

## Main changes in microfossil communities throughout the Upper Proterozoic of Russia.

### [Changements majeurs dans les assemblages de microfossiles au cours du Protérozoïque supérieur de Russie]

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**Mots-Clefs :** Microfossiles ; Protérozoïque supérieur ; plates-formes est-européenne et sibérienne

#### Introduction

More than 50 years of study have resulted in the description of hundreds of taxa of Precambrian microfossils from the different regions of Russia. These forms are usually preserved either as silicified or organic-walled remains and generally are morphologically simple and stratigraphically long-ranging. The systematics of Precambrian microorganisms still needs a serious revision, although efforts by specialists from all over the world to solve these problems have helped to clarify the biological assignment of some taxa.

Distinctive, exceptionally diverse and well-preserved microbiotas were found at several locations on the East-European and Siberian Platforms. They occur at discrete stratigraphical levels and are geographically sporadic. However, a comprehensive analysis based on the published data and original material (Fig. 1) permitted the drawing of an evolutionary trend in the main taxonomical changes that occurred in the organic world throughout the Upper Proterozoic of Russia.

For the present study the only records we used were from strata controlled either by isotopic data or other evidence of age. Both silicified and organic-walled microfossils were analyzed taxonomically. Only species with real biological meaning or biostratigraphical significance were used to define noteworthy stages in the development of Upper Proterozoic microorganisms. Five main stratigraphical levels, characterized by the FAD of distinctive species or by the occurrence of new morphological forms have been distinguished (Fig. 2).

#### The Early - Middle Riphean (R1-R2<sup>1</sup>) assemblages

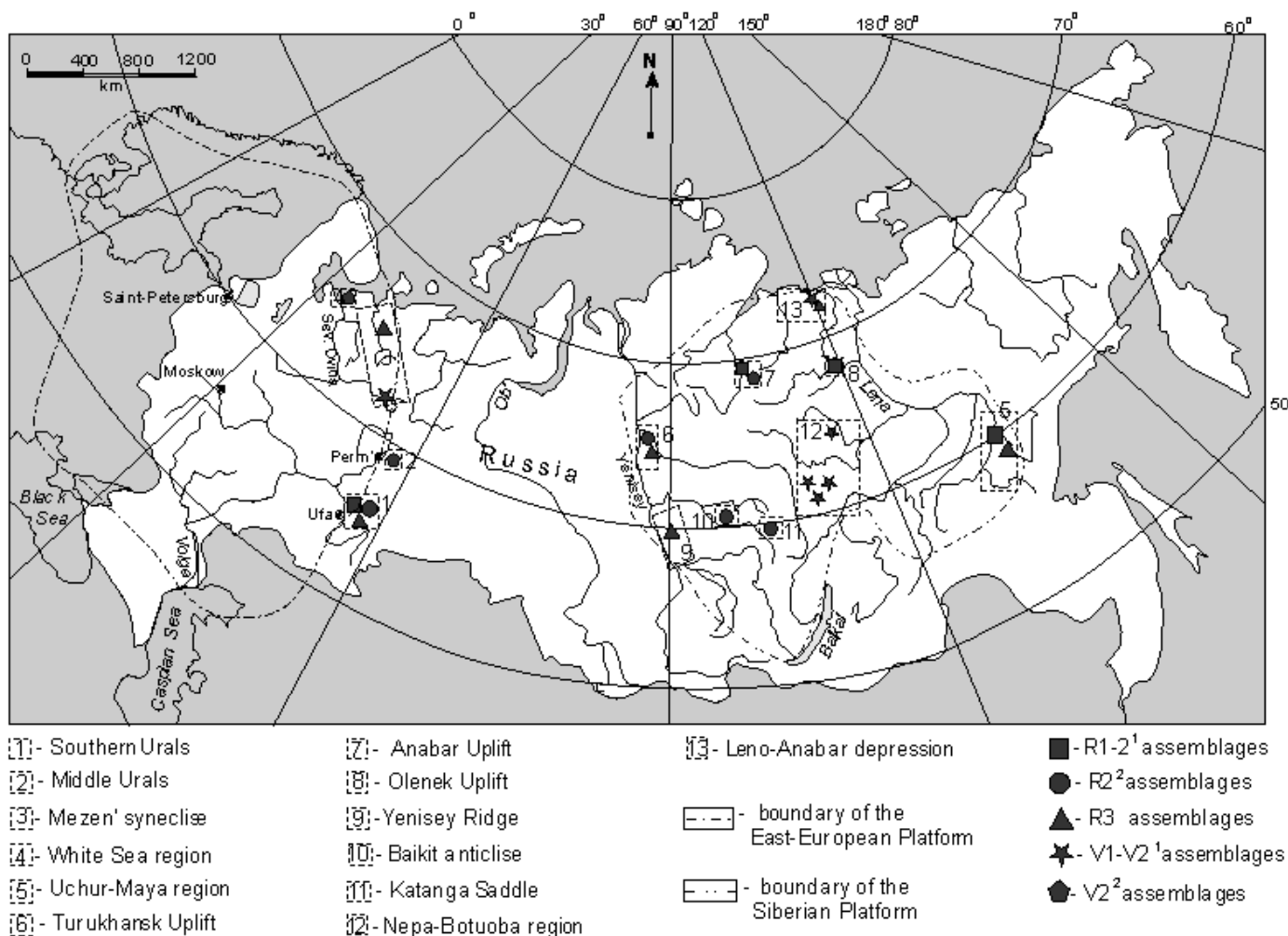
A long interval embracing the Early Riphean and the bulk of the Middle Riphean does not show much diversity in the microfossil populations.

