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The Early Cretaceous non-*Cypridea* Ostracoda from Yixian and Jiufotang formations of western Liaoning (China)

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Abstract

Based on newly collected material from the Lower Cretaceous Yixian and Jiufotang formations, twenty-one ostracod species belonging to 12 genera are described, including: *Yumenia*? *acutiuscula*, *Yumenia*? sp., *Scabriculocypris pingquanensis*, *Limnocypridea grammi*, *Candona praevara*, *Candona* sp., *Cheilocypridea trapezoidea*, *Rhinocypris jurassica*, *Rhinocypris tugurigensis*, *Rhinocypris* sp., *Djungarica camarata*, *Lycopterocypris infantilis*, *Lycopterocypris debilis*, *Damonella circulata*, *Ziziphocypris linchengensis*, *Ziziphocypris costata*, *Ziziphocypris simakovi*, *Timiriasevia jianshangouensis*, *Timiriasevia corcava*, *Alicenula leguminella*, and *Alicenula* sp. Of these, six species are with emended descriptions. All of the non-*Cypridea* species described in this paper are endemic to in eastern Asia, except for *Rhinocypris jurassica* and *Alicenula leguminella*, which have worldwide distributions and long stratigraphic ranges.

Keywords: Ostracoda; Systematics; Jehol Group; Northeast China

1. Introduction

Ostracods are a valuable tool for interbasinal and suprarregional biostratigraphic correlations (e.g., Horne, 2009; Sames, 2011a, 2011b; Sames and Horne, 2012; Wang et al., 2015). Representatives of the genus *Cypridea* Bosquet, 1852 are very common and stratigraphically useful in "Purbeck/Wealden-like" nonmarine deposits of the world (e.g., Horne, 1995; Schudack and Schudack, 2009; Sames, 2011b), as well as in other Lower Cretaceous nonmarine deposits of China, Mongolia, and Brazil (e.g., Galeeva, 1955; Zhang, 1985a; Do Carmo et al., 2008). Moreover, during the Early Cretaceous, besides *Cypridea* species, several non-*Cypridea* species are useful as a tool for biostratigraphic correlation and age determination in the western Liaoning area (Wang et al., 2015).

Since the first taxonomic study of ostracods in western Liaoning (Hou, 1958), over 220 ostracod species have been described from this area (Chen, 1965; Zhang and Zhang, 1982; Zhang, 1985a, 1985b, 2004; Cao, 1999; Zhang et al., 2012). However, it has been recently suggested (Wang et al., 2013) that the species diversity is greatly exaggerated. Ostracod species diversity in other continents also appears to have been overestimated (e.g., Khand et al., 2007; Nye et al., 2008; Horne, 2009; Schudack and Schudack, 2009; Sames, 2011a, 2011b). It is thought that such species diversity exaggeration has been caused by the use of only minor characteristical differences to distinguish species and subspecies, which may instead merely reflect ecophenotypic variation (Schudack and Schudack, 2009; Sames, 2011a, 2011b). Horne (2009) suggested, therefore, that a thorough taxonomic revision of ostracods is necessary, and future taxonomic revisions should be based on analyses of large numbers of specimens from many horizons and localities, not just comparisons of a few distinctive individuals. This approach to taxonomic revision should also be applied to ostracods of western Liaoning, because only a few revisions have been done on ostracods from the Yixian and Jiufotang formations (Wang, 2009, 2012; Wang et al., 2013). On the basis of newly collected samples, the present paper revises the non-*Cypridea* ostracods from the Yixian and

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Jiufotang formations of the western Liaoning area; and a separate study is planned to deal with the important and extremely variable *Cypridea* species of this area.

2. Geological background

In the Early Cretaceous, a series of basins were formed in western Liaoning as a result of tectonic and magmatic activity (Zhu et al., 2011): the Lingyuan–Sanshijiazi, Kazuo–Chaoyang, Jianchang, and Fuxin–Yixian–Jinzhou basins. The nonmarine Lower Cretaceous strata in these basins are divided (oldest to youngest) into the Tuchengzi, Yixian, Jiufotang, Fuxin, and Sunjiawan formations (Sha, 2007). The Yixian and Jiufotang formations are world-famous for their diverse and well-preserved fossils, such as feathered dinosaurs and birds, mammals, angiosperms, ostracods, bivalves, gastropods (e.g., Chang et al., 2003; Zhou et al., 2003). The Yixian and Jiufotang formations consist mainly of fine laminated tuffaceous siltstones and shales, silty limestons, fine-grained sandstones, thin-bedded tuffs, and conglomerate (Sha, 2007; Zhang et al., 2007) and are considered as fluvial–lacustrine depositional environments (e.g., Jiang and Sha, 2007; Jiang et al., 2012). Traditionally, the Yixian Formation is informally divided into the lower part and the upper part, and the Jiufotang Formation is divided into the lower member and the upper member (Wang et al., 1989). According to ostracod biostratigraphic and marine–nonmarine correlations (Sha, 2007; Wang et al., 2015), and radiometric dates, the lower part of the Yixian Formation is Hauterivian to Barremian, the upper part of the Yixian Formation and the lower member of the Jiufotang Formation is probably Barremian to Aptian, and the upper member of the Jiufotang Formation is Aptian in age (Smith et al., 1995; Zhu et al., 2002, 2003, 2007; Sha, 2007; Yang et al., 2007; Chang et al., 2009; Wang et al., 2015).

