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Paleontology

Biodiversity of Sarmatian Foraminifera of the Eastern Paratethys

Lamara Maissuradze*, Kakhaber Koiava**

* *The Georgian National Museum, L. Davitashvili Institute of Paleobiology, Tbilisi*
** *Alexandre Janelidze Institute of Geology, Tbilisi*

(Presented by Academy Member Abesalom Vekua)

ABSTRACT. Three important stages were distinguished in the development of Sarmatian foraminifera of the Ponto-Caspian basin of Eastern Paratethys: the early, which reflects the process of formation of foraminiferal assemblages; the middle – the time of their maximum diversification; the late, when almost all groups of foraminifera disappeared. All three stages are characterized by peculiar foraminiferal assemblages, whose distribution was controlled by different bionomic conditions in the separate regions of the huge Sarmatian basin. © *2011 Bull. Georg. Natl. Acad. Sci.*

Key Words: *Sarmatian, micropaleontology, foraminifera, Paratethyan.*

The orogenic processes, which took place in the Late Konkian led to drastic changes in marine biota during the Sarmatian [1]. A restriction of the connections between the Paratethys and the open ocean occurred at the beginning of this time. In particular the connection with the Indo-Pacific disappeared [1, 2]. The Late Konkian basin was replaced by the large, brackish isolated Sarmatian basin, which had temporary connection with the Mediterranean Sea (Fig. 1).

The Sarmatian Sea occupied the territory from the Alps to the Aral Sea and was composed of basins with different bionomic conditions: Pannonian, Dacian, Euxinic and Caspian basins. The Pannonian basin was connected to the Dacian basin via the Trans-Carpathian strait, and the Dacian basin was connected to the Black Sea basin, and from there, to the Caspian Sea. The Euxine Sea in the southwest was surrounded by the large Aegean Sea [3].

For the first time the Sarmatian stage of the Central Paratethys was established by Suess [4] which later was divided into three substages from the base to the top [5, 6]: Volhynian, Bessarabian and Khersonian. At present on the territory of Western and Central Paratethys Sarmatian "*sensu stricto*" [7] that corresponds to Volhynian and Lower Bessarabian is distinguished, while Sarmatian "*sensu lato*" of the Eastern Paratethys corre-

Fig. 1. Outline of the Paratethys-Mediterranean region during the Late Miocene (according to Rögl, 1998).

Table 1.

Stratigraphic scheme of Middle and Late Miocene interval.

Berggren et al., 1995		Rögl, 1998	Nevesskaya et al., 1986 Trubikhin, 1989	
Time (Ma)	Mediterranean Stages	Central Paratethys	Eastern Paratethys	
10	Tortonian	Pannonian	Meotian	
			Sarmatian s.l.	Upper (Khersonian)
	11.0			Middle (Bessarabian)
	Serravallian	Sarmatian s.s.		Lower (Volhynian)
14		Badenian	Konkian	

sponds to the Volhynian, Bessarabian and Khersonian substages (Table 1).

The study of foraminiferal assemblages is essential for understanding the paleoenvironmental and paleogeographical evolution of the Eastern Paratethys in the Sarmatian. In the Eastern Paratethys only some species of some genera of foraminifera from Veseliankian (Upper Konkian) basin continued into the Sarmatian. However, during this time they underwent strong morphological changes. This prevents a reliable identification of their ancestors. The evolution of the Sarmatian foraminifers in the Ponto-Caspian basin was accomplished in three stages: (1) during the first stage Lower Sarmatian foraminiferal assemblages were established, (2) during the second stage they reached their maximum diversification and (3) in the final stage almost all the groups of Foraminifera except some of the most euryhalian species disappeared in the Eastern Paratethys. The three stages are characterized by peculiar foraminiferal assemblages (Plate 1; 2) controlled by different environmental conditions in the different basins [8-13].

The cause for the drastic changes in the marine biota during the Sarmatian basin is still being debated. According to Kolesnikov [3], a large amount of freshwater possibly drained from rivers, whose mass prevailed over the mass of evaporate moisture, discharging into the Eastern Paratethys in the Early Sarmatian. The isolation of the basin and the flow of the large amount of freshwater caused a strong decrease in salinity.

A more recent study of Piller & Harzhauser [14] suggests that brackish water conditions in the Sarmatian basin of Paratethys were not constant. The Sarmatian may be subdivided into at least two stages: a short Early Sarmatian period of normal marine, probably mixohaline conditions in marginal areas, and a longer Late Sarmatian period of normal marine, occasionally hypersaline conditions. Their interpretation is based on the normal marine fauna and flora (which as a whole include foraminifera, molluscs, serpulids, bryozoans, dasycladaceae, corallinacean algae and diatoms), present in the Sarmatian deposits of the Central Paratethys.

