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Lower Triassic Stratigraphic Units of Southern Primorye. Paper 1: First Records of Ammonoids of the Genus *Churkites* on the Coast of the Ussuri Gulf

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Abstract—The ammonoid genus *Churkites*, a typical representative of the Early Olenekian assemblage (*Anasibirites nevolini* Zone) in South Primorye, is reported for the first time in the top part of the Tri Kamnya section located on the western coast of the Ussuri Gulf. *Churkites* cf. *syaskoi* Zakh. et Shig. was found in association with *Inyoites*, *Clypeoceras*, *Owenites*, *Juvenites*, *Prionites*, *Glyptophiceras*, *Brayardites*, *Mianwaliites*, *Pseudoflemingites*, *Aspenites*, *Rohillites*, *Pseudoaspedites*, *Anaxenaspis*, *Anasibirites*, *Monneticeras*?, *Shamaraites*, *Palaeokazakhstanites, Xenoceltites*, and *Arctoceras* ammonoids; the majority of these are known from the SMID section (Artem), where the *Anasibirites nevolini* Zone has been studied in great detail. In the region of Smolyaninovo Village, the type locality of *Churkites syaskoi*, the latter was found in association with *Clypeoceras*, *Juvenites*, *Mianwaliites*, Prionitidae gen. et sp. indet., as well as *Preflorianites*? and *Hanielites*?. Ammonoids from the Smithian Substage of the Olenekian Stage of the Ungun (Khabarovsk Region) and Pereval'nyi (South Primorye) sections have also been revised.

Keywords: Lower Triassic, Olenekian Stage, ammonoids, conodonts, South Primorye

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INTRODUCTION

The genus *Churkites* (with the type species *C. egregius* Zharnikova et Okuneva) was described based on materials collected from Olenekian deposits of the Bolshie Churki Range in the Khabarovsk Region [9]. *Churkites* is easily distinguished from the closely related *Arctoceras* by the presence of a ventral median keel in adults.

This paper primarily focuses on the description of *Churkites* cf. syaskoi beds of the Tri Kamnya section (western coast of the Ussuri Gulf), where they were first discovered, and on further study of the Smolyaninovo Region section (the *Churkites syaskoi* type locality) with the aim of correlating them with the SMID section (Artem) and clarifying the ammonoid and conodont systematic content of the *Anasibirites nevolini* Zone.

MATERIALS AND METHODS

This study is based on ammonoid and conodont collections from the Tri Kamnya (top part), Smolyaninovo and Abrek (top part), Golyj (middle part), and Kamenushka (middle part) sections (Fig. 1). Conodonts were extracted from the rock matrix using an acetic acid preparation. The conodont morphological characters were studied using a Zeiss EVO 40 XVP SEM at the Institute of Marine Biology of the Far East Branch (FEB) of the Russian Academy of Sciences (RAS).

The collections studied are housed at the Far East Geological Institute (DVGI) of the FEB RAS (Vladivostok) under nos. 840, 851 (ammonoids), and 12 (conodonts).

RESULTS OF THE STUDY OF THE *ANASIBIRITES NEVOLINI* ZONE SECTIONS IN SOUTHERN PRIMORYE

Anasibirites nevolini was first reported in South Primorye on the left bank of the Artemovka River (Fig. 1); the zonal index species was found in association with *Parahedenstroemia*, *Arctoceras*?, *Juvenites*, *Owenites*, *Arctoprionites*, *Hemiprionites*, *Wasatchites*, *Gurleyites*, *Preflorianites*?, *Burijites*, and *Subalbanites* [1, 3]. The thickness of the zone in the Artemovka River Basin is no less than 50–70 m [3]. The section is currently flooded because of the construction of the Artemovsk Reservoir.

The SMID in the vicinity of Artem is currently the most representative section of the *Anasibirites nevolini* Zone in South Primorye, where the index species is

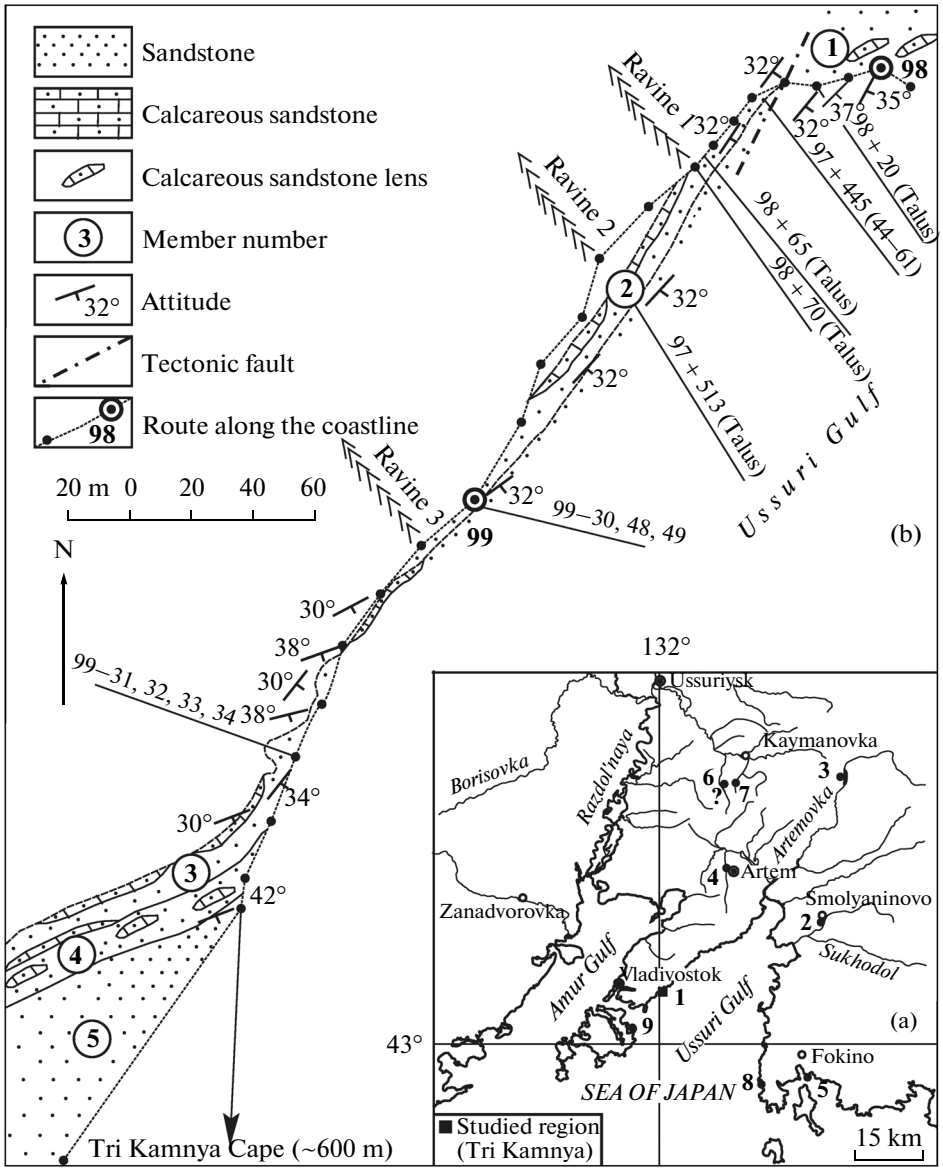


Fig. 1. Locations of Anasibirites nevolini Zone sections in South Primorye (A) and a schematic map of the top part of the Tri Kamnya section (B). The sections are as follows: (1) Tri Kamnya, (2) Smolyaninovo, (3) Artemovka (Artemovsk Reservoir), (4) SMID quarry (Artem), (5) Abrek, (6) Pereval'nyi, (7) Kamenushka (pipeline), (8) Golyj (Kom–Pikho–Sakho), and (9) Tobizin.

found in association with more than twenty ammonoid genera [25] and twelve conodont taxa [10].

