

# Badenian/Sarmatian foraminifera shift in the Central Paratethys: Two methods comparison — a morphogroup and species approach

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**Abstract:** Within occasional time intervals during the Late Badenian stage, the connection between the Central Paratethys and Mediterranean was probably closed. Changes in the water circulation regimes were reflected in the development of peculiar conditions on the sea floor. We interpret ecological parameters affecting spatio-temporal prevalence and distribution of foraminiferal assemblages and investigate similarities in functional morphology, which serves as a basis for their morphogroups ordering. The Badenian/Sarmatian boundary, characterized by a major change in the composition of benthic and planktic foraminiferal assemblages in the studied sediments, was proved by both methods.

## Introduction

Due to the great potential of foraminifera and calcareous nannoplankton to preserve in the fossil record and for their relative quick response to changes in ecological factors, they play an important role in paleoenvironmental interpretations of the Middle Miocene northern Paratethyan basins. The main aim of this work is to document the Badenian/Sarmatian boundary based on the correlations of the foraminifera and calcareous nannofossils assemblages and the change in their composition, referred as Badenian–Sarmatian Extinction Event (BSEE) by Harzhauser & Piller (2007), Holcová (2008) and Palcu et al. 2015.

## Material and methods

Rock samples of marine sediments from the key boreholes of the Vienna Basin (MZ-102, IV-19), Danube Basin (ŠVM-1, Poz-4) and East Slovakian Basin (Lo-1, Al-4) were studied and the foraminiferal and calcareous nannoplankton assemblages were quantitatively analyzed. Standard methods were used for microfossils separation and collection (Kováčová & Hudáčková 2009; Jamrich & Halášová 2010). If possible, both foraminiferal and calcareous nannoplankton was studied from the same bulk samples. Published data (Luczkowska 1976; Tóth & Görög 2008; Peryt & Jasionowsky 2012; Gebhart et al. 2009) were used for the correlation and

comparison with our results. Based on statistical analyzes (NMDS and cluster analysis), interpretation of ecological parameters affecting prevalence and distribution of foraminifera assemblages was made. Similarities in the functional morphology of foraminiferal tests enabling effective interpretation of the paleoenvironment were also investigated.

## Results

In total 77 benthic species and 7 planktic species of foraminifera were identified from the 169 samples. Thirty-four taxa stay in open taxonomy due to poor preservation and secondary calcareous coat on the foraminifera test. The Badenian acme zone Tenuitellinata (based on the dominance of *Turborotalia quinqueloba* and *Tenuitella munda*; Filipescu & Silye 2008) and *Bulimina-Bolivina*, *Ammonia*, planktic CPN8 zones (Cicha et al. 1975) were identified in the studied samples. Sarmatian sediments were assigned usually based on presence of *Elphidium reginum*, *Ortomorphina dina*, *Elphidium hauerinum*, *Articularia articulinoidea*, and specific calcareous nannofossil assemblages with acme of *Sphenolithus abies* or monoassemblage of *Braarudosphaera bigelowii* a *B. bigelowii parvula*. In the Sarmatian sediments agglutinated foraminifers absent.

From the upper Badenian sediments, based on statistical analyses (cluster analysis, NMDS analysis) of the benthic foraminiferal assemblages and functional

morphology of their tests, three main types of assemblages/paleoenvironments were interpreted: (i) the *Bulimina–Bolivina* assemblage (elongated morphotypes dominates) of the deeper neritic with restricted ventilation on the basin floor, (ii) the *Ammonia–Porosonion* assemblage (motile shallow infauna morphogroup) of the shallow-water with lowered salinity and dysoxia, and (iii) the *Elphidium–Cibicides–Asterigerinata* assemblage (epiphytic facultative motile and non-motile morphogroup) of the shallow-water with substrate covered by algae and sea grass.

From the Sarmatian sediments, beside of (i) the *Elphidium–Cibicides* association (epiphytic, facultatively motile morphogroup) of the shallow-water with the floor covered by algae and sea grass, (ii) the foraminiferal assemblage with strong prevalence of miliolids (epiphytic morphogroup C motile on algae, biconvex, with keel and morphogroup D permanently motile miliolide coiling) documents hyperhaline conditions on the shelf. An another identified special type of very low diversified assemblage dominated by pseudoplanktic *Anomalinodes badenensis* indicates according by Filipescu (2004) restricted benthic life conditions and stimulated associations in the upper, well oxygenated, part of the water column points to stratified water column conditions.

### Conclusion

Across the whole studied area, our results confirm the Badenian/Sarmatian boundary characterized by a major change in the benthic and planktic foraminiferal assemblages. This change was proved by both methods used. Sarmatian sediments differs from the Badenian by the presence of specific assemblage with a strong prevalence of miliolids of the morphogroup D. Agglutinated foraminifers are the most affected group by BSEE which representatives are absent in the Sarmatian deposits. In the studied area the agglutinated foraminifers appear again in the Pannonian stage (Hudáčková et al. 2018).

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