

A new species of the heteromorph ammonoid *Phylloptychoceras* from the lowest Maastrichtian of Hokkaido, Japan

YASUNARI SHIGETA¹ AND TOMOHIRO NISHIMURA²

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

²Hobetsu Museum, 80-6, Hobetsu, Mukawa, Hokkaido 054-0211, Japan

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Abstract. A new Cretaceous heteromorph ammonoid, *Phylloptychoceras horitai* sp. nov., is described from the lowest Maastrichtian of Hokkaido, Japan. Its shell is ornamented with very weak, broadly rounded ribs and its suture line is characterized by a deeply incised, trifid dorsal lobe and three bifid lateral saddles with minor indentations. This occurrence suggests that *Phylloptychoceras* evolved in the North Pacific during late Campanian or early Maastrichtian time and then achieved worldwide distribution during late Maastrichtian time.

Key words: ammonoid, Cretaceous, Hokkaido, Maastrichtian, *Phylloptychoceras*, *Polyptychoceras*

Introduction

Phylloptychoceras Spath, 1953, a genus belonging to the family Diplomoceratidae Spath, 1926, is one of the trombone-shaped heteromorph ammonoids of the Late Cretaceous. Complete specimens are unknown, but its shell most likely consists of several straight, parallel shafts with U-shaped whorls connecting the successive shafts, very similar to the allied genus *Polyptychoceras* Yabe, 1927. The genus is monospecific and its type species *Ph. sipho* was described by Forbes (1846) from the Upper Maastrichtian of Pondicherry, southern India. Specimens assigned to this genus are also known from the upper Campanian or lower Maastrichtian of California (Anderson, 1958) and the upper Maastrichtian of Europe and Chile (Stinnesbeck, 1986; Birkelund, 1993; Ward and Kennedy, 1993; Jagt *et al.*, 2006).

Early Maastrichtian ammonoids are fairly abundant in outcrops of the Hakobuchi Formation in the Hobetsu area of south-central Hokkaido, and over the past 65 years, nearly ten species of ammonoids have been described (Matsumoto, 1947, 1954, 1977, 1979, 1984a; Matsumoto and Saito, 1954; Shigeta, 1989; Matsumoto and Toshimitsu, 1992, 1995, 1996; Shigeta *et al.*, 2010; Shigeta and Nishimura, 2013). Recently, Yoshiyuki Horita (Mukawa, Hokkaido) collected several fragments

referable to *Phylloptychoceras* from the Hakobuchi Formation (lowest Maastrichtian) in the Hobetsu area. We herein describe these specimens as a new species of *Phylloptychoceras* and discuss the origin and evolution of this taxon.

Notes on stratigraphy

Outcrops of the Hakobuchi Formation, which are widely distributed in the Hobetsu area, make this region one of the best reference sections of the uppermost Cretaceous in the North Pacific realm (Matsumoto, 1942, 1954; Tanaka, 1960). Representing the uppermost member of the Yezo Group, the formation consists mainly of sandstone and has been divided into four lithologic units, IVa–IVd (Matsumoto, 1942) or Ha–Hd (Tanaka, 1960). With regard to lithology, the units of each scheme are essentially identical, differing only by letter designation.

Unit IVa, composed mainly of sandstone associated with conglomerate, sandy mudstone and coal beds, contains the Campanian index inoceramid bivalve *Shenoceras schmidtii* (Michael, 1899) in its middle part (Tanaka, 1960). Unit IVb, dominated by sandy mudstone, contains *Nostoceras hetonaiense* Matsumoto, 1977 and *Pachydiscus japonicus* Matsumoto, 1947, both of which are indicative of the lowest Maastrichtian

(Matsumoto, 1947, 1954, 1977; Tanaka, 1960). Unit IVc, consisting of sandstone with intercalations of conglomerate and sandy mudstone beds, contains a late early Maastrichtian fossil assemblage in its upper part, which includes *Pachydiscus kobayashii* (Shimizu, 1935), *P. gracilis* Matsumoto, 1979, *Gaudryceras izumiense* Matsumoto and Morozumi, 1980, and *Sphenoceramus hetonaianus* (Matsumoto, 1952) (Matsumoto, 1979; Matsumoto and Toshimitsu, 1992; Matsumoto *et al.*, 1993; Shigeta *et al.*, 2010). Unit IVd is composed mainly of unfossiliferous sandy mudstone.