We recently proposed a bipartite subdivision of the *Mesohedenstroemia bosphorensis* Zone (based on the Tri Kamnya section data), which includes the following from the bottom to top: (1) beds with *Ussuriflemingites abrekensis* (= *Gyronites separatus*) (25 m), and (2) beds with *Euflemingites prynadai* (around 60 m) [21, 25]. Given that the relationship of the *Euflemingites prynadai* beds with their overlying deposits is not established in the Tri Kamnya and Smolyaninovo sections (due to a supposed tectonic fault in the former and the nature of the exposed rocks in the region of the latter), we denote the parts of the section containing *Churkites* as *Churkites* cf. *syaskoi* and *C. syaskoi* beds in the description below.

Tri Kamnya (Fig. 1, 2). Beds with *Churkites* cf. *syaskoi* have been recently discovered 600–700 m north of the Tri Kamnya Cape on the western coast of the Ussuri Gulf. Below is a description of this part of the section represented by five members, the first of which corresponds to the top part of the beds with *Euflemingites prynadai* of the *Mesohedenstroemia bosphorensis* Zone.

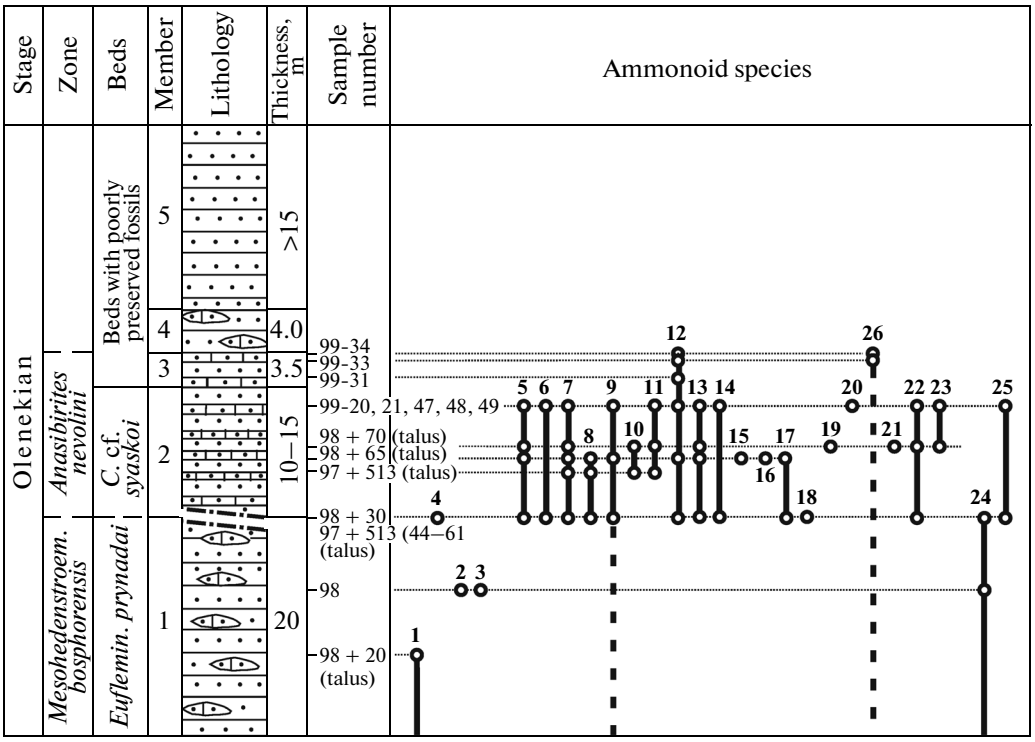


Fig. 2. Distribution of Early Olenekian ammonoids in the top part of the Tri Kamnya section. The species are as follows: (1) *Euflemingites* sp., (2) *Balhaeceras balhaense*, (3) *Anakashmirites*? sp., (4) *Inyoites* sp., (5) *Churkites* cf. *syaskoi*, (6) *Clypeoceras timorense*, (7) *Owenites koeneni*, (8) *Juvenites* sp., (9) *Prionites* sp., (10) *Glyptophiceras* cf. *sinuatum*, (11) *Brayardites* sp., (12) *Gyronitinae* gen. et sp. nov., (13) *Mianwaliites*? sp., (14) *Parahedenstroemia* sp., (15) *Pseudoflemingites* sp. nov., (16) *Aspenites* sp., (17) *Rohillites* sp. nov., (18) *Pseudoaspedites* sp., (19) *Anaxenaspis* sp., (20) *Clypeoceras* sp., (21) *Anasibirites* sp. A, (22) *Monneticeras*? sp., (23) *Shamaraites* sp., (24) *Palaeokazakhstanites ussuriensis*, (25) *Xenoceltites* sp., and (26) *Arctoceras* sp. The symbols are as in Fig. 1.

Beds with Euflemingites prynadai (top part)

(1) Sandstones small- and fine-grained, greenish gray, with calcareous-marly nodules and calcareous sandstone lenses (12–15 m).

The brachiopods *Lingula borealis* Bittn., rhynchonellids; the bivalves *Neoschizodus laevigatus* (Ziet.), *Pteria ussurica* (Kipar.), and *Leptochondria minima* (Kipar.); the ammonoids *Euflemingites* sp., *Palaeokazakhstanites ussuriensis* (Zakh.), *Balhaeceras balhaense* Shig. et Zakh., *Anakashmirites*? sp.; and others. The index species for beds with *Euflemingites prynadai* are found lower in the section [5].

As expected, the contact between Members 1 and 2 is tectonic (the azimuth of the offset plane dip is 120°, while the angle is 32°).

Beds with Churkites cf. syaskoi

(2) Sandstones fine-grained, greenish gray, with lenticular interbeds of gray calcareous sandstone-coquina (the visible bed thickness is around 10–15 m).

Small bivalves; the ammonoids *Inyoites* sp., *Churkites* cf. *syaskoi* Zakh. et Shig., *Clypeoceras timorense* (Wanner), *Clypeoceras* sp., *Owenites koeneni* Hyatt et Smith, *Juvenites* sp., *Prionites* sp., *Glyptophiceras* cf. *sinuatum* (Waagen), *Brayardites* sp., Gyronitinae gen. et sp. nov., *Mianwaliites*? sp., *Parahedenstroemia* sp., *Pseudoflemingites* sp. nov., *Aspenites* sp. nov., *Rohillites* sp. nov., *Pseudoaspedites* sp., *Anaxenaspis* sp., *Anasibirites* sp., *Monneticeras*? sp., *Shamaraites* sp., *Palaeokazakhstanites ussuriensis* (Zakh.), *Xenoceltites* sp. (pls.1, 2); and the conodonts *Hidrodontina anceps* Staeshe, *Pachycladina obliqua* Staeshe, *Hindeodella triassica* Müller, *H. nevadensis* Müller (= *Ellisonia triassica* Müller), *Furnishius triserratus* Clark, *Neospathodus waageni* Sweet, *Discretella discreta* (Müller).

Beds with Poorly Preserved Fossils

(3) Sandstones fine-grained, greenish gray, with interbeds of gray calcareous sandstone coquina (4 m).

The ammonoids Gyronitinae gen. et sp. nov., *Arctoceras* sp.

(4) Sandstones fine-grained, greenish gray, with interbeds of gray calcareous sandstone coquina (4 m).