In the opinion of the authors of this article, such supposition is subject to discussion, because the volume of deposits of Sarmatian basins of Eastern Paratethys, the composition of fossil fauna and flora and the process of their development were quite different from the picture obtaining in Central Paratethys [9, 11, 12].

According to the data of Maissuradze and Koiava [9, 12], the Early Sarmatian is characterized by two phases: (1) In the lower part of the Early Sarmatian foraminiferal assemblages are characterized by *Quinqueloculina, Sinuloculina, Varidentella, Affinetrina, Nonion, Elphidium, Cribroelphidium, Porosononion, Parellina and Ammonia. Bolivina, Discorbis, Bulimina, Glabratella, Cibicides* and *Fissurina* are relatively rare (Table 2a; 2b; 2c). Their morphology does not differ noticeably from that displayed by their Middle Miocene ancestors. These forms are also characterized by small sizes, and sometimes, transparent walls. (2) Assemblages from the upper part of the Early Sarmatian are characterized by a reduced diversity because of the disappearance of *Bolivina, Discorbis, Glabratella, Cibicides, Caucasina* (Table 2a; 2b; 2c). Nevertheless, a large number of genera survived and adapted to the new environment. They are characterized by a strong intraspecific variability and a potential for speciation.

The Middle Sarmatian can be subdivided into 3 phases: (1) The lower phase is characterized by foraminiferal assemblages very different from those observed in the Early Sarmatian. New genera such as *Dogielina, Meandroloculina,* and *Sarmatiella,* contributed a considerable number of new species. Foraminifers of these assemblages are characterized by large size. (2) The richest assemblages of endemic foraminifera are characteristic of the middle phase of the Middle Sarmatian, when the number of individuals and new species and their size reaches a maximum. (3) The last phase of the Middle Sarmatian is distinguished for a decrease in the abundance of foraminiferal genera, species and individuals. Because of the worsening of bionomic conditions the only very few representatives of the most euryhaline families survived: *Nonion, Elphidium, Porosononion, Ammonia* and very seldom *Affinetrina*, and *Varidentella*. Among them *Porosononion* is characterized by a large size and additional ornamentations on very coarse walls of tests [9, 11, 12].

