

THE SYSTEMATIC COMPOSITION OF THE MIDDLE VOLGIAN VIRGATITIDAE (AMMONOIDEA) OF CENTRAL ASIA

V. V. Mitta

All-Union Scientific Research and Petroleum Geological
Institute, St. Petersburg

Abstract: All known representatives of the family Virgatitidae from the Middle Volgian of Central Russia are considered; they belong to the genera *Acuticostites*, *Zaraiskites* and *Virgatites*, which are revised. Two new species are established and described: *Acuticostites bitrifurcatus* and *Zaraiskites michalskii*.

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The family Virgatitidae, along with the dorsoplanitids, is important for the subdivision and correlation of the Middle Volgian (Jurassic) of Central Russia. The stratigraphic distribution of these ammonites was the basis for the zonal subdivision of the Middle of the Volgian substage. Yet the data on the specific composition of the virgatitids in this region are quite out of date and in need of revision.

I have used specimens I collected in the Moscow basin and the Upper and Middle Volga regions. I have also studied type and other collections of N. P. Vishnyakov, S. N. Nikitin, A. P. Pavlov, A. O. Mikhal'skiy, N. P. Mikhaylov and P. A. Gerasimov, which are in the Vernadskiy Museum of the Geological Institute (GIN), Russian Academy of Sciences in Moscow and the museum of the Central Scientific Research Petroleum Geological Prospecting Institute (TsNIIGR) in St. Petersburg.

In revising the Virgatitidae, I have made allowance for their wide range of variability, which I characterized earlier [7].

The limitations of a journal article do not permit a detailed characterization of all the taxa. I shall here present brief information on the diagnosis, volume, composition, and distribution of the revised taxa.

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FAMILY VIRGATITIDAE SPATH, 1923

Diagnosis. Family combining descendants of ataxioceratids with fairly wide umbilicus, and transverse section through their whorls that is from round and trapezoidal to oval or high oval and arrow-shaped. Sculpture developing from end of second or with third whorl. Possibly at first consisting of ventrolateral tubercles, then giving way to solitary, bi- or tripartite or multiramose costae. In late stages of ontogenesis number of branches in rib clusters decreasing, and ribs on lateral sides possibly smoothing out. Living chamber occupying 3/4 of whorl. Aperture simple and bordered by constriction. Dimorphism manifested in different locations of points of branching of costae and variations in shape of transverse section through whorls of adult shells. Prosuture bilobate, primary suture five-lobed. Final suture line formula is $(V_1V_1) (L_2L_1L_2) (V_1V_2)I_{2,1} I_{2,1}^1 I_{2,1}^2 \cdot I_{2,1}^2 I_{2,1}^1 I_{2,1}^1 D$ [4].

Composition. Subfamilies Pseudovirgatitinae Spath, 1924 (Lower Volgian, Portlandian), and Virgatitinae Spath, 1923 (Middle Volgian).

Comparison. Differs from family Dorsoplanitidae in division of lobe I_2 into two symmetrical branches.

Remarks. The systematics of higher-rank ammonite taxa described here is not stable. Some researchers consider the virgatitids as a family consisting of the subfamilies Virgatitinae, Pseudovirgatitinae and *Ilowaiskyinae* [14]; others regard them as a subfamily of the ataxioceratids (together with the Ataxioceratinae, Lithacoceratinae and Virgatosphinctinae [4]). Moreover, there is no agreement on the nomenclature of the higher taxa. In the first instance above the virgatitids are regarded as belonging to the superfamily Perisphinctaceae Steinmann, 1890, and in the second to the superfamily Olcostephanaceae Kvantaliani et Lominadze, 1986.

The direct ancestor of the virgatitids, the genus *Ilowaiskyia*, has also been assigned by various investigators to different subfamilies and families. Moreover, there is no definite answer to the question of whether *Ilowaiskyia* is an independent genus. Some paleontologists assign all or some of its representatives to *Subplanites*, sometimes distinguishing them as a subgenus, while others prefer to regard *Ilowaiskyia* as a separate tribe within the subfamily Pseudovirgatitinae [14].

