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Early Cretaceous Ammonites of the Sikhote-Alin and their Biostratigraphic and Biogeographic Implications

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Some Early Cretaceous ammonites nominally listed in the stratigraphic schemes and works on the Lower Cretaceous stratigraphy of the Sikhote-Alin are briefly described and pictured in this paper. Side by side with the ammonites, a succession of buchian assemblages is suggested for the recognized stratigraphic levels. The Barremian species *Pseudohaploceras*, being identified for the first time in the Sikhote-Alin, closely resembles ammonites of NE China. The new species *P. chinense* has been described regarding the materials obtained from China. The Early Cretaceous marine fauna of the Sikhote-Alin has been examined, in which ammonite assemblages are represented mostly by Tethyan species, whereas benthonic assemblages contain Boreal species defining an ecotone type of the marine communities of the area.

Reliable, paleontologically provided stratigraphic base serves as the bulk of geological investigations of different character and scale and first of all geological mapping. This is equally applied not only to the regions with normally stratified rocks, but also to the regions with very complicated geological structure and evolution, to which the Sikhote-Alin system is in full extent referred. The latter, as at the present time regarded [4, 13, etc.], is of accretionary nature and consists of terranes of delaminated accretionary prisms. For this reason, it is proposed to refuse from primacy of stratigraphic methods in favour of tectono-stratigraphic complexes as the basic units for mapping [4]. Such a proposal for the complicated region seems to be expedient. Nevertheless, a correct deciphering of the structure of any terrane as well as the history of its formation is hardly possible without using biostratigraphic method and without considering paleontological data.

The Early Cretaceous is one of the most important stages in the evolution of the Sikhote-Alin system. There the beginning of the Early Cretaceous has been marked by intensive tectonic activity, i.e. along with the accumulation

of terrigenous sediments, olistostromes were forming accompanied by the generation of large allochthonous slices [5]. Hence, accurate paleontological documentation of the tectono-stratigraphic complexes formed at that time assumes particular prominence in terms of both micro- and macrofossils. Unfortunately, it should be stated that the descriptions and pictures of the Cretaceous macrofauna, first of all ammonoids from the Sikhote-Alin, are absent in published literarure as well as in manuscripts.

General and special works, mostly schemes adopted at the stratigraphic conferences [8] present lists of ammonites and bivalves including buchiids and inoceramids, which are rather significant for stratigraphy. Nevertheless, because their descriptions are still unpublished, their value appears to be less significant.

In a small paper [9] the authors have described and pictured some ammonites from the Lower Cretaceous of the Middle Sikhote-Alin. In the authors' opinion, descriptions of some more Early Cretaceous ammonites, the specimens or figures of which they possess and which are noted in papers, monographs and stratigraphic schemes, should be published as well. In addition to stratigraphic values for geological mapping and tectonic constructions, they proved to be of paramount interest in respect of paleozoogeographic reconstructions.

Early Cretaceous ammonites of the Sikhote-Alin system have been established in the northern part of the area, within the Khungari terrane, as determined by A.I. Khanchuk [13]. However, it should be pointed out that in the Far East, namely in Primorye, an ammonite assemblage from the lowermost Lower Cretaceous is known from the Khanka massif or, in the light of the latest constructions, in the Khanka-Bureya accretionary system. Here on the eastern bank of the Gulf of Ussuri the deposits of the Chigan formation contain *Pseudosubplanites* cf. *grands* (Mazenot), *P.* aff. *combesi* Le Hegarat, *Pseudosubplanites* sp., *Berriasella* ex gr. *jacobi* Maz., *Dalmasiceras* sp. nov., marking the lowermost zone of the Berriasian stage – jacobi/grands zone of the European scale [11].

In the Khungari terrane an ammonite identified by Ye.P. Brudnitskaya as *Pectinatites* sp. ind. (cf. *P. fedorovi* Mesezhnikov) (Fig. 1) has been encountered in the lowermost Cretaceous sequence in the Gobilli river area (the Anyui River basin). It bears a specific sculpture composed of frequent fine densely-spaced and slightly curved ribs, mostly bipartite with different branching habit and place. By the last volution ribs appear somewhat broader and rarer, but its specific branching habit is preserved. Such a branching habit appears to be indicative of the genus *Substeuroceras* Spath, so we identify this specimen as *Substeuroceras* cf. *kellumi* Imlay and correlate it with the forms of the species described by R. Imlay from Mexico [18, p. 50, Plate 14, Figs 1, 2] and

