ACTA PALAEONTOLOGICA ROMANIAE V. 5 (2005), P. 173-179

SARMATIAN MICROPALEONTOLOGICAL ASSEMBLAGES AND SEDIMENTARY PALEOENVIRONMENTS IN THE SOUTHERN TRANSYLVANIAN BASIN

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Abstract: Contemporary Sarmatian sedimentary environments and associated microfauna were compared in order to explore new opportunities for stratigraphic correlations. Several types of foraminiferal assemblages reflect the facies shifts related to paleoenvironmental changes produced by sea-level fluctuations. Succession of ecological zones give useful markers for sequence stratigraphy and therefore better chances to improve the existing biozonation by adding new calibration points.

Keywords: foraminifera, paleoenvironments, Sarmatian, Transylvania

INTRODUCTION

The Transylvanian Basin is the result of a long evolution which started during the Late Cretaceous. Its sedimentary fill, subdivided into four tectono-sedimentary mega-sequences, reaches locally more than 5000 m (see Krézsek & Bally, in press).

Several important papers were published throughout the past decades (Vancea, 1960; Ciupagea et al, 1970), stimulated by the economic value of the gas accumulations in the topmost (middle to upper Miocene) mega-sequence. The outcrop data were complemented by a large subsurface database owned by Romgaz (thousands of km seismic sections, more than 4000 wells).

Due to the high interest in the Sarmatian reservoirs, several stratigraphic zonations were applied along time. Lithostratigraphic and biostratigraphic markers were widely used in order to restore the reservoirs architecture (Mészáros, 1991; Popescu & Brotea, 1994; Popescu, 1995), but the interpretations had sometimes conflicting meanings because of the poor understanding of the facies.

Many problems occur when attempting to do biostratigraphy, mainly induced by the unusual poor, endemic micropaleontological assemblages, lacking planktonic markers. These assemblages were controlled by peculiar paleoenvironmental parameters, generated by the specific basinal conditions during the Sarmatian (tectonic instability, high rate of sedimentation, poor connections to the open seas). Existing biozonation (Popescu, 1995) proved to be helpless in some cases, due to the various synchronous facies setting. For this reason we decided to look more carefully for the relationship between the types of sedimentary facies and their micropaleontological content, as clues for a potentially improved biostratigraphic zonation.

MATERIAL AND METHODS

Sedimentary environments and associated microfauna were studied in more than 100 Sarmatian locations in southern Transylvania (Fig. 1), between the Târnava Mare River and Southern Carpathians, including previously studied sections (Gheorghian, 1972, 1975; Lubenescu, 1981). In addition, seismic profiles, well logs and micropaleontological data from cores were taken into consideration (wells drilled at Alțâna, Agârbiciu, Grânari, Dealu Frumos, Ghijasa, Tăuni, Valchid, Veseud, Sadânca, Săsăuşi, Buneşti, Ruşi, Cenade, Cădaciu, Porumbeni, Nocrich, and Feliceni).

Data on lithology, sedimentary structures, paleocurrents and tectonic features were collected from the outcrops. Micropaleontological samples, collected from the fine sediments, were processed by standard methods (water dispersion, 63 μm sieving), and photographed using a SEM.

SEDIMENTARY ENVIRONMENTS AND ASSOCIATED MICROFAUNA

Biozonation of the Sarmatian has been always a difficult task for the Paratethyan area and in particular for the Transylvanian Basin. Faunal endemization and absence of planktonic taxa forced the construction of regional biozonations over the last decades (Papp *et al.*, 1974).

Due to the restricted connections to the open seas and probably the dominantly unidirectional (outwards) flow of the surface waters, the planktonic fossil assemblages (e.g. calcareous nannoplankton, diatoms, planktonic foraminifera) are rare and lack index taxa used for global zonations. Besides, the particular deeper environments of the Transylvanian Basin compared to other Paratethyan Basins, generated hostile life conditions, mainly due to the poor oxygenation. Therefore it is very difficult or even impossible to apply the already established biozonations based on benthic macrofauna