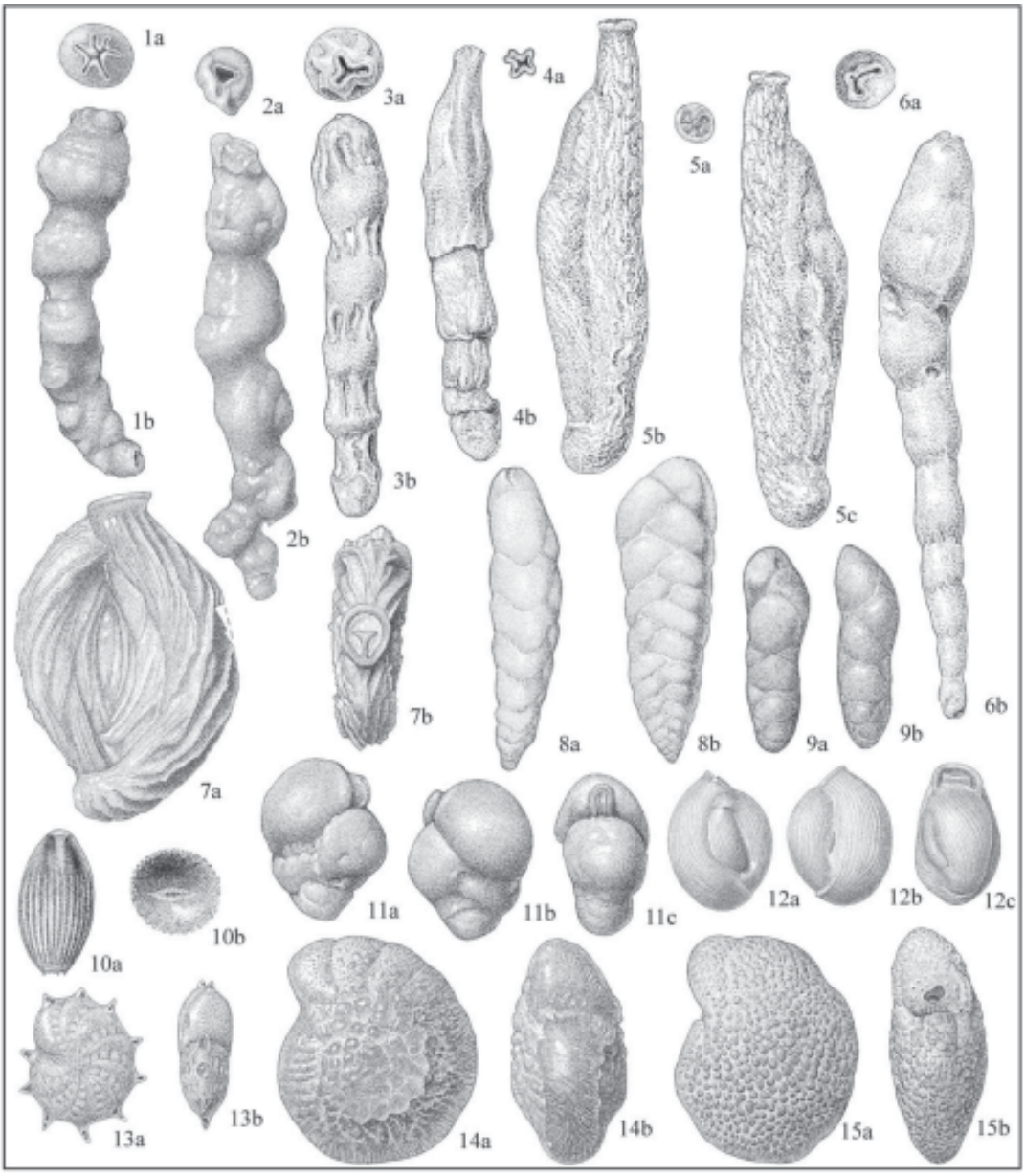

Plate 1. Sarmatian foraminifera. **1a-b** *Meandroloculina minor* Bogdanowicz, outcrop Ochkhamuri village, a x 47, b x 65; **2a-b** *Meandroloculina gracilis* Bogdanowicz, outcrop Ochkhamuri village, a x47, b x65; **3a-b** *Sarmatiella costata* Bogdanowicz, outcrop Djikhashkari village, a x 45, b x 65; **4a-b** *Articulina kalickii* Bogdanowicz, outcrop Djikhashkari village, a x 45, b x 65; **5a-c** *Dogielina sarmatica* Bogdanowicz, outcrop Djikhashkari village, a,b x 45, c x 65; **6a-b** *Sarmatiella subtilis*, Bogdanowicz, outcrop Djikhashkari village, a x 45, b x 65; **7a-b** *Spiroloculina okrajantzi* Bogdanovwicz, outcrop river Chanistskali, x 45; **8a-b** *Bolivina* aff. *dilatata* (d'Orbigny), outcrop river Chanistskali, x 45; **9a-b** *Bulimina* aff. *elongata* (D'Orbigny), outcrop village Ochkhamuri, x 65; **10a-b** *Oolina cubanica* (Bogdanowicz), outcrop Ochkhamuri village, x 100; **11a-c** *Meandroloculina dentifera* (Bogdanowicz & Maissuradze), outcrop Ochkhamuri village, x 45; **12a-b** *Varidentella reussi* costulata Maissuradze,Koiava&Spezzaferri, outcrop Ochkhamuri village, x 45; **13a-b** *Elphidium aculeatum* (d'Orbigny), outcrop Djgali village, x 47; **14a-b** *Porosononion hyalinum* Bogdanowicz, outcrop river Chanistskali, x 45; **15a-b** *Porosononion aragviensis*, Djanelidze, outcrop Ochkhamuri village, x 35. All specimens from West Georgia.

