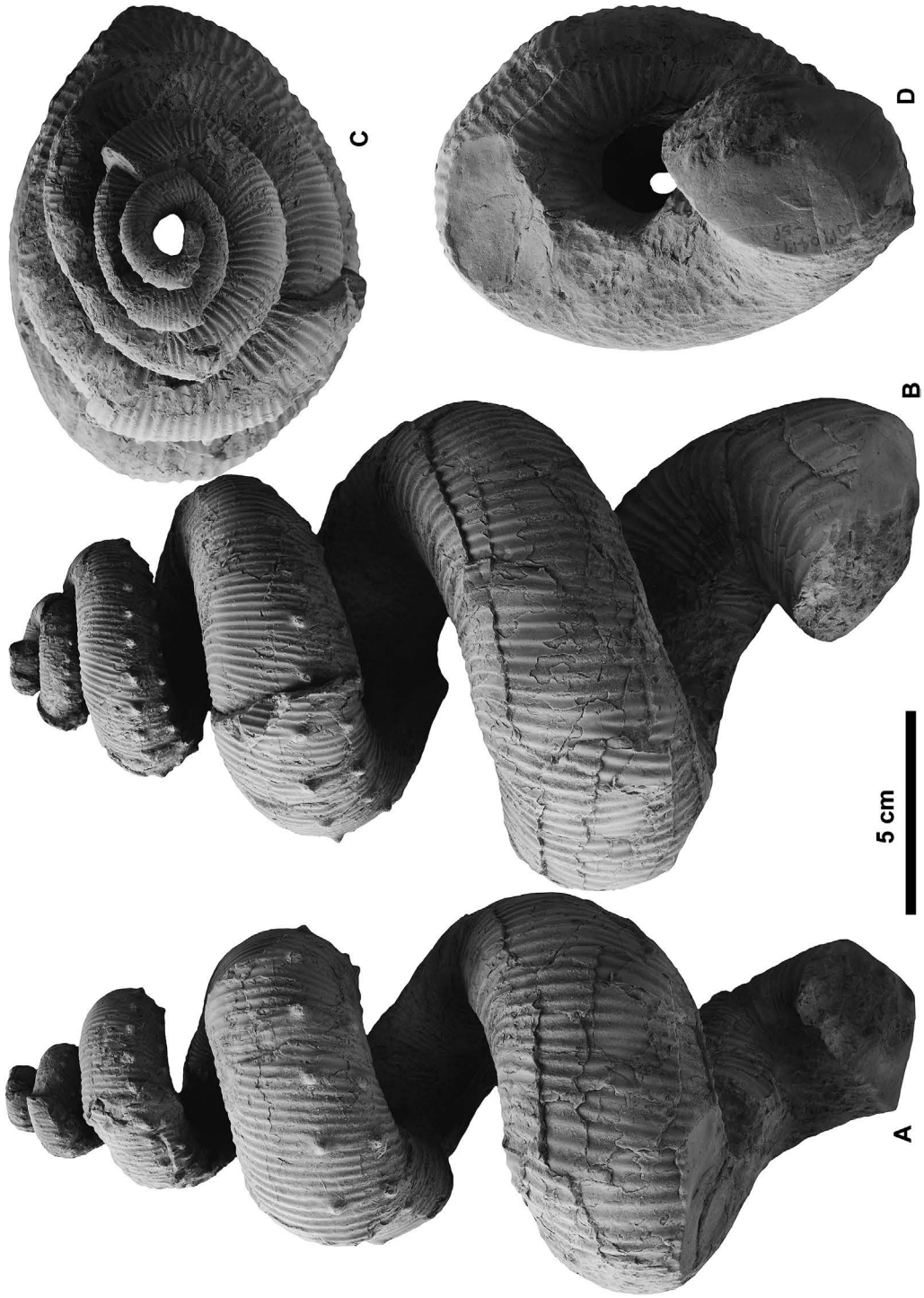

Fig. 74. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A–D, HMG-1942.

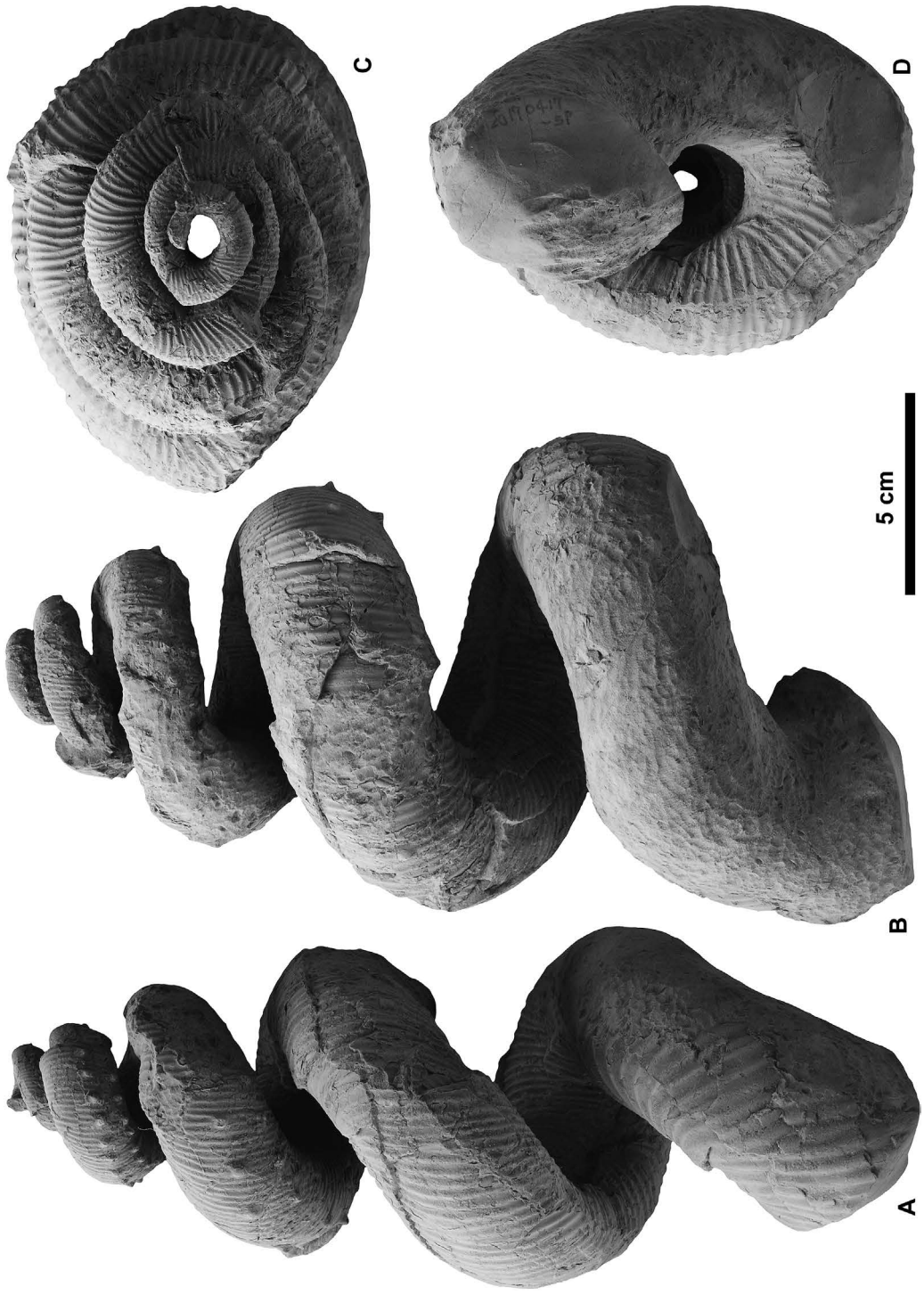

Fig. 75. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A–D, HMG-1942.

Fig. 76. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A, B, HMG-1943.

Fig. 77. *Didymoceras hidakense* Shigeta in Shigeta *et al.*, 2016 from a float concretion found at Loc. 2. A–C, HMG-1943.

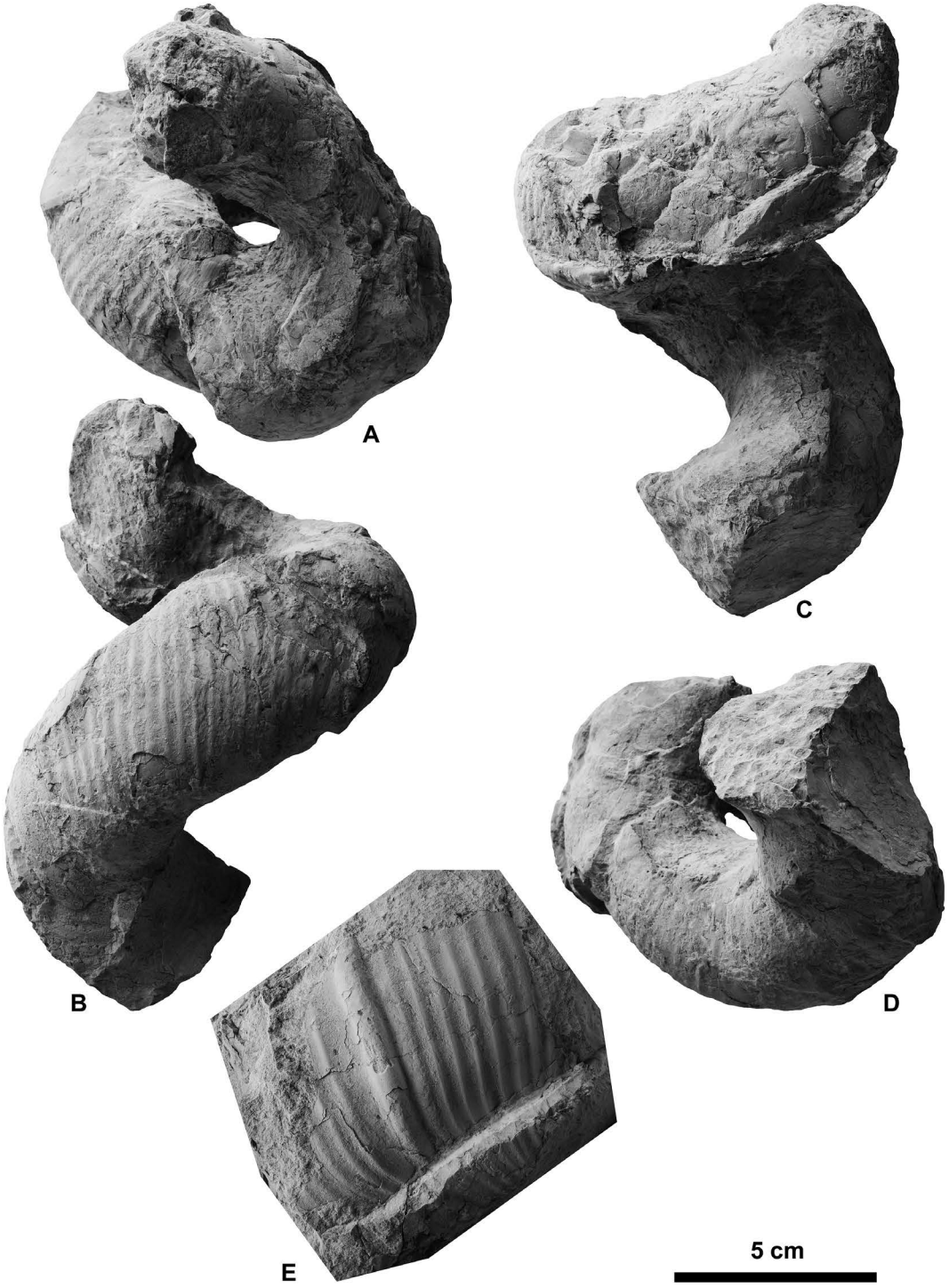

Fig. 78. *Didymoceras*? sp. from Loc. 13 in the Chinomigawa Formation. A–E, HMG-1954.

ymoceras hidakense (HMG-1938, Fig. 70B). Although the phylogenetic relationship between *D. hidakense* and *D. awajiense* is unknown, this evidence suggests that the anomiid-heteromorph ammonoid commensal relationship already existed in early late Campanian time.

Occurrence.—Described specimens were collected from float concretions that most likely came from the lower upper Campanian *Baculites subanceps* beds in the Chinomigawa Formation at study section I. *Didymoceras hidakense* is also known from the *Baculites subanceps* Zone in the Urakawa area.

Didymoceras? sp.

Fig. 78

Material examined.—One specimens, HMG-1954, from Loc. 13.

Description.—Part of phragmocone and fragment of body chamber preserved. Whorls helically coiled dextrally, longitudinally elongated, not in contact. Whorl cross section nearly circular. Shell surface ornamented with dense, oblique ribs. Distant but strong, highly elevated rib followed by a shallow constriction on body chamber. Ribs rursiradiate on lower and outer whorl faces, but curve forward on upper face and cross over dorsum in a slight convexity. Ribs become less intense as they cross dorsum.

Remarks.—Assignment of this specimen to *Didymoceras* is uncertain, because it appears to lack the two characteristic rows of tubercles, and is based only on the similarity of rib morphology with *D. hidakense*, in which its tubercles become weaker or obscure as the shell grows. This species differs from *D. hidakense* by its more loosely coiled helical whorls.

Occurrence.—Described specimen was collected from the middle Campanian *Metaplacenticeras subtilistriatum* beds in the Chinomigawa Formation at study section III.

Family Diplomoceratidae Spath, 1926

Genus ***Parasolenoceras*** Collignon, 1969

Type species.—*Parasolenoceras splendens* Collignon, 1969.

Remarks.—*Parasolenoceras* has been regarded as a subgenus of *Pseudoxybeloceras* Wright and Matsumoto, 1954 or as an independent genus. We herein follow the interpretation of Matsumoto and Miyauchi (1984) and treat *Parasolenoceras* as an independent genus.

Parasolenoceras ribiraense Shigeta sp. nov.

Fig. 79D–L

Types.—Holotype, HMG-1955, from Loc. 9; paratypes, HMG-1956, from Loc. 10 and HMG-1957, from a float concretion found at Loc. 3 that also contained *Baculites pacificus*.

Diagnosis.—*Parasolenoceras* with strong, highly elevated ribs, each of which is followed by a shallow constriction among narrowly raised ribs.

Etymology.—Named after Ribira River area, southern central Hokkaido.

Description.—Holotype, HMG-1955 (Fig. 79I–L), a fragment of phragmocone consisting of three parallel straight shafts connected by U-curves. Paratype, HMG-1956 (Fig. 79M, N), a fragment of phragmocone and body chamber consisting of straight shafts. Paratype HMG-1957 (Fig. 79D–H), a fragment of body chamber consisting of straight shaft and part of a U-shaped whorl.

Whorl cross section nearly circular. Shell surface ornamented with dense, oblique ribs and a pair of ventral tubercles on each rib. Strong, highly elevated ribs, each of which is followed by a shallow constriction that occurs among narrowly raised ribs. Strong, highly elevated ribs occur at nearly regular intervals. Ribs pass straight across venter.

Comparison.—*Parasolenoceras ribiraense* sp. nov. differs from all known species of *Parasolenoceras* by having strong, highly elevated ribs followed by shallow constrictions.

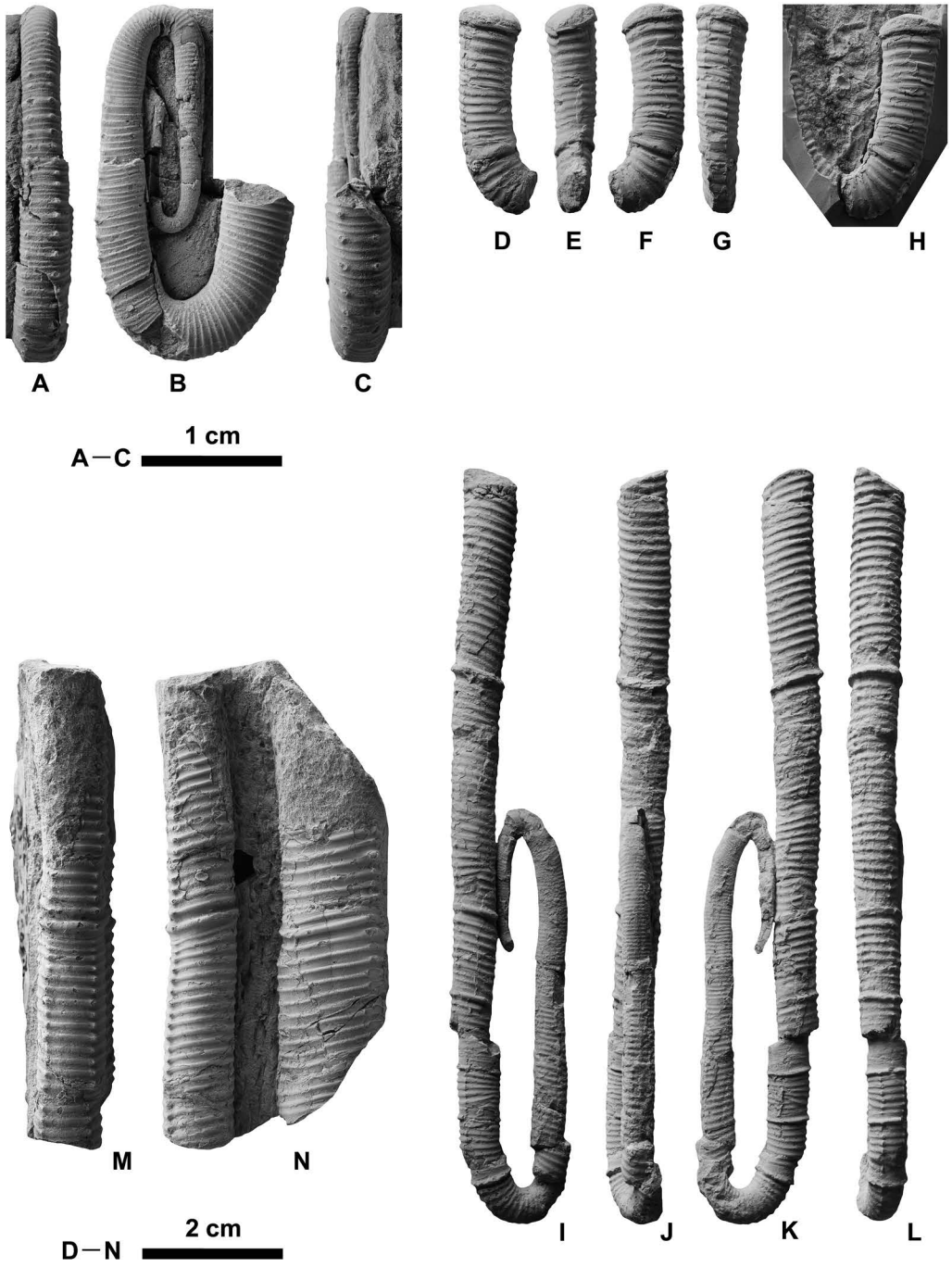

Fig. 79. *Parasolenoceras* from the Chinomigawa Formation. A–C, *Parasolenoceras* sp., HMG-1958 from Loc. 28; D–L, *Parasolenoceras ribiraense* Shigeta sp. nov.; D–H, HMG-1957 (paratype) from a float concretion found at Loc. 3; M, N, HMG-1956 (paratype) from Loc. 10; I–L, HMG-1955 (holotype) from Loc. 9.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificus* beds in the Chinomigawa Formation at study section III. Float concretion found at Loc. 3 (study section I) came from the same beds.