The most representative assemblages of this age (1,650-1,250 Ma), all of them on the Siberian platform, are from the Billyakh Group of the Anabar Uplift (VEIS *et alii*, 2001; SERGEEV *et alii*, 1995 and others), the Kytingde and Debengda formations of the Olenek Uplift, and the Omackhta Fm of the Uchur-Maya region. But more diverse Early Riphean microbiotas were described from the Burzyan Group of the Bashkirian meganticlinorium, Southern Urals, adjacent to the East-European Platform.

These assemblages are dominated by cyanobacteria. The most common are the ellipsoidal akinetes *Archaeoellipsoides* (*Nostocaceae* or *Stigonemataceae*), chroococcacean cyanobacterium *Eoentophysalis* (*Entophysalidaceae*) and empty sheaths *Siphonophycus* (*Oscillatoriaceae* or *Nostocaceae*). In addition, the less abundant taxa of various cyanophyta such as *Circumvaginalis*, *Oscillatoriopsis*, *Filiconstrictosus*, *Partitiofilum*, *Palaeolyngbia*, *Eosynechococcus*, *Sphaerophycus*, *Myxococcoides* and some others occur in these assemblages. Although the representatives of *Archaeoellipsoides*, *Eoentophysalis* and *Siphonophycus* were reported from the older sediments (approximately 1,900-2,000 Ma) of the Belcher Supergroup and the Epworth Group of Canada, they became the dominant components of microbiotas only in the Early-Middle Riphean.

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**Figure 1:** Geographical locations of the most distinctive Upper Proterozoic microbiotas of Russia.

The list of common taxa present in these assemblages includes the following: *Leiosphaeridia*, *Eomarginata*, *Simia*, *Pterospermopsimorpha*, *Satka*, *Konderia*, *Germinosphaera*, *Palaeopleurocapsa* and others.

The most diverse organic-walled assemblage is from the Ust'-Il'ya and Kotuikan formations of the above-mentioned Billyakh Group (1,490-1,250 Ma). Here, in addition to cyanobacteria and the remains of what are probably eukaryotic microorganisms, there are large spherical forms of *Chuarina circularis* WALCOTT, 1899 (400-800  $\mu\text{m}$  in diameter), large filamentous fragments of *Elatera* (*Eosolena*) and spheroids bearing one long process (considered as reproductive structure of fungi or algae) of *Caudosphaera* (VEIS *et alii*, 2001).