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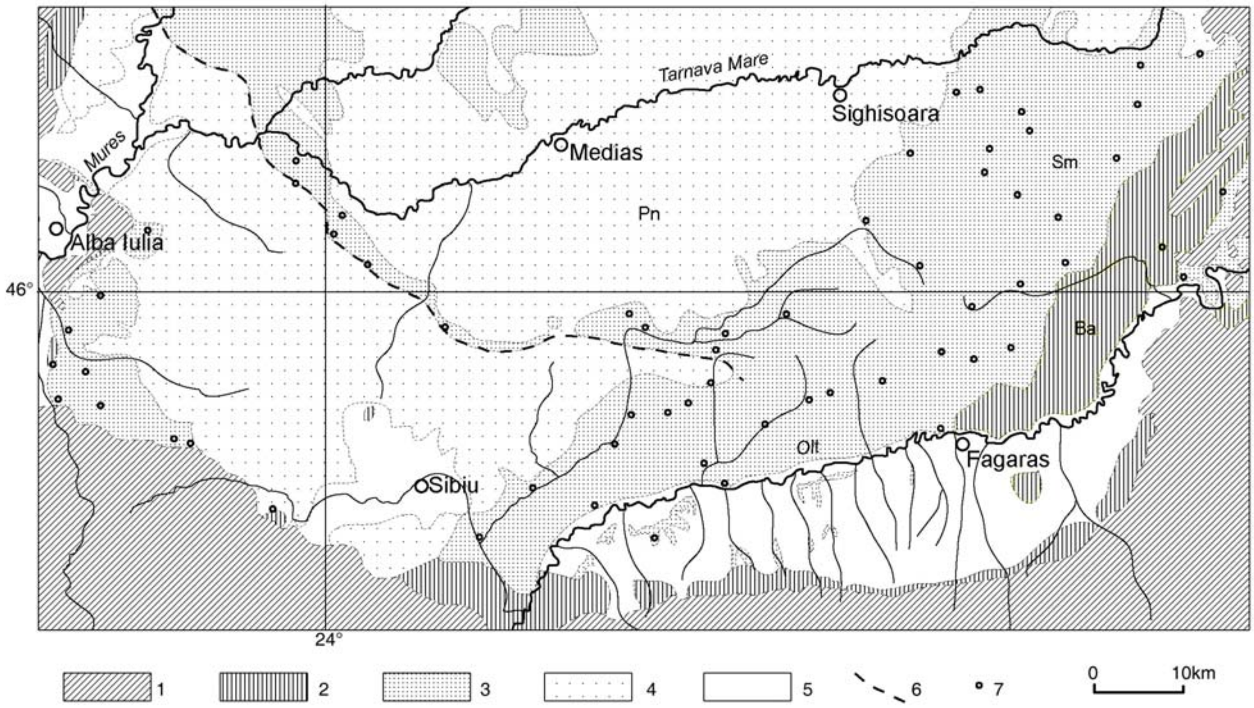

Figure 1: Position of outcrops. 1 - Pre-Middle Miocene formations of the Southern Carpathians and Apuseni Mountains; 2 – Badenian; 3 – Sarmatian; 4 – Pannonian; 5 – Quaternary; 6 – fault; 7 – position of the main outcrops

(bivalves and gastropods) or microfauna (foraminifera, ostracods).

The study of foraminifera have offered a chance to develop a more reliable biozonation, by looking carefully to the assemblages' succession in relation to the environmental changes produced by relative sea-level changes (Krézsek & Filipescu, 2005). For this reason we decided to take a closer look on the relationship between the sedimentary environments and the associated microfauna, in order to improve the biozonation proposed by Popescu (1995), by evidencing the contemporaneous assemblages occurring in different environments (Fig. 2). The facies and age control over different areas were based on data prevailed from outcrops, cores, seismic profiles and well logs.

Relative sea-level changes produced modifications of the characteristic microfaunal assemblages associated to the systems tracts. Shallow ramp to deep submarine fan conditions can be restored based on several types of foraminiferal assemblages.

Recent observations on sedimentation trend and microfauna have shown that the Badenian – Sarmatian transition clearly produced in a transgressive context (Filipescu, 2004; Krézsek & Filipescu, 2005). The lowermost Sarmatian fine deposits preserve foraminifera assemblages consisting of a typical *Anomalinoides dividens* bloom. This taxon is considered as the marker for the base of Sarmatian (Łuczkowska, 1967). Its presence was confirmed in the wells of Feliceni and the distal fan turbidites in the outcrops at Ruşi.

