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Gastropod Mollusks from the Hauterivian of Ulyanovsk (Volga Region): 1. Family Aporrhaidae

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Abstract—Data on the detailed stratigraphic range of eight species of gastropod mollusks from the Upper Hauterivian of Ulyanovsk (Volga Region) are presented. A new genus, *Trilemma*, is established within the family Aporrhaidae. Two new species of this genus, *T. russiense* sp. nov. and *T. striatocarinatum* (Sinzow, 1880), are described.

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Key words: gastropods, Upper Hauterivian, Ulyanovsk Volga Region.

INTRODUCTION

Gastropod mollusks from Cretaceous beds of central European Russia have been rather poorly studied. This is primarily because paleontologists studying the Mesozoic fauna have been concerned mainly with the study of cephalopods and bivalve mollusks, which were most important for stratigraphy. However, in recent years there is some evidence for the existence of gastropod species and assemblages of gastropod species characteristic of some regional stratigraphic units of the Mesozoic (Beisel, 1983; Poyarkova and Dzhalilov, 1985; Gerasimov, 1992; etc.). Thus, gastropods may be promising in the solution of some problems of the stratigraphy of marine Mesozoic deposits. In addition, these data on the detailed stratigraphic range and geographic position of gastropods may be useful for the solution of problems in paleogeography, paleobiogeography, and paleoecology. This paper aims to determine the taxonomic composition and describe the detailed stratigraphic range of gastropods from the Upper Hauterivian of Ulyanovsk (Volga Region).

Trautschold (1865) was the first to refer to gastropods from Simbirsk (*Inoceramus*) clay of Ulyanovsk (Volga Region): *Fusus minutus* Trd., *Acteon frearsianus* d'Orb., and *Turbo humilis* Trd. Later Laguzen (1874) reported *Turbo humilis* Trd., *T.* cf. *jasikofianus* d'Orb., *Cerithium* cf. *syssollae* Keys., *Rostellaria* cf. *bispinosa* Keys., *Eulima* cf. *splendens* Eichw., and *Acteon* sp. from the Simbirsk Clay. Kabanov (1959) recorded *Eulima* cf. *splendens* and *Buccinum* cf. *incertum* d'Orb. from the Hauterivian. A supplement compiled by Kabanov to Rogozin's monograph (1961) contains figures of five species of Hauterivian gastropods: *Eulima* cf. *splendens*, *Buccinum* cf. *incertum*, *Turbo humilis, Acteon* sp., and *Cerithium* sp. *Cerithium* sp. was subsequently described by Glasunova (1968) as *Cirsocerithium antiquum* Glasun. In addition to the descriptions and figures of the five gastropod species that were figured in the supplement to Rogozin's monograph, Glasunova's monograph (1973) provides a description and figure of one more gastropod, the variety *B. incertum* var. *plana* Glasun. (Glasunova, 1973).

It is worth noting that of all the above-mentioned species, only *B. incertum* has been recorded from both paleontological zones of the Upper Hauterivian: *versicolor* and *decheni*. The other species have only been recorded from the *decheni* Zone.

In the late 1960s Kabanov reported *B. incertum* and *Neritopsis multicostulata* Pčel. from the *versicolor* Zone and *T. humilis*, *Eulima* cf. *splendens*, and *B.* cf. *incertum* from the *decheni* Zone in his unpublished work.

A number of species that are absent (or have not been found) in the Hauterivian of Ulyanovsk (Volga Region) have been recorded from Hauterivian deposits of other areas of the Volga Region and from the northern Caspian regions in addition to some of the abovementioned gastropods. Sinzow (1880) described *Scalaria dupiniana* d'Orb. var. *rhodani* Pictet et Roux and *Aporrhais striatocarinata* Sinzow, 1880 from the Lower Cretaceous beds in the vicinity of Saratov. Morozova (1986) recorded *Scalaria dupiniana* d'Orb., *Cerithium phillipsi* Leym., *Cirsocethium antiquum* Glasun., *Melanella splendens* Eichw., *Buccinum incertum* d'Orb., *Natica laevigata* Desh., and *Acteon frearsianus* d'Orb. from the *versicolor* Zone of the northern Caspian Region.

The systematics of Hauterivian gastropods requires revision, especially at the generic level. The reason is that Mesozoic species were previously placed into widespread Cenozoic genera. Subsequently, a major

portion of Cenozoic genera were revised; thus, the lower limit of their stratigraphic range is bounded by the Upper Cretaceous.

MATERIAL AND METHODS

This paper is based on the collection of about 1000 shells of Hauterivian gastropod mollusks, which were collected during the field trips of the authors, I.V. Blagovetshenskiy (1997–2003) and I.A. Shumilkin (1985, 1997, and 1998). The specimens described in this paper are housed in the Ulyanovsk Regional Museum of Regional Studies (UKM). In addition, we examined the collection of Early Cretaceous gastropods that was collected and placed by K.A. Kabanov in the same museum and the collection of Hauterivian gastropods of the Undory Paleontological Museum (UPM). The specimens studied belong to 18 different forms. In this paper we study those 12 forms for which the systematic position is well established. The other forms await further study and additional material. The species distribution of the specimens is quite uneven: some species are represented by single shells; others, by several tens and even hundreds of shells. The material is usually in a good state of preservation; however, the apertural margin is lost in many shells, thus making the identification of some species difficult; for example, the processes of the palatal margin of the aperture are an important diagnostic character in the family Aporrhaidae.

The section of the Upper Hauterivian that was studied by the authors is located on the right bank of the Kuibyshev Reservoir between Ulyanovsk and the village of Novaya Beden'ga. This part of the bank is arbitrarily divided into segments (Fig. 1). Each of these segments is indicated by a string of symbols. The first one or two symbols are capital letters that indicate the nearest populated place: Ulyanovsk (U), small town of Polivna (P), small town of Slantsevyi Rudnik (SR), and children's sanatorium (CS). The following symbols are international notations of stratigraphic units, and the last digits denote segments.

The material was collected bed-by-bed to be correlated with ammonite zones and beds. Since landslides destroyed a considerable part of the Upper Hauterivian section within the Volga bank under study, observations were restricted to some fairly full outcrops, which were correlated based on lithological markers, most commonly horizons of lime concretions that are clearly defined in space. The stability of the dip angle makes it possible to trace the emergence of new beds and reliably correlate these markers with each other throughout the section.

