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Original Article

Megafossil biostratigraphy of the Upper Cretaceous deposits in the Sanushube River upstream area, Hobetsu, Hokkaido, Japan

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Abstract. The Upper Cretaceous deposits yielding abundant ammonoid- and inoceramid fossils are well exposed along the the Sanushube River upstream area, northern Hobetsu, Hokkaido. In this area, the Cretaceous Kashima and Hakobuchi formations, Yezo Group, and Eocene Poronai Formation are distributed. The *Inoceramus amakusensis* Zone indicating the Santonian and the *Inoceramus* (*Platyceramus*) *japonicus* Zone suggesting the Lower Campanian are recognized in the Kashima Formation. The *Nostoceras hetonaiense* Zone, an indicative of the lowest Maastrichtian, is recognized in the HKb unit of Hakobuchi Formation. The present study also revealed that the partial skeleton of the plesiosaur, Hobetsu-Araki-Ryu (HMG-1), occurs below the first appearance datum of *I.* (*P.*) *japonicus*; the Santonain/Campanian boundary, and the horizon is correlated to the upper Santonian. In addition, a stage diagnostic ammonoid suggesting the lowest Maastrichtian; *Patagiosites compressus* occurs from the *Nostoceras hetonaiense* Zone in the Hakobuchi Formation.

Key words: ammonoid, Cretaceous, Hokkaido, inoceramid, plesiosaur, Yezo Group
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Introduction

The Cretaceous Yezo Group, exposed in the meridional zone of Hokkaido and Sakhalin (Figure 1), yields many ammonoid- and inoceramid fossils (e.g., Nagao and Matsumoto, 1939, 1940; Matsumoto, 1942a). They are significant for stratigraphic correlation and to reveal the history of faunal change in the northwest Pacific province (Toshimitsu *et al*., 1995; Shigeta and Maeda, 2005; Jagt-Yazykova, 2011). The Yezo Group is also significant for understanding the evolution of marine reptile fauna because large-sized marine reptiles (e.g., plesiosaur, mosasaur, and turtle) occur from the group even though the number is not large (Sato *et al*., 2012).

In the Sanushube River upstream area, northern Hobetsu, Hokkaido (Figure 1B), a partial skeleton of a plesiosaur (HMG-1), named Hobetsu-Araki-Ryu (Figure 2A, B) which is iconic specimen of the Hobetsu area, Mukawa Town was collected in 1975—1977 (Figure 2C; Nakaya, 1985), and was described by Nakaya (1989) and Sato *et al*. (2020).

The plesiosaur locality was studied in detail, and the early Campanian age was suggested mainly by radiolarians and planktonic foraminifers (Kito *et al*., 1986). On the other hand, the other horizons and localities nearby have not yet been well investigated well. Some ammonoids and inoceramids were collected from the plesiosaur locality during excavation in 1977 and are deposited in the Hobetsu Museum. These are briefly mentioned by Kito *et al*. (1986) referring to the oral presentation by Takahashi (1982), however, additional descriptions in detail are needed as well as an update of the biostratigraphic schemes of molluscan (ammonoid and inoceramid) and planktonic foraminifera (Toshimitsu *et al*., 1988, 1995; Nishi *et al*., 2003).

The present study underwent in 2011—2024 to clarify geology of the Sanushube River upstream area and biostratigraphy using ammonoids and inoceramids including the specimens from the plesiosaur locality. As the result, detailed correlation of the plesiosaur and other ammonoid horizons were possible.

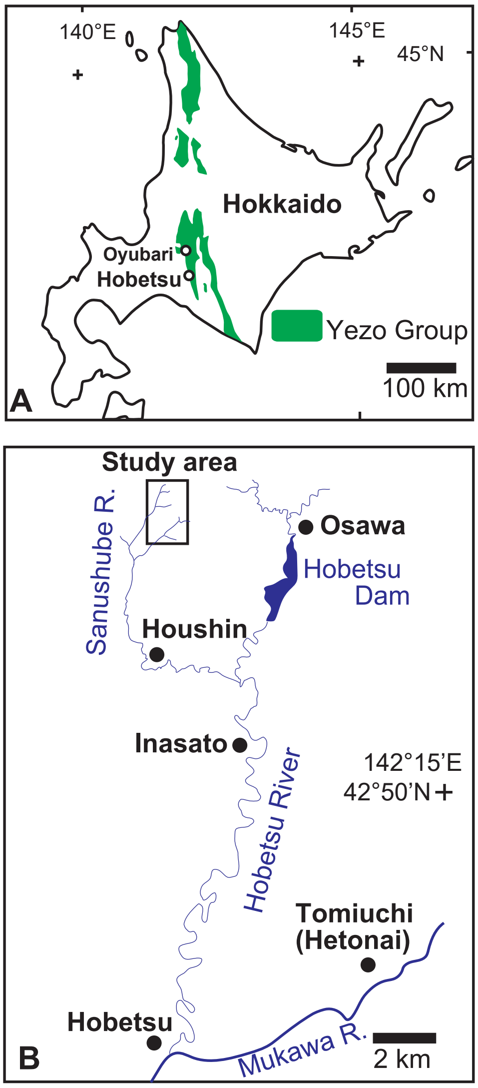

Figure 1. Index map showing the distribution of the Yezo Group in Hokkaido (**A**) and the study area in northern Hobetsu (**B**).

Notes on stratigraphy

The Cretaceous Yezo Group is widely distributed in the Hobetsu area in a north-south direction (Otatume, 1941, Takahashi and Wada, 1985). Around the study area, geological structures are complicated. In the Houshin area, the southwestern part of the study area, a large klippe called the Sanushube klippe, and some small klippes were recognized (Otatume, 1941; Takahashi *et al*., 2002).

The Yezo Group in the the Sanushube River upstream area can be divided into two formations, the Kashima and Hakobuchi formations in ascending order as defined by Matsumoto (1942a), Motoyama *et al*. (1991) and Takashima *et al*. (2004) (Figure 3). In the western part of the study area, these strata are cut by a major fault striking north to south direction (Figure 4). The Kashima Formation is composed of bioturbated massive mudstone and is distributed in the eastern and central parts of the study area. On the other hand, the overlying Hakobuchi Formation, which is composed of conglomerate, sandstone, muddy sandstone, sandy mudstone, and coal beds is distributed in the western part of the area. The Hakobuchi Formation can be subdivided into three lithostratigraphic units; HKa to HKc (Figures 3—6).

The Hakobuchi Formation is in fault contact with the Kashima Formation in the north of the study area (Shi-sanushube-sawa Creek), and the Eocene Poronai Formation in the south of the area (So-sanushube-sawa and Ino-sawa creeks) (Figure 4).

These strata are usually distributed in westward monoclinal structure. In the Shi-sanushube-sawa Creek, whereas striking N10° westward to N40° eastward and dips 40—90° westward, sometimes, the dips overturned 90—60° eastward. In the So-sanushube-sawa and Ino-sawa creeks, whereas striking N20—60° westward and dips overturned 10—70° eastward (Figure 4).

Kashima Formation (Motoyama *et al*., 1991)

The Kashima Formation is equivalent to the Upper Yezo Group of Matsumoto (1942a, 1954) in the Hobetsu area.

Distribution.— Upper course of the Shi-sanushube-sawa, So-sanushube-sawa, and Ino-sawa creeks and their tributaries (Figure 4).

Stratigraphic relationship.—The Kashima Formation is conformably overlain by the Hakobuchi Formation on the west side. The lower part of this formation is not observed.

Thickness.—More than 700 m in the Shi-sanushube-sawa, So-sanushube-sawa, and Ino-sawa creeks.

Lithology.—The formation consists mainly of dark gray, bioturbated massive mudstone (Figure 5). A few vitric tuff beds varying from 1 to 3 cm thick are intercalated in some horizons. Calcareous nodules are commonly contained in the mudstone. Siderite nodules are restrictedly contained in the upper part of the formation.

Megafossils.—Molluscan fossils abundantly occur

Figure 2. The plesiosaur Hobetsu-Araki-Ryu (HMG-1) and scenery of the study area. **A**. Reconstruction of HMG-1 (replica), **B**. Skelton of HMG-1. **C**. Excavation of HMG-1 in 1977. **D**. Locality of HMG-1 (loc. HO9446') in 2021. **E**. Loc. HO9414 in Shi-sanushube-sawa Creek, HKc of the Hakobuchi Formation in 2021.

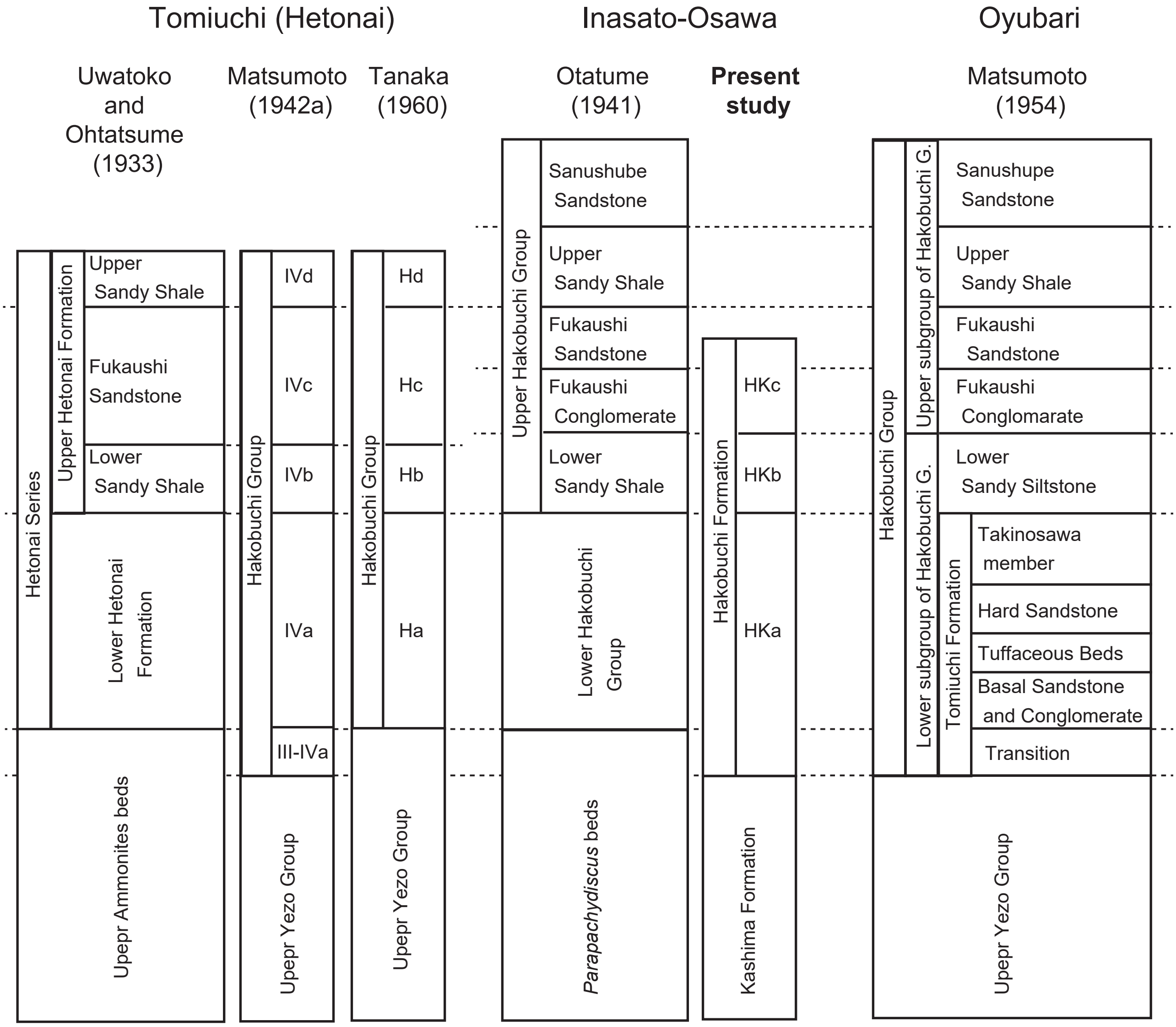

Figure 3. Comparison of lithostratigraphic divisions in the Tomiuchi, Inasato-Osawa (including the Sanushube River upstream area), and Oyubari areas of Upper Cretaceous.

from the lower to upper part of the formation (Figures 6—20). Megafossils are usually contained in calcareous nodules. The uppermost part of the formation contains siderite nodules with megafossils (e.g., *Inoceramus* (*Platyceramus*) *japonicus* Nagao and Matsumoto, 1940).

