Diversity and distribution of Cambrian acritarchs from the Siberian and East-European platforms - a generalized scheme

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[Diversité et distribution des acritarches du Cambrien des plates-formes sibérienne et européenne de l'Est - un modèle général]

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Key Words: Acritarchs; Cambrian; East-European Platform; Siberian Platform; East-European and Siberian platforms

RAEVSKAYA E. (2005).- Diversity and distribution of Cambrian acritarchs from the Siberian and East-European platforms - a generalized scheme. *In*: STEEMANS P. & JAVAUX E. (eds.), Pre-Cambrian to Palaeozoic Palaeopalynology and Palaeobotany.- Carnets de Géologie / Notebooks on Geology, Brest, Memoir 2005/02, Abstract 07 (**CG2005_M02/07**)

Mots-Clefs : Acritarches ; Cambrien ; plate-forme européenne de l'Est ; plate-forme sibérienne ; plates-formes européenne de l'Est et sibérienne

Introduction

The study of acritarchs in Russia was initiated by NAUMOVA and TIMOFEEV in the early 50s. Their initial results showed the high potential of these microfossils for biostratigraphy and was followed by a remarkable degree of research activity in the 70s-80s. During a period of more than 50 years a great quantity of material was collected from different regions of Russia and especially from the two platforms: Siberian and East-European. However, in contrast to the East-European Platform material which provided comprehensive data for the high resolution biostratigraphy for the all three Cambrian Series, data from the Siberian Platform did not furnish comparable results. The present work is intended to clarify this situation and to draw up a general scheme of acritarch distribution for the whole of the Cambrian in both regions.

Published data and information available from unpublished scientific reports on Cambrian microfossils from Russia and from former Soviet territories have been combined here (Fig. 1.A).

The East-European Platform (EEP)

Acritarchs from the Cambrian of the EEP are well studied (TIMOFEEV, 1959; VOLKOVA, 1973, 1983, 1990, VOLKOVA *et alii*, 1979; PAŠKEVIČIENĖ, 1980 and many others). They are rather abundant and well preserved in siliciclastic sequences of clays, siltstones and sandstones (Fig. 1.B) throughout the entire Cambrian succession. The best studied sections are from the Moscow syneclise (Yaroslavl' region), from the north (Vologda, Arkhangelsk regions) and northwest (St.-Petersburg, Pskov, Kaliningrad regions) of Russia, from the Baltic States, from Belorussia and from Volyno-Podoliya of the Ukraine (Fig. 1.A). Although acritarch bearing strata in some sequences are separated by depositional breaks and come from discrete areas it is possible to draw up a succession of 15 consecutive assemblages correlative with the trilobite zonation of Baltica (VOLKOVA, 1973, 1990; VOLKOVA *et alii*, 1979; VOLKOVA & KIR'JANOV, 1995; JANKAUSKAS & LENDZION, 1992). Four assemblages are distinguished in the Lower Cambrian, four are recognized in the Middle Cambrian and seven acritarch assemblages are differenciated in the Upper Cambrian (Fig. 2). Although the succession is incomplete it is the most informative representation of phytoplankton evolution for the entire Cambrian.

The oldest Cambrian acritarch assemblage differs little taxonomically from the Vendian representatives. Generally, small, morphologically simple sphaeromorph acritarchs in association with filamentous cyanophyta are present here. The base of the Early Cambrian is recognized by the appearance of two characteristic forms *Granomarginata* and *Leiomarginata*. Definite change in the content of phytoplankton communities is related to the appearance of diverse acanthomorph acritarchs at the level of the first appearance of trilobites. Several new genera, such as *Skiagia*, *Baltisphaeridium* (as *Globosphaeridium* and *Heliosphaeridium*), *Multiplicisphaeridium*, *Estiastra* and some others appear first during the Early Cambrian. In order to determine the true extent of both species diversity and evolutionary trends in the Early Cambrian acritarchs of Russia a serious systematic revision is needed. With the exception of the basal Early Cambrian, none of the filamentous algae, fungi and other microorganisms characteristic of the Precambrian microfossil communities are present in younger Cambrian acritarch assemblages.