The collection of specimens covered the total faunal assemblage of a bed. Only in individual cases the extraction of fossils from rocks took place in the field. This is because the shells are brittle, especially in the wet state, and can easily be damaged by mechanical extraction from dense clays or mudstones. Subsequently, under laboratory conditions, rock with fossils was placed in boiling water over a slow fire for an hour or more (depending on the volume, moisture, and lithological composition), resulting in a suspension of faunal remains and fragments of rock. This suspension was washed with running water through a series of mesh screens with openings of 1to 10 mm, after which the fauna caught on screens can be easily extracted. In some cases gastropods were recorded from dense limestone concretions. As a rule, they were in a very good state of preservation but required careful and time-consuming preparation, which were accompanied by considerable destruction of associated material. The shells were examined with a microscope (MBS-10), measured with an eyepiece micrometer, and photographed with a digital camera, in most cases through the MBS-10 microscope.

STRATIGRAPHY

An extensive literature exists on the stratigraphy of the Hauterivian of Ulyanovsk (Volga Region) (Milanovskii, 1940; Chernova, 1951; Sasonova, 1958; Drushchits, 1962; Glasunova, 1973; Shumilkin, 1993; Baraboshkin, 2003; etc.).

These papers show that the 50-m-thick Hauterivian clays form a transgressive overlap between the underlying phosphorite conglomerate of the Upper Valanginian and the overlying Barremian belemnite sequence. Lithologically, these clays constitute a relatively diverse sequence, which is composed predominantly of dark gray and gray (usually slightly sandy) clays with accessory bands and lenses of mudstone. The thickness of these mudstone bands is 0.2–1 m. Clays are of hydromica-montmorillonite type with minor amounts of syndiagenetic (pyrite and glauconite) and supergene (iron hydroxide) minerals. Pyrite and marcasite form small, variously shaped concretions and nodules.

The clay beds contain clay–carbonate concretions varying from 0.2–0.3 to 1.5 m in size. Usually they form horizons that show a fairly consistent spatial arrangement. In the stratigraphic scheme that follows, the Hauterivian deposits comprise 14 consistent horizons.

The Upper Hauterivian deposits include two ammonite zones: *Speetoniceras versicolor* and *Simbirskites decheni.* The *versicolor* zone is characterized by the ammonites *Speetoniceras versicolor* (Trd.), *Sp. coronatiforme* M. Pavl., *Sp. pavlovae* Tschern., *Sp. intermedium* Glasun., *Sp. polivnense* Glasun., and others, the bivalves *Inoceramus aucella* Trd., *Prochinnites substuderi* Glasun., *Astarte porrecta* Buch, and *Thracia creditica* Glasun., and the belemnites *Acroteuthis* (*Acroteuthis*) *pseudopanderi* (Sinz.), *Praeoxyteuthis jasikofiana* (Lah.), *Aulacoteuthis speetonensis* (Pavl.), *A. absolutiformis* (Sinz.), and others. The *decheni* Zone contains the ammonites *Simbirskites decheni* (Roem.), *S. umbonatus* Lah., *S. pseudobarboti* Pavl., *S. kow-*

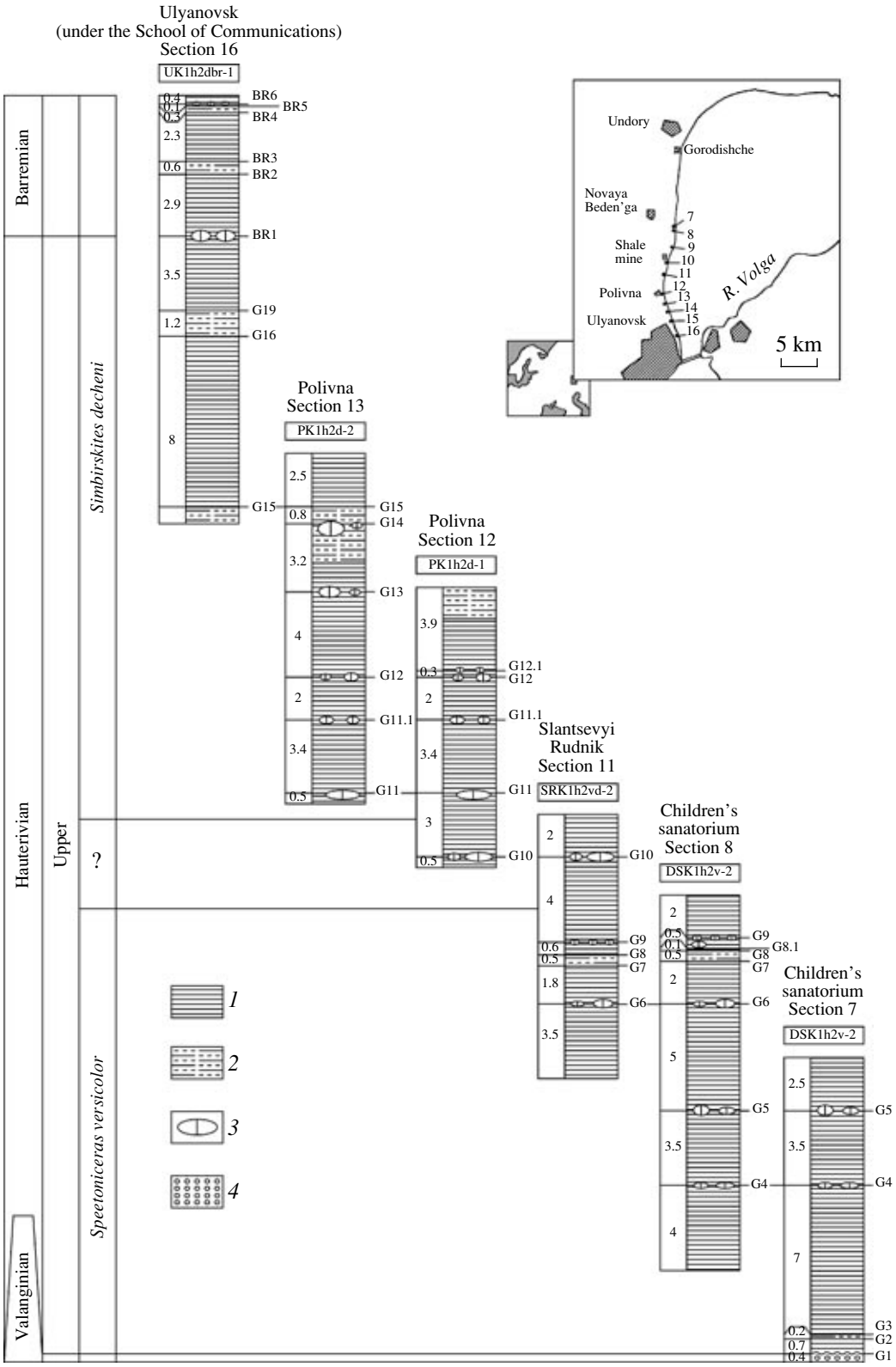


Fig. 1. Schematic map (inset) and structure of sections (see text for explanations) of the Hauterivian near Ulyanovsk (Volga Region). Designations: (*1*) clay, (*2*) clay siltstone, (*3*) limestone concretions, and (*4*) phosphorite conglomerate.

