

Early Cretaceous ammonites from eastern Heilongjiang, northeastern China, and their chronostratigraphical significance



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ARTICLE INFO

Article history:

Received 29 March 2017

Received in revised form

4 October 2017

Accepted in revised form 11 October 2017

Available online 25 October 2017

Keywords:

Ammonites

Biostratigraphy

Cretaceous

Aptian

Qihulin Formation

China

ABSTRACT

A low-diversity ammonite fauna is described from the Qihulin Formation of the dominantly non-marine Longzhaogou Group exposed in Mishan and Hulin counties in eastern Heilongjiang, northeastern China. The fauna consists predominantly of *Pseudohaploceras?* cf. *nipponicum* Shimizu, 1931, and *Pseudohaploceras?* *peideense* (Liang, 1982), with subordinate *Eogaudryceras* (*Eogaudryceras*) cf. *yunshanense* (Liang, 1982). The occurrence of *Pseudohaploceras?* and previously reported bivalves suggest an early Aptian age for the Qihulin Formation. The early Aptian transgression advanced from the east across the Hulin and Mishan area into the Jixi Basin and resulted in the deposition of the marine beds of the Qihulin and lower Chengzihe formations. The Qihulin Formation can be correlated with the lower part of the Chengzihe Formation.

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1. Introduction

The well-developed Jurassic and Cretaceous deposits in China are mainly of non-marine origin (Chen, 2003a,b; G. Li et al., 2006, 2007b, 2009a,b,c,d, 2010, 2016a,b; Chen et al., 2007; G. Li and Matsuoka, 2012; Wan et al., 2013; C.S. Wang et al., 2013; Teng et al., 2016; Y.L. Li et al., 2017; G. Li, 2017b; Teng and Li, 2017; Y.Z. Zhang et al., 2017). In order to date the well-known Jehol and Fuxin biotas (Chen and Jin, 1999; M.M. Chang et al., 2003; G. Li et al., 2007a, 2015) and to establish the position of the non-marine Jurassic–Cretaceous boundary, attention was initially focused on correlation of the non-marine beds with marine and non-marine transitional sequences (G. Li and Matsuoka, 2015). In eastern Heilongjiang, northeastern China, a succession of upper Lower Cretaceous coal-bearing, alternately marine and non-marine rocks is exposed, comprising the Jixi Group in the west and the Longzhaogou Group in the east (Fig. 1). The Jixi Group was previously dated as Late Jurassic and the Longzhaogou Group as Middle–Late Jurassic (Huang, 1963; Ju et al., 1982; Gu and Chen, 1983; W.R. Li

et al., 1986; Research Team on the Mesozoic Coal-bearing Formations in Eastern Heilongjiang, 1986). Through the reassignment of *Buchia* spp., reported from the Upper Jurassic by Gu et al. (1984a,b, 1987), Chen and Sun (1989) and Chen (1999), to *Aucellina* spp., the Longzhaogou succession was reassigned to the Lower Cretaceous (Sha, 1990, 1992; Sha and Fürsich, 1993; Sha et al., 1994). This revision sparked an interest in restudying the palaeontology and biostratigraphy of the Longzhaogou Group. Thus, Kelly et al. (1994) and Futakami et al. (1995) reassessed ammonites dated as Bathonian (Middle Jurassic) by Liang (1982) and Y.G. Wang (1983) from the dominantly marine Qihulin Formation and suggested a Cretaceous age. Gu et al. (1997) revised the bivalves of the Longzhaogou Group and placed them stratigraphically in the Barremian–Albian. Bivalves from the Qihulin Formation were described by G. Li (2001) and Jiang and Cai (2004) and by the latter authors dated as “mainly Aptian”. Sha et al. (2008, 2009) and Sha and Hirano (2012) reported the bivalves *Filosina subovalis* Yao, J. Chen & Gu (Barremian–Aptian) and *Thracia rotundata* (J. de C. Sowerby) from the formation, the latter species known from the Aptian of England. C.Q. He et al. (1999) and Sha et al. (2002) reported Hauterivian–Barremian dinoflagellate cysts from the formation. An Early Cretaceous age of the Qihulin Formation is further supported by radiolarians (G. Li and Yang, 2003) and agglutinated foraminifers (G. Li and Yu,

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2004). However, uncertainty about the precise age remains, as the ammonite determinations are based on poorly preserved material. New collections of ammonites have contributed to dating the formation (G. Li, 2001). Here, we discuss the taxonomy and biostratigraphy of the ammonites of the Qihulin Formation and the correlation between the Jehol, Jixi and Longzhaogou groups.

Biota), which are overlain by the Shaihai and Fuxin formations (yielding the Fuxin Biota) (W.L. Wang et al., 1989; Chen and Jin, 1999; M.M. Chang et al., 2003; G. Li, 2017a). Since the 1970s, new non-marine palaeontological data have made it possible to further consider the definition of a non-marine Jurassic–Cretaceous boundary in northern China. Several candidate horizons within the