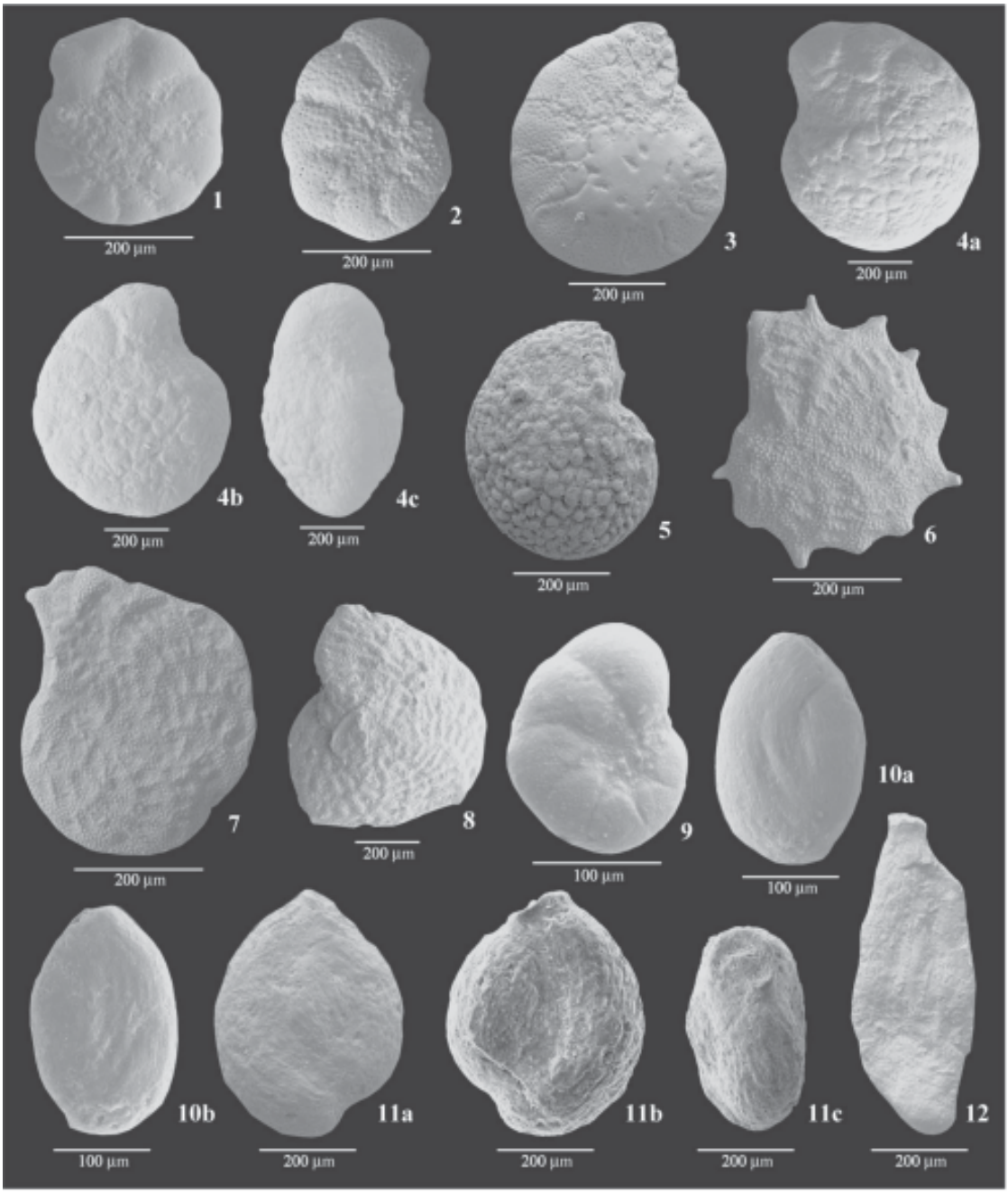

Plate 2. Sarmatian foraminifera. **1.** *Porosononion* aff. *guriensis* O. Djanelidze, oil well Karas-1; **2.** *Porosononion granosum* (d'Orbigny); **3.** *Porosononion hyalinum* (Bogdanowicz), oil well Mtsarekhevi-74. **4a-c.** *Porosononion subgranosum* (Egger), oil well *Karas-1;* **5.** *Porosononion aragviensis* (O. Djanelidze), outcrop city of Mtskheta; **6.** *Elphidium aculeatum* (d'Orbigny), outcrop river Russiani; **7.** *Elphidium fichtelianum* (d'Orbigny), outcrop river Russiani; **8.** *Elphidium regina* (d'Orbigny), oil well Vashliani-10; **9.** *Nonion* aff. *bogdanoviczi* Voloshinova, oil well Vashliani-10; **10a-b.** *Affinetrina guriana* (O. Djanelidze), oil well Karas-1; **11a-c.** *Varidentella* aff. *reussi* (Bogdanowicz), outcrop river Satskhenisi; **12.** *Dogielina sarmatica* Bogdanowicz, oil well Vashliani-2. All specimens from East Georgia.

Table 2a.

Distribution of Sarmatian foraminifera of the Euxine-Caspian basins.

