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Subdivision of the Ladinian *Stolleyites tenuis* Zone in Northern Okhotsk Region

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Abstract—The views on the zonal subdivision of the uppermost part of the Ladinian Stage in Northeast Asia, which is characterized in this region and the Svalbard Archipelago by ammonoids from the genus *Stolleyites*, and their evolution are discussed with revision and specification of the taxonomic composition and stratigraphic distribution of ammonoids through the *Stolleyites tenuis* Zone in the section at the Pravaya Vtoraya Sentyabr'skaya River (Yana Okhotskaya River basin) in northern Okhotsk region. It is established that the ammonoid species *Stolleyites tenuis* (Stolley) and *S. terminalis* sp. nov. are confined to the lower and upper parts of the *tenuis* Zone (in its original range), respectively. In this connection, the position of the upper boundary of the *tenuis* Zone in this section is displaced, with the *Stolleyites terminalis* Beds emerging as a new biostratigraphic unit overlying the *tenuis* Zone (in its new range). No presice correlatives of the *Stolleyites terminalis* Beds of northern Okhotsk region are established so far in other boreal regions, which indicates the stratigraphic completeness of the examined section and the appropriateness of its use for reconstructing the evolutionary features of the boreal ammonoids at the Middle–Late Triassic boundary. The species *Stolleyites terminalis* sp. nov., which differs from *S. tenuis* (Stolley) in its shorter early ontogenetic stage with evolute shell, relatively narrower whorls, absence of regular umbilical folds, and dentate patterns of all lobes in the outer part of the whorl, is described.

Keywords: Middle Triassic, Ladinian Stage, ammonoids, zones, ammonoid beds, northern Okhotsk region, Northeast Asia

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INTRODUCTION

In connection with the recently proposed program aimed at the selection and study of the regional stratotypes of the stages in Russia [16, 21, 26], the reconstruction of the most complete succession of bioevents in the evolution of boreal ammonoids recorded in the Middle–Upper Triassic boundary beds (or at the boundary between the Ladinian and Carnian stages) has acquired particular significance. The high-resolution biostratigraphic subdivision and correlation of the Ladinian sections in Northeast Asia proposed in [14, 28] are based on evolutionary events in the development of two ammonoid families: Tsvetkovitidae and Nathorstitidae. The appearance of the genus *Stolleyites*, which differs from the ancestral genus *Nathortstites* in its thinner shell and the presence of umbilical folds, marks the terminal stage in the Nathortstitidae evolution [15]. The beds characterized by the ammonoid forms of the genus *Stolleyites* widespread in Northeast Asia and the Svalbard Archipelago are defined into the *Nathorstites* (=*Stolleyites*) *tenuis* Zone [7, 10, 18]. The Ladinian–Carnian boundary strata of the boreal type in Northeast Asia are best characterized by ammonoids in northern Okhotsk region (the Yana Okhotskaya river basin, Pravaya Sentyabr'skaya river), where the type locality of the *tenuis* Zone is established [5, 6, 10, 17]. This region hosts the uppermost Ladinian and Carnian sections unique with respect to their completeness, which is determined by the monofacies silty–clayey composition of the sediments deposited, in the opinion of [8], in the deep shelf environments.

In this work, a more detailed biostratigraphic subdivision of the *tenuis* Zone is proposed on the basis of the revised stratigraphic distribution and taxonomic composition of the ammonoids in the terminal layers of the Ladinian Stage.

REVIEW OF THE PROBLEM

Arkhipov [1, 3] was the first to recognize as a single unit the sediments more or less equivalent to the recently defined *Stolleyites tenuis* Zone into the *Stolleyites gibbosus* Zone in eastern Yakutia (Yana River basin). The paleontological characteristic of the *gibbosus* Zone overlying the *Suordachites neraensis* Zone and crowning the section of the Ladinian Stage is to a significant extent composite, since it is based on

<table>
<tr><td>[27]</td><td>[1, 3]</td><td>[2]</td><td colspan="2">[10]</td><td colspan="2">[7]</td><td colspan="2">[11, 25]</td><td colspan="2">[14]</td><td colspan="2">[19, 22]</td><td>Proposed scale</td></tr>
<tr><td rowspan="8">Nathorstites</td><td rowspan="5">Nathorstites gibbosus</td><td rowspan="2">Nathorstites gibbosus</td><td colspan="2" rowspan="2">Nathorstites tenuis</td><td>Carnian</td><td rowspan="2">Nathorstites tenuis</td><td>Carnian</td><td rowspan="2">Nathorstites tenuis</td><td>Carnian</td><td rowspan="2">Stolleyites tenuis</td><td>Ladinian</td><td rowspan="2">Stolleyites tenuis</td><td>Stolleyites terminalis Beds</td></tr>
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<tr><td>Indigirites krugi</td><td>Indigirites krugi</td><td colspan="2">Indigirites krugi</td><td colspan="2">Indigirites krugi</td><td>Indigirites krugi</td></tr>
<tr><td colspan="2">Tsvetkovites neraensis</td><td colspan="2">Tsvetkovites neraensis</td><td>Tsvetkovites neraensis</td></tr>
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Fig. 1. Subdivision of the upper part of the Ladinian Stage in Northeast Asia (according to different authors).

