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Mongolocypris kohi sp. nov.: A new Early Cretaceous non-marine ostracod species from the Jinju Formation, South Korea

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ABSTRACT

A new non-marine ostracod *Mongolocypris kohi* sp. nov. is described from the upper Lower Cretaceous Jinju Formation of the Gyeongsang Basin, South Korea. This new species was described as *Cypridea* (*Pseudocypridina*) spp. by previous authors, but the typical rostrum shape, inconspicuous alveolar notch, the lack of alveolar ridge and the elongate limen are features that this species has in common with the genus *Mongolocypris* Szczechura, 1978. *M. kohi* sp. nov. is characterized by a reduced rostrum, the presence of a faint alveolar furrow and a slightly curved limen. This new species is considered an 'early form' of the genus *Mongolocypris* by its reduced rostrum and the faint alveolar furrow.

1. Introduction

Ostracods are small crustaceans frequently recorded from Ordovician to the present. During the Late Jurassic to Early Cretaceous, cypridoidean ostracod diversity increased in non-marine realms in particular, and their radiation might be attributed to the availability of non-marine habitats at that time as well as their adaptation to life in temporary water bodies and passive dispersal (e.g., Horne & Martens, 1998; Sames, 2011a; Sames & Horne, 2012; Whatley, 1988, 1992).

The Lower Cretaceous Jinju Formation (upper Aptian?–Albian) of the Gyeongsang Basin (Fig. 1) is known for non-marine deposits with diverse fossil biota in the Korean Peninsula including abundant fossil ostracods. The ostracod studies of the Jinju Formation were conducted by Kim (1987), Paik, Kim, and Huh (1988), Choi (1990), Seo (1996) and Choi (2014); their investigations indicate that the occurrence of ostracods in the Jinju Formation is characterized by high abundances of genera *Cypridea* and *Mongolocypris* and less dominant other genera such as *Candona*, *Ilyocypris*, *Sinocypris*, *Djungarica*, *Limnocypridea*? and *Darwinula*? Interestingly, cytheroidean ostracods have never been found in this formation.

The ostracod assemblage of the formation, however, correlates less taxonomically and biostratigraphically with other Cretaceous strata worldwide, because few studies have been conducted and their preservation is usually poor. Hence, taxonomic descriptions of those ostracods are inaccurate and insufficient for comparison on a global scale, and therefore, detailed taxonomic revisions are necessary for further investigations.

In this paper, we present a new non-marine ostracod *Mongolocypris kohi* sp. nov., and describe its dimorphism. This taxon is considered an 'early form' of the genus *Mongolocypris* because of the reduced rostrum and the faint alveolar furrow.

2. Taxonomic background

The genus *Mongolocypris* Szczechura, 1978 is a large non-marine cypridoidean ostracod (up to 2 mm maximum length), rectangular or elongate ovate to suboblong in lateral view with an entirely smooth surface of the carapace. The significant characters of the genus include: 1) rostrum broad or strongly developed (rostrum size is variable, or imperfectly formed as the right valve in *M. kohi* sp. nov.) and rostrum point rounded or somewhat acute; 2) weakly developed alveolus: alveolar notch inconspicuous or nearly absent, anteroventral margin similar to 'curved ventral margin' (see Sames, Whatley, & Schudack, 2010) in many species, faint or absent alveolar furrow (see discussion) and absent alveolar ridge; 3) elongate

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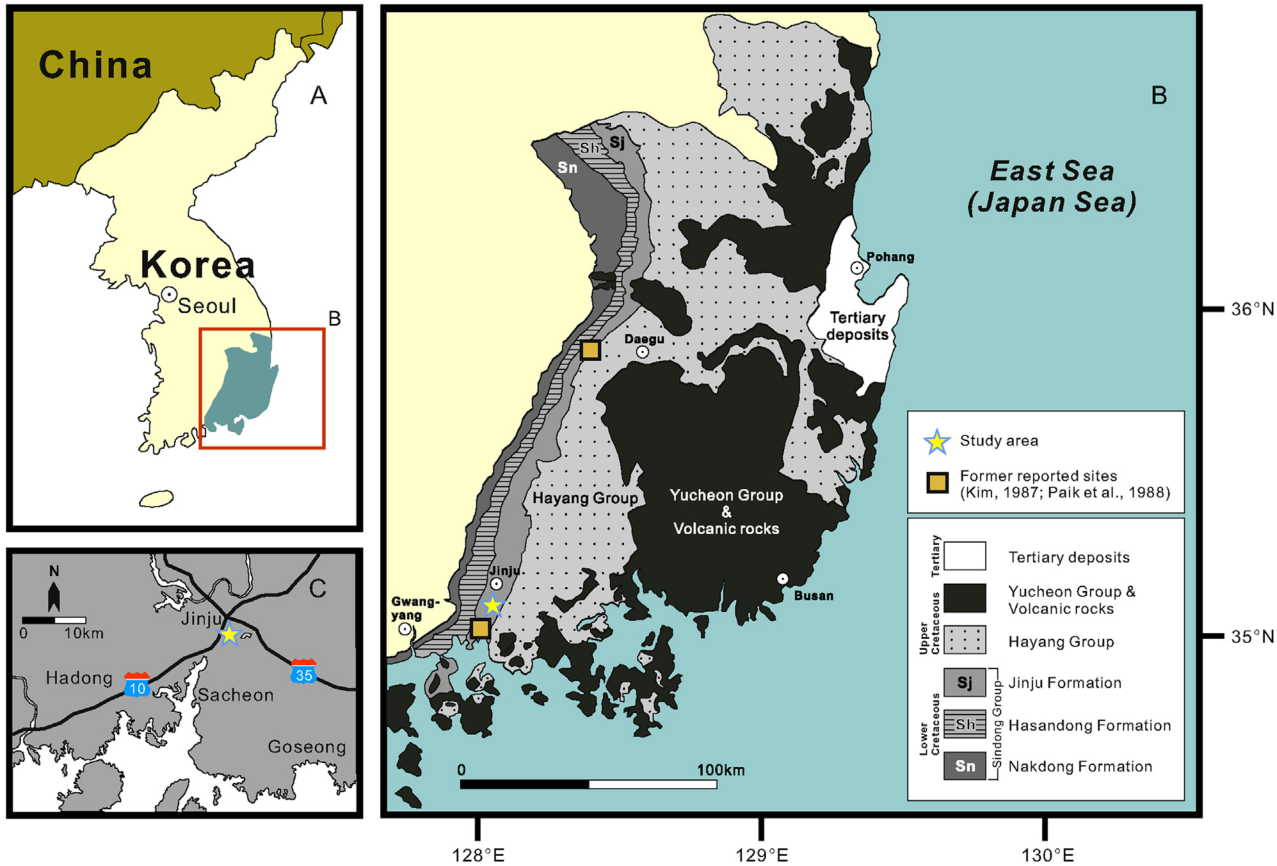

