Estonian Journal of Earth Sciences, 2014, **63**, 4, 300–304 doi: 10.3176/earth.2014.34

New data on acritarchs from the Upper Ordovician of the Tungus basin, Siberian Platform

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Received 2 July 2014, accepted 2 October 2014

Abstract. Distinctive late Ordovician acritarch assemblages have been discovered for the first time from about a 100 m sedimentary succession exposed along the Bol′shaya Nirunda River in Siberia. The studied stratigraphic interval includes the uppermost Baksian, Dolborian, Nirundian and Burian regional stages, which correspond to the Katian–?lowermost Hirnantian global stages. Acritarch assemblages from the Dolbor Regional Stage are exceptionally diverse and include aside from the long-ranging taxa several unique (endemic) morphotypes and a number of distinctive stratigraphically valuable species, well known outside Siberia. The occurrence of the acritarchs widespread outside Siberia is potentially important for interregional biostratigraphic correlations and might also play a significant role in biogeographic reconstructions. Having in mind that the Siberian palaeocontinent was located in a low-latitude tropical area during the entire Ordovician, the presence of taxa typical of cold-water settings along the Peri-Gondwana margin can be regarded as an additional evidence for penetration of cool-water currents into the epicontinental Tungus basin in the Upper Ordovician.

Key words: acritarchs, Upper Ordovician, Siberian Platform.

INTRODUCTION

So far little is known about Upper Ordovician acritarchs from Siberia. The youngest recorded species are from the lower Sandbian (Chertovskian and lower Baksian regional stages) rocks which cropped out in the Kulumbe River type section located in the Igaro-Noril′sk Region (Sheshegova in Kanygin et al. 1984). The published data unfortunately are scarce and poorly illustrated, based on outdated systematics of acritarchs and therefore not very reliable. Meanwhile, this group of microphytoplankton has been proven to be biostratigraphically useful and may appear particularly useful for interregional correlations, while most of the other fossil groups in Siberia exhibit rather a high degree of endemism. In the frame of a multidisciplinary research project on the Ordovician of Siberia, the Upper Ordovician succession along the Bol′shaya Nirunda River has been sampled for palynological studies. The aim of this short article is to present a first preliminary report of this investigation.

GEOLOGICAL SETTING

The outcrop area is located on the southern margin (in present-day orientation) of the extensive epicontinental Tungus basin on the Siberian Platform between Katanga and Enisej (also spelt Yenisei or Yenisey) Lands (Fig. 1). The studied stratigraphic interval includes the uppermost Baksian, Dolborian, Nirundian and Burian regional stages (for the regional stratigraphy see Kanygin et al. 1984, 2007), which correspond to the Katian, and probably to the lowermost Hirnantian stages of the Global Scale (Bergström et al. 2009). The succession is represented by four separated outcrops along the Bol′shaya Nirunda River, a right tributary of the Podkamennaya Tunguska River about 60 km downstream from the village of Baykit and consists of four formations: (1) The Mangazea Formation (Baksian Regional Stage) is represented by rhythmic intercalations of greenish-grey siltstone and bioclastic limestones. In many cases ripple marks can be observed on the top of limestone layers. (2) The Dolbor Formation (Dolbor Regional Stage) contains mainly greenish-grey siltstone with intercalation of thin (0.5–2 cm) limestone layers and thicker beds, sometimes with chert nodules. (3) The Nirunda Formation is only exposed in a fragmentary manner and represented by cherry-red and greenish-grey siltstone with thin laminated bioclastic limestone layers at some levels. (4) The Bur Formation is represented by intercalations of greenish-grey siltstone and grey bioclastic limestone beds with abundant big (up to 20–30 cm in diameter) tabulate-coral colonies. The whole succession is about 100 m thick and interpreted as cool-