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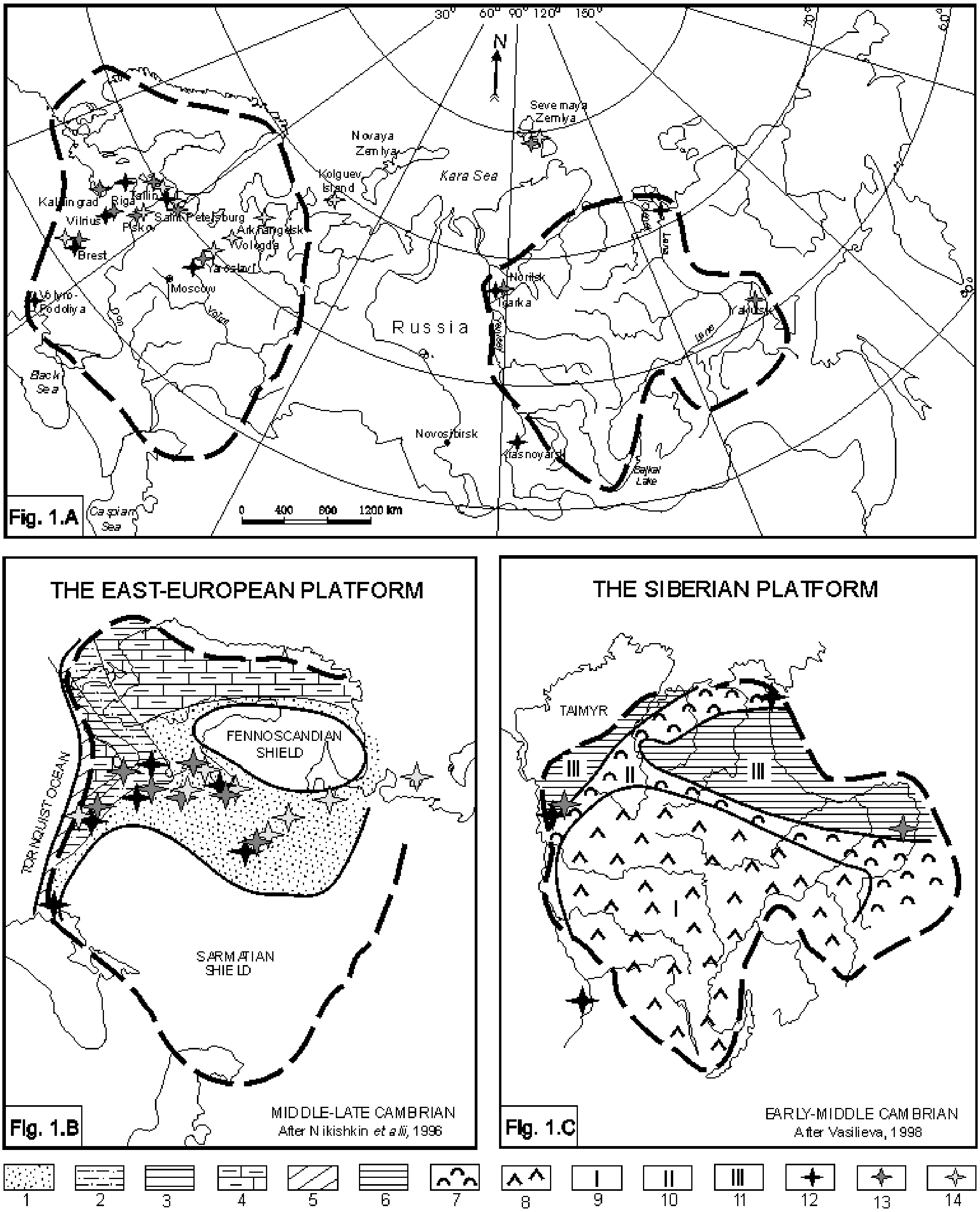

Figure 1: 1.A. Geographic location of Cambrian acritarch assemblages analyzed in this paper. **1.B-C.** Schematic sketch of facies zonation in the East-European and Siberian sedimentary basins during the Cambrian. Legend: 1- near-shore sands and shales, 2- shallow-marine sands and shales, 3- shales and sands, 4- carbonates, 5- continental slope, 6- relatively deep-water clayey limestones, 7- biohermal limestones and dolomites, 8- shallow-water dolomites, anhydrites and salts, 9- southwestern carbonaceous-evaporite basin, 10- intermediate biohermal basin, 11- northeastern normal marine basin, 12- Early Cambrian acritarch assemblages, 13- Middle Cambrian acritarch assemblages, 14- Late Cambrian acritarch assemblages.

Most of Early Cambrian taxa, including *Skiagia* disappear in the Middle Cambrian. They are replaced by herkomorph acritarchs which became dominant components in subsequent phytoplankton assemblages. *Adara*, *Eliasum*, *Cristallinium*, *Dictyotidium*, *Retisphaeridium* and

Timofeevia are the most common genera. More than 40 acritarch species have been identified at the base of the Middle Cambrian (VOLKOVA, 1990).

