

## **ANOMALINOIDES DIVIDENS BIOEVENT AT THE BADENIAN / SARMATIAN BOUNDARY – A RESPONSE TO PALEO GEOGRAPHIC AND PALEOENVIRONMENTAL CHANGES**

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**ABSTRACT.** Recent investigations on the microfauna at the Badenian / Sarmatian boundary (Middle Miocene) showed interesting characters of the *Anomalinoides dividens* foraminifera assemblages. Several taxonomic aspects are considered in order to clarify the meaning of different stratigraphic approaches. A possible planktonic or pseudo-planktonic life of the species is suggested by micropaleontologic, paleogeographic and paleoenvironmental data.

**Keywords:** foraminifera, Middle Miocene, Paratethys, paleoecology, biostratigraphy

### **INTRODUCTION**

*Anomalinoides dividens* a foraminifer species described by Łuczkowska (1967) is considered as an index taxon for the regional biostratigraphy of the Paratethyan area. Its acme characterizes the base of the Sarmatian; therefore the *Anomalinoides dividens* Biozone was introduced in order to trace the boundary between Badenian and Sarmatian deposits.

Recent sedimentologic and micropaleontologic investigations showed new possibilities to interpret the paleoenvironmental conditions around the Badenian / Sarmatian boundary.

### **MATERIAL AND METHODS**

Most of the studied specimens of *Anomalinoides dividens* come from the micropaleontological collection of Romgaz S.A. Mediaș, now in the custody of the Department of Geology of Babeș-Bolyai University. The specimens were collected from exploration wells drilled during the last decades in the Transylvanian Basin.

Individual specimens were studied by using the JEOL JSM 5510LV scanning electron microscope in the Department of Biology, Babeș-Bolyai University. The micropaleontological record was correlated with sedimentological data gathered from cores, well logs and seismic profiles (Krężsek & Filipescu, in press).

### **ANOMALINOIDES DIVIDENS ASSEMBLAGES**

According to the description of Łuczkowska (1967), the test of *Anomalinoides dividens* is "low trochospiral, circular, lobulate, periphery broadly rounded, especially in the last part of the whorl. Spiral side convex with the slightly depressed central part,

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*last whorl broad with 7-10 inflated chambers, enlarging rapidly as added, earlier whorls small and slightly visible in the middle of the depressed part, often covered with thickened shell material, sutures oblique, arcuate. Opposite side involute, umbilicate, few last chambers strongly inflated, triangular, sutures radial. Wall thin, transparent, smooth, densely perforated, especially on the spiral side, the umbilical side with earlier part more sparsely perforated or nearly devoid of pores, granular in structure... Aperture peripheral, large, semicircular, with slightly thickened lip, extending onto the spiral side”.*

Intraspecific variations of test morphology are very common for the *Anomalinoidea dividens* populations (test size and outline, last chamber size and shape, perforation patterns, etc. – see plate 1). As a consequence, several names have been used for the same species:

- *Anomalina grosserugosa* Gümbel sp. Brady, 1884, pl. 94, figs. 4,5;
- *Cibicides certus* Vengliniski, 1953, pl. 5, fig. 10-12;
- *Cibicides (Anomalinoidea) pokuticus* Aisenstat, 1954, pl. 24, fig. 3 (In: Vasilenko, 1954);
- *Cibicides (Anomalinoidea) kaluschiensis* Aisenstat, 1954, , pl. 24, fig. 4 (In: Vasilenko, 1954);
- *Cibicides (Anomalinoidea) postkarpaticus* Aisenstat, 1954, pl. 24, fig. 5 (In: Vasilenko, 1954);
- *Cibicides (Anomalinoidea) transkarpaticus* Pishvanova, 1954, pl. 24, fig. 6 (In: Vasilenko, 1954);
- *Cibicides menneri* Serova, 1955, pl. 26, figs. 6-8
- *Cibicides predecarpaticus* Aisenstat, 1955, pl. 28, figs. 3-5 (In: Serova, 1955)
- *Anomalinoidea dividens* Łuczowska, 1967, pl. 9, figs. 1-8

Although it has no priority, using the name given by Łuczowska is preferred because of the detailed description and illustration of the species.

