

黑龙江东部龙爪沟群七虎林组菊石之修定

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内 容 提 要

梁中发和王义刚分别于1982年和1983年记载了产自黑龙江东部龙爪沟群七虎林组的菊石化石。这些化石标本保存相当差,均为压模标本,当时鉴定计有 *Arctcephalites peideensis* Liang, *Calliphyloceras yunshanense* Liang, *Oxycerites yunshanensis* Liang, *Lobokosmoceras?* sp. 和 *Stenocadoceras* sp. (梁中发, 1982); *Arctcephalites* (*Cranoccephalites*) *hulinensis* Wang, *Stenocadoceras?* sp. 和 Gen. et sp. indet (王义刚, 1983) 9种。尽管他们记述菊石的产出地层名称不一,属、种鉴定也不相同,但这些化石确系产自同一层位或相当的层位中,而且都定其产出的层位时代为中侏罗世 Bathonian 期。最近,经重新研究这些化石的原标本后,认为它们应归于 *Kennicottia*, *Kossmaticeras* 和 *Pseudohaploceras* (或为 *silesitid*) 这几个类型。从这几个菊石类型的地质历程来看,它们产出的层位时代很可能是白垩纪 Barremian 期至 Campanian 期。

关键词 七虎林组 白垩纪 黑龙江东部

A REVISED CRETACEOUS AGE FOR AMMONITES, ORIGINALLY IDENTIFIED AS MIDDLE JURASSIC, FROM EASTERN HEILONGJIANG, CHINA

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Recent studies by Liang Zhongfa and Wang Yigang on the Qihulin Formation, Longzhaogou Group, eastern Heilongjiang Province of China indicated the presence of marine Middle Jurassic strata based on ammonite determinations. The original identifications were of a phylloceratid, ? oxyceritid, kosmocerotid and cardioceratid. These determinations are critically re-assessed here, and are now believed to comprise mainly desmocerataceans with subordinate tetragonitids. The Qihulin Formation is therefore of Cretaceous age, with potential ages from Barremian to Maastrichtian, but it cannot be resolved further here because of the poor ammonite preservation. This revised age has implications for the regional biostratigraphy and the lithostratigraphy, and in particular for the independent dating of the coal-bearing measures of the Longzhaogou and Jixi groups. No evidence remains for Middle Jurassic strata in eastern Heilongjiang.

Introduction

Liang Zhong-fa (1982) and Wang Yi-gang (1983) gave a Bathonian, Middle Jurassic age to ammonites from the Qihulin Formation in eastern Heilongjiang Province, Northeast China. The stratigraphy of the area was originally summarized by Gu Zhi-wei and Chen Dao-kuo (1983). The Qihulin Formation was placed as the second division of the Longzhaogou Group (Research Team and others, 1986).

Liang Zhong-fa (1982) originally figured and described ammonites including: *Arctocephalites peideensis* Liang, *Calliphylloceras yunshanense* Liang, *Oxycerites yunshanensis* Liang, *Lobokosmoceras?peideense* Liang, *Morphoceras longzhaogouense* Liang, *Paracadoceras* sp. and *Stenocadoceras* sp. Although this material was originally described as from the Peide Formation, it is actually from the Qihulin Formation. Subsequently Wang Yi-gang (1983) described *Arctocephalites* (*Cranocephalites*) *hulinensis* Wang and *Stenocadoceras?* sp. from the Qihulin Formation. These specimens provided the only evidence for Middle Jurassic strata from the southern Wanda Hills. However, despite their poor preservation, their reassessment here as desmocerataceans and tetragonitids leads to the contrasting conclusion of a Cretaceous age. This new opinion is very significant for the local stratigraphy, especially for the dating of the coal-bearing measures of the Jixi and Longzhaogou groups.

Qihulin ammonites

The original determinations of the Qihulin Formation ammonites as Middle Jurassic forms are reviewed below and the reasons for their individual re-appraisal are given. A summary of the original determinations, together with the revised determinations, is given in Table 1. The opinion of the present authors is that most of the ammonites can now be placed in the Desmoceratacea, and a small proportion in the Tetragonitidae, which suggests a Cretaceous age for the assemblages.