Tetragonites popetensis Yabe, 1903 was reported from Yabe (1903) from the *Pachydiscus* beds of Shi-sanushube-sawa (=Shi-sanushibe) Creek. *Baculites capensis* Woods, 1906 (UMUT MM7604, deposited in the University Museum, the University of Tokyo) was also reported from "*Parapachydiscus* beds" of the Shi-sanushube-sawa Creek in Yabe's collection (Matsumoto and Obata, 1963). *Anapachydiscus deccanensis yezoensis* Matsumoto, 1955 also reported from the same collection (Matsumoto, 1955, 1979). Such "*Pachydiscus* beds" and "*Parapachydiscus* beds" are interpreted as *Anapachydiscus* beds of the Upper Yezo Group (=the Kashima Formation in recent scheme) (Matsumoto, 1979).

A partial skeleton of a plesiosaur specimen (HMG-1, Hobetsu-Araki-Ryu) occurred from the loc. HO9446'

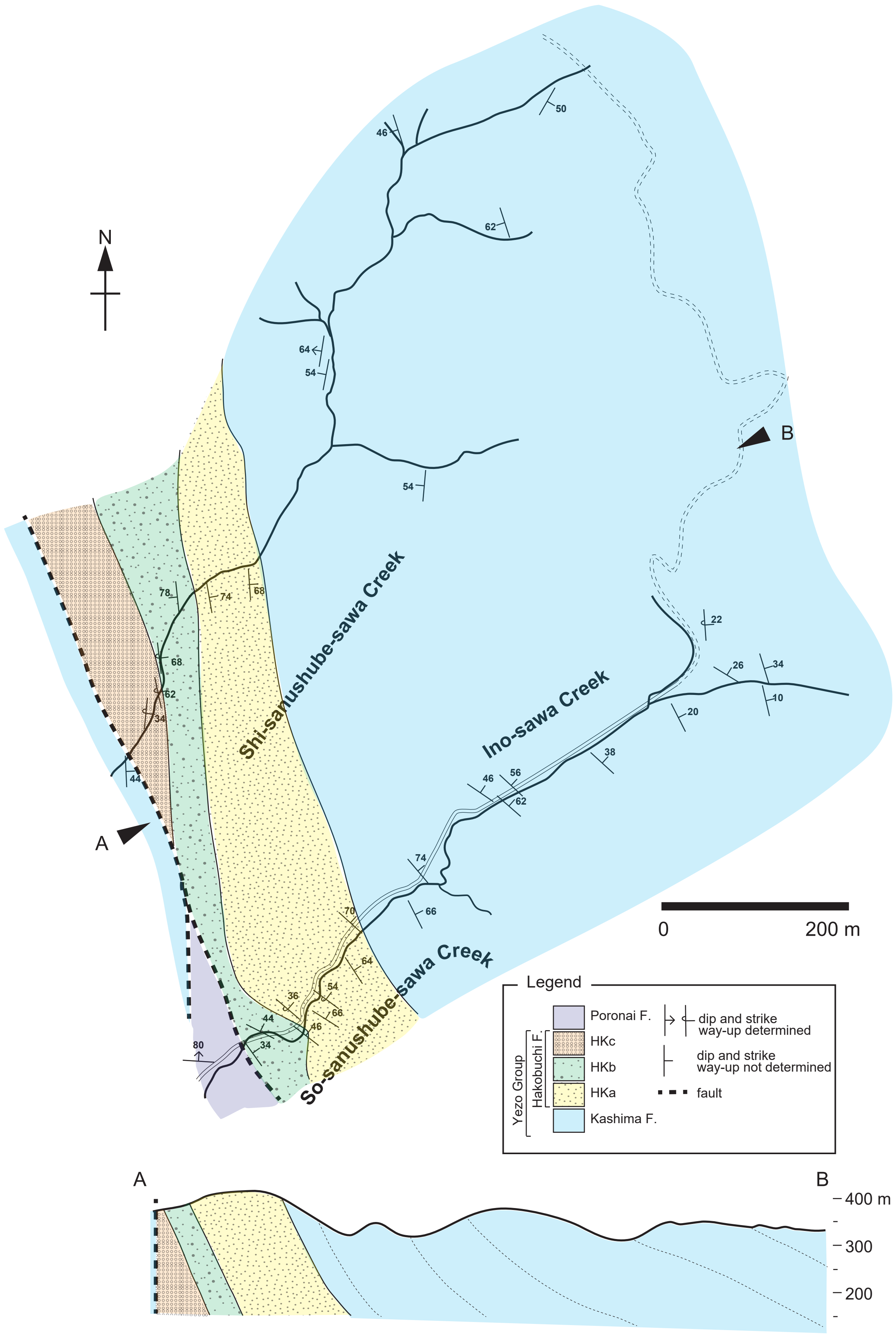

Figure 4. Geological map and cross section showing the study area.

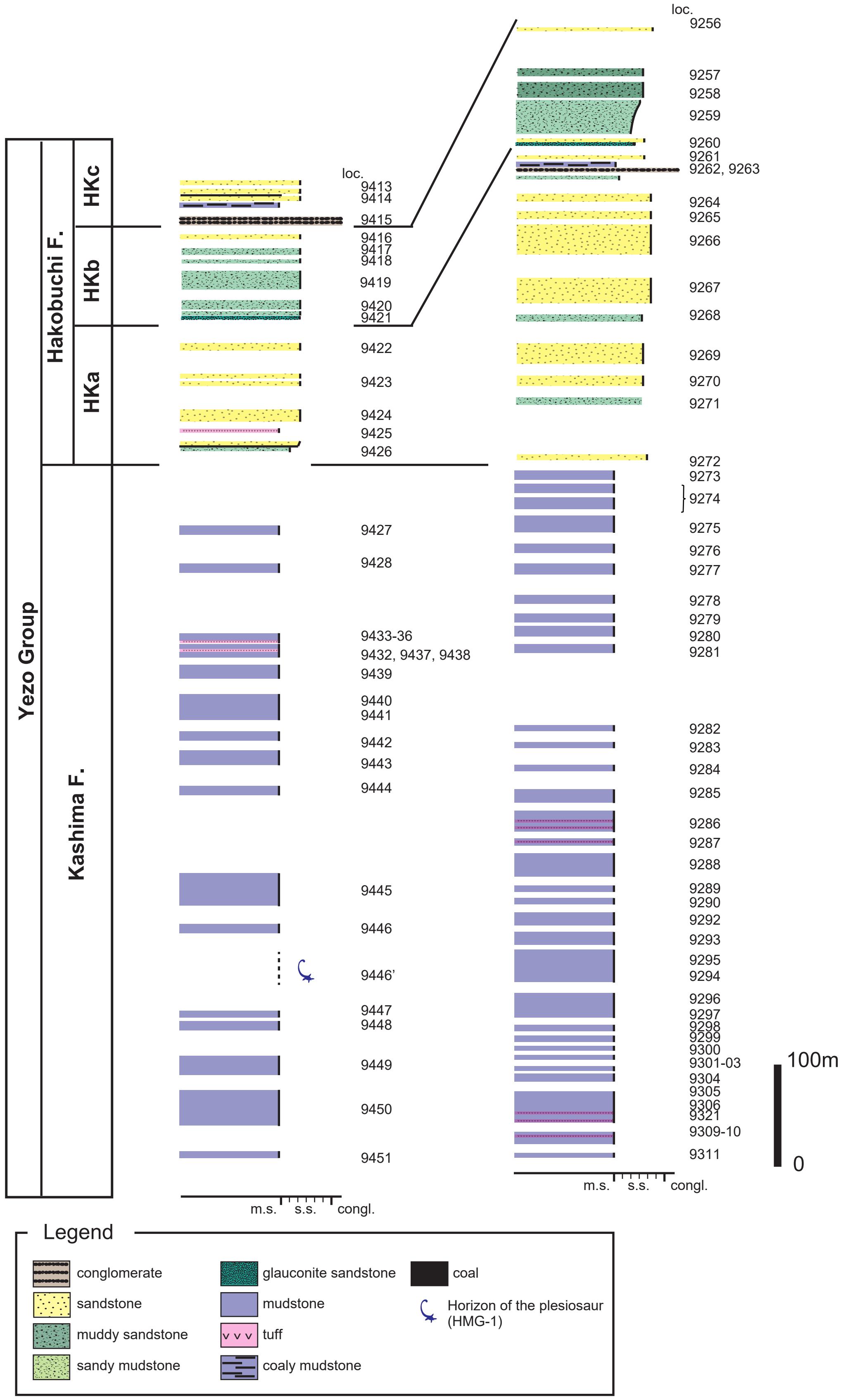

Figure 5. Column showing the study area. The column on the left is the Shi-sanushube-sawa Creek section, and that on the right is the So-sanushube-sawa and Ino-sawa creeks section. Locality no. prefix HO-.

in a tributary of Shi-sanushube-sawa Creek (Figures 2C, 2D, 4; Nakaya, 1989). A tooth of elasmobranchii co-occurred with the plesiosaur (Kuga, 1984). A partial skeleton (skull and cervical vertebrates) of a mosasaur *Tylosaurus* sp. (HMG-371) was collected from around loc. HO9439 in Shi-sanushube-sawa Creek as a float (Chitoku, 1994). This specimen was assigned to *Tylosaurus*? sp. in Sato *et al*. (2012).

Remarks.— Kaiho (1991) reported many benthic foraminifers from loc. SNS02 (= loc. HO9321) and SNS07 (= locs. HO9286—89) of Ino-sawa Creek and interpretation based on these faunas as an upper bathyal zone.

Hakobuchi Formation (Matsumoto, 1942a)

Hakobuchi Formation was demoted from the group-rank by Takashima *et al*. (2004). It is equivalent to the Hakobuchi Group of Matsumoto (1942a, 1954) in the Tomiuchi (Hetonai) and Oyubari areas, and Hakobuchi Formation of Takashima *et al*. (2004) in the Oyubari area.

Hakobuchi Formation is subdivided into several geological units separately by authors. Matsumoto (1942a) provided one of the most useful subdivisions. Previously, the boundary between IVb and IVc of Matsumoto (1942a) has been settled 10 m below the base of the Fukaushi conglomerate bed, e.g., in the Tomiuchi area (Matsumoto, 1942a) (Figure 3). In the Oyubari to Tomiuchi areas, the Fukaushi conglomerate bed overlies the Lower Sandy Siltstone or Lower Sandy Shale unit of the Hakobuchi Formation (Figure 3; Otatume, 1941; Matsumoto, 1954; Fujii, 1958; Nishimura and Komatsu, 2022) with an erosional surface. In this study, the Hakobuchi Formation is subdivided into newly defined three lithostratigraphic units; HKa, HKb and HKc, and the base of the HKc unit of the formation is defined as the erosional base of the Fukaushi conglomerate bed.

