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SHORT NOTES

Further study of the Middle Ordovician cephalopod *Holmiceras coreanicum* with a revision of two *Geisonoceras* species from Korea

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Introduction

In the cephalopod fauna from the Middle Ordovician Jigunsan Formation of Korea, the most abundant fossil is the lituitid *Holmiceras coreanicum* which is composed of an early coiled portion and a sigmoidally curved later portion (Yun, 1999). However, it is rare to discover complete individual specimens because of poor preservation, like other fossil nautiloids. Previously, Kobayashi (1934) described several annulated nautiloids as different species based on fragmentary specimens. Yun (1999) has shown that these could be reassigned to *H. coreanicum*.

H. coreanicum is characterized by having prominent annulations and fine growth lines on the shell surface. These features are, however, observed in other Ordovician nautiloid cephalopods from Korea, such as *Holmiceras*, *Cycloceras*, *Geisonoceras*, *Sactorthoceras*, *Tofangoceras*, *Kogenoceras*, *Jiangshanoceras*, *Centroonoceras*, *Wennanoceras*, *Spyroceras*, and *Centrocyrtoceras*. Among species of these genera, two species belong to *Geisonoceras*, *G. hyatti* Kobayashi, 1934 and *G. abruptum* Kobayashi, 1934. Kobayashi (1934) showed that the two species are characterized by having bands or raised lines on the shell surface, as can only be seen in the longitudinal section. The genus *Geisonoceras* is known to occur commonly from the Middle Ordovician strata in Europe and North America, but is uncommon in Asia.

In this study, the taxonomic position of the two *Geisonoceras* species from Korea is reexamined on the basis of observation of the type specimens. The specimens numbered with prefix UMUT and KPE are deposited in the University Museum, the University of Tokyo, Japan and the Department of Earth Science Education, Kyungpook National University, Korea, respectively.

Systematic paleontology

Order Tarphycerida Flower in Flower and Kummel, 1950
Family Lituitidae Phillips, 1848
Genus *Holmiceras* Hyatt, 1894

Type species.—*Lituites praecurrens* Holm, 1891 from the Middle Silurian of Bohemia, Original designation.

Holmiceras coreanicum (Kobayashi, 1927)

Orthoceras coreanicum Kobayashi, 1927, p. 181, pl. 18, fig. 6; pl. 19, figs. 3a–c.

Orthoceras makkolense Kobayashi, 1927, p. 181, pl. 19, figs. 2a–c.

Sigmorthoceras coreanicum (Kobayashi). Kobayashi, 1934, p. 413, pl. 22, fig. 7.

Sactorthoceras makkolense (Kobayashi). Kobayashi, 1934, p. 408, pl. 15, fig. 9.

Cycloceras sp. Kobayashi, 1934, p. 421, pl. 29, figs. 12–13.

Sinuitopsis kochiriensis Kobayashi, 1934, p. 360, pl. 5, figs. 1–4.

Geisonoceras hyatti Kobayashi, 1934, p. 415, pl. 23, figs. 3–4.

Geisonoceras abruptum Kobayashi, 1934, p. 416, pl. 20, fig. 3.

aff. *Trilacinoceras* sp. Ozaki and Ogino, 1968, pl. 3, fig. 3.

Holmiceras coreanicum (Kobayashi). Yun, 1998, p. 78, figs. 1c–h; Yun, 1999, p. 68, figs. 3.1a, b, 2a, b; 4.1–4.10

Material studied.—Two type specimens UMUT PM653, UMUT PM654, 19 newly collected specimens (KPE20001–KPE20007, KPE20011, KPE20013, KPE20020, KPE20023, KPE20026-1, KPE20027, KPE20028, KPE20295, KPE20302, KPE20304, KPE20307, KPE20320) from the Middle Ordovician Jigunsan Formation, Sangdong area, Gangwondo, Korea (Yun, 1999, fig. 1).