Fig. 1. (A) Location map of the Gyeongsang Basin. (B, C) Geological map with *Mongolocypris kohi* sp. nov. fossil localities (modified from Lee et al., 2010b).

limen well developed in the cyathus area; 4) elongate peculiar list and strongly developed guttur in the anteroventral area. Among these, the well-developed and remarkable internal characters such as peculiar list, guttur and limen are the most important features in this genus. However, internal characters (marginal pore canals and those listed above) of *Mongolocypris* are well known only in the type-species *Mongolocypris distributa* Stankevitch (in Stankevitch & Sochava, 1974; cf. Szczechura, 1978, 1981); they are barely known in almost all *Mongolocypris* species because the preservation of internal characters is usually poor. *M. kohi* sp. nov. has a limen, but other internal characters are unknown due to its partially preserved inner lamella, thus making it difficult to investigate.

Mongolocypris has been frequently reported from upper Lower to Upper Cretaceous (Aptian–Maastrichtian) non-marine strata of Asia in many studies (see Cao, 1996; Hou, Gou, & Chen, 2002; Khand, 2000; Wang, Sha, Pan, & Zhang, 2015; Wang, Sha, Pan, Zhang, & Rao, 2012). However, the genus mainly flourished in the Late Cretaceous. In Mongolia, *Mongolocypris* ranges from Albian to Maastrichtian (see Hayashi, 2006; Khand, 2000). In China, Ye (1994) considered that *Mongolocypris* ranges from Barremian to Paleocene (Danian), although a more correct range is probably Aptian to Maastrichtian (Wang et al., 2015; Wang pers. comm.).

Mongolocypris has been considered endemic to Asia (mainly China, Baikal region, Japan, Korea and Mongolia). However, Brouwers and De Deckker (1993) reported non-Asian *Mongolocypris* species and its allies from upper Maastrichtian deposits of Alaska, North America (Fig. 2) that probably migrated from Asia (Sames, 2011a). The origin and phylogenetic relationship with other taxa of the Family Cyprideidae Martin, 1940 (see also discussion of Sames, 2011a, p. 353–355) and evolutionary history of *Mongolocypris* remain unclear (see discussion). The most similar genus is *Paracypridea* Swain, 1946 in its lateral outline, rostrum/alveolus shape and smooth surface. However, *Paracypridea* does not have all the features of guttur, limen and cyathus or cyathus-like protrusion (Szczechura, 1978; Queiroz Neto, Sames, & Colin, 2014). In contrast, ?*P. mongolica* Szczechura, 1978 has both a guttur and a limen, thus this species is considered a *Mongolocypris* species (Khand pers. comm.).

With respect to the diversity of *Mongolocypris*, approximately 50 species have been reported (e.g., Hou et al., 2002; who list taxa described only from China, although they record most of the *Mongolocypris* species). However, morphological differences between species are not significant, and many authors depend primarily on the general outline and rostrum shape for identification. Moreover, variants (with ontogenetic variation and sexual dimorphism) considered as intraspecific variation are applied to some taxa. It is believed that these morphological characteristics lead to the overestimation of diversity or wrong identification in the *Mongolocypris* species. Also, some species of *Cypridea* were wrongly classified into the genus *Mongolocypris*.

For example, among the *Mongolocypris* species, *Mongolocypris pararostrata* Zhao (in Hou et al., 2002) does not belong to this genus. It has a deeply incised alveolar furrow and ovate carapace which are more characteristics of the subgenus *Cypridea* (*Cyamocypris*), and seems close to *Cypridea* (*Cyamocypris*) *ovatiformis* Hou, 1958. *Mongolocypris longitera* Hou (in Hou et al., 2002) will probably have to be recombined with previously described species *Mongolocypris subtera* Hou (in Hou, Ho, & Ye, 1978) because there is no diagnostic

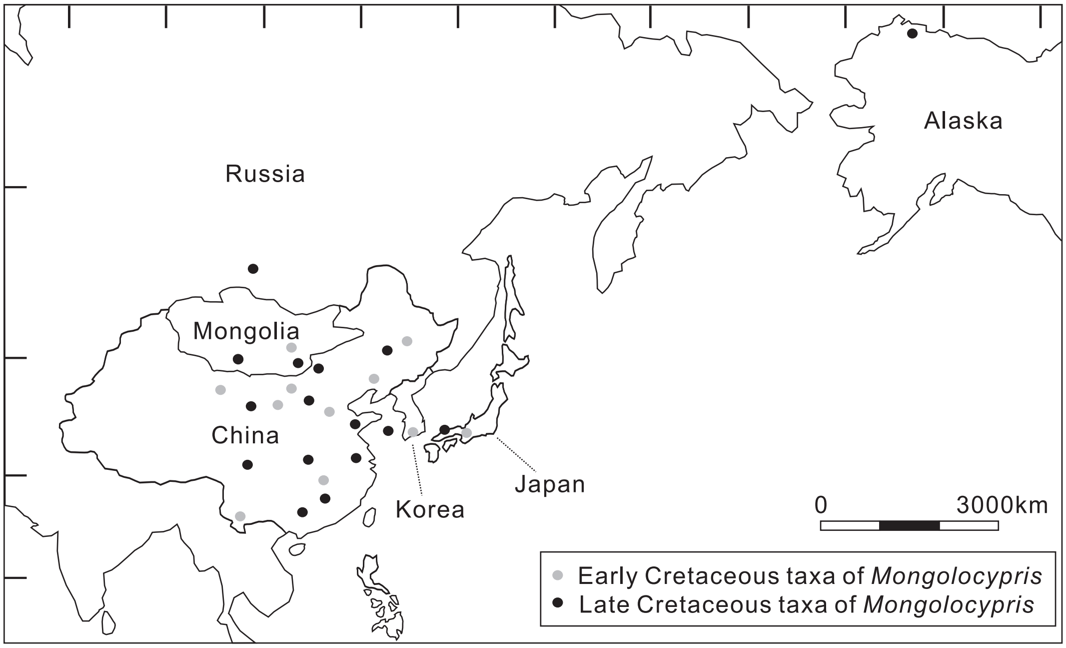

Fig. 2. Geographical distribution of *Mongolocypris*. Gray symbols are for the Early Cretaceous taxa and black symbols for the Late Cretaceous taxa. All symbols indicate approximate locations. The locations are derived from various authors; China (modified from Hou et al., 2002), Baikal region (Szczechura, 1978), Japan (from Cao, 1996; Hayashi et al., 2010), Korea (modified from Choi, 2014; Jugdernamjil, 2009), Mongolia (Hayashi, 2006; Khand, 2000) and Alaska (Brouwers & De Deckker, 1993).

