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FACULTY OF BIOLOGY AND GEOLOGY
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Habilitation thesis

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*Microfossil and Paleoenvironmental
Change from the Cretaceous to the
Quaternary*

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ABSTRACT

The scientific contributions presented in this habilitation thesis are centered on the application of micropaleontological methods to the reconstruction of past environments, climatic evolution, and basin dynamics from the Late Cretaceous to the Quaternary. Although the investigated case studies encompass diverse depositional systems, ranging from continental floodplains to shallow-marine shelves and deep-sea settings, they are united by a common scientific framework: the use of microfossils as sensitive and reliable proxies of environmental change. Through the integrated analysis of benthic and planktonic foraminifera, larger benthic foraminifera, ostracods, and calcareous nannoplankton, combined with sedimentological, stratigraphic, and paleoecological approaches, this body of work contributes to a more comprehensive understanding of paleoenvironmental evolution across different spatial and temporal scales.

A major research direction has focused on the Eocene nummulitic accumulations of the Transylvanian Basin. Detailed investigations of larger benthic foraminiferal assemblages, particularly those dominated by *Nummulites perforatus* and *Nummulites beaumonti*, have provided new insights into the origin, ecology, and depositional dynamics of extensive nummulitic buildups within the northern Tethyan realm. The results demonstrate that the development of these accumulations was primarily controlled by biological productivity, accommodation-space variations, reduced siliciclastic input, and climatic fluctuations, rather than by large-scale sedimentary reworking. Three successive assemblage types were distinguished, reflecting a gradual paleoenvironmental transition from deeper mesotrophic settings to shallower oligotrophic shelf environments. Furthermore, the recognition and analysis of previously undocumented “odd-pair” relationships among nummulitid species contributed to understanding ecological differentiation, reproductive strategies, and environmental adaptation among symbiont-bearing larger benthic foraminifera. Integrated studies of calcareous nannoplankton and smaller benthic foraminifera further revealed pronounced spatial gradients in nutrient availability, oxygenation, and hydrodynamic energy, while microfacies and diagenetic investigations provided valuable insights into the impact of burial processes on porosity and reservoir characteristics.

Another significant contribution addresses environmental and ecological changes associated with the Eocene–Oligocene Transition (EOT), one of the most important climatic reorganizations of the Cenozoic. Quantitative analyses of benthic foraminiferal assemblages from the Brebi Formation documented the response of marine benthic ecosystems to the transition from greenhouse to icehouse conditions. Statistical analyses identified distinct faunal assemblages, fluctuations in diversity, and changes in trophic conditions and bottom-water oxygenation. The results indicate that the EOT within the Central Paratethyan domain was characterized by increased environmental instability, episodic reductions in oxygen availability, and variations in organic matter flux rather than by abrupt extinction events. The recognition of a distinct transitional interval marked by significant ecological reorganization contributes to a more refined understanding of the regional manifestation of global climatic change during the latest Eocene and earliest Oligocene.

The paleoenvironmental evolution of the Lower Miocene Qom Formation in the Central Iranian Basin constitutes another important component of this research portfolio. Detailed analyses of benthic foraminiferal assemblages enabled refinement of the chronostratigraphic framework and supported the assignment of a Burdigalian age to the studied succession. Paleoecological reconstructions revealed the existence of dynamic shallow-marine depositional environments characterized by fluctuations in salinity, oxygenation, hydrodynamic conditions, and sediment input. The identification of the foraminiferal genus *Oligita* represents its first documented occurrence in the region and provides additional evidence concerning marine connectivity between the Indo-Pacific, Mediterranean, and Paratethyan realms during the Early Miocene. These findings contribute to a better understanding of

the paleogeographic consequences of the gradual closure of the Tethyan Seaway and the associated reorganization of marine circulation patterns.

Research addressing the Badenian–Sarmatian transition in the Paratethys critically evaluated existing interpretations of the so-called Badenian–Sarmatian Extinction Event. Through the reassessment of stratigraphic and micropaleontological evidence, methodological shortcomings affecting previous age determinations and paleoenvironmental interpretations were identified. The study emphasized the necessity of high-resolution sampling and comprehensive micropaleontological analyses for accurately constraining environmental and biotic changes associated with this major regional transition. The results suggest a more complex environmental evolution than previously proposed and contribute to ongoing discussions regarding the timing and nature of Paratethyan basin isolation and faunal turnover.

The application of micropaleontological approaches to modern and Quaternary marine environments is represented by investigations of benthic foraminiferal assemblages offshore Cape Blanc in Northwest Africa. Analyses of assemblages distributed across shelf, slope, and abyssal settings revealed a pronounced ecological zonation controlled by depth, oxygen availability, organic-matter supply, and regional oceanographic circulation. Five distinct assemblage types were identified and interpreted within the context of one of the world's most productive coastal upwelling systems. Furthermore, the study provided a critical assessment of widely used benthic foraminiferal oxygen proxies and demonstrated that species-based ecological classifications frequently offer higher predictive power than composite oxygen indices. These results contribute to methodological improvements in paleoceanographic reconstruction and enhance understanding of the ecological mechanisms governing benthic foraminiferal distribution in highly productive marine environments.

An additional contribution involves the description of *Globotalicypridea mirabilis*, a new non-marine ostracod species from the Upper Cretaceous deposits of the Haţeg Basin. This discovery represents the first formally described non-marine ostracod taxon from this internationally renowned vertebrate-bearing basin. Paleoecological interpretation indicates that the species inhabited freshwater floodplain ponds or oxbow-lake environments developed within a fluvial system under periodically stagnant conditions. Beyond its taxonomic significance, the discovery expands the known paleobiogeographical distribution of the Talicyprideinae and provides new information regarding the biodiversity and environmental conditions of Maastrichtian continental ecosystems.

Collectively, these investigations demonstrate the exceptional value of microfossils as high-resolution archives of environmental and climatic change. By integrating taxonomic, paleoecological, biostratigraphic, sedimentological, and quantitative analytical approaches, this body of research has contributed to advancing knowledge of marine and continental ecosystem evolution, basin development, paleoceanography, paleobiogeography, and the response of biological communities to major environmental perturbations. The results highlight the central role of micropaleontology in addressing fundamental questions concerning Earth system evolution from the Late Cretaceous to the present day.

My future academic development will focus on strengthening my international scientific profile in micropaleontology, paleoceanography, stratigraphy, and sedimentology while fostering a modern, student-centered educational environment at Babeş-Bolyai University. I aim to continuously enhance the quality of geological education through updated curricula, digital teaching resources, interactive learning methods, and field-based training. A key priority will be the development of a coherent mentoring pathway from undergraduate studies to doctoral research, promoting student involvement in scientific projects, publications, conferences, and international mobility programs. Through expanded collaborations with leading European universities and active participation in doctoral education, I seek to contribute to the training of highly skilled geoscientists equipped for both academic and professional careers.

My future research will focus on advancing knowledge in paleoceanography, paleoclimatology, micropaleontology, biostratigraphy, and sedimentary basin evolution through innovative and interdisciplinary approaches. I intend to expand the application of quantitative methods, morphometrics, statistical paleoecology, and data science to address complex geological questions while strengthening the PaleoSed research group through the integration of doctoral candidates, postdoctoral researchers, and international collaborators. Alongside securing competitive national and international research funding, I will continue contributing to academic leadership, scientific publishing, geological heritage preservation, and public engagement. My long-term objective is to help build a modern, internationally connected, research-intensive geological community that combines educational excellence, impactful research, and meaningful societal contribution.