ammonoid finds in several sections cropping out in the Kular area on the left side of the Yana River. Its zonal assemblage includes the following species: *Stolleyites gibbosus* (Stolley), *Nathorstites macconnelli* Whiteaves, *N. lenticularis* Whiteaves, *N. sublenticularis* Popow, and *Monophyllites* ex gr. *wengensis* Khipstein (=*Indigirophyllites* sp.). In its range, the *gibbosus* Zone (in the understanding of Arkhipov [1, 3]) corresponds to the upper part of the *Nathorstites* Generic Zone in [27] (Fig. 1). The validity of the genus *Stolleyites* Archipov, 1974 was first doubted by Arkhipov's colleagues and coauthors and the index species of the zone was attributed to the genus *Nathorstites* Böhm, 1903. The analysis of the stratigraphic distribution of ammonoids in several other sections of the Ladinian Stage in Northeast Asia (Omolon massif, northern Okhotsk region, upper reaches of the Kolyma River) made it possible to subsequently specify the paleontological characteristic of the *gibbosus* Zone and its range. For example, it was shown that the beds with *N. lenticularis* Whiteaves and *N. sublenticularis* Popow occupy the lower stratigraphic position in the section as compared with the beds containing *S. gibbosus* (Stolley). Taking this into consideration, they were excluded from the *gibbosus* Zone and defined as the autonomous *lenticularis* Zone [2]. *Nathorstites tenuis* Stolley is the dominant ammonoid species for the *gibbosus* Zone in such a range. This species is accompanied by the less common index species, *N. macconnelli* (Whiteaves), and *M.* ex gr. *wengensis* Khipstein (=*Indigirophyllites* sp.) [2, 4, 9]. Due to its rare occurrence and, as was thought, wide stratigraphic distribution, the index species of the *gibbosus* Zone was subsequently substituted by *Nathorstites (=Stolleyites) tenuis* [10]. The lower boundary of the *tenuis* Zone was placed at the first appearance level of the index species and *Nathorstites* (=*Stolleyites*) *gibbosus planus* Frebold.

Different points of view have been proposed on the age of the *tenuis* Zone in Northeast Asia and its analogs in other boreal regions. Debate on this problem continues to the present [19]. Initially, the *tenuis* Zone was considered as representing the upper zonal unit of the Ladinian Stage [1–4, 9, 10] despite the fact that its chronological equivalents in Spitzbergen were defined into the *Halobia zitteli* Zone with remains of ammonoid species *"Nathorstites" tenuis* Stolley, *"N." gibbosus* Stolley, *Protrachyceras?* sp., *Discophyllites* (=*Arctophyllites*) *taimyrensis* Popow and bivalves *Halobia zitteli* Lindström, which were traditionally attributed in this region to the Carnian Stage [23, 24, 31, 33]. Nevertheless, the experts in the Triassic stratigraphy of Northeast Asia found no sufficient arguments in favor of the Late Triassic age of the *tenuis* Zone, since no typical representatives of *H. zitteli* Lindström were documented in this region. In [3, 10], it was conceded that the stratigraphic distribution of this species could be wide enough to include the upper part of the Ladinian Stage. The subsequent data [32] on the correlation of the Canadian *Frankites sutherlandi* and *Trachyceras obesum* zones with the Alpine zonal scale, as well as the find of *Halobia zitteli* Lind. in the *tenuis* Zone of the section at the Pravaya Vtoraya Sentyabr'skaya River in northern Okhotsk region, provided grounds for revising the position of the Ladinian–Carnian boundary in Northeast Asia. It was placed at the base of the *tenuis* Zone [6, 7]. The absence of typical Middle Triassic ammonoid forms, for example the genus *Aristoptychites*, in its assemblage was considered as one of the features indicating Late Triassic (Carnian) age of the *tenuis* Zone. The find of the ammonoid species *Discophyllites taimyrensis* (Popow) in the *zitteli* Zone of the Svalbard Archipelago was also considered as additional evidence of this

age. In the opinion of [6, 7], *Discophyllites* is a typical Carnian element.