Table 1 Original and revised determinations of Qihulin Formation ammonites

Desmoceratacean Group A	
<i>Arctocephalites (Cranoecephalites) hulinensis</i> Wang 1983. pl. 1. fig. 1 (NIGP 74410) 2 (NIGP 74411) 3 (NIGP 74412) 4 (NIGP 74413) 5 (HM0004)	Refigured by Kelly and Wang: P1. 1. fig. 3 P1. 1. fig. 1 P1. 1. fig. 2
<i>Morphoceras lonzhaogouense</i> Liang 1982. pl. 1. fig. 3 (Ce064)	
<i>Paracadoceras</i> sp. Liang 1982. pl. 1. fig. 5 (Ce062)	
Desmoceratacean Group B	
<i>Arctocephalites peideensis</i> Liang 1982. pl. 1. fig. 6 (Ce061) 7 (Ce060)	P1. 1. fig. 5
<i>Stenocadoceras</i> sp. Liang 1982. pl. 1. fig. 9 (Ce063) Wang 1983. pl. 1. figs. 7, 8 (NIGP 74415)	P1. 1. fig. 4 P1. 1. fig. 6
<i>Lobokosmoceras? peideense</i> Liang 1982. pl. 1. fig. 4 (Ce059)	
Gen. et sp. indet. Wang 1983. pl. 1. fig. 6 (NIGP 74414)	P1. 1. fig. 9
Tetragonitid indet.	
<i>Calliphyloceras yunshanense</i> Liang 1982. pl. 1. fig. 1 (Ce057)	P1. 1. fig. 8
<i>Oxyerites yunshanensis</i> Liang 1982. pl. 1. fig. 8 (Ce058)	P1. 1. fig. 7

Desmocerataceans

The Qihulin ammonites can be divided into two morphological groups, informally referred to here as desmoceratacean groups A and B.

Desmoceratacean Group A (P1. 1, figs. 1–3) — Forms with distinct periodic constrictions comprising forms originally described as: *Arctocephalites (Cranoecephalites) hulinensis*, *Morphoceras lonzhaogouense*, and *Paracadoceras* sp.

Of the material that Wang (1983. pl. 1, figs. 1–5; Wang's figs. 3 and 5, refigured here. P1. 1, figs. 3 and 1 respectively) originally figured as *Arctocephalites*

(*Cranocephalites*) *hulinensis* sp. nov., all show marked constrictions and weak collars which appear first at a shell diameter of approximately 25mm. The constrictions occur three or four times on the last half whorl. The ribbing is weakly sigmoidal, being prorsiradiate at the umbilicus and towards the venter. The primaries branch in approximately the mid-flank region. Weak bullae may occur close to the umbilical shoulder. The precise shape of the venter is not seen in the crushed specimens, but in the photographs of Wang (1983, p1. 1, figs. 3, 5), a small portion of almost smooth venter is visible. The early whorls show a moderately high degree of involution, but the figures of Wang (1983, figs. 2, 3, 5) show a rapid change to more evolute form. The morphology indicates that the specimens cannot be accommodated within the Cardioceratidae (See Arkell *et al.*, 1957), but are better placed in the Desmoceratacea.

Morphoceras longzhaogouense Liang (1982, p1. 1, fig. 3; refigured here, P1. I, fig. 2) does bear superficial similarities to *Morphoceras* in lateral aspect, but the ventral aspect was not illustrated. The slightly flexuous ribs and forward inclined constrictions are a feature also present on a number of Cretaceous forms such as the desmocerataceans.

The specimen of *Paracadoceras* sp. (Liang, 1982, p1. 1, fig. 5) shows strong, slightly flexuous ribbing, branching close to the umbilicus, where there may be low umbilical tubercles. In *Paracadoceras* the ribs are more regularly swept forward and are straighter than this (Arkell *et al.*, 1957).

Desmoceratacean Group B (P1. I, figs. 4—6, 9) — Forms with very weak constrictions, comprising those originally described as: *Arctocephalites peideensis* Liang, *Lobokosmoceras peideense* Liang, *Stenocadoceras* sp., and Gen. et sp. indet.

The type specimens of *Arctocephalites peideensis* Liang (1982, p1. 1, figs. 6, 7; the latter refigured here, P1. I, fig. 5) have fine flexuous, prorsiradiate ribbing. However, the genus *Arctocephalites* has much straighter and coarser prorsiradiate ribbing (Arkell *et al.*, 1957).

Lobokosmoceras? peideense Liang (1982, p1. 1, fig. 4) has straight to slightly flexed ribbing. The original illustration of the venter is not clear and consequently there is difficulty in placing the specimen with confidence in any particular ammonite group.