### Microfossil assemblages of the terminal part of the Middle Riphean (R2<sup>2</sup>)

The uppermost Middle Riphean (1,250-1,000 Ma) is marked by the appearance of several new forms. The stalk-forming cyanobacterium *Polybessurus bipatitus* FAIRCHILD, 1975, ex GREEN *et alii*, 1987 occurs in silicified microbiotas from the Southern Urals and the

Turukhansk Uplift, Siberia (SERGEEV, 1994 and others). Among organic-walled microfossils the first appearances of the spherical striate eukaryote form *Valeria lophostriata* JANKAUSKAS, 1982 and of the spiral prokaryotes *Obruchevella* and *Glomovertella* are documented from the Katanga saddle, the Baikit syncline and the Patom Uplift of the Southern Siberia (NAGOVITSIN, 2001). The acanthomorphic acritarch *Tappania*, assigned by BUTTERFIELD (2005) to fungi, recently was reported from the uppermost Middle Riphean sediments of southwestern Siberia (NAGOVITSIN, 2001). *Tappania* was first described in the early Mesoproterozoic Ruyang Group of China (YIN, 1998) and the Roper Group of Australia (JAVAUX *et alii*, 2001) but differs in various aspects from the younger (~800 Ma) *Tappania* described by BUTTERFIELD (JAVAUX, pers. comm.). The branching multicellular talloms of *Ullophyton*, provisionally attributed by HERMANN (pers. comm.) to red algae, occur in the coeval strata of the Totta Fm in the Uchur-Maya region.

### The Late Riphean (R3) assemblages

The base of the Upper Riphean (approximately 1,000 Ma) is one of the most important levels in the evolution of Upper

Proterozoic microbiotas. This is expressed by incoming morphological innovations, including a remarkable increase in the diversity and size of eukaryotes.

The most distinctive and diverse microbiotas are known from the Uchur-Maya Region (the Lakhanda and Ui groups, HERMANN, 1981, 1990 and others), the Turukhansk Uplift (the Derevninya, Shorikha and Miroedikha formations, VEIS *et alii*, 1998; SERGEEV, 2001 and others) and the Yenisey Ridge (the Seryi Kluch and Dashka formations, NAGOVITSIN, 2000) of Siberia, from the Southern Urals (the Zil'merdak, Nugush, and Inzer formations, VEIS *et alii*, 2003 and others) and the Mesen' syncline (Vashkin Fm.) of the East-European Platform (VEIS *et alii*, 2004).

More than 50 species of microfossils are described from the Upper Riphean assemblages of Russia. The spherical acanthomorphic acritarch *Trachyhystrichosphaera* is of a particular interest, because it appears and

becomes common in the Upper Riphean assemblages of every region. In the Lakhanda biota from the Neryuen Fm of the Lakhanda Group (the Uchur-Maya region, eastern Siberia) diverse and abundant microorganisms belonging to fungi, algae and several problematic groups are known, including possible animals (HERMANN & PODKOVOYEV, 2002). Some taxa (*Eosacchoromyces*, *Mucorites* and *Mycosphaeroides*, HERMANN, 1990) are classified as fungi while some others have definite algal affinities. The latter include green algae, such as *Archaeoclada* (attributed to Siphonocladales), *Lomentunella* (probably belonging to Ulotrichales), *Palaeovaucheria* (assigned to Vaucheriales of a xanthophyte algae), and *Ulophyton* and *Bangiomorpha* interpreted as red algae (BUTTERFIELD, 2000). In the silicified Siberian microbiotas there are the coccoidal microfossils *Glenobotrydion*, *Palaeastrum* and *Myxococcoides* attributed to green algae of the order Chlorococcales (NAGOVITSIN, 2000 and others).