The Nathorstitidae species of the genus *Stolleyites* were subsequently found in British Columbia [35] in beds attributed by this author to the *Trachyceras dasatoeyense* Zone, the lower zonal unit of the Carnian Stage. On the basis of these data, Dagys correlated the *Stolleyites tenuis* zone of Northeast Asia and the coeval deposits in the Svalbard Archipelago, which were also suggested to be defined as the *tenuis* Zone [36], with the lower Carnian *desatoyense* Zone of North America [12, 29, 30]. At the same time, the analysis of the stratigraphic distribution of ammonoid remains in the *desatoyense* Zone carried out in [19] revealed that the representatives of the genus *Stolleyites* in the British Columbia sections are present below the first appearance level of the ammonoids from the genus *Trachyceras*, which serves as a traditional indicator for the basal layers of the Carnian Stage. On this basis, the *tenuis* Zone, as well as the beds characterized by *Stolleyites* forms, is attributed in this work to the Ladinain Stage. The validity of this position is confirmed by the find of representatives of the genus *Trachyceras* in the higher *omkutchanicum* Zone of Northeast Asia, not in the *tenuis* Zone [20, 22].

In Northeast Asia, the *tenuis* Zone was usually interpreted as an indivisible biostratigraphic unit. The first attempt to define infrazonal units in the latter was undertaken in [30] for sections of its type locality in northern Okhotsk region (by analogy with subdivision of the *tenuis* Zone in Svalbard). The lower part of the *tenuis* Zone defined in Svalbard as the *Stolleyites planus* Subzone is characterized by abundant ammonoid *Stolleyites planus* Frebold and subordinate *S. tenuis* (Stolley) finds. The species *Stolleyites planus* is characterized by a distinct umbilical depression at the early and medium stages and well-developed umbilical folds [30; plate III, fig. 4]. The upper subzone (*Stolleyites tenuis* proper) contains only the index species. At the same time, it should be kept in mind that the establishment of the subzonal units in the *tenuis* Zone of northern Okhotsk region predated revision of the Nathorstitidae representatives in this region, while the lower subzone was defined, in contrast with the Svalbard sections, on the basis of single finds of *Stolleyites planus* Frebold usually identified in open nomenclature [30, p. 196]. The subsequent revision of Nathorstitidae finds in Northeast Asia [15] revealed that some Okhotsk forms were erroneously attributed to *Stolleyites planus* Frebold [30; plate I, fig. 6] and they were interpreted as representing juvenile specimens of *S. tenuis* (Stolley) [15; plate V, fig. 8a]. Taking this interpretation into consideration, the *tenuis* Zone was subsequently considered in Northeast Asia as a single biostratigraphic unit [17, 18].

As was previously shown, the upper part of the *Stolleyites tenuis* Zone in northern Okhotsk region contains peculiar *Stolleyites* forms that differ from *S. tenuis* (Stolley) [13, 17, 18]. The subsequent investigation of the ammonoid remains from the stratotype section of the *tenuis* Zone and analysis of their stratigraphic distribution confirmed the validity of *S. terminalis* sp. nov. and demonstrated that beds characterized by this species may be defined as an separate biostratigraphic unit.

BIOSTRATIGRAPHY

The upper part of the Ladinian Stage and the basal part of the Carnian Stage crop out on the right side of the Pravaya Vtoraya Sentyabr'skaya River 0.01–1.2 km upstream of its confluence with the Levaya Vtoraya Sentyabr'skaya River (Fig. 2). The preliminary description of this section and data on the stratigraphic distribution of ammonoid, nautiloid, and brachiopod remains in the latter are available in [13]. The bed-by-bed description of this section presented below is accompanied by specific data on the distribution of ammonoids (the numerals in brackets designate the distance between the sampling level of the ammonoids and the base of the corresponding member).

Member 1. Mudstones, dark gray, thin-platy, with intercalations of spherical (0.1 m across) clayey–carbonate concretions. The apparent thickness is 20 m (Fig. 3).

Ammonoids: *Nathorstites* sp. (10.5 m).

Member 2. Siltstones, dark gray, thin–platy, with intercalations of mudstones and rare spherical clayey–carbonate concretions. The thickness is 28 m.

Ammonoids: *Nathorstites maclearni* Tozer (1.8 m), *Nathorstites macconnelli* (Whiteaves) (9.2–16.0 m).

Member 3. Siltstones, dark gray, calcareous, massive, with intercalations of their thin–platy varieties and rare clayey–carbonate concretions. The thickness is 96.5 m.

Ammonoids: *Nathorstites macconnelli* (Whiteaves), *Sphaerocladiscites* cf. *omolonensis* Bytschkov (56.5 m), *Nathorstites* sp. juv., *Sphaerocladiscites omolonensis* Bytschkov (67 m), *Nathorstites* ex gr. *macconnelli* (Whit.) (68.5 m), *Nathorstites* sp. indet. (88.5 m), *Nathorstites* cf. *lindstroemi* Böhm, *Sphaerocladiscites* sp. indet. (91 m), *Nathorstites lindstroemi* Böhm, *Stolleyites tenuis* (Stolley) (92 m), *Stolleyites* cf. *tenuis* (Stolley) (93 m).

Member 4. Siltstones, dark gray, thick–platy and massive, with intercalations of rare clayey–carbonate concretions. The thickness is 62 m.