(5) Sandstones small- and fine-grained, greenish gray (15 m).

The total thickness of the exposed beds with *Churkites* cf. *syaskoi* and the overlying beds with poorly preserved fossils in the section is around 23 m.

Smolyaninovo (Fig. 3, 4). The studied quarry, located at the northeastern edge of Smolyaninovo Village, is represented by the following deposits (beds with *Churkites syaskoi* from the bottom to top):

(1) Argillites dark gray, bedded due to thin, tuffaceous, yellow interbeds (10 m).

Ammonoids: *Mianwaliites* sp., *Churkites syaskoi* Zakh. et Shig.

(2) Sandstones fine-grained, gray, banded due to the admixture of yellow tuffogenic material (0.2 m).

(3) Alternation of banded dark gray argillites and gray fine-grained sandstones (17 m).

(4) Sandstones fine-grained, gray (0.5 m).

(5) Argillites greenish gray, with thin interbeds of gray fine-grained sandstones (6.5 m).

Ammonoids *Churkites syaskoi* Zakh. et Shig.

(6) Sandstones fine-grained, gray (0.22 m).

(7) Argillites gray, with large calcareous-marly nodules (20.2 m).

Ammonoids *Churkites syaskoi* Zakh. et Shig. (dominant), *Mianwaliites* sp., Prionitidae gen. et sp. indet., *Preflorianites*? sp. II, *Juvenites* sp., *Clypeoceras*? sp., *Hanielites*? sp. (pls. 1, 2); foraminifers.

(8) Argillites gray, with interbeds of gray fine-grained sandstones (6.5 m).

Ammonoids: *Churkites syaskoi* Zakh. et Shig., *Mianwaliites* sp.

Closed interval corresponding to no more than 1–2 m in thickness.

(9) Argillites dark gray (around 7 m).

Bivalves *Posidonia ussurica* Kipar. (clusters), ammonoids *Owenites* sp.

Beds with *Churkites syaskoi*, in total up to 68 m thick (including the thickness of Member 9), are overlain unconformably and with a gap by gritstones, sandstones, and siltstones of the Barremian Ussuri Formation.

Correlation of deposits from the top part of the Smithian Substage (Olenekian Stage) of South Primorye

In the SMID section, the zonal index species *Anasibirites nevolini* is confined to three stratigraphic divisions (members) represented by argillites with lenses and calcareous-marly nodules: (1) A (18 m), (2) B (10 m), and (3) C (4.5 m) [24].

Apart from the zonal index species (*Anasibirites nevolini* Burij et Zharn.) and *Churkites syaskoi* Zakh et Shig, the following ammonoids are found in abundance at the base of Member A: *Ussuriaspenites evlanovi* Zakh. et Smysh., *Pseudoaspedites* sp., *Monneticeras kalinkini* Zakh. et Smysh., *Juvenites* sp., *Brayardites involutus* Zakh. et Smysh., *Owenites* sp., *Anasibirites simanenkoi* Zakh. et Smysh., *Anasibirites* sp., *Hemiprionites kluge* Brayard et Bucher, *Hemiprionites* sp. (= "*Inyoites*"), *H. contortus* Burij et Zharn., *H. ovalis* Burij et Zharn., *H.* cf. *butleri* (Mathews), *Prionites subtuberculatus* Zakh. et Smysh., *Anawasatchites specious* Zakh. et Smysh., *A. vlasovi* Burij et Zharn, *Hemilecanites discus* Burij et Zharn., and *Mianwaliites zimini* Zakh. et Smysh.

The following taxa are found from the bottom and middle parts of Member B, along with the zonal index species and *Churkites syaskoi*: *Monneticeras kalinkini* Zakh. et Smysh., *Brayardites involutus* Zakh. et Smysh., *Dieneroceras* sp., *Anasibirites* sp., ?*Hemiprionites klugi* Brayard et Bucher, *Hemiprionites* sp., *H. contortus* Burij et Zharn., *H. ovalis* Burij et Zharn., *Prionites subtuberculatus* Zakh. et Smysh., *Anawasatchites specious* Zakh. et Smysh., *Arctoceras septentrionale* (Dien.), *A. subhydaspis* (Kipar.), *Churkites syaskoi* Zakh et Shig., *Glyptophiceras* cf. *sinuatum* (Waag.), *Xenoceltites*? *subvariocostatus* Zakh. et Smysh., Meekoceratidae gen. et sp. nov., *Hemilecanites discus* Burij et Zharn., and *Mianwaliites zimini* Zakh. et Smysh. *Anasibirites nevolini* Burij et Zharn. predominate at the base of Member B.

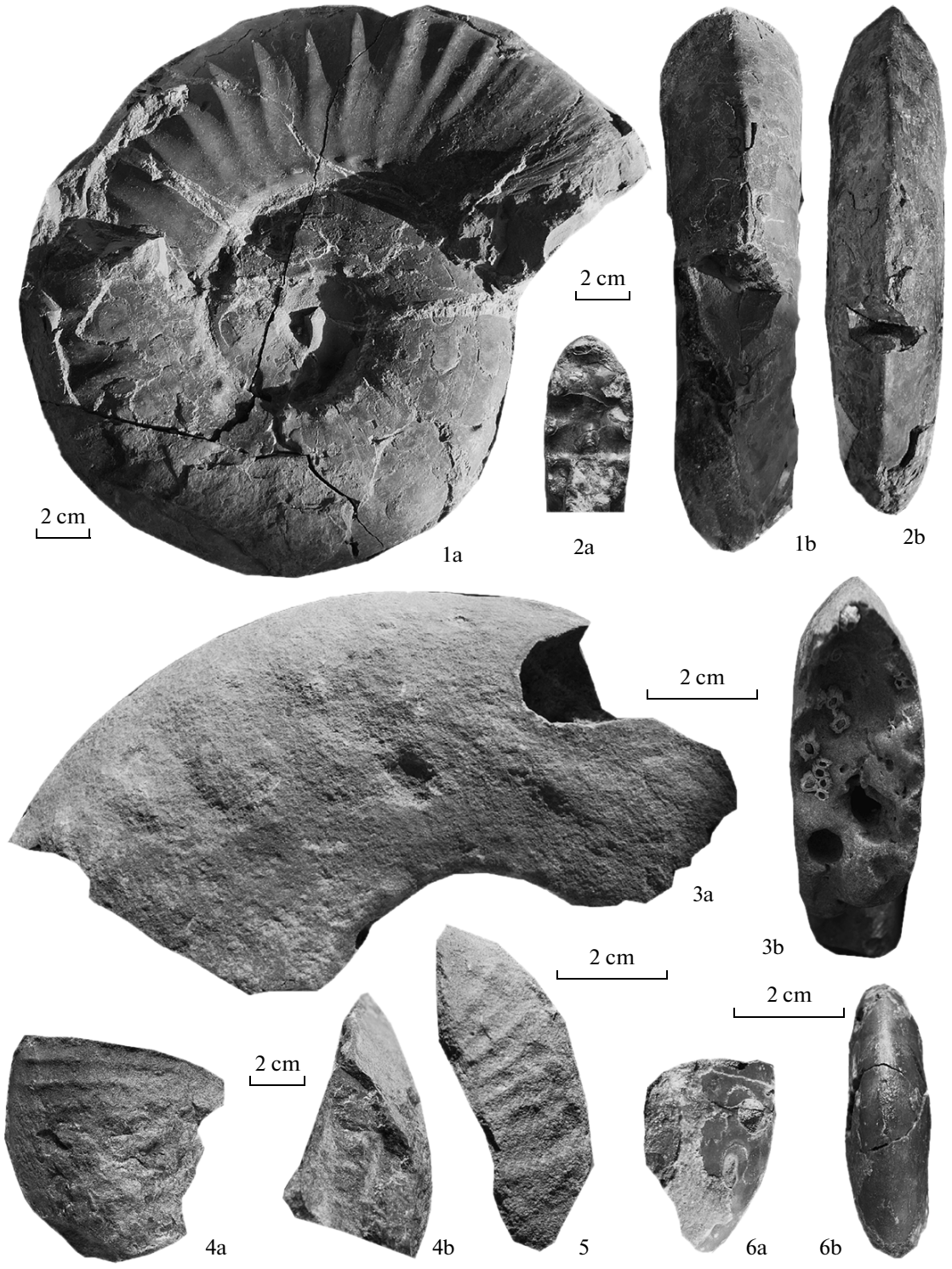
Apart from the zonal index species and *Churkites syaskoi*, the following ammonoids are found in member C: *?Ussuriaspenites evlanovi* Zakh. et Smysh., *Pseudoaspedites* sp., *Monneticeras kalinkini* Zakh. et Smysh., *Brayardites involutus* Zakh. et Smysh., *Owenites* sp., *Dieneroceras* sp., *Anasibirites simanenkoi* Zakh. et Smysh., *Anasibirites* sp., *Hemiprionites ovalis* Burij et Zharn., ?*Prionites subtuberculatus* Zakh. et Smysh., *Kashmirites shevyrevi* Zakh. et Smysh., *Owenites* sp., *Anawasatchites specious* Zakh. et Smysh., *Arctoceras septentrionale* (Dien.), *A. subhydaspis* (Kipar.), *Xenoceltites? subvariocostatus* Zakh. et Smysh., *Xenodiscoides*? sp., *Meekoceras subcristatum* Kipar., *Mianwalites zimini* Zakh. et Smysh.