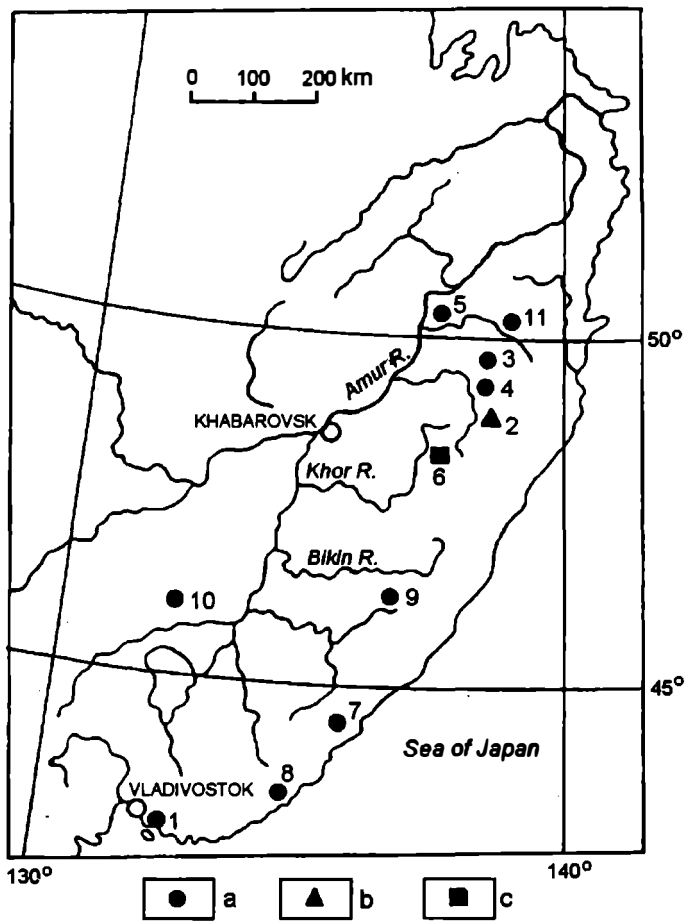
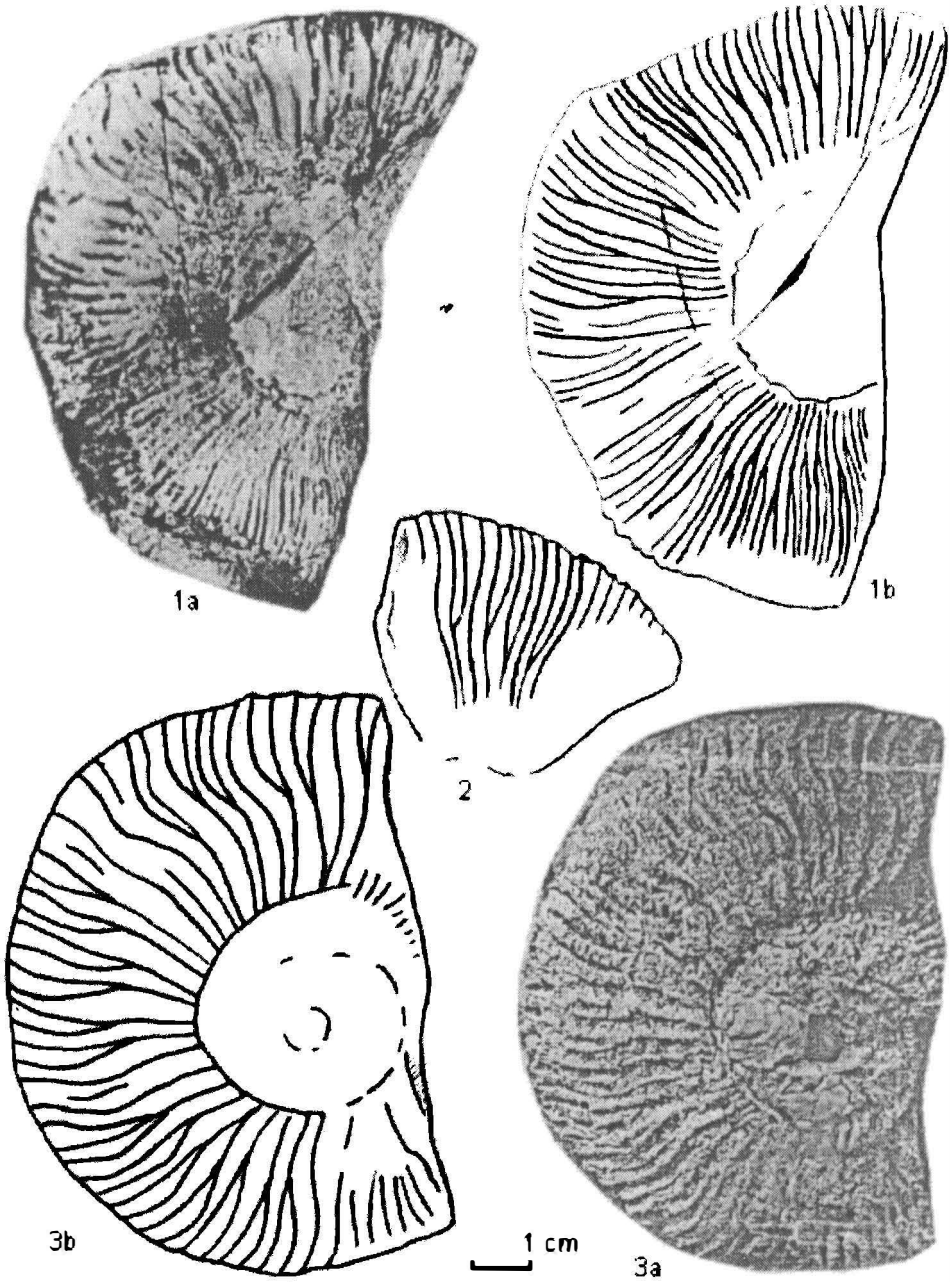


Fig. 1 Location of Early Cretaceous ammonites (Berriasian-Barremian).

1 – South Primorye, Gulf of Ussuri: *Pseudosubplanites, Berriasella, Dalmasiceras* (lowermost Berriasian); 2 – Anyui River basin, Gobilli river: *Substeuroceras, Parodontoceras* (Early Berriasian); 3 – Dzhaur River upper reaches: *Fauriella* (Early Berriasian); 4 – Anyui River basin, Taunga river: *Spiticeras, Fauriella, Berriasella*? (Late Berriasian); 5 – right bank of the Amur River, Pivan railway station: *Sarasinella* (Early Valanginian); 6 – Khor River basin, Kabuli river: *Homolsomites* (Late Valanginian-lowermost Hauterivian); 7 – Dalnegorsk region: *Olcostephanus* (Late Valanginian), *Neocomites* ("middle" Valanginian); 8 – Chernaya River: *Neocomites* (Late Valanginian); 9 – Armu River basin: *Pseudohaploceras* sp. nov. (Barremian); 10 – NE China, Heilongjiang Province *Pseudohaploceras* sp. nov. (Barremian); 11 – Gur River basin: *Crioceratinae*? (?Early Hauterivian – Early Aptian).

Ammonites: a – Tethyan, b – Pacific, c – Boreal.

Plate 1



California [19, p. 42, Plate 10, Figs 19, 20]. A photo of the ammonite of bad quality is accompanied with a picture showing more distinctly the most characteristic features of the sculpture (Plate 1, Figs 1 a, b). At present representatives of the genus *Substeuroceras*, like the *Substeuroceras* koeneni zone from Argentine, are considered as the Early Berriasian* [31, 36].