Ammonoids: *Stolleyites tenuis* (Stolley), *S.* cf. *tenuis* (Stolley) (talus in the lower part of the member), *Stolleyites* cf. *tenuis* (Stolley) (41.5 m), *S.* sp. indet. 44.7 m), *S.* cf. *tenuis* (Stolley) (52.7 m).

Member 5. Siltstones, dark gray, thin–platy, with intercalations of calcareous massive siltstones with

rare clayey–carbonate concretions. The thickness is 116 m.

Ammonoids: *Stolleyites tenuis* (Stolley), *S.* cf. *tenuis* (Stolley) (1 m), *S. tenuis* (Stolley) (9.0–9.5 m), *S.* cf. *tenuis* (Stolley) (18 m), *S. tenuis* (Stolley), *Arctophyllites taimyrensis* (Popow) (19.5 m), *S.* sp. indet. (54 m), *A. taimyrensis* (Popow) (66 m), *A. taimyrensis* (Popow), *S.* cf. *tenuis* (Stolley) (77 m), *S. tenuis* (Stolley) (82 m), *S. tenuis* (Stolley) (92–96 m), *S. tenuis* (Stolley) (105 m).

Member 6. Mudstones, dark gray, with intercalations of thin–platy siltstones and rare clayey–carbonate concretions. The thickness is 114 m.

Ammonoids: *Stolleyites terminalis* sp. nov., *S.* sp. indet. (1–19 m), *S. terminalis* sp. nov. (71–93 m).

Member 7. Siltstones, dark gray, sandy, massive, with rare interrelations of clayey–carbonate concretions. The thickness is 73 m.

Ammonoids: *Arctophyllites* cf. *taimyrensis* (Popow), *Stolleyites* sp. indet. (8 m), *Boreotrachyceras omkutchanicum* (Bytschkov) (34 m).

This succession is overlain by sandy siltstones up to 69 m thick with ammonoids *Boreotrachyceras* ex gr. *omkutchanicum* (Bytschkov), which are in turn overlain after the confluence of the Pravaya and Levaya Vtoraya Sentyabr'skaya rivers by the mudstone sequence composed of the higher layers of the Lower Carnian Substage.

The analysis of the distribution of the ammonoid remains in the section under consideration shows that the species *Stolleyites tenuis* is distributed in the interval which includes the upper 4.5 m of Member 3, Member 4, and the largest part of Member 5 from its base to the level of 105 m above the latter. The first finds of *Stolleyites terminalis* are registered in the basal part of Member 6 1 m above its base. In addition, this species occurs at different stratigraphic levels of Member 6 and probably passes into the lower 8 m of Member 7. At the same time, the information in [13, p. 90] referring to the find of *Stolleyites tenuis* in Member 6 together with *Stolleyites terminalis* should be admitted as erroneous. The section interval characterized by *Stolleyites terminalis* conditionally attributed previously to the *tenuis* Zone [17, 18] is first defined in this work as the *Stolleyites terminalis* Beds. In its range, this newly defined biostratigraphic unit corresponds to the upper part of the *Stolleyites tenuis* Zone in the previous scale [17, 18]. Despite the change in its range, the former name of the *tenuis* Zone is retained, since the *Stolleyites tenuis* Zone is the only species suitable for playing the role of index species. The lower boundary of the *Stolleyites terminalis* Beds is placed at the appearance level of the index species, whereas its upper boundary is conditionally superposed with the base of the *omkutchanicum* Zone. The newly defined biostratigraphic unit may now be established on the basis of finds of the index species only in the above-mentioned section and is interpreted as a subsidiary biostratigraphic unit.

In other boreal regions, the youngest Nathorstitidae representatives are known from the *tenuis* Zone of Svalbard [24, 30] and *Arctophyllites* cf. *taimyrensis*–*Zittelihalobia* cf. *zitteli* Beds of Arctic Canada [34, 35]. They include widespread *Stolleyites tenuis* (Stolley) or close forms and are devoid of ammonoid species, which might be identified with *Stolleyites terminalis*. Thus, no equivalents of the *Stolleyites teminalis* Beds known in northern Okhotsk region may reliably be established in other boreal regions; it is obvious that the development history of boreal ammonoids at the Middle–Late Triassic transition is most completely reconstructed in Northeast Asia.

The description of the index species of the newly defined stratigraphic unit of the Ladinian Stage in northern Okhotsk region is given below. The photographs and drawings are original. The collection (no. 940) is stored in the Monographic Department of the Central Siberian Geological Museum (CSGM) in the Institute of Geology and Mineralogy (Siberian Branch, Russian Academy of Sciences, Novosibirsk).

PALEONTOLOGICAL DESCRIPTION

Superorder Ammonoidea Zittel, 1884

Order Ceratitida Hyatt, 1884

Superfamily Nathorstitaceae Spath, 1951

Family Nathorstitidae Spath, 1951

Genus *Stolleyites* Archipov, 1974

Stolleyites terminalis Konstantinov, sp. nov.