Parasolenoceras sp.

Fig. 79A–C

Material examined.—One specimens, HMG-1958, from Loc. 28.

Description.—HMG-1958 consists of four parallel straight shafts connected by U-curves. Adjacent two shafts slightly separated. Whorl cross section nearly circular. Shell surface ornamented with dense, oblique ribs and a pair of ventral tubercles on every second or third rib. Ribs pass straight across venter.

Remarks.—The described specimen, with ventral tubercles on every second or third rib, differs from other known species of *Parasolenoceras*, all of which exhibit ventral tubercles on every rib (Matsumoto and Miyauchi, 1986). The specimen may represent a new species, but we hesitate to erect a new taxon based only on what most likely is juvenile shell.

Occurrence.—Described specimen was collected from the middle Campanian *Sphenoceramus schmidti* beds in the Chinomigawa Formation at study section VIII.

Genus ***Diplomoceras*** Hyatt, 1900

Type species.—*Baculites cylindracea* Defrance, 1816.

Diplomoceras sp.

Figs. 80, 81

Material examined.—One specimen, HMG-1959, from a float concretion found at Loc. 1; one specimen, HMG-1960, from a float concretion found at Loc. 3; two specimens, HMG-1961, 1962, from Loc. 6.

Description.—HMG-1959 consists of loosely coiled, elliptical planispiral whorls, but the earliest whorls, including initial chamber and ammonitella, are not preserved. HMG-1961 and 1962 are slightly curved whorl fragments. HMG-1960 is straight whorl fragment. Whorl cross section nearly circular. Shell surface ornamented with numerous, regularly spaced ribs, which vary from straight to oblique.

Remarks.—The fragmental nature of the specimens precludes a definitive assignment.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites rex* beds in the Chinomigawa Formation at study section II. Float concretions came from the middle Campanian *Metaplacenticeras subtilistriatum* beds and the lower upper Campanian *Baculites pacificus* or *B. subanceps* beds in the Chinomigawa Formation at study section I.

Family Baculitidae Gill, 1871

Genus ***Baculites*** Lamarck, 1799

Type species.—*Baculites vertebralis* Lamarck, 1801.

Baculites yezoensis

Matsumoto and Miyauchi, 1984

Fig. 82

Baculites chicoensis Trask. Matsumoto and Obata, 1963, p. 66, pl. 21, figs. 2, 4, text-figs. 159, 163, 164.

Baculites chicoensis yezoensis Matsumoto and Miyauchi, 1984, p. 70, pl. 25, figs. 1–5, text-fig. 11B, C.

Holotype.—GK.H5975, figured by Matsumoto and Miyauchi (1984, p. 70, pl. 25, fig. 1), from the middle Campanian *Sphenoceramus schmidti* Zone in the Soya area, northern Hokkaido.

Material examined.—Nineteen specimens, NMNS PM35243–35248, 35414–35426, from Loc. 28.

Description.—Fairly rapidly tapered, straight or gently arched shell. Whorl section oval, with narrowly rounded venter, indistinct ventral shoulders, gently convex flanks with maximum whorl width at mid-flank or slightly below, and broadly rounded dorsum. Ornamentation consists only of

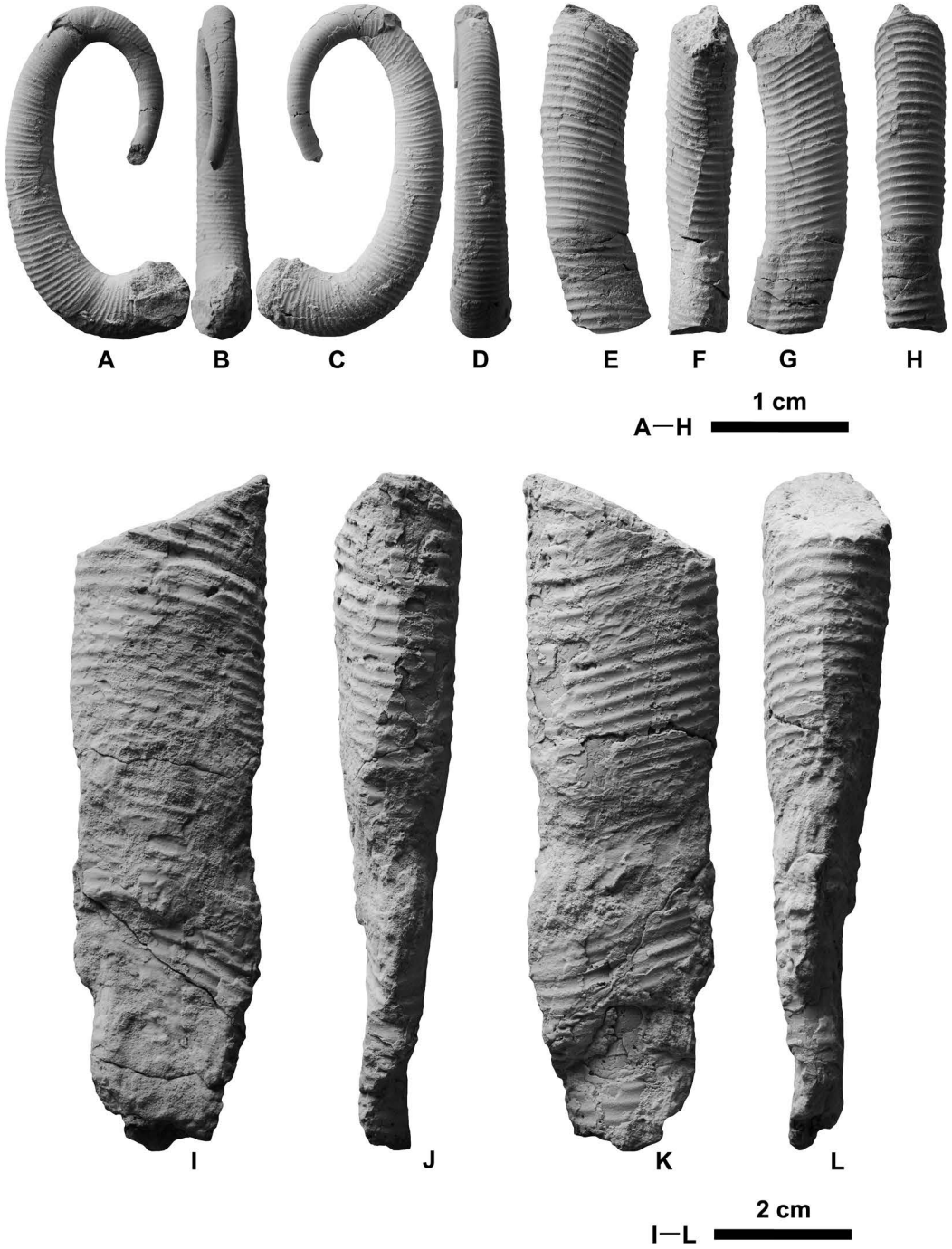

Fig. 80. *Diplomoceras* sp. from the Chinomigawa Formation. A–D, HMG-1959 from a float concretion found at Loc. 1; E–H, HMG-1961 from Loc. 6; I–L, HMG-1960 from a float concretion found at Loc. 3.

Fig. 81. *Diplomoceras* sp. from the Chinomigawa Formation. A–C, HMG-1962 from Loc. 6.

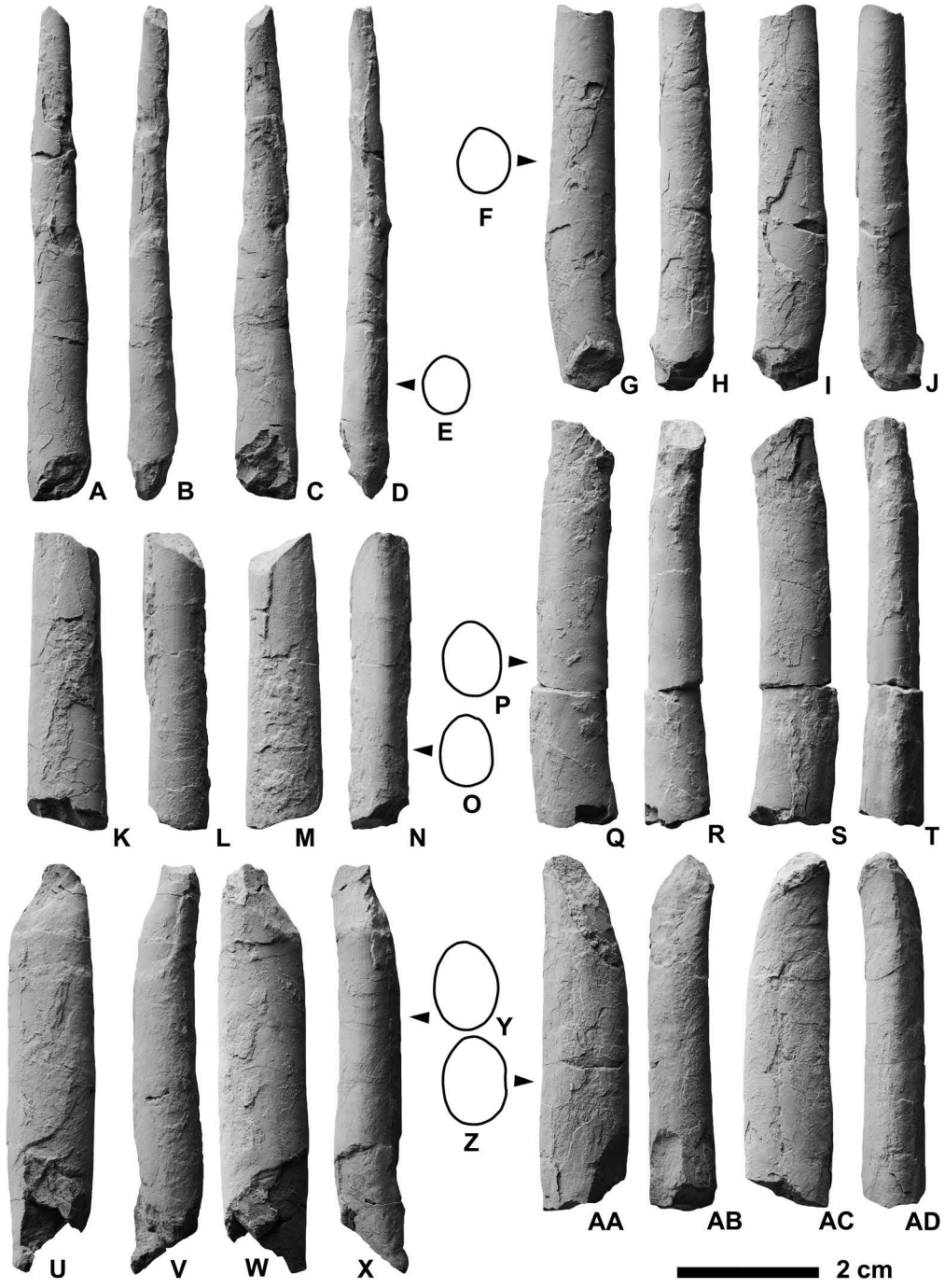

Fig. 82. *Baculites yezoensis* Matsumoto and Miyauchi, 1984 from Loc. 28 in the Chinomigawa Formation. A–E, NMNS PM35243; F–J, NMNS PM35244; K–O, NMNS PM35245; P–T, NMNS PM35246; U–Y, NMNS PM35247; Z–AD, NMNS PM35248.

fine growth lines.

Remarks.—*Baculites yezoensis* was originally described as a subspecies of *Baculites chicoensis* Trask, 1856 by Matsumoto and Miyauchi (1984), but it is smaller and has a less distinct, almost imperceptible ventral keel. Because this taxon can be clearly distinguished from *B. chicoensis*, we choose to treat it as a valid species rather than subspecies.

Occurrence.—Described specimens were collected from the middle Campanian *Sphenoceramus schmidti* beds in tin the Chinomigawa Formation at study section VIII. *Baculites yezoensis* occurs in the *Sphenoceramus schmidti* Zone in the Cape Soya area and the *Sphenoceramus orientalis* Zone in the Teshio Mountains, Hokkaido.

Baculites pacificus Matsumoto and Obata, 1984

Figs. 83–97

Baculites aff. *anceps* Lamarck. Matsumoto, 1959b, p. 130, pl. 34, fig. 3, pl. 35, fig. 1, text-figs. 42, 43.

non *Baculites anceps pacificus* Matsumoto and Obata, 1963, p. 59, pl. 20, fig. 3, text-figs. 145, 146, 156.

Baculites anceps pacificus Matsumoto and Obata. Ward, 1978, p. 1152, pl. 2, figs. 1–4, 8, text-fig. 6; Klinger and Kennedy, 2001, p. 118, fig. 90.

Baculites subanceps Haughton. Shigeta *et al.*, 2016, p. 353, fig. 28

Holotype.—LSJU. 8561, figured by Matsumoto (1959b, p. 130, pl. 34, fig. 3a–d), from the Campanian *Metaplacenticeras pacificum*-bearing beds in Arroyo del Valle, Alameda County, Bay Area, California.

Material examined.—Seventy-one specimens, NMNS PM35249–35262, 35313–35362, HMG-1963–1969, from float concretion found at Loc. 2; fifty specimens, NMNS PM35263, 35264, 35363–35404, HMG-1970–1975, from float concretions found at Loc. 3; two specimen, NMNS PM35265, 35266, from Loc. 9; three specimens, NMNS PM35267–35269, from Loc. 11; one specimen, NMNS PM35270, from Loc. 23.

Description.—Initial chamber nearly circular in median section. Initial chamber size, ammonitella size and spiral length in median section of NMNS PM35249 are 0.557 mm, 1.021 mm and 330°, respectively. Post-ammonitella shell straight or gently arched, tapers fairly rapidly at early growth stage, becoming moderate at later stages. Whorl section oval, with narrowly rounded venter, indistinct ventral shoulders, broadly rounded dorsum and gently convex flanks with maximum whorl width at mid-flank or slightly below mid-flank. Shell surface almost smooth on early growth stage, but as shell grows, it develops weak crescentic ribs on flank and strong, oblique ribs on ventral half of flank. Venter becomes corrugated. Dorsum smooth.

Remarks.—*Baculites pacificus* was originally described as a subspecies of *Baculites anceps* Lamarck, 1822 by Matsumoto and Obata (1963), but it can be clearly distinguished from this taxon by its less acute venter and its rather strong ribs, which cross the venter forming a distinctive corrugation pattern, a feature not seen in *B. anceps*. Based on these morphological differences, we treat it as a valid species rather than a subspecies.

Matsumoto and Obata (1963, pl. 20, fig. 3, text-figs. 145, 146, 156) described two specimens as *Baculites anceps pacificus* from the *Sphenoceramus schmidti* Zone in the Urakawa area, Hokkaido. However, the venter and dorsum of both specimens are wider than those of *Baculites pacificus*, and they are probably identical to *Baculites* sp. from Loc. 26 (Fig. 105) described below.

Shigeta *et al.* (2016, fig. 28) attributed seven specimens to *Baculites subanceps* from a horizon below the *Didymoceras hidakense*-bearing beds in the Urakawa area, but these specimens are characterized by flanks that either are nearly smooth or exhibit weak crescentic ribs, and a corrugated venter, all of which suggest that they should be assigned to *Baculites pacificus*.

