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Species of the genus *Cypridea* Bosquet, 1852 (Ostracoda) from the Lower Cretaceous Yixian and Jiufotang formations of western Liaoning, China

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Abstract

Based on newly collected material from the Lower Cretaceous (Hauterivian to Aptian) Yixian and Jiufotang formations of the Jehol Group, eight *Cypridea* species have been recognized in western Liaoning: *C. ganzhaoensis*, *C. gujialingensis* n. sp., *C. jiufotangensis*, *C. vitimensis*, *C. beipiaoensis*, *C. subfracta*, *C. subelongata*, and *C. semiovata*. Among them, one species from Kazuo area is new, *Cypridea gujialingensis* n. sp. Except for *C. vitimensis*, which has also been reported from Mongolia and western Siberia, the rest of the species are endemic to western Liaoning. On the basis of new material, we confirm sexual dimorphism in *C. vitimensis* and distinguish sexual and parthenogenetic populations. Paleobiologically, we infer a mixed reproduction mode for *C. vitimensis* and suggest that its sexual populations from western Liaoning could indicate stressful environmental conditions.

Keywords: Cyprideidae; Sexual dimorphism; Non-marine; Jehol Group; Northeast China

1. Introduction

Cyprideidae Martin, 1940 is an extinct family of superfamily Cypridoidea. During the late Tithonian to Early Cretaceous, the non-marine Cyprideidae reached a high diversity worldwide (Whatley, 1990, 1992; Sames and Horne, 2012). Their high diversity, frequent occurrence, and survival and dispersal strategies render them excellent candidates for regional to supraregional biostratigraphy in the Lower Cretaceous non-marine deposits worldwide (e.g., Anderson, 1985; Horne, 1995; Horne and Martens, 1998; Nye et al., 2008; Sames, 2011a; Sames and Horne, 2012; Wang et al., 2012, 2015).

The genus *Cypridea* was proposed by Bosquet (1852), based on material which once was referred to the genus *Cypris* Müller, 1776 from the Wealden-type deposits of England and Germany. More than thirty years later, Jones (1885) gave the first precise definition of *Cypridea*. However, specimens of *Cypridea* display a variable morphology with respect to shape, size, and ornamentation. Thus, the taxonomy of *Cypridea* has been discussed for a long time by many authors (e.g., Anderson, 1939, 1962, 1967; Martin, 1940; Swain, 1946; Sylvester-Bradley, 1949; Hou, 1958; Wolburg, 1959; Moore and Pitrat, 1961; Szczechura, 1981; Hou et al., 2002; Horne and Colin, 2005; Do Carmo et al., 2008; Sames et al., 2010; Sames, 2011a; Wang et al., 2013; Ayress and Whatley, 2014; Queiroz-Neto et al., 2014). For instance, Sylvester-Bradley (1949), Hou (1958), and Anderson (1962) placed *Ulwellia*, *Morinina*, *Langonia*, and *Gyamocypris*, which were all originally erected as genera by Anderson (1939), in *Cypridea* as subgenera. Later, Hou et al. (2002) and Do Carmo et al. (2008) proposed that there is no subgenus of *Cypridea*, and *Ulwellia*, *Morinina*, *Langtonia* and *Gyamocypris* are

