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THE SIGNIFICANCE OF SOME SARMATIAN FAUNAS FROM THE SOUTHWESTERN PART OF THE PĂDUREA CRAIULUI MOUNTAINS (ROMANIA)

SORIN FILIPESCU[1], MIRELA POPA[1] & FRANZ WANEK[2]

Abstract. The recently identified Sarmatian deposits from the south - western part of the Pădurea Craiului Mountains contain some very interesting and diverse micro- and macrofossil assemblages. The good preservation and typical patterns of the taxa enable interpretation of their biostratigraphy, paleoenvironment, and their paleogeographic affinity. The Early Sarmatian age of the deposits was established on the basis of the fossil foraminifera, gastropods and ostracods. The fossil assemblages are typical for a marginal shallow water paleoenvironment, with particular values of high salinity, probably extended over large areas on the border of the rising Apuseni Mountains.

Keywords: foraminifera, ostracods, gastropodss, Sarmatian, Pădurea Craiului Mountains, paleoecology, paleogeography

INTRODUCTION

In the southwestern part of the Pădurea Craiului Mountains (Fig. 1), the Vida Valley crosses over a territory with Lower Cretaceous and Jurassic deposits. Some patches of Quaternary deposits occur on the right side of the valley, (Bordea, 1986).

Exploratory drilling carried out recently on the Quaternary deposits, intercepted an unexpected sequence consisting of fine and coarse Sarmatian deposits unconformably laid over the Lower Cretaceous limestones.

A rich micro- and macrofauna was preserved in the fine grained deposits. The particular aspects of the faunas are important mainly from a stratigraphic, paleoecologic and paleogeographic point of view.

Some preliminary findings on the mentioned faunas were published by Popa et al. (1999). Similar assemblages were previously referred to by Rado (1972), Nicorici & Istocescu (1970) and Nicorici (1971) from the Beiuş and Borod basins.

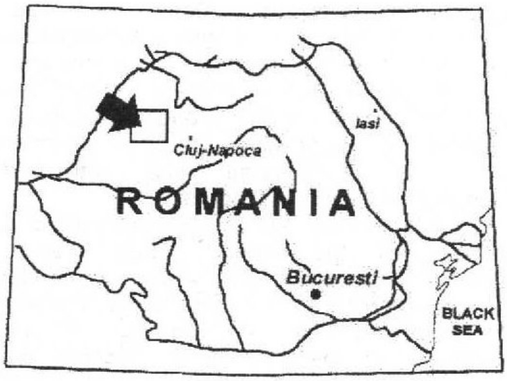

Figure 1 - Location of the studied area

MATERIAL AND METHODS

The fossil material, provided by Dr. I. Cociuba, was collected from the well Site no. 20 (Transgex S.A. Cluj). The core samples were processed by standard methods, by imersion in water and sieving the disaggregated sediment on a 63-µm mesh. The fossil fauna was picked from the entire >63-µm residue and the specimens were photographed using a SEM microscope (microfauna) and a stereo microscope (macrofauna) at Babeş-Bolyai University.

BIOSTRATIGRAPHY

The foraminifera are very typical for the Sarmatian deposits. The prevailing specimens are the miliolids, *Elphidium* and *Ammonia*.

Based on the composition of the foraminiferal assemblage and the presence of *Varidentella* spp., *Elphidium aculeatum* and *Elphidium reginum,* we confidently assigned on Early Sarmatian age (Middle to Late Volhynian) to the upper sequence (from 2 to 29 m) recovered in the hole. The reference stratigraphic scale is presented in Fig. 2.

Few taxa have a wider stratigraphic range. This could be a clue for a possible reworking or unexpected values of salinity (Plate I, II).

By analyzing the stratigraphic distribution of the gastropod species, we determined that most of them are mentioned only in the Lower Sarmatian deposits ("Mohrensternia beds" of Papp, 1954) of the Central Paratethys. Only very few taxa, such as *Acteocina lajonkaireana lajonkaireana* (BASTEROT), *Hadriania coelata* (DUJARDIN), *Hydrobia frauenfeldi* HOERNES and *Theodoxus pictus pictus* (FERRUSAC) were also mentioned from the Badenian deposits of the Central Paratethys.

The stratigraphic significance of the ostracod assemblages is also very clear, the species (especially *Aurila*) representing the Lower Sarmatian biozone B of Jiříček (1972).