Diagnosis.—Conch sigmoidally curved with early

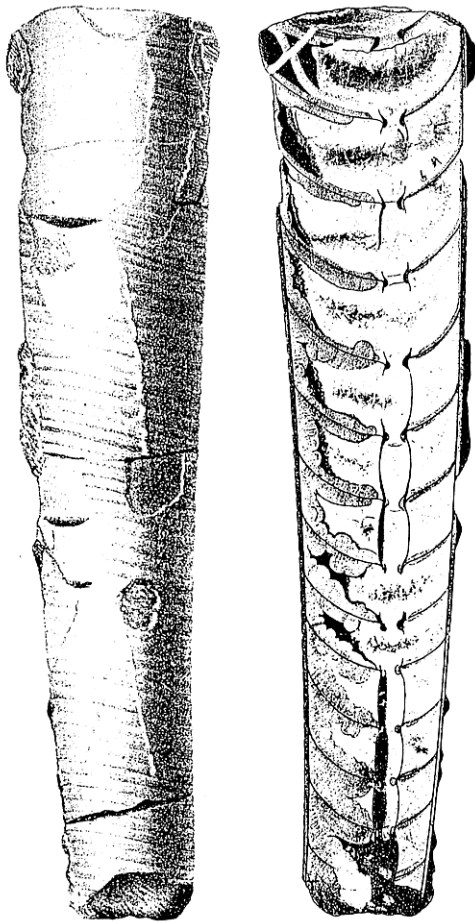


Figure 1. Type species of *Geisonoceras*, *Orthoceras rivale* (Barrande). Reproduced from Barrande (1866). $\times 0.8$.

loosely coiled portion; body chamber long; circular in cross section; siphuncular segments somewhat expanded within camera; septal necks orthochoanitic; no cameral and annulosiphonate deposits present; surface ornamented with prominent annulations and very fine growth lines (Yun, 1999).

Description.—As given by Yun (1999).

Remarks.—This species has an orthochoanitic, subcentral siphuncle, a loosely coiled early stage, and surface ornamentation of growth banding and annulations. It is the most abundant species among the Korean Ordovician nautiloids. Several nautiloids previously reported from Korea were reassigned as synonyms of *Holmiceras coreanicum* (Yun, 1999).

Kobayashi (1934) proposed *G. hyatti* and *G. abruptum* from the Middle Ordovician Jigunsan Formation of Korea on the basis of the characteristics of growth bands on conch surface. Both species are based on the monotype, UMUT

PM653 and UMUT PM654, respectively. The type species of the genus *Geisonoceras* Hyatt, 1884 is *Orthoceras rivale* Barrande, 1866 (figured pl. 209; described 1874, p. 383) from the Middle Silurian of Bohemia (Figure 1). The genus is diagnosed by the transverse lirae or broadly spaced bands which are occasionally adorally imbricated, and annulosiphonate, and have well developed cameral deposits (Sweet, 1964). The two species of *Geisonoceras* from Korea do not possess siphuncular and cameral deposits, and they therefore cannot be placed in *Geisonoceras*.

Kobayashi (1934) stated that the two species have transverse ridges that incline more steeply backward than forward. My examination of the type specimens of *G. hyatti* and *G. abruptum*, however, shows that the inclination of the transverse ridges is almost symmetric rather than adorally imbricated (Figures 2, 3) and the asymmetrical pattern of the transverse ridges illustrated in Kobayashi (1934, pl. 20, fig. 3 and pl. 23, fig. 4) could not be observed either by the naked eye or optical microscopy.

The intervals between the crests of annulations are comparable with those of other species of *Holmiceras* as well as *Cycloceras* and *Kogenoceras*. As shown in Figure 4, the annulation intervals in the type specimens of the two *Geisonoceras* species from Korea are nearly identical with those of *H. coreanicum*. Additionally, the two *Geisonoceras* species and *H. coreanicum* commonly have annulation intervals even narrower than those of *Cycloceras* and *Kogenoceras*, both with strong annulations. Consequently, *G. hyatti* and *G. abruptum* are regarded as synonymous with *H. coreanicum* in the following features: no annulosiphonate and cameral deposits in the phragmocone and narrowly spaced symmetrical annulations in both sides of conch. Without exception, *H. coreanicum* has fine growth lines and relatively strong annulations on the conch surface (see Yun, 1999, fig. 4.10). Also, its conch surface on the ventral side has prominently lobed growth lines and ridges in the juvenile stage (see Yun, 1999, fig. 4.2, 4.10).