The specimens upon which we based our new species of *Phylloptychoceras* were obtained from a float calcareous concretion that most likely came from exposures of the Unit IVb sandy mudstone along the banks of the Tonai-sawa River in the Hobetsu area.

Paleontological description

Systematic descriptions follow the classification established by Wright *et al.* (1996). Morphological terms in the systematic description are those used in the *Treatise on Invertebrate Paleontology* (Moore, 1957).

Institution abbreviations.—HMG = Hobetsu Museum, Mukawa, Hokkaido.

Superfamily Turrilitoidea Gill, 1871
Family Diplomoceratidae Spath, 1926
Genus *Phylloptychoceras* Spath, 1953

Type species.—*Ptychoceras siphon* Forbes, 1846.

Remarks.—Howarth (1965, p. 368) and Wright *et al.* (1996) treated *Phylloptychoceras* as a subgenus of *Polyptychoceras*, but Jagt *et al.* (2006) pointed out that both genera can be clearly distinguished by differences in ornamentation and the suture line. Thus, *Phylloptychoceras* is characterized by its deeply incised, trifid dorsal lobe and the same style of low, broad uniform ribbing. We agree with this interpretation and treat it as an independent genus.

Spath (1953, p. 16) included in his new genus *Phylloptychoceras* the type species *Ptychoceras siphon* from southern India and *Ph. zelandicum* Marshall, 1926 from New Zealand, but his generic diagnosis was based entirely on the type species. Henderson (1970) restudied the taxonomy of *Ph. zelandicum* and recognized that the characters of the shell and suture line did not match the generic diagnosis of *Phylloptychoceras*; he then proposed a new genus *Astreptoceras* based on *Ph. zelandicum*, which exhibits a bifid dorsal lobe.

Phylloptychoceras horitai sp. nov.

Figures 1, 2

Types.—Holotype, HMG-1587a; paratypes, three specimens, HMG-1587b, c, d. Type specimens were extracted from a float calcareous concretion found in the Tonai-sawa River (42°43'41.8"N, 142°14'12.4"E), a branch of the Saru River, in the Hobetsu area.

Diagnosis.—*Phylloptychoceras* with very weak, broadly interspaced ribs and simple suture line with deeply incised, trifid dorsal lobe and three bifid lateral saddles with minor indentations.

Etymology.—Named after Yoshiyuki Horita, who collected the specimens.

Description.—Holotype, HMG-1587a (Figure 1M–P), a fragment of phragmocone consisting of a straight shaft (46.0 mm long) and a portion of a U-shaped whorl adjoined at its adapical end that exhibits a very slowly increasing diameter and a nearly circular cross section. Ornamentation consists of very weak, broadly interspaced, radial or slightly prorsiradiate ribs and a constriction on the adapical end. Suture line simple with deeply incised, trifid dorsal lobe, bifid ventral lobe, and three narrow-stemmed, bifid lateral saddles with many small indentations (Figure 1Q).

HMG-1587b (Figure 1E–H), a fragment of phragmocone consisting of a straight shaft (46.5 mm long) and part of a U-shaped whorl at its adoral end. Adapical portion of shaft varies slightly from its straight course. Ornamentation consists of very weak, low, broadly rounded ribs. Suture line pattern same as holotype.

HMG-1587c (Figure 1A–D), a very short (18 mm long) straight fragment consisting mostly of body chamber with the last septum and very weak ornamentation.

HMG-1587d (Figure 1I–L), a fragment of body chamber consisting of straight shaft (85.0 mm long) adjoined with a U-shaped whorl at its adoral end, followed by a short, straight shaft (25 mm long), thus forming a hook. Whorl section nearly circular. Ornamentation consists of low, broadly interspaced ribs, which are very weak and transverse on dorsum, strong, straight and feebly prorsiradiate on flanks, and weak and transverse on venter. Ribs become much weaker and more crowded on U-shaped whorl and then disappear on short shaft.