HKa Unit (new definition)

Distribution.— Shi-sanushube-sawa and So-sanushube-sawa creeks (Figure 4).

Stratigraphic relationship.— The HKa unit conformably overlies the Kashima Formation.

Thickness.— 150 m in the Shi-sanushube-sawa Creek and 250 m in the So-sanushube-sawa Creek.

Lithology.— The basal part of this unit (=III-IVa of Matsumoto, 1942a) is composed of bioturbated sandy mudstone. The main part of this unit is composed of fine to medium sandstone. The sandstone beds are fine to medium grained, and show upward coarsening sequence. A parallel laminated fine vitric tuff bed more than 2 m thick is intercalated in the lower part of this unit in the Shi-sanushube-sawa Creek (loc. HO9425).

Megafossils.— No megafossil were found from this unit.

Remarks.— This unit is equivalent to the combination of III-IVa and IVa of Matsumoto (1942a). This unit is also equivalent to the Tomiuchi Formation of Matsumoto (1954) (Figure 3).

HKb Unit (new definition)

Distribution.— Shi-sanushube-sawa and So-sanushube-sawa creeks (Figure 4).

Stratigraphic relationship.— The HKb unit conformably overlies the HKa unit. In the So-sanushube-sawa Creek, the uppermost part of this unit is in fault contact with the Eocene Poronai Formation.

Thickness.— 80 m in Shi-sanushube-sawa Creek and more than 150 m in So-sanushube-sawa Creek.

Lithology.— The basal part of this unit is composed of 7 m thick glauconitic sandstone with rounded granules. The main part of this unit is composed of very fine to fine bioturbated sandy mudstone. This sandy mudstone coarsens upward, and the uppermost part becomes fine sandstone.

Megafossils.—In the So-sanushube-sawa Creek, ammonoid *Neophylloceras hetonaiense* Matsumoto, 1942b, *Anagaudryceras compressum* Shigeta and Nishimura, 2014, *Patagiosites compressus* (Matsumoto, 1954), a nostoceratid fragment, probably identified to *Nostoceras* cf. *hetonaiense* Matsumoto, 1977a, and inoceramids *Inoceramus shikotanesis* Nagao and Matsumoto, 1940 occur (Figures 6, 21, 22).

Remarks.— This unit is equivalent to the Lower Sandy Shale of Otatume (1941) and the Lower Sandy Siltstone of Matsumoto (1954). This unit is almost equivalent to IVb by Matsumoto (1942a), and Hb by Tanaka (1960). The HKb unit includes the lowermost part of IVc (Matsumoto, 1942a) and Hc (Tanaka, 1960) (Figure 3).

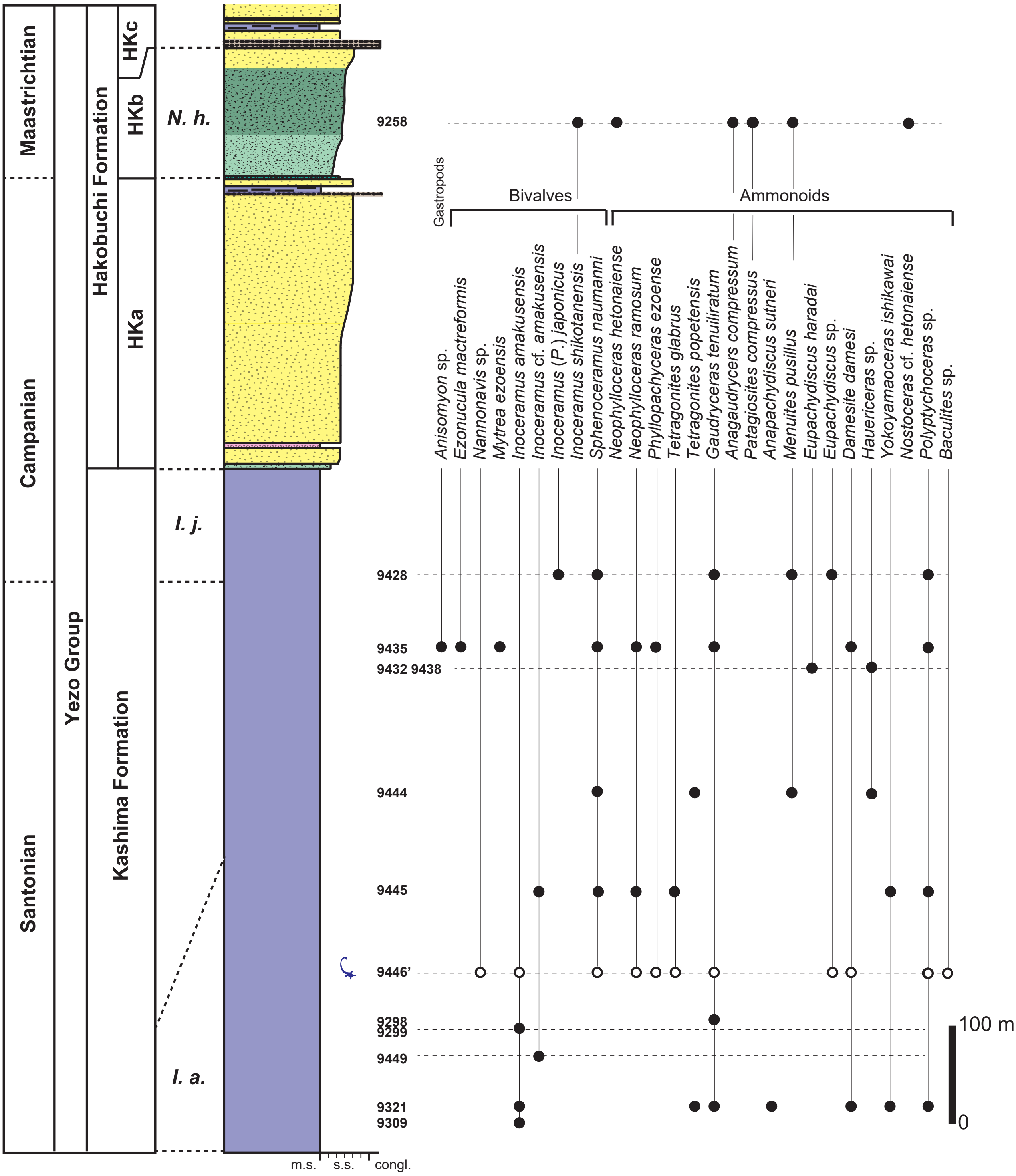

Figure 6. Stratigraphic occurrence of ammonoids, inoceramids, and other molluscs in the Kashima and the Hakobuchi formations in the Sanushube River upstream area. Solid circles are *in situ* occurrences. Open circles are possibly a float; derived from the same or slightly lower horizon. Legends are the same as Figure 5. Abbreviations: *I. a.* = *Inoceramus amakusensis* Zone; *I. j.* = *Inoceramus* (*Platyceramus*) *japonicus* Zone; *N. h.* = *Nostoceras hetonaiese* Zone.

HKc Unit (new definition)

Distribution.—Shi-sanushube-sawa Creek (Figure 4).

Stratigraphic relationship.— The HKc unit conformably overlies the HKb unit. The upper portion of this unit is in fault contact with the Kashima Formation in the Shi-sanushube-sawa Creek.

Thickness.—More than 50 m in Shi-sanushube-sawa Creek.

Lithology.— The basal part of this unit consists mainly of rounded pebbles in quarts and felspar rich medium-grained sandstone matrix and is called the Fukaushi conglomerate attaining 10 m thick (Figure 5). Coal seams, poorly sorted coaly mudstone, and arkose sandstones of 1-2 m thick are intercalated. The sandstones are parallel-laminated, or sometimes cross-laminated.

Megafossils.— No megafossil were found from this unit.

Remarks.— This unit is equivalent to the combination of Fukaushi Conglomerate and Fukaushi Sandstone of Otatume (1941) and Matsumoto (1954). This unit is almost equivalent to IVc of Matsumoto (1942a), and Hc of Tanaka (1960). The base of the HKc unit is moved to the base of the Fukaushi Conglomerate of Otatume (1941, 1943) (Figure 3).

Results

The present study follows the ammonoid- and inoceramid biostratigraphic scheme by Toshimitsu *et al*. (1995) combined with the Campanian subdivision by Shigeta *et al*. (2016, 2019).

Biostratigraphy of Kashima Formation

The lower portion of the Kashima Formation exposed along the Ino-sawa Creek upstream contains *Inoceramus amakusensis* Nagao and Matsumoto, 1940 and associate ammonoids (*Gaudryceras tenuiliratum* Yabe, 1903, *Anapachydiscus sutneri* (Yokoyama, 1890)) (Figures 6—9, 13; e.g., locs. HO9299, 9304, 9309, and 9321). This horizon is correlated to the Santonian *Inoceramus amakusensis* Zone (Figure 6).

Around the locality of a plesiosaur Hobetsu-Araki-Ryu (loc. HO9446’, Figure 2C, 2D), shell fragments probably identified to *Inoceramus amakusensis* (here I express *I*. cf. *amakusensis*; locs. HO9445 and 9449), *Sphenoceramus naumanni* (Yokoyama, 1890), and several ammonoids occur (Figure 6, loc. HO9445).

In the excavation of the plesiosaur in 1977, many megafossils were collected, and deposited in the Hobetsu Museum. *Inoceramus amakusensis* and associated ammonoids are newly identified from this collection (Figures 8, 11, 12, 18—20). These indicate the Santonian *I*. *amakusensis* Zone. In addition, *Damesites damesi* (Jimbo, 1894) with smooth shell ornament and flat flanks is discriminated (HMG-781, Figure 20B—D). This form usually occurs from the Ug to Ui-j units in the Haboto-Tappu area, northern Hokkaido, and indicates the upper Santonian to lower Campanian (T. Nishimura, pers. comm., 2024). Although these fossils are not closely associated with the skeleton of a plesiosaur, many floated calcareous nodules derived probably from the same or slightly lower horizon were found in this small creek. Thus, the plesiosaur horizon is probably correlated to the *Inoceramus amakusensis* Zone (Figure 6).

From the upper part of Kashima Formation (e.g., loc. HO9432, 9435, and 9438), *Sphenoceramus naumanni*, *Gaudryceras tenuiliratum* Yabe, 1903, and *Eupachydiscus haradai* (Jimbo, 1894) occur (Figure 6). Bivalves *Ezonucula mactreformis* (Nagao, 1932) and *Mytrea ezoensis* (Nagao, 1932), and gastropods *Anisomyon* sp. also occur from the same horizon (Figure 6). Many ammonoids occasionally occur with wood particles (Figure 20A). These inoceramids and ammonoids commonly occur from Santonian *Inoceramus amakusensis* and lower Campanian *Inoceramus* (*P*.) *japonicus* zones (Figure 6).

The uppermost part of the Kashima Formation is also fossiliferous. In this horizon, inoceramids and ammonoids occur from brown nodules, probably composed of siderite. In this horizon, *Inoceramus* (*P*.) *japonicus*, *Sphenoceramus naumanni*, *Gaudryceras tenuiliratum*, and *Polyptychoceras* sp. are common. This horizon is correlated to the Lower Campanian *I*. (*P*.) *japonicus* Zone (Figure 6).

Takahashi *et al*. (2002) mentioned distribution of the Cenomanian Inasato Formation, the Middle Yezo Group in the eastern area of the study area, i.e., the upstream of the Shi-sanushube-sawa and Ino-sawa creeks. However, the corresponding strata should be correlated to the Kashima Formation, because of the similarity of lithofacies (bioturbated mudstone) and the occurrence of Santonian *Inoceramus amakusensis* (Figure 9B, HMG-2477—2479, loc. HO9309).