distinction from the latter. *Cypridea rostrata* Galeeva, 1955 is not included in the genus *Mongolocypris* (Khand, pers. comm.), although Szczechura (1978) considered this species a junior synonym of *M. distributa*, whereas Van Itterbeeck, Markevich, and Horne (2004) considered it to be a separate *Mongolocypris* species from *M. distributa*. However, *C. rostrata* possess a well-developed alveolar notch and a pointed rostrum bending backwards compared with *M. distributa* (see Neustrueva, Sinitsa, Khand, & Melnikowa, 2005). Also, *C. rostrata* does not have some internal characters (e.g., guttur and peculiar list).

3. Geological setting

The Cretaceous Gyeongsang Basin is the largest non-marine sedimentary basin in Korea, located in the southeastern part of the Korean Peninsula. According to Chang (1975), this basin is subdivided into three groups, Sindong, Hayang and Yucheon groups, and generally, these stratigraphic units differ in lithology and their distributions (Fig. 1). The basin was formed under alluvial fan, fluvial, and lacustrine environment, and experienced increased volcanic activity during the Late Cretaceous. Among the groups of the basin, Sindong Group subdivided by Nakdong, Hasandong, and Jinju formations, is distributed in the western part of the Gyeongsang Basin, and composed of non-volcanic sedimentary rocks. The Jinju Formation is the uppermost unit of the Sindong Group, which mainly consists of gray to black shale, gray pebbly sandstone, gray to dark gray coarse sandstone and mudstone. This formation has been formed in a fluvio-lacustrine environment (Chough & Sohn, 2010).

Many previous paleontological studies on the Jinju Formation investigated the following biota: palynomorphs (Choi, 1985; Choi & Park, 1987; Yi, Cho, & Chi, 1994), stromatolites (Choi, 2007; Lee & Kong, 2004; Paik, 2005), charophytes (Choi, 1990), ostracods (Choi, 1990; Paik et al. 1988), conchostracans (Choi, 1990; Park & Chang, 1998), isopods (Park, Wilson, Lee, & Choi, 2012), insects (Baek & Yang, 2004; Park, Kim, & Nam, 2013), spider (Selden, Nam, Kim, & Kim, 2012), mollusks (Yun & Yang, 2004), fishes (Kim, Chang, Wu, & Kim, 2014), dinosaur footprints (Kim, Lockley, Woo, & Kim, 2012) and pterosaur teeth (Yun & Yang, 2001). The geological age of this formation was estimated as pre-Aptian in many studies on the bases of micropaleontological data (Choi, 1985; Choi & Park, 1987; Yi et al., 1994). In addition, Hayashi (2006) has concluded that the Jinju Formation (incorrectly name Dongmyeong Formation therein) was deposited during the Barremian based on the correlation with Asian ostracod assemblages, but this result was derived from sparse and poorly preserved data available for this formation. Recently, Lee, Park, Chun, and Yi (2010) estimated that the lower part of the formation age based on the SHRIMP U–Pb age is late Aptian to early Albian, whereas Lee, Choi, Lim, and Orihashi (2010) determined the youngest detrital zircon age for the Jinju Formation as being 106 ± 1.9 Ma (Albian).

4. Material and methods

In this study, ostracod fossils were collected from seven horizons of two sections of the Jinju Formation which are located in Jeongchon area (GPS: N35° 07′–35° 08, E128° 05′–128° 06), Jinju city, Gyengsangnam-do. All ostracod specimens were found in black shale (Fig. 3). The fossils were extracted using the freeze-thaw method after soaking dried samples in warm water for hours and by using sodium sulfate (Na_2SO_4). The samples were then washed in sieves (1 mm–125 μm in size), and finally, the ostracod fossils were collected under a stereo-microscope (Leica EZ4). Scanning electron microscope (Hitachi S-4700) was used to examine, measure, and photograph ostracod specimens.

5. Systematic paleontology

All specimens of *Mongolocypris kohi* sp. nov. collected in this study are deposited at the Korea Dinosaur Research Center, Chonnam National University, Gwangju, South Korea, designated under KDRC-JJ-numbers.