Occurrence.—Described *in-situ* specimens were collected from the lower upper Campanian *Baculites pacificus* beds in the Chinomigawa Formation at study section III and V. Float concretions probably came from the same beds at study section I. *Baculites pacificus* is known from the lower upper Campanian in the Urakawa area, and the Campanian *Metaplacenticeras*

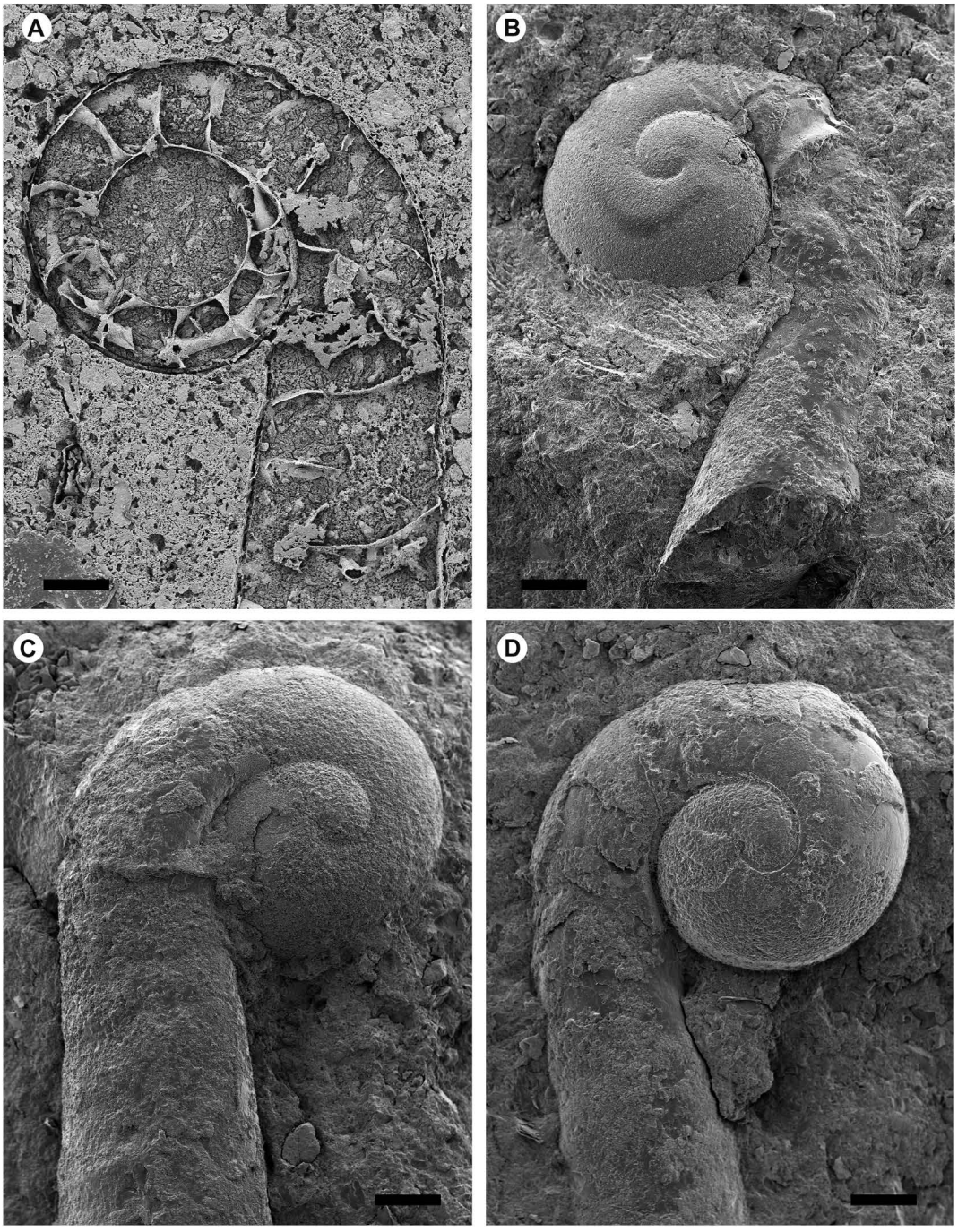

Fig. 83. Earliest whorls including initial chamber and ammonitella of *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A, NMNS PM35249, median section; B, NMNS PM35250; C, NMNS PM35251; D, NMNS PM35252.

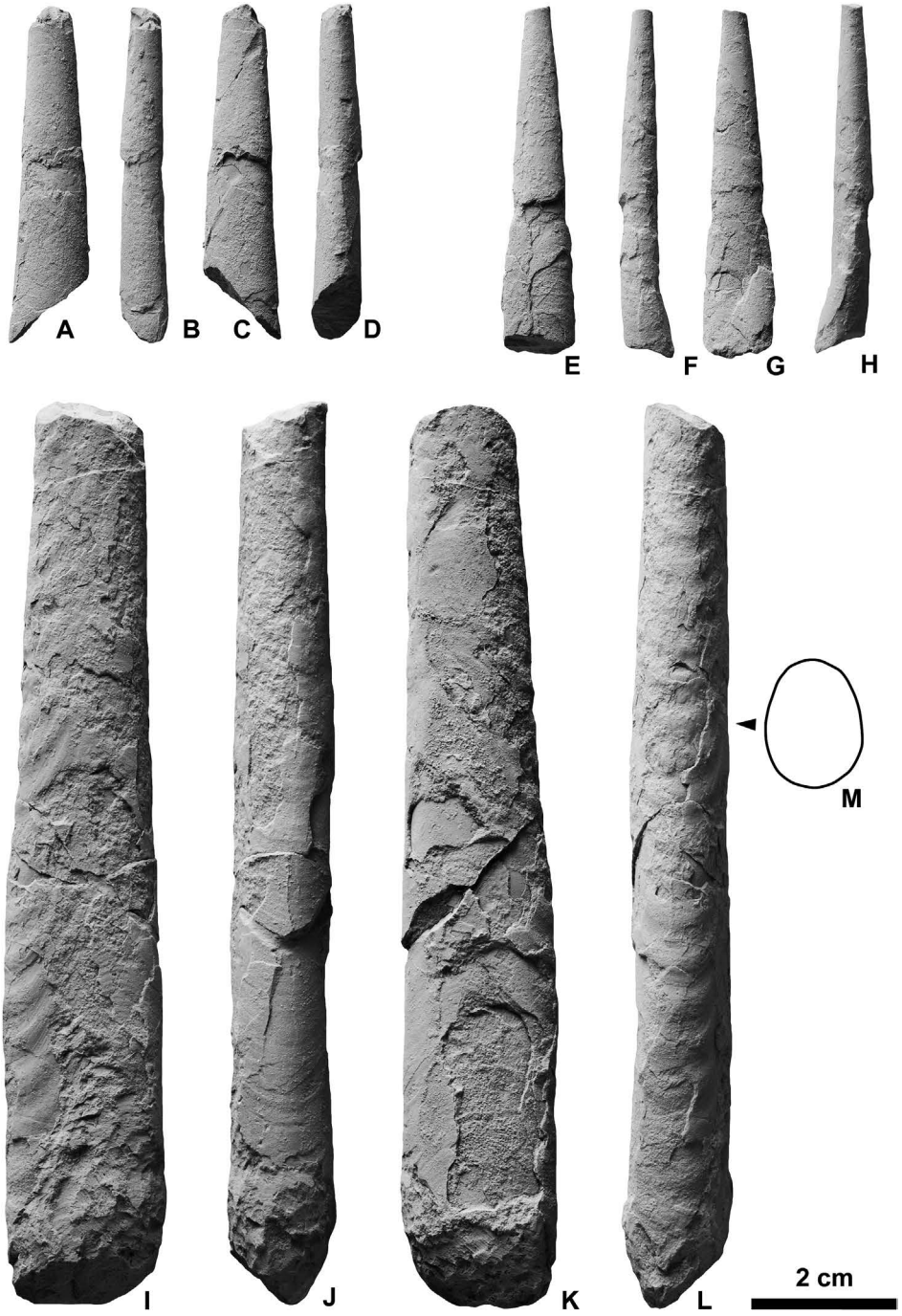

Fig. 84. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–D, NMNS PM35253; E–H, NMNS PM35254; I–M, NMNS PM35255.

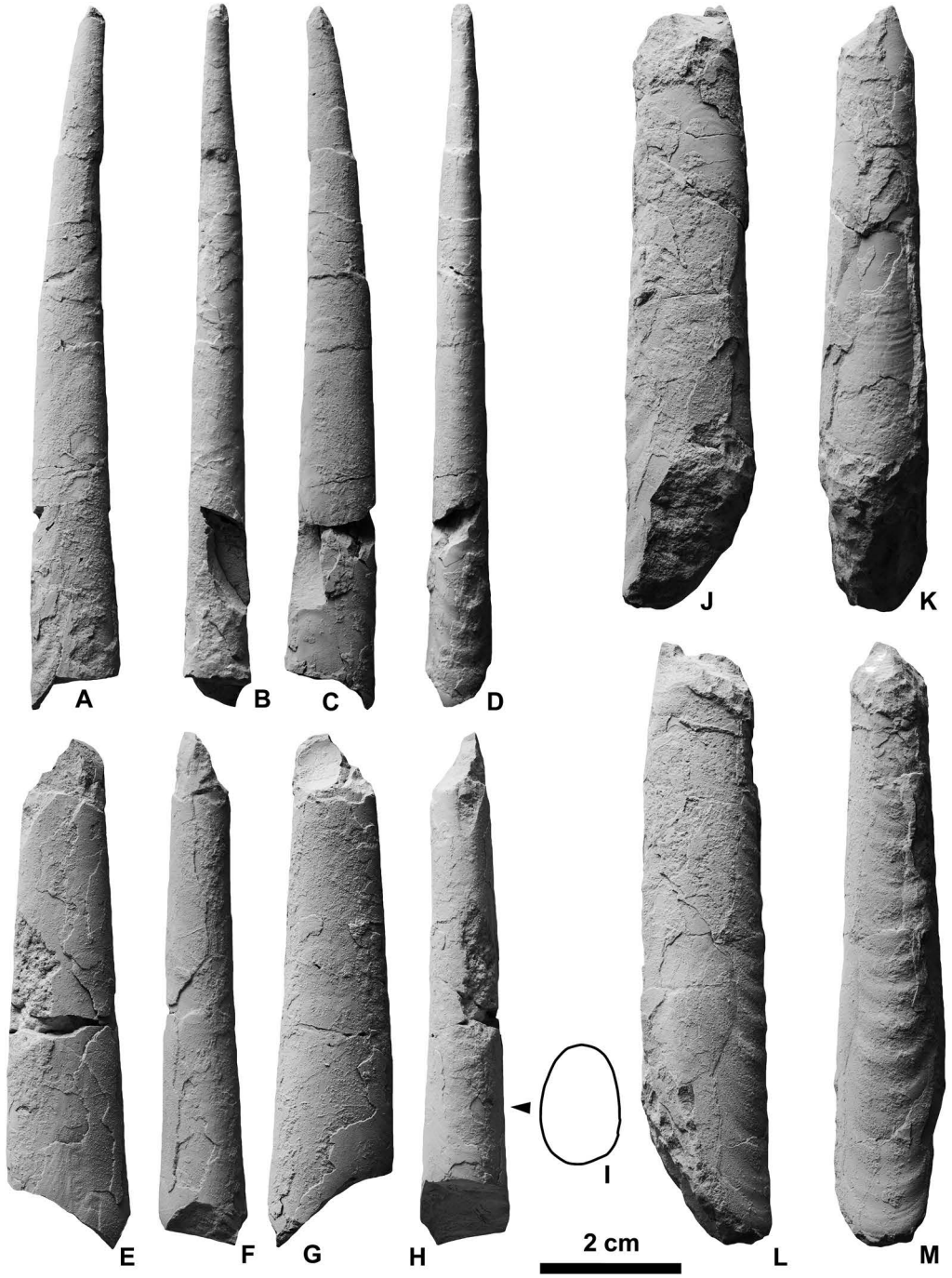

Fig. 85. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–D, HMG-1963; E–I, NMNS PM35256; J–M, NMNS PM35257.

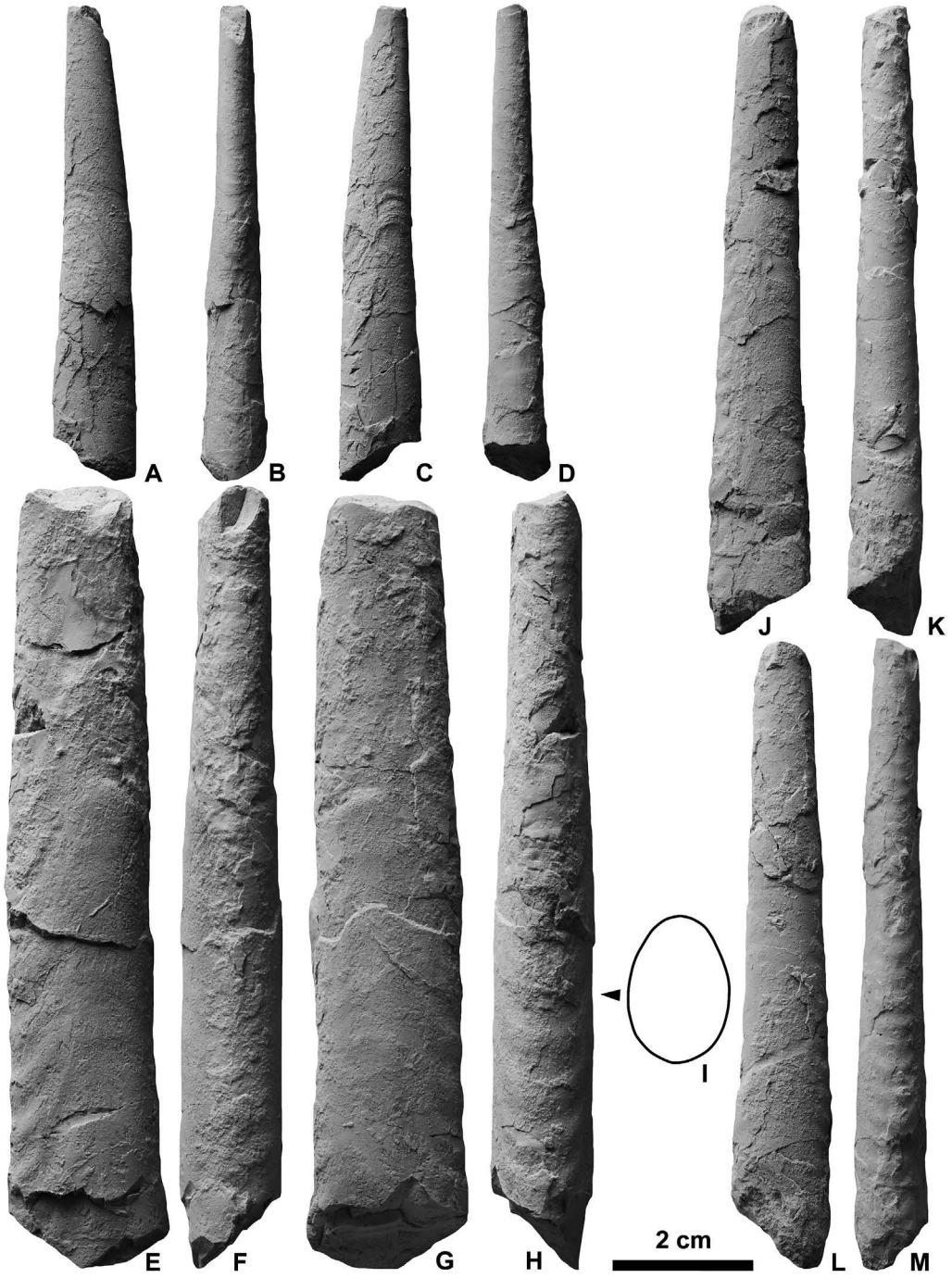

Fig. 86. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–D, NMNS PM35258; E–I, NMNS PM35259; J–M, NMNS PM35260.

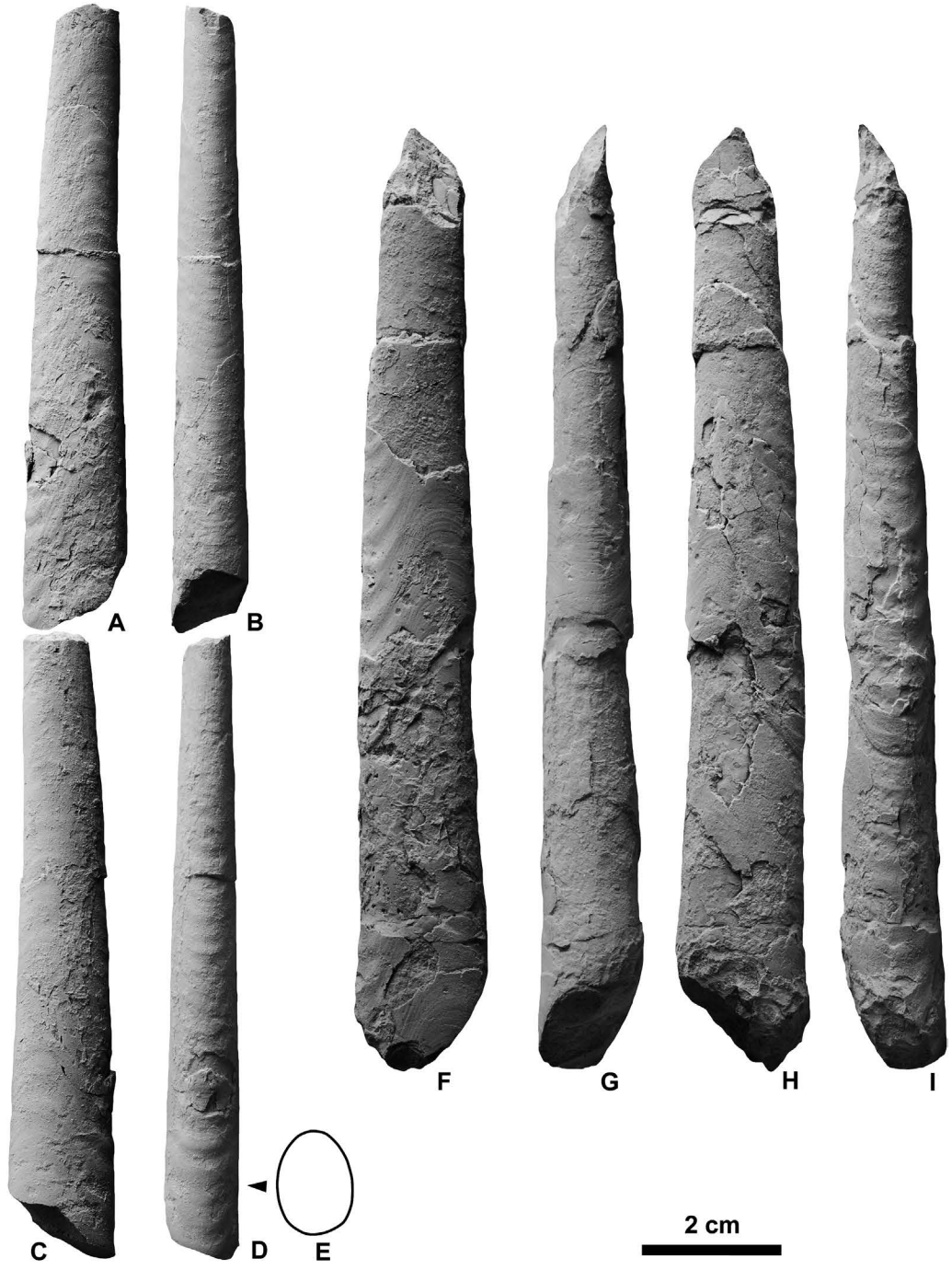

Fig. 87. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–E, HMG-1964; F–I, HMG-1965.

