

# The Key Role of Aptian-Albian Marine Fossils from Eastern Heilongjiang in Marine-Nonmarine Stratigraphic Correlation

Gang Li<sup>1\*</sup>, Peter Bengtson<sup>2</sup>

<sup>1</sup>State Key Laboratory of Palaeobiology and Stratigraphy, Center for Excellence in Life and Palaeoenvironment, Nanjing Institute of Geology and Palaeontology, Nanjing, China

<sup>2</sup>Institute of Earth Sciences, Heidelberg University, Heidelberg, Germany

Email: [gangli@nigpas.ac.cn](mailto:gangli@nigpas.ac.cn)

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## Abstract

The alternating marine and nonmarine coal-bearing Lower Cretaceous successions are well developed in eastern Heilongjiang, northeastern China, including the Jixi Group in the west and the Longzhaogou Group in the east. The correlation of these two lithostratigraphic groups with the nonmarine Jehol Group is important for dating the exceptionally well-preserved Jehol Biota. The Early Cretaceous marine fossils recovered from eastern Heilongjiang include ammonites, bivalves, radiolarians, foraminifers and dinocysts. During the early Aptian transgression the ammonite fauna entered the Hulin and Mishan areas and the bivalve *Aucellina* fauna in the Jixi area. This enables correlation of the marine lower part of the Chengzihe Formation of the Jixi Group with the Qihulin Formation of the Longzhaogou Group.

## Keywords

Lower Cretaceous, Aptian, Albian, Marine-Nonmarine Correlation, Marine Fossils, Eastern Heilongjiang, Northeastern China

## 1. Introduction

The upper Mesozoic deposits in China are mainly of nonmarine origin [1] [2]. The lack of index fossils makes it difficult to correlate precisely the nonmarine Cretaceous successions with the standard geological time scale. In particular, it is problematic to identify the nonmarine Jurassic-Cretaceous boundary [3], and to date the well-known Jehol Biota [4] [5]. In eastern Heilongjiang in northeastern China, an upper Lower Cretaceous succession of alternately marine and nonma-

rine coal-bearing rocks is well-developed, comprising the Jixi Group in the west (in which component taxa of the Jehol Biota were recovered) and the Longzhaogou Group in the east [6]. Since the discovery of the first ammonite specimen in 1958 [7], the coal-bearing beds in eastern Heilongjiang have attracted the attention of the Chinese geologists, not only because of the economic value of the coal, but also owing to the difficulties of stratigraphic correlation of the nonmarine and marine beds.

## 2. Marine Transgressions in Eastern Heilongjiang

The Early Cretaceous transgressions introduced marine faunas into eastern Heilongjiang, thus providing opportunities to correlate the Jixi and Longzhaogou groups. During the early Aptian transgression, the seawater advanced from the eastern continental margin through a narrow bay across the Hulin and Mishan areas to the Jixi area. The lower Aptian marine beds of the lower part of the Chengzihe Formation (Jixi Group) have yielded an *Aucellina* (*A.*) *caucasica-Filosina subovalis-Thracia rotundata* assemblage [8]. The contemporaneous marine Qihulin Formation (Longzhaogou Group) has yielded the following macro- and micro-faunas: 1) a low-diversity ammonite fauna dominated by *Pseudohaploceras?* cf. *nipponicum* and *Pseudohaploceras peideense*, with subordinate *Eogaudryceras* (*E.*) cf. *yunshanense* [9]; 2) an abundant bivalve fauna containing *Nuculana* (*Praesacella*) cf. *yatsushiroensis*, *Filosina subovalis* and *Thracia rotundata* [8]; 3) a low-diversity, poorly preserved radiolarian fauna containing *Archaeodictyomitra* sp., *Novixitus* sp. and *Xitus* sp. [10]; 4) a low-diversity agglutinated foraminifer fauna with *Cribrostomoides nonioninoides*, *Haplophragmoides concavus* and *H. gigas minor* [11].

The upper Aptian marine deposits of the upper part of the Yunshan Formation (Longzhaogou Group) are characterized by an *Aucellina* (*Aucellina*) *caucasica-A. (A.) aptiensis-Filosina subovalis-Thracia rotundata* bivalve assemblage, overlain by beds containing an *Aucellina* (*A.*) cf. *caucasica-A. (A.) cf. aptiensis* bivalve assemblage and an *Odontochitina operculata-esperopsis didaoensis* dinocyst assemblage. The upper part of the Chengzihe Formation (Jixi Group) contains a marine *Sinopsamobia ovalis-Filosina subovalis* bivalve assemblage [8].

The Albian marine transgression introduced dinocysts to the Muling Formation (Jixi Group), which include the endemic taxa *Circulodinium cingulatum* and *Sentusidinium* sp., and the cosmopolitan species *C. attadalicum*, *Palaeoperidinium cretaceum* and *Oligosphaeridium totum* [8]. A contemporaneous marine *Sinopsamobia ovalis* bivalve fauna has been identified in the Zhushan Formation (Longzhaogou Group).

## 3. Marine-Nonmarine Correlation

The marine lower part of the Chengzihe Formation can be correlated with the Qihulin Formation through the early Aptian marine transgression that brought the ammonite fauna to the Hulin and Mishan areas and the bivalve *Aucellina* to

the Jixi area [9]. The brackish-water bivalve *Sphaerioides yixianensis* (= *Tetoria yixianensis*) and the freshwater bivalves *Arguniella* cf. *quadrata* and *Arguniella* cf. *ventricosa* from the upper Chengzihe Formation provide direct correlation with the Shaihai Formation of the Jehol Group in western Liaoning [9]. The overlying Fuxin Formation of the upper part of the Jehol Group can be correlated with the Muling Formation of the upper part of the Jixi Group, through a *Sphaerium* bivalve fauna contained in both formations.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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