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Biostratigraphy and paleoenvironment of the Sarmatian (s. l.) deposits from the eastern part of the Moldavian Platform (Comarna borehole) based on foraminifera

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Due to the change of the Paratethys' marine regime with normal salinity to the brackish regime, the Moldavian Platform deposits of this time period are characterized by euryhaline microfaunal forms. Foraminifera species *Lobatula lobatula* (W. et J.) (*Cibicides lobatulus W. et J.*), *Cycloforina karreri ovata* (Serova) (*Quinqueloculina karreri ovata* Serova), *Cycloforina fluviata* (Vengl.) (*Q. fluviata* Vengl.) mark the beginning of the Sarmatian period in the Moldavian Platform; the presence of other genera, like *Nonion, Elphidium*, *Articulina* indicate that part of the Upper Badenian specific microfauna adapted to lower salinity water of the Paratethys. Having a small size, the Cibicides genus, marks the sudden change in the environmental conditions and the installation of the brackish regime. The predominance of benthic foraminifera forms indicates a normal oxygen content at the substrate surface, and the abundance of foraminifera species with calcareous tests indicates that the sedimentation of the Lower Sarmatian deposits was made in warm sea conditions.

Keywords: foraminifera, biostratigraphy, paleoecology, Sarmatian (s.l.), Miocene, Moldavian Platform

INTRODUCTION

This study is based on the micropaleontological researches performed in the Sarmatian (s.l.) deposits from the Eastern Moldavian Platform, at the level of Buglovian (Darabani-Mitoc Clays), Volhynian (Darabani-Mitoc Clays) and Lower Bessarabian (Clays with *Cryptomactra*) of a drilling executed in Comarna locality (Fig. 1).

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The drilling from Comarna has been studied by various authors in several papers. Grasu et al. (2002) reported on the core samples of this drilling the Volhynian/Bessarabian limit at 230 metres deep, Brânzilă (2004) identified foraminiferal fauna composed mainly of elphidiids, nonionids and miliolids in the Bessarabian deposits, Brânzilă and Țabară (2005) also, identified a content of palynomorphs in the lower Bessarabian deposits of the Moldovian Platform intercepted by this drilling, while Țabară and Chirilă (2012a, b) made paleoclimatic estimations based on this microfloral content.

