

The Volgian *Praechetaites exoticus* Zone: Geochronological Range, Stratigraphic Position and Interregional Correlation (a Response to the Paper by S.V. Meledina et al. “On the Position of the *Praechetaites exoticus* Zone in the Volgian Stage”)

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Abstract—The *Praechetaites exoticus* Zone is characterized; its definition, geographical range and correlation in the Panboreal Superrealm are discussed. New evidence supports the Middle Volgian age of the *Exoticus* Zone. It is shown that the presence of the characteristic ammonoid assemblage allows the recognition of this zone in the sections of North Siberia and Spitzbergen. The suggested key characters defining the zone include the appearance of the ammonites from the *P. exoticus* group at the lower boundary and *Craspedites* ex gr. *okensis* at the upper boundary. The stratigraphic distribution of boreal genera of ammonites at the Middle–Upper Volgian boundary is discussed.

Keywords: Volgian Stage, Panboreal correlation, *Praechetaites exoticus* zone.

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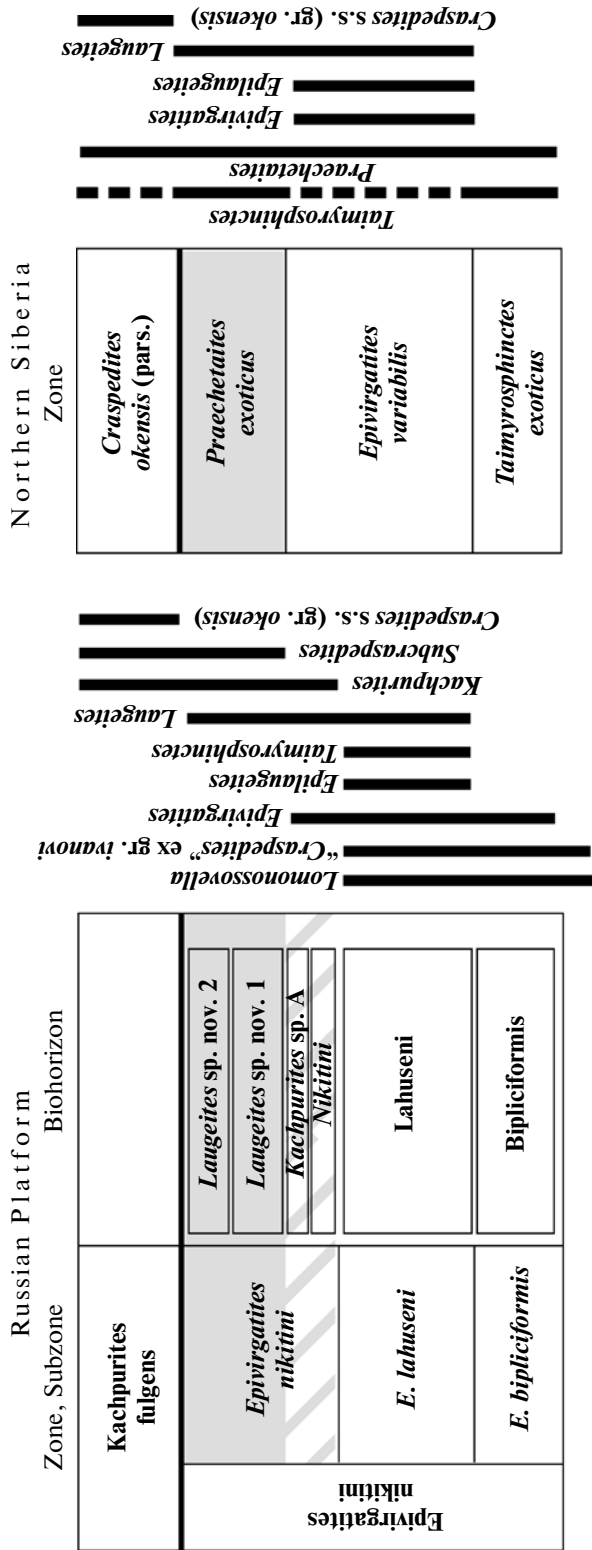
INTRODUCTION

The history of the recognition of the *Exoticus* Zone and changes in its rank (from subzonal to zonal) have been discussed in detail by our opponents (Meledina et al., 2010). Therefore we begin with the characterization of the zone and evaluation of criteria, allowing its assignment to the Upper Volgian Substage, and discuss the arguments of our opponents.