alewskii Pavl., *S. volgensis* Glasun., *Craspedodiscus discofalcatus* Lah., *Cr. progredicus* Lah., *Cr. borealis* Glasun., *Cr. speetonensis* Young et Bird, and others, the bivalves *Oxytoma cornueliana* d'Orb., *Ox. parvula* Glasun., *Ox. rara* Glasun., *Aucella polivnensis* Glasun., *Inoceramus aucella* Trd., *Camptonectus imperialis* Keys., *Lima consobrina* d'Orb., *Phacoides pseudofornicatus* Glasun., *Protocardia concinna* Buch, *Dosiniopsis* (*Dosinimeria*) *parva* Sow., *Corbula striatula* Sow., *C. polita* Trd., and others, and the belemnites *Acroteuthis* (*Acroteuthis*) *pseudopanderi* Sinz., *Aulacoteuthis recta* Glasun., *A. speetonensis* Pavl., *A. tenebrosa* Glasun., *A. absolutiformis* Sinz., *Praeoxyteuthis jasikofiana* (Lah.), and others. A characteristic feature of these deposits is that beds with rich faunas alternate with beds almost devoid of fauna.

This paper presents a correlation scheme of a number of reference sections of the Hauterivian deposits of Ulyanovsk (Volga Region) (Fig. 1) that greatly supplements the previous scheme (Shumilkin, 1993). Using this correlation scheme, we compiled the composite section of the Upper Hauterivian of Ulyanovsk (Volga Region) (Fig. 2). These schemes show that the 50-m-thick Hauterivian sequence is divided into 24 beds, which differ in lithology and fauna. Each bed is designated by a small letter plus a hyphen and digits (for example, g-14). The neighboring beds are separated by a level that corresponds to the change in the depositional environments. Each level is designated by a capital letter and digits (for example, G14). In most cases levels correspond to horizons with concretions, which are good lithological markers: in many instances they differ in size, shape, surface character, lithological features, internal structure, the presence or absence of fauna, and in faunal composition. Each specimen recovered under field conditions was reliably assigned to a certain level or bed. Our designations of beds and levels are used in Material sections in Systematic Paleontology.

Our analysis of the stratigraphic range of gastropods in the Hauterivian deposits of Ulyanovsk (Volga Region) shows the presence of two assemblages of species: the Lower *Simbirskites* assemblage (*versicolor* Zone) and the Upper *Simbirskites* assemblage (*decheni* Zone) (Fig. 2).

The Lower *Simbirskites* assemblage comes from beds g-4.1, g-5, and g-6 and from concretions of level G4 and includes the following characteristic species: *Trilemma russiense* sp. nov., *Turbinopsis multicostulata* Pčel., *Sulcoacteon* sp. nov., and *Eucyclus* sp. The Upper *Simbirskites* assemblage comes from beds g-11, g-11.1, g-12, g-12.1, g-13, and g-14 and from concretions of the levels that separate these beds and include the following characteristic species: *Trilemma striatocarinatum* (Sinzow), *"Turbo" humilis* Trd., and new as-yet undescribed forms. Both assemblages contain *Hudlestonella pusilla* (Tullberg), *Tornatellaea* sp. nov., *Claviscala antiqua* (Glasun.), and *Khetella* sp. nov. The first two species are more abundant in the Upper *Sim-*

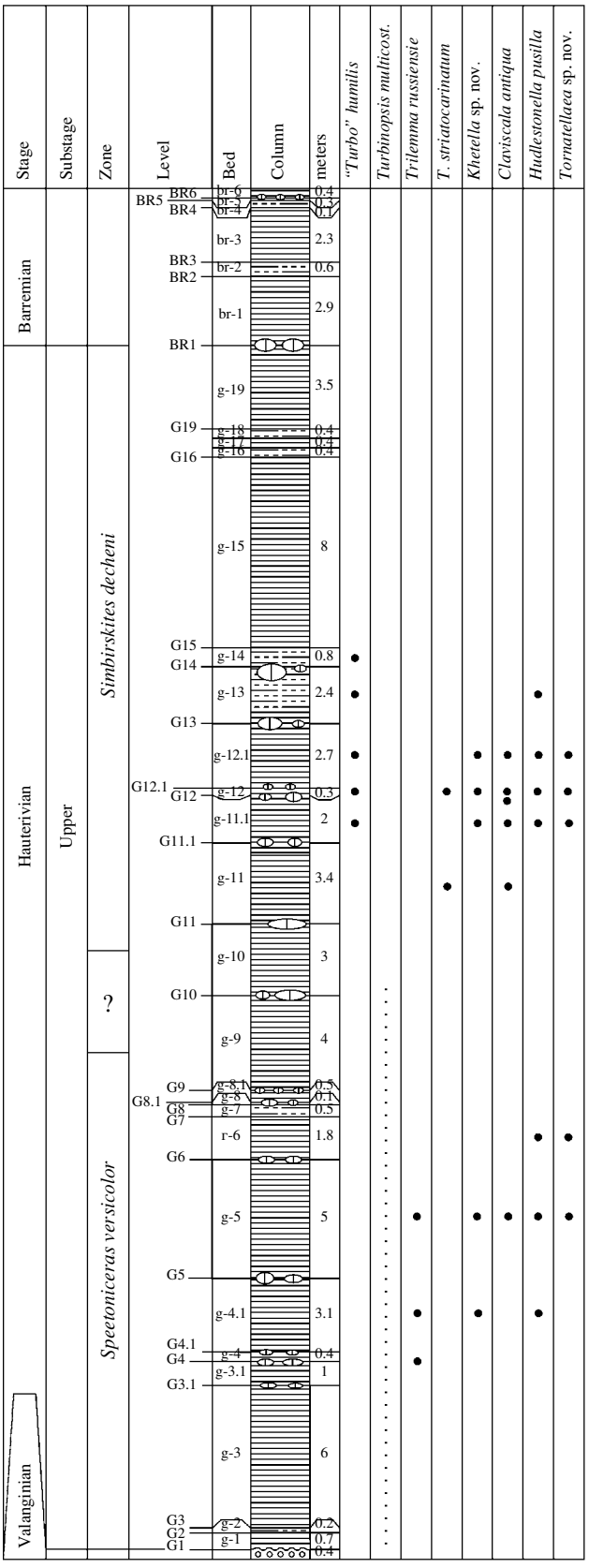


Fig. 2. Distribution of gastropod mollusks in the Upper Hauterivian of Ulyanovsk (Volga Region). Designations in Fig. 1.