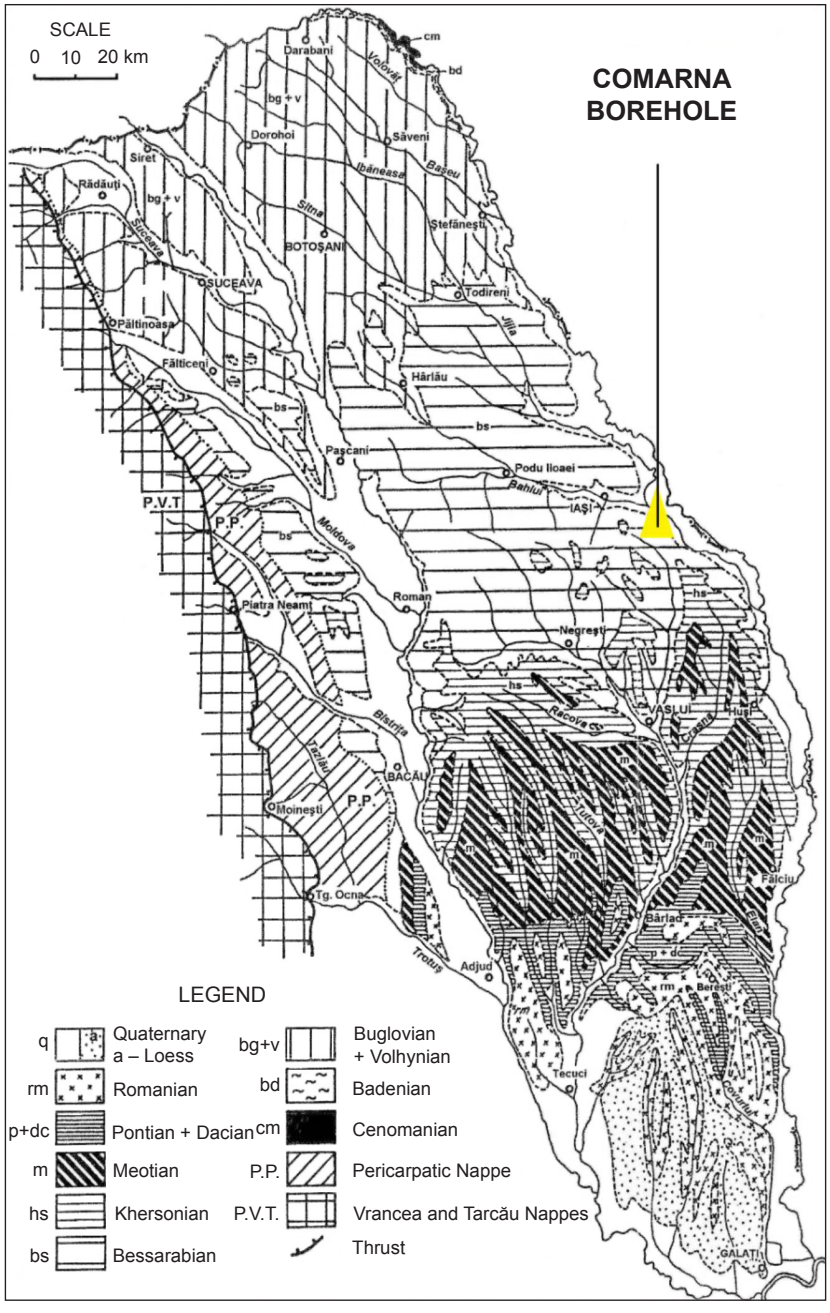

Fig. 1. Location of the Comarna borehole (map taken from Ionesi et al., 2005)

GEOLOGY OF THE STUDIED AREA

The Moldavian Platform represents the southwestern part of the East European Platform. On the territory of Romania, it has an extension between the Oriental Carpathians and the Prut River (L. Ionesi et al., 2005; V. Mutihac, G. Mutihac, 2010), being limited by the Pericarpic Fault in the west, the Fălciu-Plopana Fault in the south, and by the state border in the east and in the north (L. Ionesi, 1994; Brânzilă, 2003).

The Sarmatian is part of the Sedimentary Cover and outcrops on the entire Moldavian Platform, being composed of four substages: Buglovian, Volhynian, Bessarabian, and Khersonian (L. Ionesi, 1994).

The Buglovian (sensu Laskarev) outcrops only in the northern platform, consisting predominantly of clays, tuffs, sands, conglomerates and limestones, and from the faunistic point of view it is represented by associations of bivalves, gastropods, foraminifera, ostracods,

bryozoans etc. (L. Ionesi and B. Ionesi, 1982; Brânzilă, 2003).

The Volhynian is open in several localities from the northern Moldavian Platform (L. Ionesi, 1994) and consists predominantly of clays, silts, sands, sandstones, limestones, rudites and arenites. The characteristic fauna of this substage is represented by bivalves, gastropods and foraminifera (Brânzilă, 2003).

The Bessarabian is open from the Baia-Santa Mare line in the south till Vaslui (L. Ionesi, 1994; Brânzilă, 2003), consisting mainly of clays, sands, gravels, limestones and characterized, from the faunistic point of view, by molluscs, foraminifera, and vertebrate remains (Brânzilă, 2003).

MATERIALS AND METHODS

The ten fossiliferous samples were collected for micropaleontological analyses: three at the Buglovian level, three from Volhynian deposits and four belonging to Bessarabian (Fig. 2).

These samples were processed at the Geology and Palaeontology Laboratory of the Faculty of Geography and Geology in accordance with the micropaleontology-specific methods.

The photographing of foraminifera taxa was carried out with the electron microscope of the Faculty of Biology of "Alexandru Ioan Cuza" University.