CHARACTERIZATION OF THE *PRAECHETAITES EXOTICUS* ZONE AND ITS DEFINITION

Shulgina (1967) originally established this unit without giving it any description, placing it in a correlation scheme as a *Virgatosphinctes exoticus* Subzone and mentioning in the text as the “beds with *Virgatosphinctes exoticus*”. Shortly afterwards, Saks (1969) gave a characterization of the subzone, and noted that it contained only “*Virgatosphinctes*.” No data on the type section or definitions of its lower and upper boundaries were given. Our opponents also suggest that the zone be considered as a stratigraphic interval, containing only ammonoids of the genus *Praechetaites* (Meledina et al., 2010). The stratotype of the *Praechetaites exoticus* Zone was proposed by Baraboshkin (2004) in the section along the Kheta River, which cannot be considered as a good solution, because in this section the base of the zone is not

present (see Saks, 1969 for the section description). Previously the section along the Levaya Bojarka River was suggested as the stratotype of the *Okensis* Zone (together with the *Exoticus* Subzones) (Mesezhnikov, 1984). In the same paper Baraboshkin (2004) suggested that the base of the zone should be drawn based on the appearance of the genus *Praechetaites*, and the upper boundary based on the appearance of *Craspedites okensis*. Meledina et al. (2010), as far as we understand, defined the lower boundary of the zone based on the disappearance of the genera *Epivirgatites* and *Laugeites*, based on evidence from the Kheta and Bojarka sections. In our opinion, the previous definitions of the lower boundary of the zone are not acceptable. The ammonites of the genus *Praechetaites* appear far below the base of the *Exoticus* Zone (the earliest representatives are known from the Middle Volgian *Dorsoplanites ilovaiskii* Zone), whereas *Laugeites* in the sections on the Kheta and Bojarka rivers are exceptionally rare; there is a record of a single specimen, which was collected loose (Saks et al., 1969). Data on other regions (Russian Platform, Spitzbergen, and Nordvik) show that the stratigraphic ranges of the genera *Epivirgatites* and *Laugeites* are different (figure). In our opinion, in all sections containing the *Praechetaites exoticus* Zone the base of the zone can be defined by the appearance of large *Praechetaites*, similar to *P. exoticus* (Schulgina). The ultimate size of the shell of earlier *Praechetaites* does not usually exceed



Distribution of ammonites in the Middle-Upper Volgian boundary interval in different regions. The *Exoticus* Zone and its equivalents are shown by gray shading (gray hatching shows the interval of uncertain correlation).

5 cm, whereas the average size of *P. exoticus* is over 10 cm (Shulgina, 1967; see also plate, figs. 1–3). *Epivirgatites* are absent in the *Exoticus* Zone, whereas species of *Laugeites* at this level are represented by large forms with ornamentation disappearing early in ontogeny. The zone is characterized by the increase in the number of *Praechetaites* beginning from its base (usually these ammonites are dominant in this zone). It is universally agreed that the upper boundary of the *Exoticus* Zone is defined by appearance of the *Craspedites* ex gr. *okensis* (d'Orb.)

PRAECHETAITES EXOTICUS ZONE IN THE SECTION OF THE NORDVIK PENINSULA

In the opinion of our opponents, we made several mistakes while drawing the boundaries and indexing beds of the *Praechetaites exoticus* Zone in the section of the Nordvik Peninsula (Zakharov and Rogov, 2008). Our opponents consider that the existing data on the ammonite distribution do not allow the recognition of this zone at this site. We agree with the remarks concerning the indexing of the beds and placement of some boundaries. Indeed, Bed 32/2 should correspond to the Bed 33/9 or to part of it, rather than overlying it. Correspondingly, Bed 32/3 should have been placed in Fig. 1 in our paper (Zakharov and Rogov, 2008) instead of Beds 32/2 and 32/3. The upper boundary of the *Exoticus* Zone, as correctly remarked by our opponents, should be placed approximately 1 m upward in the section from its position in the figure (as shown in Houša et al., 2007).