Species	Age	Geographic Distribution				
		WGEO	EGEO	UKR	MDA	WPC
Quinqueloculina oblonga Didkowsky	N_1s_2			●	●	
Q. grosniensis Bogdanowicz	N_1s_2		●	●	●	
Q. laticostata Didkowsky	N_1s_2			●	●	
Q. longuscola Didkowsky	N_1s_2			●		
Q. collaris (Gerke&Issaeva)	N_1s_1	●	●	●	●	●
Q. minakovae ukrainica Didkowsky	N_1k			●		
Q. arkuata (Didkowsky&Gudina)	N_1s_2			●	●	
Q. sinzovi Didkowsky	N_1s_2			●	●	
Q. sokolovi Didkowsky	N_1s_2			●	●	
Cycloforina karreri Reuss	N_1s_1 - N_1s_2	●	●	●	●	●
C. karreri ovate Serova	N_1s_2			●		
C. perlucida Bogdanowicz	N_1s_2		●			●
C. costata d'Orbigny	N_1s_1			●		
C. odessae Didkowsky	N_1s_2			●		
C. fluviata Venglinsky	N_1s_1 - N_1s_2			●	●	
C. stomata Luczkowska	N_1s_2		●			
C. badenensis (d'Orbigny)	N_1s_2		●			
C. contora (d'Orbigny)	N_1s_2		●			
C. rotunda (Gerke)	N_1s_1 - N_1s_2			●		
C. complanata (Gerke&Issaeva)	N_1s_2	●	●	●	●	●
Articulina problema Bogdanowicz	N_1s_1 - N_1s_2	●	●	●	●	●
A. sarmatica (Karrer)	N_1s_1		●	●		●
A. tamanica Bogdanowicz	N_1s_1	●	●	●		●
A. bidentata costata Didkowsky	N_1s_2		●	●	●	
A. glabra (Cushman)	N_1s_2			●	●	
A. monodentata sarmatica Didkowsky	N_1s_1 - N_1s_2			●	●	
A. apsheronica Bogdanowicz	N_1s_2	●	●	●	●	●
A. paradoxalis Bogdanowicz	N_1s_2	●	●	●	●	●
A. kalickii Bogdanowicz	N_1s_2		●	●	●	●
A. stelligera Didkowsky	N_1s_1 - N_1s_2			●		
A. volhynica Didkowsky	N_1s_2			●		
A. voloshinovae Bogdanowicz	N_1s_1 - N_1s_2	●	●			●
Articularia articulinoides (Gerke&Issaeva)	N_1s_1	●	●	●		●
Flintina tutkowskii Bogdanowicz	N_1s_2	●		●		●
F. volhynica Didkowsky	N_1s_2			●	●	
F. schweyeri Bogdanowicz	N_1s_2		●	●		●
Sarmatiella costata Bogdanowicz	N_1s_2		●	●	●	●
S. moldowiensis Bogdanowicz	N_1s_2	●	●	●	●	●
S. prima Bogdanowicz	N_1s_2	●		●		●
S. subtilis Bogdanowicz	N_1s_2		●	●	●	●
Dogielina sarmatica Bogdanowicz&Voloshinova	N_1s_2	●	●	●	●	●
D. kaptarenko Bogdanowicz&Didkowsky	N_1s_2	●		●	●	●
Sinuloculina consobrina (d'Orbigny)	N_1k - N_1s	●	●	●	●	●
S. consobrina sarmatica (Gerke)	N_1s_1	●	●	●	●	●
S. angustioris Bogdanowicz	N_1s_2	●	●	●	●	●
S. nitens (Reuss)	N_1s_1 - N_1s_2	●	●	●	●	●
S. delicatula Kolesnikova	N_1s_2	●	●	●		●
S. consobrina plana Voloshinova	N_1s	●	●	●	●	●
Miliolinella ex. gr. *circularis* (Bornemann)	N_1s_1 - N_1s_2		●	●		●

WGEO - Western Georgia; **EGEO** - Eastern Georgia; **UKR** - Ukraine; **MDA** - Moldova; **WPC** - Western Precaucasus; E_1 - **Rec.** - Paleocene to Recent; E_2 - **Rec.** - Eocene to Recent; E_1 - N_2 - Paleocene to Pliocene; E_3^2 - N_1S_2 - Late Oligocene to Middle Sarmatian; N_1 - Miocene; N_1 - **Rec.** - Miocene to Recent; N_1k - Konkian; N_1k - N_1s - Konkian to Sarmatian; N_1k - N_1s_1 - Konkian to Upper Sarmatian; N_1s - Sarmatian; N_1s_1 - Upper Sarmatian; N_1s_1 - N_1s_2 - Upper and Middle Sarmatian; N_1s_2 - Middle Sarmatian; N_1s_2-**Rec.** - Middle Sarmatian to Recent.