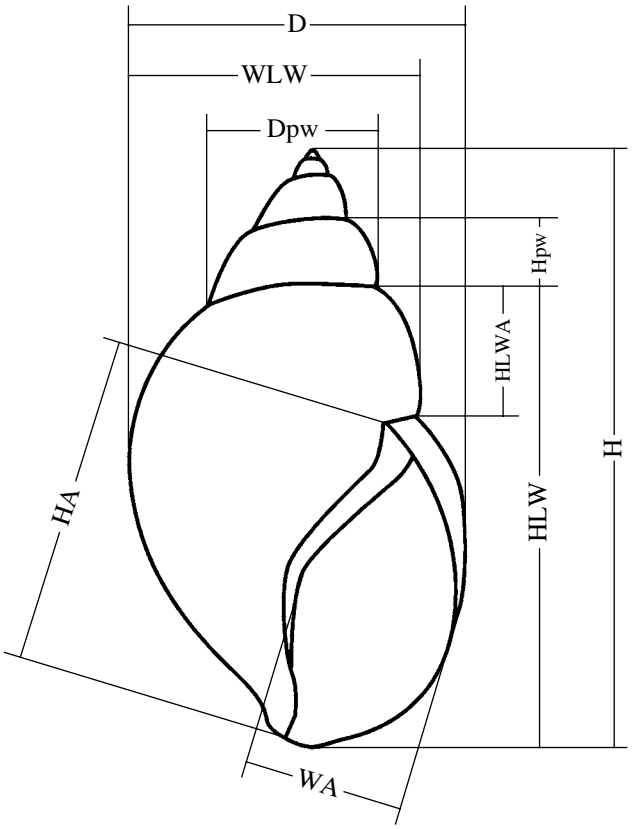


Fig. 3. Scheme of shell measurements: (H) height of the shell, (Hpw) height of the penultimate whorl, (D) diameter of the shell, (Dpw) diameter of the penultimate whorl, (HLW) height of the last whorl, (HLWA) height of the last whorl above the aperture, (WLW) width of the last whorl measured above the aperture, (HA) height of the aperture, and (WA) width of the aperture.

birskites assemblage. Among aforementioned species, *H. pusilla* and *"Turbo" humilis* Trd. are abundant, *Kh.* sp. nov. and *C. antiqua* (Glasun.) occur sporadically, and the other species are infrequent.

In this paper we use the system of prosobranch mollusks that was developed by Golikov and Starobogatov (1975).

The scheme of shell measurements and terminology are shown in Figs. 3 and 4.

In this paper we describe two species of the family Aporrhaidae: *Trilemma russiense* sp. nov. and *T. striatocarinatum* (Sinzow, 1880), of which the former occurs exclusively in the *versicolor* Zone; and the latter, in the *decheni* Zone. Both species are fairly common and are clearly distinguishable even though the winglike extension of the palatal margin of the aperture may be lost or undeveloped; and hence, they may be considered as index forms for these zones.

SYSTEMATIC PALEONTOLOGY

Order Alata

Superfamily Stromboidea Rafinesque, 1815

Family Aporrhaidae Gray, 1850

Genus *Trilemma* Blagovetshenskiy et Shumilkin, gen. nov.

Etymology. From the Greek *tria* (three) and *lemma* (membranous margin, cuticle).

Type species. *Aporrhais striatocarinata* Sinzow, 1880; Lower Cretaceous; Saratov Region.

Diagnosis. Fusiform shells of medium size, with bicarinate whorls, smooth (not tuberculate) carinae,

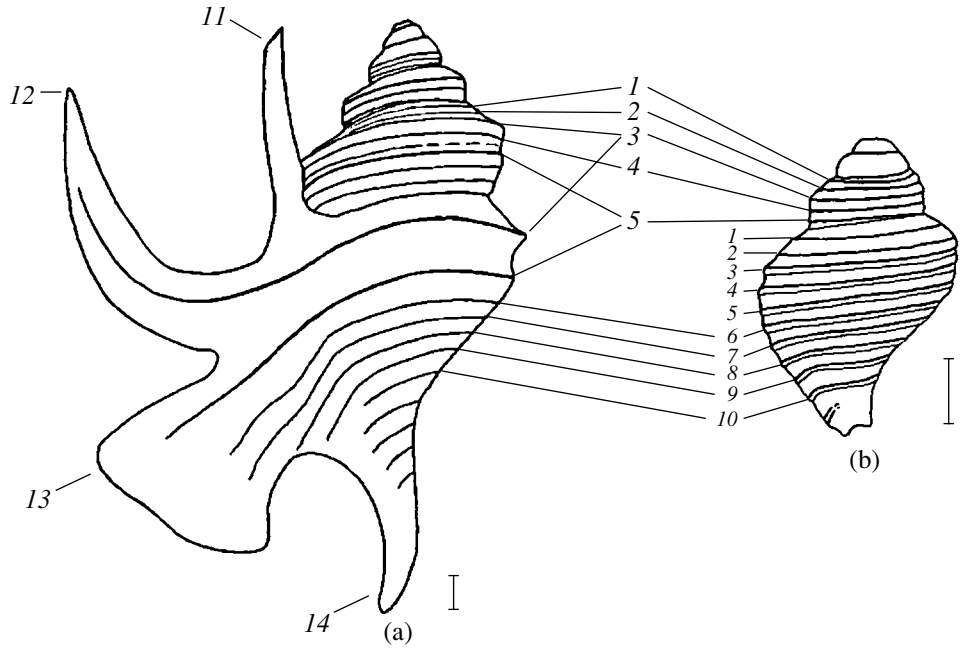


Fig. 4. The structure of shell and the development of ornamentation in *Trilemma russiense*; (a) adult individual and (b) juvenile individual. Designations: (*1–10*) spiral costae: (*1*) first, (*2*) second, (*3*) third (upper carina), (*4*) fourth, (*5*) fifth (lower carina), (*6*) sixth, (*7*) seventh, (*8*) eighth, (*9*) ninth, and (*10*) tenth; (*11–14*) processes: (*11*) posterior, (*12*) posterolateral, (*13*) anterolateral, and (*14*) anterior (rostrum); Scale bar 1 mm.

and poorly developed axial ornamentation. Aperture with robust, downwardly curved rostrum. Winglike extension of palatal margin of aperture with three sickle-shaped processes of narrowly elongated or, more rarely, broadly elongated, flattened shape. Posterior process and adapical spire whorls coalesced to a greater or lesser extent.