3. Material and methods

The studied materials were collected from six fossil sites in western Liaoning (Fig. 1): Sihetun (Libalanggou, Dabeigou) of Beipiao City, Jingangshan (Zaocishan) of Yixian County, Pijiagou, Tulongshan, and Sandaohao of Yixian County, Sanguanmiao of Harqin Left Wing Mongolian Autonomous County (= Kazuo County), Jiufotang of Kazuo County, Liujiawopu of Lingyuan City, and Weijialing of Jianchang County. Thirty-three samples were processed, of which twenty-one samples contained ostracods (Fig. 2).

The rock samples (weight around 400 g to 500 g) were broken into small (roughly centimetre-sized) pieces, soaked in warm water for 3–6 h, and finally washed through a series of sieves of sizes ranging from 1 mm to 0.097 mm. The fraction retained on the 0.097 mm sieves was dried and ostracods were picked out under a binocular microscope. In some cases, where individual ostracods had small sediment particles adhered, the specimens

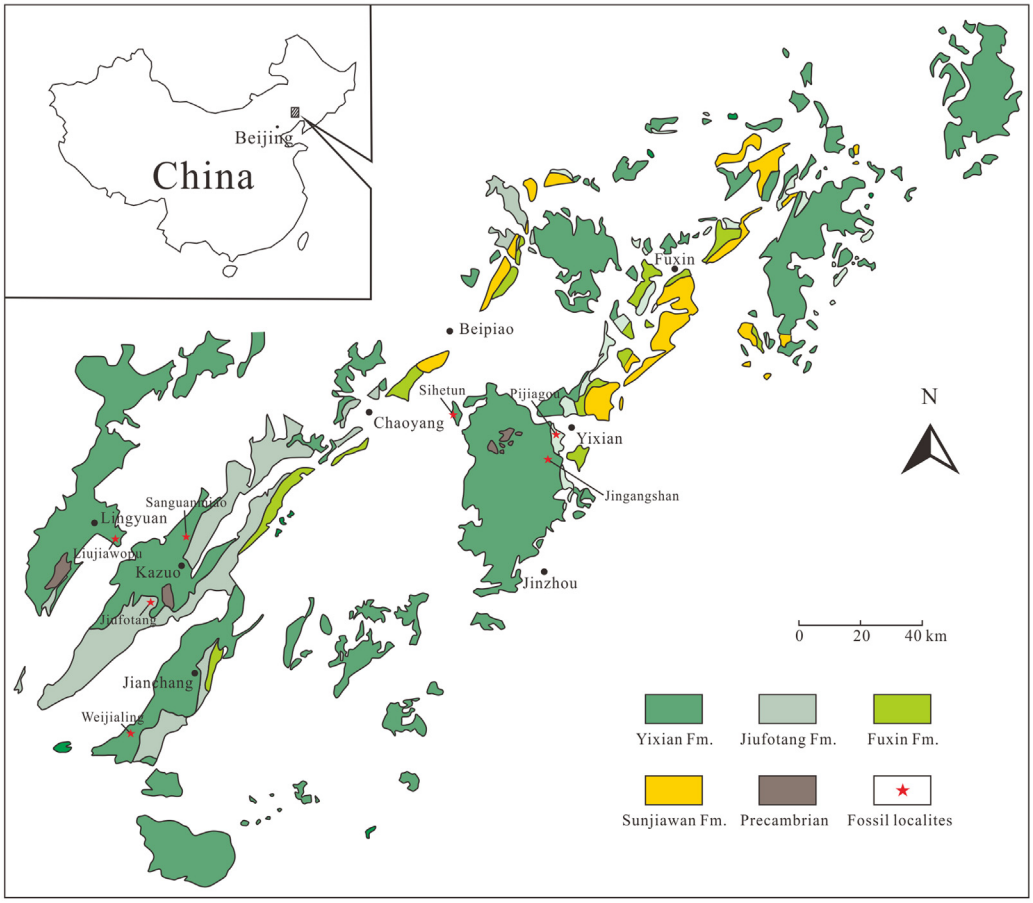

Fig. 1. Distribution of the Cretaceous formations and fossil localities in western Liaoning (modified from Jiang and Sha, 2007, fig. 1).