Along the Gobilli river apart from the location of the above-mentioned ammonite there were found buchians, namely: *Buchia hyatti* (Pavl.), *B. tenuicollis* (Pavl.), *B. trigonoides* (Lah.), *B.* cf. *russiensis* (Pavl.), *B.* cf. *lahuseni* (Pavl.), and *B. fischeriana* (Orb.) (identified by Ye.P. Brudnitskaya and L.D. Tretyakova). According to the list, the assemblage indicates Late Volginian age. Based on the recent concepts, the Late Volginian substage belongs to the Cretaceous system and is related to the Early Berriasian [7, 12, 36] coinciding with ammonite dating.

Also in the Gobilli River basin (the Taunga River) there was found a fragment of a large ammonite volution which was first determined by Ye.P. Brudnitskaya as *Parodontoceras* ? sp. ind., and then as *Pectinatites*. However, the former definition seems to be more correct. The specimen resembles *Substeuroceras* in sculpture but at the same time it is closely allied to the fragment *Parodontoceras reed* (Anderson) from British Columbia [21, Plate 1, Fig. 3]. According to H. Verna and G. Westermann [34, p. 228], the two genera have many characters in common and in many cases it may be difficult to differentiate them, hence we preserve the original definition, that is *Paradontoceras* sp. ind. for this ammonite (Plate 1, Fig. 2). The ammonite is probably dated as the Early Berriasian.

Ammonite from the Upper Dzhaur river is most likely the early Berriasian, being previously identified by N.P. Luppov as *Berriasella* aff. *gallica* Maz. and figured later on as *B. (Fauriella)* aff. *gallica* [14] and *Fauriella* aff. *gallica* [8]. Nevertheless, this ammonite differs considerably from *F. gallica* [28, p. 140,

*At present there is no universal subdivision of the Berriasian into substages. We date B. jacobi/P. grands and Tirnovella occitanica zones as Early Berriasian , and Fauriella boissieri zone as Late Berriasian of the European scale.

Plate 1

Fig. 1 a, b *Substeuroceras* cf. *kellumi* Imlay.

Gobilli river, Anyui River basin. Collected by I.P. Boiko, 1965. Lower Berriasian.

Fig. 2 *Parodontoceras* sp. ind.

Taunga river, Anyui River basin. Collected by S.L. Shteinberg, 1965. Lower Berriasian.

Fig. 3 a, b *Fauriella* ex gr. *floquinensis* Le Hegarat.

Dzhaur River upper reaches, Gur River basin. Collected by N.P. Makeeva, 1970. Lower Berriasian.

Plate 23, Figs 3, 4] in size, the whorl pattern and especially in type of sculpture. This peculiar large ammonite is distinguishable by its high whorl and has clear, fine sickle-curved, moderately frequent ribs, which are separated by broader intercostal spaces.The ribs are bipartite and simple, with branching near the middle of the flanks, the branching point, however, appears unfixed. In some cases, ribs are arranged in pairs at the umbilical shoulder.

Anyhow, out of the known *Fauriella* the above-described specimen seems to be closely allied to *Fauriella floquinensis* Le Hegarat [23, p. 156, Plate 47, Figs 4, 5] from the Lower Berriasian of France. It is also distinguished by a large shell and rather rare ribs including those on the earlier volutions. Fascicules and tubercles are observed only on the living chamber that our specimen most likely did not preserve. Therefore we restrict it to the mentioned species determining it as *Fauriella* ex gr. *floquinensis* (Plate 1, Figs 3 a, b), but with some degree of doubt. At the same location and nearby the ammonite there was found an association of the Late Volginian buchias: *B. fischeriana, B. unschensis, B. terebratuloides,* and *B.* aff. *B. okensis* suggesting the age of the ammonite not older than Early Berriasian.

Next stratigraphic level containing ammonites and buchias has been established in the Taunga River basin. The first ammonites were encountered here. They were identified as *Craspedites?* sp. ind. and *Surites*? sp. ind., and then re-determined (without descriptions and pictures) by Ye.A. Kalinin.He identified the former as *Spiticeras (S.) multiforme* Djanelidze that, in our opinion, seems exact, despite the fact that it is figured only as *Spiticeras (S.)* sp. in literature [1, 8]. The ammonite is a small semi-involute shell and has a typical spiticeratic sculpture composed of short relief primary ribs and fascicules arranged in 3 or 4 finer secondary ribs. A distinct constriction can be observed (Plate 2, Fig. 6). Species *S. (S.) multiforme* is known from South Europe [15, p. 143, Plate 7, Fig. 3; 20, p. 68, Plate 3, Fig. 3] and according to Le Hegarat [23, p. 232], indicates Late Berriasian age.

Another specimen *(Surites?)* referred to the genus *Tirnovella* by Ye.A. Kalinin [1] is part of a small ammonite characterized by a low last volution and being grouped in pairs at the umbilical shoulder. The specimen has sickle-curved, bipartite ribs with tubercles at the base.Such aribbing habit is typical of two Berriasian genera – *Tirnovella* and *Fauriella*. Of these, the former commonly has more involute shell with a high last volution. By the height of its volution and umbilicus width the specimen might be correlated with *Fauriella* and identified as *Fauriella* sp. ind. (Plate 2, Fig. 7).

In addition, from the Taunga River basin Ye.A. Kalinin [1, 8] recognized *Berriasella* sp. However, the ammonite differs by fragmentary material on its inner volutions and fine straight, bipartite and simple ribs. This suggests that the specimen might be identified only as *Berriasella*? (Plate 2, Fig. 4).

Along with the above-mentioned ammonites, based on Ye.A. Kalinin's data, there were found buchias – *Buchia okensis* (Pavl.) and *B. volgensis* (Lah.) suggesting the affinity of the assemblage to lower Upper Berriasian substage. On the basis of the buchias pictured in the manuscripts, Late Berriasian uppermost beds containing *B. uncitoides* (Pavl.), *B. tolmatschowi* (Sok.), and *B. inflata* (Lah.) occur in the Taunga River basin.