Table 2b.

Distribution of Sarmatian foraminifera of the Euxine-Caspian basins.

Species	*Age*	*Geographic Distribution*				
		WGEO	EGEO	UKR	MDA	WPC
Meandroloculina litoralis Bogdanowicz	N_1s_2	●	●	●	●	●
M. bogatschovi Bogdanowicz	N_1s_2		●	●		●
M. minor Bogdanowicz	N_1s_2		●	●	●	●
M. aculeata Bogdanowicz	N_1s_2		●	●		●
M. gracilis Bogdanowicz	N_1s_2	●	●	●		●
M. schirwanensis Bogdanowicz	N_1s_2	●		●		●
M. conicocamerale Bogdanowicz	N_1s_2	●	●	●		●
M. dentifera Bogdanowicz&Maissuradze	N_1s_2		●			●
Affinetrina guriana (O. Djanelidze)	N_1k - N_1s	●	●	●	●	
A. cubanica (Bogdanowicz)	N_1s	●		●		●
A. ucrainica ucrainica (Serova)	N_1s			●		
A. ucrainica siwashica (Didkowsky)	N_1s_1 - N_1s_2			●	●	●
A. ucrainica sarmatica (Didkowsky)	N_1s_2		●	●	●	
A. voloshinovae voloshinovae (Bogdanowicz)	N_1s_2	●	●	●	●	●
A. voloshinovae timenda (Chutzieva)	N_1s_2		●	●		●
A. voloshinovae caudata (Bogdanowicz)	N_1s_2	●	●	●		●
A. voloshinovae brevidentata (Bogdanowicz)	N_1s_2		●	●		●
A. voloshinovae eldarica Maiss.,Koiava&Spezzaferri	N_1s_2	●	●			
A. voloshinovae pectiniformis (Bogdanowicz)	N_1s_2		●			●
A. fasseta (Didkowsky)	N_1s_2			●	●	
A. perelegantissima (Bogdanowicz)	N_1s_2			●	●	●
A. prava (Didkowsky)	N_1s_2			●		
A. pseudoinflata (Didkowsky)	N_1s_2			●		
A. pseudoukrainica (Didkowsky)	N_1s_2			●		
Varidentella reussi (Bogdanowicz)	N_1s_1 - N_1s_2	●	●	●	●	●
V. reussi costulata Maissuradze, Koiava&Spezzaferri	N_1s_2	●	●			●
V. luczkowskae Maissuradze, Koiava&Spezzaferri	N_1s_2	●	●			●
V. floriformis (Bogdanowicz)	N_1s_2		●			●
V. echinata (Maissuradze)	N_1s_2	●				
V. sartaganica (Krasheninnikov)	N_1s_2	●	●			●
V. nanae (Maissuradze)	N_1s_2	●				
V. nanae megrelica (Maissuradze)	N_1s_2	●				
V. trebujenica (Didkowsky et Gudina)	N_1s_2				●	●
Spiroloculina okrajantzi Bogdanowicz	N_1s_1 - N_1s_2	●	●	●	●	●
S. kolesnikovii Bogdanowicz	N_1s_2	●				●
S. aff. okrajantzi Bogdanowicz	N_1s_2		●			
Spirolina acuminata Didkowsky	N_1s_2			●	●	
S. bogdanowiczi Didkowsky	N_1s_2			●	●	
S. eliptica Didkowsky	N_1s_2			●	●	
S. irregularis Didkowsky	N_1s_2			●	●	
S. litoralis litoralis Didkowsky	N_1s_2			●	●	
S. litoralis krykovi Didkowsky	N_1s_2				●	
S. litoralis evolutica Didkowsky	N_1s_2				●	
S. sarmatica Didkowsky	N_1s_2				●	
S. peneroploides peneroploides Didkowsky	N_1s_2				●	
S. peneroploides spirolinoides Didkowsky	N_1s_2				●	
Peneroplis orbiculatus Didkowsky	N_1s_2				●	
P. sarmaticus Didkowsky	N_1s_2				●	
Neopeneroplis sarmaticus Didkowsky	N_1s_2-Rec.				●	