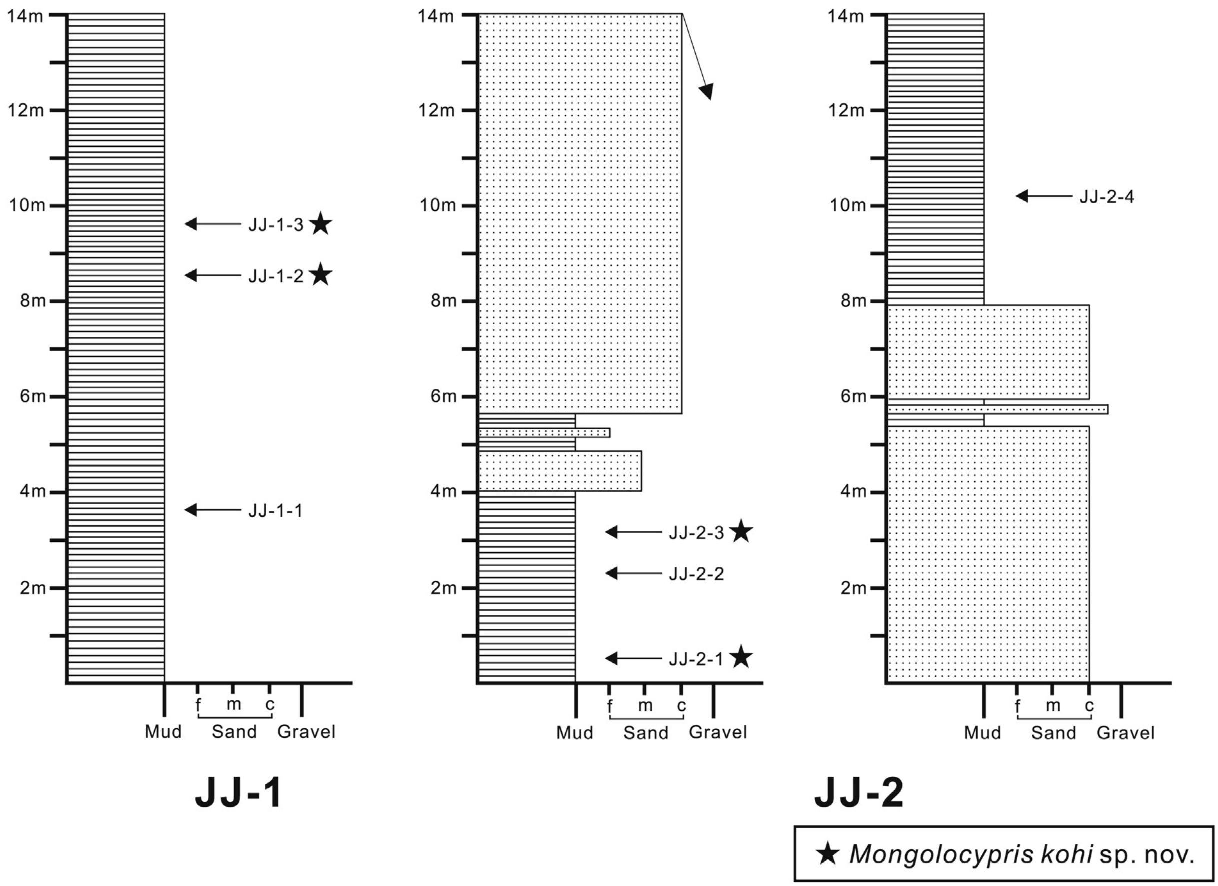

Fig. 3. Columnar sections and ostracod bearing horizons of the Jeongchon area, the Jinju Formation.

Morphologic terms follow Szczechura (1978) and Sames (2011b).

Abbreviations are as follows: LV = left valve, RV = right valve, L = length, H = height, W = width, AMS = adductor muscle scar, FS = frontal scar.

The size parameters in this study are based on Sames (2011a): Very small = length 0.02–0.60 mm, Small = length 0.60–1.00 mm, Medium = length 1.00–1.50 mm, Large = length 1.50–5.00 mm.

Class Ostracoda Latreille, 1802.

Order Podocopida Müller, 1894.

Superfamily Cypridoidea Baird, 1845.

Family Cyprideidae Martin, 1940.

Genus *Mongolocypris* Szczechura, 1978.

Type species. *Cypridea distributa* Stankevitch, 1974; Stankevitch and Sochava, pp. 274, 275, pl. 1, Fig. 4a, b.

Original diagnosis. "Cypridinid genus, longer than 1.3 mm, subovate in lateral outline, rather slim; length less than twice the height. The left, larger valve overlaps the right one almost all around. Both valves anteroventrally bear rounded, beak-like extensions [rostrum used herein] followed by weak incision [alveolar notch used herein] behind. Inner side of valves reveals gutter-like depression designated herein guttur in the place of a beak and distinct, peculiar list obliquely crossing the free part of inner lamella. Posteroventral part of the right valve is conically inflated, whereas posteroventral part of the opposite valve develops a stop-ridge, designated herein limen. Hinge adont. Duplicature wide, particularly frontally, with distinct vestibula. Marginal pore canals numerous, straight, moderately long. Valve surface smooth." (cited after Szczechura, 1978, p. 93).

Mongolocypris kohi sp. nov.

1987 *Cypridea* (*Pseudocypridina*) sp. 1 Kim, pp. 33, 34, pl. 1, Figs. 1–3 [unpubl.].

1987 *Cypridea* (*Pseudocypridina*) sp. 2 Kim, p. 34, pl. 1, Figs. 4 and 5 [unpubl.].

1988 *Cypridea* (*Pseudocypridina*) sp. 1 Paik, Kim and Huh, pp. 103, 104, pl. 2, Figs. 6 and 7.

1988 *Cypridea* (*Pseudocypridina*) sp. 2 Paik, Kim and Huh, p. 104, pl. 2, Figs. 5 and 8.

1988 *Cypridea* (*Pseudocypridina*) sp. 3 Paik, Kim and Huh, p. 104, pl. 2, Figs. 9 and 10.

1996 *Cypridea* cf. *curtorostrata* Hao; Seo, pp. 24, 25, pl. 1, Figs. 1–4.

Etymology. In honor of Professor Yeong Koo Koh (Chonnam National University, Gwangju) in recognition of his important contribution to micropaleontology of Korea.

Authorship. *Mongolocypris kohi* Choi and Huh.

Holotype. KDRC-JJ-001, a complete carapace of presumed male (Fig. 4.1) sample JJ-1-2. L: 1.34 mm, H: 0.72 mm.

Illustrated specimens. Presumed males: Holotype, carapace, KDRC-JJ-001 (Fig. 4.1) sample JJ-1-2; Paratype, carapace, KDRC-JJ-002 (Fig. 4.2a, b) sample JJ-1-2; Paratype, carapace, KDRC-JJ-003 (Fig 4.3) sample JJ-1-2; Paratype, carapace, KDRC-JJ-004 (Fig. 4.4) sample JJ-1-2; Paratype, carapace, KDRC-JJ-005 (Fig. 4.5) sample JJ-1-2; Paratype, carapace, KDRC-JJ-006 (Fig. 4.6) sample JJ-1-2; Paratype, carapace, KDRC-JJ-014 (Fig. 5.1) sample JJ-1-3; Paratype, carapace, KDRC-JJ-015 (Fig. 5.2) sample JJ-1-2; Paratype, carapace (juvenile?), KDRC-JJ-016 (Fig. 5.3) sample JJ-1-2. Presumed females: Paratype, carapace, KDRC-JJ-007 (Fig. 4.7) sample JJ-1-2; Paratype,