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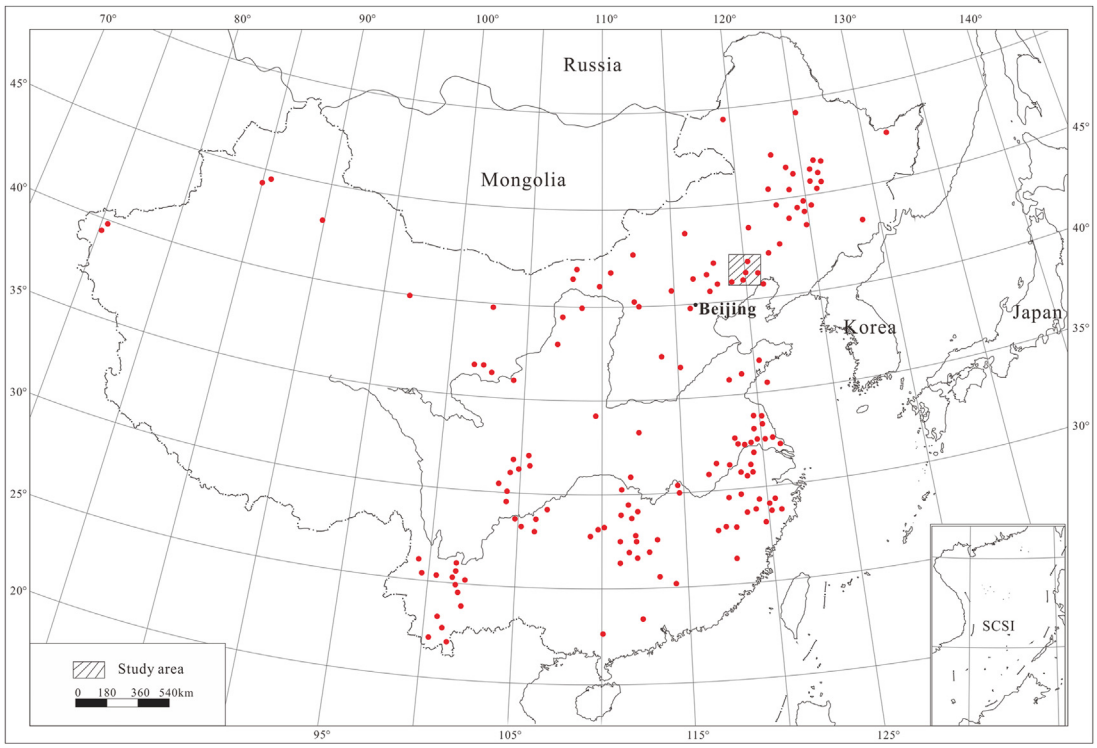

Fig. 1. The distribution of *Cypridea* in China (modified from Hou et al., 2002, fig. 1–1) (SCSI = the South China Sea Islands).

synonyms of *Cypridea*. The history of classification of this genus and its relations and representatives has been documented and discussed in detail by Sames (2011a, pp. 354–363). This revision work (Sames, 2011a, 2011b, 2011c) is largely followed in this paper.

Cypridea was distributed worldwide except for Australia and Antarctica, ranging from the Late Kimmeridgian to Eocene (Horne and Colin, 2005; Sames, 2011a). It has been frequently reported from the Cretaceous to Palaeogene strata of China (Fig. 1). Based on the correlation charts of ostracod-bearing formations/groups in China (Wang et al., 2012, tables 1, 2), the specimens encountered in the Yixian Formation are the earliest records of this genus in China. Wang et al. (2013) emended some cypridean species from the Yixian Formation of the Beipiao–Yixian Basin, based on a large number of specimens. However, they only revised a small group of *Cypridea*, which was restricted to the Yixian Formation of the Beipiao–Yixian Basin. Following more detailed investigations, more material has been collected from western Liaoning area, in addition to the localities in the Beipiao–Yixian Basin. This gives us an opportunity to revise more *Cypridea* species from the Yixian and Jiufotang formations. Therefore, this paper focuses on the systematics of the *Cypridea* species from the Yixian and Jiufotang formations of the western Liaoning area. Eight *Cypridea* species, including one new species, are revised and figured (Figs. 4–6).

2. Geological setting

Non-marine Early Cretaceous deposits are widely distributed in western Liaoning. According to Sha (2007), the Lower Cretaceous strata of western Liaoning are subdivided into four formations: the Yixian, Jiufotang, Fuxin, and Sunjiawan formations (in ascending order). Among these formations, the Yixian and Jiufotang formations are the lowest parts of the Jehol Group, which yields representatives of well-preserved terrestrial vertebrates, invertebrates, and plants (e.g., Chang et al., 2003; Zhou et al., 2003). These two formations were deposited in a fluvial-lacustrine environment which was influenced by volcanic activity (Jiang et al., 2012). Wang et al. (2015) concluded that the lower part of the Yixian Formation was deposited during the Hauterivian–Barremian, the upper part of the Yixian Formation and the lower member of the Jiufotang Formation are dated Barremian to Aptian, and the upper member of the Jiufotang Formation is dated as Aptian, based on the ostracod biostratigraphic correlations with Mongolia, Japan, and South Korea (Wang et al., 2015).

3. Materials and methods

The studied fossil material was collected from several different localities, which are dispersed in four Mesozoic basins in western Liaoning: the Lingyuan–Sanshijiazi, Kazuo–Chaoyang, Jianchang, and Fuxin–Yixian–Jinzhou basins (Fig. 2). We collected 33 samples, of which 21 contained fossil ostracod material, and processed them by the method introduced by Wang et al. (in press). The ostracods mainly come from calcareous claystones, limestone, marls, calcareous silt, and sandstones. Illustrations of carapaces and valves scanned with a Hitachi su3500 Scanning Electron Microscope at Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences

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