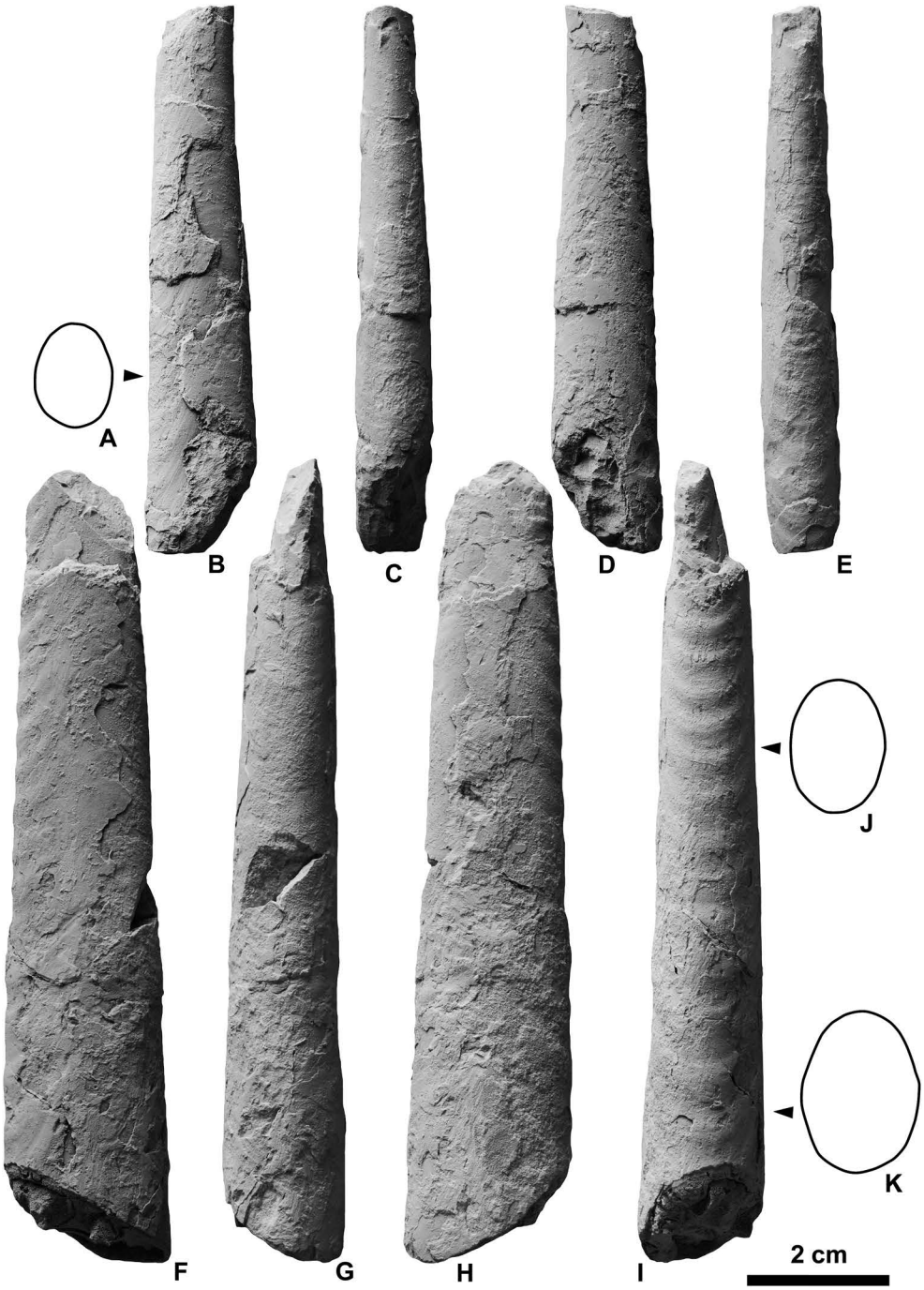

Fig. 88. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–E, NMNS PM35261; F–K, NMNS PM35262.

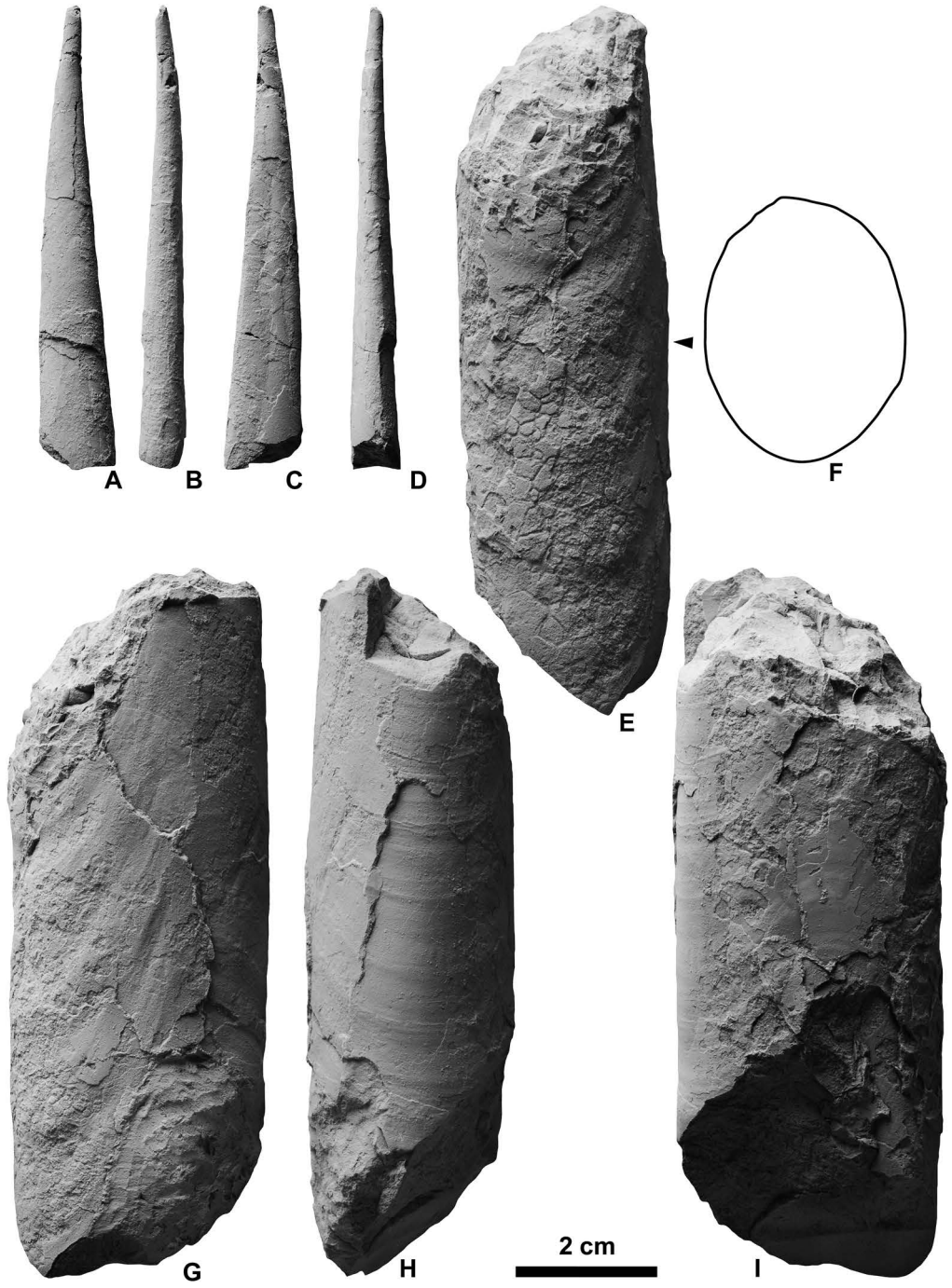

Fig. 89. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–D, HMG-1966; E–I, HMG-1967.

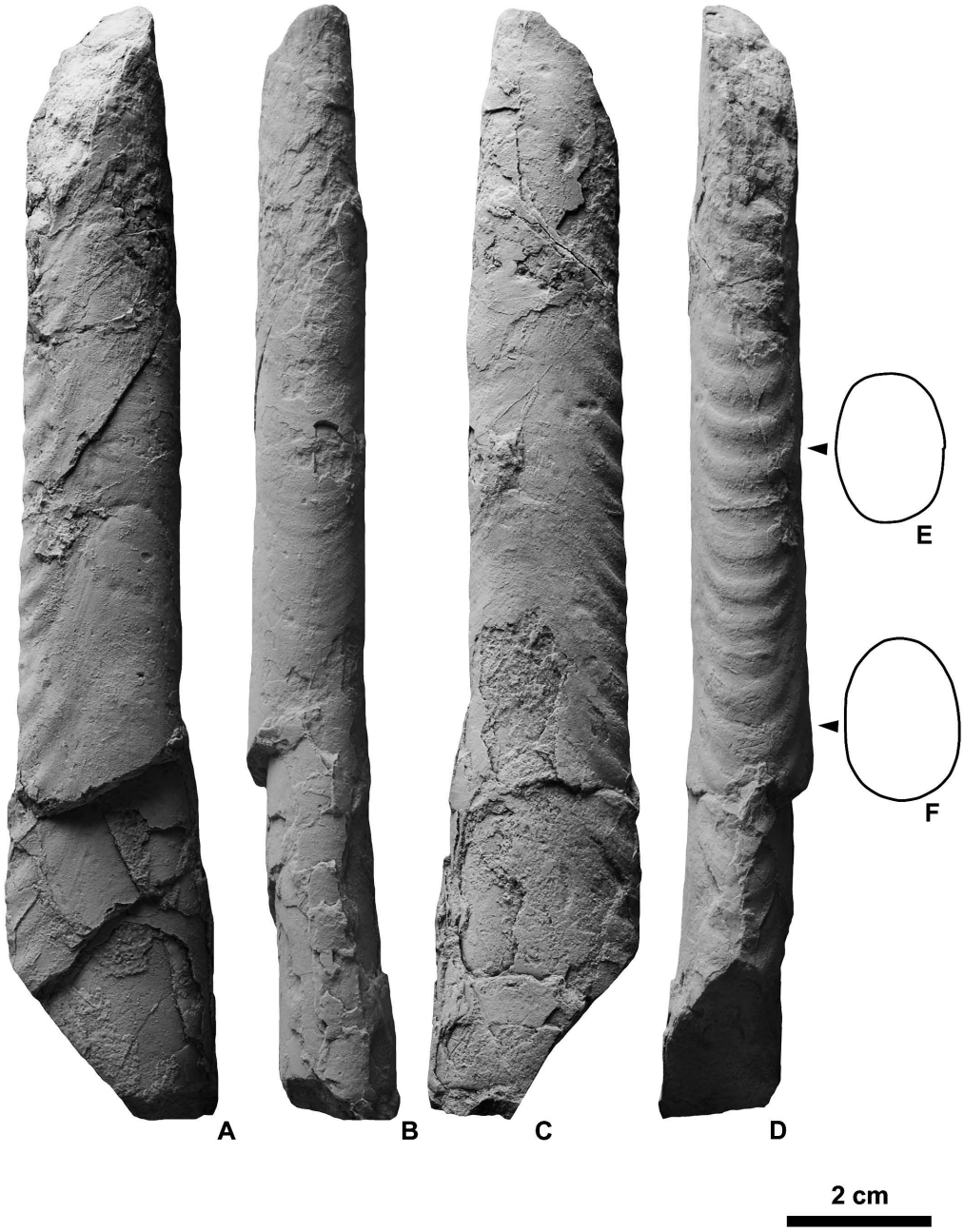

Fig. 90. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–F, HMG-1968.

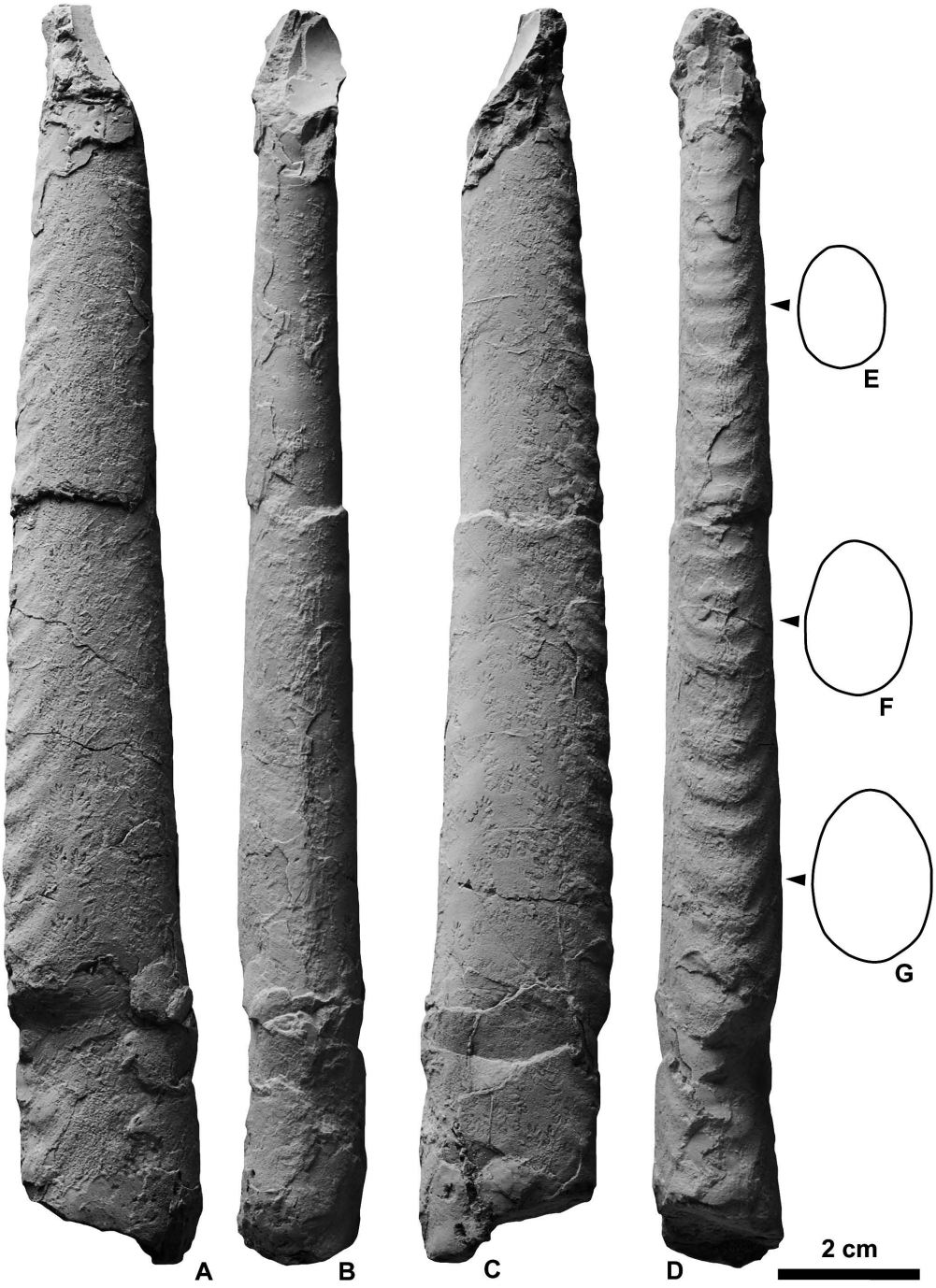

Fig. 91. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 2. A–G, HMG-1969.