SUBFAMILY VIRGATITINAE SPATH, 1923

Diagnosis. Combining last representatives of virgatitids existing during Middle Volgian time on East European platform. Retaining many features typical of ancestral subfamily Pseudovirgatitinae (shell form and, partly, mode of development of sculpture), and also taking on some different characteristics. Sculpture arising at end of second whorl in form of ventrolateral tubercles, later transformed into single and then into bi- and tripartite costae. On fourth whorl (at diameter of about 10 mm), tubercle-like swellings seen in periumbilical part (*Virgaticostites*, *Acuticostites*). Merging of bipartite and other costae in periumbilical region resulting in formation of bidichotomous and polydichotomous clusters that are then replaced by virgatitome clusters. Number of branches in these bundles gradually increasing, sometimes reaching 7 or 8. With increasing individual age, number of branches again decreasing until simple costae reappear. Within any genus and even species, morphogenesis of sculpture varying within quite wide limits. One or another stage of development of sculpture possibly occupying entire whorl or more, or reduced to point of complete suppression.

Composition. Genera *Acuticostites*, *Zaraiskites* and *Virgatites*.

Comparison. Virgatitinae differ from ancestral Pseudovirgatitinae, which are very close in shell form, in generally less densely clustered sculpture and in different stratigraphic range.

Distribution. *Panderi* and *virgatus* zones of Volgian stage of East European platform and parts of neighboring regions.

Genus *Acuticostites* Semenov, 1898

Type species. *Olcostephanus acuticostatus* Michalskiy, 1890; monotypic.

Diagnosis. Shell in early and middle whorls having widely spaced bipartite costae, replaced in adult whorls by single ribs or, on contrary, by multipartite clusters with vigatotome arrangement of branches.

Distribution. Occurs in *panderi* zone of central part of East European platform.

Composition. This genus has hitherto been assigned to dorsoplanitids [11, 13], but character of its sculpture shows it to be closest to genera *Zaraiskites* and *Virgatites*. Two species:

(1) *A. acuticostatus* (Michalskiy, 1890). Holotype not designated. Type series from Middle Volgian in Moscow vicinity, housed in TsNIGR Museum as Coll. No. 300; and

(2) *A. bitrifurcatus* sp. nov., described below.

Acuticostites bitrifurcatus Mitta, sp. nov.

Pl. III, fig. 2

Olcostephanus sp.: Mikhal'skiy, 1890, p. 88, pl. 5, fig. 1.

Specific name. Latin *bis* (twice), Greek *tria* (three) and Latin *furca* (fork).

Holotype. PIN No. 3990/44; Moscow region, bank of Istra River near Pavlovskaya Sloboda settlement; *panderi* zone.

Shell form. Shell is medium-sized, with slowly growing and slightly involute whorls of medium thickness. Transverse section through whorls is low and reniform at D = 10-15 mm, with increasing age gradually becoming higher and more trapezoidal appearance, greatest width being in periumbilical part. At D = 100 mm, height is somewhat less than thickness of whorl. Umbilicus is deep and fairly narrow in early whorls, then widens with increasing age. Turn of umbilicus is round. Umbilical wall is steep. Length of living chamber is unknown: only small part of it (1/8 of whorl) preserved in holotype.

Dimensions in mm and ratios:

Spec. No.	D	H	W	Du	H/D	W/D	Du/D	Ch
Holotype PIN 3990/44	118	35	36	55	0.29	0.30	0.46	2.8
	92	28	32	40	0.30	0.35	0.43	2.5
3990/45	60	22	20	22	0.36	0.33	0.36	2.4
	28	11	13	10	0.39	0.46	0.35	-
3990/46	20	8	11	7	0.40	0.55	0.35	2.4
3990/47	16	6	10	6	0.37	0.62	0.37	2.4

Holotype with complete living chamber must have exceeded 150 mm in diameter.