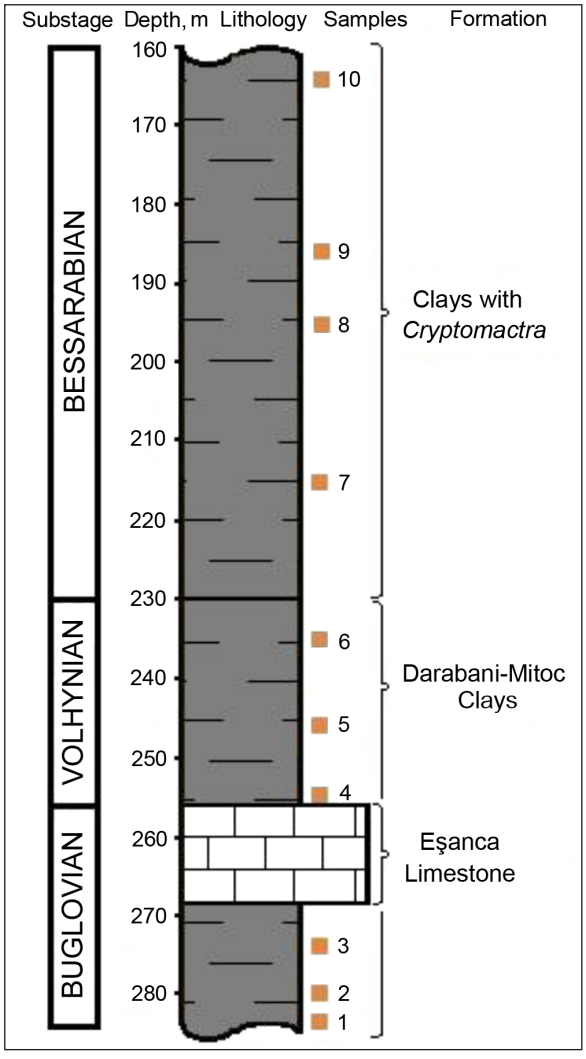

Fig. 2. The lithological column of the Comarna drilling

IDENTIFIED MICROFAUNA

The foraminifera association identified at the Buglovian level (Table) consists of miliolids (*Quinqueloculina*, *Cycloforina*, *Varidentella*, *Nodobaculariella* and *Articulina* genera), elphidiids (*Elphidium* and *Porosononion* genera), nonionids (*Nonion* genus), and cibicidids (*Cibicides* and *Lobatula* genera). Miliolids have a high abundance in sample 1, and the *Elphidium* genus has a significant abundance at the level of sample 3.

The foraminifera index-species specific of the Buglovian substage are *Lobatula lobatula* (W. et J.) (*Cibicides lobatulus* W. et J.), *Cycloforina karreri ovata* (Serova) (*Quinqueloculina karreri ovata* Serova) and *Cycloforina fluviata* (Vengl.) (*Q. fluviata* Vengl.) (B. Ionesi, 1991), but although are present in the association, they are low in frequency.

The analysed Buglovian samples also revealed a significant number of ostracods and otoliths.

The Volhynian analysed in samples 4, 5 and 6 (Table) is characterized by a foraminifera association in which the miliolids (*Quinqueloculina*, *Articulina* and *Cycloforina* genera), the elphidiids (*Porosononion* genus) and the nonionids (*Nonion* genus) are significantly abundant. Within this association, the presence of ostracods was also signalled.

A microfauna of foraminifera characterized by a generally low frequency resulted from

Table. **The microfaunal association identified in the Sarmatian deposits from the core samples of the Comarna borehole. Taxa 1–34 denote foraminifera species (Plates I, II, and III)**

Criterion Number	Substages	Buglovian			Volhynian			Bessarabian			
	Species/Samples	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	*Articulina problema* BOGD.	1		1			10			1	1
2	*Articulina sarmatica* (KARRER)	1	1								
3	*Cibicides badenensis* (d'ORB.)			9							
4	*Cycloforina fluviata* (VENGL.)	2				3					
5	*Cycloforina karreri ovata* (SEROVA)		1								
6	*Cycloforina toreuma* (SEROVA)		2								
7	*Elphidium aculeatum* (d'ORB.)			8				2			
8	*Elphidium flexuosum* (d'ORB.)			5							
9	*Elphidium hauerinum* (d'ORB.)	4									
10	*Elphidium listeri* (d'ORB.)			2							
11	*Elphidium macellum* (F. et M.)										1
12	*Elphidium macellum tumidocamerale* BOGD.			11							1
13	*Elphidium rugosum* (d'ORB.)										1
14	*Elphidium subumbilicatum* CZJZEK		5								
15	*Elphidium* sp.	3								1	
16	*Lobatula lobatula* (W. et J.)			5							
17	*Nodobacullariella ovalis* VENGL.			1							
18	*Nonion bogdanowiczi* VOLOSH.	4	2		26	1	2			1	2
19	*Nonion* sp.				26		2			1	
20	*Porosononion martkobi* (BOGD.)	3									
21	*Porosononion subgranosus* (EGGER)	1	2		4	79	1			1	4
22	*Porosononion subgranosus* ssp.									1	8
23	*Porosononion subgranosus umboelata* GERKE		1							1	2
24	*Quinqueloculina akneriana* d'ORB.	1	2			1					
25	*Quinqueloculina akneriana argunica* GERKE	3					3				
26	*Quinqueloculina akneriana longa* GERKE	7			1		3				
27	*Quinqueloculina gracilis* KARRER					1					
28	*Quinqueloculina karreri* REUSS	1									
29	*Quinqueloculina pseudoangustissima* KRASH.						3				
30	*Quinqueloculina reussi* BOGD.	2									
31	*Quinqueloculina reussi virgata* SEROVA	4			1			1			
32	*Quinqueloculina* sp.	15				59	43				1
33	*Turborotalia bykovar* AISENSTAT									1	
34	*Varidentella georgiana* ŁUCK.		4								
35	*Bivalvia* sp.									1	
36	*Gastropoda* sp.										1
37	*Ostracoda* sp.	7	12	34		3					
38	Otoliths	2						66	5		1