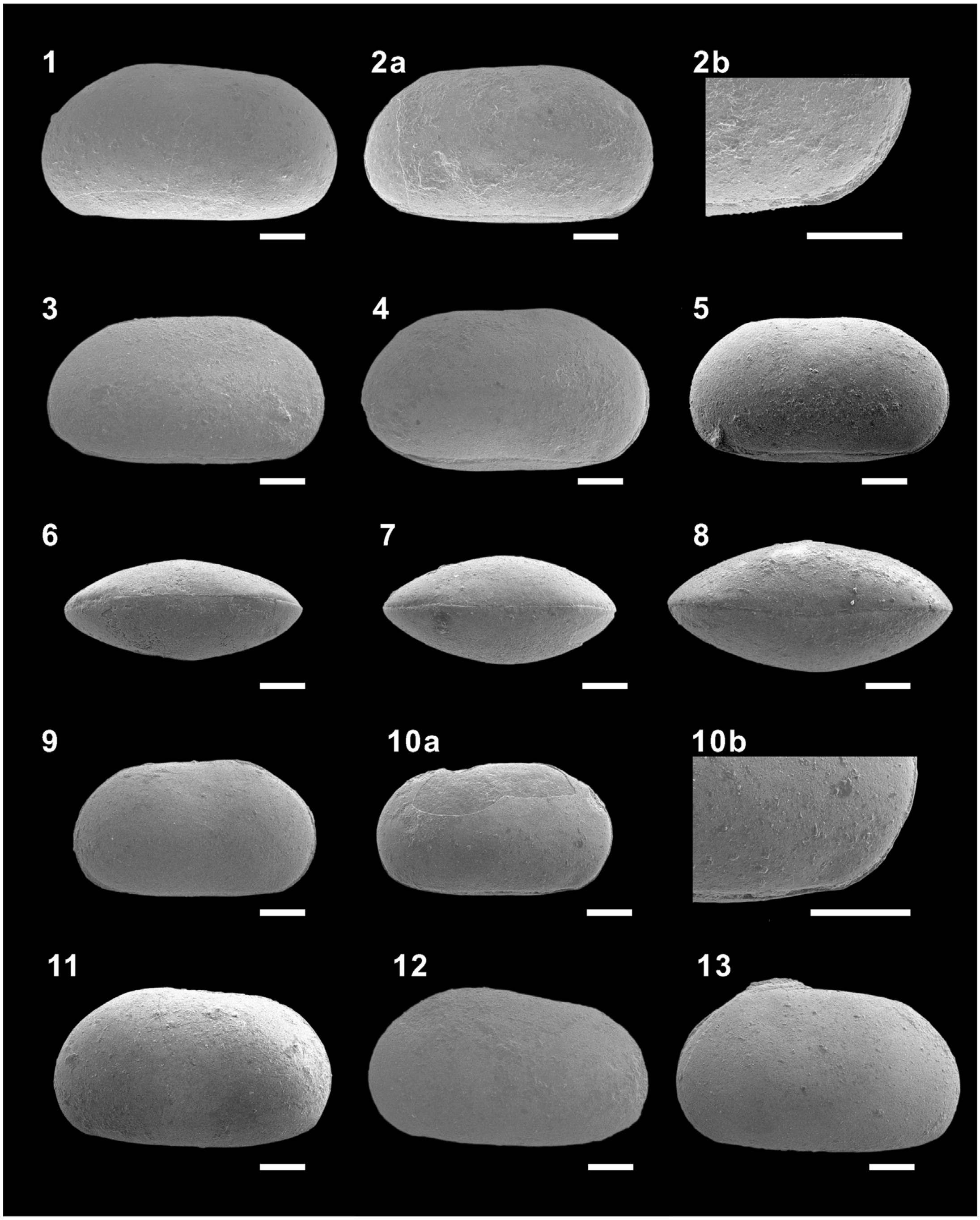

Fig. 4. *Mongolocypris kohi* sp. nov.: 1–6. Presumed males: 1. Holotype KDRC-JJ-001, carapace, left-lateral view (anterior end to the left); 2a. Paratype KDRC-JJ-002, carapace, right-lateral view (anterior end to the right); 2b. idem, detail of the anteroventral area; 3. Paratype KDRC-JJ-003, carapace, right-lateral view (anterior end to the right); 4. Paratype KDRC-JJ-004, carapace, right-lateral view (anterior end to the right); 5. Paratype KDRC-JJ-005, carapace, right-lateral view (anterior end to the right); 6. Paratype KDRC-JJ-006, carapace, dorsal view (anterior end to the left). 7–13. Presumed females: 7. Paratype KDRC-JJ-007, carapace, dorsal view (anterior end to the left); 8. Paratype KDRC-JJ-008, carapace, ventral view (anterior end to the left); 9. Paratype KDRC-JJ-009, carapace, right-lateral view (anterior end to the right); 10a. Paratype KDRC-JJ-010, carapace, right-lateral view, faint alveolar furrow (anterior end to the right); 10b. idem, details of the anteroventral area; 11. Paratype KDRC-JJ-011, carapace, left-lateral view (anterior end to the left); 12. Paratype KDRC-JJ-012, carapace, left-lateral view (anterior end to the left); 13. Paratype KDRC-JJ-013, carapace, left-lateral view (anterior end to the left). Scale bars = 200 μm.

carapace, KDRC-JJ-008 (Fig. 4.8) sample JJ-1-2; Paratype, carapace, KDRC-JJ-009 (Fig. 4.9) sample JJ-1-3; Paratype, carapace, KDRC-JJ-010 (Fig. 4.10a, b) sample JJ-1-2; Paratype, carapace, KDRC-JJ-011 (Fig. 4.11) sample JJ-1-2; Paratype, carapace, KDRC-JJ-012 (Fig. 4.12) sample JJ-1-2; Paratype, carapace, KDRC-JJ-013 (Fig. 4.13) sample JJ-2-1; Paratype, carapace, KDRC-JJ-017 (Fig. 5.4) sample JJ-1-2; Paratype, carapace, KDRC-JJ-018 (Fig. 5.5a, b) sample JJ-2-1; Paratype, left valve, KDRC-JJ-019 (Fig. 5.6a–c) sample JJ-1-2.

Material. About 800 carapaces and several valves, presumed males and females (or adults and pre-adults).

Type locality and horizon. Jeongchon area near Jeongchon-myeon (township) office, Jinju City, Gyeongsangnam-do (province), South Korea (Fig. 1); Horizon number JJ-1-2 (Fig. 3).