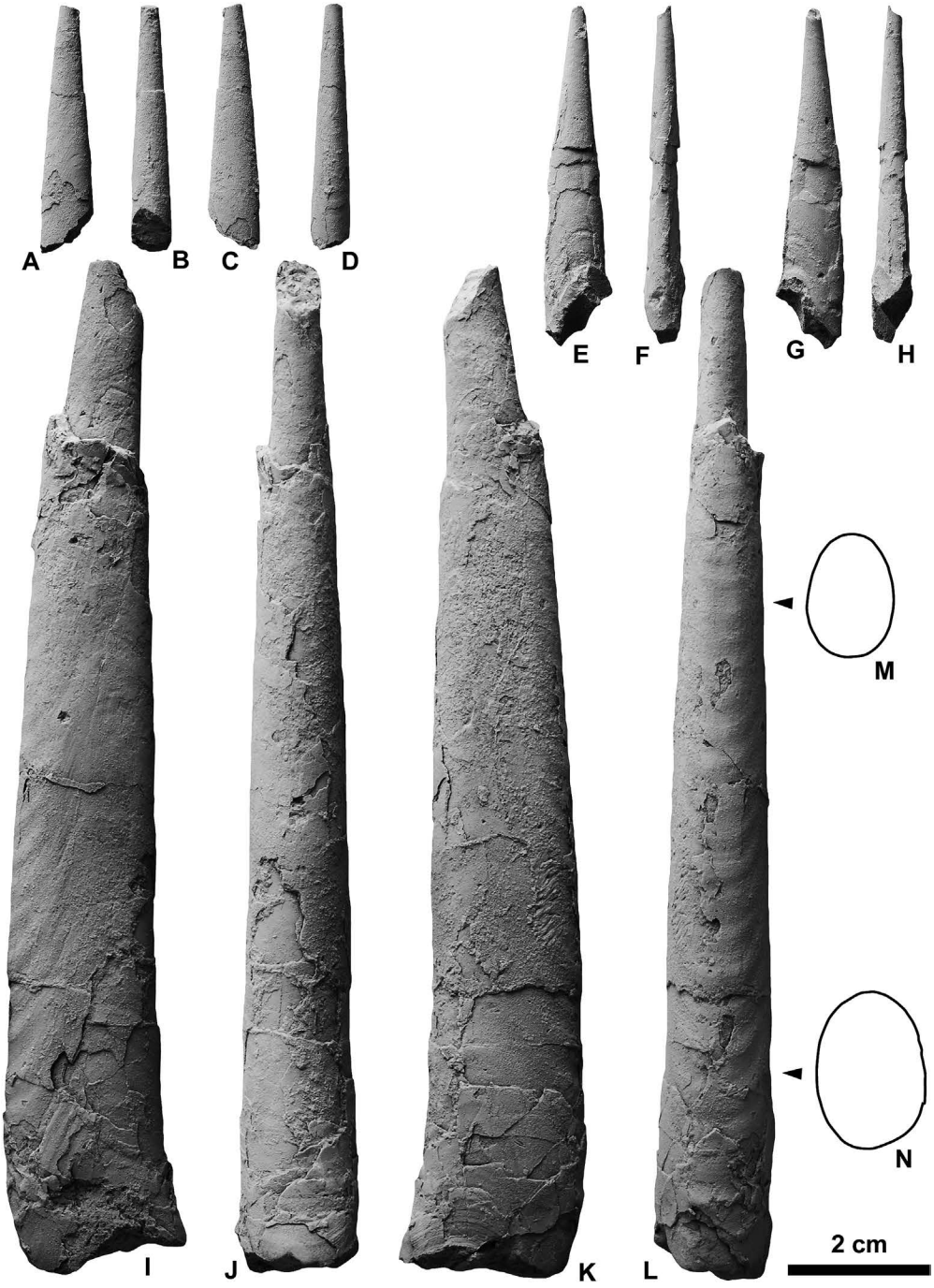

Fig. 92. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 3. A–D, NMNS PM35263; E–H, NMNS PM35264; I–N, HMG-1970.

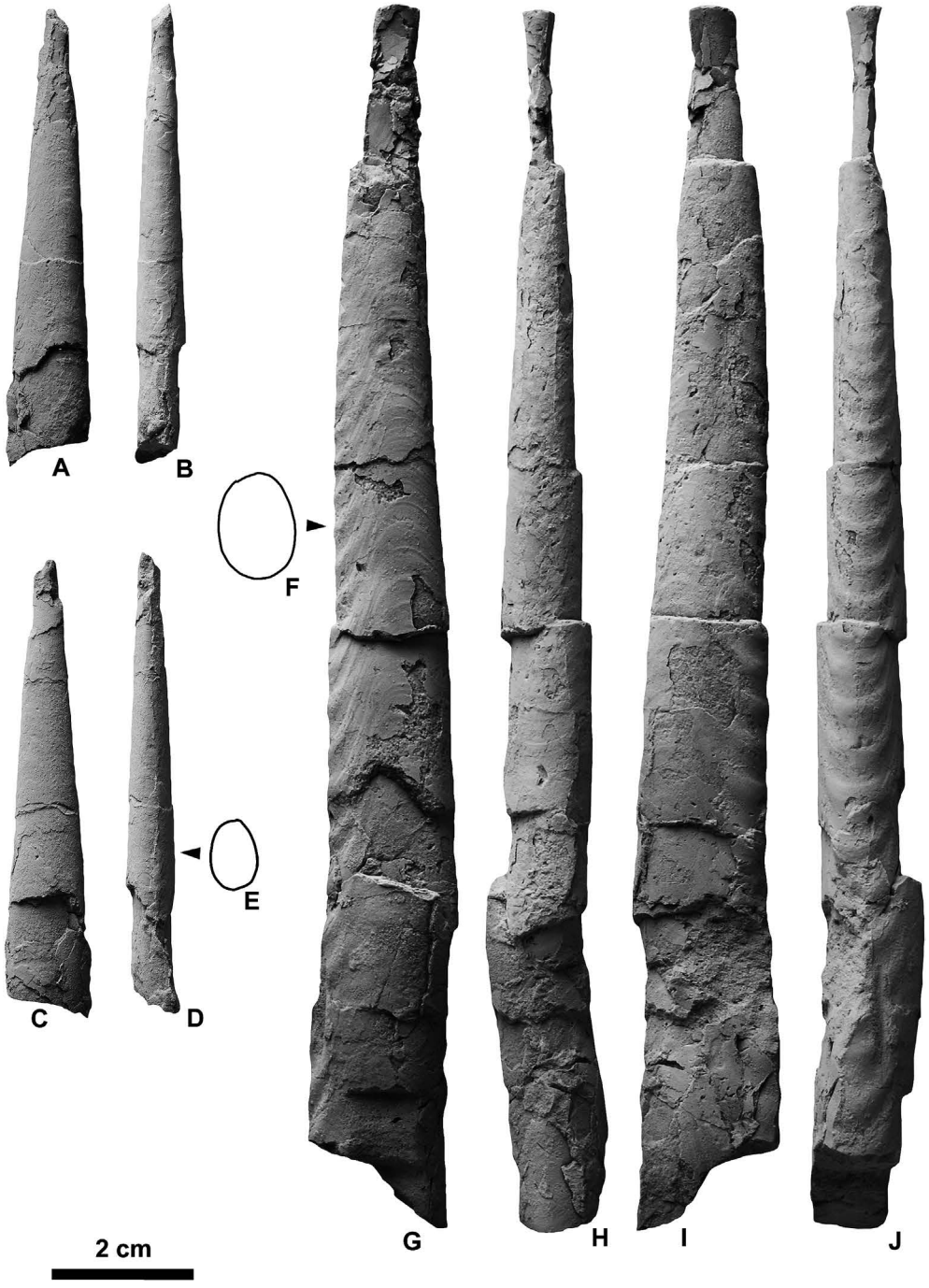

Fig. 93. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 3. A–E, HMG-1971; F–J, HMG-1972.

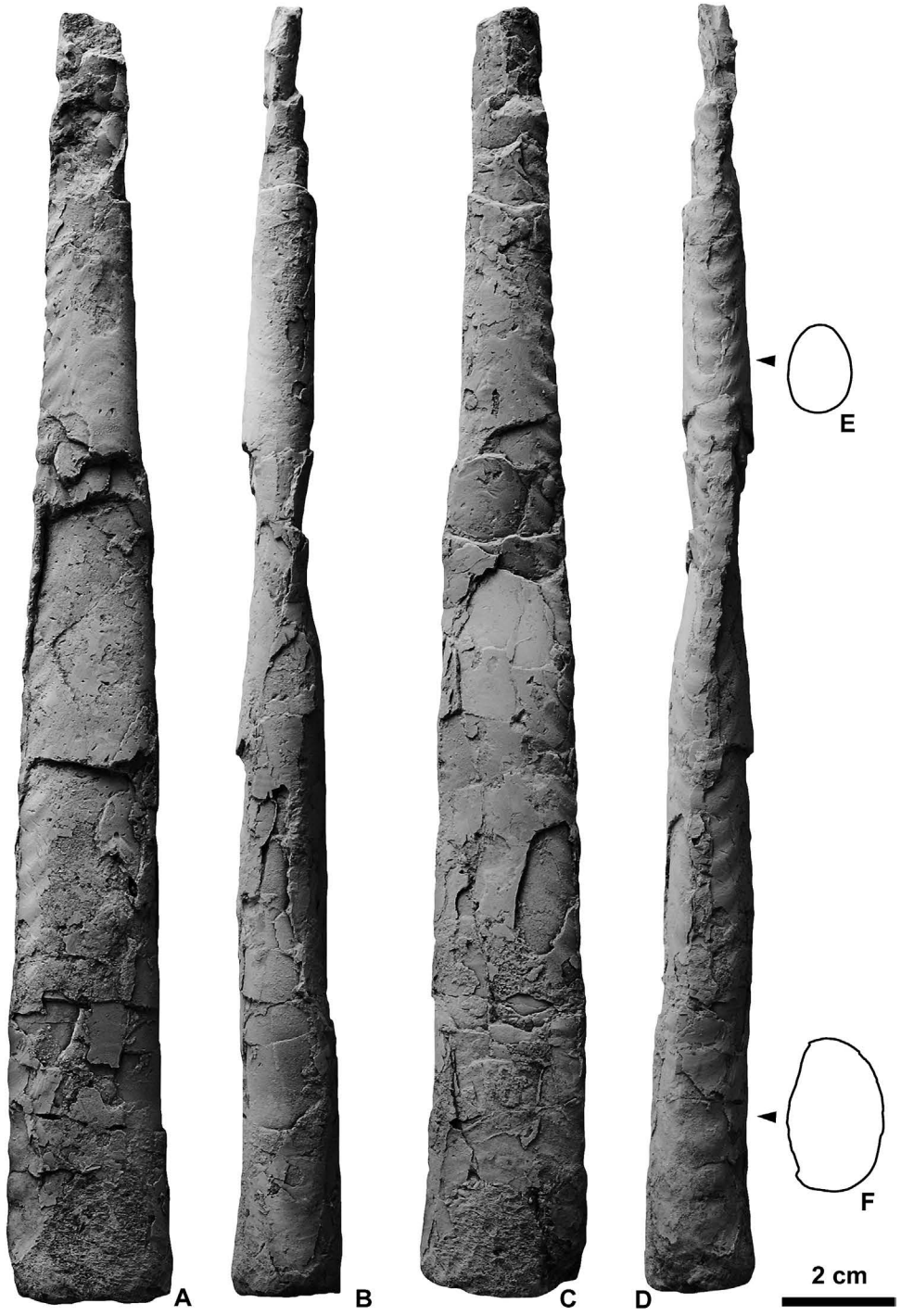

Fig. 94. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 3. A–F, HMG-1973.

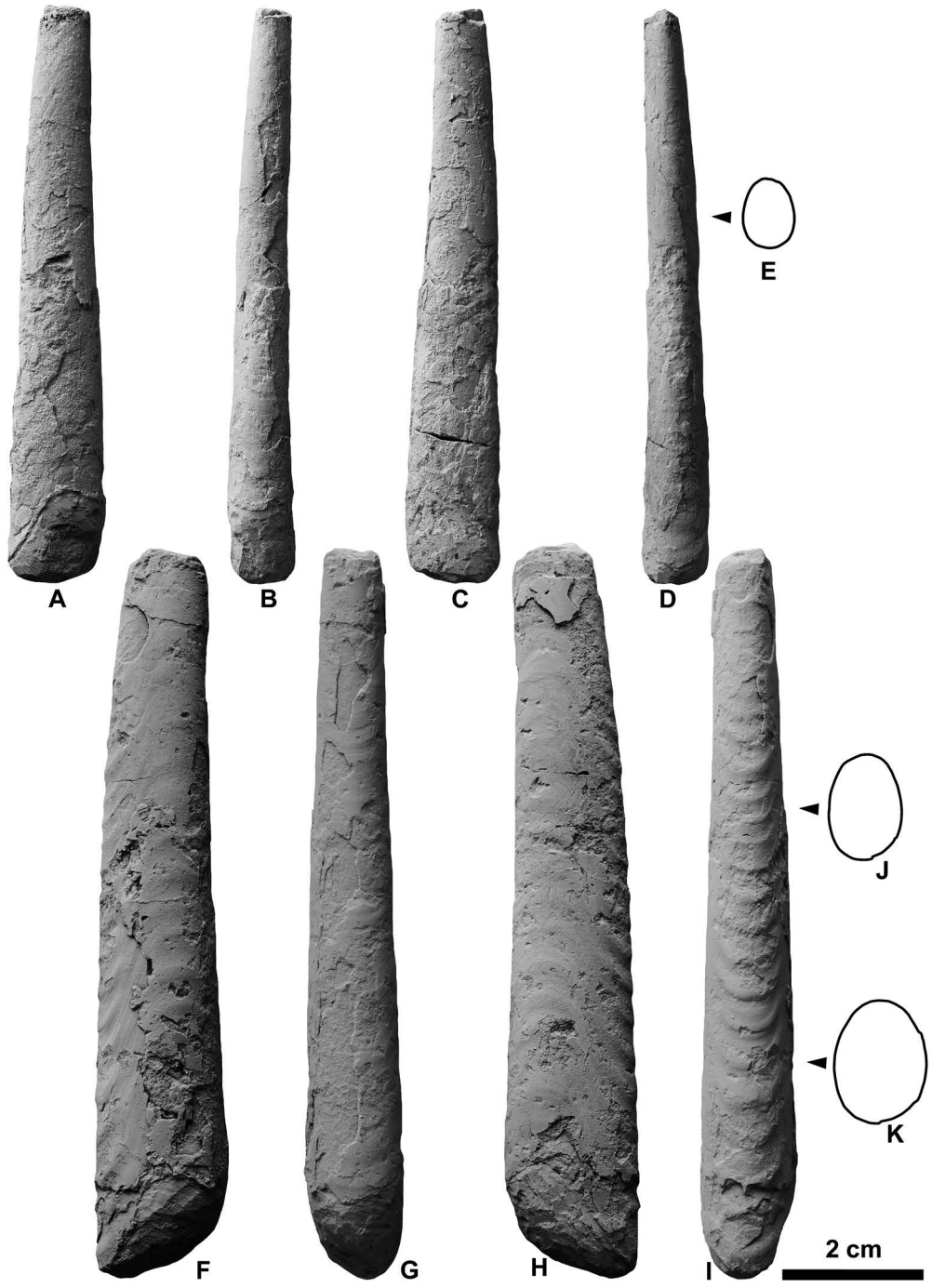

Fig. 95. *Baculites pacificus* Matsumoto and Obata, 1963 from a float concretion found at Loc. 3. A–E, HMG-1974; F–K, HMG-1975.

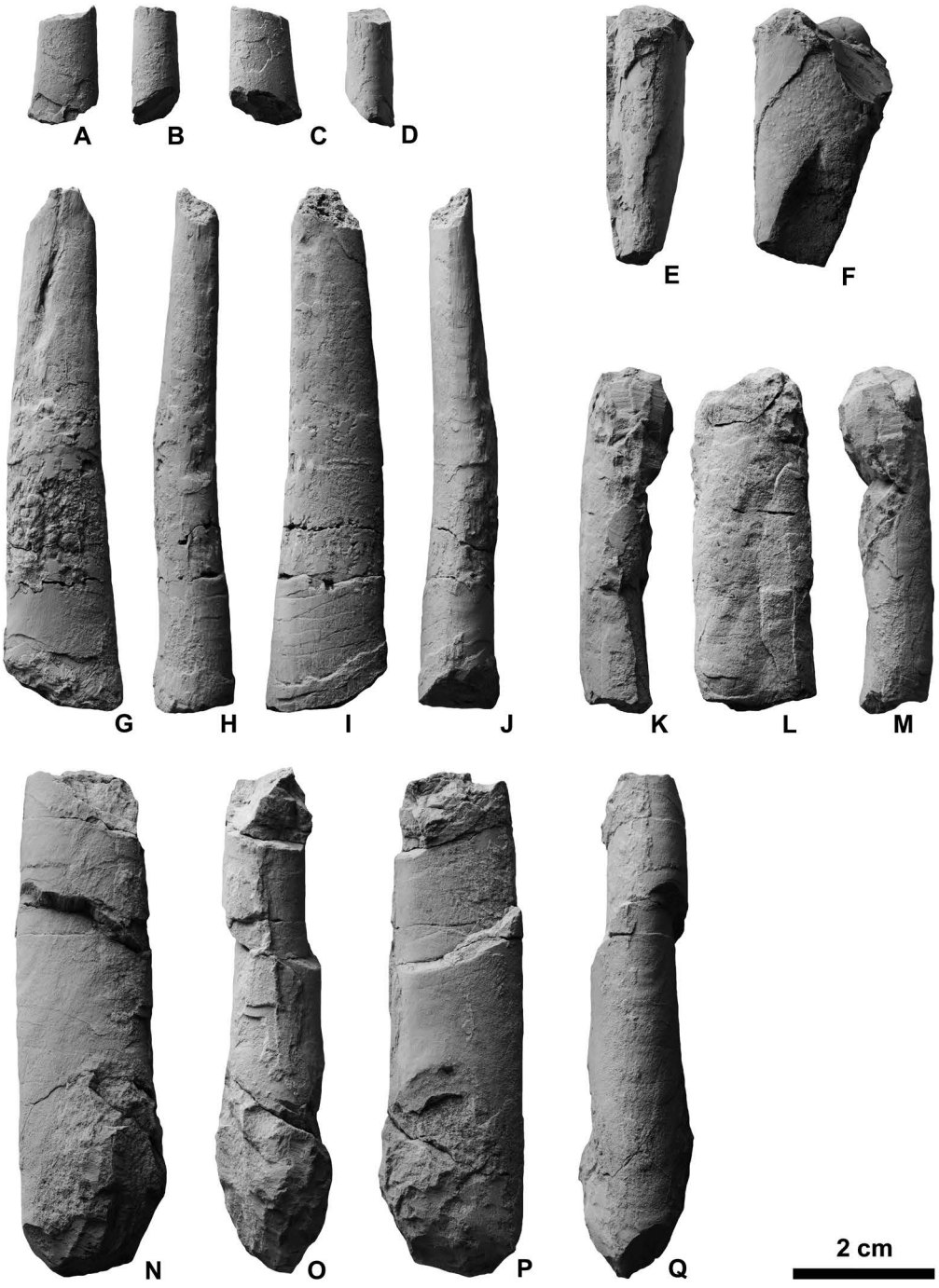

Fig. 96. *Baculites pacificus* Matsumoto and Obata, 1963 from the Chinomigawa Formation. A–D, NMNS PM35265 from Loc. 9; E, F, NMNS PM35266 from Loc. 9; G–J, NMNS PM35267 from Loc. 11; K–M, NMNS PM35268 from Loc. 11; N–Q, NMNS PM35269 from Loc. 11.

