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Ammonite Assemblages from Basal Layers of the Ryazanian Stage (Lower Cretaceous) of Central Russia

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Abstract—Five successive ammonite assemblages are distinguished in the basal part (*Riasanites rjasanensis* Zone s. l.) of the Ryazanian Stage of the East European platform. These are (from the base upward) (1) *Hectoroceras tolijense*; (2) *Hectoroceras kochi*; (3) *Riasanites swistowianus*; (4) *Riasanites rjasanensis*; and (5) *Transcaspiites transfigurabilis* assemblages. Two lower assemblages consist entirely of boreal taxa, which occur in association with diverse ammonites of the Tethyan origin higher in the section. The data obtained show that three upper assemblages are correlative with the Berriasian *Dalmasiceras tauricum, Riasanites rjasanensis–Spiticeras cautleyi*, and *Euthymiceras euthymi* subzones of the northern Caucasus. The succession of five–six ammonite assemblages established in the East European platform above the top of the *Craspedites nodiger* Zone may correspond to the same number of ammonite assemblages characterizing lower subzones of the standard Berriasian. *Berriasella rulevae* Mitta, sp. nov. from the upper part of the *Riasanites rjasanensis* Zone (*transfigurabilis* biohorizon) is described.

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Key words: Berriasian, Ryazanian Stage, ammonites, biostratigraphy, East European platform.

INTRODUCTION

The data discussed below are obtained in the course of my systematic work in Moscow and Ryazan regions during last several years. Used in addition are all the published data and museum materials: the unpublished collection of A.P. Pavlow from the Vernadsky State Geological Museum (SGM) in Moscow, which has been considered lost; the original collections of S.N. Nikitin from the Ryazan region by stored in the Mining Museum, of N.A. Bogoslovskii and I.G. Sazonova stored in the Chernyshev Central Research Geological–Prospecting Museum (CRGPM) in St. Petersburg, and collection of N.I. Sei and E.D. Kalacheva from the northern Caucasus stored in the CRGPM.

When subdividing and correlating the basal part of the Ryazanian Stage, I interpret stratigraphic units of the lowest rank as equal to each other in particular region. For the Berriasian and Ryazanian stages, ranks of stratigraphic units have been often determined subjectively because of historical traditions, zone or subzone thickness in geological section, viewpoints of a particular researcher, etc. In my opinion rooted in classical work by Le Hegarat (1973), subzones of the standard Berriasian and "zones" of the Ryazanian Stage in understanding of Mesezhnikov represent just biohorizons, the categories, which are widely used as the lowest-rank (infrasubzonal) stratigraphic subdivisions of the Jurassic System. Standardization of stratigraphic nomenclature for subdivisions of the "zonal group" (by analogy with the generic group in taxonomy) in isolated paleogeographic provinces is, however, a long-lasting process that is already in the sphere of conventionality. Therefore, it would be optimal to operate here with faunal (ammonite) assemblages regardless of formal ranks of relevant stratigraphic units.

HISTORICAL REVIEW

Nikitin (1888), who was first to define the "horizon with *Hoplites rjasanensis*, mentioned simultaneously the two-member structure of this subdivision in the Staraya Ryazan area at the Oka River (Fig. 1): its lower part with *Hoplites rjasanensis* Lahus. and *H. swistowianus* Nik. and the upper one with *Olcostephanus spasskensis* Nik., *O.* aff. *subditus* Tr., and *O.* cf. *unshensis* Nik.[1] These two beds are considered now respectively as the *Riasanites rjasanensis* and *Surites tzikwinianus* zones of the Ryazanian regional stage (*Unified Stratigraphic Schemes…*, 1993; *Resolution…*, 1997). In his work, Nikitin noted also the joint occurrence of *Oxynoticeras subclypeiforme* Milasch. and *O.* cf. *tolijense* Nik. at the Oka River near the Novoselki Village.

Pavlow (1894) described the following structure of the interval under consideration (hereinafter from base upward):

[1] Hereinafter, I retain original spelling and nomenclature of taxa, except for orthographic errors.

Fig. 1. Geographic scheme of Volgian–Ryazanian boundary sections with numbered localities: (1) quarries 10 and 12-2, the Lopatin phosphorite mine; (2) Kuz'minskoe and Novoselki sections at the Oka River; (3) Staraya Ryazan, Shatrishche, Chevkino, and Nikitino sections at the Oka River; (4) group of outcrops along the Pronya River; (5) outcrops along the Most'ya and Pozhva rivers.

(1) Beds with *Oxynoticeras subclypeiforme* and *Craspedites* close to *C. nodiger*;

(2) Phosphorite sandstone with *Hoplites rjasanensis*;

(3) *Aucella* Beds with *Hoplites* similar to *H. rjasanensis* and ammonites close to *Ammonites stenomphalus.*

N.A. Bogoslovskii, who introduced term the "Ryazan Horizon," arrived at the conclusion that "available materials are insufficient for subdividing the horizon into successive, distinctly individual subhorizons (or "zones," according to some researchers); neither faunal nor petrographic characteristics of the horizon justify such a subdivision" (1896, p. 127). Nevertheless, very thorough field observations of this scientist, descriptions and figures of ammonite specimens are of great interest even nowadays. Of particular importance are some statements quoted below.

Shortly upstream of the Kuz'minskoe Village at the Oka River, Bogoslovskii (1896, p. 28) described above the member of glauconite sand with *Olcostephanus okensis* d'Orb., *Oxynoticeras fulgens* Traut., and *O.* cf. *catenulatum* Fisch. "the dark red ferruginate compact sandstone splitting into horizontal plates" 0.1 m thick and containing abundant *Oxynoticeras subclypeiforme* Milasch. and rare *Olcostephanus* cf. *kaschpuricus* Trd. (inner whorls) and *O.* cf. *nodiger* Eichw. Above that sandstone, there is the Ryazan Horizon proper represented by "dark greenish phosphorite–glauconite sandstone readily spitting into polyhedral fragments" (ibid, p. 28) and bearing *Hoplites rjasanensis, H. swistowianus, H. subrjasanensis, Olcostephanus dorsorotundus*, and other ammonites. The horizon is 0.17 m thick.

Bogoslovskii divided the Ryazan Horizon exposed near the Novoselki Village in two beds with poorly preserved fossils. Of interest is underlying brown sand with phosphorite nodules and abundant *Oxynoticeras subclypeiforme* Milasch., rare *Olcostephanus kaschpuricus* Traut., doubtful fragment of *Olcostephanus* cf. *nodiger* Eichw., and *Oxynoticeras* cf. *tolijense* Nik.; below, there are sands of the *fulgens* Zone in the recent understanding.