Comparison.—*Phylloptychoceras horitai* sp. nov. is very close to *Ph. siphon* (Forbes, 1846), but differs by its much weaker and denser ribs and much simpler suture line. It resembles *Cyrtoptychoceras undulatus* (Forbes, 1846) in having low, broadly interspaced ribs. However, the latter has a single curved shaft, while the former possesses straight shafts and U-shaped whorls. This new species is similar to *Polyptychoceras pseudogaultinum* (Yokoyama, 1890) in having the trombone-like shell and

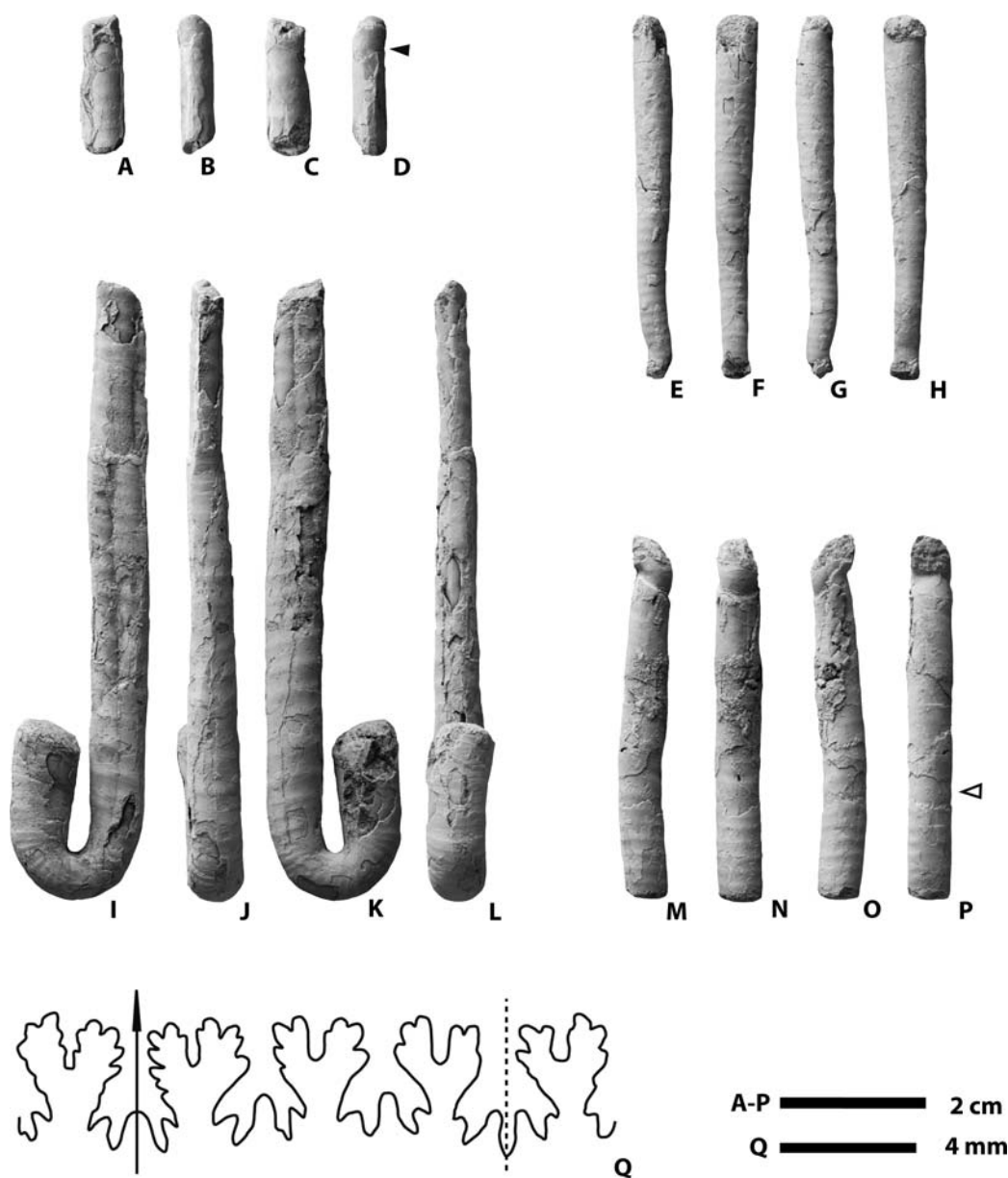


Figure 1. *Phylloptychoceras horitai* Shigeta and Nishimura sp. nov., from the Hobetsu area, Hokkaido. **A–D**, HMG-1587c, paratype; **A**, lateral view; **B**, ventral view; **C**, lateral view rotated 90 degrees from **B**; **D**, dorsal view, showing the position of the last septum (black arrow); **E–H**, HMG-1587b, paratype; **E**, lateral view; **F**, ventral view; **G**, lateral view rotated 90 degrees from **F**; **H**, dorsal view; **I–L**, HMG-1587d, paratype; **I**, lateral view; **J**, ventral view; **K**, lateral view rotated 90 degrees from **J**; **L**, frontal view; **M–P**, HMG-1587a, holotype; **M**, lateral view; **N**, ventral view; **O**, lateral view rotated 90 degrees from **N**; **P**, dorsal view; **Q**, suture line of holotype, taken at white arrow in view (**P**). Solid line represents the siphuncle, and broken line indicates the middle dorsal position.