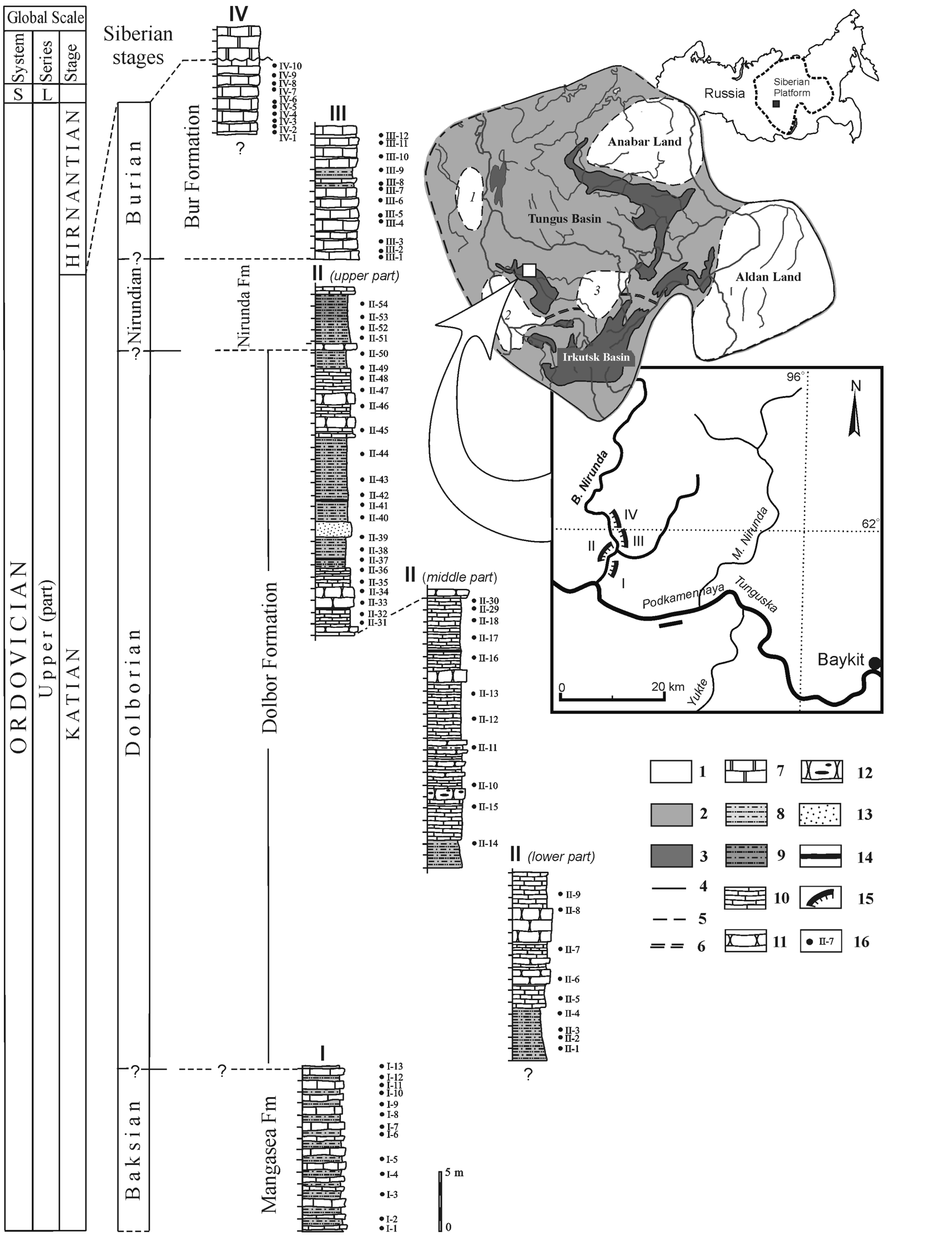

Fig. 1. Location and stratigraphy of the studied Ordovician sections. **1**, Land areas without Ordovician deposits (*1*, Turukhan Land, *2*, Enisej Land, *3*, Katanga Land); **2**, Ordovician deposits in subsurface areas; **3**, Ordovician outcrop areas; **4**, boundary of the Siberian Platform; **5**, provisional boundaries of the Siberian Platform and land areas; **6**, provisional boundary of the Tungus and Irkutsk basins; **7**, Silurian thick-bedded dark grey limestone (mudstone to wackestone); **8**, greenish-grey siltstone; **9**, red siltstone; **10**, thin-bedded bioclastic limestone and intercalation of limestone and siltstone; **11**, thick-bedded bioclastic limestone; **12**, limestone beds with chert nodules; **13**, fine-grained quartz sandstone; **14**, K-bentonite layers; **15**, outcrops; **16**, samples collected for acritarchs.

water carbonates (Dronov 2013). Debris of trilobites, brachiopods and ostracods is the most common among bioclasts, with a significant number of bryozoans, pelmatozoans and mollusks. The most typical and widespread sedimentary structures are indicative of storm-induced sedimentation (Dronov 2013).

MATERIAL

In total 80 samples (Fig. 1) were processed following standard palynological procedures involving acid treatment and concentration of organic residue by sieving through a 15 µm screen. Neither oxidative nor alkali treatments were applied. Almost all samples yielded well-preserved acritarchs, although their abundance and variety differed in the different samples. The palynological slides comprising the studied material are stored in the collections of the Stratigraphy Department of FGUNPP 'Geologorazvedka', St. Petersburg.