Three outcrops described in the area between outskirts of the Staraya Ryazan and Shatrishche villages are important for subdividing the Ryazan Horizon proper. In this area, Bogoslovskii distinguished three beds: the lower one largely containing *Hoplites rjasanensis* Nik., *H. subrjasanensis, Olcostephanus dorsorotundatus*, and other unidentifiable ammonites; the middle bed that yields ammonite specimens described by Bogoslovskii as *Hoplites* and *Olcostephanus*; and the upper bed with abundant *Olcostephanus* (*O. tzikwinianus* Bog. included) and rare *Hoplites* cf. *privasensis* Pict. It is remarkable that *Hoplites swistowianus* is absent here. Bogoslovskii mentions this species from westerly outcrops located along the Pronya River, where it is usually associated with *Hoplites rjasanensis, H. subrjasanensis* (in some easterly outcrops), and sometimes with *Olcostephanus bidevexus* Bog. and *O.* cf. *pronus* Opp. Nevertheless, in the Most'ya River outcrops, *Hoplites swistowianus* occurs in association with other *Riasanites* and diverse "*Olcostephanus*" forms. It is also noteworthy that in Pozhva River outcrops (Mikhei Village) *Hoplites rjasanensis* and *H. swistowianus* have been found largely in the lower incoherent bed, whereas other ammonites (*H. subrjasanensis* etc.) occur mostly higher in the section.

Consequently, Bogoslovskii has already obtained data implying a complex structure of the Ryazan Horizon but thought it impossible to distinguish units of a lower rank. It is of interest also that he mentioned ammonites of the Tethyan origin (*"Hoplites"*) mainly from lower layers of the Ryazan Horizon and only once from "the horizon with *Olcost. lgowensis, hoplitoides*, etc." (*Nikitinoceras hoplitoides* Zone in current understanding).[2]

Sazonova (1971) listed the following assemblage of the *rjasanensis* Zone: *Riasanites rjasanensis*

[2] "*Hoplites* aff. *Arnoldi* Pict. et Camp." described by Bogoslovskii from "Neocomian sands with *Olc. lgowensis*" (Bogoslovskii, 1896, p. 112, Plate 6, fig. 7), i.e., from the *Nikitinoceras hoplitoides* Zone of recent nomenclature, is stored at the CRGPM. The ammonite is filled in with brown glauconite sandrock typical of the *rjasanensis* Zone, being enclosed in gray hard phosphatic sandstone of the *hoplitoides* Zone. I have no doubts that this specimen belongs to the genus *Mazenoticeras* and is redeposited from the *rjasanensis* Zone into the *hoplpitoides* Zone. According to my observations, ammonites of the Tethyan origin are characteristic only of the *rjasanensis* Zone.

(Wenetzk.), *R. subrjasanensis* (Nik.), *R. swistowianus* (Nik), *R. micheicus* (Bogosl.), *Pronjaites bidevexus* (Bogosl.), *Euthymiceras transfigurabile* (Bogosl.), *E. inexploratum* (Bogosl.), *E. hospes* (Bogosl.), *E.* ? aff. *arnoldi* (Pict. et Camp.), *Neocomites* ex gr. *occitanicus* (Pict.), and *N.* aff. *neocomiensis* (d'Orb.). In her subsequent work, Sazonova (1971) added to the list *Riasanites decorus* Sasonova, *Prorjasanites plumatus* Sasonova, and *P. vnignii* Sasonova. According to this researcher, ammonites of the overlying *spasskensis* [= *tzikwinianus*] Zone are exclusively of Boreal origin, while "species of the genus *Euthymiceras* occur only in its lower layers and appear to be redeposited" (Sazonova, 1971, p. 7).

Judging from published data, Sazonova have studied the only section of the Oka River (between the Nikitino and Chevkino villages) that was certainly insufficient for the *rjasanensis* Zone subdivision. Researchers who have studied later on several other sections in that area tend to subdivide this zone into several beds or "horizons." In the work by Casey et al. (1977), the *rjasanensis* Zone is subdivided into the following units:

(1) Sandstones with *Garniericeras subclypeiforme* (Milasch.), *Riasanites rjasanensis* (Wenetzk.), and *R.* cf. *swistowianus* (Bog.);

(2) Sandstones with *Hectoroceras kochi* Spath and *Riasanites* sp.;

(3) Sands with *Riasanites* spp. and rare *Euthymiceras*;

(4) Sands and sandstones with *Riasanites* spp., *Euthymiceras* spp., *Surites* spp., *Externiceras solowaticum* (Bog.);

(5) Sandstones with *Riasanites* spp., *Euthymiceras* spp., *Surites* spp., *Peregrinoceras* ex gr. *pressulum* (Bog.), *Externiceras.*

However in Table 3 of the cited work, the zone is divided into four, not five, units in the rank of faunal beds, and upper two subdivisions (except for *Garniericeras* and *Hectoroceras* beds) are united into the *Euthymiceras transfigurabilis* Horizon.

Units reported in the subsequent work by Mesezhnikov et al. (1979) are as follows:

(1) Sandstone with *Garniericeras, Riasanites*, and *Euthymiceras*; the lower boundary corresponds to the first occurrence level of *Riasanites* and *Euthymiceras* species;

(2) Sandstone with *Hectoroceras* accompanied by *Riasanites* and *Euthymiceras*;

(3) Glauconite sand with *Riasanites*, and *Euthymiceras.*

Later on, Mesezhnikov (1984) arrived at the conclusion that the *rjasanensis* Hyperzone should be subdivided into three subunits:

(1) The *Riasanites rjasanensis–Garniericeras subclypeiforme* Zone with *Riasanites* spp., *Euthymiceras* spp., *Garniericeras subclypeiforme* Milasch.), and *Craspedites* ex gr. *kaschpuricus* (Trd.);

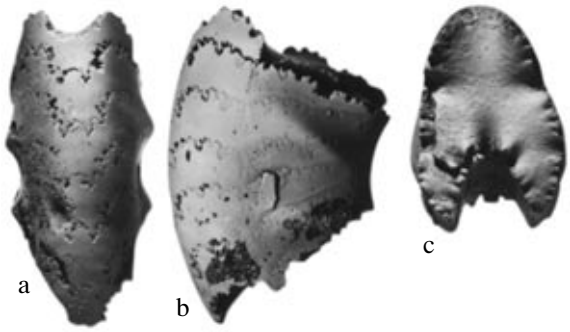


Fig. 2. Platylenticeratinae gen. et sp. indet, SGM, Specimen II-117/247-2: (a) ventral view; (b) side view; (c) whorl section; Ryazan region, Oka River bank near the Kuz'minskoe Village, Valanginian?, collection of A.P. Pavlow.

(2) The *Riasanites rjasanensis–Hectoroceras kochi* Zone with *Hectoroceras kochi* Spath, *Schulginites* sp., *Craspedites* ex gr. *kaschpuricus* (Trd.), *Riasanites* spp., and *Euthymiceras* spp.;

(3) The *Riasanites rjasanensis–Surites spasskensis* Zone with *Surites spasskensis* (Nik.), *Surites (Caseyceras)* spp., *Externiceras solovaticum* (Bog.), *Borealites suprasubditus* (Bog.), *Riasanites* spp., and *Euthymiceras* spp. The upper boundary corresponds to the last occurrence levels of *Riasanites, Euthymiceras*, and *Caseyceras* and to first occurrence level of *Surites tzikwinianus* (Bog.).

Unfortunately, Mesezhnikov, who carried out his work largely in the Ryazan region, failed to complete his study of the taxonomic composition of ammonites and their description.