Plate 1.

Figs. 1–2. *Churkites syaskoi* Zakh. et Shig.: (*1*) DVGI no. 130/851 ((1a) lateral view, (1b) ventral view) (from member 6, field no. 746-1); (*2*) DVGI no. 131/851 (ventral view) (from member 6, field no. 746-2); South Primorye, quarry on the northern outskirts of Smolyaninovo Village; Olenekian Stage.

Figs. 3–6. *Churkites* cf. *syaskoi* Zakh. et Shig.: (*3*) DVGI no. 132/851: (3a) lateral view, (3b) whorl cross section (from member 2, field no. 97+445 (44)); (*4*) DVGI no. 133/851, whorl fragment: (4a) lateral view, (4b) cross section (from member 2, field no. 97+513 [45]); (*5*) DVGI no. 134/851 (whorl fragment, lateral view) (from member 2, field no. 97+445 [59]); (*6*) DVGI no. 135/851 ((6a) fragment with suture, lateral view, (6b) entral view (from member 2, field no. 98+70 [3]); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Plate 1



Micropaleontological studies of the SMID section [10, 24] indicate that the conodont zone *Scythogondolella milleri* corresponds to just the bottom part of the *Anasibirites nevolini* Zone (Member A). *Scythogondolella milleri* (Müller) (dominant), *Ellisonia nevadensis* Müller, *Furnishius triserratus* Clark, *Hadrodontina subsymmetrica* (Müller), *"Hindeodella" nevadensis* Müller, *Novispathodus* ex gr. *waageni*

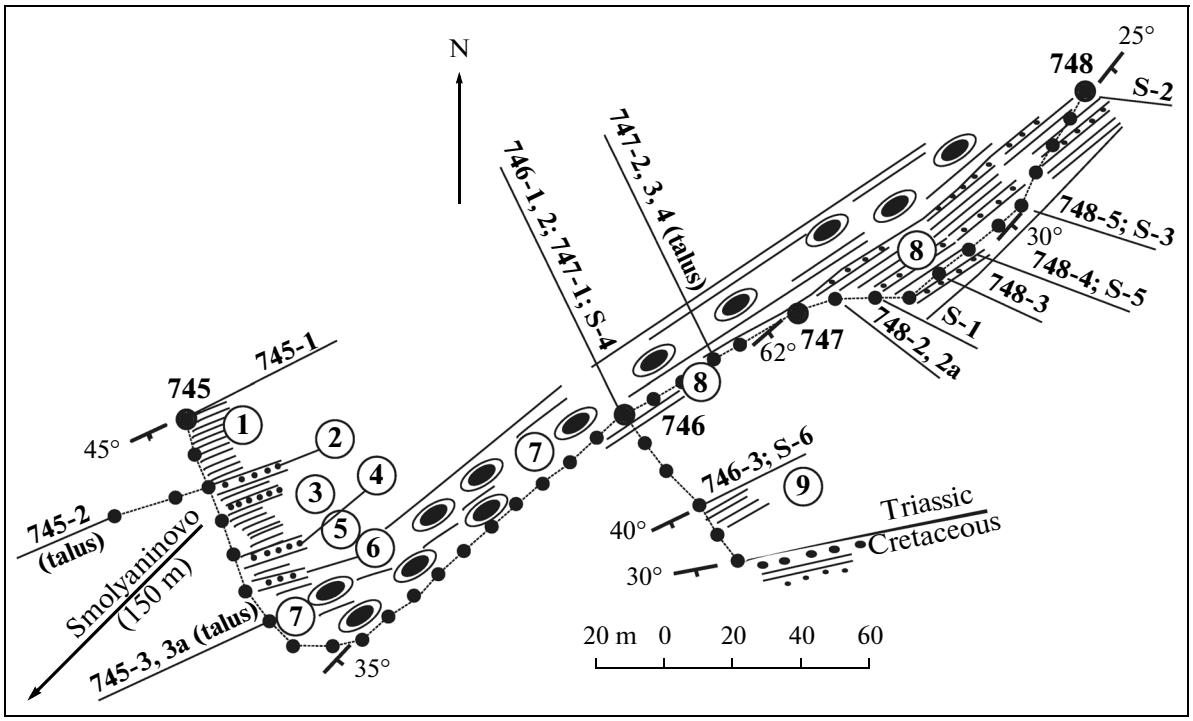


Fig. 3. Schematic map of beds containing *Churkites syaskoi* in the vicinity of Smolyaninovo Village in South Primorye. The symbols are as in Fig. 4. The circled numbers indicate the member numbers.

Sweet, *Scythogondolella mosheri* (Kozur et Mostler), and *Scythogondolella* sp. nov. conodonts are known from Member A. The only conodonts known from Member B are *Discretella discreta* (Müller), *Hindeodella nevadensis* Müller, *Furnishius triserratus* Clark, *Hadrodontina* sp., *Neospathodus novaehollandiae* McTavish, and Neogondolellidae represented by elements S3-4 (A, B) and P2 [10].

We provisionally assigned members D (around 4 m) and E (around 9 m) of the SMID section, which are characterized by *Arctoceras septentrionale* (Dien.) and *Anawasatchites*? sp. indet., to the *Anasibirites nevolini*

Plate 2.

Fig. 1. Prionitidae gen et sp. indet., DVGI no. 136/851 (lateral view) (from member 8, field no. S5); South Primorye, quarry on the northern outskirts of Smolyaninovo Village; Olenekian Stage.