Fig. 4, 1–8; Figs. 5, 6.

Species name: terminalis (Latin)—terminal, boundary.

Holotype: CSGM, specimen 5/940; northern Okhotsk region, Yana Okhotskaya River basin, Pravaya Vtoraya Sentyabr'skaya River, Outcrop S-5, Zhakan Formation, Ladinian Stage, Upper Ladinian Substage, *Stolleyites terminals* Beds.

Shape (Fig. 5). In the first three whorls, shell is evolute, strongly convex, with slightly enveloping whorls of the transverse–oval section, slowly growing in the height. In more adult specimens, the relative height of the whorls increases, while their width decreases. At the fourth whorl, the shell acquires rapidly convolute outlines and its umbilicus becomes narrower. By the end of the fourth whorl, the shell becomes convex, pachycone, with completely enveloping whorls of the crescent section. The ventral side is widely rounded, grading into the convex lateral side, which slopes toward the rounded umbilical edge. The umbilical wall is relatively high, convex, overhanging. The umbilicus is relatively narrow, deep. By the end of the fifth whorl, the height of the whorls exceeds their width and their transverse section becomes helm-shaped with a tapered ventral side. Adult specimens with D = 20–

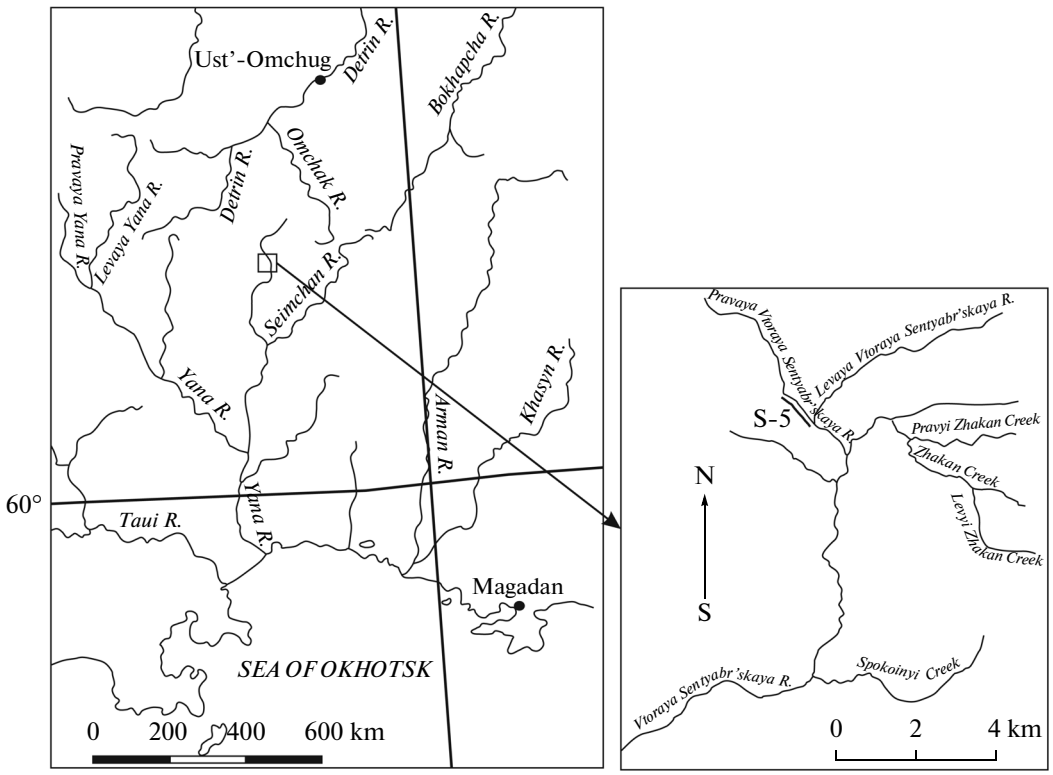

Fig. 2. Location of the study area and section of the uppermost Ladinian–basal Carnian beds (deposits) in the schematic map of northern Okhotsk region. The line shows the position of Outcrop S-5.

35 mm are oxycone, involute, flattened, with entirely enveloping whorls of the spear-shaped section. Umbilicus closed, entirely overlapped by the thickened shelly layer on the umbilical side. The body chamber is unpreserved.

Sizes in mm and ratios

Specimen number	D	H	W	UD	H/D	W/D	UD/D
1/940	6.8	3.6	3	0.45	53	44	7
2/940	8.6	5	3.6	0.6	58	42	7
3/940	12	6.3	3.8	0.9	53	32	7.5
	17.5	12	5.5	1	57	31	5.7
4/940	21	12.2	6	1.05	58	28	5
5/940	27.3	17	7	0	62	26	0

(D) diameter of the shell; (H) height of the whorl; (W) width of the whorl; (UD) umbilicus diameter.