Sculpture. At D = 10-15 mm shell has quite sharply pointed costae, most bifurcate, some tripartite, as well as intercalar ribs and single costae immediately following constrictions. At D = 25-30 mm costae are bifurcate. Rare tripartite and simple ribs are associated with constrictions. Subsequently tripartite ribs appear without constrictions, at D = 100 mm almost completely displacing bipartite costae; constrictions are accompanied in front by single and behind by tri-, quadripartite or bidichotomous costae. With further growth, number of branches in costal clusters may increase to 4 or 5. Bifurcate ribs branch around middle of lateral sides. Tripartite ribs on young whorls at first double in periumbilical part; then at about middle of sides posterior costa again divides. With increasing age point of first and second branching may become higher. Constrictions are narrow, 5 or 6 per whorl.

Variation. Limited material does not permit full characterization of variability in this species. Nevertheless, available specimens show both brady- and tachymorphy: first quadripartite costae not associated with constrictions appear in holotype at D = 110 mm, whereas in specimen illustrated by Mikhal'skiy (TsNIGR Museum No. 72/300) such ribs appear already at D = 80 mm, while in ammonite of Gerasimov's collection (Spec. No. 319) at D ~ 90 mm, ribs have up to 5 branches.

Comparison. While having early whorls of closely similar structure, (at D = 10-20 mm), new species differs clearly from *A. acuticostatus* in adult whorls, which have trapezoidal transverse section and are covered with multiramose costae.

Remarks. Mikhal'skiy did not doubt that *Olcostephanus* is a separate species, and did not give the type specimen its own specific name only because of the insufficiency of his material, having only two specimens that lacked a precise correlation [9, p. 92]. Rozanov mentions *Olcostephanus* sp. nov. (*Olcostephanus* sp. Mich.) [10, p. 23] along with other forms, and leaves undescribed the new forms from the Volgian of Moscow and its environs.

Distribution. *Panderi* zone of Moscow basin.

Material. Holotype, and 6 variously preserved specimens from sections along Moscow River (Kolomenskoye, Moskvorech'ye) and the pits of the Lopatin phosphorite mine.