Although the *Stenocadoceras* sp. figured by Liang (1982, p1. 1, fig. 9) does superficially resemble *Stenocadoceras*, the degree of ribbing is more flexuous. The specimens which Wang (1983, p1. 1, figs. 7, 8; refigured here, P1. I, fig. 6) referred to *Stenocadoceras?* sp. show a form with fairly straight prorsiradiate and mainly simple ribbing which lacks tubercles. There are constrictions. The shell is moderately involute, having just over half the previous whorl covered. The constrictions preclude a cardioceratid identification.

The specimen of Gen. et sp. indet. of Wang (1983, p1. 1, fig. 6; refigured here, P1. I, fig. 9) showed an ammonite having traces of constrictions and sigmoidal ribbing. The venter is flattened. The umbilical region is not seen clearly.

Affinities of the Qihulin desmoceratacean faunas

From the material available at present it is not clear whether the two desmoceratacean groups represent two separate taxa, or whether they represent the morphological extremes of a single taxon. These groups have their closest representatives in the genera *Kossmaticeras*, *Kennicottia*, *Pseudohaploceras* or one of the more involute silesitids. These

taxa are examined and their biostratigraphic significance discussed.

1. *Kossmaticeras* De Grossouvre (1901), type species *K. theoboldianum* (Stolickzka, 1865; see also Kennedy and Klinger, 1985; Matsumoto, 1955, 1956), from the Santonian of southern India, is a moderately involute and oval to compressed desmoceratacean; ribbing normally passes over the venter without interruption; usually with only weak umbilical tubercles in *K.* (*Kossmaticeras*). The constrictions show marked obliquity with the ribs.

The oblique relationship between ribbing and constrictions appears weakly on some of the Chinese specimens (Pl. I, figs. 1—3). However, the smooth venter (Pl. I, figs. 3, 9) contrasts with *Kossmaticeras*.

2. *Kennicottia* Imlay (1959), type species *K. bifurcata* Imlay, Early Albian, Alaska. Involute puzosiine with subquadrate whorl section, flexuous ribbing and constrictions, reduced secondary ribs on the venter. The Qihulin fauna is all more coarsely ribbed than both *K. bifurcata* and *K. rugosa* Imlay (1959, 1960).

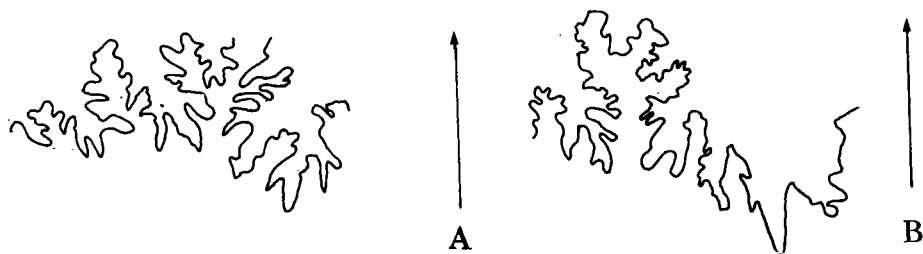
3. *Pseudohaploceras* Hyatt (1900), type species *Ammonites liptoviensis* Zeuschner, Barremian of Austria; genus ranges into Aptian. A compressed puzosiine with regular straight or slightly sinuous constrictions (some collared), with finer ribs in between. The Qihulin specimens are much finer and less flexuously ribbed than the specimens referred to *Pseudohaploceras* spp. by Liu Gui-fang (1988) from the Aptian of Xizang (Tibet).

4. *Silesites* Uhlig (1883), type species *Ammonites seranonis* D'orbigny (1841) from the Barremian of France; genus ranges into Aptian. Generally an evolute desmoceratacean. One of the closest geographical occurrences to China was described from the Late Barremian of the Crimea (Drushchits and Kudryavtseva, 1960). The ribbing in this species is rectiradiate and often tuberculate at the ventrolateral shoulder where secondaries form before being swept forward over the venter. The Qihulin specimens differ in having slightly more flexuous ribbing and the secondary ribs branching slightly higher on the flank.