Thus, the century-long study of the Ryazanian Stage and boundary deposits confirmed the complex structure of this stratigraphic interval. In addition, practically all the researchers emphasized sharp thickness changes of separate layers up to their complete wedging out, i. e., the lateral variability. It is understandable why researches who studied ammonites of the Ryazanian Stage, which are poorly preserved in the mentioned sections, met difficulties by their preparation, taxonomic classification, and stratigraphic analysis. Another factor that influenced negatively the effectiveness of research is the limited spatial distribution of the *rjasanensis* Zone s. str. in its classical understanding (joint occurrence of "Boreal" and "Tethyan" ammonites) within the Ryazan region, the Oka River basin.

MATERIALS AND DISCUSSION

Since 1980, I studied ammonites of the Ryazanian Stage in quarries of the Lopatin and Egor'evsk phosphorite mines in the southeastern Moscow region. Rocks of the quarries, which are under mining since the 1930s, yield perfectly preserved fossils of the Volgian

Plate I

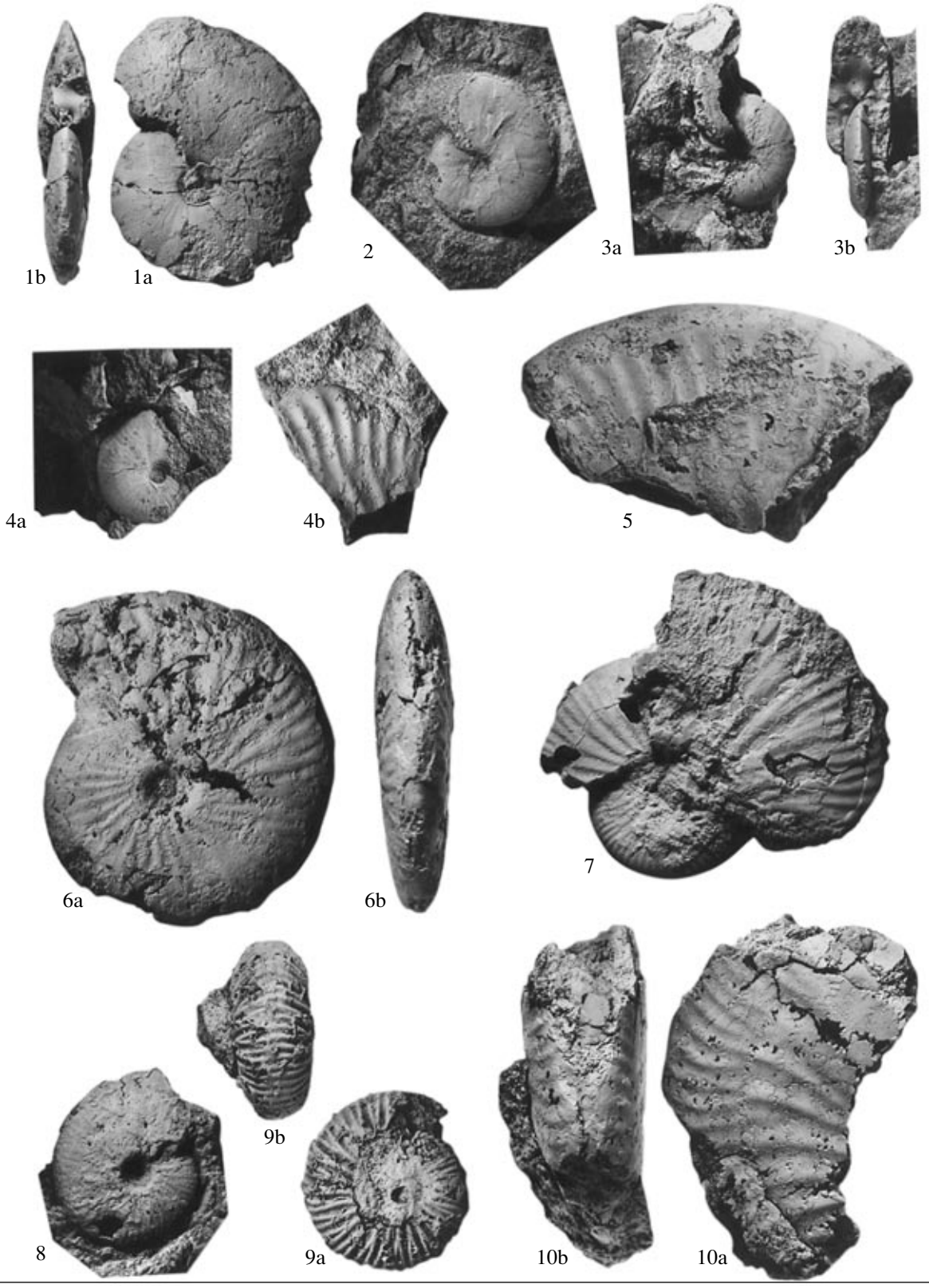


Plate I. Ammonites from the Volgian–Ryazanian boundary layers.

(1) *Garniericeras subclypeiforme Milaschewitsch*), SGM, Specimen II-117/247-1: (a) side view, (b) apertural view; (2–5) *Hectoroceras tolijense* (Nikitin): (2) SGM, Specimen II-117/248-1: (a) side view, (3) SGM, Specimen II-117/248-2: (a) side view, (b) section, (4) SGM, Specimen II-117/248-3: (a) side view of juvenile whorls, (b) side view of the older whorl fragment in the same rock sample, (5) SGM, Specimen II-117/248-4: (a) side view; (6–8) *Hectoroceras kochi* Spath: (6) PIN, Specimen 3990/251: (a) side view, (b) ventral view, (7) PIN, Specimen 3990/252: (a) side view, (8) PIN, Specimen 3990/253: (a) side view; (9) *Praesurites* sp. juv. cf. *nikitini* (Gerasimov) emend. Mitta, PIN, Specimen 3990/254: (a) side view, (b) ventral view; (10) *Hectoroceras* cf. *kochi* (Spath), PIN, Specimen 3990/234: (a) side view, (b) ventral view. (1–5) Ryazan region, Oka River bank, Kuz'minskoe section; platy sandstone at the base of the Ryazanian Stage; collection by A.P. Pavlow. (6–8) Moscow region, Lopatin mine, quarry 12-2, platy sandstone at the base of the Ryazanian Stage (*kochi* Biohorizon, collection of A.V. Stupachenko. (9) the same locality and age, collection of V.V. Mitta. (10) Moscow region, Lopatin mine, quarry 10, *rjasanensis* Zone (*rjasanensis* Biohorizon), Bed 8b (Mitta, 2005b), collection of V.V. Mitta. All the phragmocones are figured in natural size.

Stage, mostly from the interval between the *Virgatites virgatus* and *Craspedites subditus* zones. Unfortunately, phosphatic sandstones of the *Riasanites rjasanensis* Zone and clay–sandy sediments of the *Surites tzikwinianus* Zone were practically ignored by researchers for a long time because of rock compactness and scarcity of well-preserved ammonites. Accordingly, my collections sampled during first 20 years and collections of other researchers and amateur paleontologists from quarries nos. 5, 7, 7-2', 8, 9, 9', 9-2', 10, and 11 contain only few specimens of *Riasanites rjasanensis* (Nikitin) and *R. swistowianus* (Nikitin). Richer collections have been obtained only during purposeful work of 2000–2002 in quarry no. 10 prior to its flooding. The last collections and several new taxa defined elucidate much better the taxonomic composition of ammonites from the *rjasanensis* Zone of the Moscow region (Mitta, 2002b, 2004b).[3]

Later on, I worked in quarry 12-2 located several kilometers southwest. Despite laborious overburden operations, hardness of the "Ryazanian plate," and difficulties in ammonites' preparation, my work resulted in substantial replenishment of ammonite collection. Comparison of ammonite assemblages sampled in this quarry and quarry 10 seemingly from the same layer and stratigraphic interval (the lower part of Bed 8b, Mitta, 2005) led to unexpected results.