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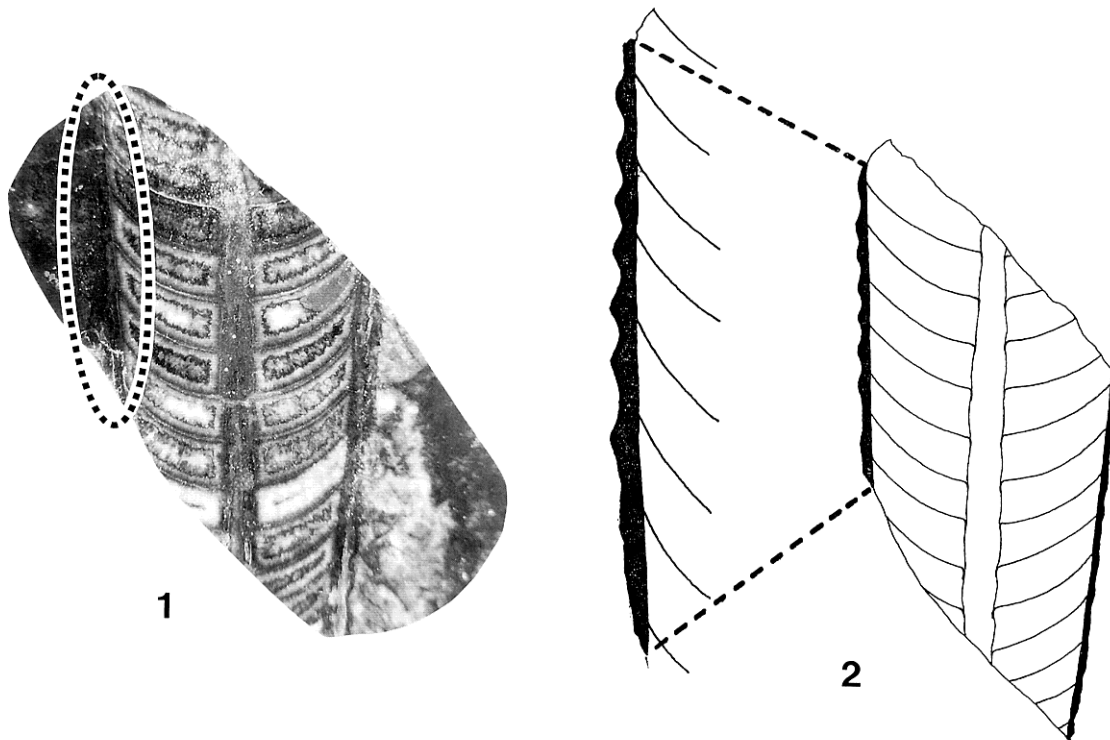


Figure 2. Details of annulation represented on the longitudinal section. 1. *Geisonoceras abruptum* Kobayashi, UMUT PM654, $\times 1.5$. 2. Diagrammatic section of internal structure and surface ornamentation, showing the nearly symmetrical annulations, $\times 1.5$.