Biostratigraphy of Hakobuchi Formation

In the Hakobuchi Formation, megafossils are generally few in most horizons. The HKb unit in So-sanushube-sawa Creek yields *Inoceramus shikotanensis*, *Anagaudryceras compressum*, and *Patagiosites compressus* occurred (Figures 21, 22). This association is the same as that of IVb in the southern part of the Hobetsu area; *Nostoceras hetonaiense* Zone and/or *Pachydiscus* (*Neodesmoceras*) *japonicus* Zone (Matsumoto, 1942a; Shigeta and Nishimura, 2014).

Discussion

Geological age of the plesiosaur Hobetsu-Araki-Ryu

Santonian *Inoceramus amakusensis* and Lower Campanian *I.* (*P.*) *japonicus* zones are recognized in the Kashima Formation of the Sanushube River upstream area (Figure 6). The horizon of the plesiosaur, Hobetsu-Araki-Ryu is located below the lower Campanian *Inoceramus* (*P.*) *japonicus* Zone (Figure 6). Around the plesiosaur horizon, fragmental specimens (HMG-2497, 2498, Figures 8B, 9C) identified to *I.* cf. *amakusensis* occur from the levels both above and below. The plesiosaur horizon seems to be correlated to the upper Santonian just below the Santonian/Campanian boundary by inoceramids.

On the other hand, texanitine ammonoids are good stage-diagnostic for the Santonian to lower Campanian subdivision in the northwest Pacific province (Toshimitsu, 1988; Toshimitsu *et al.*, 1995). However, these taxa occur sporadically in the province (e.g., Toshimitsu, 1988), and no texanitine ammonoid was collected in the present study. Most associated ammonoids are long-ranging species, and it is impossible to determine strictly either the upper Santonian or lower Campanian by themselves.

Planktonic foraminifers occurring with the plesiosaur roughly suggest the same result as the ammonoid and inoceramid biostratigraphy. *Globotruncana arca* (Cushman, 1926) which also occurs from the plesiosaur horizon (Kito *et al.*, 1986) has been treated as an index of the base of the Campanian (e.g., Hancock and Gale, 1996). Nishi *et al.* (2003) considered that the Santonian/Campanian boundary is placed within the *G. arca* Interval Zone based on the data from Moriya *et al.* (2001). The age of *G. arca* Interval Zone is assigned to the late Santonian to the early Campanian. From the viewpoint of inoceramid biostratigraphy, the first appearance datum (FAD) of *I.* (*P.*) *japonicus* is treated as the Santonian/Campanian boundary (Toshimitsu *et al.*, 1995). *G. arca* has not been found with *I. amakusensis* but found from above the last appearance datum (LAD) of *I. amakusensis* (Moriya *et al.*, 2001). In contrast, the result of the present study suggested the possibility of *G. arca* and *I. amakusensis* occurring from the same horizon. However, *I.* cf. *amakusensis* (HMG-2498, Figure 9C) from just above the horizon of the plesiosaur is too fragmental. It is difficult to determine the detailed relationship between the LAD of *I. amakusensis*, the FAD of *G. arca*, and the FAD of *I.* (*P.*) *japonicus*. The plesiosaur horizon is assigned to around the Santonian/Campanian boundary, the upper Santonian, and is roughly concordant to inoceramid, ammonoid, and planktonic foraminifers biostratigraphy.

Many radiolarian fossils were also reported from the horizon of the plesiosaur Hobetsu-Araki-Ryu (Kito *et al.*, 1986). The detailed result from the megafossil biostratigraphy of the present study slightly conflicts with previous radiolarian biostratigraphy. Kito *et al.* (1986) estimated the Campanian age of the plesiosaur horizon by compilation of overlapping ranges of the radiolarian assemblages (=concurrent-range zone) based on biostratigraphic schemes outside the northwest Pacific province (Campbell and Clark, 1944; Pessagno, 1963; Empson-Morin, 1981, 1984). However, ranges of such radiolarian species are variable and do not necessarily show concurrent occurrence (Kito *et al.*, 1986). Thus, the detailed radiolarian biostratigraphy from the Santonian to Campanian should be revised and updated.

The *Inoceramus* (*Platyceramus*) *japonicus* Zone has been correlated to the upper Santonian before the 1980s (Matsumoto, 1959, 1977b). Several biostratigraphic studies argued that the *I.* (*P.*) *japonicus* Zone should be shifted upward to the lower Campanian (Matsumoto

Figure 7. *Inoceramus amakusensis* Nagao and Matsumoto, 1940, HMG-2495 from loc. HO9299 of the Kashima Formation.

Figure 8. Inoceramids from the Kashima Formation. **A**. *Inoceramus amakusensis* Nagao and Matsumoto, 1940, HMG-802, from a float concretion found from loc. HO9446'. **B**. *Inoceramus* cf. *amakusensis* Nagao and Matsumoto, 1940, HMG-2497 from loc. HO9449.

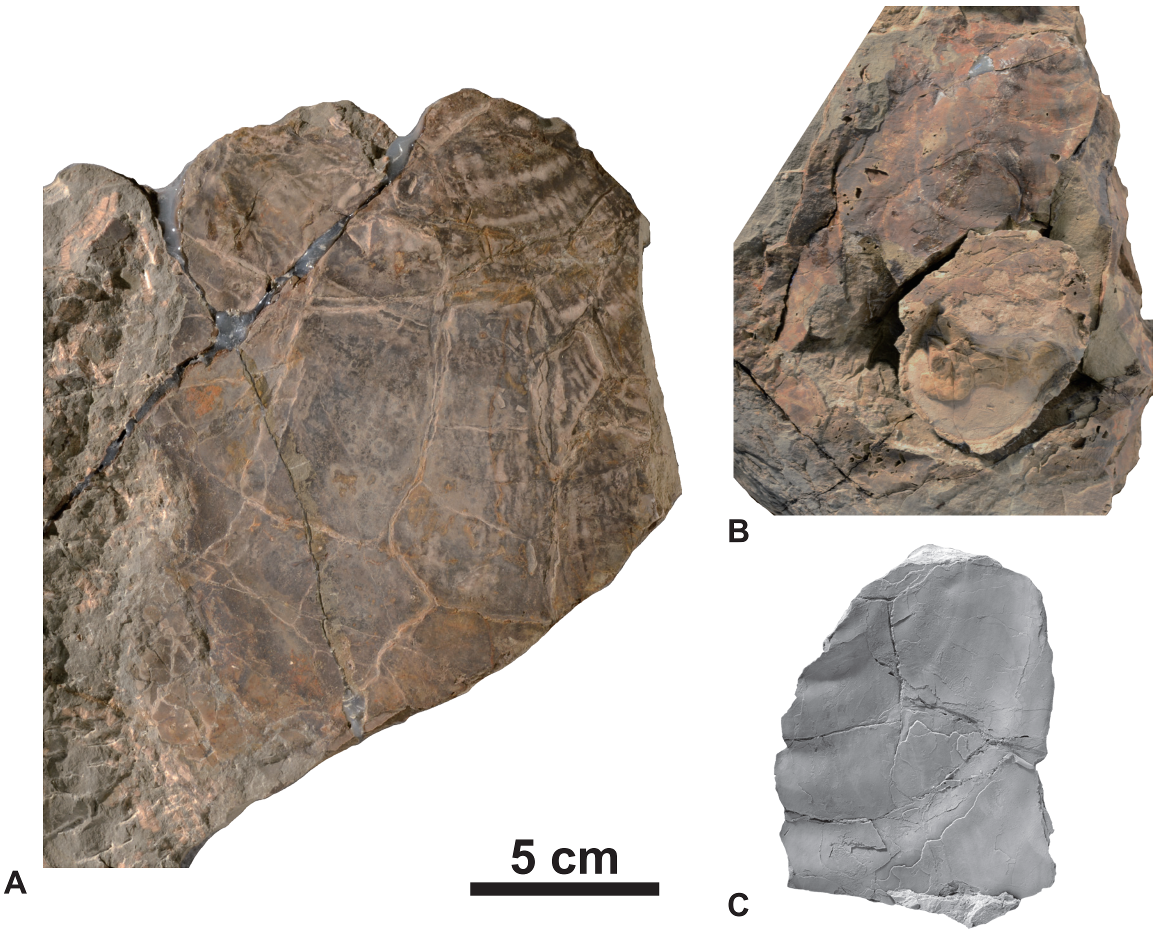

Figure 9. Inoceramids from the Kashima Formation. **A**. *Inoceramus amakusensis* Nagao and Matsumoto, 1940, HMG-2480, from loc. HO9321. **B**. *Inoceramus amakusensis* Nagao and Matsumoto, 1940, HMG-2477, from loc. HO9309. **C**. *Inoceramus* cf. *amakusensis* Nagao and Matsumoto, 1940, HMG-2498 from loc. HO9445.

and Tashiro, 1982; Matsumoto and Takahashi, 1986; Matsumoto *et al*., 1988; Toshimitsu, 1988; Moriya *et al*., 2001). Kito *et al*. (1986) followed the biostratigraphic scheme by Matsumoto (1959) and assigned the plesiosaur Hobetsu-Araki-Ryu horizon to the lower Campanian. Lower Campanian of the 1980s should have been correlated to *Sphenoceramus orientalis* and/or *S. schmidti* zones. In the Tomiuchi area, southern Hobetsu, *S. orientalis* and *S. schmidti* occur from the Hakobuchi Formation (= previously ranked as Hakobuchi Group) (Matsumoto, 1942a), but both inoceramids never occur from the Kashima Formation (=Upper Yezo Group). Such discrepancy of correlation had remained for a long time. The present study and updated the ammonoid-, inoceramid-, and planktonic foraminiferal biostratigraphical schemes (e.g., Toshimitsu *et al*., 1995; Nishi *et al*., 2003; Shigeta *et al*., 2019) cleared the problem.

Patagiosites compressus as a newly defined index fossil in lowest Maastrichtian

Inoceramus shikotanensis (Figure 21A) commonly occurs from the HKb unit in the So-sanushube-sawa Creek. The species ranges from the upper Campanian to lower Maastrichtian (Matsumoto, 1942a; Morozumi, 1985; Toshimitsu *et al*., 1995, Matsunaga *et al*., 2008, Shigeta and Izukura, 2018). On the other hand, *I. shikotanensis* often co-occurs with *Patagiosites compressus* (Figures 6, 22). The latter species has not been known from the upper Campanian, and allied species, *Patagiosites alaskensis* Jones, 1963 and *P. laevis* Morozumi, 1985 occur from Hokkaido and southwest Japan (Morozumi, 1985; Shigeta and Izukura, 2018). Therefore, *P. compressus* is useful to determine the lowest Maastrichtian as well as the *Nostoceras hetonaiense*, *Pachydiscus* (*Neodesmoceras*) *japonicus* Matsumoto, 1947, and *Gaudryceras hobetsense* Shigeta and Nishimura, 2013.

Figure 10. *Inoceramus* (*Platyceramus*) *japonicus* Nagao and Matsumoto, 1940, HMG-2542, from a float siderite concretion found from loc. HO9438. This specimen is derived from the uppermost part of the Kashima Formation, because of the siderite concretion.