The assemblage from the indicated interval in quarry 10 of the Lopatin mine includes *Riasanites rjasanensis* (Nikitin) (Plate II, fig. 1), rare *R. swistowianus* (Nikitin), *Subalpinites krischtafowitschi* Mitta, *Malbosiceras* sp., *Mazenoticeras* sp., *Praesurites nikitini* (Gerasimov), *Pseudocraspedites bogomolovi* Mitta, *Ps. craspeditoides* Girmounsky, and *Hectoroceras* cf. *kochi* Spath (Plate I, fig. 10). These species are accompanied by scarce *Dalmasiceras* cf. *djanelidzei* Mazenot (Mitta, 2004b, Plate 1, fig. 3; Mitta, 2005, Plate 2, fig. 2) and *Malbosiceras nikolovi* Le Hegarat (Mitta, 2004b, Plate 1, fig. 5; Mitta, 2005, Plate 2, fig. 4) represented by single specimen each. Species *Pronjaites bidevexus* (Bogoslowsky) was found slightly higher, in Bed 8c.

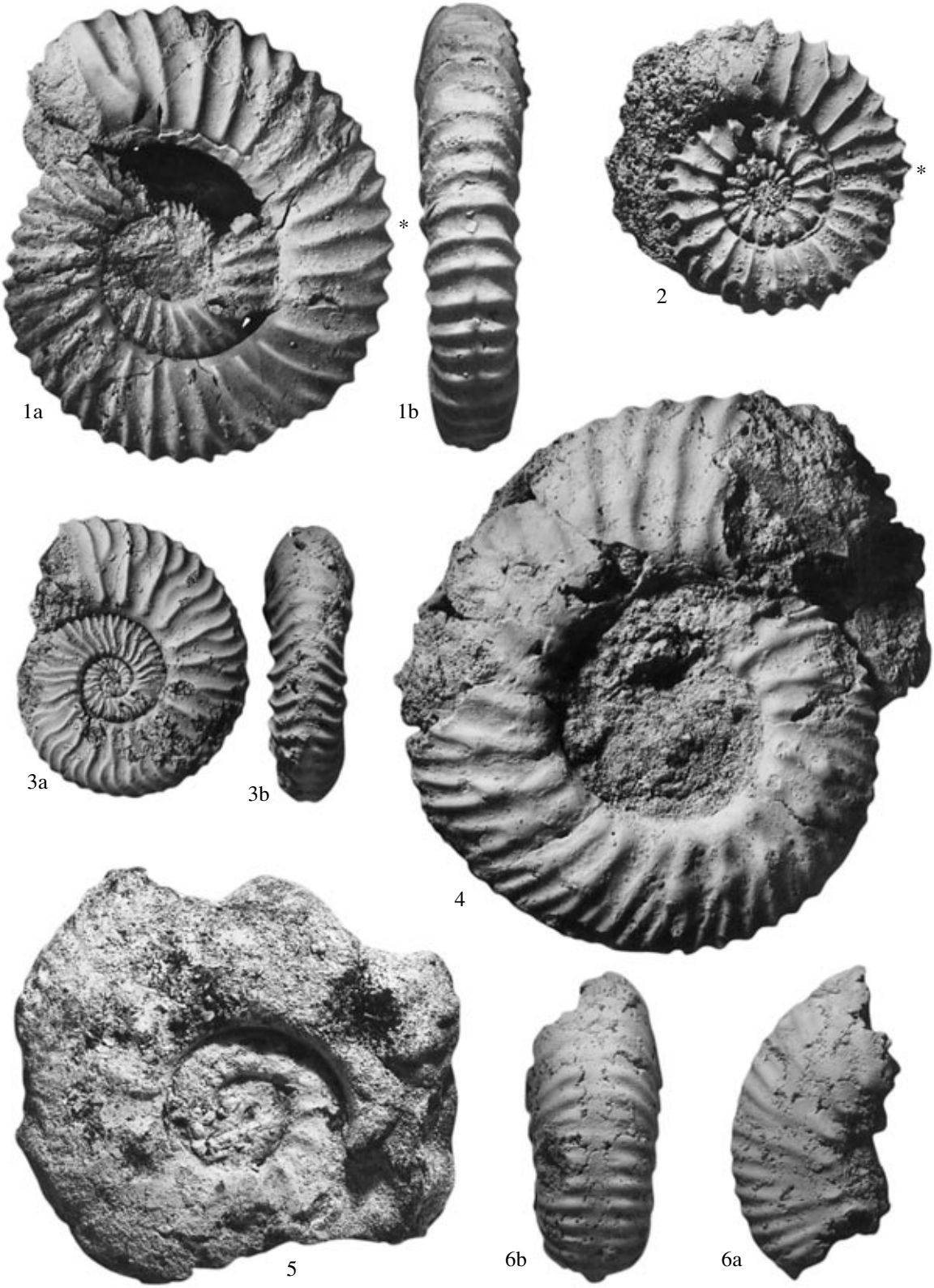
The same interval of section in quarry 12-2 yielded abundant *Riasanites swistowianus,* scarce *R. rjasanensis*, numerous Himalayatidae (?) gen. et spp. nov. (Plate II, fig. 3), *Subalpinites* sp. nov. (of older character than *S. krischtafowitschi* and resembling *Pseudosubplanites*), *S.* aff. *fauriensis* Mazenot, *Mazenoticeras* spp. (*M.* cf. *urukhense* Kalacheva et Sey included, Plate II, fig. 4), *Malbosiceras* sp. (sp. nov. ?), one specimen of *Dalmasiceras crassicostatum* Djanelidze (Mitta, 2004b, Plate 1, fig. 4; Mitta, 2005b, Plate 2, fig. 3), not scarce *Pseudocraspedites bogomolovi,* and more rare *Praesurites* sp. It is remarkable that most taxa of this assemblage, primarily ammonites of the "Tethyan" affinity, have never been found in other quarries of the Lopatin mine: they are missing in my collection and collections of many amateur paleontologists. The compositional difference between assemblages from the same lithological layer in quarries 10 and 12-2 became notable only after long purposeful sampling. The discrete secular distribution of various *Riasanites* species in the East European platform was noted recently (Mitta, 2005a), although this can be assumed from previous observations of researchers (see the above historical review).