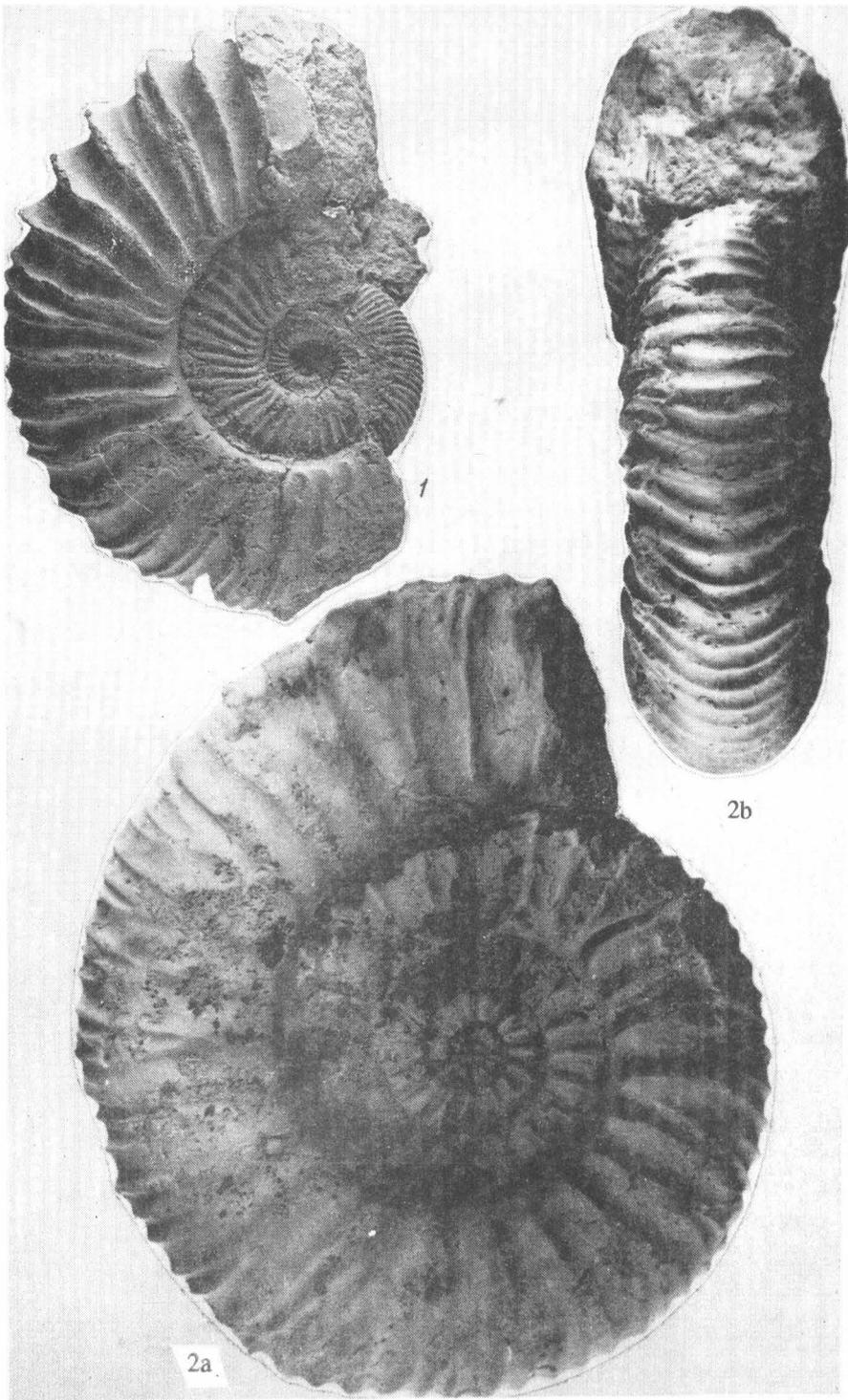


PLATE III

Type species. *Perisphinctes zarajskensis* Mikhal'skiy, 1890.

Diagnosis. Shells with closely spaced, predominantly bifurcate costae, lacking tubercle-like swellings on early whorls, which easily distinguishes them from similar *Acuticostites* and *Virgatites*. Reliably known from *panderi* zone of central and southeastern parts of East European platform, Kazakhstan, and Poland.

Composition. In Central Russia, 5 species:

1. *Z. michalskii* nom. nov. (pl. III, fig. 1). Holotype TsNIGR Museum No. 120/300; Moscow, Mnevniky; *panderi* zone. Illustrated by Mikhal'skiy [9, pl. 9, fig. 3] as *Perisphinctes apertus* Vischniakoff. Vischniakoff illustrated specimens under name *Ammonites virgatus* var. *aperta* that should be regarded as belonging to *Virgatites pallasianus* (Orbigny) [19, pl. 4, figs. 4, 6]. Later Mikhal'skiy described *Perisphinctes apertus* Vischniakoff, including in synonyms of this species only one specimen of those illustrated by Vischniakoff (pl. 4, fig. 6), while another (pl. 4, fig. 4) he assigned with question mark to *Olcostephanus pusillus* (*-Virgatites pallasianus*). Study of specimens from Vischniakoff's collection in Vernadskiy Museum — Spec. No. VI-64/21 [19, pl. 4, fig. 4] and Spec. No. VI-64/23 [19, pl. 4, fig. 6] — showed that these ammonites should be assigned to *Virgatites pallasianus* (Orbigny). Thus *Ammonites virgatus* var. *aperta* Vischniakoff, 1882 is a junior subjective synonym of *Ammonites pallasianus* Orbigny, 1845, and the first name cannot be used for taxon of specific group that Mikhal'skiy called *Perisphinctes apertus*. Last species thus obtains new name; its description is given by Mikhal'skiy [9, p. 146].

2. *Z. quenstedti* (Rouillier et Fahrenkohl, 1849). Holotype not specified. Place where type series (or specimen?) from Middle Volgian in Moscow vicinity is housed is not stated. Authors of this species should be Rouillier et Fahrenkohl, not Rouillier et Vosinskiy, as was erroneously thought earlier. Article describing this species was signed by Rouillier, but plate with illustration of *Ammonites quenstedti* includes "Rouillier et Fahrenkohl" in caption. To this species I assign some of forms described by Ilovaiskiy as *Virgatites (Provirgatites) scythicus* var. *diprosopa* [3].