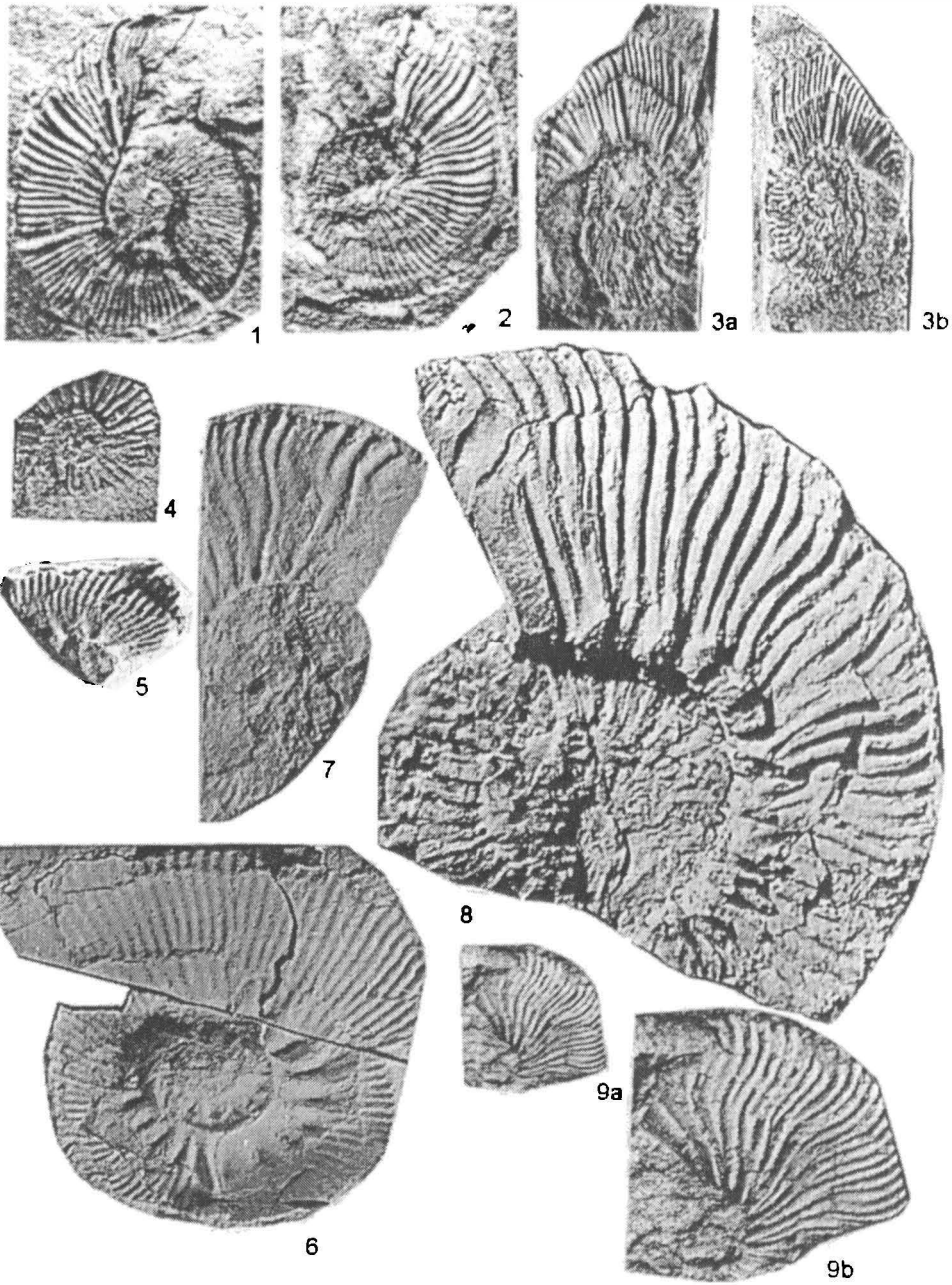
Valanginian ammonites within the Northern Sikhote-Alin are rather scarse. The only specimen to be characterized is that from the Pivan cross-section on the Amur River right bank (Gorin terrane) known as *Polyptychites*, which was later on transformed into *Kilianella* [1, 8]. In contrast to kilianellas, this large ammonite is distinguished by its involute shell and high last volution, comparatively narrow umbilicus and very large circum-umbilical tubercles with 2 or 3 coarsely-spaced ribs deviated from the tubercles in the form of fascicles. This specimen is specific enough to be referred to the genus *Sarasinella*. On the basis of the whorl pattern and the general type of sculpture, the specimen is most closely similar to *S. varians* Uhig [33, p. 236, Plate 81, Fig. 3] and can be identified as *Sarasinella* cf. *varians* Uhig (Plate 2, Fig. 8). The startigraphic distribution of the species has not been established. The genus *Sarasinella* is widespread throughout the Valanginian and lowermost Hauterivian. Ye.A. Kalinin [1] places the ammonite into Lower Valanginian beds containing *Buchia keyserlingi,* although its Late Valanginian age seems probable.

Beds containing *Homolsomites* sp. found by Ye.A. Kalinin in the Kabuli River basin, a tributary to the Khor River (Khungari terrane) might occupy a higher stratigraphic position. Ye. Kalinin established the following succession for the Valanginian of the region: beds with Early Valanginian *B. keyserlingi* and *B.* cf. *inflata,* beds containing Late Valanginian *B. crassicollis* and *B. sublaevis,* and beds with Late Valanginian – Early Hauterivian *Homolsomites* sp. and *B.* aff. *sublaevis* [2]. Unfortunately, the description of the Sikhote-Alin *Homolsomites* has not been published*. However, it is one of the few Boreal elements in the Early Cretaceous ammonite fauna of the region.

When dealing with Northern Sikhote-Alin, one should mention another known ammonite. We mean the specimen from the Gur River basin which G.Ya. Krymgolts identified as Toarcian *Lillia* sp. (=*Phymatoceras*). Afterwards the specimen has been conventionally referred to the family Hammatoceratidae (Toarcian-Bajocian) from the photo available. A.A. Kapitsa and L.D. Tretyakova proposed a younger age of the ammonite as early as in the 1960s. The ammonite under discussion is either part of the whorl of a large evolute ammonite with

*The manuscript is deposited in VINITI.