A few other confusions were done along time:

1. The species was erroneously diagnosed as “*Cibicides lobatulus*”, the type species of the genus *Lobatula* (e.g. Costea & Balteş, 1962; Paghida-Trelea, 1969). *Cibicides lobatulus* (Walker & Jacob) has a flat to irregular spiral side showing thickened sutures, with carinate periphery (see also Loeblich & Tappan, 1988) and these diagnostic features do not conform with the diagnosis of the genus and species in discussion (Plate I).

2. The species was sometimes cited as “*Cibicides badenensis*” or “*Anomalinoidea badenensis*” (e.g. Brestenská, 1974), a typical species for the “upper lagenide zone” of the Badenian. According to Papp & Schmid (1985) d’Orbigny’s species *Anomalina badenensis* has a small, radiate-oval aperture and an ornamented test and differs from the species cited from the Sarmatian.

## DISCUSSIONS

Popescu (1995) considered that the replacement of the Badenian marine faunas with brackish assemblages at the boundary with the Sarmatian could be associated with a global cooling event. This hypothesis is weakly supported both by the global context and the transgressive pattern of sedimentation associated to the *Anomalinoidea* acme (Krezsek & Filipescu, in press).

The “total isolation” of the Paratethyan area at the end of Badenian was a widely accepted working hypothesis until recent decades (e.g. Rögl, 1985, 1998). Sedimentologic and micropaleontologic data (Krezsek & Filipescu, in press) suggest the existence of connections of the Transylvanian Basin to the open seas, at least during the Early Sarmatian. The transgression initiated around the Badenian / Sarmatian boundary occurred during global highstand conditions (see Haq et al., 1988). Probably the switch to the brackish environments produced due to the interference with the tectonic evolution of the Carpathians during the Late Badenian, which restricted the communications to the open seas. This produced water stratification, with a surface brackish layer (supplied by the increased influx of continental water) and an oxygen-depleted deeper layer (a situation analogous to the modern-day Black and Marmara seas).

The unidirectional circulation of the surface waters severely restricted the migration of the normal marine planktonic faunas from the open seas to the Paratethyan basins. Just a few small globigerinids can be found in the lowermost Sarmatian sediments. In such transgressive conditions, with stratified waters, the massive occurrence of endemic populations with *Anomalinoides dividens* needs to be reconsidered. Although it is considered a benthic species, its behavior (spectacular bloom), test structure and exclusive association with small planktonic species, suggests at least a pseudo-planktonic way of life.

As shown in Plate I, fig. 9, the wall structure of the test is bilamellar, a typical feature of planktonic foraminifera. Its morphologic characters are not far from non-spinous, herbivorous, symbiont barren planktonic species. An alternative to the supposed planktonic life could be its pseudo-planktonic behavior, temporarily attached to the floating algae with the spiral side of the test.

Rare small globigerinids (*Globigerina praebulloides*, *G. tarchanensis*, *G. subcretacea*), that occur together with *Anomalinoides* in the deep marine sediments at the Badenian / Sarmatian boundary, were the only typical planktonics able to tolerate the lowered salinity. In such conditions, the ecologic place of the globigerinids was rapidly taken by the endemic *Anomalinoides dividens*.

The transgressive setting at the Badenian / Sarmatian boundary places the *Anomalinoides dividens* acme in a well-defined position within the sequence stratigraphic interpretations. As a consequence of subsequent strong endemization of the Paratethyan faunas, *Anomalinoides dividens* Biozone might be the last confident biozone preceding the ecozones in use for the remaining Miocene.

## CONCLUSIONS

The *Anomalinoides dividens* bioevent represents a valuable biostratigraphic marker with implications in sequence stratigraphic studies. Its occurrence in transgressive settings, together with smaller globigerinids, shows a similar behavior to the planktonic assemblages. The planktonic or pseudo-planktonic life of the species was probably determined by the paleoenvironmental setting, with stratified water column which suppressed most of the benthic life and stimulated the faunas in the upper, well oxygenated, water body.

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**Plate I** - Specimens of *Anomalinoidea dividens* Łuczowska from the Sarmatian of the Transylvanian Basin (scale bar 100 µm): 1-3 Spiral view (1,2 Well 14 Ţelina; 3 Well 11 Fântânele); 4-6 Umbilical view (4,6 Well 14 Ţelina; 5 Well 11 Fântânele); 7-9 Apertural view (Well 14 Ţelina; arrow on specimen 9 shows bilamellar wall); 10 Twin specimens (Well 14 Ţelina); 11, 12 Morphologic variations of the test (Well 11 Fântânele).

Plate I