3. *Z. scythicus* (Vischniakoff, 1882). Lectotype: Vernadskiy Museum, No. VI-64/35; Moscow, Mnevniky; Middle Volgian. Illustrated by Vischniakoff [19, pl. 3, fig. 1] and Arkell [1, p. 45, fig. 3], designated by latter. For this species I leave the established name and authorship

KEY TO PLATE III

All illustrations natural size.

Fig. 1. *Zaraiskites michalskii* nom. nov., Spec. No. 3990/137, side view; Moscow, Mnevniky; *panderi* zone.

Fig. 2. *Acuticostites bitrifurcatus* sp. nov., Holotype No. 3990/44: 2a - side view, 2b - apertural view; Moscow region, bank of Istra River at Pavlovskaya Sloboda settlement; *panderi* zone.

of Vischniakoff, although *Ammonites biplextruncatus* Trautschold, 1861 and *Ammonites auerbachii* Eichwald, 1868 have priority over *Ammonites scythicus* Vischniakoff, 1882. Trautschold's and Eichwald's types remain inaccessible (if, indeed, they have been preserved at all). Moreover, these names have not been used since their establishment, whereas *Z. scythicus* has been used as a valid name by many investigators. In order to validate their nomenclature, one must refer to the International Code of Zoological Nomenclature. Pending a decision by the Commission, it is most appropriate to use the name *Z. scythicus* for this species, to which are assigned also some forms described by Ilovaitskiy as *Virgatites (Provirgatites) scythicus* var. *diprosopa* [3].

4. *Z. tschernyschovi* (Michalskiy, 1890). Holotype not specified. Type series from Middle Volgian in Moscow vicinity housed at TsNIGR Museum, including specimens not yet illustrated (Nos. 113/300, 114/300 and 116/300). In choosing lectotype, it should be kept in mind that first description illustrated only shells, which author of species called "mutational" (Nos. 111/300, 112/300).

5. *Z. zarajskensis* (Michalskiy, 1890). Holotype not specified. Type series from Middle Volgian housed in TsNIGR Museum (Spec. No. 73-78/300 from Moscow and vicinity, No. 219/300 from Poland). To this species I also assign forms previously identified as *Z. pilicensis* (Michalskiy) and *Z. stschukinensis* (Michalskiy).

Genus *Virgatites* Pavlow, 1892

Type species. *Ammonites virgatus* Buch, 1830.

Diagnosis. Shells with tubercle-like swellings on early whorls at stage of first appearance of sculpture, differentiating it from closely similar genus *Zaraiskites*. Early whorls of *Virgatites* resembling those of *Acuticostites*, but with comparatively higher transverse section and also thinner and more frequent costae. Reliably known only from *virgatus* zone in central and southeastern parts of East European platform.

Composition. Six species.

1. *V. crassicostatus* Mitta, 1987. Holotype PIN No. 3990/18; Moscow region, Lopatin mine; *virgatus* zone. Illustrated by Mitta [6, fig. 1a, b].

2. *V. gerassimovi* Mitta, 1983. Holotype PIN No. 3990/8; Moscow region, Lopatin mine; *virgatus* zone. Illustrated by Mitta [5, pl. 2, fig. 1].

3. *V. larisae* Mitta, 1983. Holotype PIN No. 3990/1; Moscow region, Lopatin mine; *virgatus* zone. Illustrated by Mitta [5, pl. I, fig. 1].

4. *V. pallasianus* (Orbigny, 1845). d'Orbigny illustrated, in greatly idealized form, only one specimen of those at his disposal. Later Douville [15] published photograph, and also illustrations of other specimens of Verneuil's collection used by d'Orbigny in establishing *Ammonites pallasianus*. Specimen illustrated by d'Orbigny was designated by Douville as holotype, and remaining specimens of type series as cotypes (lectotype and paralectotypes, respectively, in current terminology). Type series comes from Middle Volgian of Moscow vicinity. I regard forms previously known as *V. pusillus* (Michalskiy) and *V. pallasii* (Orbigny), as belonging to single species, for which I restore author's original name of *V. pallasianus* (Orbigny).