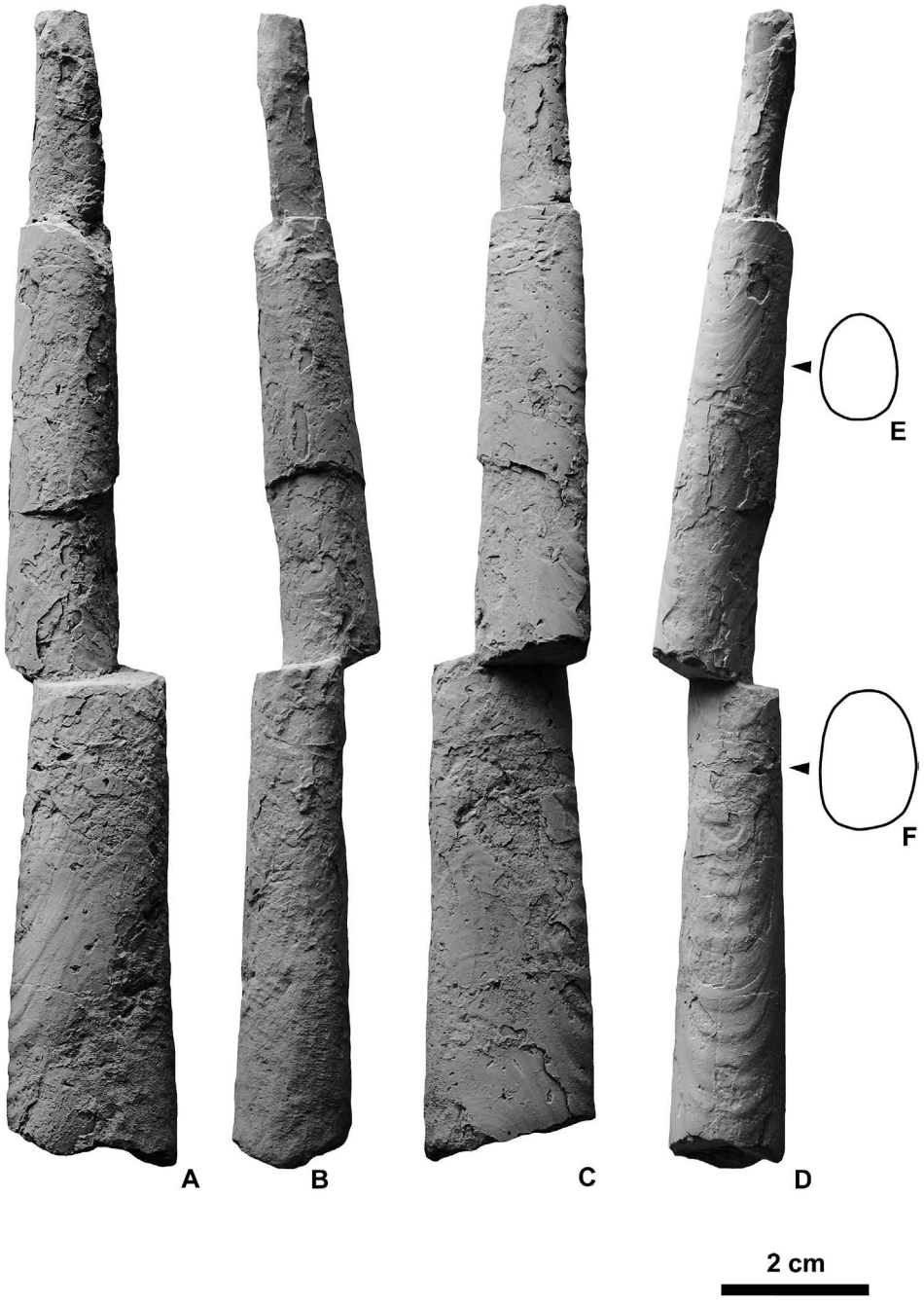

Fig. 97. *Baculites pacificus* Matsumoto and Obata, 1963 from the Chinomigawa Formation. A–F, NMNS PM35270 from Loc. 23.

pacificum-bearing beds in California and British Columbia.

Baculites subanceps Haughton, 1925

Figs. 98–100

Baculites subanceps Haughton, 1925, p. 278, pl. 14, figs. 6–8; Howarth, 1965, p. 368, pl. 5, fig. 3, pl. 6, figs. 6, 7, text-figs. 4, 13–15; Klinger and Lock, 1978, p. 77, fig. 5a–l; Luger and Gröschke, 1989, p. 400, pl. 49, fig. 1, text-fig. 15a–h; Klinger and Kennedy, 1997, fig. 131; Klinger and Kennedy, 2001, p. 203; Shigeta *et al.*, 2016, p. 353, figs. 22–27.

non *Baculites subanceps* Haughton. Shigeta *et al.*, 2016, p. 353, fig. 28 (= *Baculites pacificus*).

Lectotype.—Specimen designated by Howarth (1965, p. 368), is SAM-6829, original of Howarth (1965, p. 368, pl. 6, fig. 6) from the upper Campanan–lower Maastrichtian of Carimba, Angola.

Material examined.—Two specimens, HMG-1976, 1977, from float concretion found at Loc. 1'; four specimens, HMG-1978–1981, from float concretions found at Loc. 2; two specimens, HMG-1982, 1983, from float concretion found at Loc. 3; one specimen, HMG-1984, from float concretion found at Loc. 3'; one specimen, HMG-1985, from Loc. 17.

Description.—Shell straight or gently arched, tapers fairly rapidly at early growth stage and moderately at later stages. Whorl section oval, with narrowly rounded venter, indistinct ventral shoulders, broadly rounded dorsum, and gently convex flanks with maximum whorl width at mid-flank or slightly below mid-flank. Shell surface almost smooth on early growth stage, but as shell grows, weak to strong crescentic nodes develop on flanks and venter becomes corrugated. Dorsum smooth.

Remarks.—Specimens attributed to *Baculites subanceps* by Shigeta *et al.* (2016, fig. 28) from a horizon below the *Didymoceras hidakense*-bearing beds in the Urakawa area are here reassigned to *Baculites pacificus*, because their flanks are either nearly smooth or they exhibit weak crescentic ribs.

Occurrence.—Described *in-situ* specimen was collected from the lower upper Campanian *Baculites subanceps* beds in the Chinomigawa Formation at study section IV, and float concretions probably came from the same beds at study section I. *Baculites subanceps* is known from the upper Campanian in the Urakawa area, Hokkaido, upper middle to lower upper Campanian of the western coastal region of North America, upper Campanian of Egypt, and upper Campanian (lower Maastrichtian?) of Angola.

Baculites rex Anderson, 1958

Figs. 101–104

Baculites rex Anderson, 1958, p. 191, pl. 49, fig. 2; Matsumoto, 1959b, p. 136, pl. 31, fig. 5, pl. 34, fig. 5, pl. 39, figs.1–3, pl. 40, fig. 1, text-figs. 45–52; Matsumoto and Obata, 1963, p. 64, pl. 19, fig. 3, text-figs. 158, 165; Ward, 1978, p. 1152, pl. 2, figs. 7, 10, text-fig. 2; Klinger and Kennedy, 2001, p. 192, figs. 108A–C, 147.

Holotype.—CAS 28325, figured by Anderson (1958, p. 191, pl. 49, fig. 2), from the upper Campanian of Crow Creek, West San Joaquin Valley, California.

Material examined.—Twenty specimens, NMNS PM35271–35278, 35405–35413, HMG-1986–1988, from Loc. 6.

Description.—Shell straight or gently arched, tapers fairly rapidly at early to middle growth stages and moderately at later stages. Whorl section oval, with narrowly rounded venter, indistinct ventral shoulders, broadly rounded dorsum, and gently convex flanks with maximum whorl width at mid-flank or slightly below mid-flank. Shell surface almost smooth, but weak crescentic ribs tend to develop on flanks.

Occurrence.—Described specimens were collected from the lower upper Campanian *Baculites rex* beds in the Chinomigawa Formation at study section II. *Baculites rex* is known from the upper Campanian in the Nakatonbesu area, Hokkaido, upper Campanian *Metaplacenticeras pacificum* Zone in British Columbia, and upper Campaian–lower Maastrichtian? in California.

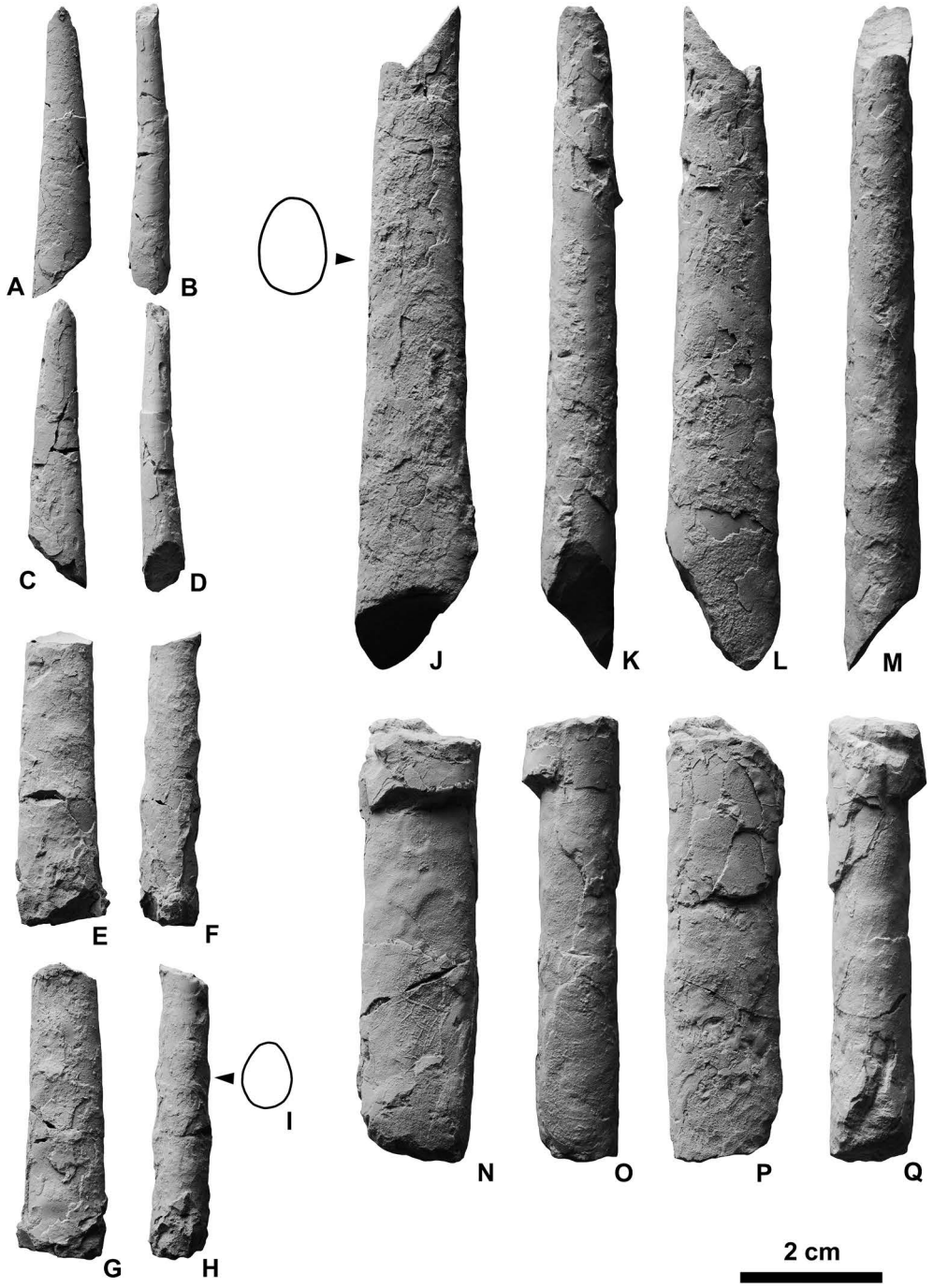

Fig. 98. *Baculites subanceps* Haughton, 1925 from float concretions found at Loc. 2. A–D, HMG-1978; E–I, HMG-1979; J–M, HMG-1980; N–Q, HMG-1981.

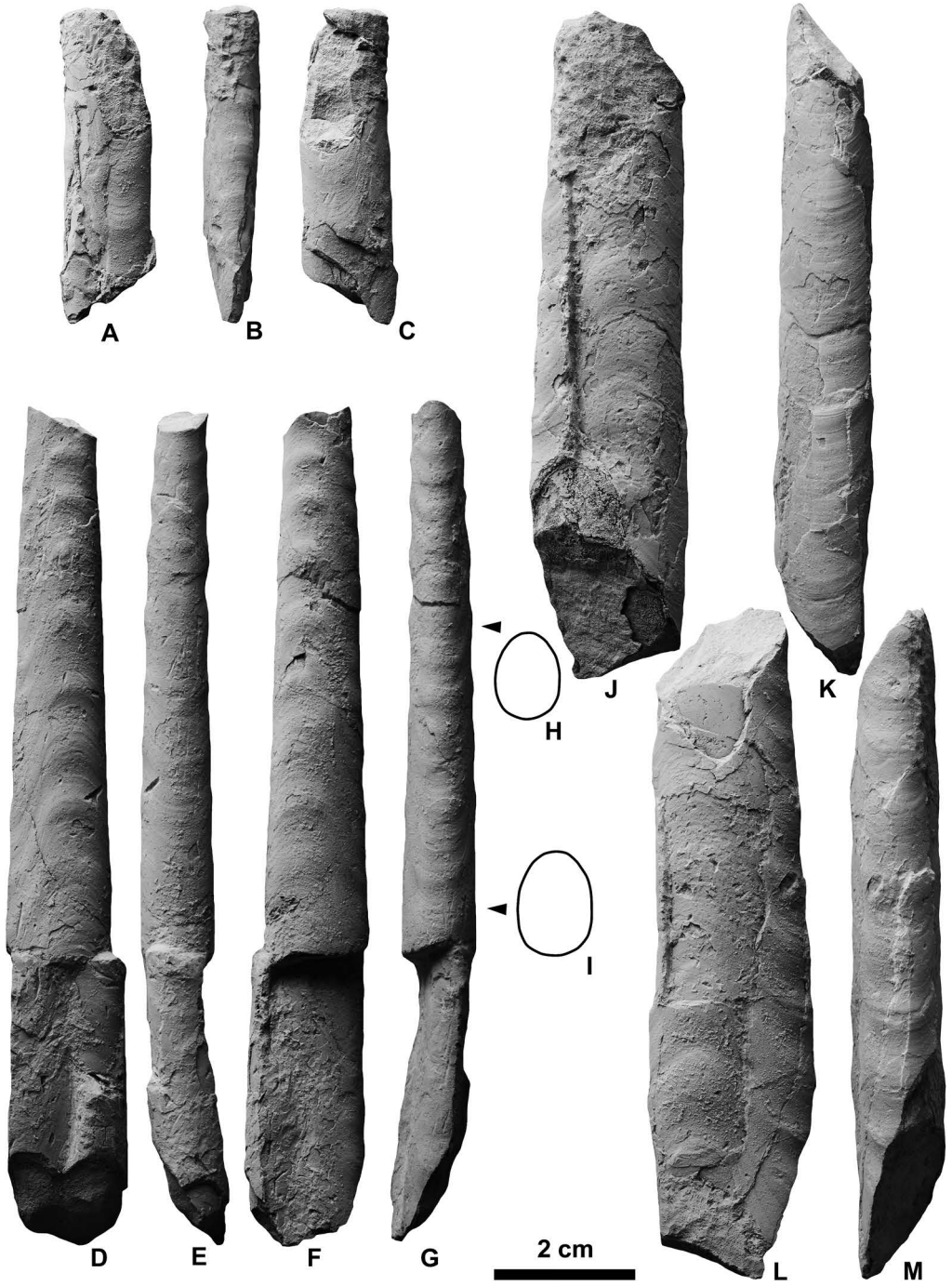

Fig. 99. *Baculites subanceps* Haughton, 1925. A–G, from a float concretions found at Loc. 3; A–C, HMG-1982; D–I, HMG-1983; J–M, HMG-1984 from a float concretions found at Loc. 3'.