Parasilesites, type species *P. bullatus* Imlay (1959), originally stated to occur in the Albian of Alaska (Imlay, 1960), actually occurs in the Late Aptian, *jacobi* Zone equivalent (Owen, 1988). It is not a silesitid, but is the puzosiinid, *Callizoniceras* (*Wollemaniceras*) (H. G. Owen, pers. comm. 1990). It is differentiated from the Qihulin desmocerataceans by its overall more evolute form. *Silesites sensu stricto* and *Neosilesites* (See Arkell *et al.*, 1957) are both contrasted with *Parasilesites* by the more rectiradiate ribbing and branching of the ribs high on the flank. The specimens figured on Pl. I, figs. 3, 9 show suppression of the ribbing on the venter, a feature which also appears weakly on the illustrations of the type specimens of *Parasilesites bullatus* Imlay (1959, pl. 1, figs. 4, 6, 7). In *Umsinenoceras* Kennedy *et al.* (1979), from the Middle Albian of Zululand, southern Africa, there is a smooth, tabulate venter, and the development of ventrolateral tubercles.

The Chinese specimens show some resemblance to *Silesites antarcticus* Thomson (1974) from the Fossil Bluff Group of Alexander Island, Antarctica. The Antarctic specimens differ in having ribs which are more strongly swept forward at the venter and pass across it. Initially, Thomson was unsure of the age of this material and dated it broadly as Barremian to Albian. Subsequently, this has been refined by Kelly (in press) who dated the appearance as Early Aptian. The species is also recorded from the Albian on James Ross Island (Thomson, 1984). Other austral material from the Late Albian of Patagonia, southern

Argentina, has been referred to the genus *Eommarshallites* by Medina and Rinaldi (1986), a form with well-developed umbilical tubercles, which they placed within the family Kossmaticerataidae because the ribbing was stated to be oblique to the constrictions.



Text-fig. 1 A. Detail of suture line of Ce060, desmoceratacean Group B. $\times 5$ (See also Pl. 1, fig. 5). B. Detail of suture line of Ce056, tetragonitid indet., $\times 6.4$ (see also Pl. 1, fig. 8).

Tetragonitids

The type specimen of *Calliphyloceras yunshanense* Liang (1982, pl. 1, figs. 1—2) (refigured here, Pl. 1, fig. 8) shows about one-third of a partly septate whorl with nearly rounded cross section. The characteristic feature is the appearance of five regular, straight, radial and unflexed constrictions upon an otherwise nearly smooth shell interior. An incomplete suture is shown on Text-fig. 1a. According to Arkell *et al.* (1957), *Calliphyloceras* is compressed and the interior constrictions are sigmoidal. The Heilongjiang specimens could be much better accommodated within the Tetragonitidae, possibly *Eotetragonites* Breistoffer (1947) from the ? Barremian, Aptian to Albian (See Murphy, 1967), *Anagaudryceras* Shimizu (1934) from the Albian to Maastrichtian, or *Zelandites* Marshall (1926) also from the Albian to Maastrichtian. M. A. Murphy (personal communication 1991) believed that Plate 1, figs. 7, 8 probably represented *Anagaudryceras*.

The apparently oxyconic *Oxycerites yunshanensis* Liang (1982, pl. 1, fig. 8) (refigured Pl. 1, fig. 7) is actually crushed. It has a compressed whorl section, but with a rounded venter. The ornament comprises fine, dense, almost straight lirae with spaced, raised collar-like ribs also covered by the lirae. Although similar ornament is also found on desmocerataceans such as *Barremites* (Hauterivian—Barremian) or *Pachydesmoceras* (Late Albian—Turonian), the collars are nearly straight and lack the sinuosity of these genera. Such collars and lirae are typical of tetragonitids.

Other opinions on the age of the Qihulin Formation

Independent to our own observations, Sha Jin-geng had received previously comments from other palaeontologists concerning the age of the Qihulin Formation ammonites, mainly based on examination of photographs. I. I. Sey and E. D. Kalacheva (VSEGEI, Leningrad) had suggested that Liang's (1982) specimens included gaudryceratines, and that Wang's (1983) specimens included *Pseudohaploceras*. He Guo-xiong (Nanjing) also suggested that the ammonites of the Qihulin Formation are more similar to those of Early Cretaceous than those of Middle Jurassic age.