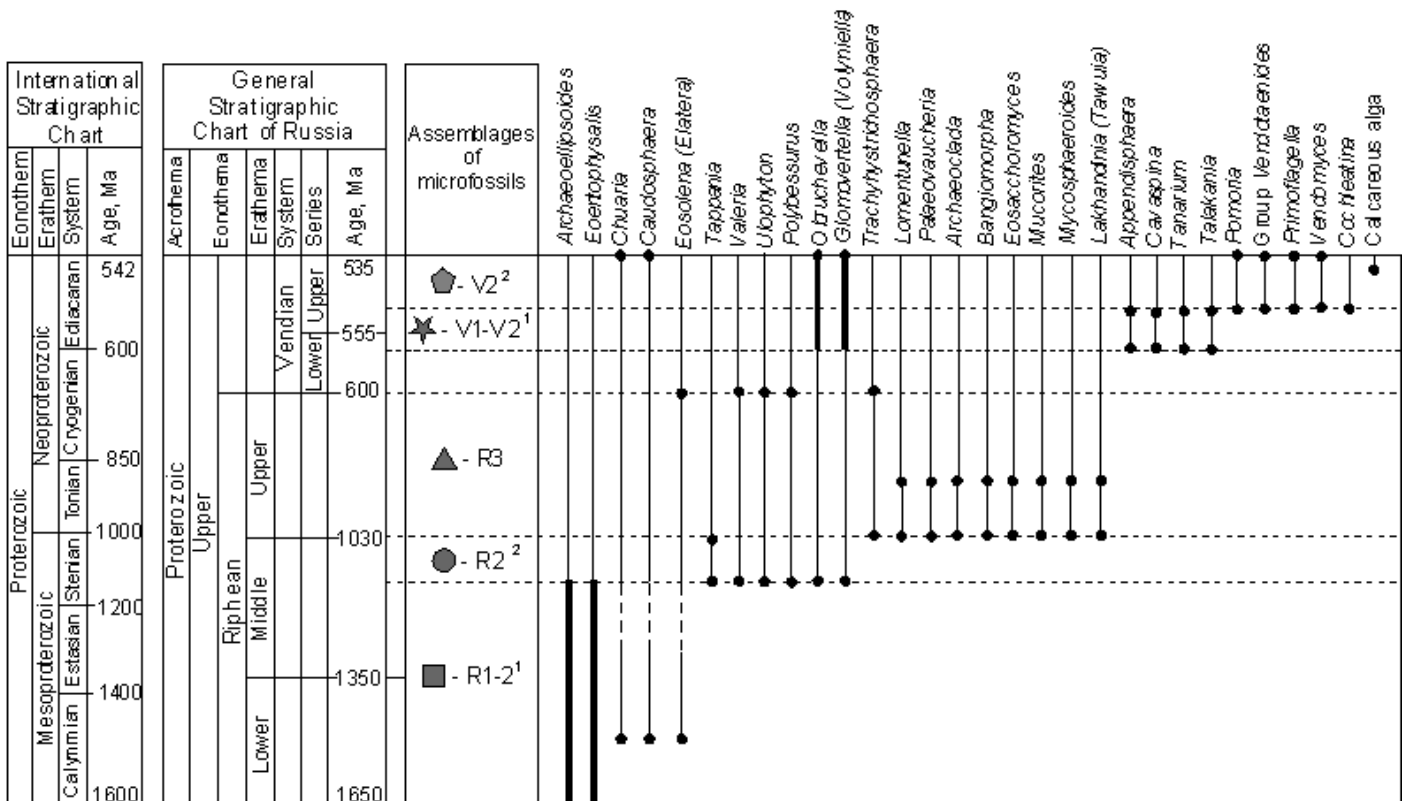


Figure 2: Cambrian acritarch-based biostratigraphy of the East-European Platform and stratigraphical positions of recorded acritarch data from the Siberian Platform.