broadly interspaced ribs (Okamoto and Shibata, 1997), but is easily distinguished by its deeply incised, trifid dorsal lobe (Figure 1Q). *Poly. pseudogaultinum* has a slightly incised, trifid dorsal lobe (Yokoyama, 1890, pl. 20, fig. 2a).

Discussion.—The four specimens described here were collected from a single calcareous concretion, and even

though they were not connected to each other, the compact nature of their occurrence in the concretion suggests that they probably belong to the same individual (Figure 2).

Parts of U-shaped whorls are observable on the adapical end of HMG-1587a and the adoral end of HMG-1587b, and since these shafts were preserved adjacently

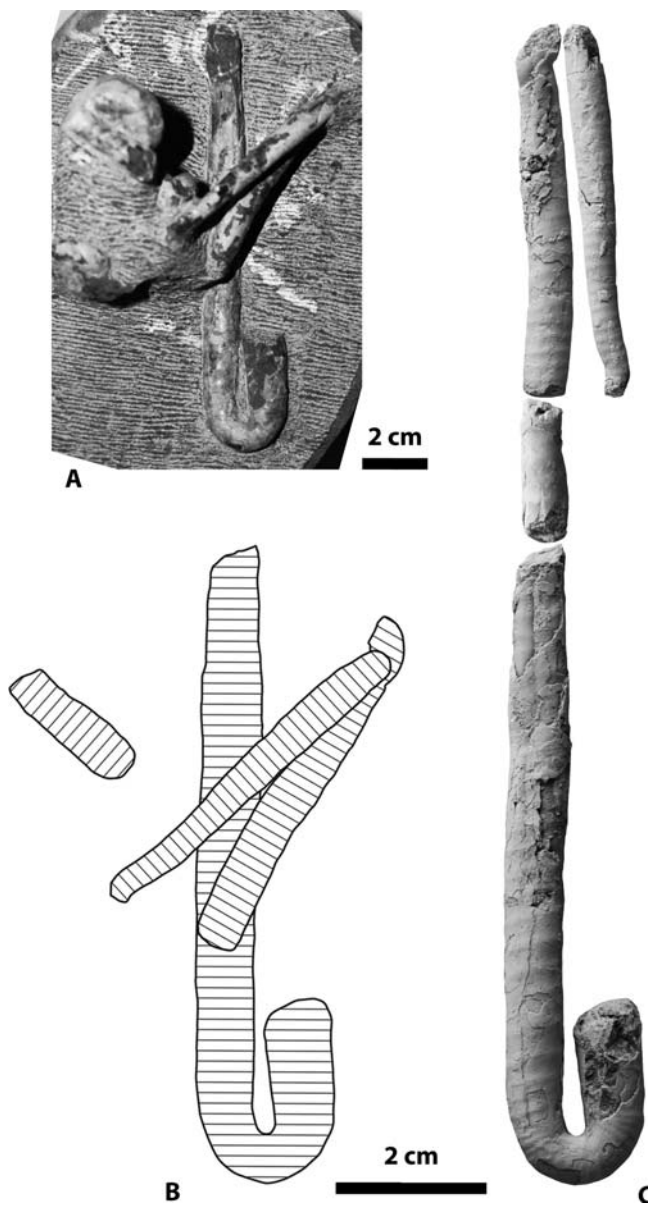


Figure 2. *Phylloptychoceras horitai* Shigeta and Nishimura sp. nov., HMG-1587a–d, from the Hobetsu area, Hokkaido. **A**, mode of occurrence in a calcareous concretion; **B**, diagrammatic sketch; **C**, reconstruction of the shell.

in the concretion, they most likely were connected to each other before fragmentation. Specimen 1587c probably connected the adoral end of HMG-1587a with the adapical end of body chamber HMG-1587d, because the last septum is observable in HMG-1587c. If they did connect with each other in this manner, then the straight shaft is at least 155 mm long (Figure 2).