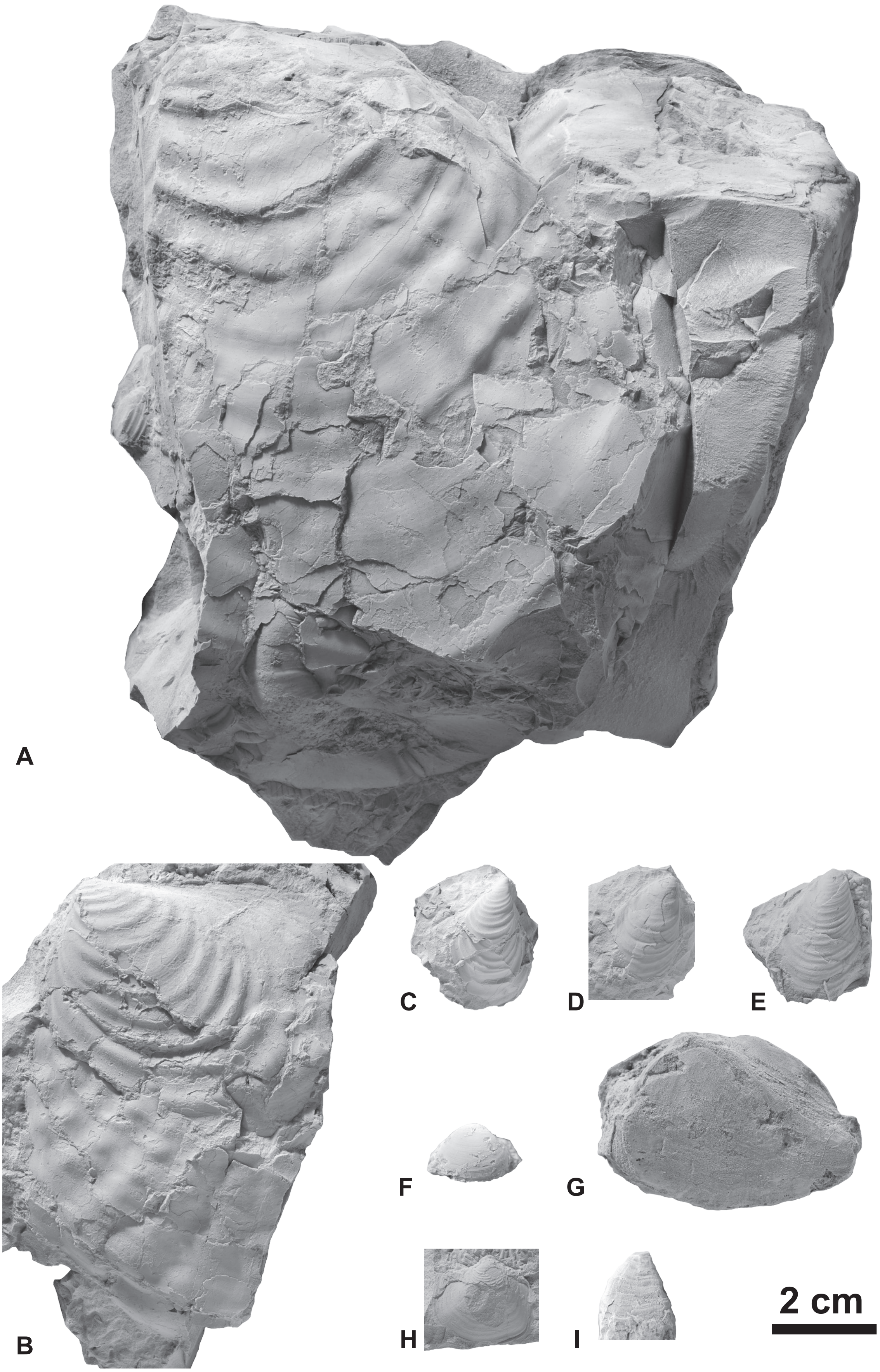

Figure 11. Bivalves and gastropods from the Kashima Formation. **A**, **B**. *Inoceramus* (*Platyceramus*) *japinicus* Nagao and Matsumoto, 1940, from loc. HO9428. A. HMG-2544. B. HMG-2545. **C**—**E**. *Sphenoceramus naumanni* (Yokoyama, 1890). C. HMG-2549, from loc. HO9428. D. HMG-2519, from loc. HO9444. E. HMG-794, from a float concretion found from loc. HO9446'. **F**. *Ezonucula mactreformis* (Nagao, 1932), HMG-2529, from loc. HO9435. **G**. *Nannonavis* sp., HMG-805, from a float concretion found from loc. HO9446'. **H**. *Mytrea ezoensis* (Nagao, 1932), HMG-2531, from loc. HO9435. **I**. *Anisomyon* sp., HMG-2527, from loc. HO9431.

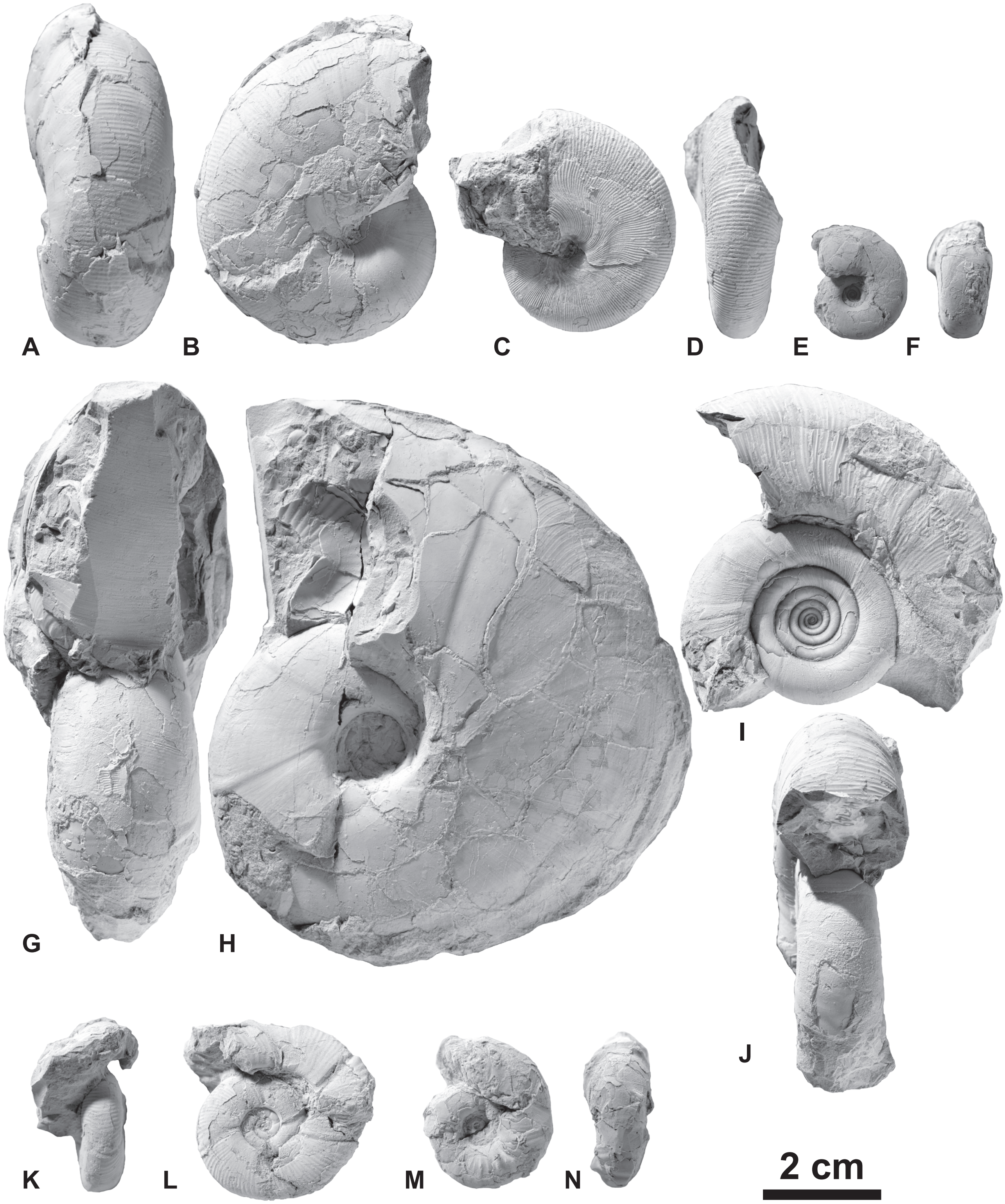

Figure 12. Ammonoids from the Kashima Formation. **A**, **B**. *Phyllopachyceras ezoense* (Yokoyama, 1890), HMG-759, from a float concretion found from loc. HO9446'. **C**, **D**. *Neophylloceras ramosum* (Meek, 1858), HMG-756, from a float concretion found from loc. HO9446'. **E**, **F**. *Tetragonites popetensis* Yabe, 1903. HMG-2521, from loc. HO 9444. **G**, **H**. *Tetragonites glabrus* (Jimbo, 1894), HMG-772, from a float concretion found from loc. HO9446'. **I**, **J**. *Gaudryceras tenuiliratum* Yabe, 1903, HMG-749, from a float concretion found from loc. HO9446'. **K**, **L**. *Yokoyamaoceras ishikawai* (Jimbo, 1894), HMG-2492, from loc. HO9321. **M**, **N**. *Menuites pusillus* Matsumoto, 1955, HMG-2522, from loc. HO9444.

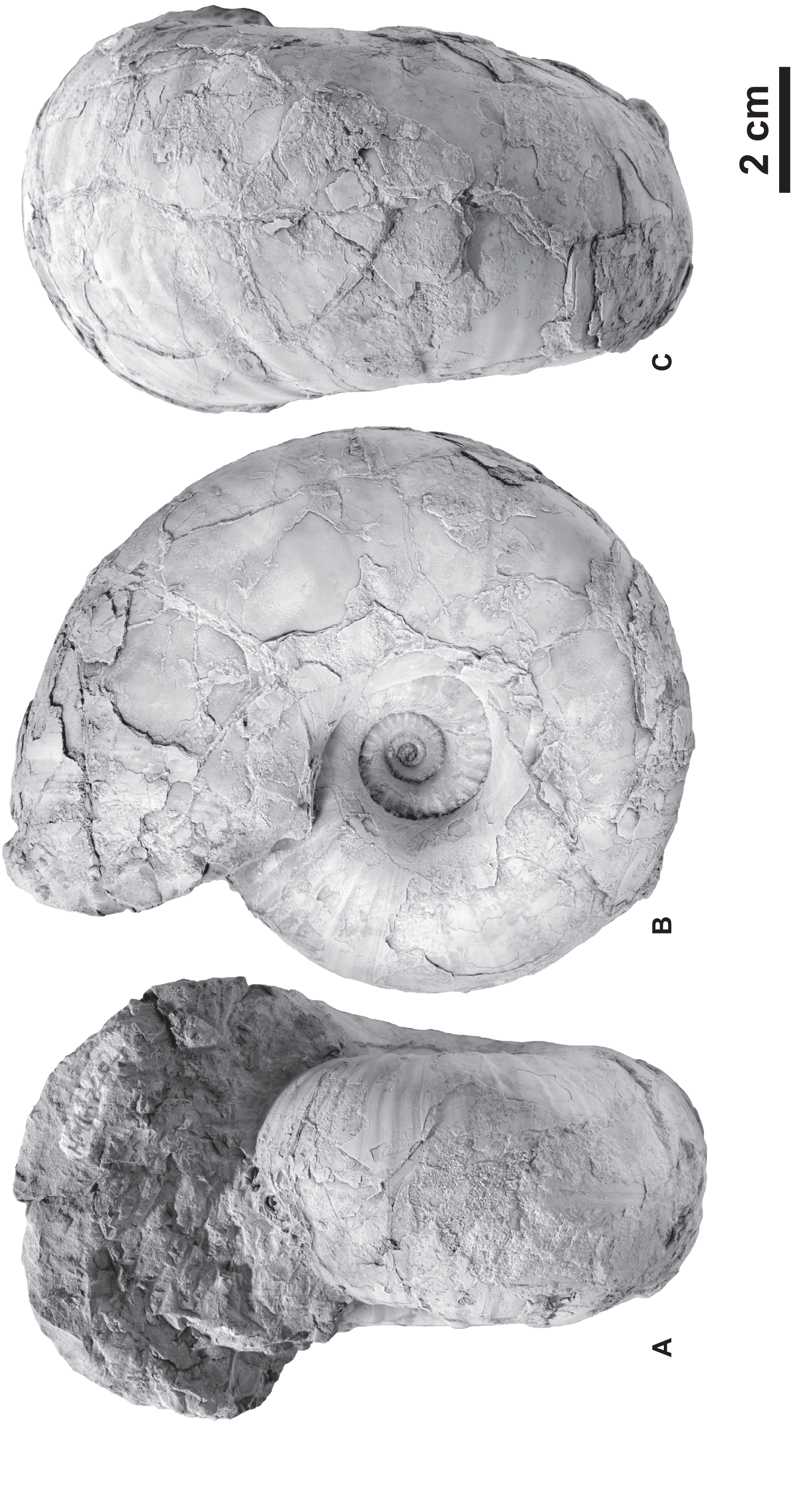

Figure 13. *Anapachydiscus sutneri* (Yokoyama, 1890), HMG-2402 from loc. HO9321 of the Kashima Formation.