The difference between two assemblages sampled from the same stratigraphic interval at the sites insignificantly spaced from each other is substantial. I explain this by occurrence of lenses with fossils slightly different in age within the sampled interval of sediment condensation. Provided the *Riasanites rjasanensis* occurrence in younger sediments as well (see below), the second assemblage appears to be older than the assemblage from quarry 10. Sei and Kalacheva (*The Berriasian of the North Caucasus*, 2002) insist that *R. swistowianus* is associated only with "upper *Riasanites* (*rjasanensis/angulicostatus* Subzone); two juvenile specimens (less then 3 cm across) from their collection can be identified ambiguously, I think, and hardly belong to this species. In my opinion, we are dealing with a reversed succession: *R. swistowianus* ⟶ *R. rjasanensis.*

In quarry 10, as I have reported already, there is dark brown, almost black compact phosphorite concretions up to 0.05 m thick, which yield rare fragments of *Riasanites* sp., *Hectoroceras* sp., and other forms typical of the *rjasanensis* Zone base (Mitta, 2005b, Bed 8a). In quarry

[3] In the last article, ammonites figured in Plates I and II are unfortunately reduced to ×0.9 and ×0.8 in the Russian and English versions, respectively, without any notification.

Plate II



12-2, this bed is undestroyed being represented by continuous dark gray to black, very hard phosphatic sandstone layer with obscure bedding. It contains very impoverished ammonite assemblage of typical *Hectoroceras kochi* Spath (Plate I, figs. 6–8), *Praesurites*, and/or *Pseudocraspedites* sp. juv. (Plate I, fig. 9) with pearly fragments of *Riasanites swistowianus* (Nikitin) "soldered" into shell surface and sharply different from the matrix and better preserved main ammonites of the assemblage. This layer is remarkable primarily owing to absence of "Tethyan" ammonites in situ; the characteristic species of this oligotaxonic assemblage is *Hectoroceras kochi.*

As is mentioned, the black platy phosphorite sandstone at the base of the Ryazanian Stage in the Kuz'minskoe section at the Oka River is known for a long time to contain *Garniericeras* forms which fact was later confirmed by the Mesezhnikov's team. In the Vernadsky State Geological Museum RAS, I have found, with assistance of I. A. Starodubtseva, two boxes with samples in a storage cabinet with working collections of A.P. Pavlow. Samples were accompanied by labels: one field label was written on a piece of paper in old Russian, the second one indicated the collection belonging to the Geological Cabinet of the Emperor Moscow University, and two others standard labels of the Geological Museum of the Moscow Geological–Prospecting Institute written recently. The labels evidence that samples II-117/247 (five stored units) and II-117/248 (eight units) are undoubtedly from collection of A.P. Pavlow sampled in the Kuz'minskoe section. My conclusions after examination of samples are as follows: four specimens represent fragments of *Garniericeras subclypeiforme* (Milaschevitch in Nikitin) with partly preserved pearl in a dark gray to rusty brown phosphorite sandstone (one of them is figured in Plate I, fig. 1); one similarly preserved specimen in the same matrix is a fragment of *Craspedites* sp. indet. or *Pseudocraspedites* sp. indet.; three juvenile specimens and two fragments of larger phragmocone whorls exemplify phosphorite casts of "*Schulginites*" *tolijense* (Nikitin) in a dark gray compact phosphorite sandstone with vaguely bedded (Plate I, figs. 2–5); next sample is similarly preserved fragment of *Garniericeras* sp. indet. or "*Schulginites*" sp. indet. in sandstone matrix; and a hand specimen of dark gray compact phosphorite sandstone with obscure bedding. Besides, I identified one fragment of unusual ammonite represented by phosphorite cast with pearl remains and well-preserved lobe lines (Fig. 2), one fragment of *Riasanites* sp. (cast with pearl remains) associated in phosphorite sandstone with fragments and molds of *Buchia* sp., and a piece of gray sandy phosphorite concretion with remains of *Nikitinoceras* sp. cf. *hoplitoides* (Nikitin).

As is evident, the listed ammonites are mostly species *"Schulginites" tolijense* (Nikitin). According to Alekseev (1984), this genus appears earlier than *Hectoroceras*, i.e., the descendant of *"Schulginites."* The succession *tolijense* ⟶ *kochi* implies individual character of assemblage from the Kuz'minskoe section, which is older than the aforementioned assemblages. It should also be noted that *Hectoroceras* ex gr. *kochi* Spath was repeatedly reported and figured from the "main" layer of the *rjasanensis* Zone together with *Riasanites* forms (Casey et al., 1977, Plate 1, fig. 4; Plate 2, fig. 6; Mesezhnikov et al., 1979, Plate 1, figs. 5, 7; Mitta, 2005b, Plate 1, fig. 3). One more specimen from the same interval is shown in Plate I, fig. 10. *"Schulginites"* sp. ind. from the "upper part of the Ryazanian plate," which was figured by Mesezhnikov et al. (1983, Plate 6, fig. 4), is also attributable to *Hectoroceras* ex gr. *kochi* according to its well-ornamented internal whorls.

Based on museum collection, it is difficult to decide whether ammonites *Garniericeras subclypeiforme* and *Hectoroceras tolijense* from the Kuz'minskoe section are concurrent, or the first one is redeposited: they are set in slightly different matrix. In any case, the genus *Garniericeras* appears substantially earlier, at the beginning of the late Volgian Age. Therefore, *Hectoroceras tolijense* is most characteristic species of this assemblage consisting of first undoubtedly "post- Volgian" *Craspedites* forms. Contrary to S.N. Alekseev, who rejects possibility of *Schulginites* origination after *Hectoroceras* (in Mesezhnikov et al., 1983), I consider the succession *subclypeiforme* ⟶ *tolijense* ⟶ *kochi* as a phylogenetic lineage. Other *Craspedites* species from this assemblage determined by previous researchers in open nomenclature are most likely their descendants though poorly known.

In conclusion, it should be emphasized that the list of taxa under consideration indicates their confinement to different stratigraphic levels, the Valanginian *Nikitinoceras hoplitoides* Zone included. The specimen shown in Fig. 2 also originates from the Valanginian and is a representative of the subfamily Platylenticera-

Plate II. Ammonites from the *rjasanensis* Zone of the Ryazanian Stage.

(1) *Riasanites rjasanensis* (Nikitin), PIN, Specimen 3990/262: (a) side view, (b) ventral view; (2) *Riasanites swistowianus* (Nikitin), PIN, Specimen 3990/263: (a) side view; (3) Himalayitidae gen. et sp. nov. (in litt.), PIN, Specimen 3990/264, phragmocone: (a) side view, (b) ventral view; (4) *Mazenoticeras* cf. *urukhense* Kalacheva et Sey, PIN, Specimen 3990/265, phragmocone: (a) side view; (5) *Dalmasiceras* ? sp., PIN, Specimen 3990/266, phragmocone: (a) side view; (6) *Malbosiceras* cf. *macphersoni* (Kilian), PIN, Specimen 3990/267, phragmocone: (a) side view, (b) ventral view.

(1–4) Moscow region, Lopatin mine, *rjasanensis* Zone: (1) quarry 10, (2) quarry 11, (3, 4) quarry 12-2, collection of V.V. Mitta, (6, 7) Ryazan region, Oka River bank near the village of Nikitino, *rjasanensis* Zone, upper part (*transfigurabilis* Biohorizon), collection of V.V. Mitta and I.A. Starodubtseva. All the specimens are figured in natural size; asterisk indicates beginning of the living chamber.