Subsequent to the *Anomalinoides* interval, transgressive conditions give different assemblages. The assemblage of Sărata is very diverse, with fully developed specimens of miliolids, nonionids, and aculeate elphids (equivalent to *Elphidium reginum* Biozone), typical for shallow ramp conditions. Deeper assemblages (with *Nonion* and *Bolivina*) of the same age are present at Arpaşu de Jos. Another example comes from the mid to distal fan turbidites of the same age at Felmer, where deep assemblages with *Bolivina moldavica* are present. Deep environments are also suggested by the assemblage with *Articularia articulinoides* of the Late Sarmatian (Sadânca).

The transition between the transgressive and highstand conditions was usually characterized by more diverse microfauna. Examples could be given from the submarine fan or ramp deposits of Făgăraş, Dacia (Early Sarmatian) or Mureni (Late Sarmatian) Plate 1. Together with foraminifera (*Porosononion* and *Nonion* species), ostracods and dasyclad algae are present (Plate 3). The high proportion of juvenile specimens suggests improper life conditions in the environment and/or transport from the shallower areas.

A particular diverse assemblage was found at Dobârca in proximal ramp conditions, corresponding to the highstand interval of the late Early Sarmatian. Species of *Elphidium, Porosononion* and *Ammonia* are dominant (Plate 2), but they are small, suggesting improper life conditions in the paleoenvironment. Mysid statoliths are also present in this interval, probably associated to delta front environments. Another example could be the miliolid microfauna at Mihai Viteazu (Plate 2), illustrating a possible reworking of the shallow marsh assemblages into the mid to

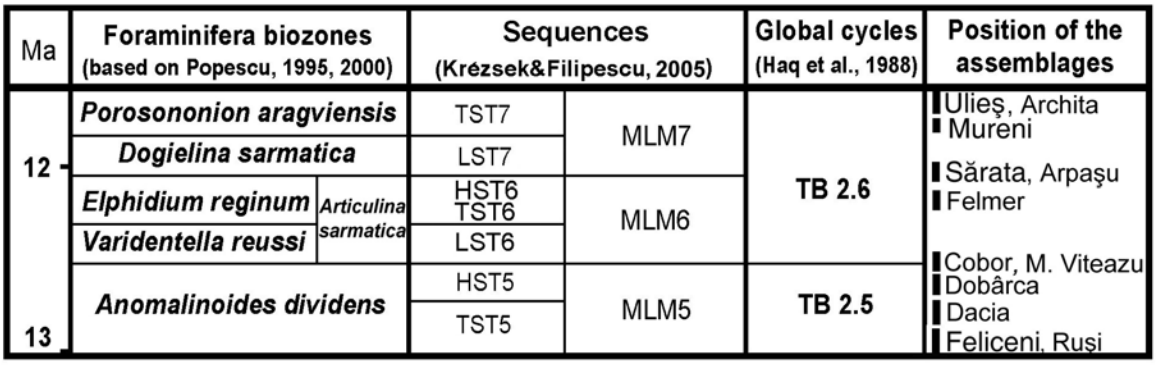

Figure 2: Position of the main types of microfaunal assemblages identified in the southern part of the Transylvanian Basin

distal submarine fans during the transgression or at the base of the highstand.

The late highstand and the transition to the lowstand conditions can be demonstrated by rare shallow foraminifera assemblages with *Porosononion* and *Elphidium*, as identified in the Lower Sarmatian at Cobor (Plate 2).

Erosion prevailed during the lowstand intervals. For this reason, the submarine fans / fandeltas mainly consist of coarse sediments (e.g. conglomerates at Dacia and Beia) and only occasionally preserve reworked faunas.

Characteristic for the transition to the transgressive conditions, the ramp deposits at Ulieş preserve a shallow type of Late Sarmatian with evolved species of *Porosononion* and ostracods (Plates 1, 3).

DISCUSSIONS

The biozones established for the Sarmatian in Romania (e.g. Popescu, 1995) were separated in different facies conditions compared to the situation in the Transylvanian Basin. The benthic assemblages lived in deep-sea conditions, probably with a low oxygenation of the bottom waters (water-column stratification). Therefore, the poor micropaleontological content usually gives a low biostratigraphic control on the Sarmatian deposits.

We consider that submarine fan assemblages consist in a large proportion of transported faunas from the shallower ramp environments. This is probably the reason for the high proportion of juvenile specimens, which were not able to reach the full ontogenetic development because of the improper life conditions. Few taxa living in the deep environments were adapted to a lower oxygen content (e.g. *Bolivina*).