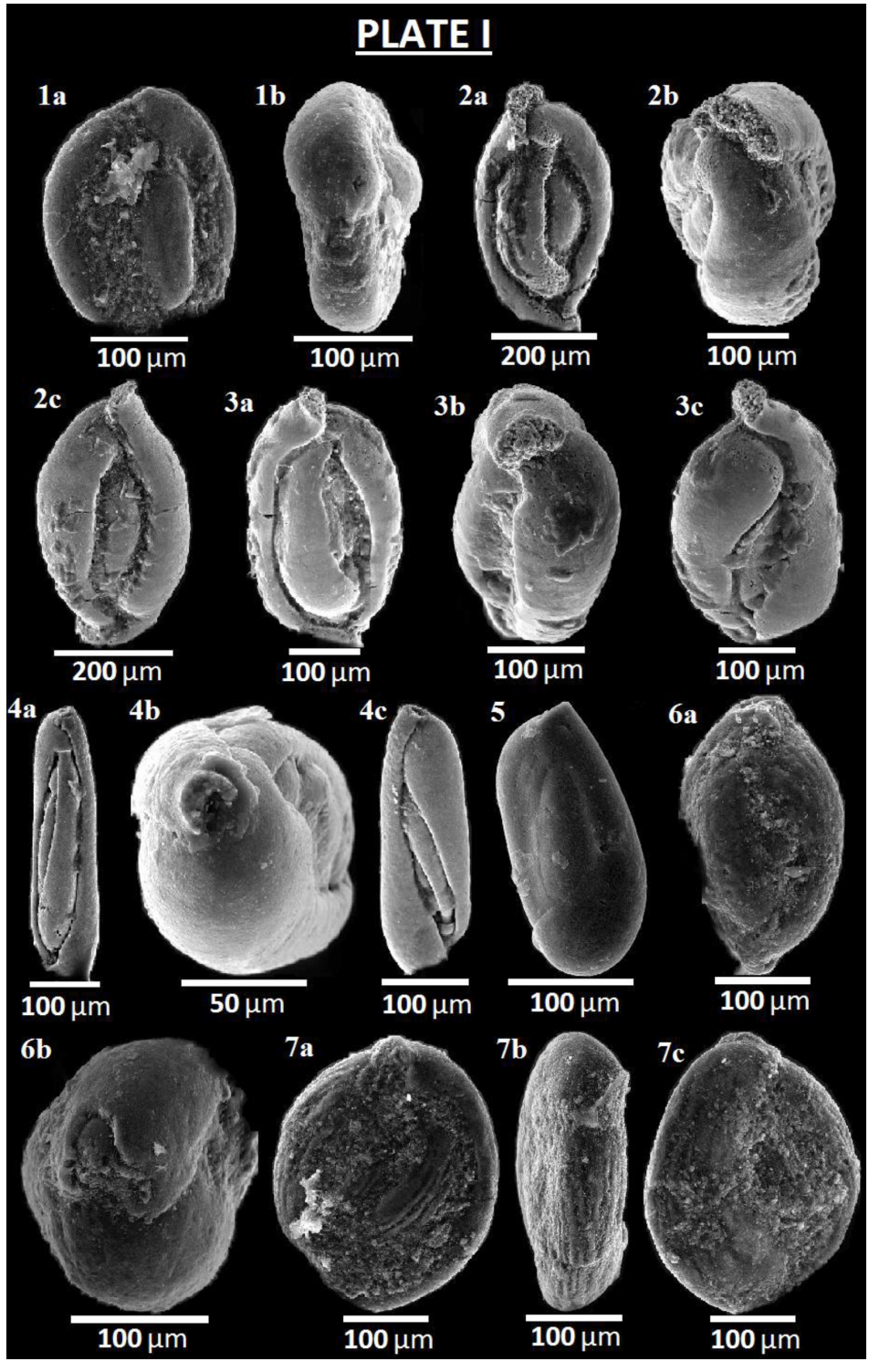

PLATE I: 1 a,b – *Quinqueloculina akneriana akneriana* d'Orbigny, 1846 – sample 2; 2 a,b,c – *Quinqueloculina akneriana argunica* Gerke, 1938 – sample 6; 3 a,b,c – *Quinqueloculina akneriana longa* Gerke, 1938 – sample 6; 4 a,b,c – *Quinqueloculina pseudoangustissima* Krasheninnikov, 1959 – sample 6; 5 – *Quinqueloculina reussi virgata* Serova, 1955 – sample 7; 6 a,b – *Cycloforina karreri ovata* (Serova, 1955) – sample 2; 7 a,b,c – *Cycloforina toreuma* (Serova, 1955) – sample 2