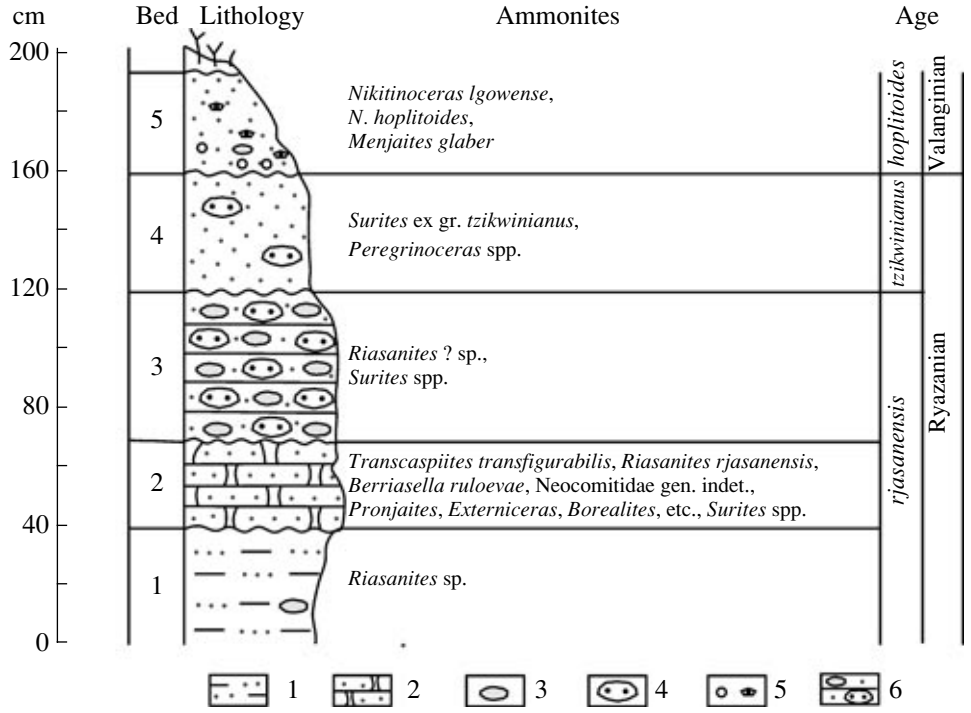


Fig. 3. Lower Cretaceous section at the Oka River downstream of the Nikitino Village: (1) clayey sand; (2) sandstone; (3) phosphorite nodules; (4) sandstone nodules; (5) pebble and debris; (6) conglomerate.

tinae Casey, 1973 unknown as yet from the East European platform.

Besides the Lopatin mine in the Moscow region, I have carried out fieldworks in the Oka River basin. In summer of 2001, I managed to stripe a small outcrop pf Berriasian–Valanginian rocks at the right bank of the Oka River downstream of the Nikitino Village, the Spassk area of the Ryazan region. The examined section important for topic of this article is described below.

NIKITINO SECTION

A landslide examined in the bank reveals the following undisturbed succession of beds (from the base upward, Fig. 3):

Ryazanian Stage, Riasanites rjasanensis Zone

Bed 1. Dark greenish gray to, locally, brown glauconite sand, fine-grained, clayey, with rare *Buchia* and *Riasanites* sp. molds or less common clayey casts in incoherent sandy phosphorite. The apparent thickness is 0.4 m.

Bed 2. Greenish brown, slightly compact glauconite sand with numerous *Buchia* and ammonites *Riasanites rjasanensis* (Nikitin) (Plate III, figs. 3, 4), *Transcaspiites transfigurabilis* (Bogoslowsky) (ibid., figs, 1, 2), *Berriasella rulevae* sp. nov. (ibid., figs. 6, 7; for description, see below), *Malbosiceras* cf. *macphersoni* (Kilian) poorly studied as yet (Plate II, fig. 6), *Dalmasiceras* ? sp. (ibid., fig. 5), *Riasanites* ? sp. (Plate III, fig. 5), and other species partly similar to forms described by Bogoslovskii (1896) in open nomenclature as *Hoplites* and *Pronjaites* cf./aff. *bidevexus* (Bogoslowsky). The bed also yields numerous ammonites representing various species of genera *Externiceras, Gerassimovia, Borealites, Surites*, and *Caseyceras.* The thickness is 0.3 m.

Bed 3. Mottled conglomerate composed of dark brown, sandy phosphorite nodules cemented by rusty–brown sandy–clayey irregularly compacted material. *Buchia* and other bivalves occur throughout the bed; poorly preserved ammonites (*Riasanites* ? sp., *Surites* spp.) occur rarely only in its lower part. The thickness is 0.5 m.

Surites tzikwinianus Zone

Bed 4. Greenish gray medium-grained slightly clayey sand locally cemented into relatively compact sandstone with rare poorly preserved *Surites* ex gr. *tzikwinianus* (Bogoslowsky) and *Peregrinoceras* spp. The thickness is up to 0.35 m; the bed is wedging out along the strike.

Valanginian Stage. Nikitinoceras hoplitoides Zone

Bed 5. Reddish yellow quartzose inequigranular sand with small rounded pebbles and inclusions of sandstone debris. A thin interlayer (2–3 cm) at the base

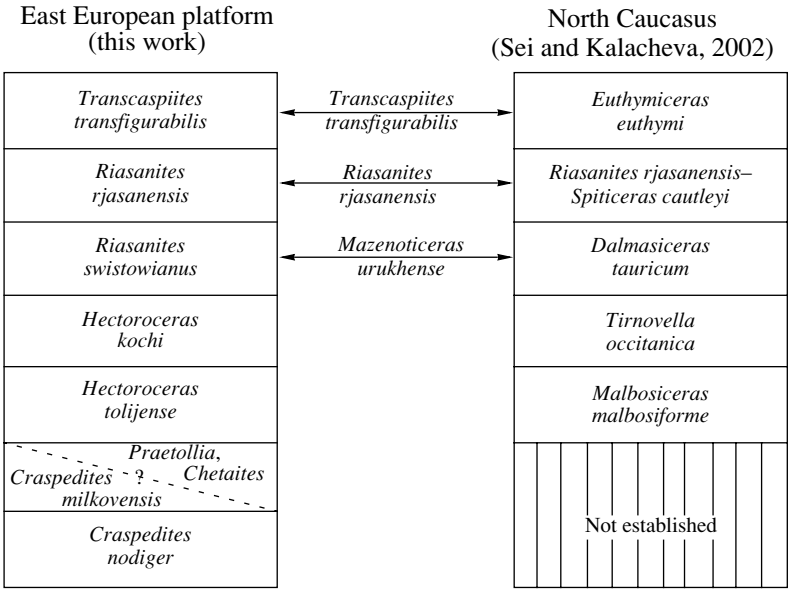


Fig. 4. Ammonite assemblages from Jurassic–Cretaceous boundary deposits of the East European platform and their correlation with the basal part of the Cretaceous section in the North Caucasus.

consists of dark sandstone pebbles (5a) cemented by comparable matrix material. Subordinate segregations of dark gray to gray inequigranular sandy phosphorite in the interlayer contain *Nikitinoceras lgowense* (Nikitin), *N. hoplitoides* (Nikitin), and *Menjaites glaber* (Nikitin). The apparent thickness (up to the soil) is 0.35 m.