Ornamentation. The shell is surface covered by frequent radial growth lines forming wide projections in the middle part of the lateral side and at transition to the ventral side and narrow shallow sinuses in the upper third of the height and on the ventral side. The cast surface is smooth. In shells with D = 5–10 mm, the lateral side (1/3 of the whorl height from the umbilicus) bears a small relatively wide spiral furrow.

Suture (Fig. 6). In shells with H = 11.5 mm, the outer side of the whorl bears seven lobes between the external saddle and umbilical suture, which form an arc with its convex part oriented toward the shell growth and rising toward the umbilicus. All the lobes are dentate at their bases with denticles slightly overlapping saddle walls in the ventral, lateral, and first umbilical lobes. Saddles with rounded apexes are slightly inclined toward the umbilicus.

Comparison. The species under consideration differs from the similar form *Stolleyites tenuis* (Stolley) in relatively narrower whorls, the presence of a spiral furrow on the lateral sides in juvenile specimens, and the absence of regular near-umbilical folds and ribs at the all growth stages. In addition, *S. terminalis* is characterized by a closed umbilicus at the terminal growth stages and dentate bases of lobes in the umbilical area of the whorl.

Remarks. The new species is likely close genetically to *Stolleyites tenuis* (Stolley) distributed in the immediately underlying strata and originated likely from the latter due to its accelerated ontogenetic development. It is established that *Stolleyites terminalis* sp. nov. is characterized by a shorter evolute stage, which