Plate 2



an extensive shell spiral or part of coiled ammonite having wide rarely spaced ribs grouped in pairs near the umbilical shoulder and constrictions (Plate 3, Fig. 4). However, the taxonomical affinity of the ammonite appeared undetermined, but its Cretaceous age is the most probable. Some representatives of the subfamily Crioceratinae (Lower Hauterivian-Lower Aptian) have close ribbing habit, although other taxonomical comparisons might be made.

Valanginian ammonites are widely distributed in the southeastern part of the Sikhote-Alin system, within the Pribrezhny or Taukha terranes. Some of them, as it has been mentioned, were previously published [9], but we re-reproduce them giving a brief characteristics and detailed idefntifications.

The first ammonite to be begun with is *"Stephanoceras* ex gr. *umbilicus"* from the Rudnaya River basin (Tigrovyi Creek) being for a long time indicative of the Middle Jurassic for the Gorbusha suite (series). According to V.A. Mikhailov [4, 6], the ammonite originates from neoautochthonic terrigenous formations overlying with erosion allochthonous slices of the Gorbusha series. The ammonite is distinguishable by having wide, rounded, involute whorls, narrow umbilicus with vertical walls, high, elongated triangle-formed primary ribs, ending in tubercles with fascicles of fine ribs. On the ground of these characters, the species might be related to the genus *Olcostephanus*. On the species level, it closely resembles *Q. quadriradiatus* Imlay [17, p. 554, Plate 5, Figs. 1, 2] from the Upper Valanginian of Mexico

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Plate 2

Figs 1-3 *Pseudohaploceras chinense* sp. nov. 1,2 – Chinese ammonites from NE China, Heilongjiang Province, Qihulin Formation, Lungzhagou Group [Liang Zhong-fa, 1982, Plate 1, fig. 3,5 = *Arctocephalites (Cranocephalites) hulinensis* sp. nov.]. 3. Holotype: a – core, b – imprint. Specimen 160/12949, CNIGR museum, St.-Petersburg. Armu River basin, Molodezhny settlement area. Barremian.

Fig. 4 *Berriasella*? Taunga River, Anyui River basin. Collected by L.D. Tretyakova, 1969. Upper Berriasian.

Fig. 5 *Olcostephanus* sp. juv. Rudnaya River basin. Collected by N.K. Zharnikova, 1984. Valanginian.

Fig. 6 *Spiticeras (Spiticeras) multiforme* Djanelidze. Taunga River, Anyui River basin. Collected by L.D. Tretyakova, 1969. Upper Berriasian.

Fig. 7 *Fauriella* sp. ind. Taunga River, Anyui River basin. Collected by L.D. Tretyakova, 1969. Upper Berriasian.

Fig. 8. *Sarasinella* cf. *varians* (Uhlig). Amur River, opposite Komsomolsk (Pivan landing). Collected by A.A. Kapitsa and L.D. Tretyakova, 1965. Lower Valanginian.

Fig. 9 a, b *Neocomites* sp. a – natural-size specimens; b – 2 × exaggeration. Rudnaya River basin. Collected by N.K. Zharnikova, 1984. Upper Valanginian.

Natural size of specimens is given here, except for those specially mentioned.

Plate 3

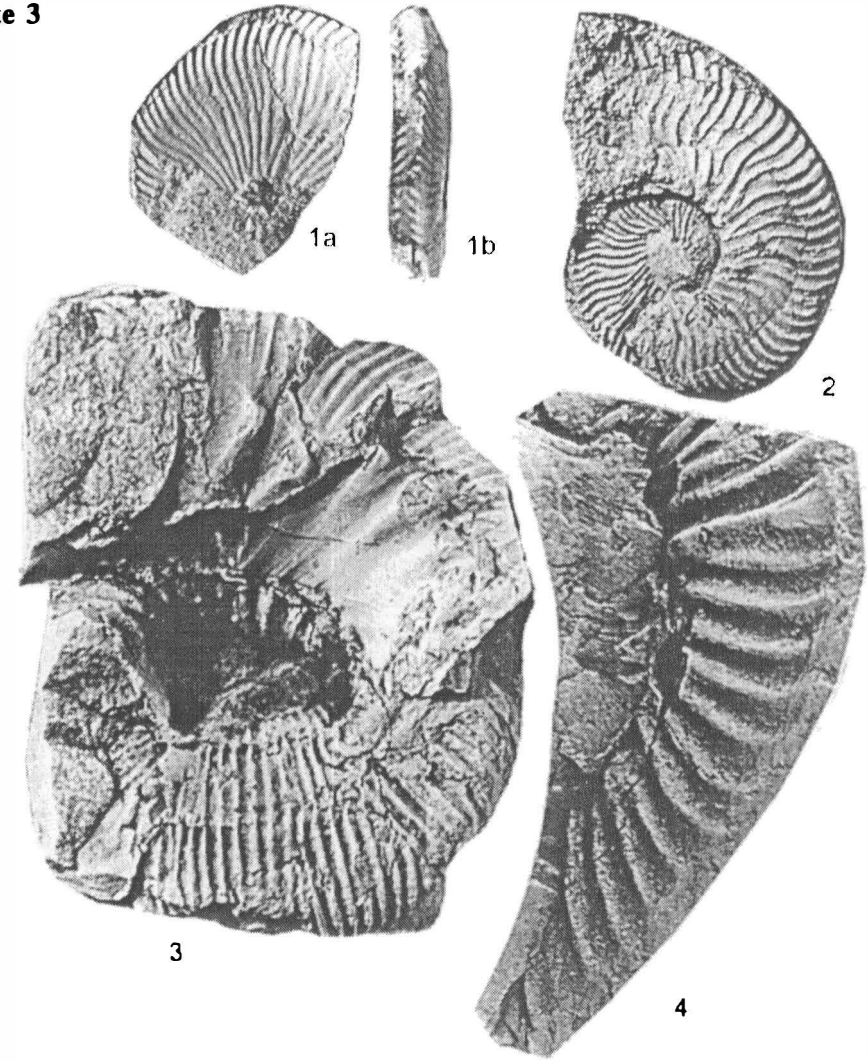

Fig. 1 a, b *Neocomites neocomiensis* (Orbigny). Chernaya River. Collected by V.P. Mikhnovich, 1958. Collection of N.S. Voronets, N 6401, CNIGR museum, St.-Petersburg. Valanginian.