The ammonite assemblage from Bed 2 is most informative in this section, because immediately underlying and overlying strata contain poorly preserved ammonites. In this assemblage, *Riasanites rjasanensis* (a form different and probably later than that from the Moscow region) is associated with first occurring *Transcaspiites transfigurabilis.* The last species described initially from the Ryazan region is also common in the *Euthymiceras euthymi* Subzone of the northern Caucasus (*The Berriasian of the North Caucasus…*, 2002). The collected specimens are more close to the form described by Grigor'eva (1938) from the Berriasian of the Aminovka River section (Belaya River basin, North Caucasus).[4] Another noteworthy moment is absence of *Riasanites swistowianus* and occurrence of necomitids unknown from the Moscow region. The diversity of Craspeditidae practically unknown from the Moscow region, except for *Pronjaites* cf./aff. *bidevexus,* and distant in terms of phylogeny from late Volgian representatives of this family indicate undoubtedly the younger age of this assemblage as compared to those considered above.

Neocomitids and other ammonites of the Tethyan origin from the East European platform certainly need a revision based on new materials. Here I describe only one new species having shell shape and ornamentation, which are unusual in the study region.

DESCRIPTION

FAMILY NEOCOMITIDAE SALFELD, 1921

Genus *Berriasella* Uhlig, 1905

Berriasella rulevae sp. nov.

Plate III, figs. 6, 7

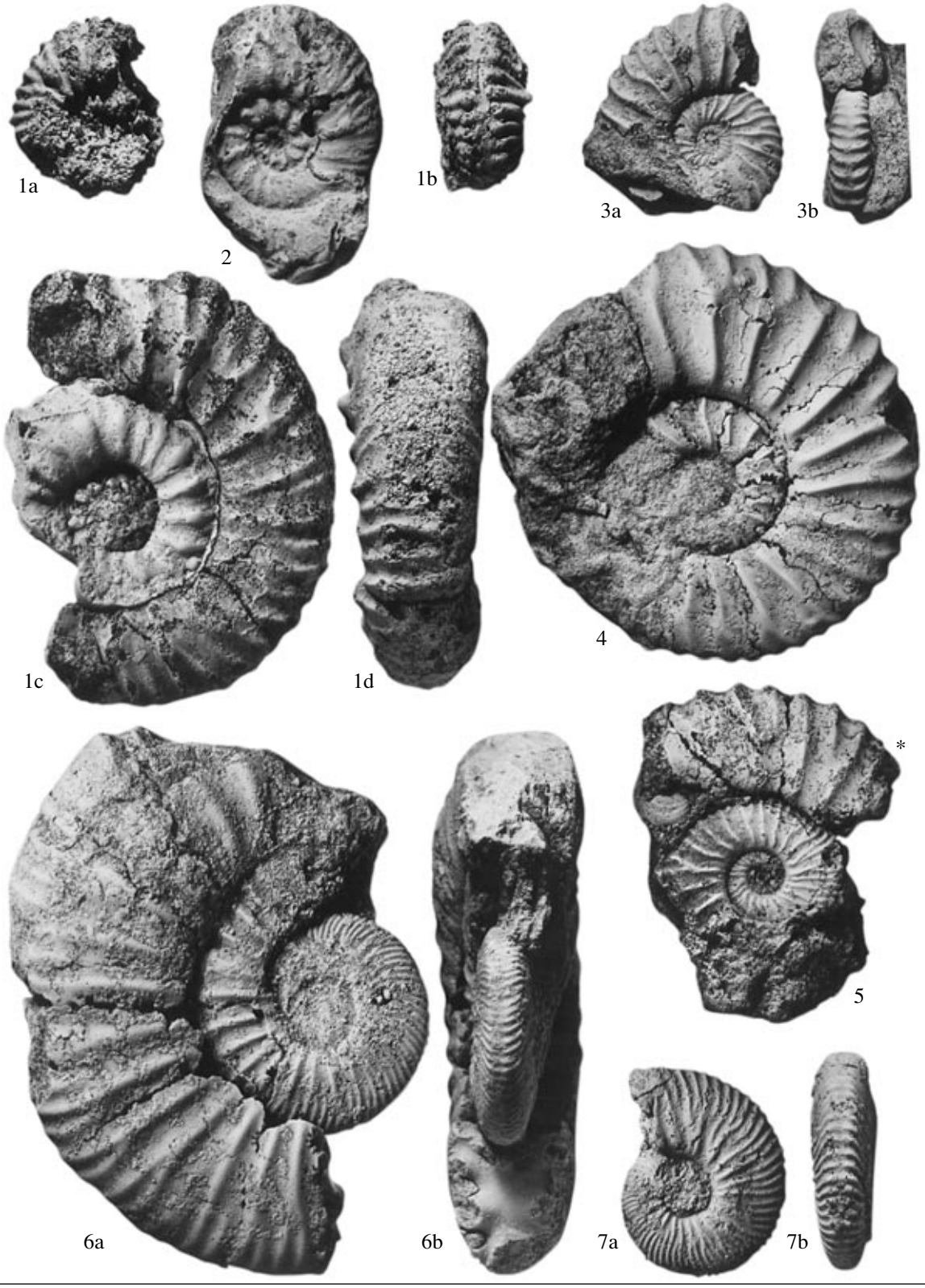
Etymology. The species is named in honor of I.A. Starodubtseva born Ruleva, a geologist and historian of geology, who took active part in field trips of 1998–2003.

Holotype. PIN RAS, specimen 3990/260, Ryazan region, Spassk district, Oka River bank downstream of the Nikitino Village; Ryazanian Stage, *Riasanites rjasanensis* Zone, *Transcaspiites transfigurabilis* Biohorizon; collections of V.V. Mitta and I.A. Starodubtseva, 2001.

Description. Phragmocone is medium-sized (initial diameter of living chamber is approximately 100 mm), with flattened whorls of suboval section and slightly convex lateral and rounded ventral sides. Young whorls (25–35 mm in diameter) are of medium thickness, almost rectangular in cross section, having flattened ventral side. Umbilicus is relatively narrow, with gently sloping walls; in young whorls, it is wider, having

[4] Ammonite found in talus near the studied locality (Mitta, 2002a) is similar to specimen described by Grigor'eva in the cited work as "*Blanfordiceras (Boehmiceras) caucasicum* s. nov." This also indicates similarity of ammonite assemblages from Berriasian deposits of the Oka and Belaya river basins. Judging from matrix, this ammonite is derived from Bed 2.

Plate III



steeper walls. Only initial, slightly deformed part of the living chamber is preserved in holotype.

Sculpturing of initial whorls is largely represented by regularly elevated ribs curved sometimes in falcate manner toward the anterior part of phragmocone. Ribs of umbonal part are relatively more elevated. Ribs are furcated or tripartite, less commonly, simple and inserted. Their anterior branches take origin already in the umbonal part, and posterior branches diverge near the middle of lateral sides. At the ventrolateral kink, ribs are slightly elevated, being lowered then in the middle of the ventral side and forming a weakly expressed ventral furrow. In the terminal part of phragmocone, well-developed primary ribs reaching the middle of sides bifurcate then in two or, less commonly, three branches, which cross the ventral side without apparent break or flattening.