Species composition. In addition to the type species, eight more species: *T. ebrayi* (Loriol, 1882) from the Albian of Switzerland and Barremian–Lower Aptian of the Saratov Region, *T. moreausianum* (d'Orbigny, 1842) from the Neocomian of France and Germany, *T. retusum* (Sowerby, 1836) from the Albian of western Europe, *T. russiense* sp. nov. from the Upper Hauterivian of the Ulyanovsk Region, *T.? arrialoorense* (Stoliczka, 1867) from the Senonian of southern India, *T.? bicarinatoides* (Wollemann, 1903) from the Aptian–Albian of northern Germany, *T.? piettei* (Buvignier, 1852) from the Upper Jurassic of Denmark, and *T.? pyriforme* (Kner, 1848) from the Maastrichtian of the Donets Basin and the L'vov Region.

Comparison. This genus differs from the genus *Tessarolax* Gabb, 1864 in the absence of a projection on the side of the shell that is opposite to the winglike extension of the palatal margin of the aperture; it differs from the very closely related genus *Aporrhais* Costa, 1778 in the less developed axial ornamentation, the smooth (not tuberculate) carinae, and in that the structure of the palatal margin of the aperture is usually less complicated.

Remarks. Some authors referred the species that we place in the genus *Trilemma* to the genus *Tessarolax* Gabb, 1864. However, the type species of this genus, *Tessarolax distortus* Gabb, 1864, has a very prominent distinguishing feature, a projection of rounded to angular shape on the side of the shell that is opposite the winglike extension of the palatal margin of the aperture. This has led us to believe that the genus *Tessarolax* should include only those species that have such a projection.

***Trilemma russiense* Blagovetshenskiy et Shumilkin, sp. nov.**

Plate 5, figs. 1–9

Etymology. From Russia.

Holotype. UKM, no. 432; Ulyanovsk Region, village of Novaya Beden'ga; Upper Hauterivian, *versicolor* Zone.

Description (Fig. 4). The shell is of medium size, fusiform, with a winglike extension of the palatal margin of the aperture, and consists of eight or nine bicarinate whorls. In the spire whorls the lower carina usually runs just over the suture and, thus, is poorly seen. On the last whorl both carinae are equally well expressed. In addition, some large individuals show rudiments of a third carina at the base of the last whorl, below the two main carinae. The surfaces of the whorls are concave between the two main carinae and slightly concave or flat above and under the carinae.

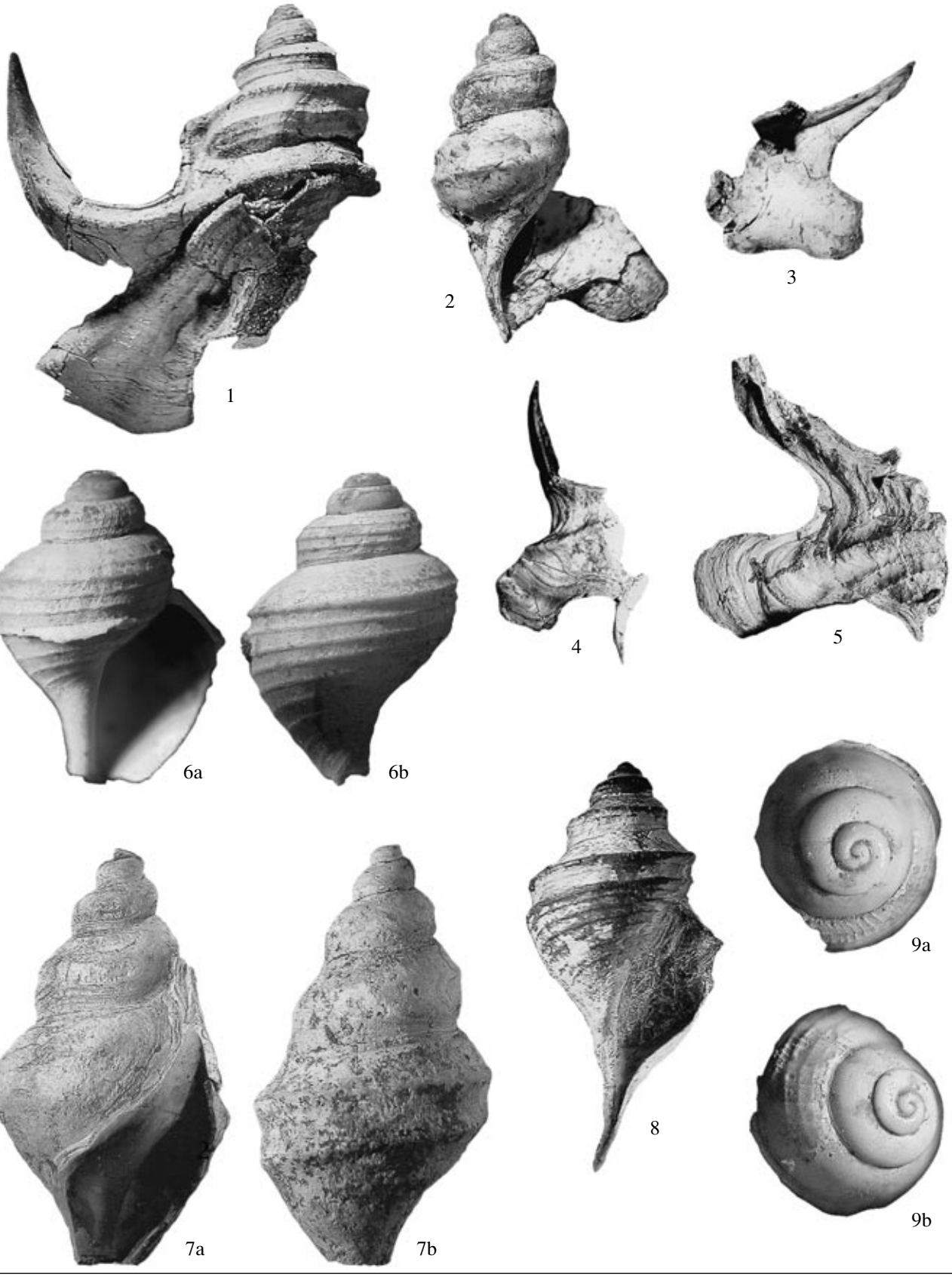
The height of each spire whorl is 1.8–2.3 of the preceding. The ratio of the width of the last whorl measured above the aperture to the height of the last whorl above the aperture is 2.5–3.0. The apical angle is 80°–85°. The generating line is slightly convex.