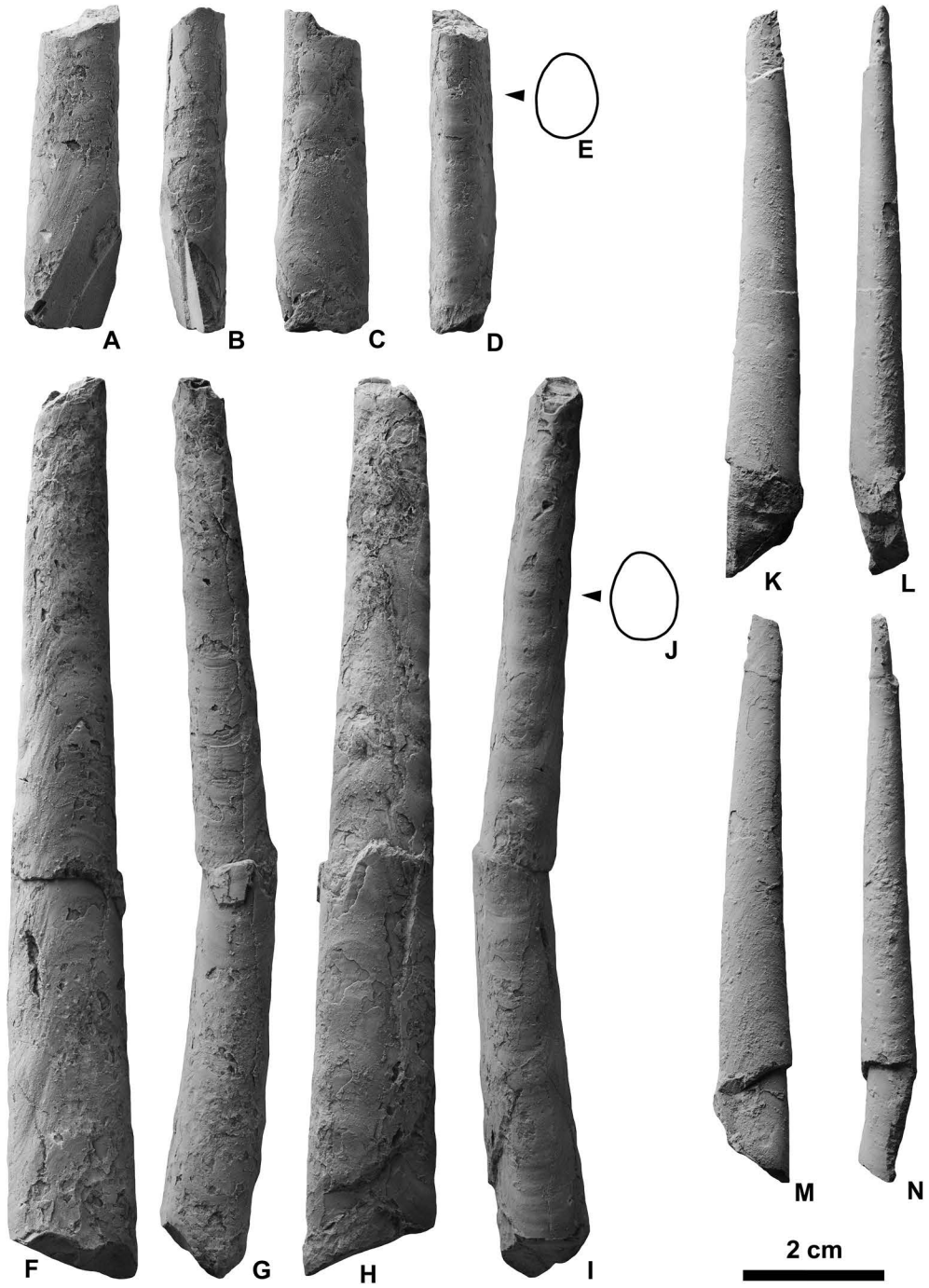

Fig. 100. *Baculites subanceps* Haughton, 1925. A–J, from a float concretion found at Loc. 1'; A–E, HMG-1976; F–J, HMG-1977; K–N, HMG-1985 from Loc. 17.

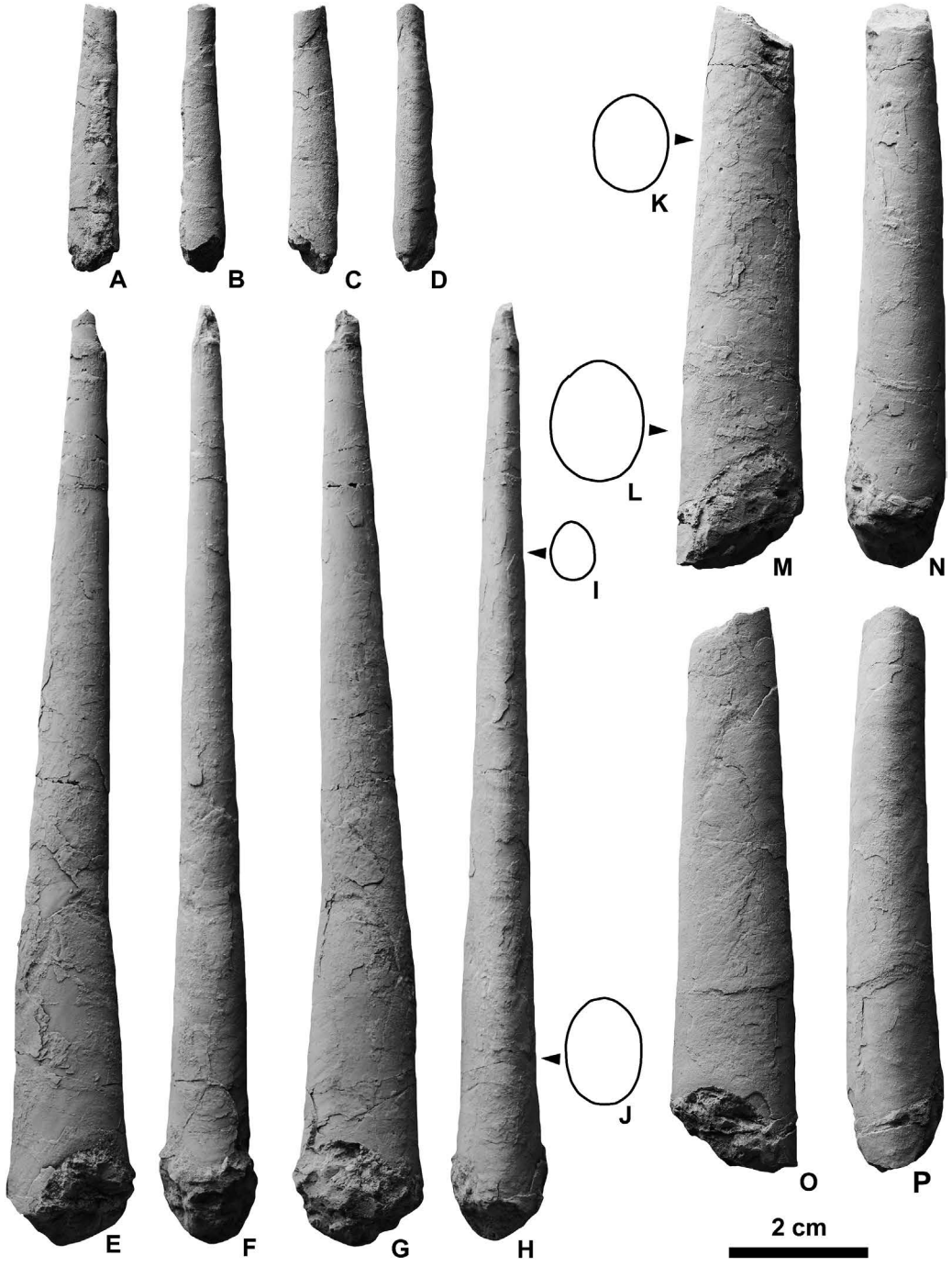

Fig. 101. *Baculites rex* Anderson, 1958 from Loc. 6 in the Chinomigawa Formation. A–D, NMNS PM35271; E–J, NMNS PM35272; K–P, NMNS PM35273.

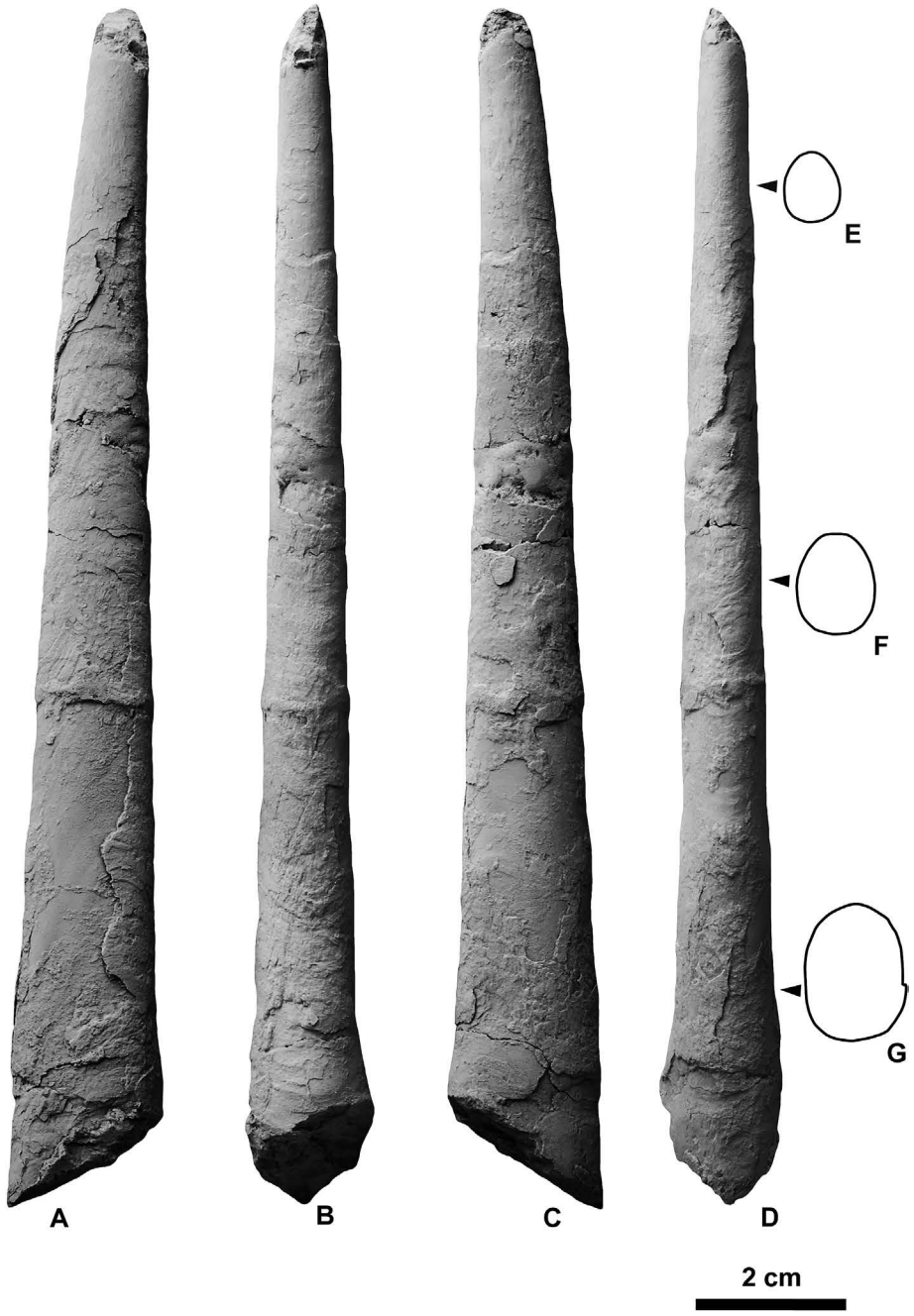

Fig. 102. *Baculites rex* Anderson, 1958 from Loc. 6 in the Chinomigawa Formation. A–G, HMG-1986.

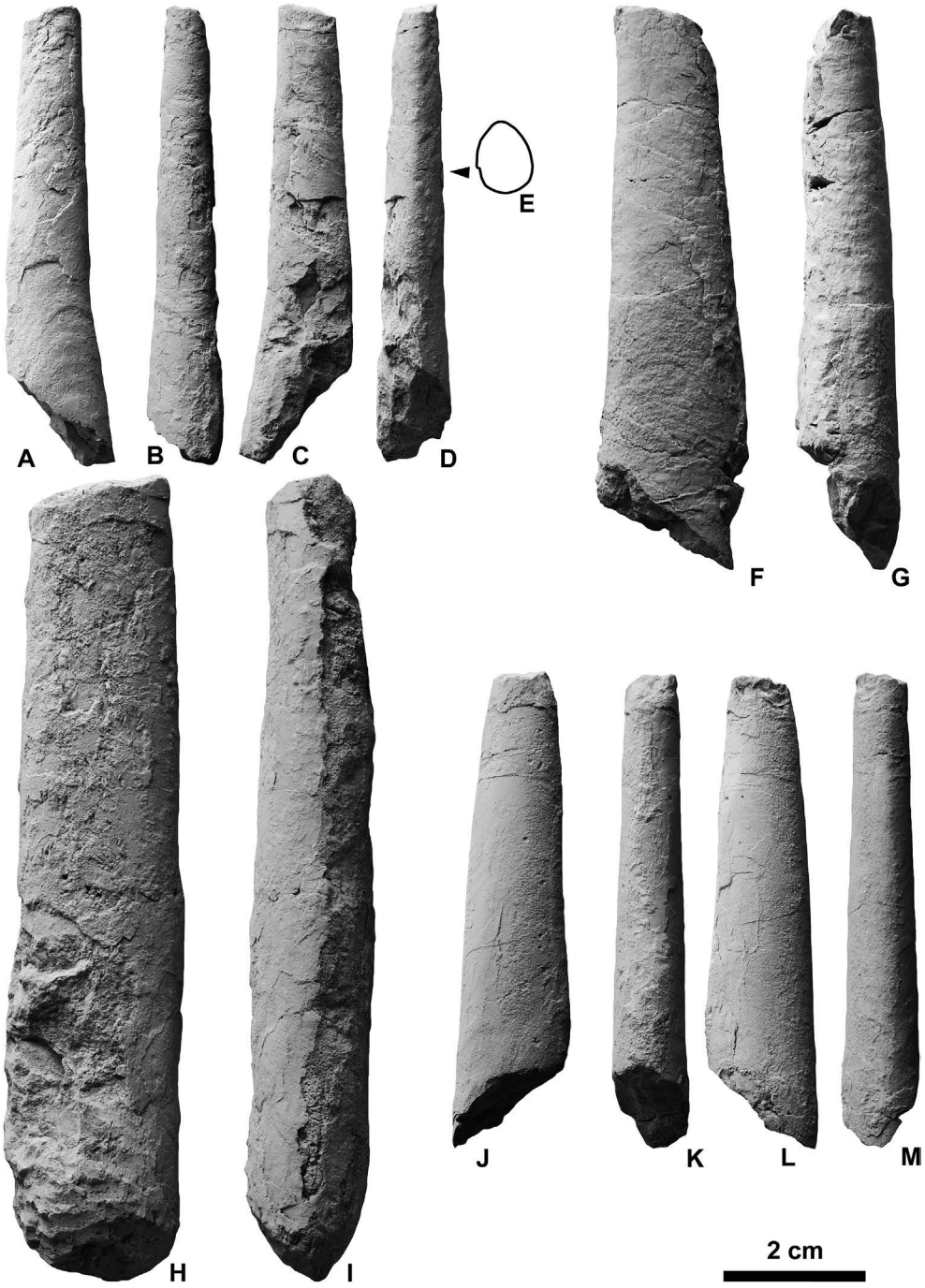

Fig. 103. *Baculites rex* Anderson, 1958 from Loc. 6 in the Chinomigawa Formation. A–E, NMNS PM35274; F, G, NMNS PM35275; H, I, NMNS PM35276; J–M, HMG-1987.

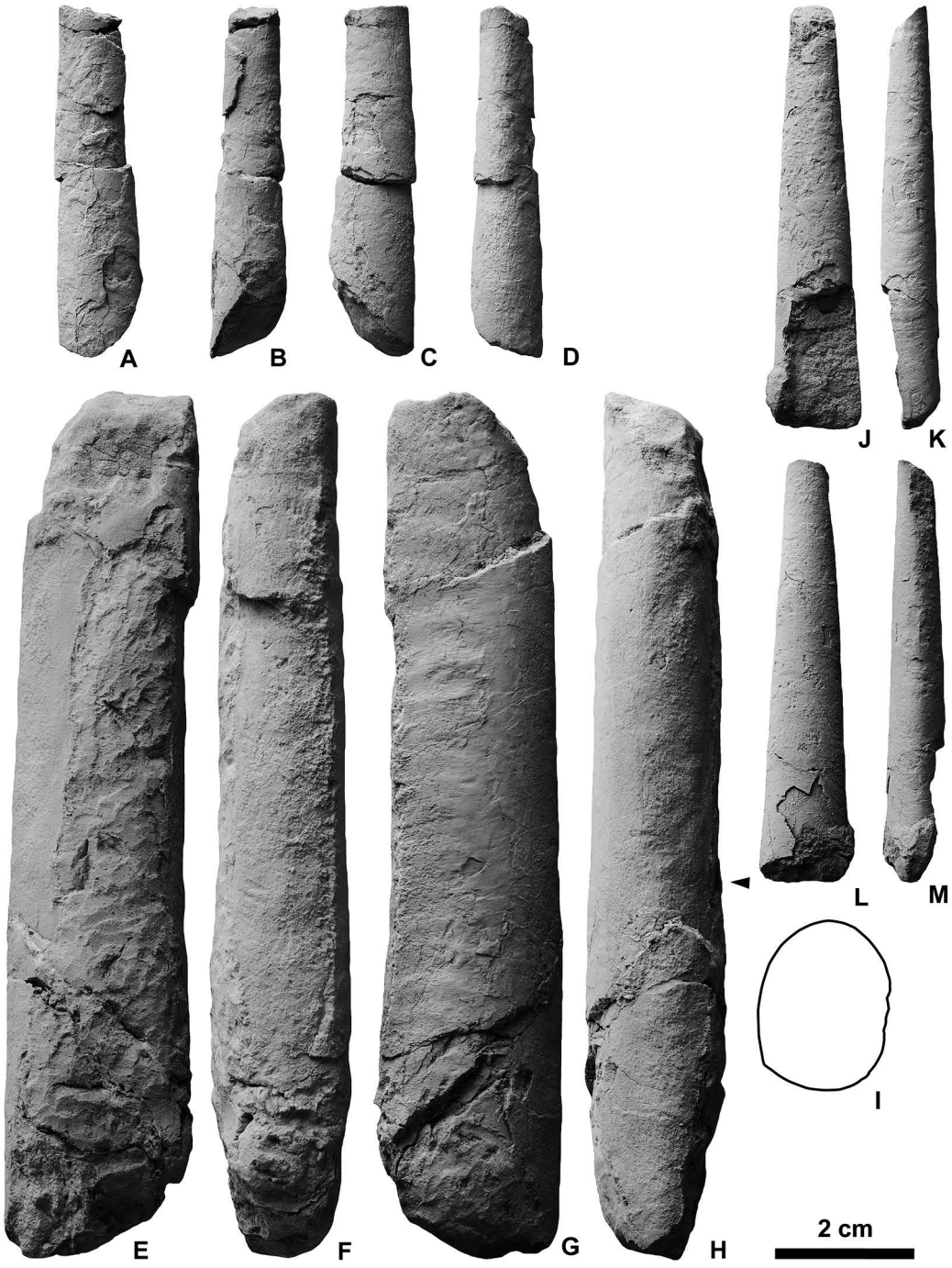

Fig. 104. *Baculites rex* Anderson, 1958 from Loc. 6 in the Chinomigawa Formation. A–D, NMNS PM35277; E–I, NMNS PM35278; J–M, HMG-1988.