Occurrence.—HMG-1587a–d were found in a float calcareous concretion together with *Tetragonites terminus*

Shigeta, 1989 (HMG-1588) and *Damesites hetonaiensis* Matsumoto, 1954 (HMG-1589). Although the exact horizon from which the concretion originated is uncertain, judging from the locality where it was found, its lithology and co-occurring fossils, it almost certainly came from the sandy mudstone of Unit IVb of the Hakobuchi Formation, which can be correlated with the *Nostoceras hetonaiense* Zone of earliest Maastrichtian age (Toshimitsu *et al.* 1995).

Discussion

Early species of *Phylloptychoceras* are restricted to the North Pacific realm. Anderson (1958) described a small specimen as *Neocyrtochilus bryani* from the upper Campanian or lower Maastrichtian of California. Although the suture line, one of the most significant diagnostic characters, has never been illustrated, it was apparently assigned to *Phylloptychoceras* only on the basis of its similar shell morphology and ornamentation (Kennedy and Henderson, 1992). This evidence plus the fact that *Ph. horitai* sp. nov. occurs in the lowest Maastrichtian of Hokkaido suggests that *Phylloptychoceras* probably originated in the North Pacific realm during late Campanian or early Maastrichtian time.

Among the family Diplomoceratidae, *Phylloptychoceras* and *Polyptychoceras* share a trombone-shaped shell, oblique ribs, a lack of tuberculation, and a simple suture line with a trifold dorsal lobe (Wright *et al.*, 1996), all of which suggest a close phylogenetic relationship (Spath, 1953). Several species of *Polyptychoceras* occur in the Coniacian to upper Campanian of Hokkaido (Yokoyama, 1890; Jimbo, 1894; Yabe, 1927; Wright and Matsumoto, 1954; Matsumoto, 1977, 1984b; Matsumoto and Nihongi, 1979; Okamoto and Shibata, 1997) and the upper Santonian and lower Campanian on Vancouver Island (Whiteaves, 1879). Notwithstanding the occurrence of *Polyptychoceras* in the upper Campanian or basal Maastrichtian of Angola (Howarth, 1965) and the reported occurrence of questionable fragments from the upper Santonian to Campanian of northern Germany (Schlüter, 1872; Wiedmann, 1962) and the upper Campanian of Graham Land of the Antarctic Peninsula (Spath, 1953), the flourishing of *Polyptychoceras* and appearance of early species of *Phylloptychoceras* in the North Pacific realm suggests that *Phylloptychoceras* originated from *Polyptychoceras* in this province. The suggestion seems to be supported by the morphological similarity between *Ph. horitai* sp. nov. and *Poly. pseudogaultinum*.

Reports of *Phylloptychoceras* from the upper Maastrichtian of Europe (Birkelund, 1993; Ward and Kennedy, 1993; Jagt *et al.*, 2006), southern India (Forbes, 1846; Kennedy and Henderson, 1992) and Chile

(Stinnesbeck, 1986) suggest that this genus most likely extended its geographical distribution during late Maastrichtian time. Although the occurrence of this late Maastrichtian taxon in the North Pacific realm has not yet been accurately documented, the late Maastrichtian ammonoid fauna of the Northwest Pacific does include certain pandemic species, i.e., *Zelandites varuna* (Forbes, 1846) and *Pseudophyllites indra* (Forbes, 1846), which contrasts with the early Maastrichtian ammonoid fauna, which is characterized by many endemic or North Pacific species (Maeda *et al.*, 2005). The previous scarce record of *Phylloptychoceras* in the upper Maastrichtian in the Pacific realm seems superficial because the circum-Pacific upper Maastrichtian sections remain largely to be investigated in detail.

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