The protoconch consists of 3.3–3.5 whorls. The first whorl is smooth apically, then weak spiral costellae appear, and the first elements of axial ornamentation appear within 0.1 whorl. The boundary between the protoconch and teleoconch is poorly defined and is arbitrarily determined by the appearance of the surface ornamentation. The fourth and fifth spire whorls contain five or six or, rarely, seven spiral costae each, of which the third (counting from the adapical suture) is slightly larger than the others and develops a carina-like appearance on the sixth whorl (upper carina). In adult specimens with a well-developed winglike extension, this carina passes into a posterolateral process (Fig. 4). At the end of the sixth–beginning of the seventh whorls, the fifth (counting from the adapical suture) spiral costa becomes more robust to make the second (lower) carina more prominent. In adult individuals, it continues on the anterolateral process. Between the upper and lower carinae, a weak spiral costella persists (the fourth counting from the upper carina) and, occasionally, one more such costella (secondary, i.e., formed during the development of the teleoconch) appears. In adult individuals, two more spiral costa (sixth and seventh), which were earlier obscured by overlapping whorls, become visible on the spire below the second carina. This is due to the increased whorl height. Above the upper carina the surface of whorls is flat or slightly concave, with two weak spiral costellae, which correspond to the first and second costae of the early whorls. On the last whorl, under the second carina, adult individuals have eight or nine spiral costellae; young individuals, six or seven.

The fourth whorl gives rise to axial ornamentation in the form of costellae that are bent rightward. The angulation of the axial costellae occurs at the level of the third spiral costa; on the fifth whorl, at the level of the upper carina. The axial costellae are approximately three times as narrow as the spiral costellae and considerably lower, i.e., ornamentation is of a decussate type. The intersecting costellae of the spiral and axial ornamentations form rhomboid meshes. The axial ornamentation can only be clearly traced up to the fifth whorl. On the later whorls it is hardly visible even in well-preserved specimens. Only the upper carina shows fragments of axial costellae in the form of elongated tubercles.

The aperture is elongated and elliptical and passes into a parietal canal adapically. The posterior process (in adult specimens) and the lower part of the adapical spire whorl coalesce. The upper part of the posterior process is lost; however, it probably rose higher than the initial whorls of the shell. The anterior process (rostrum) is fairly long, somewhat backwardly curved. The

Plate 5



palatal margin of the aperture extends to form a winglike structure and have two processes, posterolateral and anterolateral.

The posterolateral process continues the upper carina. It is typically sickle-shaped, is directed rightward and upward, stops short of the upper whorls of the shell, and has a notch on the apertural side. In certain specimens the posterolateral process is directed slightly upward or even nearly horizontally.

The anterolateral process is wide, flat, rounded or somewhat angular at the end, expanded, and is directed rightward and downward. In the upper part of this process, there is an extension of the lower carina, under this extension there are extensions of six to nine spiral costae. The columellar and parietal margins of the aperture have a smooth, bright surface, which has preserved its initial brown color in certain individuals. The umbilicus is absent.

Measurements in mm and ratios:

Specimen no.	H	D	HLW	HA	WA	NW	H/D	HLW/H	HA/H
49/5	4.6	3.3	–	–	1.4	5.6	–	–	–
316	8.7	4.2	7.5	–	–	4.3(6)	–	0.84	–
315	14.5	15.6	12.4	–	–	4(7)	0.9	0.84	–
500/1	11.6	8.1	8.4	–	–	4.6(7)	1.44	0.73	–
201	15.0	7.4	12.5	10.0	3.6	5(7)	2.0	0.83	0.66
Holotype 432	15.1	12.7	–	–	–	6(8)	–	–	–
49/1	18.5	10.3	–	–	–	4.8(9)	–	–	–

Note: Specimen no. 49/5 is a young individual in which the processes are either undeveloped or broken and the protoconch contains 3.5 whorls of the total of 5.6 whorls; specimen no. 316 has the anterior process; specimen no. 315 has the posterolateral and, partly, posterior processes; specimen no. 500/1 has the anterolateral and, partly, anterior processes; specimen no. 201 has a fragment of the anterolateral process; holotype no. 432 has the anterolateral, posterolateral, and, partly, posterior processes; and specimen no. 49/1 has a fragment of the posterior process.

Ontogenetic changes. The height of the whorl increases with age; thus, the later spire whorls show more spiral costae. The degree of the development of the processes of the palatal margin of the aperture and, probably, their shape depend on the age of the mollusk. Young individuals have a relatively shorter and more rounded anterolateral process and a less bent posterolateral process.

Variability. The structural features of the winglike extension of the palatal margin of the aperture vary. The posterolateral processes vary from those sickle-shaped, directed rightward and upward to almost straight, elongated, and pointed (swordlike), directed at an acute angle to the axis of the shell (occasionally, almost at a right angle, because this angle varies considerably). The anterolateral process either has approximately the same width along its entire length or becomes wider at the end and varies from rounded to slightly bent, angular.

Comparison. This species differs from the other species of the genus *Trilemma* in the wide, flat anterolateral process.

Remarks. Some of the specimens studied are nearly devoid of ornamentation. This may be explained by preburial transport, which destroyed not only the finest axial costellae, but also the coarser elements of the spiral ornamentation after death of the organisms.