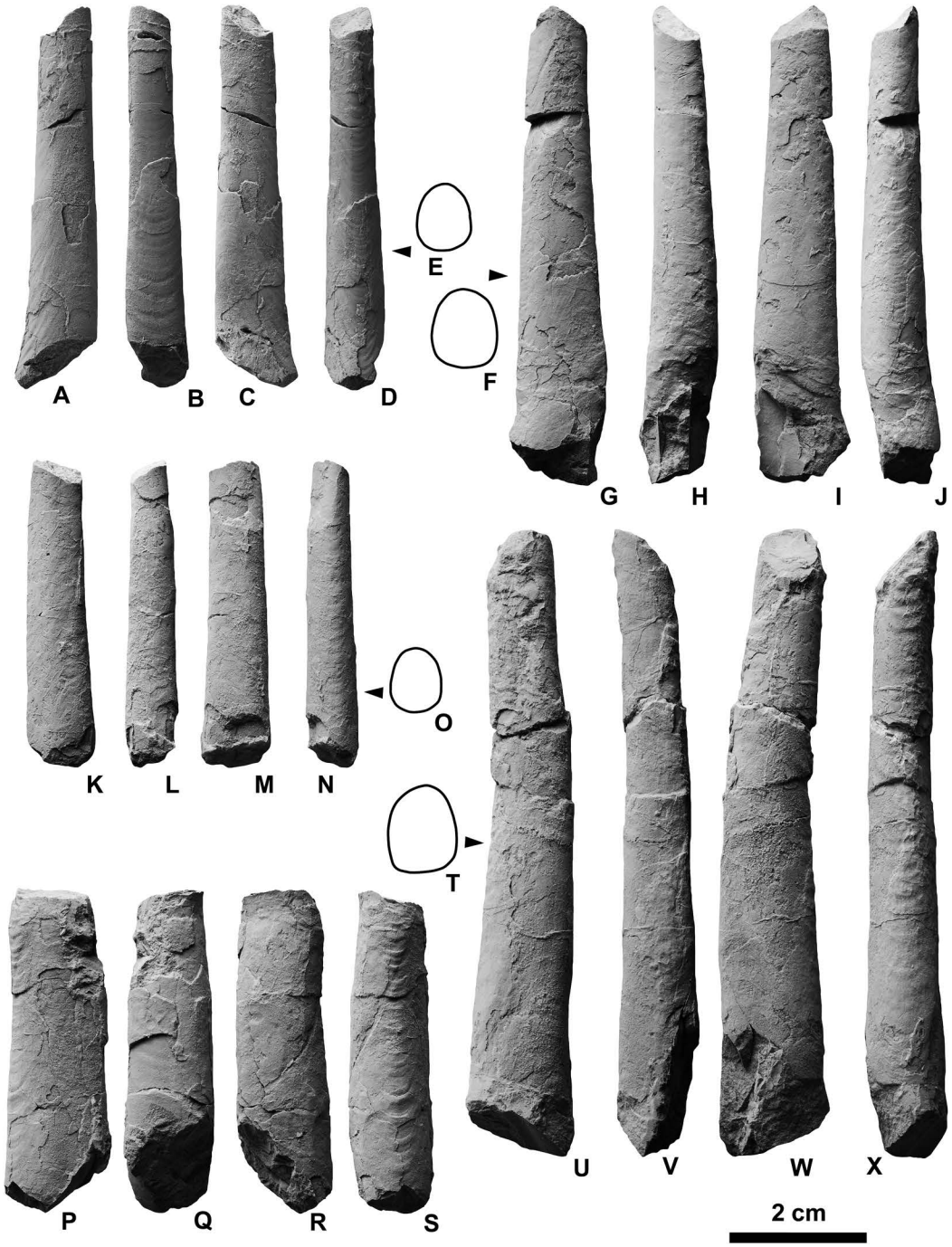

Fig. 105. *Baculites* sp. from Loc. 26 in the Chinomigawa Formation. A–E, NMNS PM35279; F–J, NMNS PM35280; K–O, NMNS PM35281; P–S, NMNS PM35282; T–X, NMNS PM35283

Baculites sp.

Figs. 105

Baculites anceps pacificus Matsumoto and Obata, 1963, p. 59, pl. 20, fig. 3, text-figs. 145, 146, 156.

Material examined.—Five specimens, NMNS PM35279–35283, from Loc. 26.

Description.—Moderately tapered, straight or gently arched shell. Whorl section subtrigonal, with narrowly rounded venter, indistinct ventral shoulders, gently convex flanks, and flattened or broadly rounded dorsum. Shell surface ornamented with numerous, fine, oblique ribs on ventral half of flank, which cross the venter with projection. Dorsum smooth.

Remarks.—Specimens attributed to *Baculites anceps pacificus* by Matsumoto and Obata (1963, pl. 20, fig. 3, text-figs. 145, 146, 156) from the *Sphenoceramus schmidti* Zone in the Urakawa area are probably the same as the present specimens, but their fragmental nature and poor preservation prevent a definitive species assignment.

Occurrence.—Described specimens were collected from the middle Campanian *Sphenoceramus orientalis* beds in the Chinomigawa Formation at study section VII. Identical specimens are known from the *Sphenoceramus schmidti* Zone in the Urakawa area.

Conclusions

1. Thirty-seven species of Campanian (Late Cretaceous) ammonoids, which included three newly described species (*Neophylloceras nodosum* sp. nov., *Menuites armatus* sp. nov. and *Parasolenoceras ribiraense* sp. nov.), and four species of inoceramid bivalves are reported from the Urakawa and Chinomigawa formations of the Yezo Group in the Ribira River area, southern central Hokkaido, Japan.

2. Seven distinct Campanian ammonoid and inoceramid assemblages are recognized as follow, in ascending order: the lower Campanian *Gaudryceras tenuiliratum* beds, the middle Campanian *Sphenoceramus orientalis* beds, *Sphenoceramus schmidti* beds and *Metaplacenticeras subtilistriatum* beds, and the lower upper Campanian *Baculites pacificus* beds, *B. subanceps* beds and *B. rex* beds.

3. The discovery of *Pachydiscus excelsus* in the middle Campanian *Metaplacenticeras subtilistriatum* beds as well as the lower upper Campanian *Baculites pacificus* to *B. rex* beds in the Ribira River area suggests that the genus extended its geographical distribution from other regions to the Northwest Pacific area during middle Campanian time, as did other ammonoid taxa, e.g. *Pseudophyllites*, *Desmophyllites*, *Saghalinites* and *Metaplacenticeras*.

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Appendix. List of ammonoids and inoceramids from the Urakawa and Chinomigawa formations of the Yezo Group in the Ribira area, southern central Hokkaido, northern Japan. Locality, sample (= concretion) and register numbers are shown. Suffix "p" of sample number means the concretion was found as float. HMG, Hobetsu Museum, Mukawa; NMNS, National Museum of Nature and Science, Tsukuba.

locality	sample	ammonoids and inoceramids
1	20100814p	*Phyllopachyceras ezoense* (NMNS PM35191, 35192), *Tetragonites popetensis* (NMNS PM35195), *Desmophyllites diphylloides* (NMNS PM35219), *Metaplacenticeras subtilistriatum* (HMG-1930), *Diplomoceras* sp. (HMG-1959)
1'	20180401-9p	*Didymoceras hidakense* (HMG-1937, 1938), *Baculites subanceps* (HMG-1976, 1977)
2	20091030-1p	*Didymoceras hidakense* (HMG-1943*), *Baculites subanceps* (HMG-1980, 1981)
	20120917-1p	*Baculites pacificus* (NMNS PM35249–35262, 35313**–35362**, HMG-1963–1969)
	20160826-1p	*Didymoceras hidakense* (HMG-1939, 1940)
	20160826-2p	*Didymoceras hidakense* (HMG-1941), *Baculites subanceps* (HMG-1978, 1979)
	20170417-5p	*Didymoceras hidakense* (HMG-1942)
3	20091030-2p	*Pachydiscus excelsus* (HMG-1926*)
	20091030-3p	*Menuites nelchinensis* (HMG-1916*)
	20091030-4p	*Menuites nelchinensis* (HMG-1917*)
	20091115-1p	*Phyllopachyceras ezoense* (NMNS PM35193), *Tetragonites popetensis* (HMG-1860, 1861), *Desmophyllites diphylloides* (HMG-1895), *Menuites armatus* (HMG-1913), *Parasolenoceras ribiraense* (HMG-1957), *Baculites pacificus* (HMG-1974, 1975)
	20100417-1p	*Didymoceras hidakense* (NMNS PM35242)
	20100417-2p	*Didymoceras hidakense* (HMG-1945)
	20100417-3p	*Patagiosites* sp. (HMG-1924)
	20100516-4p	*Diplomoceras* sp. (HMG-1960)
	20110423-3p	*Baculites pacificus* (NMNS PM35402**, 35403**)
	20110429-p	*Neophylloceras ramosum* (HMG-1849)
	20110612-2p	*Baculites pacificus* (NMNS PM35404**)
	20120917-1p	*Gaudryceras* sp.1 (HMG-1877–1879), *Desmophyllites diphylloides* (HMG-1894), *Menuites* sp. (HMG-1919, 1920)
	20120917-3p	*Didymoceras hidakense* (NMNS PM35239)
	20121006-1p	*Didymoceras hidakense* (NMNS PM35427**)
	20130428-5p	*Baculites pacificus* (NMNS PM35263, 35264, 35374**–35386**, HMG-1970–1973)
	20130525-2p	*Pachydiscus excelsus* (NMNS PM35229)
	20130823-1p	*Pachydiscus excelsus* (HMG-1927)
	20160802-1p	*Didymoceras hidakense* (NMNS PM35237, 35238, 35428**), *Baculites subanceps* (HMG-1982, 1983)
	20160826-3p	*Tetragonites popetensis* (NMNS PM35196), *Didymoceras hidakense* (HMG-1944)
	20160826-6p	*Gaudryceras* sp. 1 (NMNS PM35212)
	20160826-7p	*Desmophyllites diphylloides* (HMG-1896), *Baculites pacificus* (NMNS PM35387**–35401**)
	20160826-8p	*Tetragonites popetensis* (NMNS PM35197, 35198), *Baculites pacificus* (NMNS PM35363**–35373**)
	20160826-9p	*Desmophyllites diphylloides* (HMG-1893), *Didymoceras hidakense* (NMNS PM35429**)
	20170525-1p	*Didymoceras hidakense* (NMNS PM35240, 35241)
	20170713-1p	*Menuites nelchinensis* (HMG-1918*)
3'	20120917-3p	*Didymoceras hidakense* (HMG-1948)
	20130414-2p	*Didymoceras hidakense* (HMG-1947), *Baculites subanceps* (HMG-1984)
	20160826-4p	*Didymoceras hidakense* (HMG-1946, NMNS PM35430**)
4	20100501-1	*Tetragonites popetensis* (HMG-1862, 1863), *Gaudryceras* sp. 1 (HMG-1880), *Desmophyllites diphylloides* (HMG-1897)
5	20110820-6	*Pachydiscus excelsus* (NMNS PM35230)
6	20111002	*Baculites rex* (NMNS PM35271–35278, 35405**–35413**, HNG-1986–1988)
	20120717-1	*Gaudryceras* sp. 2 (NMNS PM35213)
	20120717-5	*Diplomoceras* sp. (HMG-1961)
	20160527-1	*Tetragonites popetensis* (NMNS PM35199), *Pachydiscus excelsus* (NMNS PM35231–35233)
	20160527-2	*Gaudryceras* sp. 2 (NMNS PM35214)
	20170502-1	*Diplomoceras* sp. (HMG-1962)
7	20110503-4	*Desmophyllites diphylloides* (NMNS PM35223)

locality	sample	ammonoids and inoceramids
8	20100504-1	*Neophylloceras nodosum* (HMG-1848), *Patagiosites* sp. (HMG-1925)
9	20110430-1	*Neophylloceras ramosum* (HMG-1850), *Tetragonites popetensis* (HMG-1864), *Gaudryceras* sp. 1 (HMG-1881–1886), *Desmophyllites diphylloides* (HMG-1898, 1899, NMNS PM35220–35222), *Menuites nelchinensis* (HMG-1915), *Menuites* sp. (HMG-1921–1923), *Parasolenoceras ribiraense* (HMG-1955), *Baculites pacificus* (NMNS PM35265, 35266)
10	20130512-1	*Parasolenoceras ribiraense* (HMG-1956)
11	20120917	*Neophylloceras nodosum* (HMG-1851), *Baculites pacificus* (NMNS PM35267–35269)
12	20160904-1	*Metaplacenticeras subtilistriatum* (HMG-1931)
	20161119-2	*Canadoceras multicostatum* (HMG-1911)
13	20160904-8	*Menuites fascicostatus* (NMNS PM35227), *Didymoceras*? sp. (HMG-1954)
14	20130428-2p	*Ainoceras kamuy* (HMG-1950–1952)
	20131014-1p	*Ainoceras kamuy* (HMG-1953), *Sphenoceramus orientalis* (NMNS PM35304)
	20150426-1p	*Ainoceras kamuy* (HMG-1949), *Sphenoceramus orientalis* (NMNS PM35303)
15	20110503-6	*Menuites fascicostatus* (NMNS PM35225)
	20110820-1	*Phyllopachyceras ezoense* (HMG-1852–1854), *Tetragonites popetensis* (NMNS PM35200)
	20110830-1	*Metaplacenticeras subtilistriatum* (HMG-1932–1934)
	20160826-11	*Menuites fascicostatus* (NMNS PM35226)
16	20110521-p	*Gaudryceras tenuiliratum* (NMNS PM35208)
	20110820-2p	*Gaudryceras tenuiliratum* (NMNS PM35206)
	20130512-2p	*Gaudryceras tenuiliratum* (HMG-1868, NMNS PM35207)
17	20110505-1	*Menuites nelchinensis* (NMNS PM35228)
	20130525-1	*Pachydiscus excelsus* (NMNS PM35234)
	20150426-1	*Baculites subanceps* (HMG-1985)
18	20160826-5	*Pachydiscus excelsus* (NMNS PM35235)
19	20161014-1	*Tetragonites popetensis* (HMG-1865)
20	20100504-1	*Menuites fascicostatus* (HMG-1914)
21	20110820-3	*Metaplacenticeras subtilistriatum* (HMG-1935, 1936)
	20161014-2	*Canadoceras multicostatum* (NMNS PM35224)
22	20130421-1	*Pachydiscus excelsus* (NMNS PM35236)
	20160908-1	*Pachydiscus excelsus* (HMG-1928)
23'	20110504p	*Tetragonites popetensis* (NMNS PM35201), *Menuites sanadai* (HMG-1912)
23	20161014-3	*Baculites pacificus* (NMNS PM35270)
24	20131014-1	*Saghalinites teshioensis* (HMG-1856)
	20170502-3	*Pachydiscus excelsus* (HMG-1929)
25	20161014-4	*Tetragonites glabrus* (HMG-1857)
26	20100516-2	*Phyllopachyceras ezoense* (HMG-1855), *Gaudryceras striatum* (HMG-1875), *Damesites* sp. (NMNS PM35218)
	20110505-1	*Tetragonites glabrus* (HMG-1858, 1859), *Gaudryceras striatum* (HMG-1874), *Damesites* sp. (HMG-1887), *Baculites* sp. (NMNS PM35280), *Inoceramus ezoensis* (NMNS PM35292, 35293), *Sphenoceramus orientalis* (NMNS PM35297–35300)
	20110505-2	*Damesites* sp. (HMG-1889, NMNS PM35215), *Inoceramus ezoensis* (NMNS PM35291), *Sphenoceramus orientalis* (NMNS PM35301)
	20120429-2	*Phyllopachyceras ezoense* (NMNS PM35194), *Damesites* sp. (HMG-1888), *Baculites* sp. (NMNS PM35281–35283), *Inoceramus ezoensis*(NMNS PM35284–35289), *Sphenoceramus orientalis* (NMNS PM35302)
	20130421-7	*Damesites* sp. (NMNS PM35216, 35217), *Baculites* sp. (NMNS PM35279), *Sphenoceramus orientalis* (NMNS PM35296)
	20131014-2	*Eupachydiscus haradai* (HMG-1900)
	20150426-2	*Gaudryceras striatum* (HMG-1876), *Damesites* sp. (HMG-1890–1892), *Inoceramus ezoensis* (NMNS PM35290), *Sphenoceramus pseudosulcatus* (NMNS PM35294), *Sphenoceramus orientalis* (NMNS PM35295)

locality	sample	ammonoids and inoceramids
27	20110505-3p	*Gaudryceras intermedium* (HMG-1873)
28	20110506-2	*Tetragonites popetensis* (NMNS PM35202–35204), *Canadoceras mysticum* (HMG-1902, 1907–1910), *Gaudryceras mamiyai* (NMNS PM35211), *Canadoceras* sp. (HMG-1901), *Parasolenoceras* sp. (HMG-1958), *Sphenoceramus schmidti* (NMNS PM35305–35308)
	20110506-3	*Tetragonites popetensis* (NMNS PM35205), *Baculites yezoensis* (NMNS PM35243–35248, 35414**–35426**)
	20170502-4	*Tetragonites popetensis* (HMG-1866, 1867), *Canadoceras mysticum* (HMG-1903–1906), *Sphenoceramus schmidti* (NMNS PM35309–35312)
29	20110506-1p	*Gaudryceras tenuiliratum* (HMG-1869–1872, NMNS PM35209, 35210)

*, specimen collected by N. Sasaki
**, specimen not illustrated

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