Fig. 2 *Neocomites teschenensis* (Uhlig). Monastyrka River basin, Dalnegorsk region. Collected by P.V. Markevich, 1958. Valanginian.

Fig. 3 *Olcostephanus* cf. *quadriradiatus* Imlay. Rudnaya River basin, Tigrovy Spring. Collected by Yu.T. Gurulev, 1959. Upper Valanginian.

Fig. 4 Crioceratinae? A fragment of an ammonite volution, earlier determined as *Phymatoceras* or *Hammatoceratidae*. The right bank of the Gur River, Darvi Creek upper reaches. Collected by V.I. Pliev, 1954. Hauterivian-Aptian?

Natural size.

and we have identified it as *Olcostaphanus* cf. *quadriradiatus* Imlay (Plate 3, Fig. 3).

Also from the area of Dalnegorsk region (the Monastyrka River basin) V.N. Vereshchagin identified *Neocomites* cf. *neocomiensis* (Orb.). As compared to the species *neocomiensis*, the given ammonite differs from it in having more evolute shell, coarser and rare ribs swelled near the ventral margin (Plate 3, Fig. 2). Therefore we agree in considering the above ammonite to be the closest ally of *Neocomites teschenensis* (Uhlig) [30, p. 32, Plate 3, Fig. 13]. This species appears to be commonly developed in the uppermost Lower to lowermost Upper Valanginian of the European sections.

Neocomites from the stratotype of the Taukha suite on the Chernaya river, in the southern Pribrezhny terrane, is figured in various works under different names, for instance, *N.* aff. *occitanicus, N.* aff. *retowski,* and *N. ussuriensis.* The given specimen is characterized by having an involute flattened shell consisting of high whorls, narrow closed umbilicus, and fine frequent ribbing. Owing to these distinctions, the specimen can be identified with *Neocomites neocomiensis* (Orb.) (Plate 3, Figs 1 a,b). The species is widespread in the uppermost Lower and dominantly in the Upper Valanginian.

In our collection there is an ammonite from newer – Barremian deposits which we identified as *Pseudohaploceras.* It occurs in the Armu River basin, within Molodyozhny settlement (Zhuravlevka terrane). Apart from the stratigraphic importance, the ammonite is interesting for its closest resemblance to ammonites from Qihulin Formation of Lungzhagou Group, Northeastern China. The latter were at one time considered Jurassic in age [24, 35] and were attributed to *Arctocephalites, Stenocadoceras* and other Bathonian genera. At the same time Oxfordian-Kimmeridgian buchias have been obtained from the superjacent Yunshan and Donganzhen Formations.

Acquaintance with typical Boreal Arctocephalitinae and buchias gives a doubt concerning the correctness of identifications and we come to conclusion that the age of the fauna from Northeastern China might be determined as the Early Cretaceous. As a result of the taxonomical revision made by the authors, *"Arctocephalites"* along with some other ammonites have been referred to Barremian-Aptian *Pseudohaploceras*, whereas buchiids from the overlying complexes have been ascribed to *Aucellina.* In 1987 information related to these alternatives has been transferred to the Chinese colleagues. Subsequently, the identifications and conclusions concerning the age of the ammonites from Northeastern China have been confirmed. Initially most of the ammonites were identified as Barremian-Campanian Desmoceratacea [22], and later on *"Arctocephalites"* and some other genera were described as Barremian *Pseudohaploceras* cf. *liptoviense* (Zeuschner) [16].

The analysis of our specimen and numerous pictures of *Pseudohaploceras* from Northeastern China have evidenced that these ammonites, although demonstrating certain similarity to *P. liptoviense*, show specific difference in general type of sculpture and hence may be related to a new species described below.

Genus *Pseudohaploceras* Hyatt, 1900

***Pseudohaploceras chinese** sp. nov.**

Plate 2, figs 1-3

Arctocephalites peideense: Liang, 1982, pl. 1, figs. 6,7.

Morphoceras longzhaogouense: Liang, 1982, pl. 1, fig. 3.

Lobokosmoceras? peideense: Liang, 1982, pl. 1, fig. 4.

Paracadoceras sp.: Liang, 1982, pl. 1, fig. 5.

Stenocephalites sp. : Liang, 1982, pl. 1, fig. 9.

Arctocephalites (Cranocephalites) hulinense: Wang, 1983, pl. 1, figs 1-8.

Desmoceratacean Group A (Pl. 1, figs 1-3); Group B (Pl. 1, figs 4-6, 9): Kelly *et al.*, 1994.

Pseudohaploceras cf.*liptoviense* (Zeuschner): Futakami *et al.*, 1995, p.82, fig. 3, A-F; Pl. 1, figs. 3-10.

Holotype. Specimen N 160/12949, Central museum, St.-Petersburg. The Armu River basin, Molodyozhny settlement. Barremian.

Material. One specimen – incomplete core and imprint. The species is characterized on the account of analogous ammonites from Northeastern China. All specimens are deformed (crushed).

Description. The ammonite has a rather medium-sized, flattened shell, its diameter measures just 35 to 45 mm, rarely about 75 mm. It has an involute shell and a narrow low umbilicus on its early and middle volutions, and a more evolute shell on its late volutions. Umbilicular walls are probably vertical. The sculpture includes ribs, varices, and constrictions. The ribs are generally more numerous, slightly curved and fair, they appear to be especially fair and dense on the early volutions. Ribs begin in pairs or individually straight from the umbilical shoulder, some of them became bifurcated near the mid flanks. Slightly curved or straight ribs appear on the last volutions accompanied by narrow low constrictions. They range in size and number (maximum 4 at 1/2 whorl). Some specimens may have no constrictions. The specimens show considerable variations in the whorl pattern, especially in specific ribbing habit.