Figure 14. *Eupachydiscus haradai* (Jimbo, 1894), HMG-2524a from loc. HO9432 of the Kashima Formation.

Figure 15. *Eupachydiscus haradai* (Jimbo, 1894), HMG-2524a. The same specimen as Figure 14.

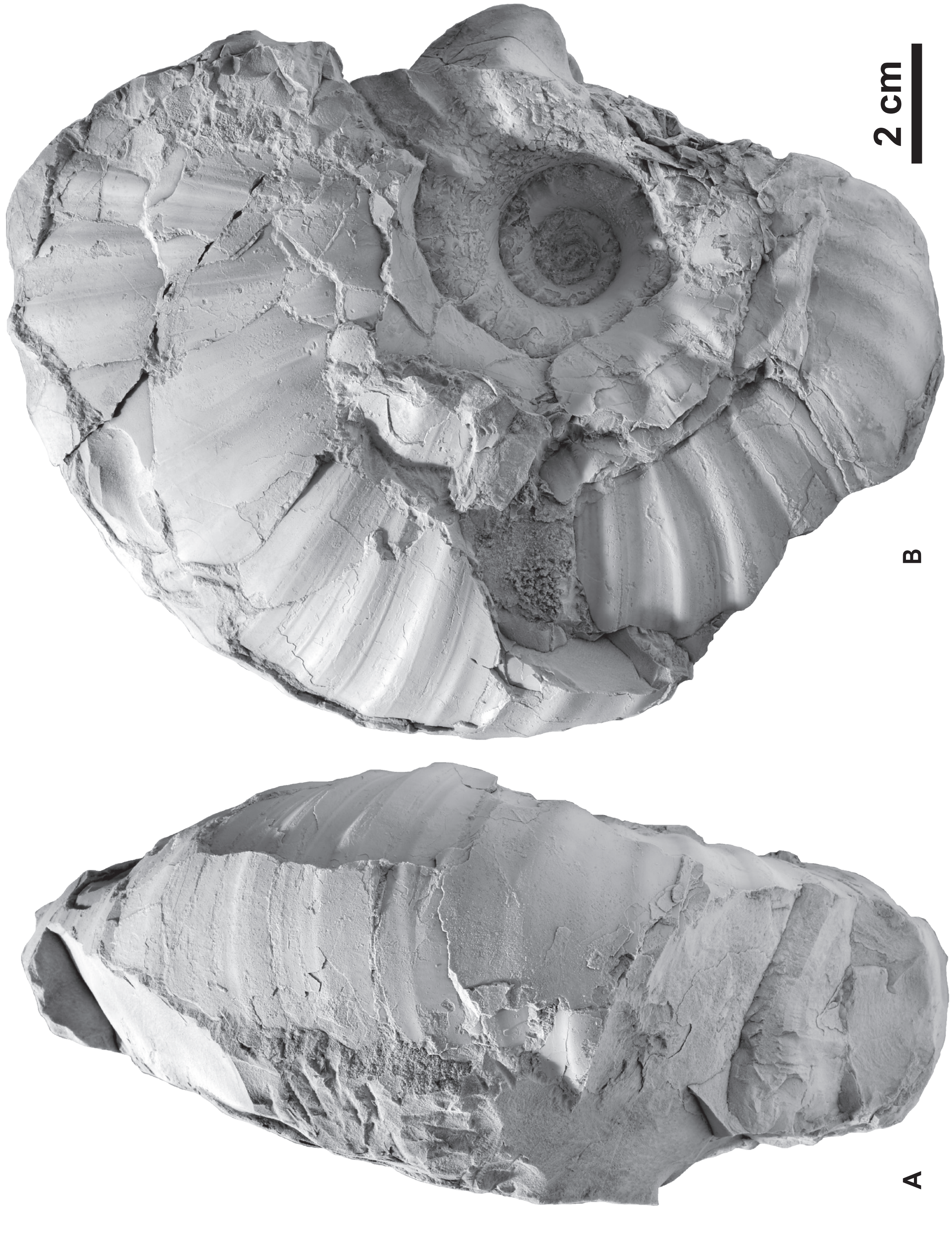

Figure 16. *Eupachydiscus haradai* (Jimbo, 1894), HMG-2525 from loc. HO9438 of the Kashima Formation.

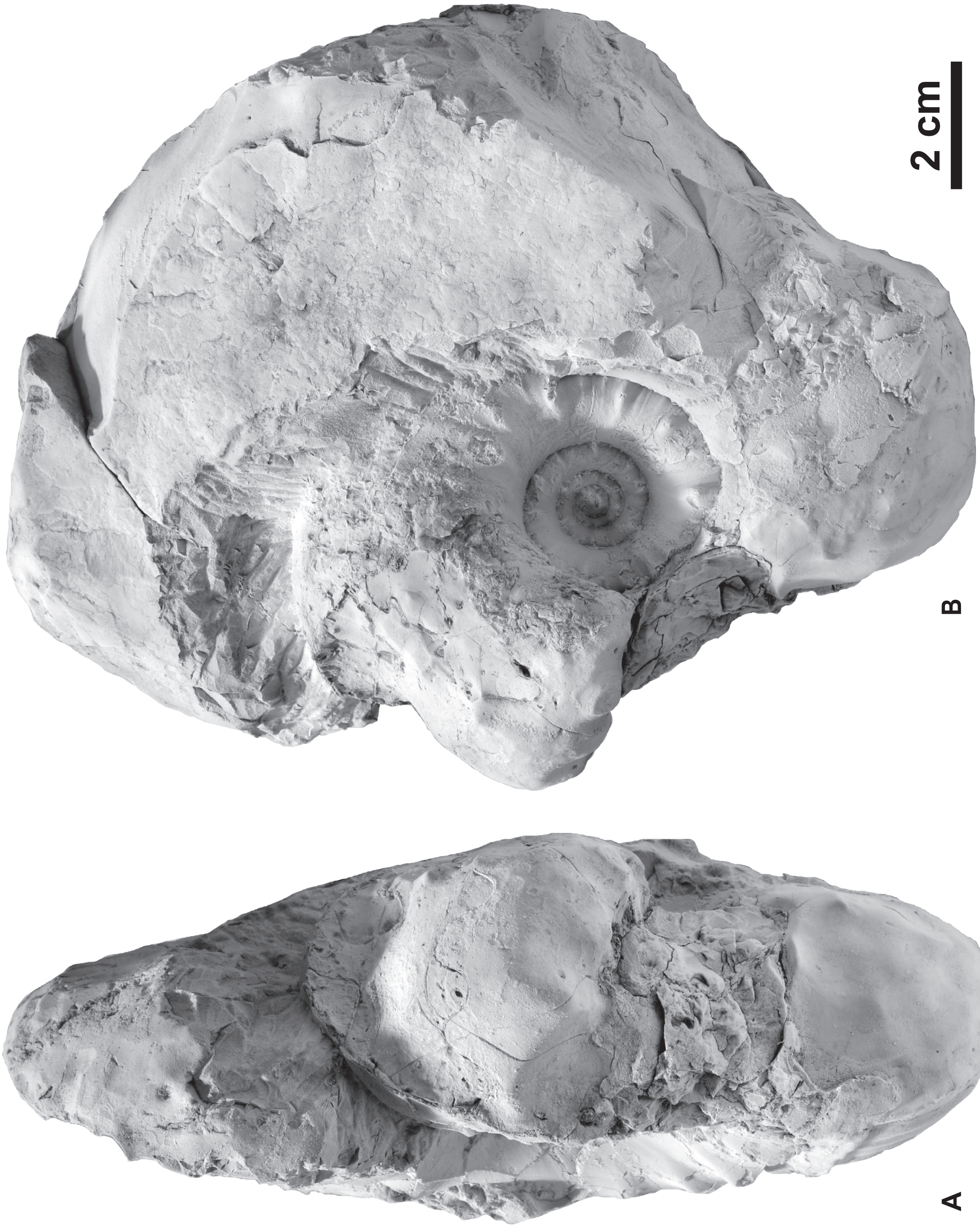

Figure 17. *Eupachydiscus haradai* (Jimbo, 1894), HMG-2525. The same specimen as Figure 16.

Figure 18. *Eupachydiscus* sp., HMG-776, from a float concretion found from loc. HO9446' of the Kashima Formation.

Figure 19. *Eupachydiscus* sp., HMG-777, from a float concretion found from loc. HO9446' of the Kashima Formation.