[1] Babeş-Bolyai University, Department of Geology. Str. Kogălniceanu 1, 3400 Cluj-Napoca, Romania.
[2] Geological Institute of Romania, Cluj Branch, P.O. Box 181, 3400 Cluj-Napoca, Romania

CARPATHIAN AREA			PANNONIAN AREA		
CHRONO-STRATIGRAPHIC UNITS		BIOSTRATIGRAPHIC UNITS (based on Popescu, 1998)	CHRONO-STRATIGRAPHIC UNITS	BIOSTRATIGRAPHIC UNITS (based on Jiricek, 1972)	
SARMATIAN (BARBOT DE MARNY, 1866)	CHERSONIAN	—	PANNONIAN		
	BESSARABIAN	Porosononion aragviensis	?	A	Hemicytheria hungarica / Miliammina subvelatina
		Dogielina sarmatica	SARMATIAN (SUESS, 1866)	E	Porosononion subgranosum
	VOLHYNIAN	Schackoinella imperatoria / Elphidium reginum		D	
				C	Elphidium hauerinum
		Varidentella / Articulina		B	Elphidium reginum Aurila mehesi / Aurila merita
		Anomalinoides dividens		A	Anomalinoides dividens Quadracythere svagrovskyi

Figure 2 - Stratigraphic correlation table of Sarmatian

PALEOECOLOGY

The foraminiferal assemblage consists mainly of Paratethyan endemic miliolids: *Pseudotriloculina angustioris* (BOGDANOWICZ), *P. consobrina* (D'ORBIGNY), *Quinqueloculina akneriana* D'ORBIGNY, *Q. buchiana* D'ORBIGNY, *Q. hauerina* D'ORBIGNY, *Spiroloculina okrajantzi* BOGDANOWICZ, *Varidentella pseudocostata* (VENGLINSKI), *V. reussi* (BOGDANOWICZ), *V. sarmatica* (KARRER). Those are associated with different species of *Elphidium*: *E. aculeatum* D'ORBIGNY, *E. flexuosum* (D'ORBIGNY), *E. incertum* (WILLIAMSON), *E. josephinum* (D'ORBIGNY), *E. macellum* (FICHTEL & MOLL), *E. puscharovski* SEROVA, *E. reginum* (D'ORBIGNY) – and other hyaline forms, among which *Ammonia beccarii* LINNÉ and *Nonion bogdanowiczi* VOLOSHINOVA are common.

The above mentioned assemblage can be associated with a morphogroup living in a marginal marine environment. It is well known that the forms with imperforate porcellaneous wall, hosting chlorophycean symbionts, have higher nutritional requirements and need higher light levels. The dominance of such forms in our assemblages suggest shallow environment conditions, probably between 0-15 m or slightly more.

The majority of the specimens were epifaunal and mainly epiphytic, the abundance of the vegetal material being also noticed in the washed residue. The porcellaneous taxa were mainly herbivore, free or clinging on vegetation. The keeled forms of *Elphidium* were, herbivore, epifaunal, free or clinging on vegetation, while the non-keeled forms were free, mainly infaunal, detritivore or herbivore. All the specimens lived on a muddy sand substrate, in temperate – warm conditions.

Traditionally, the Sarmatian environments were considered brackish, but, taking into consideration our faunas, we believe that, during Early Sarmatian, not always the salinity values were situated below normal parameters (32-37‰). The assemblages from the recent brackish marginal environments have no (or a very low) porcellaneous component, except near-marine, and also a high agglutinated content. The presence of euryhaline *Ammonia*, *Elphidium* and miliolid specimens provide evidence for abnormal values of salinity. The high porcellaneous content and the absence of the agglutinated taxa in our samples could argue for normal to hypersaline environment. Some similarities with certain recent faunas from the hypersaline environments living in the Gulf of Mexico, Carribean lagoons and other regions can be drawn (see Murray, 1991). There are some similar examples even in the fossil record, such as the Paleogene hypersaline marginal environments (Paris Basin, Transylvania, etc.) with miliolids associated with cerithid gastropods.

