



UNIVERSITY OF
BUCHAREST
VIRTUTE ET SAPIENTIA

THE 14th ROMANIAN
**SYMPOSIUM
ON PALAEOONTOLOGY**
BUCHAREST - September 14th - 15th, 2023
ABSTRACT BOOK

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EDITURA UNIVERSITĂȚII DIN BUCUREȘTI
BUCHAREST UNIVERSITY PRESS

2023

TALK

A new, long view on an old mammalian island radiation – updating the history of kogaionid multituberculates

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Keywords: Kogaionidae, Transylvanian Landmass, latest Cretaceous, distribution, evolution

The Kogaionidae is a very distinctive family of derived, cimolodontan multituberculates, an extinct group of superficially rodent-like Mesozoic-Paleogene mammals (Kielan-Jaworowska and Hurum, 2001). It is diagnosed mainly by synapomorphies of the skull and especially dentition (e.g., Csiki-Sava et al., 2022; Smith et al., 2022), and is known to be restricted exclusively to the latest Cretaceous and Paleocene of Europe. Most importantly, the group appears to have been strictly endemic to an emergent landmass of southeastern Europe during the latest Cretaceous (the Hațeg Island; Csiki-Sava et al., 2015), as fossils of its members are recorded only from uppermost Cretaceous continental deposits of the Transylvanian area, western Romania, rocks that represent the remnants of this once-existing landmass within the Late Cretaceous European Archipelago.

It is in these deposits that kogaionids reached their peak diversity (with 5 species belonging to 3 genera described formally until recently; Csiki-Sava et al., 2022; Smith et al., 2022) and are represented by an impressive fossil record (for Mesozoic mammalian standards), including several more or less complete skulls, tooth-bearing gnathic remains, scores of isolated teeth, and even partial skeletons that document important diversity and disparity in body size and dental morphology. By adding together all these characteristics, the latest Cretaceous Transylvanian kogaionids can be easily portrayed as members of an endemic deep-time island radiation, one that poses several intriguing questions related to their origin, evolutionary history, and significance for wider multituberculate (and mammalian) evolution. Stemming from these considerations, our team set out a few years ago to find answers to some of these questions, our research being funded through a grant of the Romanian Ministry of Research, Innovation and Digitalization, project PN-III-P4-ID-PCE-2020-2570 – ‘Natural history of an endemic island radiation’. Herewith, we sum up and offer a synthetic overview of the results achieved up to the present in this project, review ongoing research activities, and highlight the lead-ups to future research seeded by the project.

The aims of the project were several-fold, including (i) the mapping of the temporal and spatial distribution of the latest Cretaceous Transylvanian kogaionids; (ii) establishing their taxonomic identity and diversity, systematic affinities, as well as phylogenetic relationships; and (iii) studying their cranial morphology, with special emphasis on brain structure and development of sense organs, in order to understand the influence of these palaeobiological features upon their evolutionary fate and, more widely, on the evolution of multituberculate and mammalian sensorial abilities. The most important results and outcomes of the project can be summed up as follows:

- prospecting of the main uppermost Cretaceous fossiliferous continental units from the Hațeg, Rusca Montană, and southwestern Transylvanian basins have led to the discovery of several new fossiliferous localities, including some that also yielded remains of multituberculates; we have reported on 4 new multituberculate localities identified (but never mentioned previously) before 2021, and identified 3 entirely new multituberculate occurrences, bringing the grand total of known kogaionid localities to 30, mostly situated in the Hațeg Basin; detailed study of some of the older, as well as of the newly identified, kogaionid assemblages is underway, but will be completed only in a

short-to-medium term, given the large amount of fossil material currently available. It appears that even potentially new taxa may be represented among the studied material.

- palaeontological survey of both the newly discovered fossil localities and that of some of the previously known ones led to the identification of new occurrences of several other vertebrate, invertebrate, and ichnofossil taxa, whereas the sedimentological-taphonomic study of their hosting rocks allowed a better definition of the local palaeo-habitats, thus completing our knowledge concerning the abiotic and biotic environment within which the kogaionids once lived; detailed investigation of these new fossil assemblages is still underway, but will extend in the foreseeable future as well, as preliminary investigations suggest the possible presence of new taxa.

- gathering together both previously published and newly acquired information, a detailed general overview of the kogaionid spatio-temporal distribution was accomplished (Csiki-Sava et al., 2022), documenting exhaustively aspects such as sedimentary/living environment, sympatric fossil assemblages, and age of the different occurrences; on its turn, this synthesis allowed us to draw a novel picture of their geographic and stratigraphic distribution patterns, and to reveal/hint at certain previously unrecognized features of their evolutionary history and palaeoecology; the patterns identified in this overview must be checked through further, more in-depth studies of the available kogaionid material, its associated fossil assemblages, as well as that of the hosting rocks.

- the collection and analysis of a large number (several tens) of palynological samples from the fossiliferous continental beds yielded new constraints on the age/temporal distribution, as well as on the palaeoenvironmental conditions of the kogaionids and their associated fauna/flora; additionally, collection of an even larger number of palynological and micropalaeontological (foraminifera, calcareous nannoplankton) samples from marine beds of the wider Transylvanian area either immediately underlying and/or correlative with the continental beds offered new insights both in the timing of the emergence of the Hațeg Island as well as that of its vertebrate faunas, including the kogaionids (e.g., Țabără et al., 2022). Analysis and assessment of the samples from several regions that are considered in this research is still in progress, while further sampling is planned notwithstanding in certain areas, with the aim to further detail the already existing or currently emerging stratigraphic and palaeoenvironmental information.

- the first ever U-Pb geochronometry data were gathered, using both igneous and detrital zircon samples from the areas of interest, supplementing the 'classical' biostratigraphic age constraints. Albeit many of the samples are yet to be analysed, or with the results of the analyses under evaluation, it is nevertheless already clear that the new geochronometric data refine or even alter significantly previously established temporal constraints on the evolution of Hațeg Island and its kogaionids.

- finally, a large sample of kogaionid skulls had been microCT-scanned, the scans are being rendered and segmented, offering the first insights into the cranial anatomy, brain and sensory organs of a wide range of kogaionids; these studies will be completed in the medium-to-long term.

Acknowledgments: This research was supported by Ministry of Research, Innovation and Digitization, CNCS – UEFISCDI, project PN-III-P4-ID-PCE-2020-2570, within PNCDI III; we also warmly thank the contribution and support of all our collaborators (too many to name them here), from Romania and abroad.

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