WGEO - Western Georgia; **EGEO** - Eastern Georgia; **UKR** - Ukraine; **MDA** - Moldova; **WPC** - Western Precaucasus; E_1 - **Rec.** - Paleocene to Recent; E_2 - **Rec.** - Eocene to Recent; E_1 - N_2 - Paleoceneo to Pliocene; E_2^2 - N_1S_2 - Late Oligocene to Middle Sarmatian; N_1 - Miocene; N_1 - **Rec.** - Miocene to Recent; N_1k - Konkian; N_1k - N_1s - Konkian to Sarmatian; N_1k - N_1s_1 - Konkian to Upper Sarmatian; N_1s - Sarmatian; N_1s_1 - Upper Sarmatian; N_1s_1 - N_1s_2 - Upper and Middle Sarmatian; N_1s_2 - Middle Sarmatian; N_1s_2-**Rec.** - Middle Sarmatian to Recent.

Table 2c.

Distribution of Sarmatian foraminifera of the Euxine-Caspian basins.

Species	Age	Geographic Distribution				
		WGEO	EGEO	UKR	MDA	WPC
Cibicides aff. lobatulus (Walker and Jacob)	N_1k - N_1s			●	●	
C. badenensis (d'Orbigny)	N_1k - N_1s				●	
Discorbis obtusum (d'Orbigny)	N_1k - N_1s_1		●	●	●	●
D. platyomphalus (Reuss)	N_1k - N_1s		●	●	●	●
Nonion bogdanowiczi Voloshinova	N_1k - N_1s	●	●	●	●	●
N. punctatus (d'Orbigny)	N_1k - N_1s			●		●
Porosononion martkobi (Bogdanowicz)	N_1k - N_1s	●	●	●	●	●
P. granosum (d'Orbigny)	E_2^2 - N_1s	●	●	●	●	●
P. subgranosum subgranosum (Egger)	N_1k - N_1s	●	●	●	●	●
P. subgranosum umboelata (Bogdanowicz)	N_1s_1 - N_1s_2	●	●	●	●	●
P. aragviensis (O. Djanelidze)	N_1s_2	●	●			●
P. hyalinum (Bogdanowicz)	N_1s_2	●	●	●	●	●
Elphidium aculeatum (d'Orbigny)	E_1 - Rec.	●	●	●	●	●
E. angulatum (Egger)	E_1 - N_2		●	●	●	
E. crispum (Linné)	E_1 - Rec.	●	●	●	●	●
E. fichtellianum (d'Orbigny)	E_2 - Rec.	●	●	●	●	●
E. hauerinum (d'Orbigny)	N_1 - Rec.	●	●	●	●	●
E. Josephina (d'Orbigny)	N_1		●		●	●
E. macellum macellum (Fichtel et Moll)	E_2 - Rec.	●	●	●	●	●
E. macellum tumidocamerale Bogdanowicz	N_1		●			●
E. reginum reginum (d'Orbigny)	N_1	●	●	●	●	●
E. reginum caucasicum Bogdanowicz	N_1		●		●	●
E. rugosum (d'Orbigny)	N_1	●	●	●	●	●
E. subumbilicatum (Czjzek)	N_1	●	●	●		●
E. gunteri Cole	N_1			●		
E. loloviensis Venglinsky	N_1s			●	●	
E. jukovi Serova	N_1s	●	●	●		
E. minutum Reuss	N_1			●	●	
E. flexuosum (d'Orbigny)	N_1s_1	●		●		●
E. incertum (Williamson)	N_1k - N_1s_1			●		●
E. grilli Papp	N_1s_1		●	●		
Elphidiella artifex (Serova)	N_1s_1			●		
Ammonia beccarii (Linné)	N_1 - Rec.	●	●	●	●	●
Bulimina elongata d'Orbigny	N_1k - N_1s		●			●
B. aff. pyzula d'Orbigny	N_1k - N_1s			●		
B. elegans (d'Orbigny)	N_1				●	
Bolivina moldawica Didkowsky	N_1s				●	
B. nisporenica Didkowsky	N_1s		●	●	●	
B. sagittula Didkowsky	N_1s			●	●	
B. sinzovi Didkowsky	N_1s			●	●	
B. sarmatica Didkowsky	N_1s		●	●	●	
B. dilatata dilatata Reuss	N_1s	●				
B. dilatata brevissima Cicha&Zapletalova	N_1s_2		●	●	●	
Oolina cubanica Bogdanowicz	N_1k - N_1s	●	●	●	●	●
O. marginata (Walker&Boys)	N_1	●	●	●		●
O. elongata Pobedina	N_1s_2	●	●	●		●
O. horrida Bogdanowicz	N_1s_2	●				●
O. irma Bogdanowicz	N_1s_2	●	●			●
O. karreri Bogdanowicz	N_1s_2	●	●			●