Figs. 2–3. *Anasibirites* sp., DVGI no. 137/851: (*2*a) lateral view, (*2*b) ventral view) (from member 2, field no. 98+75)), (*3*) DVGI no. 138/851 (lateral view) (from member 2, field no. 98+75); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Fig. 4. *Pseudoflemingites* sp. nov., DVGI no. 110/840 (lateral view) (from member 2, field no. 98+65); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Figs. 5–8. *Preflorianites*? sp. II: (*5*) DVGI no. 139/851 (lateral view) (from member 7, field no. S4), (*6*) DVGI no. 140/851 (lateral view) (from member 7, field no. S4), (*7*) DVGI no. 141/851 (lateral view) (from member 8, field no. S5), (*8*) DVGI no. 142/851 (lateral view) (from member 7, field no. S4); South Primorye, quarry on the northern outskirts of Smolyaninovo Village; Olenekian Stage.

Figs. 9–10. *Mianwaliites* sp.: (*9*) DVGI no. 143/851 (lateral view) (from member 8, field no. S5), (*10*) DVGI no. 144/851 (lateral view) (from member 8, field no. S5); South Primorye, quarry on the northern outskirts of Smolyaninovo Village; Olenekian Stage.

Fig. 11. Gyronitinae gen. et sp. nov., DVGI no. 145/840 (lateral view) (from member 2, field no. 98+65); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

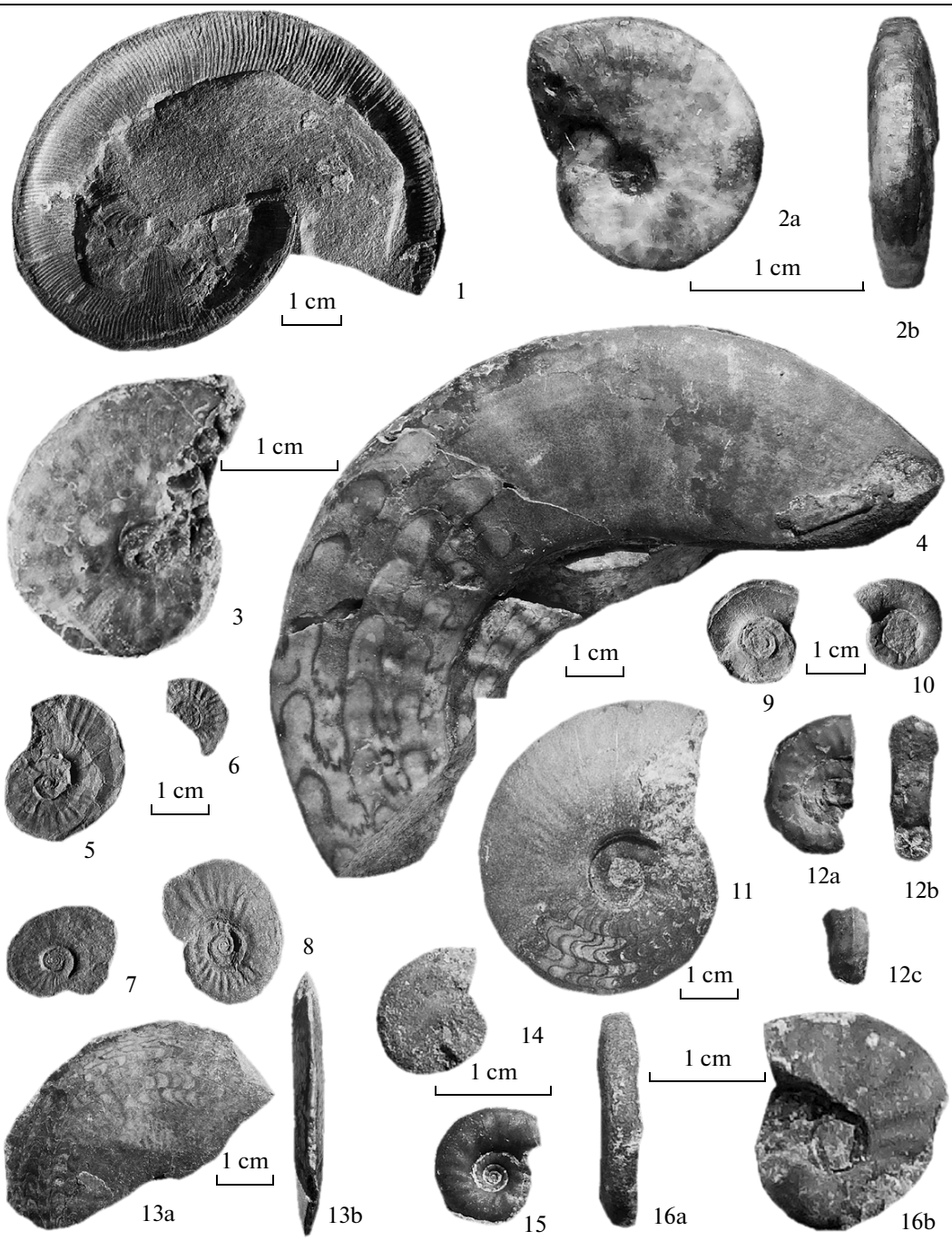
Fig. 12. *Inyoites* sp., DVGI no. 146/851: (*12*a) lateral view, (*12*b) cross section, (*12*c) ventral view (from member 2, field no. 97+445 [50]); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Figs. 13–14. *Aspenites* sp. nov.: (*13*) DVGI no. 111/840: (*13*a) lateral view, (*13*b) ventral view (from member 2, field no. 98+65); (*14*) DVGI no. 112/840 (lateral view) (from member 2, field no. 98+65); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Fig. 15. *Xenoceltites* sp., DVGI no. 147/851 (lateral view) (from member 2, field no. 97+445 [51]); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Fig. 16. *Brayardites* sp., DVGI no. 148/851: (*16*a) ventral view, (*16*b) lateral view (from member 2, field no. 98+65); South Primorye, Tri Kamnya Cape region; Olenekian Stage.

Plate 2



Zone because *Arctoceras* species have never been found in the overlying *Tirolites-Amphistephanites* Zone, which was studied in detail in Primorye, while species of *Anawasatchites* are common for the top part of the Smithian Stage.

Thus, beds containing *Churkites syaskoi* in the SMID section constitute the main part of the *Anasibirites nevolini* Zone (members A–C) [24]. The zonal index species *Anasibirites nevolini*, along with other species of this genus, are found abundantly in the reference section in Member A and at the base of Member B, i.e., mainly within the *Scythogondolella milleri* conodont zone. *Anasibirites* species are rare in member C.

Deposits underlying the *Anasibirites nevolini* Zone in the SMID section, as well as members A–C of the *Anasibirites nevolini* Zone, are characterized by a representative ammonoid assemblage (*Mesohedenstroemia olgae* Zakh. et Mous. Abnavi, *Subvishnuites*