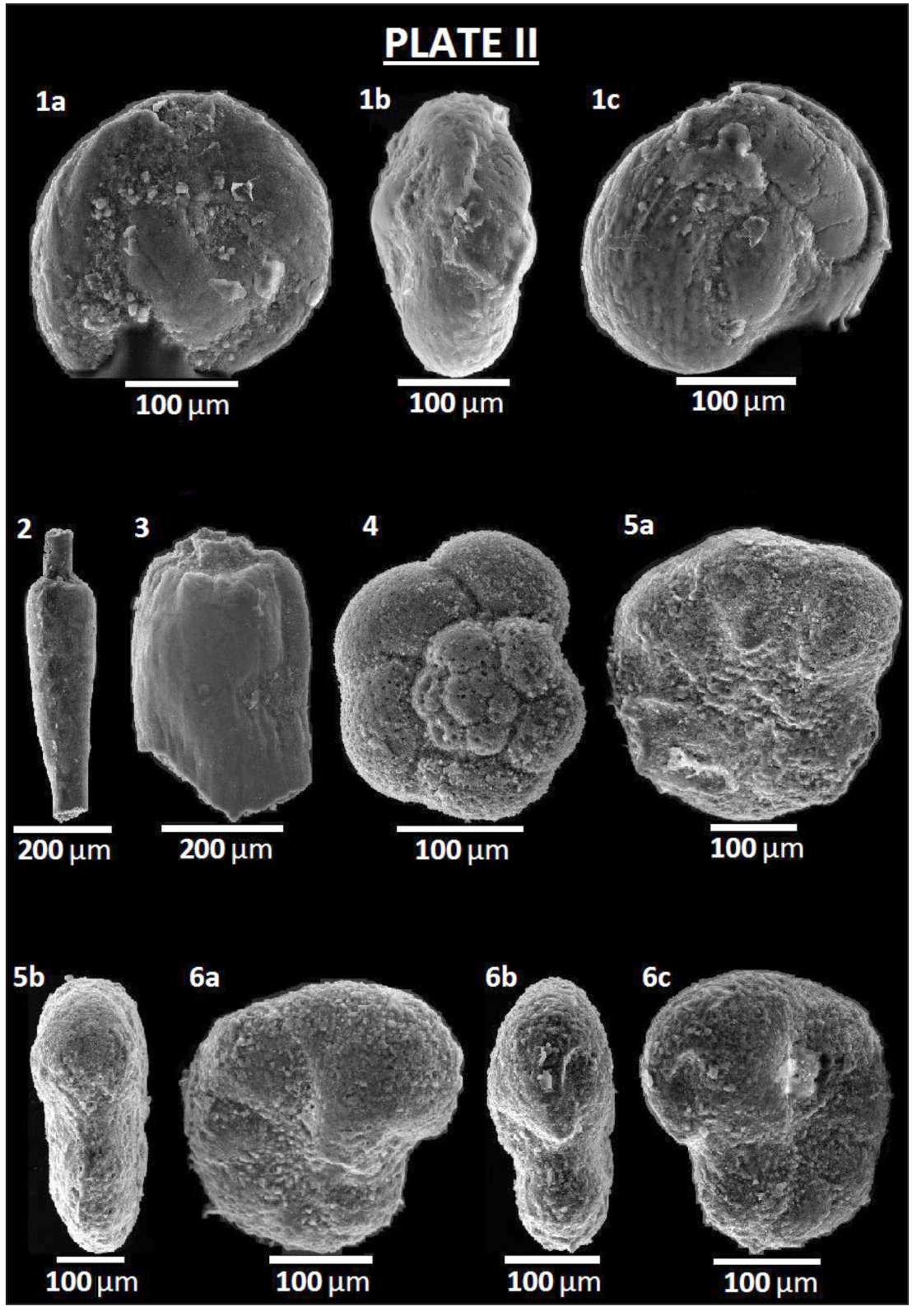

PLATE II: 1 a,b,c – *Varidentella georgiana* Łuczkowska, 1974 – sample 2; 2 – *Articulina problema* Bogdanowicz, 1952 – sample 6; 3 – *Articulina sarmatica* (Karrer, 1877) – sample 2; 4 – *Turborotalia bykovae* Aisenstat, 1960 – sample 9; 5 a,b – *Cibicides badenensis* (d'Orbigny, 1846) – sample 3; 6 a,b,c – *Lobatula lobatula* (Walker et Jacob, 1798) – sample 3