RESULTS

The majority of extracted palynomorphs throughout the section are represented mainly by pylomate sphaeromorphic and simple acanthomorphic acritarchs associated with cryptospores and fragmented chitinozoans and scolecodonts. Long-ranging *Baltisphaeridium*, *Goniosphaeridium*, *Micrhystridium* and *Solisphaeridium* are common in most samples. Nevertheless, at least four distinctive acritarch assemblages can be recognized, providing particular taxonomic characteristics of the studied strata. The assemblage from the Baksian Stage is characterized by the predominance of *Dicommopalla macadamii* Loebl., *Sacculidium inornatum* Rib. et al., *S. macropylum* (Eis.) Rib. et al., *Peteinosphaeridium* aff. *P. armatum* Tong. et al., *Peteinosphaeridium* spp. and *Gyalorhethium* spp. The uppermost part of the Baksian Stage contains large numbers of a very specific form with vermicular solid processes, preliminarily attributed to the genus *Gorgonisphaeridium* (Fig. 2F). The Dolborian Regional Stage is exceptionally rich in acritarchs. Its lower boundary is marked by the appearance of *Dactylofusa* (*Moyeria*) *cabottii* (Cram.) Fensome et al. In addition, numerous new morphotypes appear a little above the base of the stage. These include different kinds of specimens with hollow conical processes, whose terminal parts resemble either nipples or claws. They are considered in the present paper as Gen indet. A. sp. 1, 2, etc. Other types possess similarly constructed processes but branching up to the second, third or fourth order and are attributed to Gen indet. B (Fig. 2M, N). None of these acritarchs have ever been described and may be endemic of Siberia. The general abundance and diversity of acritarchs decrease in the upper part of the Dolborian Stage, although some new taxa such as *Oppilatala* sp. and *Actinotodissus* spp. appear. Acritarchs from the Nirundian and Burian regional stages are relatively scarce and represented only by few transitional taxa.

DISCUSSION

It is worthy of note that the acritarch assemblages discovered in the studied succession include besides the typical Siberian taxa several representatives of different Ordovician microphytoplankton 'provinces' (Servais et al. 2003). For example, *D. macadamii* is most typical of Laurentia basins (Loeblich 1970), while *Oppilatala* occurs in Laurentia and Baltica (Delabroye et al. 2011), and *S. inornatum*, *S. macropylum* and *P. armatum* are distinct elements of Baltic and South China assemblages (Tongiorgi et al. 2003). In contrast, *D.* (*Moyeria*) *cabottii* is most common in settings along the Peri-Gondwana border and North China (Tarim) (Vecoli & Le Hérissé 2004; Li et al. 2006; Paris et al. 2007). Having in mind that the Siberian palaeocontinent was located in a low-latitude tropical area during the entire Ordovician (Cocks & Torsvik 2007), the presence of the last-mentioned acritarch in the assemblage from the Dolborian Regional Stage confirms in addition to lithological evidences (Dronov 2013) that cool-water currents penetrated in the Upper Ordovician into the epicontinental Tungus basin of the Siberian Platform.

CONCLUSIONS

1. The acritarchs described in the present paper, especially the ones which are known from outside Siberia, have a high potential for interregional biostratigraphic correlations and biogeographic reconstructions.
2. The presence of taxa indicative of cool-water settings and typical of high-latitude Peri-Gondwana seas could be regarded as an additional independent evidence for cool-water conditions in the Upper Ordovician of the Tungus basin.

Acknowledgements. This work was performed according to the Russian Government Programme of Competitive Growth of Kazan Federal University. Financial support was also provided from the Russian Foundation for Basic Research Grant No. 13-05-00746. The paper is a contribution to IGCP Project 591.