An evolution of euryhaline Badenian genera can be observed within the ostracod fauna. Beside the occurrence of these genera, which are exclusively marine, the absence of freshwater forms is noteworthy, as these are usually very common in brackish environments. All the taxa in our assemblages are related to shallow waters, rich in aquatic vegetation. Among the identified taxa, *Cytheridea hungarica* (ZALÁNYI) is the last representative of the genus in the Central Paratethyan area. It dissapeared in the Zone B - also equivalent to *Elphidium reginum* Zone - Kollmann, 1960; Jiříček, 1974). The other common forms - *Aurila mehesi* (ZALÁNYI), *Aurila merita* (ZALÁNYI), *Callistocythere maculata* PIETRZENIUK, *Graptocythere loerentheyi sarmatica* (JIŘÍČEK) and *Loxoconcha* cf. *dobrotici* STANCHEVA - are the representatives of the genera that resisted environmental changes. These forms generated successful, well-adapted assemblages for the rest of Sarmatian and, subsequently, for

Pannonian and Pontian (the genus *Hemicytheria* arose at the beginning of Pannonian from the genus *Aurila*).

The mollusk assemblage is dominated by more than twenty gastropod taxa. Only very few juvenile cardiids occur in the lower part of the sequence. The genus *Mohrensternia* prevails: *M. angulata* (EICHWALD), *M. graecensis* HILBER, *M. hydrobioides* HILBER, *M. inflata* JEKELIUS, *M. multicostata* (SENEŠ), *M. pseudosarmatica* FRIEDBERG, *M. sarmatica* FRIEDBERG, *M.* cf. *styriaca* HILBER. It is quantitativelly followed by *Pirenella picta picta* (DEFRANCE) and other species of *Acteocina, Calliostoma, Caspia, Hadriania, Hydrobia, Pseudamnicola, Theodoxus* and *Valvata* (Popa et al., 1998). The assemblage was euryhaline, well adapted to a wide range of salinity, living on the same tipe of muddy sand substrate (*Caspia, Pseudamnicola, Theodoxus, Valvata*) or adhering on the vegetation (*Mohrensternia, Pseudamnicola, Valvata*).

The composition of the fossil assemblages suggests that, following the brackish environments represented by the lower part of Volhynian, normal marine to hypersaline conditions were reinstated during the Late Volhynian. Boda (1974) had already found that although the new brackish foraminifera and mollusk faunas widely spread over the Paratethyan realm at the beginning of Sarmatian, they became extinct later in Sarmatian. Other interesting conclusions were presented by Jámbor (1978), based on certain lithological and geochemical aspects. He assumed that, after the significant decrease of salinity at the Badenian / Sarmatian boundary, which produced the extinction of marine Badenian faunas, an important increase of salinity occurred (even to hypersaline conditions). This change could not be clearly reflected in the fossil record because the geographical isolation made impossible the large scale repopulation of the Paratethyan basins by the typical open marine taxa. The same author considered that the next essential decrease of salinity occurred only during Pannonian.

CONCLUSIONS

The occurrence of lower Sarmatian deposits in this part of the Pădurea Craiului Massif suggests at least the existence of some gulfs extending further east over the rising mountains during Sarmatian. A likely scenario is that the Sarmatian sea covered significant areas in the western part of the Pădurea Craiului, joining the Borod and the Beiuş basins together and probably other areas towards east. This idea was afirmed by Nicorici (1988) who considered that the connection between the two basins existed in Vârciorog area. It is also likely that some of the other quaternary patches scattered over broad areas in the Pădurea Craiului mountains hide older formations, and further studies could provide a clearer image on the paleogeographic evolution of the area.

Although some caution has to be taken when assemblages with different ages are compared, taking into account the existing and recent data, we believe that the salinity of the environment during Sarmatian was higher than stated before, at least at certain stratigraphic levels.

Acknowledgments

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REFERENCES

Boda, J., 1974: A magyarországi szarmata emelet rétegtana. *Földt. közl.*, 104, 3, p. 249-260. Budapest.

Bordea, S., Bordea, J., Mantea, J., Costea, C., 1986: *Harta geologică a României, scara 1:50.000, Foaia Zece Hotare*. Institutul Geologic al României, Bucureşti.

Jiříček, R., 1972: Problém hranice sarmat / pannon ve Widenské, Podunajské a Vychodoslovenské pávni. *Mineralia Slovaka*. IV, 14, p. 39-82. Spisca Nova Ves.

Jiříček, R., 1974: Biostratigraphische Bedeutung der Ostracoden des Sarmats s.str. *Chronostratigraphie und Neostratotypen, M5 Sarmatien*. p. 434-457, 4 pl. Bratislava.