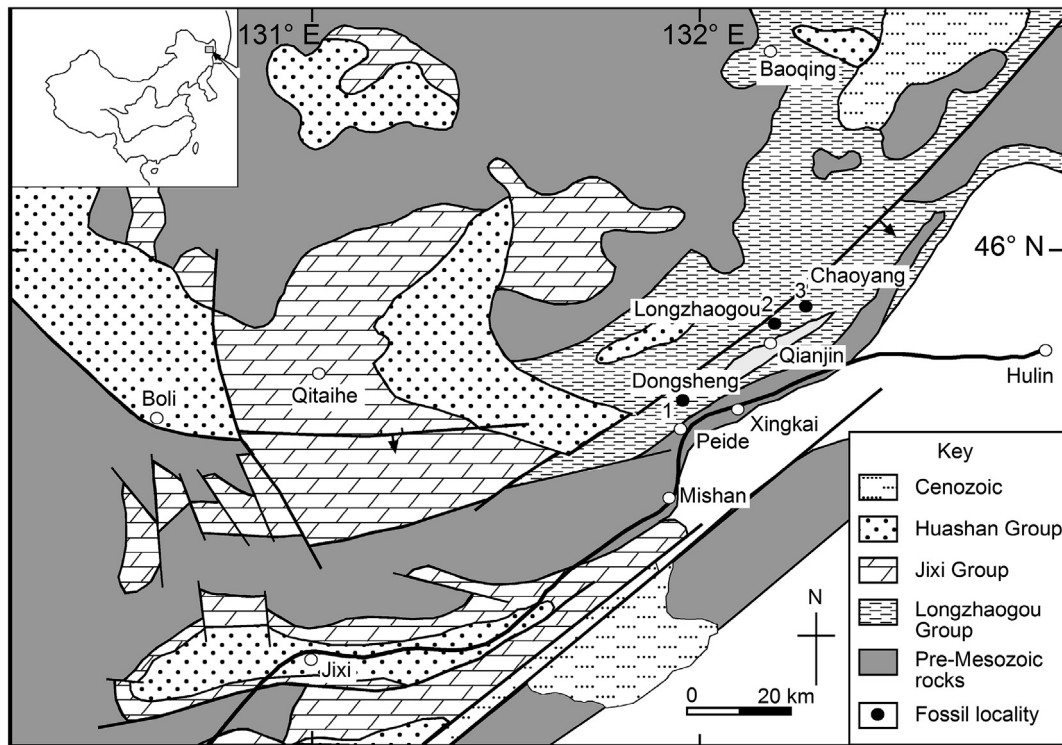


Fig. 1. Simplified geological map of the Jixi and Hulin areas showing localities sampled: 1. Dongsheng village; 2. Longzhaogou valley; 3. Chaoyang village (after Research Team on the Mesozoic Coal-bearing Formations in Eastern Heilongjiang, 1986).

2. Material and methods

The Longzhaogou Group is exposed in the Hulin, Mishan and Baoqing counties in eastern Heilongjiang (Fig. 1) and divided into four formations (Sha et al., 2003), in ascending order the Peide, Qihulin, Yunshan and Zhushan formations (Fig. 2). Exposures are limited in extent, the rocks strongly faulted and in most areas can only be studied in test trenches. The ammonites occur in a 2-m-thick black mudstone bed in the upper part of the dominantly marine Qihulin Formation. The formation is 430–680 m thick and consists of black shales, yellowish green sandstones and dark green siltstones, with coal-bearing beds in the lower part. In an attempt to find better preserved ammonites to allow a more reliable determination and dating of the formation, extensive field work and sampling were carried out by G. L. in 1995, 1997 and 1998 in Mishan and Hulin counties. A total of 96 ammonite specimens were collected from three localities (Fig. 1). Of these, 32 specimens are sufficiently well preserved for identification and are described below.

3. Previous work

In northeastern China there are three coeval Lower Cretaceous coal-bearing groups, the non-marine Jehol Group in western Liaoning and the alternately marine and non-marine Jixi and Longzhaogou groups in eastern Heilongjiang. The Jehol Group is divided into the Yixian and Jiufotang formations (yielding the well-known Jehol

Jehol Group were proposed to define this boundary (Hao et al., 1982; Chen, 1988), although other workers have insisted on a Jurassic age for the entire Jehol Group (Gu, 1982a,b; 1983). For dating the non-marine Jehol and Fuxin biotas using marine fossils, the eastern Heilongjiang area is a key region, because marine fossils and members of the Jehol and Fuxin biotas have been recovered from the Jixi and Longzhaogou groups. Three field campaigns were carried out separately in eastern Heilongjiang during the late 1970s and early 1980s.

In 1979, at the Second Chinese National Stratigraphic Congress, the Research Team on the Mesozoic Coal-bearing Formations in Eastern Heilongjiang (RTMCFH) presented an abstract on the Longzhaogou Group, dividing it in ascending order into the Middle Jurassic Peide and Qihulin formations and the Upper Jurassic Yunshan and Zhushan formations (Fig. 3). The Yunshan Formation was later further divided into the Lower Yunshan (or Xiayunshan) and Upper Yunshan (or Shangyunshan) formations (Gu and Chen, 1983; Research Team on the Mesozoic Coal-bearing Formations in Eastern Heilongjiang, 1986; Sha et al., 1994; Y.P. He, 2006). At the same congress, in 1979, an alternative subdivision was proposed, where the Longzhaogou Group was assigned to the Middle–Upper Jurassic and divided into the Dongshengcun Formation, Peide Formation (including the ammonite-bearing beds as the Qihulin member, as mentioned by Gu et al., 1997), and Yunshan Formation (divided into three members) (Ju et al., 1981). The two lower members of the Yunshan Formation were subsequently combined into the Chaoyangtun Formation (Ju et al., 1982) (Fig. 3). A further subdivision

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