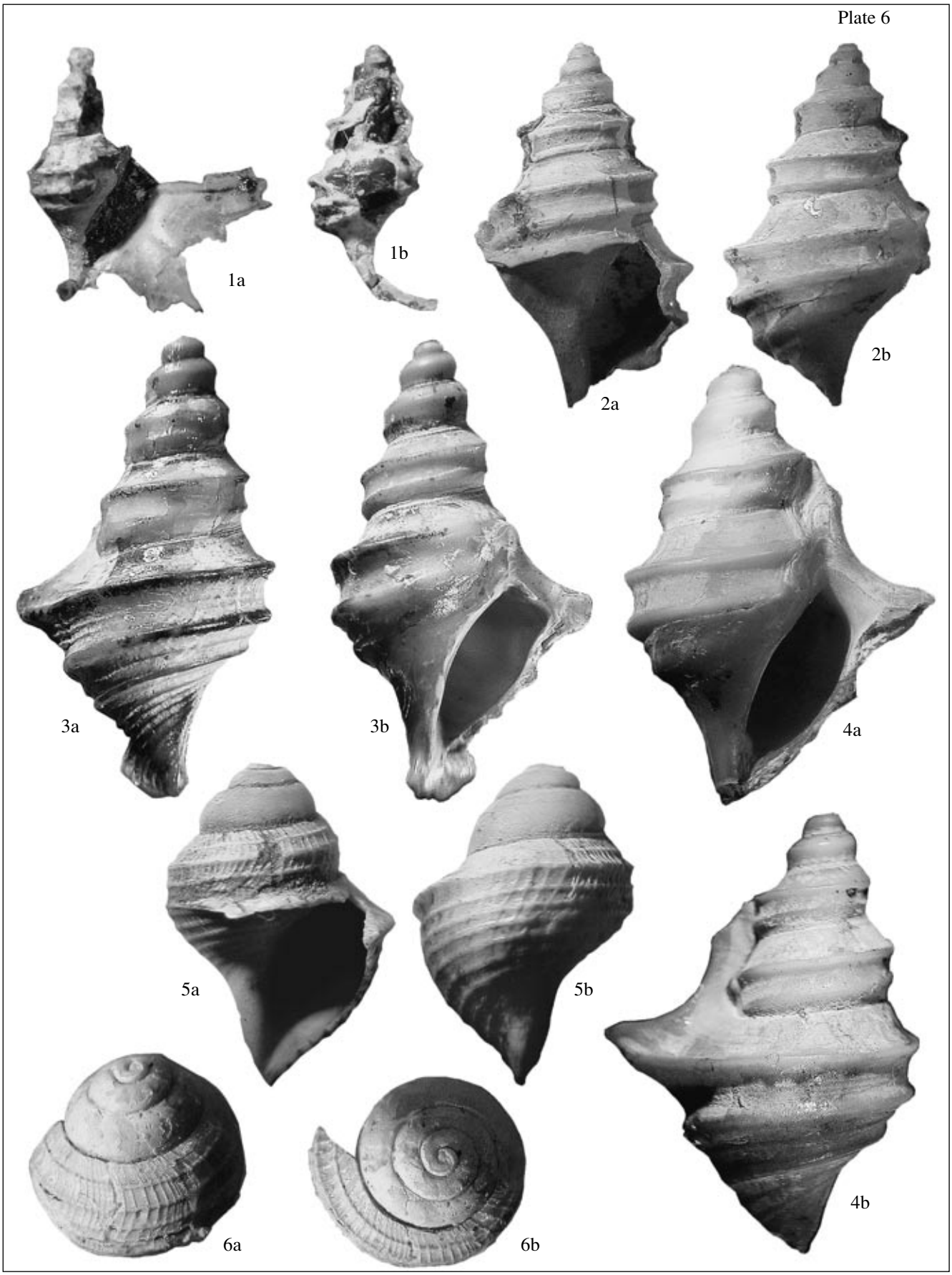
Occurrence. Upper Hauterivian, *versicolor* Zone of Ulyanovsk (Volga Region).

Material. About 40 specimens in a good or satisfactory state of preservation from sandy clay with a low sand content and carbonate concretions: UKM, no. 201; level G4 (carbonate concretions); 1 km south of the small town of Slantsevyi Rudnik (SR K1h2v, d-1); nos. 495, 499, 500/1-2, and 507; bed g-4.1; 3.5 km southeast of the village of Novaya Beden'ga (CS K1h2v-2); nos. 49/1.5-10, 60/1.2; bed g-5; near the small town of Slantsevyi Rudnik (SR K1h2v, d-1);

Explanation of Plate 5

Figs. 1–9. *Trilemma russiense* sp. nov.; (1) holotype UKM, no. 432, abapertural view, ×5; village of Novaya Beden'ga; *versicolor* Zone; (2) specimen UKM, no. 500/1, apertural view, ×5; village of Novaya Beden'ga; *versicolor* Zone, bed g-4.1; (3) specimen UKM, no. 500/2, winglike extension of the palatal margin of the aperture, apertural view, ×5; same locality and age; (4) specimen UKM, no. 507, winglike extension of the palatal margin of the aperture, abapertural view, ×5; same locality and age; (5) specimen UKM, no. 499, winglike extension of the palatal margin of the aperture, abapertural view, ×5; same locality and age; (6) specimen UKM, no. 49/5, ×12: (6a) young individual with a partly preserved protoconch, apertural view, (6b) abapertural view; small town of Slantsevyi Rudnik; *versicolor* Zone, bed g-5; (7) specimen UKM, no. 49/1, ×4: (7a) apertural view, (7b) abapertural view; same locality and age; (8) specimen UKM, no. 201, apertural view, ×5; small town of Slantsevyi Rudnik; *versicolor* Zone, level G4; (9) specimen UKM, no. 495, protoconch, ×30: (9a) abapical view, (9b) oblique abapical view; village of Novaya Beden'ga; *versicolor* Zone, bed g-4.1.

Plate 6



nos. 315 and 316; bed g-5; 3 km southeast of the village of Novaya Beden'ga (CS K1h2v-2); holotype no. 432; 4 km southeast of the village of Novaya Beden'ga (CS K1h2v-2).

***Trilemma striatocarinatum* (Sinzow, 1880)**

Plate 6, figs. 1–6

Aporrhais striatocarinata: Sinzow, 1880, p. 6, pl. 3, figs. 1–4.

Aporrhais (*Tessarolax*) *bicarinata*: Wollemann, 1912, p. 181, pl. 13, fig. 12.

Holotype was figured by Sinzow (1880, pl. 3, fig. 1); Saratov Region; Lower Cretaceous.

Description. The shell is of medium size, fusiform, with a winglike extension of the palatal margin of the aperture, and consists of seven or eight predominantly bicarinate whorls. The upper carina is located just above the mid-whorl of the spire, the lower carina runs above the abapical suture. Both carinae are approximately equally developed and are shaped like rollers. In adult individuals a third carina, which is of slightly smaller size, appears at the base of the last whorl under the second carina. On the last whorl the interspaces between the carinae are of approximately equal size. The surface of whorls is concave between the carinae and becomes concave to almost flat and inclined at 40°–50° to the axis of the shell above the upper carina.

The height of each spire whorl is 1.4–1.7 of the preceding. The ratio of the width of the last whorl measured above the aperture to the height of the last whorl above the aperture is 2.0–2.1 in adult individuals and 2.9 in young individuals. The apical angle is 80°–90°. The generating line is slightly convex.

The protoconch is smooth and consists of 3.5 whorls, after which the spiral and (slightly later) axial costellae appear. The boundary between the protoconch and teleoconch is arbitrarily determined by the appearance of the surface ornamentation. The fourth spire whorl bears four spiral costellae, of which the second (counting from the adapical suture) is slightly larger than the others and passes into the upper carina on the fifth whorl. In adult individuals with a well-developed winglike extension of the palatal margin of the aperture, the upper carina passes into the posterolateral process. On the fifth (or sixth) whorl, the development of the fourth (or fifth) spiral costa results in the formation of the lower carina, which extends in adult individuals over the anterolateral process. Between the upper and lower carinae, a weak spiral costella (the third, counting from the upper carina) persists. The later whorls contain additional (secondary) costellae between the carinae, the eighth whorl contains three such costellae. On the last whorl of adult individuals, the sixth (or seventh counting from the adapical suture) costa becomes more robust to make the third carina, which is less developed than the upper two, more prominent. The third carina also extends over the anterolateral process. Between the third and the two upper carinae, there is a weak spiral costella. On the last whorl of adult individuals, there are seven spiral costellae above the third carina and three spiral costellae, of which two are secondary, above the upper carina. In young individuals (which consist of five whorls), there is one spiral costella above the upper carina.