Occurrence. Jinju Formation (Aptian?–Albian). Horizon

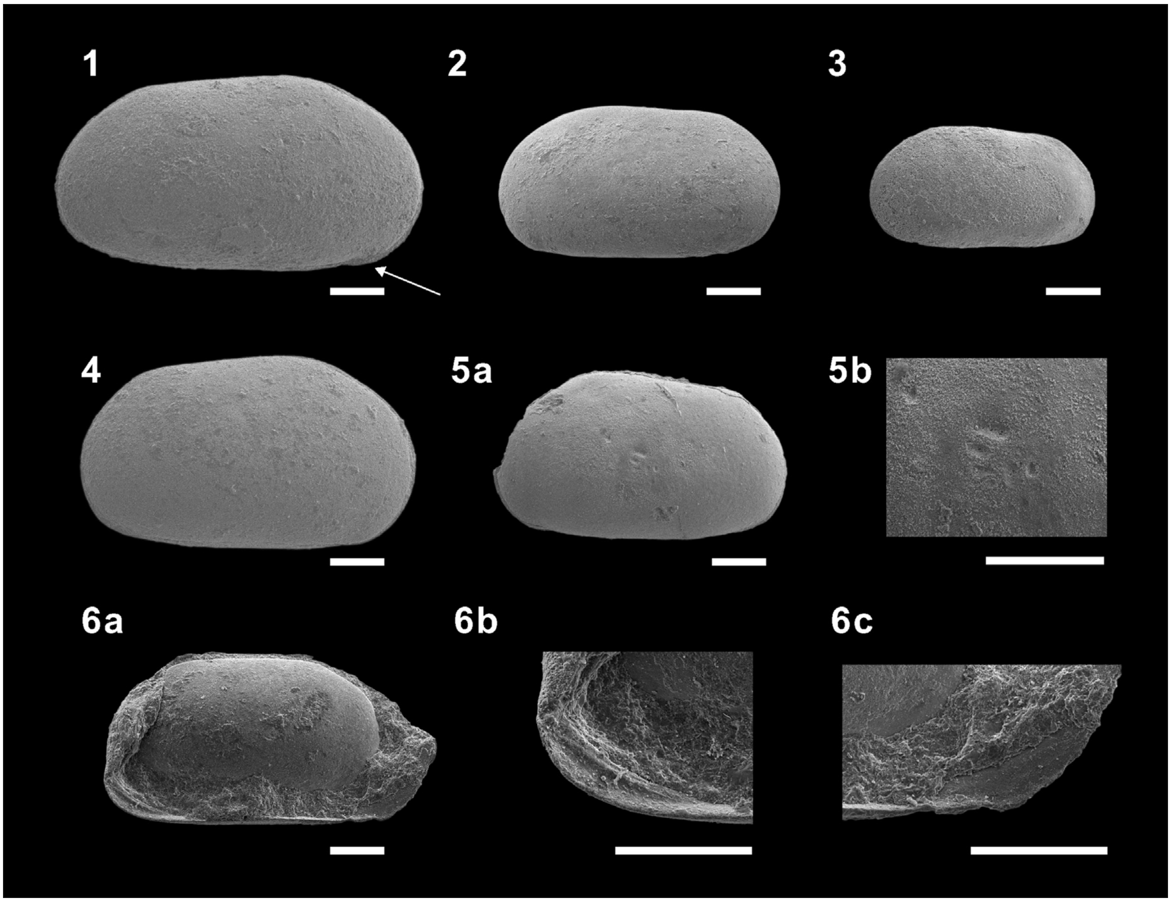

Fig. 5. *Mongolocypris kohi* sp. nov.: 1–3. Presumed males: 1. Paratype KDRC-JJ-014, carapace, right-lateral view (anterior end to the right; arrow indicates unknown damage to RV's anteroventral area); 2. Paratype KDRC-JJ-015, carapace, left-lateral view (anterior end to the left); 3. Paratype KDRC-JJ-016, carapace (juvenile?), left-lateral view (anterior end to the left); 4–6. Presumed females: Paratype KDRC-JJ-017, carapace, right-lateral view (anterior end to the right); 5a. Paratype KDRC-JJ-018, carapace, left-lateral view (anterior end to the left); 5b. idem, detail of the muscle scar pattern; 6a. Paratype KDRC-JJ-019, left valve, internal view (anterior end to the right; it is covered by other valve and sediments); 6b. idem, details of the cyathus and limen in the posteroventral area; 6c. idem, detail of the inner part of the anteroventral area. Scale bars = 200 μm.

numbers JJ-1-2, JJ-1-3, JJ-2-1 and JJ-2-3 (Fig. 3) from Jeongchon area, Jinju City in this study; Chinju 1, Chinju 2, Taegu 4, Taegu 5 and Taegu 6 (correct designations are 'Jinju' and 'Daegu') sections of the same formation from Kim (1987) and Paik et al. (1988).

Stratigraphic range. upper Aptian?–Albian.

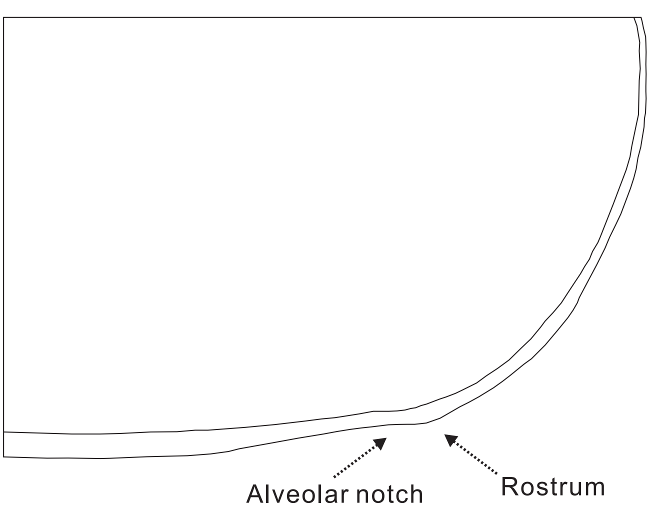

Fig. 6. Sketch of the rostrum and alveolar notch in *Mongolocypris kohi* sp. nov. (paratype KDRC-JJ-010).

Dimensions (mm).

Presumed males. L: 1.07–1.47, H: 0.57–0.79, W: 0.48–0.60.

Presumed females. L: 1.19–1.37, H: 0.67–0.77, W: 0.51–0.62.