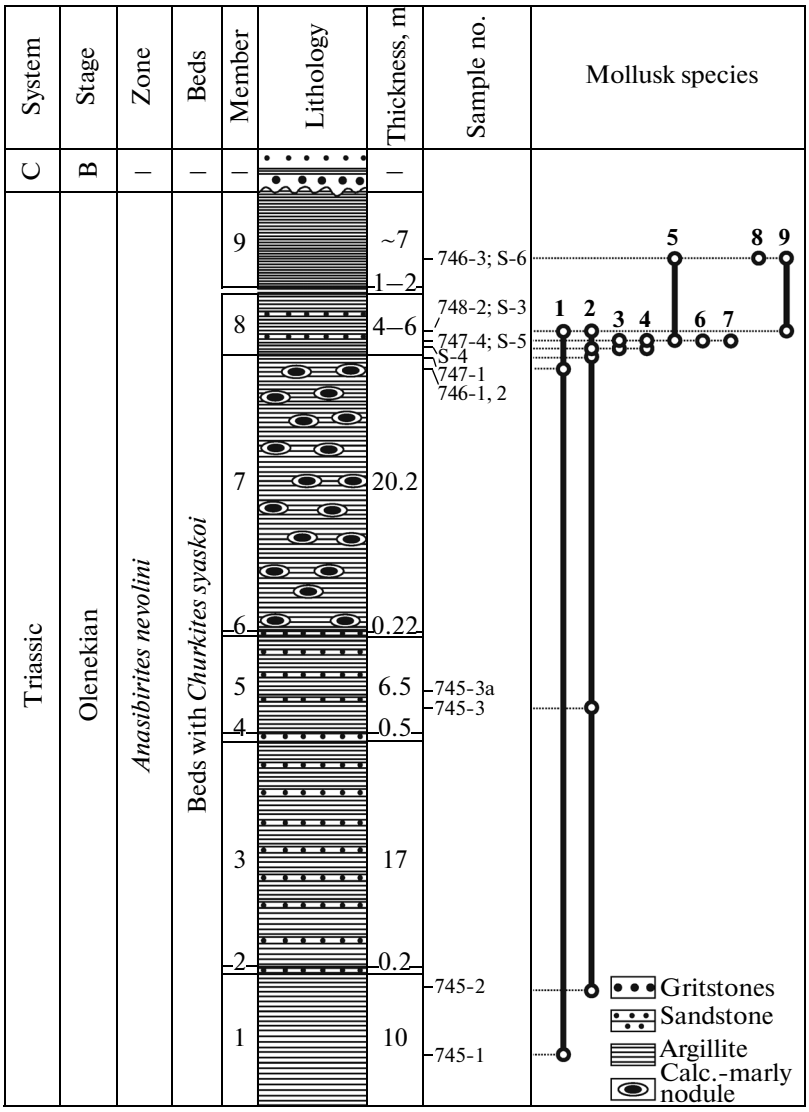


Fig. 4. Distribution of Early Olenekian mollusks in the Smolyaninovo section.

The abbreviations are as follows: (C) Cretaceous; (B) Barremian; (Calc.-marly nodule) calcareous-marly nodule. The species are as follows: (1) *Mianwaliites* sp., (2) *Churkites syaskoi*, (3) *Prionitidae* gen. et sp. indet., (4) *Preflorianites*? sp. II, (5) *Juvenites* sp., (6) *Clypeoceras*? sp., (9) *Hanielites*? sp., (8) *Owenites* sp., (9) *Posidonia ussurica*.

shigetai (Zakh. et Mous. Abnavi) (=*"Inyoites"*), *Metussuria* sp., *Arctoceras septentrionale* (Dien.), *Dieneroceras* sp., *Prosphingitoides* sp., *Ussurijuvenites artyomensis* Smysh. et Zakh., *U. popovi* Smysh. et Zakh., *Owenites koeneni* Hyatt et Smith, *Anaxenaspis* sp., *Flemingites* sp., *Euflemingites artyomensis* Smysh., *Eulemingites* sp., and others) [6, 23]. The conodont assemblage of this level in South Primorye (beds with *Eulemingites prynadai* of the *Mesohedenstroemia bosphorensis* Zone) is represented by *Neospathodus pakistanensis*, *N. spitiensis*, *Furnishius triserratus*, and others [2, 19].

Based on the available data, we suggest that the studied beds with *Churkites* cf. *syaskoi* in the Tri Kamnya section and beds with *Churkites syaskoi* in Smolyaninovo, which are characterized by the paucity or absence of *Anasibirites* species and distinguished by a relatively lower conodont taxonomic diversity, could more or less correspond to the top part of the *Anasibirites nevolini* Zone.

The perhaps insufficiently studied beds containing *Radioprionites abrekensis* (silty argillites with calcareous-marly nodules and white limestone and gray calcareous sandstone lenses with a total thickness of around 35-45 m), which compose the whole upper part of the section, correspond to the *Anasibirites nevolini* Zone in the Abrek Bay quarry (Fig. 1). This assumption is based on the evidence of extensive development of *Posidonia* bivalves in this part of the section; this is typical of the SMID section [24]. *Radioprionites abrekensis* Shig. et Zakh. in the Abrek section associates with *Arctoceras subhydaspis* (Kipar.), *Juvenites* sp., *Pseudoaspidites* sp., *Bal-*

chaeceras balhaense Shig. et Zakh., and rare conodonts *Novispathodus waageni* (beds with *Radioprionites abrekensis* are stratigraphically higher than the bed with *Eulemingites prynadai* in this section, not lower, as was thought previously by some authors [19]). *Arctoceras subhydaspis* is typical of the *Anasibirites nevolini* Zone of the reference section (SMID) [24].

Scythogondolella milleri conodonts are found in association with *Anasibirites nevolini* Burij et Zharn., *Prionites* sp. (= *"Meekoceras subcristatum"*), *Arctoceras septentrionale* (Dien.) (= *"Proptychites robinsoni"*), *Prosphingitoides ovalis* (Kipar.) (=*"Prosphingites"*), and other ammonoids in the region of Pereval'nyi Spring (upper reaches of the Kamenushka River) (Fig. 1) [2]. The preliminary results of the fieldwork conducted by us in the Autumn of 2013 indicate the presence of *Churkites* species in a new Lower Triassic section of the Kamenushka River Basin (pipeline region) (Fig. 1). The *Churkites* species were found in beds that contained *Anasibirites*? sp., *Prionites markevichi* Zakh. et Smysh., *Arctoceras septentrionale* (Dien.), *A. subhydaspis* (Kipar.), *Owenites koeneni* Hyatt et Smith, and *Prosphingitoides ovalis* (Kipar.). These beds are overlain here by the *Tirolites-Amphistephanites* Zone deposits.

The bottom boundary of the *Anasibirites nevolini* Zone in the region of Golyj Cape (Kom-Pikho-Sakho) on the eastern cost of the Ussuri Gulf (Fig. 1), which is represented by siltstones with calcareous-marly lenses and nodules that change into light-gray bedded calcareous sandstones higher in the section, can be tentatively drawn based on the first appearance of *Arctoceras* cf. *subhydaspis* (=*Paranorites* cf. *labogensis*). Macrofaunistic fossils were not found in the bedded calcareous sandstones. The presence of only authentically ramiform conodonts, including *Hindeodella triassica* Müller, was established from the conodont fauna based on new collections. Considering the stratigraphic position of the *Tirolites-Amphistephanites* Zone in this section, which is characterized by the presence of *Tirolites* sp. and articulate brachiopods, the thickness of the *Anasibirites nevolini* Zone here is around 30–40 m.

The lower boundary of the *Anasibirites nevolini* Zone cannot be precisely identified in the considerably shallow facies of the Smithian Substage of Russky Island due to the rare occurrence of ammonoids in its bottom part. The upper boundary of the zone on the Tobizin Peninsula (Fig. 1) is defined by overlaying of the deposits containing *Parahedenstroemia conspicienda* Zakh., *Anasibirites* sp., *Hemiprionites* sp., *Wasatchites sikhotealinensis* Zakh., *Wasatchites* sp., *Arctoceras septentrionale* (Diener), *Arctoceras subhydaspis* (= *Paranorites labogensis*), *Churkites*? sp. (living chamber fragment), *Meekoceras subcristatum* Kipar., and others by the *Tirolites–Amphistephanites* Zone beds containing *Bajarunia dagysi* [7].

Details of the precise stratigraphic position of *Churkites* in the Artemovka River Basin [4, 9] are absent. At present, it is difficult to confirm that they belong to *C. egregius* Zharn. et Okuneva, as the species was described based on evidence from shells collected only in the Khabarovsk Region. We only know that the Triassic deposits exposed in the Artemovka River Basin correspond to both the *Mesohedenstromia bosphorensis* and *Anasibirites nevolini* zones [3].