Several types of assemblages can be found in recurrent position, such as *Bolivina* and *Porosononion* assemblages in the Early and Late Sarmatian. This contrasts with the biozonation in use, which considered these two assemblages as typical only for the Late Sarmatian. Although the type of assemblage is similar, usually the specific content is different (e.g. *Porosononion subgranosum* vs. *Porosononion aragviensis*), as a result of the general trend of taxonomic evolution.

The only chance to improve the biostratigraphic value of the micropaleontological assemblages is to put them in relationship to the sedimentary facies shifts related to relative sea-level changes. In most cases relative sea-level fluctuations produced noticeable microfaunal changes, either by migration of ramp assemblages to the deeper area of submarine fans during the highstand, falling stage or lowstand or by upslope migrations during the transgressions. The migration of ecozones is very helpful in order to restore the key surfaces in sequence stratigraphy, and to restore the general evolution of the basin. The use of paleoecological events could reinforce the biozonation based on the taxonomic evolution by adding control points given by sequence stratigraphy. Together with the main 3rd order ciclicity (Krézsek & Filipescu, 2005), higher frequency ciclicity influenced the major sedimentary trend (e.g. within the transgressive trend characterized by the *Anomalinoides dividens* Biozone). Sometimes these minor cyclicities can totally change the local sedimentary configuration, making the interpretation at outcrop level very difficult without well log or seismic control.

CONCLUSIONS

Sarmatian formations in the southern part of the Transylvanian Basin offer good chances to compare contemporary sedimentary facies and associated microfauna.

Several types of foraminiferal assemblages give a good image on facies migrations associated to the sea-level changes and occur repeatedly in the stratigraphic record (e.g. *Porosononion* assemblages related to the low rates of sea-level changes close to the inflection points of the relative sea-level curve).

Biostratigraphy of the Sarmatian in the Transylvanian Basin shows a low degree of reliability if not correlated with sedimentological data. Further work could improve the biostratigraphic zonation by giving more importance to the effects of the sea-level changes.

ACKNOWLEDGEMENTS

The authors are grateful to Netherlands Research Centre for Integrated Solid Earth Science and Cushman Foundation for Foraminiferal Research for funding the field work, also to S.N.G.N Romgaz S.A. Mediaş for giving access to the primary data, Franz Wanek for helping with the ostracod faunas, and to dr. Gheorghe Popescu for reviewing the manuscript.