Diagnosis. Rostrum noticeable in LV, but very small, not overreaching the ventral margin of larger valve (LV), whereas RV has an imperfect rostrum. Alveolar notch inconspicuous, faint alveolar furrow developed or absent. Elongate, slightly curved limen distinct

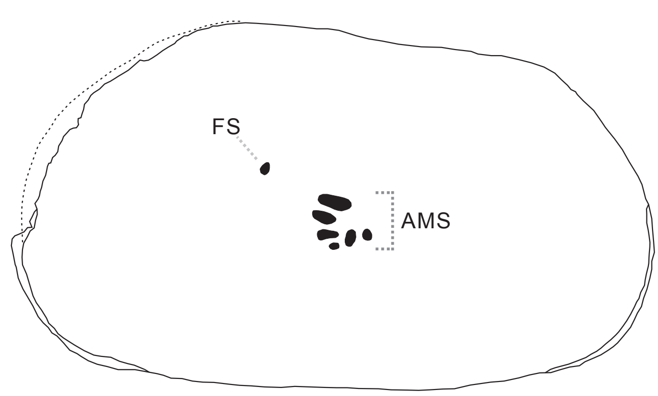

Fig. 7. Line drawing and the muscle scar pattern of *Mongolocypris kohi* sp. nov. (paratype KDRC-JJ-018, presumed female).

in cyathus area.

Description. Medium-sized carapace, elongated rectangular to rounded suboblong in lateral view. LV > RV; LV slightly overlaps RV along the entire margin, but indistinct along the hinge and dorsal margins. Greatest length slightly below mid-height, maximum height at anterior cardinal angle and maximum width at mid-length. Dorsal margin almost straight and slightly inclined towards posterior end; hinge margin parallel to dorsal margin. Ventral margin generally straight, but RV somewhat concave and LV slightly convex; ventral overlaps strongly at mid-length in ventral view. Rostrum small and somewhat broad in LV, imperfect in RV; rostrum point not overreaching the larger valve's ventral margin (Fig. 6). Weakly developed alveolus; alveolar notch inconspicuous, faint alveolar furrow developed in the anteroventral area (Fig. 4.10b) or absent. Anterior margin broadly infracurvate to slightly equicurvate; anterior cardinal angle rounded and weakly marked. Posterior margin infracurvate to equicurvate; posterior cardinal angle rounded but well-marked. In dorsal view, lenticular outline tapering towards both anterior and posterior ends. Muscle scar pattern (only identified from steinkern; paratype, KDRC-JJ-018) consists of six AMS and one FS; AMS, four scars are toward the anterior end, the lowest is the smallest, and two scars behind these four scars in AMS field. One FS higher than AMS (Fig. 5.5a, b; Fig. 7). Surface smooth.

Internal characters. The cyathus is not easily recognizable in lateral view and weakly visible in internal view. Elongate, slightly curved limen distinct in cyathus area of LV (Fig. 5.6a, b). The other characters (hinge type, marginal pore canals, guttur and peculiar list) are unknown in this species.

Dimorphism. Sexual dimorphism in *Mongolocypris kohi* sp. nov. is tentatively presumed herein. Presumed males with relatively elongate carapace, posterior margin tapering to posterior end or less rounded from behind the posterior cardinal angle (variable) and slender in dorsal view, whereas presumed females have more shorter carapace, comparatively rounded posterior margin and inflated shape in dorsal view. In addition, length/height ratio is higher in presumed males; the plot of length versus height (Fig. 8) shows that two morphotypes can be attributable to sexual dimorphism. This assumption is inferred from the sexual dimorphism of the type species *M. distributa* Stankevitch, 1974 in Szczechura (1978), many cases of species of *Cypridea* in Sames (2011a) and *Cypridea subvaldensis* Hanai, 1951, section 2 (the latter author used length/width ratio). However, we applied the length/height ratio only on the carapace outline; thus, the two morphotypes could also be identified as ontogenetic pre-adult instars (presumed females herein) and adults (presumed males herein). Because important internal characters (complete inner lamella and hinge) are missing (due to filling with sediment or poor preservation), the dimorphs are difficult to define.

Variation. Dorsal margin is variable; it is straight in most of the specimens and somewhat convex in some specimens (Fig. 4.13).

Ontogeny. Not doubtlessly identified in this species. Some poorly preserved specimens might represent instars or presumed males? (Fig. 5.3; L: 0.87 mm, H: 0.46 mm), respectively.

Remarks. All of the three species identified as *Cypridea* (*Pseudocypridina*) sp. 1, *C.* (*P.*) sp. 2 and *C.* (*P.*). sp. 3 by Paik et al. (1988) belong to *Mongolocypris kohi* sp. nov., the taxa do not differ from each other in shape, and they are considered presumed males herein. Possible presumed females were illustrated as '*Cypridea* (*Pseudocypridina*) sp. 1' by Kim (1987), and specimens therein have a more inclined dorsal margin and narrower posterior margin than presumed females herein. However, he did not measure the sizes of the specimens, and illustrations remained unpublished.

Mongolocypris kohi sp. nov. differs from other *Mongolocypris* species by its reduced rostrum.

M. limpida Zhang (in Zhang, 1987) from the Lower Cretaceous (Albian) in China, shows similarities to *M. kohi* sp. nov. in general outline, but it is distinguished by a larger rostrum and developed alveolus in both valves.

M. kohi sp. nov. resembles *M. subtera* Hou, 1978 (in Hou et al., 1978) from the Upper Cretaceous (Campanian–Maastrichitian in China; Hayashi (2006) showed that the origin of this species was possibly in the Albian of Mongolia). The latter shows similarity in lateral outline to presumed females of *M. kohi* sp. nov. but differs from the former by a well-developed and broad rostrum, which fully overreached the ventral margin and outline (but the rostrum