The axial ornamentation appears on the fourth whorl in the form of costellae bent rightward. The angulation occurs at the level of the second (from the top downward) spiral costa (which becomes the upper carina on the later whorls). In young individuals (consisting of five whorls), the axial costae on the last whorl beneath the upper (and still single) carina are slightly bent to the left in the middle part. The axial costellae are approximately three times as narrow as the spiral costellae and are slightly lower, i.e., the ornamentation is decussate. The axial and spiral costellae cross to form a mesh in the form of a narrow parallelogram, which is aligned along the axis of the shell (ornamentation of an oblique lattice type). The axial ornamentation is clearly defined only on the fourth and fifth whorls and then becomes almost imperceptible.

The aperture is oval, as viewed from the columellar margin, and angular, as viewed from the carinae. The upper palatal-parietal margin of the aperture passes into the posterior process, which coalesces with the surface of the last whorl up to the level of the upper carina, or even up to the nearest adapical spire whorl, and up to the upper carina. The posterior process is lost; however, it probably rose higher than the initial whorls of the shell. The anterior process is robust, considerably curved backwardly. The palatal margin of the aperture extends to form a winglike structure and have two narrow, triangle-shaped, approximately equally developed processes. The posterolateral process is directed horizontally rightward and, subsequently, probably turns upward. The anterolateral process is directed rightward and downward. On the apertural side, the processes have shallow notches, which correspond to the carinae on the opposite side. No complete anterior and poste-

Explanation of Plate 6

Figs. 1–6. *Trilemma striatocarinatum* (Sinzow); (1) specimen UPM, no. 519, ×2.5: (1a) apertural view, (1b) abapertural view; small town of Polivna; *decheni* Zone, level G12; (2) specimen UKM, no. 53/1, ×5: (2a) apertural view, (2b) abapertural view; small town of Polivna; *decheni* Zone, bed g-12; (3) specimen UPM, no. 168/1, ×4: (3a) abapertural view, (3b) apertural view; small town of Polivna; *decheni* Zone, bed g-11; (4) specimen UPM, no. 168/3, ×5: (4a) apertural view, (4b) abapertural view; small town of Polivna, *decheni* Zone, bed g-12; (5) specimen UKM, no. 53/4, young individual, with a partly preserved protoconch, ×20: (5a) apertural view, (5b) abapertural view; same locality and age; (6) specimen UKM, no. 444/6, protoconch, ×25: (6a) abapertural view, (6b) abapical view; same locality and age.

rior lateral processes have been preserved; however, they were probably narrow, elongated, with pointed ends. The columellar and parietal margins of the aperture have smooth bright surface of gray color. The umbilicus is absent.

Measurements in mm and ratios:

Specimen no.	H	D	HLW	HA	WA	NW	HLW/H
53/4	3.0	2.2	–	–	0.9	5.1	–
168/3	16.3	11.7	–	8.6	2.6	4.5(7)	–
168/2	17.7	10.5	–	8.1	3.1	5(7)	–
53/1	13.8	8.0	–	6.7	2.9	6(8)	–
168/1	21.4	12.0	15.2	10.9	3.1	5(8)	–
519	19.7	17.4	13.1	–	–	3.8(7)	0.63

Note: Specimen no. 53/4 is a young individual, in which the processes are undeveloped and the protoconch contains 3.5 whorls of the total of 5.1 whorls; in specimens no. 168/1, 168/2, 168/3, and 53/1 the posterolateral process is partly preserved, and in specimen no. 519 all processes are preserved to a greater or lesser extent.

Ontogenetic changes. The height of the whorl increases slightly with age; the degree of the development of the carinae and the processes of the palatal margin of the aperture also increases. In adult individuals the axial ornamentation is leveled.

Variability. The height of the whorl varies: in certain individuals (specimen no. 168/1), the lower carina rises considerably higher above the suture than in other individuals. In addition, specimen 168/1 has higher volutions, a fact reflected in the relatively larger distance between the carinae (a) in comparison with the other individuals (Dpw/a = 4.4 instead of 5.1–5.5 in other individuals). All these factors elongate the shell. The extent to which the posterior process coalesces with the adapical whorls varies. The coalescence may reach up to the upper carina of the last whorl and may run onto the penultimate volution, up to the upper carina.

Comparison. This species differs from *Trilemma russiense* (described above) in the narrower and less pointed anterolateral process, sharply defined roller-shaped carinae, formation of the upper carina from the second (counting from the adapical suture) spiral costa (in *T. russiense* the upper carina forms from the third spiral costa), and in the shape of meshes, formed by the intersecting costellae of the axial and spiral ornamentations (in *T. striatocarinatum*, the meshes are shaped like a narrow parallelogram; in *T. russiense*, they are rhombic); it differs from the closely related *T. ebrayi* from the Barremian–Lower Aptian of the Saratov Region (Ivanova, 1959, p. 364, pl. 15, figs. 8–9) in the more pronounced gradation of whorls and in the presence of two carinae on the spire whorls (the Saratov species shows only one upper carina, the other carinae are closed by overlapping whorls); it differs from the classical *T. ebrayi* from the Albian of Switzerland (Loriol, 1882, p. 25, pl. 3, figs. 16–20) in the more sharply defined roller-shaped carinae and, thus, more angular whorls, in the smaller extent of the coalescence of the posterior process and the adapical whorls, and in the less complicated anterior processes (in *T. ebrayi*, it is usually bifurcated); and it differs from *T. moreausianum* from the Neocomian of France (d'Orbigny, 1842–1843, p. 301, pl. 211, fig. 1.2) in the gradually narrowing anterior and posterior lateral processes (in the French species they narrow abruptly) and in having two carinae on the spire whorls (the French species shows only one carina).

Occurrence. Upper Hauterivian, *decheni* Zone of Ulyanovsk (Volga Region).

Material. Twenty-five specimens in a good or satisfactory state of preservation from sandy clay with a low sand content and limestone concretions: UPM, no. 168/1-3; bed g-11; small town of Polivna (P K1h2d); UKM, no. 53/1,4; bed g-12; 2.5 km south of the small town of Polivna (P K1h2d-3); UKM, no. 444/6; bed g-12; 1.5 km south of the small town of Polivna (P K1h2d-3); UPM, no. 519; level G12 (lime concretions); near the small town of Polivna (K1h2d).

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