Comparison. Ammonites described have much in common with the specimens *Pseudohaploceras liptoviense* (Zeuschner) from upper Barremian of Austria [32, pl. 17, figs 17, 18; pl. 18, figs 1, 3, 5, 6], but they differ from

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*Name from the occurrence of most ammonites of this species

them, however, in having more compressed shells with stepped umbilicus, in contrast to funnel-form umbilicus from the Austrian specimens. The most distinctive morphological feature is the sculpture. Austrian specimens have much larger and sharply curved varices. Intermediate ribs appear considerably higher of the umbilicular shoulder in the form of irregularly curved fascicles. Circum-umbilical part is smooth that is indicative of the earlier growth stages. Similar differences as compared to the ammonites described are common with *Pseudohaplocerus japonicum* [29, p. 28, pl. 2, figs 4,5].

Age. Barremian of Sikhote-Alin and NE China.

Hence, within the Sikhote-Alin system deposits of Lower to Upper Berriasian, Lower to Upper Valanginian and Upper Valanginian to lowermost Hauterivian and Barremian (?) are documented paleontologically by specific specimens.

Stratigraphic sequence is shown in Fig. 2.

Ammonite assemblages described and associated bivalves are evidence that during the Early Cretaceous within the Far Eastern region like that in Jurassic time, marine fauna showed a clearly distinct ecotone nature. This is connected with the position of the region at the boundary between Boreal and Tethyan realms and Pacific zoochoria, the rank of which changed at different time spans. Ammonite fauna at that time consisted mainly of Tethyan communities, while Boreal and Pacific species were limited in distribution.

Ammonite assemblage of the earliest Berriasian from South Primorye containing *Dalmasiceras, Pseudosubplanites,* and *Berriasella* appears rather unique for East Russia and adjacent countries and therefore can be considered as an analogue to West Tethyan communities [10]. The former two genera are known mainly from the south of the European continent. Where *Berriasella* is concerned, they are also found in South Tibet, besides Primorye [25]. Presence of *Berriasella* in other parts of East Tethyan seems to be doubtful in most cases.

Typical Pacific taxa – *Substeuroceras* and *Parodontoceras* and South European *Fauriella* occur among occasional early Berriasian ammonites. Representatives of Tethyan communities – Tethyan cosmopolitian *Spiticeras, Fauriella* and a problematic *Berriasella?* have been fixed in the Late Berriasian.

Tethyan habit is typical for ammonite fauna of the Sikhote-Alin during the Valanginian, too. At the genera level it is represented by pan-Tethyan *Sarasinella, Neocomites, Olcostephanus* and probably *Thurmanniceras.* At the same time, correlation at the species level varies from American *Olcostephanus quadriradiatus* and *Thurmanniceras jenkinsi* to Himalaya and European *Sarasinella varians* and *Neocomites teschenensis.* Individual Boreal species *Homolsomites* and presumably *Tollia* occur at the Tethyan background.

Stage	Substage	Ammonites	Buchias
Barremian	Upper		*Inoceramids*
	Lower	*Pseudohaploceras chinense* sp. nov.	
Hauterivian	Upper		
	Lower		
Valanginian	Upper	*Homolsomites* sp. / *Olcostephanus* cf. *quadriradiatus*, *Neocomites neocomiensis*,	*B. crassicollis* *B. sublaevis*
	Lower	*Neocomites teschenensis*, *Sarasinella* cf. *varians*, *Thurmanniceras jenkinsi*	*B. keyserlingi* *B. inflata*
Berriasian	Upper	*Spiticeras (S.) multiforme*, *Fauriella* sp. ind., *Berriasella ?*	*B. tolmatschowi* *B. uncitoides* *B. volgensis* *B. okensis*
	Lower	*Substeuroceras* cf. *kellumi*, *Parodontoceras* sp. ind., *Fauriella* ex gr. *floquiensis*	*B.* aff. *B. okensis* *B. unschensis* *B. terebratuloides*
		Pseudosubplanites cf. *grandis* *Berriasella* ex gr. *jacobi* *Dalmasiceras* sp. nov.	*B. piochii* *B. fischeriana* *B. trigonoides*

Fig. 2 Early Cretaceous ammonite (Berriasian – Barremian) and buchian (Berriasian – Hauterivian) assemblages of the Sikhote-Alin and Bureya-Khanka regions.

Homolsomiteses and some olkostephaniids probably existed in the Early Hauterivian. As a whole, the Hauterivian-Barremian in East Russia is characterized by an intense tectonic activity, which was accompanied, as being proposed, by reconstruction of the marine basins [3]. Nevertheless, Sikhote-Alin ammonite community preserved its Tethyan habit. *Pseudohaploceras* determined there like similar ammonites from the above-described adjacent area of NE China, are found to be typical Tethyan forms. The Sikhote-Alin ammonite, therefore, traces straight the direction of warm

current resulting in dispersal of *Pseudohaploceras* in the north of China that is evidenced by paleogeographic constructions made by M. Matsukawa and his colleagues [26]. The Sikhote-Alin *Haploceras* and *Crioceratites* (C.) mentioned from the Barremian are attributed to southern faunas [8,27].

In general, Tethyan ammonite fauna in the Berriasian-Early Hauterivian throughout the Sikhote-Alin system including South Primorye existed at the background of the Boreal benthos represented almost exclusively by Boreal buchias which in all probability formed communities of high population density. This phenomenon is more likely connected with a broad tolerance of buchias to the temperature conditions. In contrast to stenothermal ammonites, they might exist in rather warm waters differing from their high-latitude analogues by a smaller size. These ecotone communities containing buchias and having a high stratigraphic potential can be instrumental in solving the problems related to Boreal-Tethyan correlation including those of the Jurassic-Cretaceous boundary.

It should be emphasized, in conclusion, that stratigraphic constructions are not to be considered reliable if not confirmed by paleontological publications, i.e.faunal descriptions and pictures. A precise age correlation of the deposits and detailed analysis of fossils might be based on such materials that enable identification of faunal migration and determination of allochthonous faunal communities that is necessary for reconstruction of paleotectonic and paleogeographic environments and creation of geodynamic model for Sikhote-Alin.