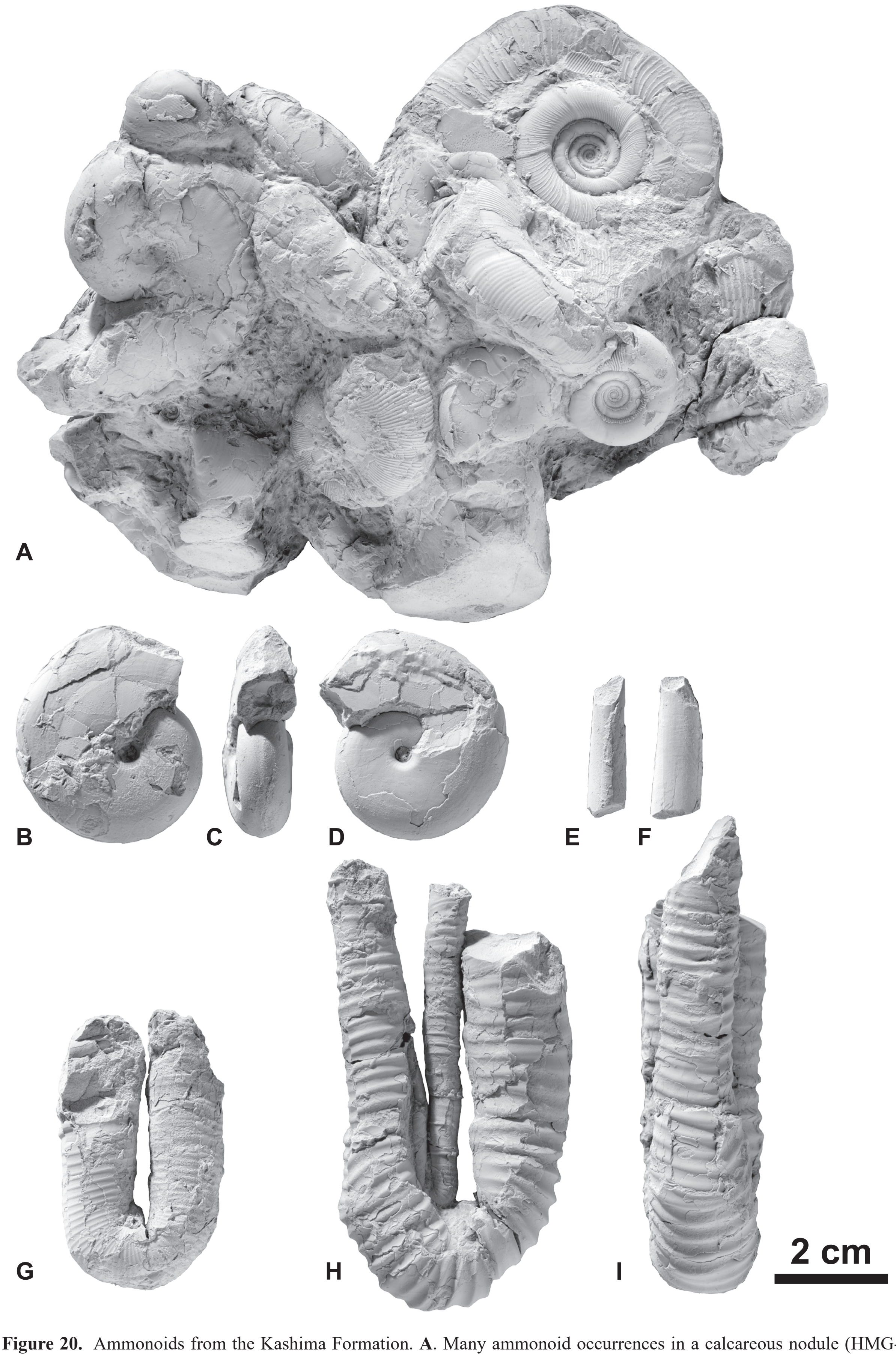

Figure 20. Ammonoids from the Kashima Formation. **A**. Many ammonoid occurrences in a calcareous nodule (HMG-2526) from loc. HO9435. *Neophylloceras ramosum*, *Phyllopachyceras ezoense*, *Gaudryceras tenuiliratum*, and *Damesites damesi* are included. **B**—**D**. *Damesites damesi* (Jimbo 1894), HMG-781, from a float concretion found from loc. HO9446’. **E**, **F**. *Baculites* sp., HMG-778, from a float concretion found from loc. HO9446’. **G**. *Polyptychoceras* sp., HMG-782, from a float concretion found from loc. HO9446’. **H**, **I**. *Polyptychoceras* sp., HMG-2553, from loc. HO9428.

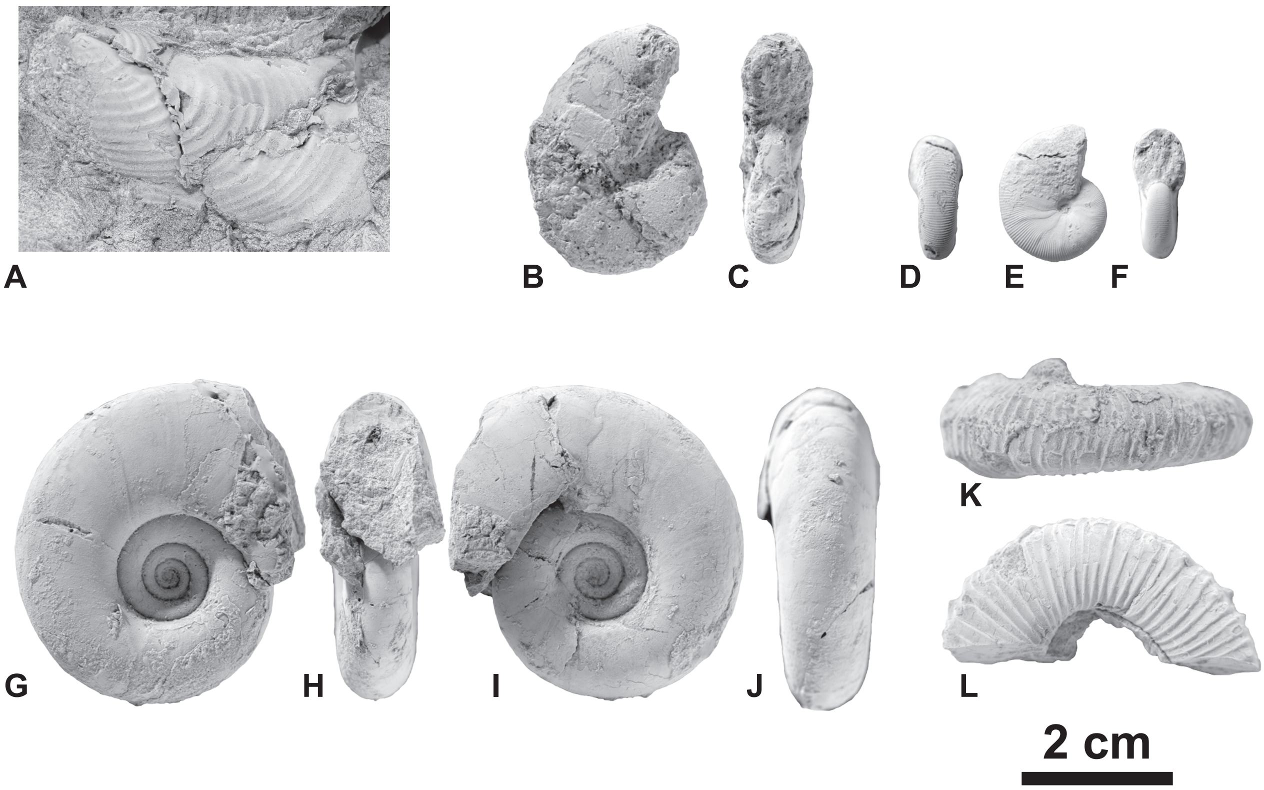

Figure 21. Inoceramids and ammonoids from loc. HO9258 of the Hakobuchi Formation. **A**. *Inoceramus shikotanensis* Nagao and Matsumoto, 1940, HMG-2555. **B**—**F**. *Neophylloceras hetonaiense* Matsumoto, 1942b. B, C. HMG-2556. E—F. HMG-2557. **G**—**J**. *Anagaudryceras compressum* Shigeta and Nishimura, 2014, HMG-2558. **K**, **L**. A fragment of nostoceratid ammonoids, probably identified *Nostoceras* cf. *hetonaiense* Matsumoto, 1977a, HMG-2562.

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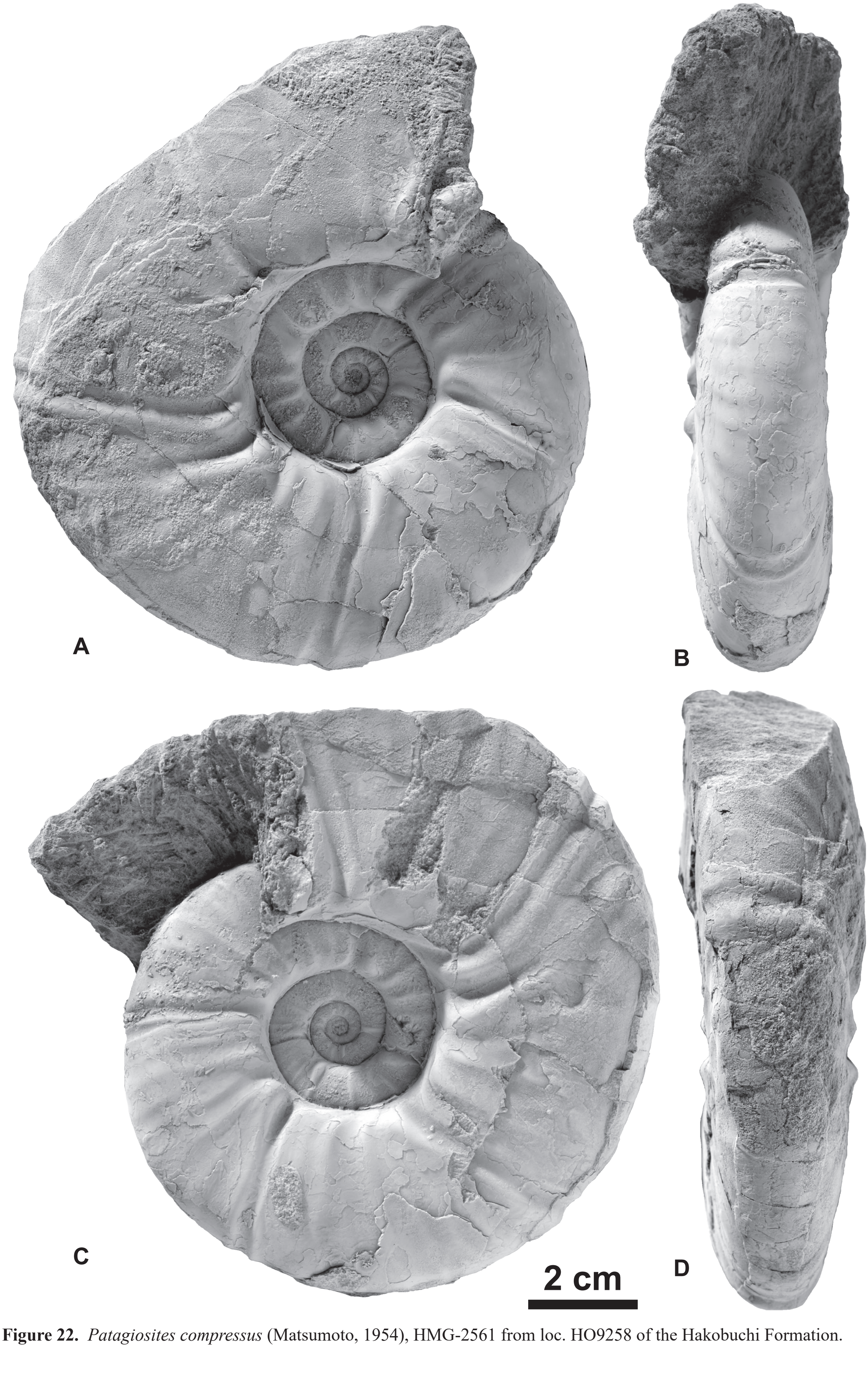

Figure 22. *Patagiosites compressus* (Matsumoto, 1954), HMG-2561 from loc. HO9258 of the Hakobuchi Formation.