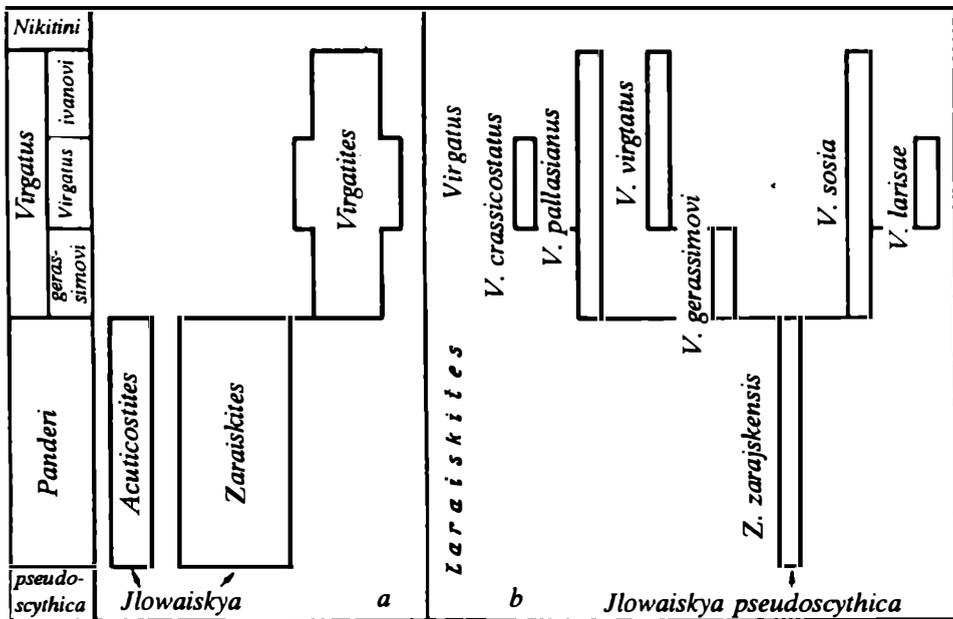


Fig. 1. Phylogenetic interrelationships among Middle Volgian ammonites (Virgatitidae) of Central Russia: *a* - on generic, *b* - on specific levels.

5. *V. sosia* (Vischniakoff, 1882). Holotype not designated. Type series housed in Vernadskiy Museum (Coll. No. VI-64); Middle Volgian at Mnevniki, Moscow. Designation as holotype of specimen illustrated by Mikhal'skiy [9, pl. 4, fig. 7; TsNIGR Museum No. 51/300], proposed by Yakovleva [12, p. 35], is not valid.

6. *V. virgatus* (Buch, 1830). Lectotype is specimen illustrated by Buch from Middle Volgian in Moscow vicinity; designated by Arkell [1, pl. 45, fig. 1]. Designation as holotype of specimen illustrated by Mikhal'skiy [9, pl. 1, fig. 1]; TsNIGR Museum No. 1/300, as proposed by Yakovleva [12, p. 31], is not valid according to rules of ICZN. Above specimen also cannot be lectotype of *V. virgatus*, as Muravin proposes [2, p. 45]. Species *V. rosanovi* Michailov, 1957 was established on basis of unsatisfactorily preserved material, and was described from two fragments. Holotype [8, pl. I, fig. 1], in its large size and wide tripartite costae smoothing out markedly on lateral sides resembles *V. sosia*, *V. larisae* and *V. crassicosatus*, and paratype [8, pl. I, fig. 2] is similar to *V. virgatus* and *V. sosia*. Name *V. rosanovi* must, therefore, be considered doubtful (nomen dubium).

SUBJECTIVE SYNONYMS

Ammonites biplex truncatus Trautschold [18, p. 84, pl. 8, fig. 4] [= *Zaraiskites scythicus* (Vischniakoff)].

Ammonites auerbachii Eiwald [16, p. 1092, pl. 34c, d] [= *Zaraiskites scythicus* (Vischniakoff)].