H. G. Owen and M. K. Howarth (British Museum of Natural History) indicated, on seeing the original published figures of Wang Yi-gang (1983) and Liang Zhong-fa (1982),

the probable presence of *Pseudohaploceras* and *Silesites* amongst these faunas. However, on re-examination of fresh photographs, they felt strongly that the assemblage appeared to be of Late Cretaceous age, probably Campanian. W. J. Kennedy (University of Oxford) felt that the whole assemblage was either Albian or Campanian.

Biostratigraphic relationships of the Qihulin Formation

The occurrence of Jurassic-Cretaceous boundary buchiid bivalves (Sha Jin-geng and Yuan Fu-sheng, 1985) in the Dong'anzen Formation, indicates that the Qihulin Formation must be younger than the Dong'anzen Formation.

The Upper Yunshan Formation, which was stated by Gu Zhi-wei and Chen Dao-kuo (1983) to be above the Qihulin Formation, was originally dated Late Jurassic. However, Sha Jin-geng (1990) described two levels in the formation in which the bivalve *Aucellina* occurred. A lower level contained *A. aptiensis-caucasica-jeletzki* group and a higher level *A. aptiensis-caucasica*. The genus *Aucellina* is a mid-Cretaceous bivalve which ranges from the Barremian to the Turonian and the *aptiensis-caucasica* group occurs in Barremian—earliest Albian. It appears, therefore, that the relationship between the Upper Yunshan Formation and the Qihulin Formation may not be clear. If a Campanian age can be demonstrated for the Qihulin Formation, then the Upper Yunshan Formation is the older unit. However, if a late Early Cretaceous age can be demonstrated, then the Upper Yunshan Formation might be coeval or even younger.

Conclusions

The poor preservation of the Qihulin ammonite faunas is a serious problem which has affected the opinions of those people who have offered determination. This problem still prevents their precise determination. Clearly, the original Middle Jurassic age given for the formation (Liang, 1982; Wang, 1983) is no longer tenable. Whilst the bulk of the Qihulin ammonite collections comprise desmocerataceans, their precise generic attribution remains unresolved. The most likely placement is within *Kennicottia*, *Kossmaticeras*, *Pseudohaploceras* or as a silesitid. *Kennicottia* would suggest a Late Aptian age. *Pseudohaploceras* and silesitids would indicate Barremian to Aptian, while *Kossmaticeras* ranges from Albian to Campanian. On desmoceratacean evidence, the age of the Qihulin Formation must be constrained within the Barremian to Campanian stages. The stratigraphic occurrence of the tetragonitids *Pachydesmoceras*, *Eotragonites*, *Anagaudryceras* and *Zelandites* also fall largely within the same range, but may be as late as Maastrichtian. More precise generic determinations and full revision of the systematics of these ammonites will depend on further biostratigraphic collections to be made. The most likely age of the Qihulin ammonite fauna is probably Albian or Campanian, although the possible range is from Barremian to Campanian, with one or more stages being represented. Future collections may show greater affinity with other Late Cretaceous faunas, in particular the desmocerataceans, illustrated by Henderson (1970) from the Mata Series of New Zealand and by Henderson and McNamara (1985) from the Miria Formation of Australia.

The results of this conclusion have considerable significance for the biostratigraphy of eastern Heilongjiang Province, in particular for the Longzhaogou Group of the Southern

Wanda Hills, and the Jixi Group of the Jixi and Boli Coal Fields. They bear out the conclusions of Sha Jin-geng (1990) that Cretaceous rocks are present in the basins. However, they indicate that biostratigraphic relationships between lithostratigraphic units are not reliable at present. A thorough major revision of the biostratigraphy in this economically significant area is urgently required. Such a work should be based on a composite study of all biota, but especially well-preserved ammonites, bivalves and microbiota, based on new and detailed bed-by-bed collecting on well exposed stratigraphic sections.

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Explanation of Plate I

All specimens from the Qihulin Formation, eastern Heilongjiang Province. Figs. 1—7 are lateral views. $\times 1$: Figs. 8, 9 are oblique lateral views. $\times 1$.

1—3. desmoceratacean ammonite group A: 1. HM004; 2. Ce064; 3. NIGP 74412.

4—6, 9. desmoceratacean ammonite group B: 4. Ce063; 5. Ce060 (see also Text-fig. 1A); 6. NIGP74415; 9. NIGP74414.

7, 8. tetragonitid ammonite: 7. Ce058. showing shell exterior; 8. Ce056. partly exfoliated shell showing exposed suture (see also Text-fig. 1B)