Diversity and abundance of phytoplankton continue to increase gradually during the Late Cambrian. Here, the number of identified taxa is at least four times greater than that of the Middle Cambrian. The first triangular forms and forms with large openings (*Cymatiogalea*, *Stelliferidium*) occur in the the lower-middle part of the Upper Cambrian. The last portion of the Upper Cambrian is characterized by a great number of morphological varieties in acritarchs, especially those with bipolar ornamentation (*Acanthodiacrodium*, *Actinotodissus*, *Arbusculidium*, *Dasydiacrodium*, *Lophodiacrodium*, *Schizodiacrodium*, *Dicrodiacrodium*, *Buchinia*, *Ladogella*, *Nellia*, *Lusatia*, *Ooidium* and *Trunculumarium*). Other genera such as *Impluviculus*, *Vulcanisphaera*, *Saharidia*, *Elenia*, *Calyxiella*, *Izhoria* and many others also characterize upper Cambrian assemblages in the EEP.

The Siberian Platform

Three discrete facies belts are recognized in the Cambrian of the Siberian Platform (Fig. 1.C). They are: a southwestern carbonaceous-evaporite zone, a northeastern normal marine zone and an intermediate biohermal zone. The first occupies about two-thirds of Siberia and is dominated by shallow water dolomites, anhydrites and salts. The northeastern basin was comparatively deep. Here clayey limestones were the major accumulation. In the intermediate zone dolomites and biohermal limestones predominate. The occurrence of phytoplankton in Siberia is strongly controlled by these facies. Cambrian sediments in the southwestern shallow water evaporite basin do not yield acritarchs. Assemblages from southern Siberia, known in literature as Vendian-?Early Cambrian (RUDAVSKAYA, 1964, 1985) were subsequently dated as undoubtedly Vendian (FAIZULLIN, 1996; MOCZYDLOWSKA *et alii*, 1993). The earliest Cambrian acritarch assemblages are recorded from the southwestern marginal trough in the Mana depression of the Krasnoyarsk region (PYATILETOV, 1976). They include *Granomarginata*, *Leiomarginata*, *Micrhystridium*, *Baltisphaeridium* and are correlated with the oldest Cambrian assemblages of the EEP, *i.e.* with the collection from the Lontovaskiy Horizon (Fig. 2) and possibly with the succeeding younger one. However, the validity of the correlation is problematic. First, the appearance of the two first-mentioned taxa in the EEP is documented as being at the base of the Cambrian. But in Siberia these forms are present in strata definitely of Vendian age. A second difficulty is probably due to confusion regarding systematics along with differing interpretations regarding the taxonomics of East-European and Siberian taxa. The Lena-Olenek area of the intermediate facies belt of Siberia (Fig. 1.C) is the only locality where two consecutive undoubted Early Cambrian acritarch assemblages have been established (RUDAVSKAYA, unpublished; VASIL'EVA & RUDAVSKAYA, 1989; FAIZULLIN, 1996). They are interpreted as representing the "Lontovaskiy" and "Talsinskiy" types of the EEP assemblages (Fig. 2).

Only poor acritarch data mainly of leiosphaerids are known from the upper Lower Cambrian sediments of the Igaro-Norilsk region (MIKHAILOVA, 1987), in the northeastern facies zone of Siberia (Fig. 1.C).

Middle Cambrian species, identified as *Baltisphaeridium kenkemense* RUDAVSKAYA 1978, *Baltisphaeridium* spp., occur in rather poor, almost monospecific associations at the upper limit of the Siberian Amgian Stage in the Yakutsk region (RUDAVSKAYA & KOKOULIN, 1978) and from the Mayan Stage in the Igaro-Norilsk region (MIKHAILOVA, 1987).

Nothing has yet been published on Upper Cambrian acritarchs from Siberia.

Conclusions

It is evident that one of the main reasons for the conspicuous difference in the quantity of acritarch data from the East-European and Siberian platforms is Cambrian palaeogeography (LI & POWELL, 2001). The discrete palaeolongitudinal positions of the two platforms caused sedimentation to differ in the two palaeobasins. The EEP, a part of Baltica, was situated at about 30°S palaeolatitude in the Early Cambrian (530 Ma) and between 30°S and 60°S in the Late Cambrian (505 Ma). There, in a relatively cool climate, thick siliciclastic sequences accumulated. These sediments are favorable to the growth of acritarchs and their preservation. On the other hand, although the original south latitude was about the same for both basins during the Early Cambrian, Siberia drifted towards the equator, where in a warm climate carbonaceous and evaporitic rocks were deposited. Dolomites, anhydrites, and salts, which are widely distributed on the Siberian Platform, do not contain acritarchs. Another reason for the limited records concerning the acritarchs of Siberia is the inadequate study of deep water facies there. Middle and Upper Cambrian strata have not been studied adequately, because for many years the main interest of acritarchologists working in Siberia was the study of the Precambrian-Cambrian boundary interval. To develop our ideas about Cambrian phytoplankton diversity and distribution on the Siberian Platform more palynological investigations are necessary.