### The Early? - Late Vendian (V1?-V2<sup>1</sup>) assemblages

The microfossil assemblages of Early? - Late Vendian age (0.6-0.55 Ma) are recorded from the Kursov and Parshin formations of the Nepa-Botuoba region and from the Turkut Fm of the Lena-Anabar depression of Siberia (RUDAVSKAYA & VASIL'eva, 1989; MOCZYDLOWSKA, 2004). There is but one report of what is probably a contemporaneous microbiota from the

Vychegota Fm of the Mesen' syncline, in the northeastern part of the East-European Platform (VEIS, pers. comm.). These assemblages are stratigraphically below the first appearance of Metazoa. The large spherical acritarchs (100 - 200 μm in diameter, probably green algae, MOCZYDLOWSKA, 2004), ornamented with various processes, are the most characteristic features of these assemblages. Among them species of the genera *Tanarium* (as *Goniosphaeridium*), *Cavaspina*,

*Appendisphaera* (as *Meghystrichosphaeridium*), *Ericiasphaera* and *Multifrosphaeridium* have been identified, as well as numerous algal filaments like *Talakania*, *Glomovertella* (= *Volyniella*) and *Obruchevella*.

### The Late Vendian (V2<sup>2</sup>) assemblages

The most representative Late Vendian microbiotas (0.55-0.535 Ma) in Russia are from the Redkin and Kotlin Horizons of the East-European Platform. They are also recorded from the Buton Fm of the Serebryan Group, Middle Urals (GOLOVENOK *et alii*, 1989) and from the White Sea region where strata also yielded an ediacarian macrofossil. In Siberia, late Vendian acritarch assemblages are documented from the Nemakit-Daldyn Fm of the Anabar Uplift (RUDAVSKAYA & VASIL'EVA, 1989). A diverse assemblage of silicified microfossils has been found in the Yudoma Group of the Uchur-Maya Region.

In contrast to the early Vendian assemblages, those of the younger Vendian are dominated by cyanobacteria: *Obruchevella* and *Glomovertella* (= *Volyniella*) are the most common. Filamentous algae *Pomorja rhomboidalis* (SIVERZEVA, 1985), SIVERZEVA, 1989, *Striatella coriaceae* ASSEJEVA, 1983, *Palaeolyngbia* sp., *Oscillatoriopsis* sp., *Siphonophycus* sp. and the rare small acritarch *Micrhystridium* are associated with the cyanobacteria. A typical Late Vendian taxon is *Cochleatina*. The name is apt for it describes chitinoid spirals with a complex morphology. In addition to those found on the east-European Platform, these fossils are recorded from the Nemakit-Daldyn Fm of the Anabar Uplift of Siberia and are interpreted as reproductive structures of algae adapted to subaerial environments (BURZIN, 1996). Late Vendian fungi are represented by *Vendomyces major* BURZIN, 1993, which had been assigned by BURZIN (1993) to Chytridiomycetes. This form occurs in the Khatyspyt Fm of the Olenek Uplift, in the Nemakit-Daldyn Fm of the Anabar Uplift of Siberia and in the Kotla Fm of northwestern Russia. Other characteristic components of the Late Vendian biotas are the macro remains of multicellular *Vendotaenia*, a formal group of Metaphyta and a specific bacterial organism *Primoflagella* attributed to Actinomycetes (GNILOVSKAYA, 1988). An important biological event of the uppermost Precambrian is the first appearance of calcareous algae, which in the Cambrian become one of the main bioherm-forming organisms of Siberia.

### Conclusions

The last compilation on Precambrian microphytofossils from the former Soviet Union by YANKAUSKAS *et alii* (1989) provided descriptions of more than 300 species assigned to 150 genera, and suggested recognition of three main epochs in their evolution: the Early-

Middle Riphean, Late Riphean and Vendian. Since that time there have been many new finds of rich microbiotas previously unknown in Russia. Taxonomical concepts have changed slightly and the stratigraphical distribution of characteristic taxa had been modified. Although the suggested biological affinities of many of the acritarchs cited above remain to be confirmed, the Upper Proterozoic strata of Russia contain a very rich record of the evolution of the early biosphere, thus permitting the recognition and definition of five stratigraphical levels (R1-R2<sup>1</sup>, R2<sup>2</sup>, R3, V1?-V2<sup>1</sup> and V2<sup>2</sup>) each characterized by the appearance of new taxa.

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