Jámbor, Á., 1978: Új elképzelések a magyarországi neogén tengerek vizenék sótartalom-változásairól. *MÁFI évi jel. 1976 ról*, p. 261-265. Budapest.

Kollmann, K., 1960: Cytherideinae und Schulerideinae n. subfam. (Ostracoda) aus dem Neogen des östl. Österreich. *Mitt. d. Geol. Ges.*, 51, p. 89-195, 21 pl. Wien.

Murray, J.W., 1991: *Ecology and Paleoecology of Benthic Foraminifera*. Logman Scientific & Technical and John Wiley & Sons, 397 p. Harlow, New York.

Nicorici, E., 1971: *Fauna sarmatiană de la Vârciorog (Bazinul Vadului)*. St. Cerc. Geol. Geof. Geogr. (Geol.), 16, 1, p. 215-232, 7 pl., 1 fig., Bucureşti.

Nicorici & Istocescu, 1970: *Cercetări biostratigrafice asupra Sarmatianului de la Vârciorog (Bazinul Vadului)*. Studia Univ. "Babeş-Bolyai", Geol.-Min., fasc. 2, p. 47-55, Cluj.

Papp, A., 1954: *Die Molluskenfauna im Sarmat des Wiener Beckens*. Mitt. Geol. Gess., 45, 112 p., 20 pl., Wien.

Popa, M., Cociuba, I., Filipescu, S., 1998 – The occurrence of Sarmatian deposits close to the springs of Vida Valley (Apuseni Mountains, Romania). Studia Univ. "Babeş-Bolyai", Geologia, XLIII, 2, p. 57-64, 2 fig., 1 tab., 2 pl. Cluj-Napoca.

Popescu, Gh., 1998: Stratigrafia Miocenului mediu marin din Paratethysul Central. *Bul. Soc. Paleont. Rom., 4, p. 13-19.* Bucureşti.

Rado, G., 1972: *Studiul biostratigrafic al Sarmatianului din zona Bucuroaia – Calea Mare – Mierlău (Bazinul Beiuş)*. Analele Univ. Bucureşti, Geol., XXI, p. 117-125, 5 pl, Bucureşti.

PLATES

Plate I - Foraminifera from Well no. 20 (scale bar 100μm)