Perisphinctes stschukinensis Michalskiy [9, p. 110, pl. 6, figs. 8, 9; pl. 13, fig. 9] [= *Zaraiskites zarajskensis* (Michalskiy)].

Perisphinctes pilicensis Michalskiy [9, p. 117, pl. 6, fig. 10] [= *Zaraiskites zarajskensis* (Michalskiy)].

Credonites kuncevi Michailov [8, p. 151, pl. 2, figs. 6, 7; fig. 3] [= *Virgatites pallasianus* (Orbigny)].

Virgatites giganteus Yakovleva [12, p. 33, pl. 8, fig. 2]. Synonyms include large *Virgatites* specimens illustrated earlier as *Ammonites virgatus* [19, pl. 5, fig. 2] [= *Virgatites gerassimovi* Mitterer] and *Olcostephanus virgatus* [10, p. 22, pl. 2, fig. 1; pl. 3, fig. 1] [= *Virgatites virgatus* (Buch)]. Fragment illustrated by Yakovleva from Glebovo settlement is tentatively assigned to *V. virgatus* (Buch).

SPECIES OF DOUBTFUL SYSTEMATIC POSITION

Ammonites miatschkoviensis Vischniakoff [19, pl. 3, fig. 7] [= *Zaraiskites* (non *Michalskia miatschkoviensis* Ilovaiskiy)]. Only specimen is small phragmocone.

Virgatites? contradictionis Ilovaiskiy [3, p. 126, pl. 26, figs. 49, 50] [= *Zaraiskites*]. Jurassic of Orenburg; it may possibly come from Lower Volgian substage.

PHYLOGENETIC RELATIONSHIPS AMONG MIDDLE VOLGIAN VIRGATITIDS OF CENTRAL RUSSIA

The phylogenetic interrelationships of the Middle Volgian virgatitids were traced on the basis of their shell morphogenesis and stratigraphic distribution (fig. 1).

At the beginning of Middle Volgian (the *panderi* phase), the first representatives of the subfamily Virgatitinae—descendants of the earlier Pseudovirgatitinae—*Acuticostites* and *Zaraiskites*, appeared. These ammonites, with a similar type of development of their sculpture (virgatotome clusters) to the *Ilovaiskiya*, differ from the latter in the presence of ventrolateral tubercles on their initial whorls as their sculpture first appears in ontogenesis. At the same time, *Acuticostites* differs from *Zaraiskites* in the tubercle-like swellings in the periumbilical parts of its lateral sides, which can also be observed in their juvenile growth stage, but later than the stage of ventrolateral tubercles. In *Zaraiskites* such tubercle-like swellings, if present, are only rudimentary. It is interesting that the descendants of *Zaraiskites*, the representatives of the genus *Virgatites*, also show a growth stage in which tubercle-like swellings are present.

The genera *Acuticostites* and *Zaraiskites* died out at the end of the *panderi* phase. The *Zaraiskites* with a well-developed stage of virgatotome rib clusters (*Z. zarajskensis*) gave rise to *Virgatites* species that appeared at the beginning of the *virgatus* zone (*V. gerassimovi*, *V. pallasianus*, *V. sosia*). These already have well-developed tubercle-like swellings on their juvenile whorls. In the *virgatus* subphase *V. gerassimovi* gave rise, by a closer spacing of the virgatotome clusters and reduction the number of their number, to *V. virgatus*, which is characterized by further reduction of its branches in the costal clusters in the *ivanovi* subphase. *V. crassicostatus* arose from *V. pallasianus* in the *virgatus* subphase, by reduction of the number of branches in the rib clusters and prolongation of the stage of bipartite costae (tachygenesis). *V. sosia*, also in the *virgatus* subphase, gave rise to *V. larissae* by increasing the number of branches in the rib clusters (bradygenesis).

Virgatites, represented by three species in the *gerassimovi* subphase, flourished in the *virgatus* subphase (five species) and then ceased to exist at the end of the *ivanovi* subphase. *Acuticostites* and *Virgatites* are endemic to Central Russia. *Zaraiskites* has a more extensive distribution and also occurs on the margins of the East European platform, from western Kazakhstan in the south and the Pechora basin in the north to the Polish lowlands in the west.

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