Global Standard		East-European Platform North-western part of Russia and Moscow sineclise			
System	Series	Zones	Horizons	Acritarch assemblages (Volkova, 1973, 1990; Volkova et alii, 1976; Volkova and Kirjanov, 1995)	
CAMBRIAN	Upper	*Acerocare*			
		Peltura: *Peltura scarabaeoides*	Ladozhskiy	VK4B	*Izhoria angulata*, *Ooidium rossicum*, *Arbusculidium destombesii*, *Nellia* spp, *Calyxiella izhoriensis*, *Vogtlandia notabilis*, *Schizodiacrodium* spp.
		Peltura: *Peltura minor*; *Protopeltura praecursor*	Volodarskiy	VK4A	*Impluviculus villosiusculus*, *Lusatia dendroidea*
		Leptoplastus	Tsitretskiy	VK3	*Acanthodiacrodium* spp., *Lusatia* sp. *Polygonium* sp., *Trunculumarium revinium*
		Parabolina spinulosa	Vorchinskiy	VK2B	*Dasydiacrodium caudatum*, *Stellechinatum uncinatum*
				VK2A	*Veryahium dumontii*, *Stelliferidium cortinulum* *Impluviculus multiangularis*
		Olenus	Volitskiy	VK1B	*Cymatiogalea* spp., *Stelliferidium* spp.
		Agnostus pisiformis	Tolbukhinskiy	VK1	*Timofeevia pentagonalis*, *Vulcanisphaera turbata*
	Middle	*Paradoxides forchhammeri*	Lukovskiy	SK2	*Timofeevia phosphoritica*, *T. lancarae*, *Cristallinuim dubium*, *Comasphaeridium* spp., *Aranidium* sp.
				SK2A	
		Paradoxides paradoxissimus	Veselovskiy	SK1	*Adara* sp., *Eliasum* sp.,*Cristallinium cambriense*, *Celtiberium?* sp., *Retisphaeridium* spp.
		Eccaparadoxides: *E. prinus*		?	
		Eccaparadoxides: *E. insularis*	Kibartaiskiy	KB	*Cristallinium* sp., *Baltisphaeridium pseudofaveolatum*, *B. latviense*, *Lophosphaeridium variabile*, *Liepaina plana*, *Micrhystridium notatum*
	Lower	*Protolenus*	Rausvenskiy	NK5	*Volkovia dentifera*, *Eliasum llaniscum*, *Multiplicisphaeridium* sp., *Skiagia insigne*
		Holmia kjerulfi	Vergalskiy	NK4	*Baltisphaeridium dissimilare*, *Micrhystridium* spp., *Estiastra minima*
		Holmia mickwitzi	Lukatinskiy (Talsinskiy)	NK3	*Baltisphaeridium cerinum*, *Skiagia compressa*, *S. ornata*, *Archaeodiscina* sp.
		Platysolenites	Lontovaskiy	NK2	*Granomarginata prima*, *G. squamacea*, *Leiomarginata simplex*, *Tasmanites* sp. *Asteridium*, *Comasphaeridium*
V		*Sabellidites vendotaenia*	Rovenskiy	NK1	*Leiosphaeridia* spp., *Micrhystridium tonarium*

* taxonomy needs to be revised

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

Global Standard		Siberian Platform				
System	Se ies	Regional Stages		Horizons (North-East Siberia)	Acritarchs: Assemblages (Pyatiletov, 1976; Rudavskaya, 1985; Rudavskaya and Vasilieva, 1985)	Acritarchs: Records (Timofeev, 1966; Rudavskaya, 1978; Mikhailova, 1987)
CAMBRIAN	Upper		Aksayan	Ketyjskiy		
				Jurakijskiy		
			Saksian	Encijskiy		
				Maduiskiy		
			Ayusokanian	Tavgijskiy		
				Nganasanskiy		
	Middle		Mayan	Siligirskiy		
				Dzhakhtarskiy		
				Olenekskiy		*Baltisphaeridium kenkemense*, *B.* sp.*
			Amgan	Suorbalakhskiy		
				Salankanskiy		
				Torkukujskiy		
				Kyranskiy		
	Lower	Lenian	Toyonian	Elanskiy		*Lophosphaeridium* sp., *Micrhystridium* sp., *Leiosphaeridium* sp.
				Ketemenskiy		
			Botoman	Kutorginovy		
				Sinskiy		
				Tarynskiy		
		Aldanian	Atdabanian	Attdabanskiy	"Talsinskiy"	
			Tommotian	Kenyadinskiy		
				Sunnaginskiy	"Lontovaskiy"	
V						

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