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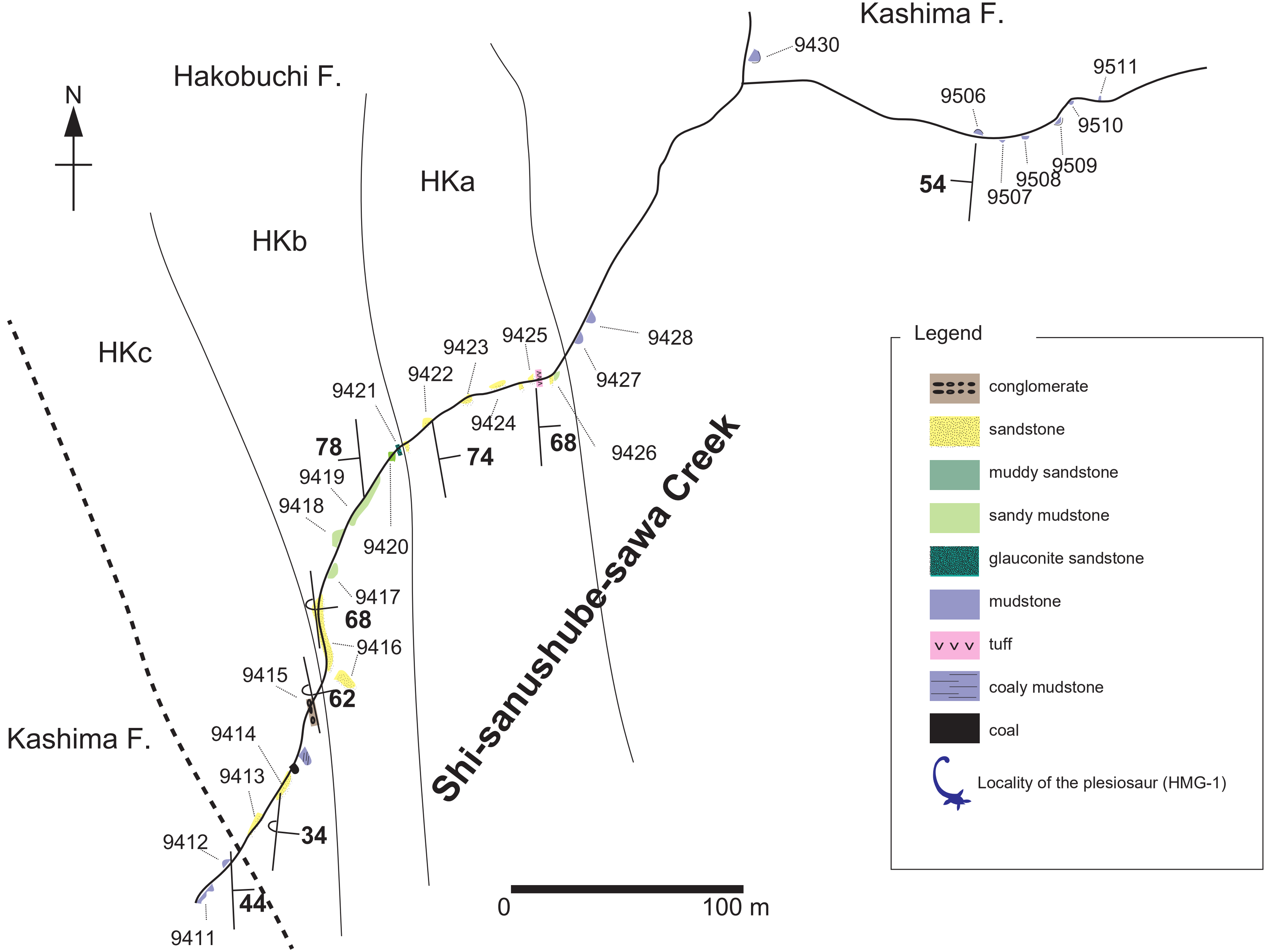
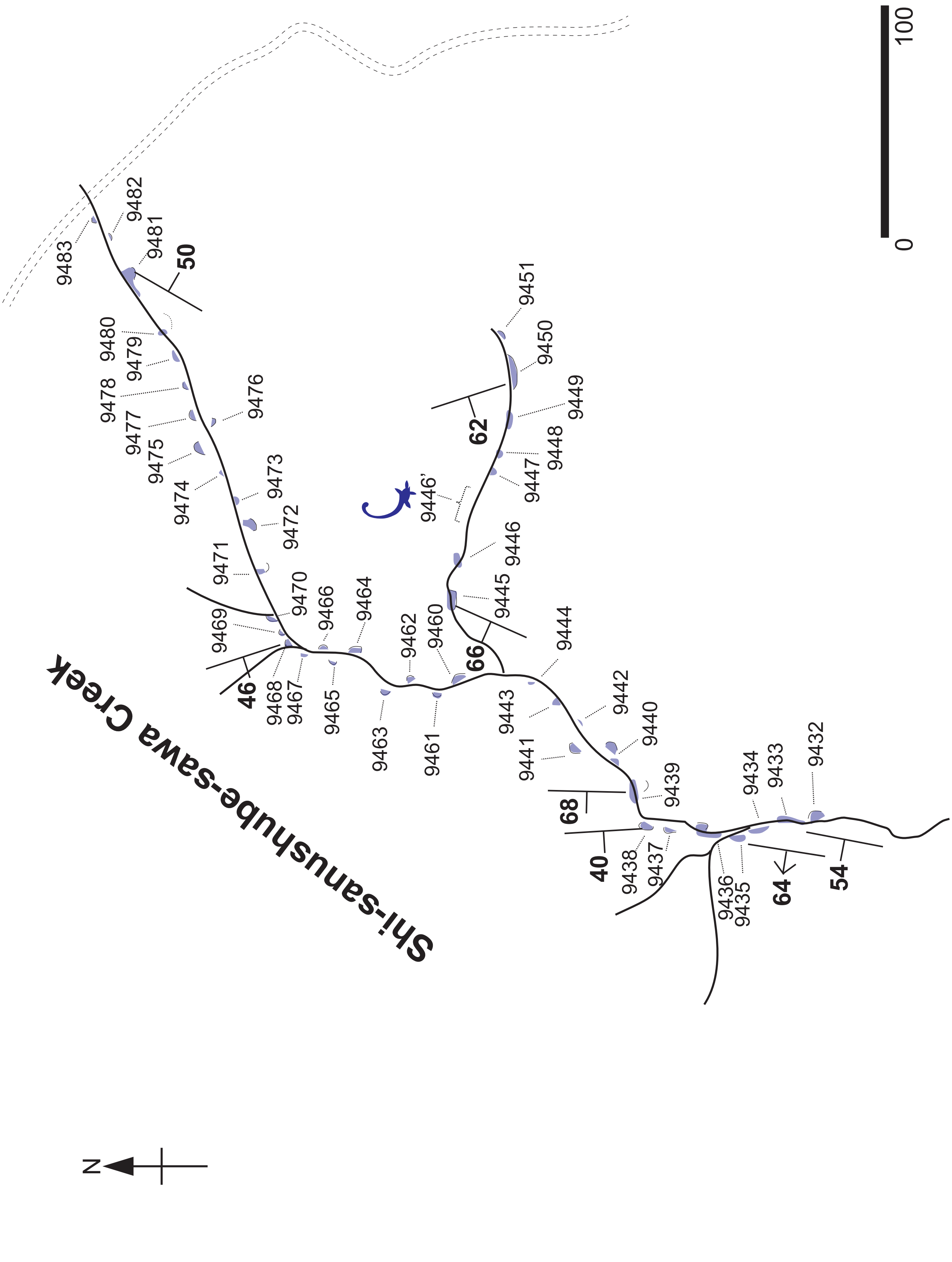
（要　旨）

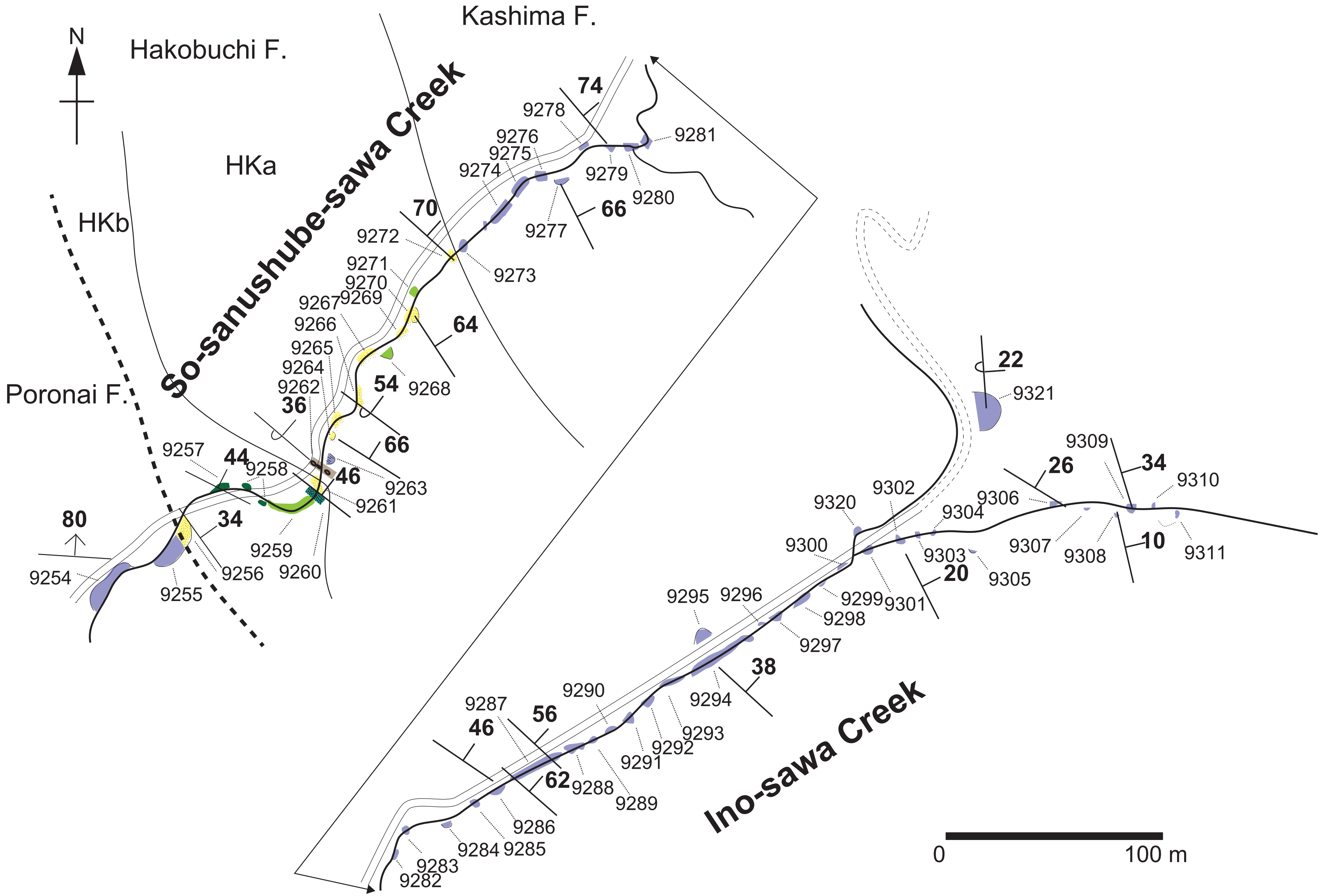
北海道むかわ町穂別長和地域のシサヌシュベ川上流域に分布する白亜系蝦夷層群の地質・大型化石層序を調べた．この地域には蝦夷層群鹿島層と函淵層，および始新統幌内層が分布する．鹿島層にはサントニアン階 *Inoceramus amakusensis* 帯および下部カンパニアン階 *I.* (*Platyceramus*) *japonicus* 帯，函淵層の HKb ユニットには下部マーストリヒチアン階の *Nostoceras hetonaiense* 帯の化石が産出する．この地域の鹿島層から産出するクビナガリュウ類ホベツアラキリュウ標本（HMG-1）は *I.* (*P.*) *japonicus* の初産出層準であるサントニアン / カンパニアン境界よりも下位のサントニアン階上部から産出したことが新たに明らかになった．加えて函淵層から産出するアンモナイト *Patagiosites compressus* が最下部マーストリヒチアン階の示準化石になりうることを示した．



Appendix 1. Locality map along the Shi-sanushube-sawa Creek. Locality no. prefix HO-. Shi- of Shi-sanushube-sawa means "real" in the Ainu words.



Appendix 2. Locality map along the Shi-sanushube-sawa Creek 2. Locality no. prefix HO-. Legends are the same as Appendix 1.



Appendix 3. Locality map along the So-sanushube-sawa and Ino-sawa creeks. Locality no. prefix HO-. So- of So-sanushube-sawa means "fall" in the Ainu words. Legends are the same as Appendix 1.