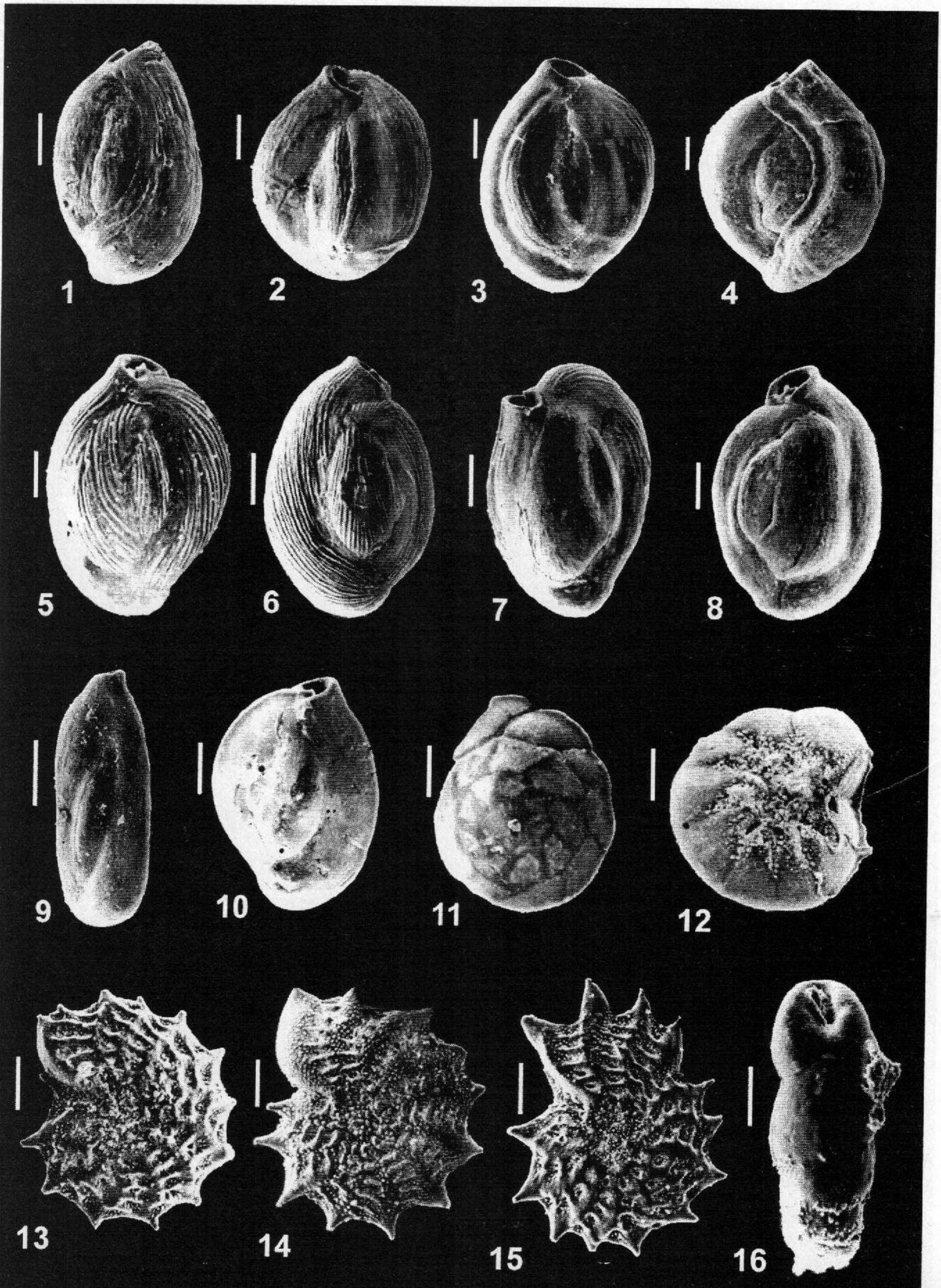
1. *Quinqueloculina* aff. *akneriana* D'ORBIGNY; 11m
2-4. *Varidentella reussi* (BOGDANOWICZ); 14m
5, 6. *Varidentella pseudocostata* (VENGLINSKI); 14m
7. *Varidentella sarmatica* (KARRER); 12.5m
8. *Varidentella* sp.; 12.5m
9. *Pseudotriloculina consobrina* (D'ORBIGNY); 12.5
10. *Quinqueloculina buchiana* D'ORBIGNY; 14m
11, 12. *Ammonia beccarii* LINNÉ; 11m
13, 14. *Elphidium aculeatum* D'ORBIGNY; 14m
15. *Elphidium josephinum* (D'ORBIGNY); 11m
16. *Caucasina subulata* (CUSHMAN & PARKER); 12.5m

Plate II - Foraminifera and ostracods from Well no. 20 (scale bar 100μm)

1. *Elphidium flexuosum* (D'ORBIGNY); 11m
2-5 *Elphidium macellum* (FICHTEL & MOLL); 2 - 14m; 3 - 12.5m; 4,5 - 11m
6. *Elphidium reginum* (D'ORBIGNY); 12.5m
7. *Elphidium incertum* (WILLIAMSON); 11m
8. *Elphidium puscharovski* SEROVA; 11m
9. *Nonion bogdanowiczi* VOLOSHINOVA; 14m
10. *Aurila merita* (ZALÁNYI); 12.5m
11. *Aurila mehesi* (ZALÁNYI); 12.5m
12, 13. *Hemicytheria loerentheyi sarmatica* JIŘÍČEK; 11m
14. *Callistocythere maculata* PIETRZENIUK; 11m
15, 16. *Cytheridea hungarica* (ZALÁNYI); 12.5m
17. *Loxoconcha* cf. *dobrotici* STANCHEVA; 12.5m