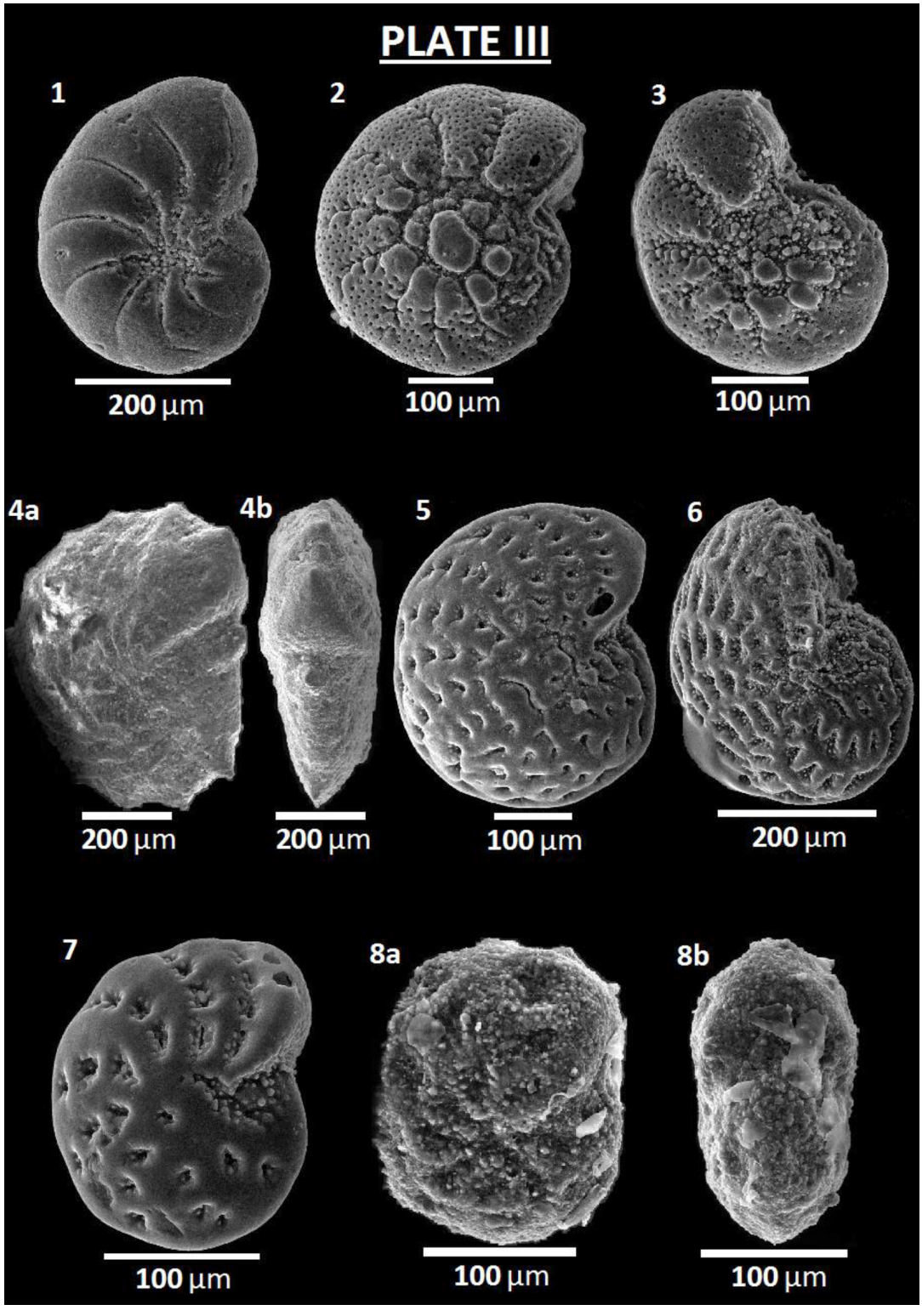

PLATE III: 1 – *Nonion bogdanowiczi* Voloshinova, 1952 – sample 2; 2 – *Porosononion subgranosus* (Egger, 1857) – sample 10; 3 – *Porosononion subgranosus umboelata* Gerke, 1960 – sample 10; 4 a,b – *Elphidium aculeatum* (d'Orbigny, 1846) – sample 3; 5 – *Elphidium macellum* (Fichtel et Moll, 1798) – sample 10; 6 – *Elphidium macellum tumidocamerale* Bogdanowicz, 1932 – sample 10; 7 – *Elphidium rugosum* (d'Orbigny, 1846) – sample 10; 8 a,b – *Elphidium subumbilicatum* Czjzek, 1848 – sample 2

the analysis of the Bessarabian samples (Table). The elphidiids (*Porosononion* and *Elphidium* genera) have a greater weight within the identified association. The miliolids (*Quinqueloculina* and *Articulina* genera), the nonionids (*Nonion* genus) and the globorotaliids (*Turborotalia* genus) have a low frequency. Noteworthy is the presence of a significant number of otoliths in the Bessarabian microfaunal association, especially at the level of sample 7.

SIGNIFICANCE OF ANALYSED MICROFAUNA

The foraminifera microfauna identified in the Buglovian deposits at the level of the first three samples taken from the core samples of the Comarna drilling presents a wide variety of species and a high abundance of individuals, which suggests optimum conditions of living and food.

There is a predominance of euryhaline forms of miliolids and elphidiids. The Badenian stenohaline forms, such as *Bulimina*, *Bolivina* (Popov et al., 2004) and *Velapertina* (Popescu, 1995; Ispas, 2016; 2017), are missing, which means that a transition from a normal salinity marine regime to a brackish regime took place at the beginning of the Sarmatian. Although the planktonic forms are missing, the abundance of benthic calcareous forms shows a normal oxygen content in the warm water of the sea. The miliolids and the *Elphidium* genus, suggest a marine shelf environment.

The Volhynian deposits have varied foraminifera microfauna and a high abundance of individuals, which proves normal living conditions. There is a predominance of euryhaline forms of miliolids, nonionids, and *Porosononion* genus, which justifies a brackish regime and a marine shelf environment with warm and still waters.