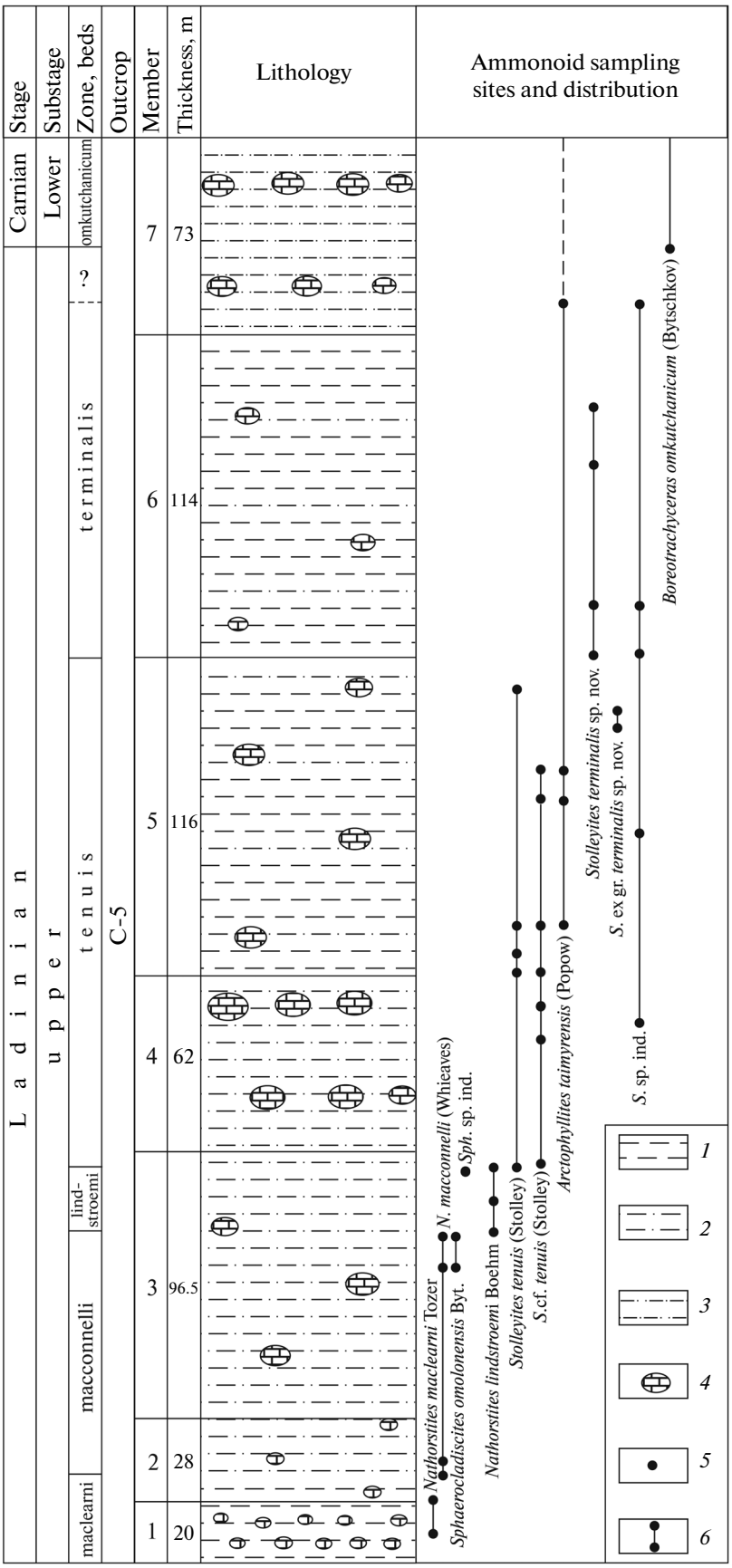

Fig. 3. Stratigraphy of the Upper Ladinian–basal Carnian beds on the right side of the Pravaya Vtoraya Sentyabr'skaya River 1.2–0.01 km upstream of the mouth (Outcrop S-5). (*1*) mudstones, thin–platy; (*2*) siltstones, thin–platy; (*3*) siltstones, calcareous, and sandy, massive; (*4*) clayey–carbonate concretions; (*5*) ammonoid sampling sites; (*6*) documented stratigraphic distribution of species.