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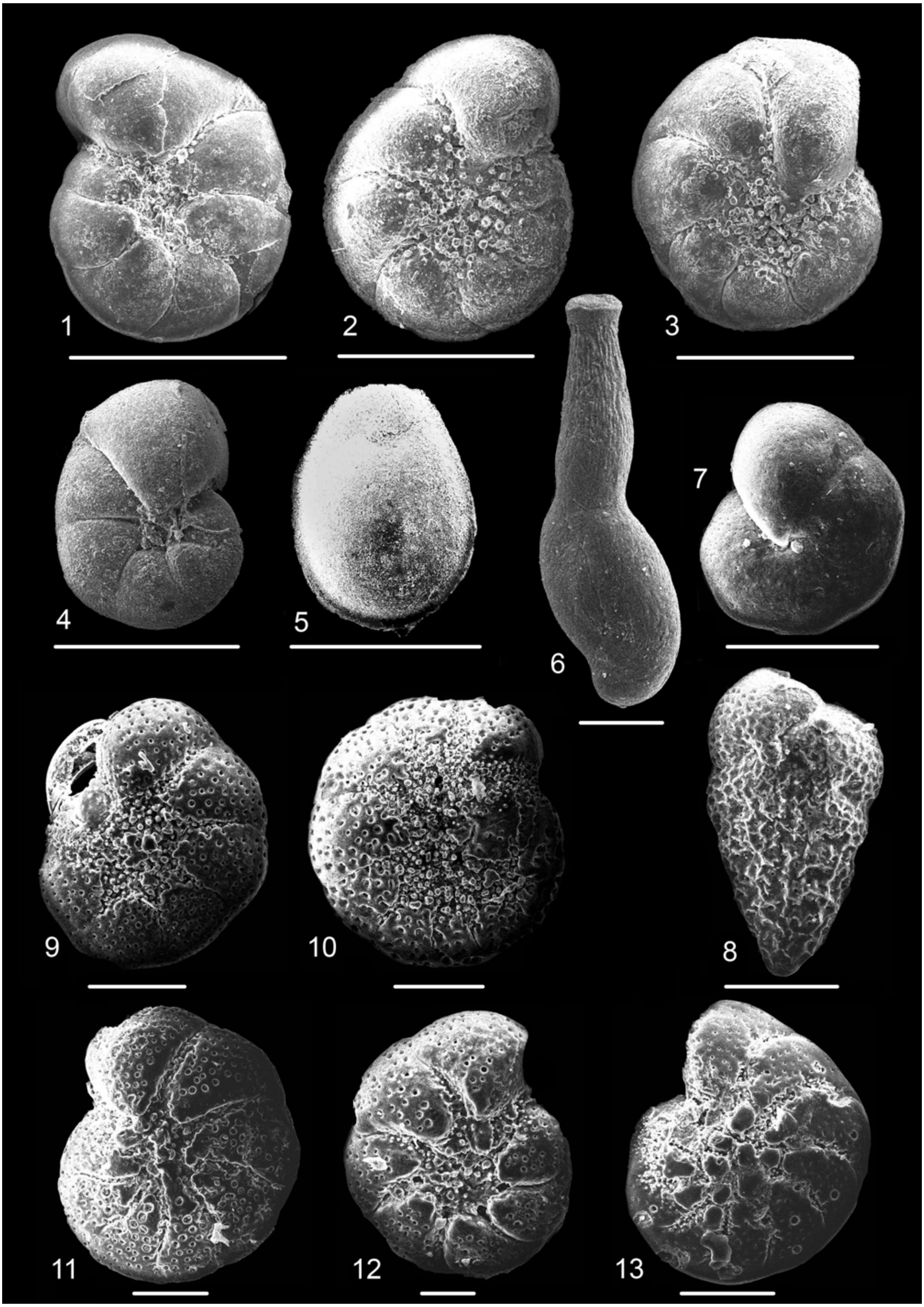
PLATE EXPLANATIONS

PLATE 1: 1-5 Early Sarmatian foraminifera from Dacia: 1. *Nonion* sp. 1; 2, 3. *Porosononion subgranosum* (Egger); 4. *Nonion* sp. 2; 5. *Fissurina bessarabica* Popescu; **6. Late Sarmatian, Sadânca:** *Articularia articulinoides* (Gerke & Issaeva); **7-8 Early Sarmatian, Felmer:** 7. *Nonion* sp. 3; 8. *Bolivina moldavica* Didkovski; **9-10 Late Sarmatian, Ulieş:** 9. *Porosononion martkobi* (Bogdanowicz); 10. *Porosononion bessarabiensis* Popescu; **11-13 Late Sarmatian, Mureni:** 11. *Porosononion martkobi* (Bogdanowicz); 12. *Porosononion sarmaticum* Popescu; 13. *Porosononion hyalinum* Bogdanowicz.

PLATE 2: 1-8 Early Sarmatian foraminifera from Dobârca: 1, 2. *Ammonia beccarii* (Linné): 1-umbilical view, 2-spiral view; 3. *Anomalinoides dividens* Łuczkowska; 4, 5. *Elphidium hauerinum* (d’Orbigny); 6. *Elphidium obtusum* (d’Orbigny); 7. *Nonion serenus* Venglinski; 8. *Nonion tumidulus* Pishvanova; **9. Early Sarmatian, Cobor:** *Porosononion* sp.; **10-12 late Early Sarmatian, Mihai Viteazu:** 10. *Cycloforina contorta* (d’Orbigny); 11. *Triloculina* aff. *gubkini* (Bogdanowicz); 12. *Varidentella reussi* (Bogdanowicz); 13. *Articulina* sp.

PLATE 3: 1-3 Early Sarmatian ostracods form Dacia: 1. *Callistocythere* sp.; 2. *Mediocytherideis* sp.; 3. *Leptocythere (Amnicythere)* sp. 1.; **4-7 Late Sarmatian ostracods from Ulieş:** 4. *Leptocythere (Amnicythere)* sp. 2.; 5. *Aurila* sp.; 6. *Loxoconcha kochi* Méhes; 7. *Haplocytheridea dacica dacica* Hejjas; **8 Early Sarmatian dasyclad from Dacia:** *Halicoryne moreletti* (Pokorny)