Plate III - Gastropods from Well no. 20

1. *Calliostoma angulatum spirocarinatum* (PAPP); 11m, x11
2. *Theodoxus pictus pictus* (FERRUSAC); 11m, x6
3. *Valvata moesiensis* JEKELIUS; 14m, x28
4. *Valvata soceni wiesenensis* PAPP; 11m, x24
5. *Hydrobia frauenfeldi* (HOERNES); 12.5m, x15
6. *Hydrobia cf. stagnalis* (BASTEROT); 12.5m, x10
7. *Hydrobia suturata* FUCHS; 12.5m, x12
8. *Pseudamnicola inflata* JEKELIUS; 12.5m, x20
9. *Pseudamnicola sarmatica* JEKELIUS; 12.5m, x14
10. *Caspia graciliformis* PAPP; 11m, x18
11. *Mohrensternia angulata* EICHWALD; 12.5m, x8
12. *Mohrensternia graecensis* HILBER; 14m, x8
13. *Mohrensternia inflata* ANDRUSOV; 12.5m, x10
14. *Mohrensternia hydrobioides* HILBER; 11m, x7
15. *Mohrensternia multicostata* SENEŠ; 12.5, x8
16. *Mohrensternia* cf. *styriaca* HILBER; 11m, x13
17. *Mohrensternia pseudosarmatica* FRIEDBERG; 11m, x18
18. *Mohrensternia sarmatica* FRIEDBERG; 11, x14
19. *Pirenella picta picta* (DEFRANCE); 11m, x2.5
20. *Hadriania coelata* (DUJARDIN); 14m, x6
21. *Acteocina lajonkaireana lajonkaireana* (BASTEROT); 12.5m, x24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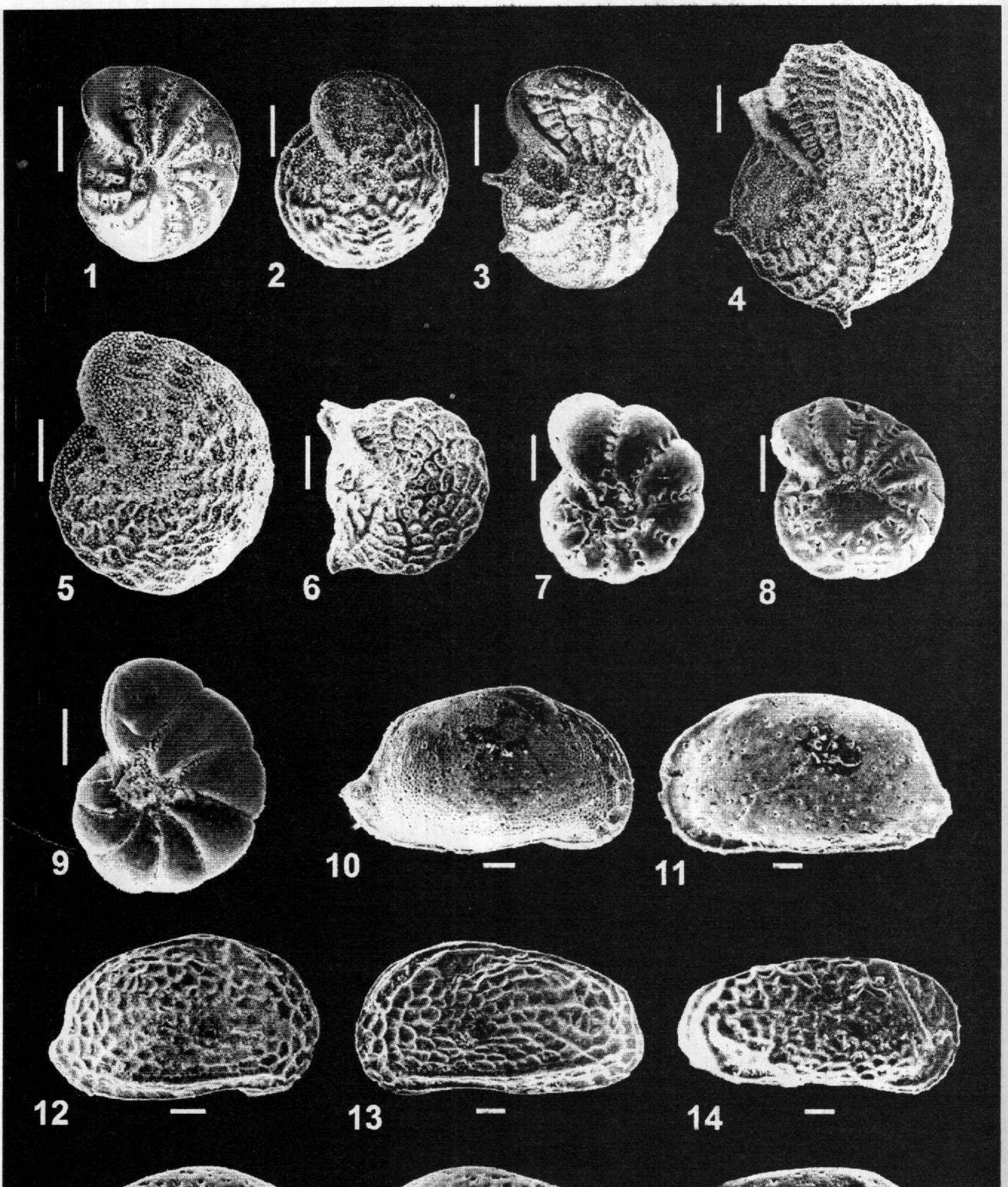
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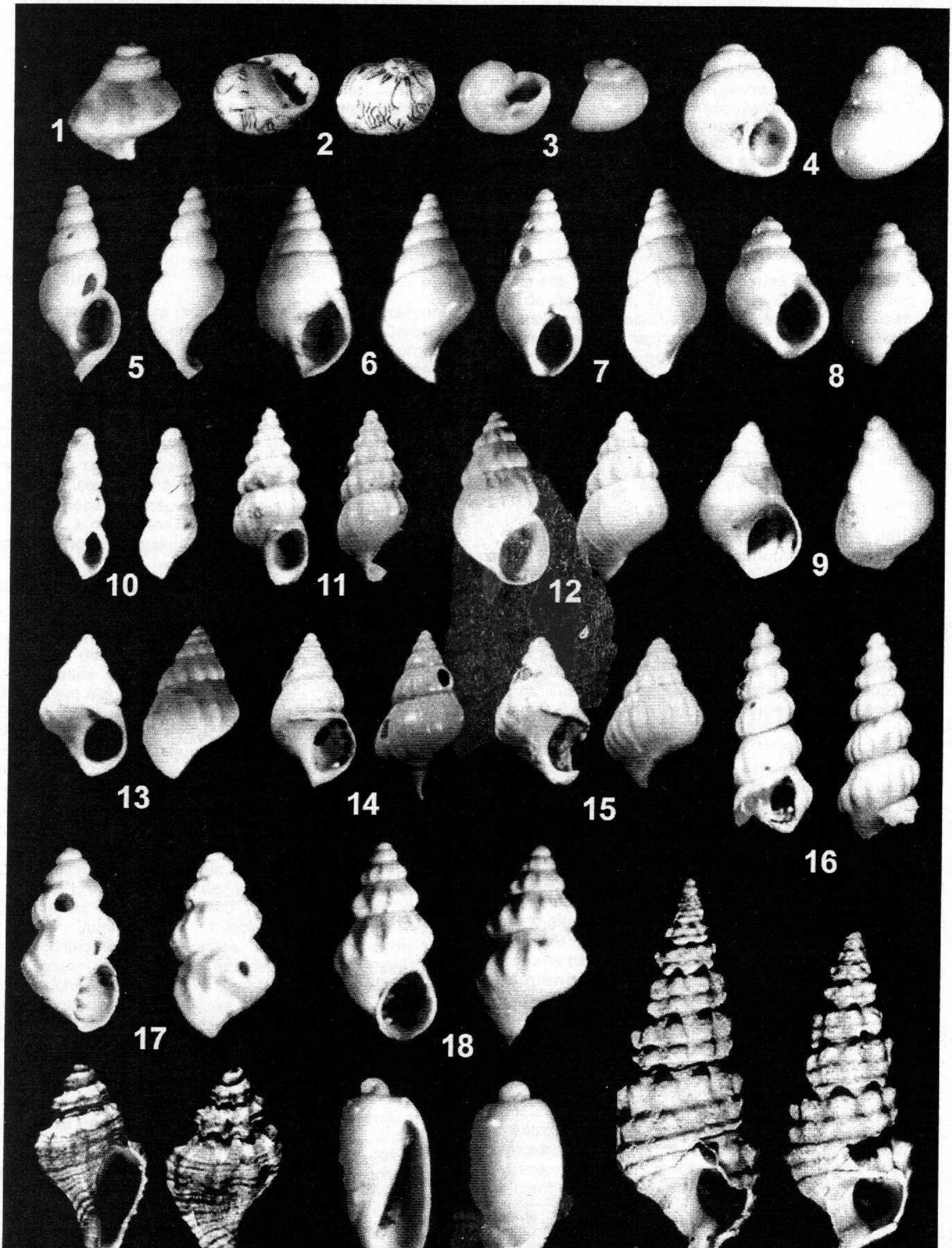
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