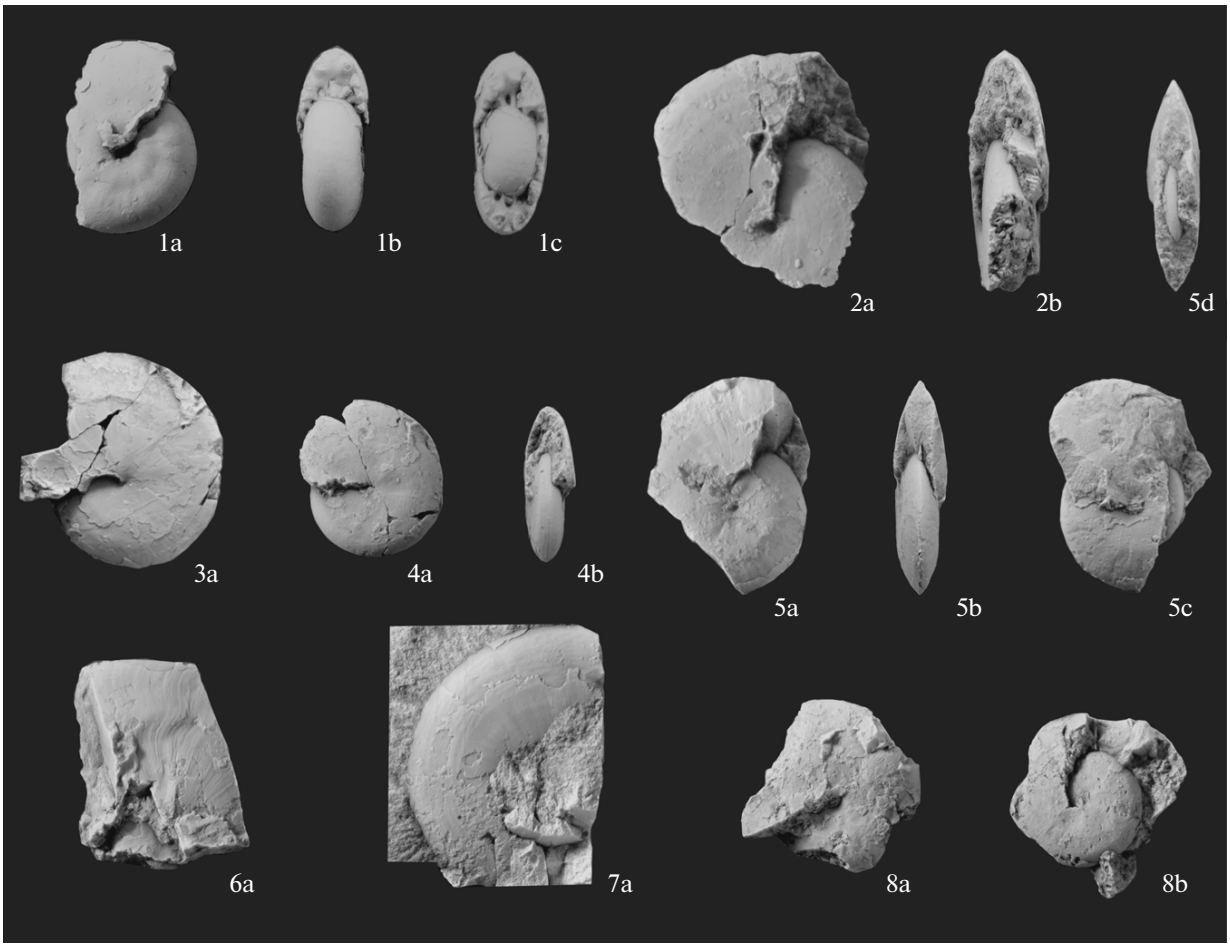

Fig. 4. Ammonoid species *Stolleyites terminals* sp. nov.
(1) specimen 2/940 (×*3*): (a) lateral view with visible spiral furrow in the lower third of the whorl, (b) apertural view, (c) ventral view with partly visible internal whorls; (2) specimen 3/940 (×*2*): (a) lateral view, (b) apertural view; (3) specimen 8/940 (×*1*): (a) lateral view; (4) specimen 4/940 (×*1*): (a) lateral view, (b) apertural view; (5) specimen 5/940 (×*1*): lateral view (from the one side), (b) apertural view, (c) lateral view (from the other side), (d) ventral view; (6) specimen 7/940 (×*1*): (a) lateral view, two-sinus growth striae on the lateral side of the whorl; (7) specimen 10/940 (×*1*): (a) lateral view with radial fine growth lines and spiral striae on the surface of the shelly layer; (8) specimen 6/940 (×*1*): lateral view (from one side), b) lateral view (from other side). Northern Okhotsk region, Yana Okhotskaya River basin, Pravaya Vtoraya Sentyabr'skaya River, Outcrop S-5; Zhakan Formation, Upper Ladinian, *Stolleyites terminalis* Beds. Collections by A.G. Konstantinov, E.S. Sobolev, and I.I. Kharitonov, 1988.

encompasses the first three whorls, while in *S. tenuis* it includes the four initial whorls. The main trend in the evolution of the genus *Stolleyites* is likely reflected in the reduction of the evolute shell stage in its early ontogeny, decrease in the relative width of the whorls, disappearance of the umbilical depression, ornamentation smoothing, and dentate patterns of all the lobes [30].

Despite the observable morphological differences from the type species, the new species is attributed to the genus *Stolleyites* since it is characterized by a typical feature of the latter: arcuate rise of the suture from the ventral side toward the umbilicus.

Distribution. Northern Okhotsk region, Yana Okhotskaya River basin, *Stolleyites terminalis* Beds.

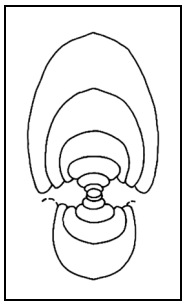

Fig. 5. Whorl cross section in *Stolleyites terminalis* sp. nov. Specimen 1/940 (×*7*), northern Okhotsk region, Yana Okhotskaya River basin, Pravaya Vtoraya Sentyabr'skaya River, Outcrop S-5, Zhakan Formation, Upper Ladinian, *Stolleyites terminalis* Beds.

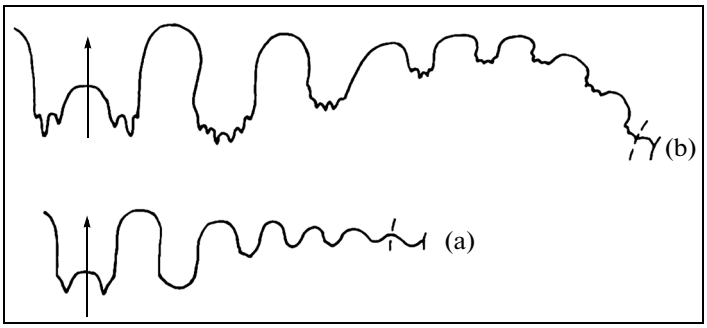

Fig. 6. Sutures in *Stolleyites terminalis* sp. nov.
(a) specimen 2/940: H = 3.5 mm, W = 3.0 mm; northern Okhotsk region, Yana Okhotskaya River basin, Pravaya Vtoraya Sentyabr'skaya River, Outcrop S-5, Zhakan Formation, Upper Ladinian, *Stolleyites terminalis* Beds; (b) specimen 4/940: H = 11.5 mm, W = 6.0 mm; locality and age the same.

Material. Northern Okhotsk region, Yana Okhotskaya River basin, Pravaya Vtoraya Sentyabr'skaya River (14 specimens).

CONCLUSIONS

The presented data allow the following conclusions.

(1) Revision of the taxonomic composition of ammonoids and their stratigraphic distribution has made it possible to specify and refine the biostratigraphic subdivision of the uppermost strata of the Ladinian Stage in northern Okhotsk region. The range of the *Stolleyites tenuis* Zone in the uppermost Ladinian Stage at the Pravaya Vtoraya Sentyabr'skaya River (Yana Okhotskaya River basin) has been changed for the first time with the definition of a new biostratigraphic unit: the *Stolleyites terminalis* ammonoid beds overlying this zone.

(2) The species *Stolleyites terminals* sp. nov. is likely close genetically to *S. tenuis*, originating presumably from the later due to accelerated ontogeny evolution.

(3) The ammonoid species *Stolleyites terminalis* is likely the youngest representative of the family Nathorstitidae, which are still known only in northern Okhotsk region. Their find on the right side of the Pravaya Vtoraya Sentyabr'skaya River characterizes most likely the complete and unique section of the Ladinian Stage in the region under consideration.

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