PLATE 1



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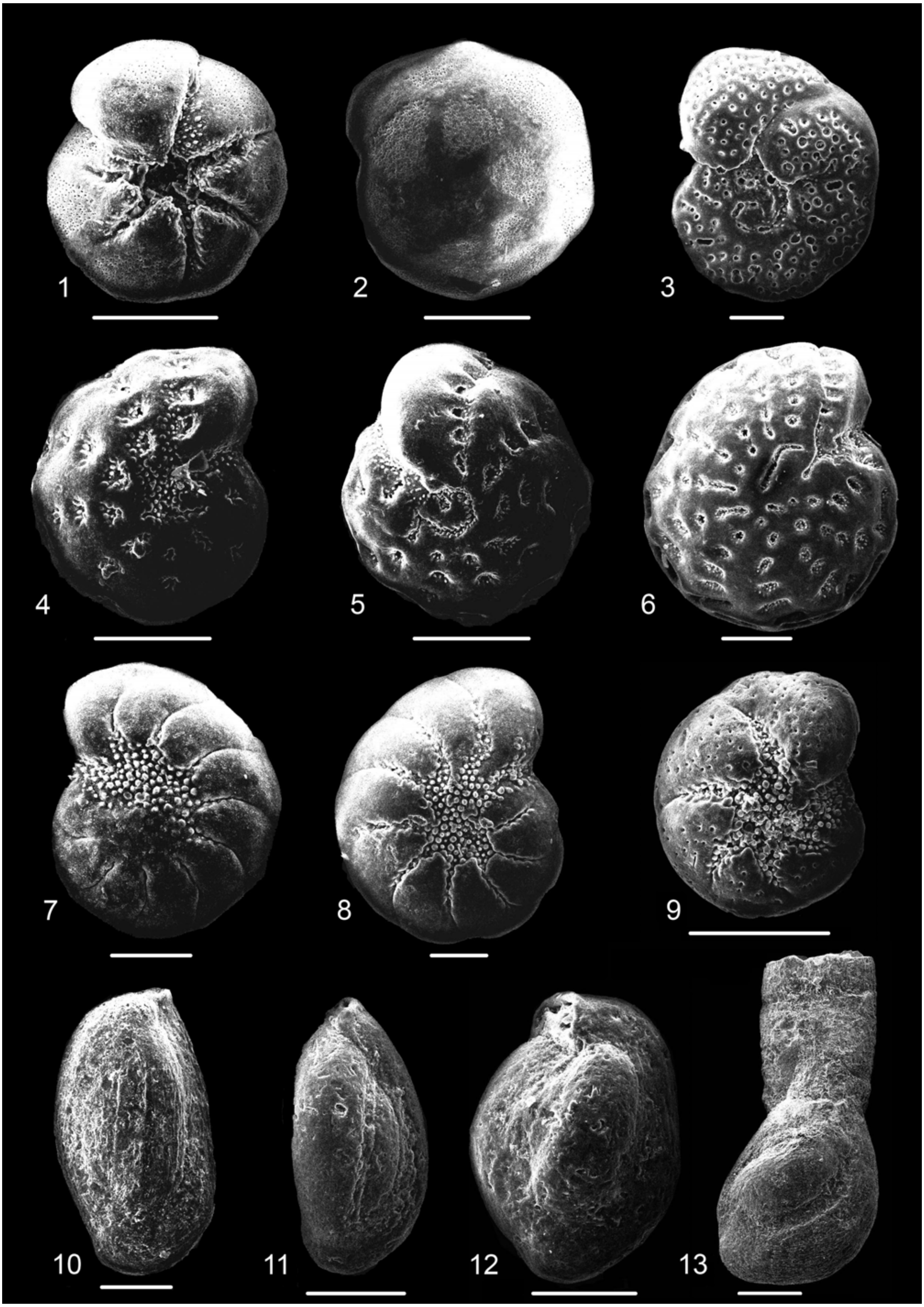