The lower boundary of the zone is drawn provisionally. Unfortunately, a large interval of the section (ca. 2 m thick) between the last occurrence of *Epivirgatites variabilis* and the first occurrence of *Praechetaites* did not contain identifiable ammonites, and we drew the lower boundary of the *Exoticus* Zone based on previous research (Zakharov et al., 1983). The position of the Middle–Upper Volgian boundary in the Nordvik Section proposed in our paper (Zakharov and Rogov, 2008) does not entirely correspond to previously published data, according to which *Craspedites okensis* appears 1.5 m above the base of Bed 32/3 (Zakharov et al., 1983). During fieldwork in 2003, we did not find *Craspedites* in this part of the section, but we found *Laugeites* with smooth external whorls at a similar level. These ammonites, when poorly preserved, can easily be confused with *Craspedites* ex gr. *okensis* (d'Orb.). Apart from our own collection, we re-exam-

ined material from the Nordvik Section collected by N.I. Shulgina. The collection contains five specimens of *Praechetaites*, partly collected from the beds (of these, two specimens come from the *Exoticus* Zone (in our interpretation), while 1 specimen comes from the *Okensis* Zone s.s., Plate 1, figs. 1, 2), and excellently preserved late *Laugeites* sp., from an unknown stratigraphic level.

Our opponents consider that in the Nordvik section interval characterized by ammonites of the genera *Laugeites* and *Praechetaites*, belong to the Middle Volgian, but cannot be named as the *Exoticus* Zone. In our opinion, the presence or absence of *Laugeites* cannot be an argument supporting the assignment of this interval to the *Exoticus* Zone, because ammonites of this genus have different stratigraphic ranges in different regions (figure). The criteria selected establishing the base of the *Exoticus* (entry of *Praechetaites* ex gr. *P. exoticus* and numerical dominance of *Praechetaites*) allow a positive recognition of this zone in the Nordvik Section.

GEOGRAPHIC RANGE AND INTERREGIONAL CORRELATION OF THE *PRAECHETAITES EXOTICUS* ZONE.

The *Exoticus* zone was originally established on a restricted territory, in the basins of the Kheta and Levaya Bojarka rivers, while its correlation with the sections of other regions was based (apart from a few exceptions) on its relative stratigraphic position. Because this unit is considered as a lower subzone of the Upper Volgian *Okensis* Zone, it is automatically correlated with the lower part of the Upper Volgian Substage. Consequently, intervals with *Praechetaites* (in Spitzbergen and in Eastern Greenland) are considered within the Upper Volgian.

In the recent years we showed (Zakharov and Rogov, 2008; Rogov and Zakharov, 2009), that the *Exoticus* can be recognized in other sections of Northern Siberia and in Spitzbergen. It is always recognized based on the mass occurrence of *Praechetaites* and the absence of *Praechetaites* ex gr. *exoticus* (Schulg.). Judging from the results of the 2009 fieldwork, the equivalents of this zone can also be present in the sections of the lower reaches of the Lena River.

Difficulties with the correlation of terminal part of the Middle Volgian can be explained both by insufficient knowledge of this interval and by sharp differences in the relative stratigraphic distribution of ammonite genera in different regions (figure). There is

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Ammonites of the genus *Praechetaites* from the Northern Siberia sections (the collection is housed in Vernadsky State Geological Museum (SGM), Russian Academy of Sciences, Moscow, scale bar = 1 cm).

(1) *Praechetaites* cf. *exoticus* (Shulg.), specimen SGM 1333-04/BP-10010, Nordvik Section, Outcrop 30, Bed 1, *Exoticus* Zone (coll. by N.I. Shulgina, 1967); (2) *Praechetaites* sp., specimen SGM 1333-06/BP-10012, Nordvik Section, Outcrop 32, Bed 13, *Okensis* Zone (coll. by N.I. Shulgina, 1967); (3) *Praechetaites exoticus* (Shulg.), specimen SGM 1333-03/BP-10009, Kheta River, left bank 6 km upstream of the Bukatyi Creek, Outcrop 22, Bed 2 (coll. by N.I. Shulgina).