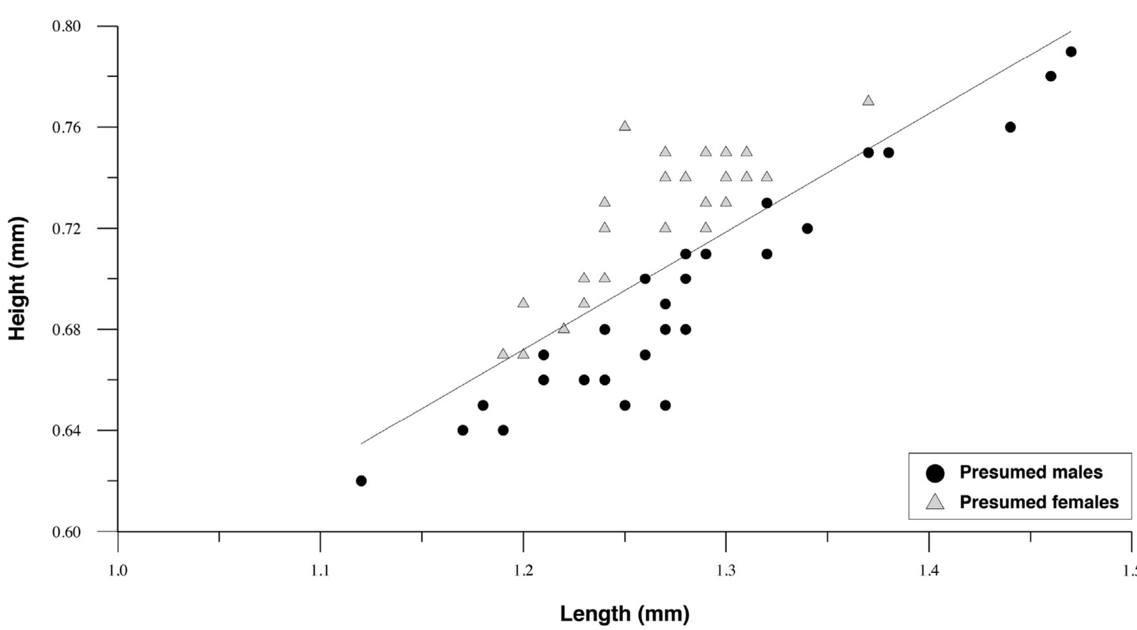

Fig. 8. Plot of the length versus the height of *Mongolocypris kohi* sp. nov.; selected specimens from the Jeongchon area, the Jinju Formation, showing presumed males and presumed females.

size is variable therein and other references; e.g., Zhang, 1987) in both valves. It has a nearly vertical posterior margin and very large carapace.

M. tabulata Ding from the Santonian of the Songliao Basin (in Scott, Wan, Wang, & Huang, 2012; Xi et al., 2012) has a more variable dorsal margin (straight to convex) and distinct rostrum overreaching the ventral margin.

At first glance, *Cypridea* (*Pseudocypridina*) *laevigata*/*setina* species-group (see Sames, 2011a and references therein, e.g., Anderson, 1985; Schudack & Schudack, 2009) is very similar to *M. kohi* sp. nov. in general outline, but differs from the latter by its pointed rostrum and a more distinct alveolus.

Associated occurrences. *Candona* sp., *Cypridea* spp., *C.* (*Pseudocypridina*) *jinjuria* Choi, 1990 (this taxon needs further revision), *Darwinula*? sp., *Djungarica* sp., and *Limnocypridea*? sp.

6. Discussion

Although some important phylogenetic concepts for representatives of the extinct Family Cyprideidae Martin, 1940 (Bajocian–Eocene) of the Superfamily Cypridoidea have been discussed (see Sames et al., 2010; Sames, 2011a and references therein), the evolution of Cyprideidae is still poorly understood. Additionally, the evolutionary process of *Mongolocypris* within this family has not been examined, and therefore, its origin and phylogenetic relationships with other taxa of Cyprideidae are unclear. The new taxon *Mongolocypris kohi* sp. nov. appears to be an 'early form' of the genus because of the reduced rostrum (Fig. 6) and the faint alveolar furrow in the anteronventral area. However, these features are unusual for *Mongolocypris*. In general, the rostrum is prominent in both valves, but the alveolar furrow is absent in this genus. If *M. kohi* sp. nov. is an early form of the genus, then it is possible that the species is the ancient representative of the genus *Mongolocypris*. However, a fully developed rostrum has been found in taxa such as *M. globra* Hou and *M. limpida* Zhang of the same age. Thus, two hypotheses could potentially explain this 'early form'. The first is that the new species is a separate lineage within *Mongolocypris*; if this hypothesis is correct, *M. kohi* sp. nov. can be segregated into a separate subgenus. The second hypothesis assumes that the species is a survivor of the predecessor of *Mongolocypris*; thus the ancestor or transitional species survived into the Albian and the taxon coexisted with typical taxa (those having well-developed rostrum) of *Mongolocypris*. In the case of the first hypothesis, we consider that a reduced rostrum and a faint alveolar furrow are insufficient to elevate the taxon to the subgenus rank within the genus because the hypothesis needs to be evaluated by additional evidence. Accordingly, the phylogenetic position of *M. kohi* sp. nov. is seemingly consistent with the latter hypothesis. Nevertheless, the lack of diagnostic information (e.g., guttur and peculiar list) hinders the comparison and reconstruction of the evolutionary routes. Yet, *M. kohi* sp. nov. has a slightly curved limen and a narrower cyathus area compared to the Late Cretaceous species *M. distributa*.

The dimorphism of *M. kohi* sp. nov. indicates either sexual dimorphism or ontogenetic variations.

Cretaceous non-marine ostracod assemblages of the Korean Peninsula have rarely been recognized in the past. Among the known taxa, *Mongolocypris* is a common ostracod element in non-marine Cretaceous deposits in Korea including the Jinju Formation, and *M. kohi* sp. nov. represents the earliest probable record of the species of this genus in the basins of the Korean Peninsula. Generally, many Mesozoic non-marine ostracods are not endemic (Sames & Horne, 2012). To date, it is uncertain whether *M. kohi* sp. nov. was endemic or pandemic, in terms of biogeographical distribution. Despite insufficient taxonomic and phylogenetic information, it is expected that the new species would be important for the establishment of a non-marine ostracod biostratigraphy in the Gyeongsang Basin.

7. Concluding remarks

The early evolution of *Mongolocypris* was not known until recently. The new taxon *Mongolocypris kohi* sp. nov. from the Jinju Formation (upper Aptian?–Albian), South Korea is considered an 'early form' of the genus because of the reduced rostrum and the faint alveolar furrow compared with the typical *Mongolocypris* species. This new species might be an ancestor or transitional species which survived into the Albian. More detailed evolutionary routes should be investigated further, and *M. kohi* sp. nov. will provide an understanding on the early evolution of *Mongolocypris*.

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