At the level of Bessarabian deposits, the identified foraminifera association presents a moderate variety of species and a low abundance of individuals. The elfidiids (especially *Porosononion* genus), which are forms adapted generally to the sandy, hard and even muddy substrate (Brânzilă, 1999), have a significant weight in this foraminifera association. The Bessarabian microfauna includes otoliths, which attests to a normal regime of oxygenation of the sea water, as well as optimal conditions of life and food.

CONCLUSIONS

The Lower Sarmatian is characterized by varied and abundant foraminifera microfauna. Due to a sudden change of the marine regime with normal salinity to a brackish regime of the Paratethys waters, stenohaline forms specific to the Upper Badenian are replaced by the euryhaline forms. Foraminifera species that indicate the beginning of the Sarmatian on the Moldavian Platform are *Lobatula lobatula* (W. et J.), *Cycloforina karreri ovata* (Serova) and *Cyclophorina fluviata* (Vengl.), but they are low in frequency.

The predominant foraminifera are miliolids, elphidiids, nonionids, and benthic calcareous forms, suggesting a marine shelf environment with warm, still waters, optimal oxygenation regime, and normal living conditions (B. Ionesi, 1968; Ispas, 2016).

The *Cibicides* genus, although present in low quantities and small size, indicates a sudden modification of the marine regime at the beginning of the Sarmatian (Paghida-Trelea, 1969).

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References

1. Brânzilă M. Geologia părții sudice a Câmpiei Moldovei. Iași: Corson; 1999. 221 p., 33 pl. Romanian.
2. Brânzilă M. Geologia României. Iași: Univ. "Al. I. Cuza"; 2003. Romanian.

3. Brânzilă M. Foraminifera assemblages of the backbulge depozone from the Moldavian Platform – the Basarabian. Acta Palaeontologica Romaniae. 2004; 4: 45–54.

4. Brânzilă M, Ţabără D. The palynological content of Lower Basarabian (The clays with *Cryptomactra*) on the Moldavian Platform. Analele Ştiinţifice ale Universităţii "Al. I. Cuza" Iaşi, Geol., T. XLIX – L (2003–2004), 2005; 277–91.