Plate



no a single ammonite species for which the range would be the same in the four above regions! What should be the guiding principles in correlation of the *Exoticus* Zone with its equivalents? We suggest that the main criteria for the correlation of the *Exoticus* Zone can be: (a) appearance of characteristic species, which in different regions can be considered as geologically synchronous (*Praechetaites exoticus* (Shulg.), *Craspedites okensis* (d'Orb.)); (b) distribution of species, the stratigraphic position of which is determined in the phylogenetic succession in at least one region (*Laugeites* ex gr. *groenlandicus* (Spath)—*L. lambecki* (Ilov.)—*Laugeites* sp. nov. 1, 2). Consequently, the lower boundary of the *Exoticus* Zone, which as it was shown in two sections (Nordvik (Northern Siberia) and Festningen (Spitzbergen)), coincides with the appearance of the late smooth-shelled *Laugeites*, should be placed somewhat above the base of the *Nikitini* Subzone of the Middle Volgian *Nikitini* Zone of the Russian Platform (Rogov, 2010, plate). This does not contradict the knowledge from the sections of the Khatanga Basin, where species of *Laugeites* are absent, because in all cases, representatives of the genus *Epivirgatites* do not continue into the *Exoticus* Zone. *Epivirgatites* also does not occur in the upper part of the *Nikitini* Zone on the Russian Platform (Rogov and Zakharov, 2009). The origin of *Craspedites* ex gr. *okensis* (d'Orb.) remains doubtful. These ammonites are very different in their considerably larger size from "*Craspedites*" (ex gr. *ivanovi* Geras.) from the Middle Volgian Substage. We observed that "*Craspedites*" ex gr. *ivanovi* Geras. are often found in the *Virgatus* Zone, are only occasionally found in the lower part of the *Nikitini* Zone, and are completely absent from its upper subzone. These ammonites are present only in the sections of the central part of the Russian Platform (Moscow and Yaroslavl Regions) and unknown from other regions, in contrast with wide distribution of *Craspedites* ex gr. *okensis* (d'Orb.). Nevertheless, despite the uncertain origin of *Craspedites* ex gr. *okensis* (d'Orb.), the appearance of these ammonites in different sections may be considered as geologically synchronous (Baraboshkin, 2004).

The correlation of the beds with *Praechetaites tenuicostatus* recognized in Eastern Greenland with the *Praechetaites exoticus* Zone can be established based mainly on indirect evidence. In the sections of Kuhn Islands, the succession *Laugeites lambecki*, *L. parvus*—*Epilaugeites* sp.—*Praechetaites tenuicostatus* has been traced (Surluk, 1978). The position of the species *L. lambecki* and *L. parvus* is clearly distributed in the sections of Spitzbergen: they are immediately overlain by the *Exoticus* Zone. The level with *Epilaugeites* in Eastern Greenland is usually recognized as *E. vogulicus*, although Greenland representatives *Epilaugeites* are different from those in the Urals in their larger size, and there is no certainty in the correspondence of the ranges between this zone and on in the Urals. Apparently, in Greenland, the range of *Epil-*

augeites is smaller than in the Subpolar Urals. In Eastern Greenland, the Upper Volgian ammonites are very rare and are not found in the sections with *Praechetaites tenuicostatus*. The position of the beds with *Praechetaites tenuicostatus* can be identified only based on comparison with the sections of Spitzbergen, where *Praechetaites* do not occur in the Upper Volgian Substage. The position of the *Epilaugeites vogulicus* Zone in the Subpolar Urals remains unclear. In the sections of Northern Siberia and the Russian Platform *Epilaugeites* occur below the equivalents of the *Exoticus* Zone. If it is accepted that ranges of *Epilaugeites* in this region are at least partly overlapped, the *Groenlandicus* Zone of the Subpolar Urals has a smaller range than the same zone in Eastern Greenland and Spitzbergen. The position of the top of the *Epilaugeites vogulicus* Zone of the Subpolar Urals is also unclear. In other regions *Epilaugeites* are not found in the terminal part of the Middle Volgian Substage. *Laugeites* with ornamentation disappearing early in ontogeny characteristic of the uppermost Middle Volgian are also absent in the Subpolar Urals. Therefore it can be suggested that the interval of the section corresponding to the part of the *Exoticus* Zone and the upper or two upper (?) faunal horizons of the *Nikitini* Zone in the Subpolar Urals, is somehow missing from the section. In Western Siberia *Laugeites*, *Epilaugeites*, and *Praechetaites* are present in the upper part of the Middle Volgian Substage (*Praechetaites* is also confirmed in the Upper Volgian (see Alifirov, 2009)). Most of these ammonites are found in isolated boreholes, and their mutual arrangement in the section is not quite clear. Therefore, it is difficult to suggest a possibility of the presence of the equivalents of the *Exoticus* Zone or the beds with *Praechetaites tenuicostatus*. All figured specimens of *Praechetaites* from Western Siberia have small size and show early presence of thin ribbing with a high ribbing coefficient; members of the *P. exoticus* group are not found here.

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