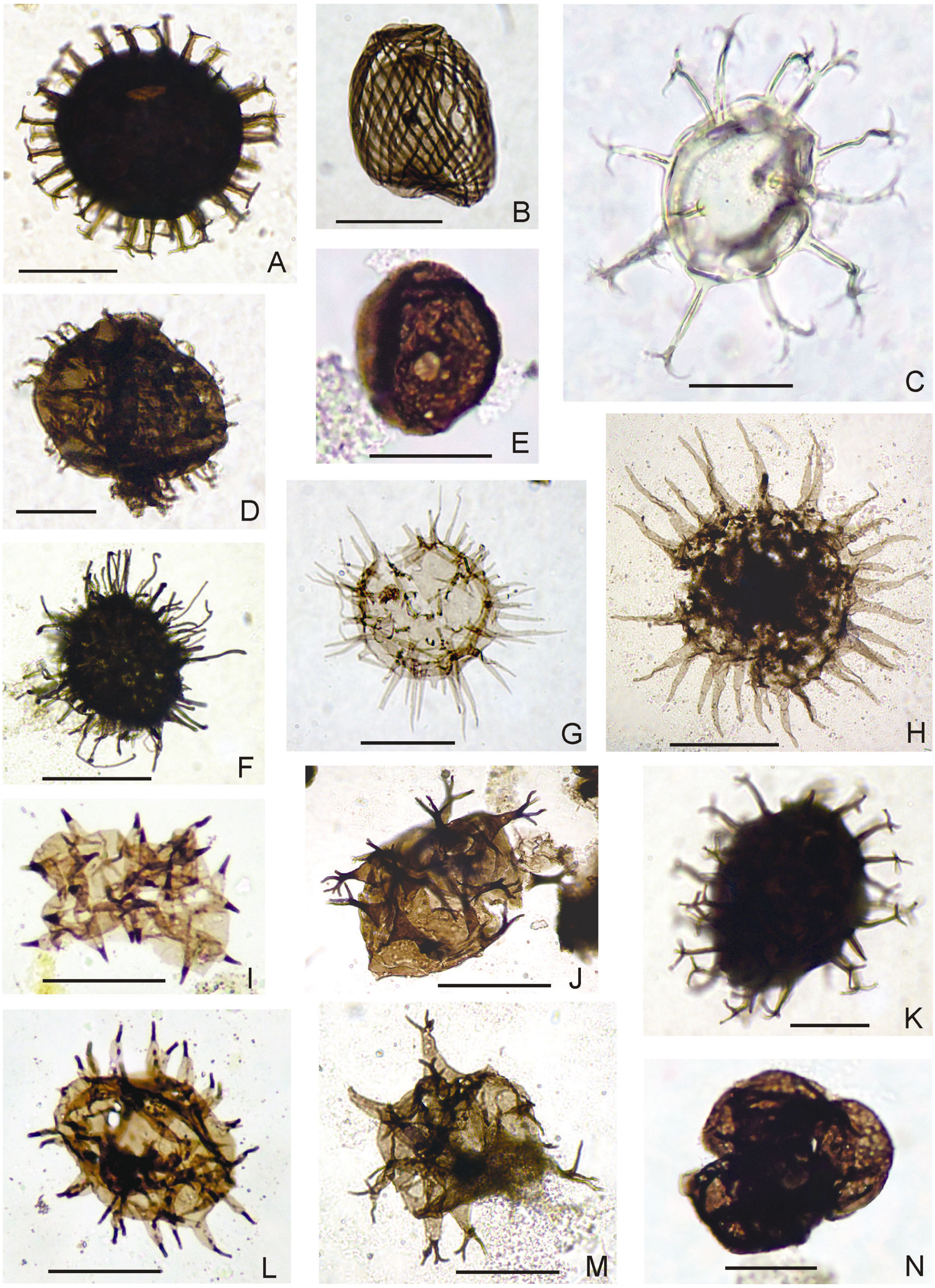

Fig. 2. Acritarchs from the Upper Ordovician of the Bol′shaya Nirunda River, Siberian Platform. **A**, *Peteinosphaeridium armatum* Tongiorgi, Yin Lei-ming & Di Milia, 1995, II-2, D46/2. **B**, *Dactylofusa* (*Moyeria*) *cabottii* (Cramer, 1971) Fensome, Williams, Barss, Freeman & Hill, 1990, II-2, L30/3. **C**, *Oppilatala* sp. II-36, V22/3. **D**, *Sacculidium* aff. *S. macropylum* (Eisenack, 1959) Ribecai, Raevskaya & Tongiorgi, 2002, I-5, M26/4. **E**, *Dicommopalla macadamii* Loeblich, 1970, II-17, R26/3. **F**, *Gorgonisphaeridium* sp. 1. I-11/1, Q41/4. **G**, *Gyalorhethium* sp. IV-7, C23/1. **H**, *Gyalorhethium* sp., I-3, W36/2. **I**, Gen. indet. A, sp. 1. II-2, B36/2. **J**, **M**, Gen. indet. B, sp. 1. II-8/2, 10-V37; 13-Q46. **K**, *Peteinosphaeridium* sp., II-8/1, S34/4. **L**, Gen. indet. A, sp. 2. II-2, Q34/2. **N**, Cryptospore, II-5, P34/4. Scale bare represents 30 µm.

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