5. Grasu C, Brânzilă M, Crina M, Boboş I. Sarmaţianul bazinelor de foreland ale Carpaţilor Orientali. Bucureşti: Ed. Tehnică; 2002. Romanian.

6. Ionesi B. Stratigrafia depozitelor miocene de platformă dintre valea Siretului şi valea Moldovei. Bucureşti: Ed. Acad. Rom;1968. 391 p. Romanian.

7. Ionesi B. Biozonation du Sarmatien de la Plate-forme Moldave. Comun. ses. şt. Univ. "Al. I. Cuza" Iaşi 25-20/X, 1991. In L. Ionesi (1995) Rom J Stratig. 76/2. p. 7, Bucureşti. Romanian.

8. Ionesi L. Geologia unităţilor de platformă şi a Orogenului Nord – Dobrogean. Bucureşti: Editura Tehnică; 1994. Romanian.

9. Ionesi L, Ionesi B. Contribution a l'etude du Bouglovien d'entre Başeu et Prut. An. Şt. Univ. Iaşi, T. XXVIII, s. II b, Geol.-Geogr. 1982. French.

10. Ionesi L, Ionesi B, Lungu A, Roşca V, Ionesi V. Sarmaţianul mediu şi superior de pe Platforma Moldovenească. Bucureşti: Ed. Academiei Române; 2005. 558 p. Romanian.

11. Ispas B-A. Reconstituirea paleomediilor de sedimentare la limita Badenian/Sarmaţian, din nord-estul Platformei Moldoveneşti, pe baza faunei de foraminifere. Teză de doctorat. Univ. "Al. I. Cuza" Iaşi. 2016.

12. Ispas B-A. New genera of foraminifera identified for the upper Badenian deposits to the North-Eastern part of the Moldavian Platform. Journal of Earth Science and Engineering 7. 2017; 20–7. doi: 10.17265/2159-581X2017.01.003.

13. Mutihac V, Mutihac G. Geologia României în contextul geostructural central – est – european. Bucureşti: Ed. Didactică şi Pedagogică; 2010. Romanian.

14. Paghida-Trelea N. Microfauna Miocenului dintre Siret şi Prut. Bucureşti: Ed. Acad. Rom; 1969. 189 p., 14 pl.

15. Popescu Gh. Contribution to the knowledge of the Sarmatian foraminifera of Romania. Rom J Paleontology. 1995; 76: 85–98.

16. Popov SV, Rögl F, Rozanov AY, Steininger FF, Shcherba IG, Kováč M. Lithological-paleogeographic maps of Paratethys. Courier Forschungsinstitut Senckenberg. 2004; 250: 46 p.

17. Ţabără D, Chirilă G. Palaeoclimatic estimation from Miocene of Romania, based on palynological data. Carpathian Journal of Earth and Environmental Sciences. 2012a; 7(2): 195–208.

18. Ţabără D, Chirilă G. The evolution of the Sarmatian palaeoclimate in North-Eastern Romania: a palaeobotanical approach. Analele Ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, seria Geologie. 2012b; 58(1): 5–21.

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FORAMINIFERAIS PAGRĮSTA RYTŲ MOLDAVIJOS PLATFORMOS SARMATIJOS PERIODO (PLAČIĄJA PRASME) TELKINIŲ BIOSTRATIGRAFIJA IR PALEOAPLINKA

Santrauka

Šis tyrimas pagrįstas mikropaleontologiniais tyrimais, atliktais Rytų Moldavijos platformos Sarmatijos periodo (plačiąja prasme) telkiniuose. *Lobatula lobatula* (W. et J.), *Cibicides lobatulus* (W. et J.), *Cycloforina karreri ovata* (Serova), *Quinqueloculina karreri ovata* (Serova), *Cycloforina fluviata* (Vengl.), *Q. fluviata* (Vengl.) foraminiferų rūšys, žyminčios Sarmatijos periodo pradžią Moldavijos platformoje, taip pat kitos gentys, tokios kaip *Nonion*, *Elphidium*, *Articulina*, rodo, kad gręžinio viršutinės Badeno periodo dalies specifinė mikrofauna prisitaikė prie Paratetijos jūros mažesnio druskingumo vandens.

Raktažodžiai: foraminifera, biostratigrafija, paleoekologija, Sarmatijos periodas (plačiąja prasme), miocenas, Moldavijos platforma