In the Khabarovsk Region, *C. egregius* was found in a quarry located 5.5 km southwest of Ungun Village [8, 9]. Okuneva [9] first described the Lower Triassic section of this site based on fieldwork data from 1986. According to these data, the lower beds exposed in the Ungun section are represented by sandstones with Late Induan *Gyronites subdharmus* Kipar and several other poorly preserved ammonoids. The overlying Olenekian Stage deposits are represented by the following members (bottom-to-top):

(1) Thinly bedded siltstones (the thickness is not given).

Ammonoids *Meekoceras boreale* Diener.

(2) Fine-grained sandstones with siltstone interbeds (2 m).

Ammonoids *Euflemingites prynadai* (Kipar) (a typical representative of the *Mesohedenstroemia bosphorensis* Zone of South Primorye [25]).

(3) Thinly alternating fine-grained sandstones and siltstones with poorly preserved bivalvian fossils (12 m).

(4) Micaceous sandstones with siltstone interbeds (5 m). All the organic remnants found in this member come from a 50 cm interbed of conglomerates found in the middle part of the member.

Ammonoids: *Parahedenstroemia nevolini* (Birij et Zharn.) (= *"Owenites"*), *Dieneroceras chaoi* Kipar., *Arctoceras septentrionale* (Dien.), *A. subhydaspis* (Kipar.) (= *"A. simile"*), *Proshingitoides ovalis* (Kipar.) (= *"Prosphingites"*), *Churkites egregius* Zharn. et Okun., and some poorly preserved ammonoids.

Conodonts: *Scythogondolella milleri* (Müler) (identification by T.V. Klets).

(5) Sandstones, calcareous in places (the thickness of this poorly exposed member is not given).

Ammonoids: *Anasibirites onoi* (Yehara), *Wasatchites* sp. indet. and, some poorly preserved ammonoids.

Based on Okuneva's documentation [9], which indicated that *Churkites egregius* was found in association with *Shythogondolella milleri* in the Khabarovsk Region, Zakharov [4] concluded that the beds containing *Churkites egregius* correspond to the Upper Smithian. However, Klets [8] later considerably refined the conodont distribution in the Ungun section, thus showing this conclusion to have been erroneous (in reality, *Shythogondolella milleri* is found in beds that contain *Anasibirites onoi* and *Wasatchites* sp.

indet., while only the conodont *Furnishius triserratus* Clark was found in the underlying deposits that contain *Churkites egregius*).

As a result, based on the presently available data on the Russian Far East, we suggest that *Churkites syaskoi*, which is found in the *Anasibirites nevolini* Zone, is one of the main elements of the Late Smithian ammonoid assemblage [24], while *C. egregius* occurs in deposits directly underlying the *Anasibirites nevolini* Zone.

Outside the Russian Far East, *Churkites* was only found in the top part of the beds containing *Owenites* in the State of Utah [11, 20] and in the top part of the *Meekoceras gracilitatis* Zone in the State of Nevada [14, 15] of North America. In all the sections of this region, beds containing *C. noblei* Jenks are overlain by the *Anasibirites kingianus* Zone characterized in southwestern Utah (Cedar City section) by *Scythogondolella milleri* (Müller), *Guangxidella*? cf. *bransoni* (Müller), and *Ellisonia*? sp. [17].

Stephen et al. [20] distinguish the following Smithian beds in the middle part of the Thaynes Formation (Group) in Utah (bottom to top): (1) *Meekoceras,* (2) *Inyoites*, and (3) *Anasibirites*. They assigned beds with *Meekoceras* and *Inyoites* to the *Meekoceras gracilitatis* Zone, and beds with *Anasibirites* to the *Anasibirites kingianus* Zone. The limestone bed in which they found *Churkites noblei* Jenks (in association with *Inyoites*, *Wyomingites*, ?*Kashmirites*, *Juvenites*, ?*Clypeoceras*, *Lanceolites*, and *Pseudosageceras*) is around 4 m below the *Anasibirites kingianus* Zone, which is thin (0.3 m) in the studied Confusion Range section.

Brayard et al. (11) recently completed a detailed study of the Thaynes Group in Utah; they found *Churkites noblei* in beds with *Owenites* in a number of sections. In the Confusion Range section, where these beds are characterized by the presence of *Hedenstroemia*, *Aspenites*, *Owenites*, *Parussuria*, *Guodunites*. *Inyoites*, *Lanceolites*, *Xenoceltites*, *Juvenites*, *Dieneroceras*, and others [11], *Churkites noblei* was found in an interval approximately 1 to 27 m below the *Anasibirites kingianus* Zone. The *Anasibirites kingianus* Zone ammonoid assemblage in sections in Utah is characterized by a relatively low ammonoid taxonomic diversity (*A. kingianus* (Waagen), *A. multiformis* Welter, *A.* cf. *angulosus* (Waagen), *Wasatchites perrini* Mathews, *Wasatchites* sp., *Hemiprionites* cf. *typus* (Waagen), *Arctoprionites resseri* (Mathews), and *Xenoceltites* sp. indet. A [11, 16]).

According to Jenks [14], *C. noblei* was found directly at the top of the *Meekoceras gracilitatis* Zone (Thaynes Group) in the Crittenden Springs section (Nevada). The species is found in association with *Preflorianites toulai* (Smith), *Wyomingites whiteanus* (Waagen), *Aspenites acutus* Hyatt et Smith, *Subvishnuites stokesi* (Kummel), *Hemiprionites roberti* Brayard, Byund et Jenks, and *Guodunites* cf. *monneti* (Brayard et Bucher) [14, 15]. The Thaynes Group *Anasibirites kingianus* Zone in Nevada, which is characterized by *A. kingianus* (Waagen), *Wasatchites*? sp., *Arctoprionites* sp. indet., *Pseudosageceras augustum* (Brayard et Bucher), *P. multilobatum* Noetling, and also (in the top part) *Xenoceltites youngi* Kummel et Steele, is quite thin (no more than 0.8 m) [14, 15]. Black shales and numerous compressed *Tirolites* sp. shells [18] represent the overlying deposits of the Thaynes Group in Nevada.

Thus, based on the available data, *Churkites* species from the Khabarovsk Region (*C. egregius*), and Utah and Nevada (*C. noblei*) are present in beds that were deposited at the end of the Middle Smithian, while *C. syaskoi* from Primorye originates from deposits that formed somewhat later (Late Smithian).

As was noted above, the lower part of the *Anasibirites nevolini* Zone of South Primorye is characterized (based on the SMID section) by an extremely high ammonoid taxonomic diversity (*Pseudosageceras*, *Arctoceras*, *Brayardites*, *Churkites*, *Juvenites*, *Prosphingitoides*, *Owenites*, *Dieneroceras*, *Ussuriaspenites*, *Pseudoaspedites*, *Monneticeras*, *Inyoites*, *Anasibirites*, *Hemiprionites*, *Prionites*, *Anawasatchites*, *Hemilecanites*, *Mianwaliites*, and others) and the dominance of the conodont *Shythogondolella milleri* [10, 24].

The middle part of the *Anasibirites nevolini* Zone (based on the SMID section [24]) is also characterized by a representative ammonoid assemblage (*Pseudosageceras*, *Glyptophiceras*, *Arctoceras*, *Churkites*, *Brayardites*, *Juvenites*, *Owenites*, *Dieneroceras*, *Ussuriaspenites*, *Pseudoaspedites*, *Monneticeras*, *Anasibirites*, *Hemiprionites*, *Prionites*, *Mianwaliites*, *Xenoceltitites*, and others). *Shythogondolella milleri* appears to be absent from the conodont assemblage [10].