Specimen	D	H	W	Du	H/D	W/D	Du/D
Holotype 3990/260	~98	34	25	34	0.35	0.25	0.35
	52	22	14	18	0.42	0.27	0.35
Paratype 3990/261	35	15	10	10	0.43	0.29	0.29
	24	11	8	7	0.46	0.33	0.29

Comparison and comments. The species under consideration has no morphological analogues in the Ryazanian Stage. In some features of morphology and sculpturing, it is similar to several genera of the basal Berriasian–basal Valanginian (similar specimens were likely described by Sazonova, as *Neocomites*), although it is difficult to define particular generic affiliation of the species. This is the reason why the species is attributed to the genus *Berriasella* s. l.

Material: two figured specimens; Bed 2 of the section described above, *Riasanites rjasanensis* Zone, *Transcaspiites transfigurabilis* Biohorizon.

CONCLUSION

Based on new data, five ammonite assemblages termed after most typical species are defined in the basal part of the Ryazanian Stage of the East European platform (from the base upward):

(1) *Hectoroceras tolijense* (Nikitin) assemblage; to define its other components it is necessary to verify primarily the occurrence in situ of *Garniericeras subclypeiforme* (Milaschewitsch). The assemblage corresponds approximately to the "*Riasanites rjasanensis–Garniericeras subclypeiforme* Zone" in understanding of Mesezhnikov (1984), although *Riasanites* forms are absent.

(2) *Hectoroceras kochi* Spath assemblage; the associated taxa are *Praesurites* and/or *Pseudocraspedites* sp.

(3) *Riasanites swistowianus* (Nikitin) assemblage; its index species accompanied by scarce *R. rjasanensis* (Nikitin) and *Dalmasiceras crassicostatum* Djanelidze, rare *Malbosiceras* sp. (sp. nov.), numerous Himalayitidae (?) gen. et sp. nov. (in litt.), *Subalpinites* aff. *fauriensis* Mazenot, *Mazenoticeras* cf. *urukhense* Kalacheva et Sey, *Pseudocraspedites bogomolovi* Mitta, and *Praesurites* sp.

(4) *Riasanites rjasanensis* (Nikitin) assemblage; the associated species are rare *R. swistowianus* (Nikitin), *Subalpinites krischtafowitschi* Mitta, *Malbosiceras* sp. *Mazenoticeras* sp., *Praesurites nikitini* (Gerasimov) em. Mitta, *Pseudocraspedites bogomolovi* Mitta, *Ps. craspeditoides* Girmounsky, and *Hectoroceras* cf. *kochi* Spath.

Assemblages 3 and 4 probably correspond to the "*Riasanites rjasanensis–Hectoroceras kochi* Zone" in understanding of Mesezhnikov (1984), although mass appearance of *Hectoroceras kochi* Spath is recorded earlier, in the assemblage lacking ammonites of the "Tethyan" origin according to my observations. Prior to works by Mesezhnikov, layers with two lower assemblages were excluded from the *rjasanensis* Zone and Ryazan Horizon as a whole. These layers are excluded also from the Volgian Stage, the upper boundary of which was initially determined by Nikitin (an author of the stage) at the top of the *Craspedites nodiger* Zone. Thus, assemblages 1 and 2 might may define in future an individual stratigraphic unit of the zone rank, the terminal one prior to invasion of Tethyan elements. Attribution of this conventional zone can be attributed to either the Jurassic or the Cretaceous depending on the boundary positioning between these systems after eventual correlation of Berriasian and Ryazanian stages.

5. *Transcaspiites transfigurabilis* (Bogoslowsky) assemblage; associated ammonites are "*Riasanites*

Plate III. Ammonites from the upper part of the *rjasanensis* Zone (Ryazanian Stage).

(1, 2) *Transcaspiites transfigurabilis* (Bogoslovsky), (1) PIN, Specimen 3990/255: (a) side view of juvenile whorls (×2), (b) the same ventral view (×2), (c) living chamber with gypsum replica of internal whorl, side view, (d) the same, ventral view; (2) PIN, Specimen 3990/256, phragmocone, side view; (3, 4) *Riasanites rjasanensis* (Nikitin), (3) PIN, Specimen 3990/257, phragmocone: (a) side view, (b) apertural view, (4) PIN, Specimen 3990/258, phragmocone, side view; (5) *Riasanites* (?) sp., PIN, Specimen 3990/259, phragmocone with the initial living chamber, side view; (6, 7) *Berriasella rulevae* sp. nov., (6) holotype, PIN, Specimen 3990/260: (a) phragmocone with a fragment of initial living chamber, side view, (b) the same, ventral view, (7) paratype, PIN, Specimen 3990/261, phragmocone: (a) side view, (b) ventral view. All specimens are from the Ryazan region, Oka River bank, downstream of the village of Nikitino, *rjasanensis* Zone, upper part (*transfigurabilis* Biohorizon), collection of V.V. Mitta and I.A. Starodubtseva. All the specimens, except for specially marked, are figured in natural size; asterisk designates beginning of the living chamber.

rjasanensis (Nikitin), *Berriasella rulevae* sp. nov., other Neocomitidae (poorly studied as yet), *Pronjaites* cf./aff. *bidevexus* (Bogoslowsky), *Externiceras, Gerassimovia, Borealites*, and *Caseyceras* forms.

This assemblage belongs undoubtedly to the "*Riasanites rjasanensis–Surites spasskensis* Zone" in understanding of Mesezhnikov; the further subdivision of this interval cannot be ruled out. Correlation of this assemblage precisely (not of the entire *rjasanensis* Zone) with ammonites of the *paramimounum* Subzone of the standard Berriasian scale seems quite valid. This conclusion is supported by correlation of the *Transcaspiites transfigurabilis* assemblage (based on this species finds) with the *Euthymi* Subzone in the Urukh section of the northern Caucasus (Fig. 4). According to abundance of *Riasanites rjasanensis* and position in the section, the underlying assemblage should correspond to "lower *Riasanites*" beds of the northern Caucasus, i.e., to the "*Rjasanensis/Cautleyi* Subzone" in nomenclature of Sei and Kalacheva. Based on associated *Mazenoticeras* cf. *urukhense*, the *Riasanites swistowianus* assemblage is correlative with the "*Tauricum Subzone*" of the northern Caucasus,

Thus, five successive ammonite assemblages are recognized in the lower part of the Ryazanian Stage in the East European platform. The youngest (fifth) assemblage is correlative with the sixth (from below) ammonite assemblage of the standard Berriasian. Taking into consideration ambiguous age of the *Praetollia* and *Chetaites* beds in the East European platform, which are hardly older, however, than the *Craspedites milkovensis* Subzone, the terminal subzone one in the *Craspedites nodiger* Zone and than the Volgian Stage as a whole, we have additional, though formal arguments in favor of approximate isochronism of the Berriasian and Ryazanian lower boundaries. In any case, this hypothesis seems more substantiated than correlation of the upper Volgian Substage with the middle Berriasian based on their position in the section.

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Reviewer M.A. Rogov

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