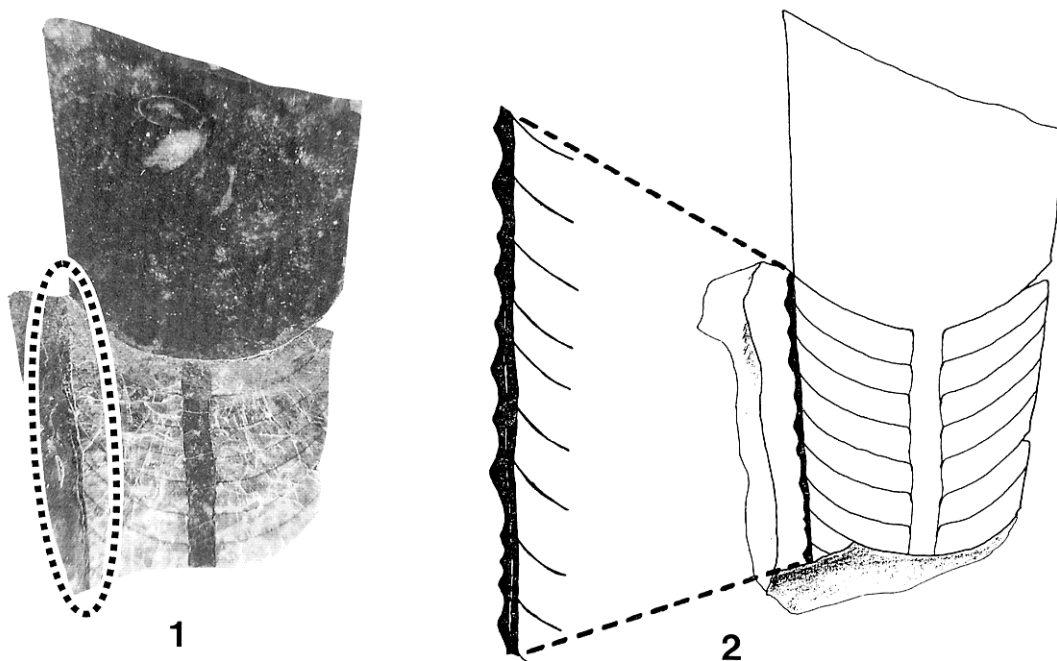


Figure 3. Details of annulation represented on the longitudinal section. 1. *Geisonoceras hyatti* Kobayashi, UMUT PM653, $\times 1.5$. 2. Diagrammatic section of internal structure and surface ornamentation, showing the nearly symmetrical annulations, $\times 1.5$.

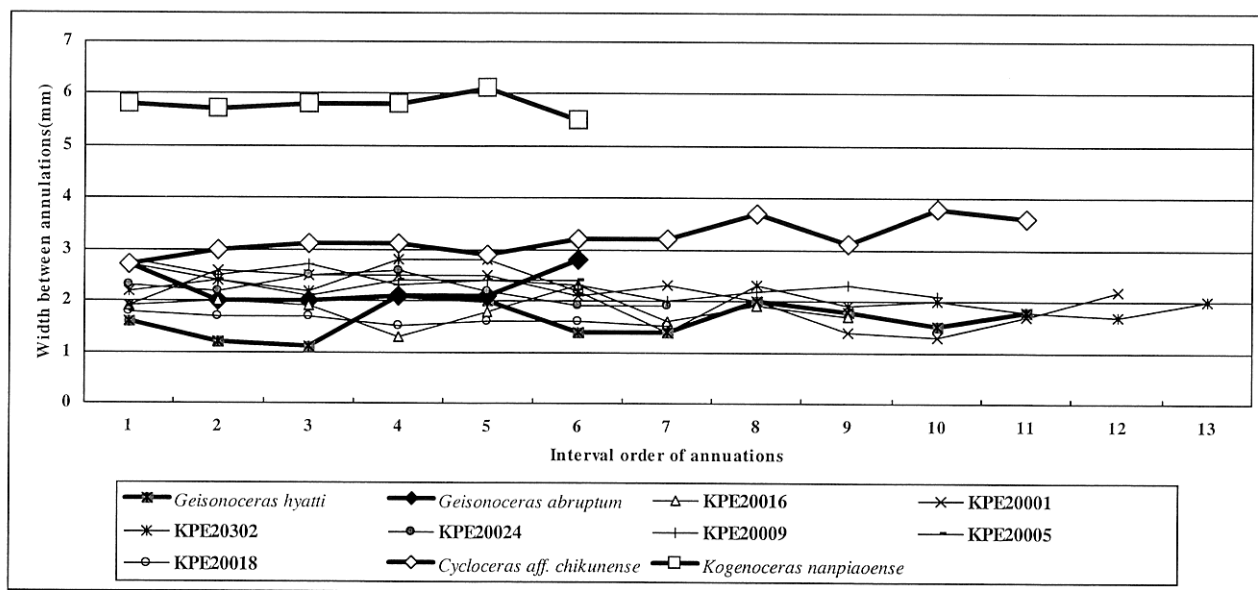


Figure 4. Comparison of annulation intervals in several nautiloids with annulations. The specimens belonging to *Geisonoceras* and *Holmiceras* commonly have even narrower intervals than those of *Cycloceras* and *Kogenoceras*, both with strong annulations. The specimens with prefix KPE are all *Holmiceras coreanicum* (Kobayashi).

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