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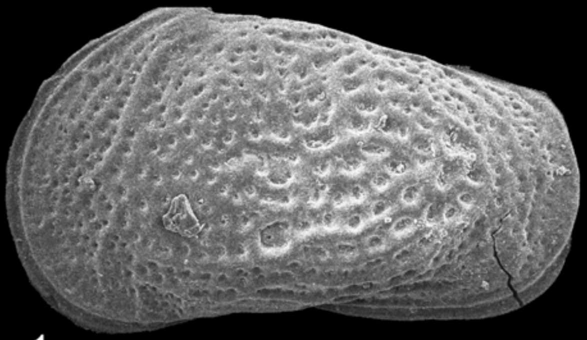
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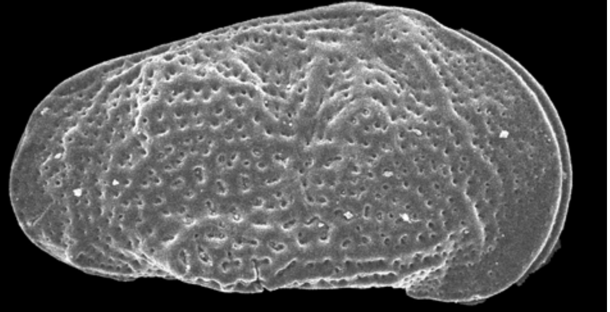
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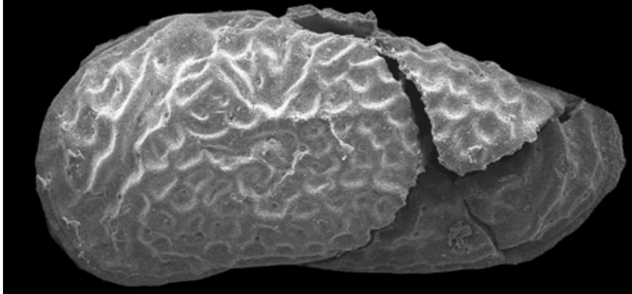
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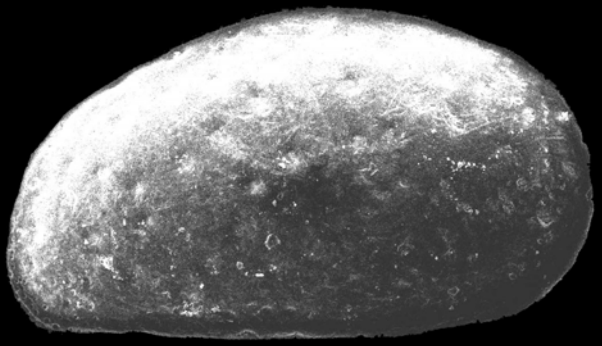
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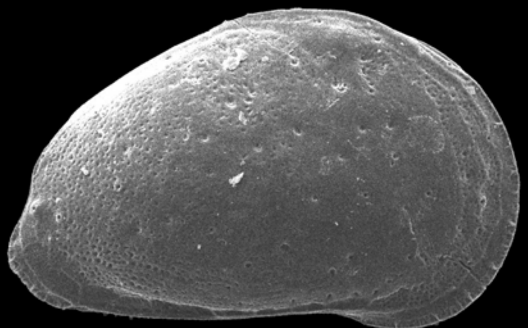
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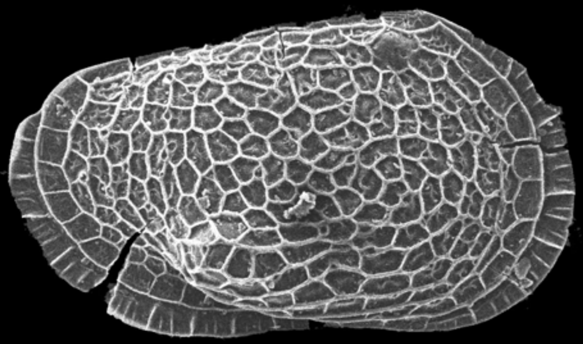
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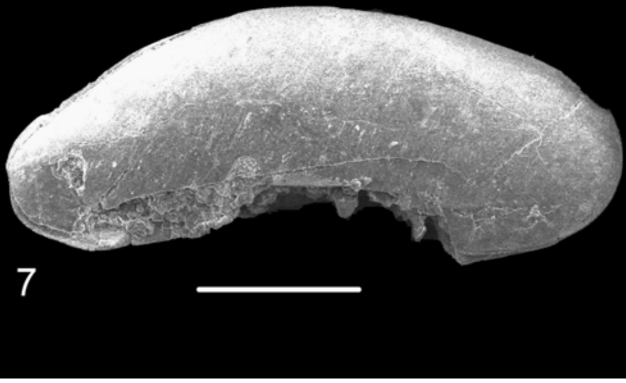
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