REFERENCES

1. Kalinin, Ye.A., in: *Tezisy dokladov IV Dalnevostochnogo regionalnogo mezhvedomstvennogo stratigraficheskogo soveshchaniya* (Abstr. of the IV Far East regional interdepartmental stratigraphic meeting) (Khabarovsk, 1990): 239-240.
2. Kalinin, Ye.A., *Tikhookeanskaya geologiya* N6: 78-85 (1990).
3. Kirillova, G.L., *Tikhookeanskaya geologiya* **16** 6: 3-20 (1997).
4. Mikhailov , V.A., *Stratigraphy. Geol. Correlation* **5** 4: 85-94 (1997).
5. Mikhailov, V.A., *Tikhookeanskaya geologiya* N 1: 83-91 (1987).
6. Mikhailov, V.A., Volokhin, Yu.G., Parnyakov, V.P. and Oleinik, L.M., *Tikhookeanskaya geologiya* N 4: 70-78 (1989).
7. *Postanovleniya mezhvedomstvennogo stratigraficheskogo komiteta i ego postoyannykh komissii* (Decisions of Interdepartmental Stratigraphic Committee and Its Permanent Commissions). Issue 29 (St.- Petersburg, 1997).
8. *Resheniya IV mezhvedomstvennogo regionalnogo stratigraficheskogo sovesccchaniya po dokembriyu i fanerozoyu yuga Dalnego Vostoka i Vostochnogo Zabaikaliya* (Resolutions of IV Interdepartmental Regional Stratigraphic Meeting on the Precambrian and Phanerozoic of the Far East south and Eastern Zabaikalie. Khabarovsk, 1990) (Khabarovsk: KHGGGP, 1995).

9. Sey, I.I. and Kalacheva, Ye. D., in: *Yarusnye i zonalnye shkaly Borealnogo mezozoya SSSR* (Stage and zonal scales of the Boreal Mesozoic of the USSR) (M., Trudy IGG SO AN SSSR, issue 722, 1989): 139-145.
10. Sey, I.I. and Kalacheva, E.D., in: *Biostratigraficheskie kriterii granitsy yurskoi i melovoi sistem dlya territorii Rossii* (Biostratigraphic criteria of the Jurassic-Cretaceous boundary for the territory of Russia) (St. Petersburg: VSEGEI, 1993).
11. Sey, I.I. and Kalacheva, E.D., *Tikhookeanskaya geologiya* **14** 2: 75-88 (1995).
12. Sey, I.I. and Kalacheva, E.D., *Stratigraphy. Geol. correlation* **5** 1: 42-59 (1997).
13. Khanchuk, A.I., *Geologicheskoe stroenie i razvitie kontinentalnogo obramleniya severo-zapada Tikhogo okeana* (Geology and evolution of the northwestern Pacific continental framing). Doctoral Thesis. (Moscow, 1993).
14. Khudoley, K.M., in: *Pogranichnye yarusy yurskoi i melovoi sistem* (Boundary stages between the Jurassic and Cretaceous systems) (Moscow: Nauka, Trudy IGG SO AN SSSR, issue 644, 1984): 107-114.
15. Djianelidze, A., *Mem. Carte Geologique Detaillee France. Impr. Nationale* (Paris, 1922).
16. Futakami, M., Matsukawa, M., Chen, P., Cao, Z., and Chen, J., *Jour. Geol. Japan* **101** 1: 79-85 (1995).
17. Imlay, R., *Bull. Geol. Soc. Amer.* **49** 4: 539-602 (1938).
18. Imlay, R., *Bull. Geol. Soc. Amer.* **50** 1: 1-78 (1939).
19. Imlay, R. and Jones D., *U.S. Geol. Surv.* Prof. Pap. 647-B: 1-59 (1970).
20. Immel, H., *Zitteliana* N 15: 3-163 (1987).
21. Jeletsky, Y.A., *Geol. Assoc. Canada.* Spec. Pap. N 27: 175-255 (1984).
22. Keely, S.R.A., Wang, Y.G. and Zhang, J.A., *Acta Palaeontol. Sinica* **33**: 509-517 (1994).
23. Le Hegarat, G., Le Berriasien du Sud-East de la France (Lyon, 1973).
24. Liang, Z.G., *Bull. Shenyang Inst. Geol. Min. Res., Chinese Acad. Geol. Sci.* N5: 63-72 (1982).
25. Lia Guifang and Wang Sien, *Prof. Paper Stratigr. Palaeontol. (Beijing)* N 17: 143-166 (1987).
26. Matsukawa, M., Kalinin, Ju.A., Futakami, M., and Chen, P., *Plaeogeogr., Palaeoclimatol., Palaeoecol.* N 105: 71-81 (1993).
27. Matsukawa, M., Takahashi O., Hayashi K., Ito M., and Konovalov V., *Mem. Geol. Soc. Japan* N 48: 29-42 (1997).
28. Mazenot, G. *Soc. Geol. France Mem. 41, new ser.* **18** (1939).
29. Obata, I., Matsukawa, M., Tanaka, K., Kanai, Y., and Watanabe, T., *Bull. Nath. Sci. Mus. Tokio.* Ser. C. **10** (1): 9-37 (1984).
30. Sayan, G., *Mem. Soc. Geol. France. Paleontologie* **15**: 29-36 (1907).
31. Tavera, J.M., *Tesis Doct. Univ. Canada* (1985).
32. Uhlig, V., *Denkschr. K. Acad. Wiss., math.-naturwiss. Kl. Wiena* **46**: 127-290 (1883).
33. Uhlig, V., *Paleont. Indica, ser. XV* (Calcuta, 1903-1910) **4**.
34. Verna, H. and Westermann, G.E.G., *Bull. Amer. Paleontology* **63** (277) (1973).
35. Wang, Yi-gang., in: *Fossils from the Middle-Upper Jurassic and Lower Cretaceous in Eastern Heilonghiang Province, China.* Part 1. (Heilongjiang Sci. Technol. Publishing House, Harbin, 1983).
36. Zeiss, A., *Acta Geol. Hungarica* **29** (1-2): 27-30 (1986).

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