The top part of the *Anasibirites nevolini* zone (based on the SMID [24], Tri Kamnya, and Smolyaninovo sections) is characterized by *Parahedenstroemia*, *Glyptophiceras*, *Arctoceras*, *Churkites*, *Brayardites*, *Juvenites*, *Owenites*, *Dieneroceras*, *Ussuriaspenites*, *Pseudoaspedites*, *Shamaraites*, *Palaekazakhstanites*, *Monneticeras*?, *Clypeoceras*, *Hemiprionites*, *Prionites*, *Anawasatchites*, *Kashmirites*, *Mianwaliites*, *Xenoceltitites*, *Pseudolemingites*, *Anaxenaspis*, and also the rarely occurring *Anasibirites*. *Shythogondolella milleri* conodonts were likewise not found here.

Only the topmost part of the Smithian Substage section, which is positioned near the *Tirolites–Amphistephanites* Zone boundary of the Spathian Substage, is characterized by a relatively lower taxonomic diversity of ammonoids (*Arctoceras*, *Churkites*?, *Juvenites*, *Meekoceras*, *Hemiprionites*, *Anasibirites*, *Wasatchites*, *Xenoceltites*, *Anaxenaspis*) based on the Kamenushka, Tobizin (7), and SMID [24] sections.

The data from South Primorye contradict the relatively low taxonomic diversity of the Late Smithian anasibiritic fauna proposed by Brayard and coauthors [11], which, according to them, manifested globally. It would be more logical to link the low taxonomic diversity of

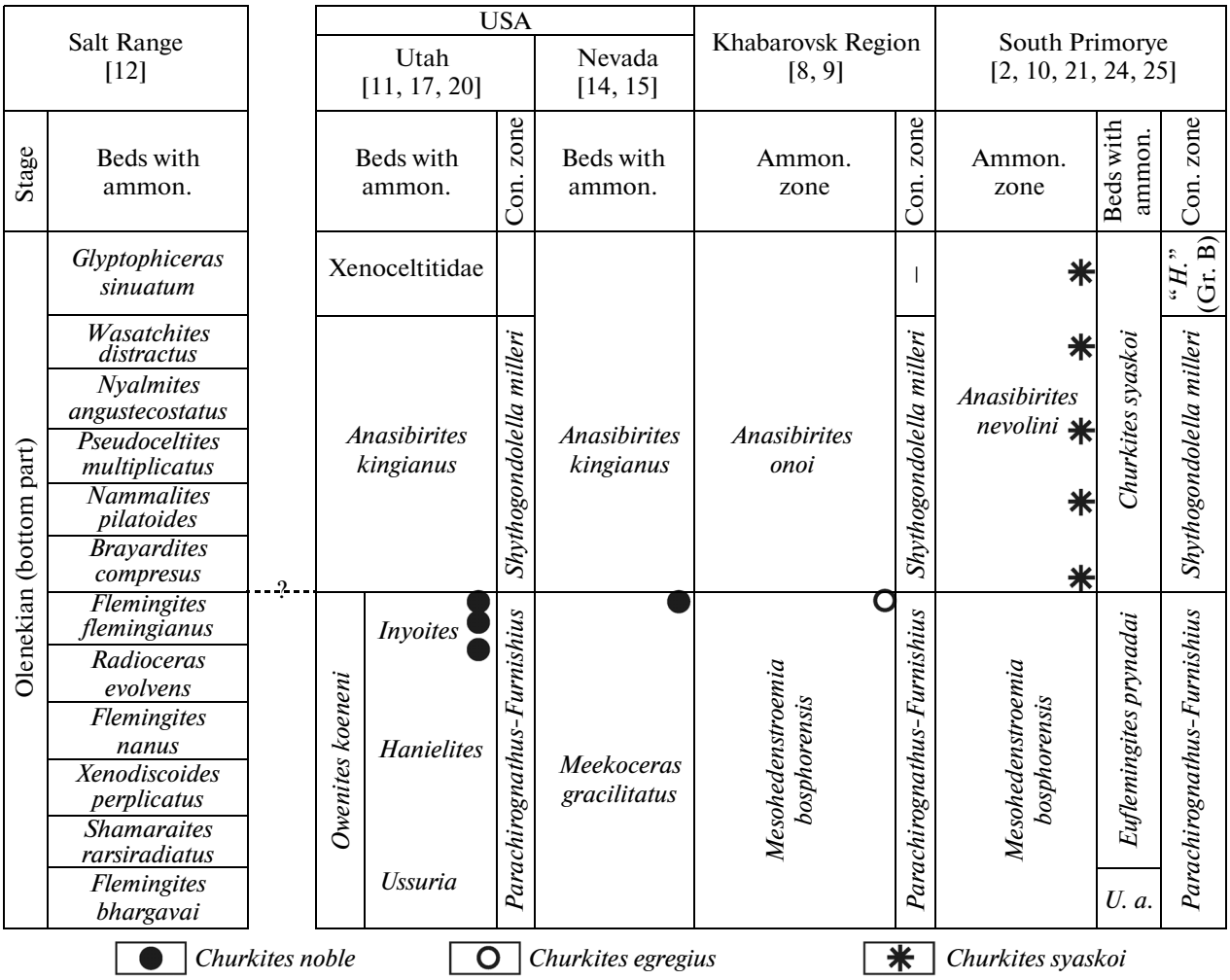


Fig. 5. Correlation of deposits of the Smithian Substage of the Olenekian Stage of the Salt Range (Pakistan), the United States, the Khabarovsk Region, and South Primorye.

The abbreviations are as follows: (beds with ammon.) beds with ammonoids, (ammon. zone) ammonoid zone, (con. zone) conodont zone, (*U. a.*) *Ussuriflemingites abrekensis*.

the Late Smithian ammonoids of North America with the regional facial conditions rather than with a global extinction of ammonoids throughout the whole, brief Late Smithian interval [11].

A number of authors [11, 12] correlate beds with *Brayardites compressus* from the Salt Range (Pakistan) with deposits located in other regions of the world that are considerably stratigraphically lower than beds with *Anasibirites*. However, members of this genus in South Primorye are also found in the *Anasibirites nevolini* Zone, which should be considered in terms of the global correlation. Our suggested version of the correlation of this part of the Lower Triassic section with the Nammal section of the Salt Ridge (Fig. 5) is only preliminary due to a lack of data on the *Shythogondolella milleri* conodont distribution in this region of the Himalayas. At this stage, we can only confidently discuss the correspondence of beds containing *Wasatchites distractus*, which are characterized in the Nammal section by *Wasatchites*, *Anasibirites*, *Hemiprionites*, *Mianwaliites*, and *Subinyoites* [12], with some part of the *Anasibirites nevolini* Zone of South Primorye. Given the presence of *Glyptophiceras* cf. *sinuatum* (Waagen) in the middle part of the *Anasibirites nevolini* Zone of South Primorye, at least this part of the Olenekian Stage section can be tentatively correlated with beds containing *Glyptophiceras sinuatum* in the Salt Range [11, 12].

CONCLUSIONS

Churkites ammonoid species in the Far East are found within a relatively small stratigraphic interval. *C. egregius* from the Khabarovsk Region, as *C. noblei* from North America, is established in a member that is directly below the *Shythogondolella milleri* conodont zone, while, on the contrary, *C. syaskoi* from South Primorye is distributed directly above the bottom

boundary of this zone. Thus, it appears that the ammonoid genera *Monneticeras*, *Brayardites*, *Pseudoflemingites*, and *Rohillites* have a broader stratigraphic distribution within the confines of the Olenekian Stage than was thought until recently [12].

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