WGEO - Western Georgia; **EGEO** - Eastern Georgia; **UKR** - Ukraine; **MDA** - Moldova; **WPC** - Western Precaucasus; **E_1 - Rec.** - Paleocene to Recent; **E_2 - Rec.** - Eocene to Recent; **E_1 - N_2** - Paleocene to Pliocene; **E_2^2 - N_1S_2** - Late Oligocene to Middle Sarmatian; **N_1** - Miocene; **N_1 - Rec.** - Miocene to Recent; **N_1k** - Konkian; **N_1k - N_1s** - Konkian to Sarmatian; **N_1k - N_1s_1** - Konkian to Upper Sarmatian; **N_1s** - Sarmatian; **N_1s_1** - Upper Sarmatian; **N_1s_1 - N_1s_2** - Upper and Middle Sarmatian; **N_1s_2** - Middle Sarmatian; **N_1s_2-Rec.** - Middle Sarmatian to Recent.

Several species of some genera (*Elphidium, Nonion, Porosononion, Ammonia*) of upper parts of the Middle Sarmatian assemblages also occur in Upper Sarmatian (Table 2a; 2b; 2c). Frequently, these forms show deformation, irregular cameras or immature shell development and are presented only in some parts of the Late Sarmatian basin. The above mentioned anomalies of shells point to the existence of nonoptimal conditions for foraminifera. According to one opinion, salinity of that basin does not exceed 4-9‰ [3, 15].

Fossils studied from the sections of Eastern Georgia (Eldari) [10, 12, 13], Azerbaijan (Nakhichevanian, Kirovabadian and Precaspian district) [16], South Ukraine (Borisfensky Bay), the Crimea (Kop-Takil) [17] and in some regions of Pre-Caucasus [18] that are characterized only by euryhaline forms: *Ammonia, Elphidium , Nonion* (foraminifera); fresh water *Leptocytere, Cyprideis, Iliocypres, Candona, Xostoleberis* (ostracods) and remains of *Characeae;* some species of molluscs *Mactra caspia* Eichv., *M.bulgarica* Toula, which phylogenetically were connected with Middle Sarmatian *Mactra* [19] indicate existance of brackish conditions of Late Sarmatian basin.

Thus the existence of normal marine and hypersaline conditions in the Upper Sarmatian basins of Eastern Paratethys, supposed by Pillar & Harzhauser [14], is not proved paleontologicaly. Though taking into consideration Belokris's [20] supposition that there were hypersaline conditions in Borisfensky Bay in the Late Sarmatian basin (increase in salinity is proved by the author by obvious limestone dolomitization and climate aridization) it can be supposed that together with brackish regime in the Upper Sarmatian of Eastern Paratethys in some parts of the basin there were hypersaline conditions.

paleontologia

aRmosavleT parateTisis sarmatuli foraminiferebis biomravalferovneba

l. maisuraZe*, k. qoiava**

** saqarTvelos erovnuli muzeumi, paleobiologiis instituti, Tbilisi*
*** aleqsandre janeliZis geologiis instituti, Tbilisi*

(warmodgenilia akademiis wevris a. vekuas mier)

sarmatuli saukunis dasawyisSi parateTisis kavSiri wynar da indoeTis okeaneebTan TiTqmis Sewyda. gviankonkuri auzis nacvlad warmoiqmna uzarmazari izolirebuli sarmatuli zRva, romelic mxolod epizodurad ukavSirdeboda xmelTaSua zRvis auzs. igi gavrcelebuli iyo alpebidan aralis zRvamde da iyofoda gansxvavebuli bionomiuri pirobebis mqone panoniur, dakiur, evqsinur da kaspiur auzebad. swored gansxvavebuli bionomiuri pirobebiT aris gamowveuli aRniSnuli auzebis biocenozebis mravalferovnebac.

aRmosavleT parateTisis ponto-kaspiuri auzis foraminiferebis istoriuli ganviTarebis Seswavlam saSualeba mogvca gamogvevlina foraminiferebis kompleqsebis kanonzomieri cvalebadoba drosa da sivrceSi, risafuZvelzec gamoyofilia maTi ganviTarebis sami ziriTadi etapi: adreuli, romelic foraminiferebis Camoyalibebis process asaxavs; Sualeduri – maTi maqsimaluri gafurCqvnis Tanadrouli, da gviani, rodesac foraminiferebis TiTqmis yvela jgufi amowyda.

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