

Final report on the Plant mesofossil-based environmental reconstruction of the Late Cretaceous land of dinosaurs in the Bakony Mts. project

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The researched did not follow the research plan of the project due to the pandemic, but the overall project schedule was sustainable.

1.) Studies on the macroflora from Iharkút.

The recent, OTKA related study is focused on the vegetation reconstruction of Iharkút based on leaf flora. 253 leaf specimens were studied from the collection of the Hungarian Natural History Museum. Most specimens are angiosperms, but *Sphenopteris gruenbachiana* was also found. Before the Iharkút findings, the species was unique for the Grünbach Flora. Despite their fragmentary preservation the Iharkút specimens were clearly assigned to *S. gruenbachiana* species based on the pronounced and cordate bases as well as the uniform marginal teeth. The monocots are represented by *Pandanites* sp. The most common forms are the platanoids (60 specimens). Naming Cretaceous platanoid leaves is still questionable. We used *Ettingshausenia* sensu Maslova for these fossils. The other important dicot genus is *Juglandophyllites*. Based on the leaf flora from Iharkút there are two canopy habitats distinguishable: a juglandoid and *Pandanites* dominated wetland forest (bed-1) and an *Ettingshausenia* dominated riparian plant community (bed-6).



Juglandophyllites

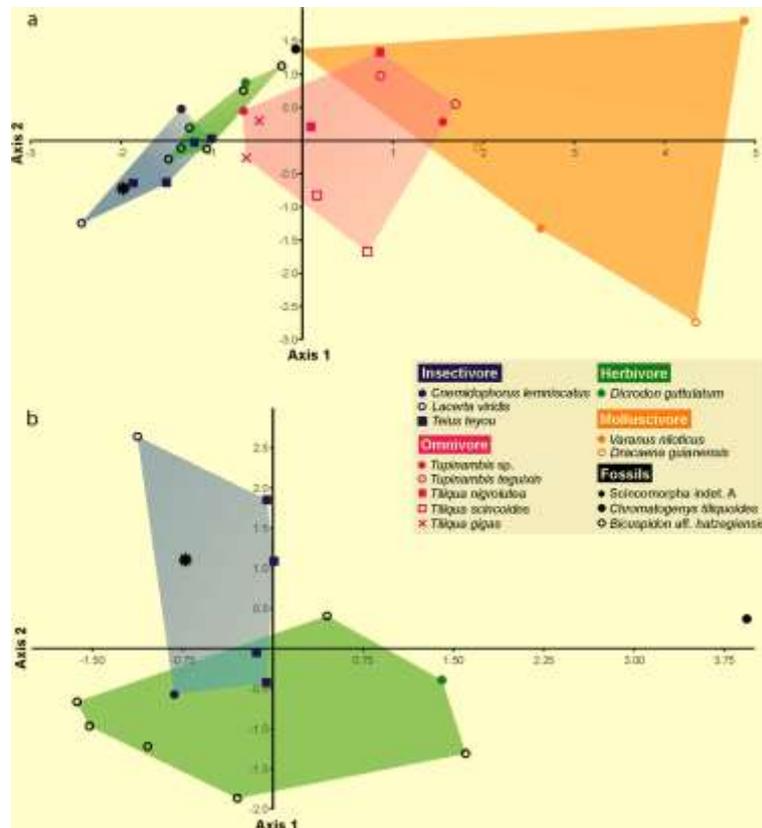
Publication:

Bodor, ER ✉ ; Erdei, B ; Kvacek, V ; Botfalvai, G The leaf flora of the Iharkút Dinosaur Site (Bakony Mts. NW Hungary) In: Crespo, VD (szerk.) 2nd Palaeontological Virtual Congress : Book of Abstracts Valencia, Spanyolország : Universitat de Valencia (Spain) (2020) p. 120

2.) Applied study of the vegetation results and morphometrical methods

Iharkút vertebrate locality provided a diverse lizard fauna. In order to infer their food preference, jaw and tooth morphology, as well as dental macro- and microwear were analysed in the paper of Kinga Gere et al. Extant lizards, including omnivores, durophages, insectivores, molluscivores and a herbivore, were used as analogies for interpretation. Based on morphological and dental wear studies, *Bicuspidon* with its complex bicuspid teeth might have fed on both softer and harder food items, and according to dental wear analysis, its diet can be placed between herbivory and insectivory. From the macroflora the *Sphenopteris gruenbachiana* was possible food for *Bicuspidon*. In the mesofossil record we can find seeds and fruits of the undergrowth as representatives of Ericaceae, Urticaceae, Sabiaceae.

Testing multivariate morphometrical analyses of different fossil groups is also an important aim of the recent NKFIH project. Data from morphometric and microwear studies were statistically analysed with Principal Components Analysis (PCA) and Linear Discriminant Analysis (LDA). Based on LDA 68.97% of the material is correctly classified. The majority of the recent lizards are retained in the original dietary category what makes the analyses reliable.



Results of the LDA analysis. (A) includes all the extant and fossil taxa

Publications:

Gere, K ✉ ; Bodor, ER ; Makádi, L ; Ősi, A Complex food preference analysis of the Late Cretaceous (Santonian) lizards from Iharkút (Bakony Mountains, Hungary) HISTORICAL BIOLOGY 33 : 12 pp. 3686-3702. , 17 p. (2021)

3) Comparing the Iharkút locality with other European Late Cretaceous continental vertebrate sites was important aim of NKFIH project. Due to the pandemic these works were focused on already collected materials.

3.1) Hateg Basin

One of the most important classical dinosaur localities of the Carpathian region is the area of Hateg. In the early years of the 20th century, Ottokár Kadić discovered a rich and diverse Late Cretaceous vertebrate material assemblage around Vălioara in the Hateg Basin, including fossils of several dinosaurs and the holotype remains of the unique *Allodaposuchus* crocodile. These vertebrate fossils were collected from seven different main sites localities and are now housed in the collections of the MBFSZ of Hungary. However, the collection was mixed after the 2nd World War and thus this unprovenanced material currently can't be used for further palaeoecological investigations. Nevertheless, by the aid of Kadić's archive excavation map the former excavation sites have been localized. It shows the exact positions of the seven sites localities around Vălioara after georeferencing the map, making it relevant and possible and allows to matching these localities with the historically collected specimens using geochemical methods. In order to determine potential geochemical differences among the sites, we selected several specimens with recorded stratigraphic position, measured their trace element compositions, and used these as independent proxies to assess the probable stratigraphic origin of the historical vertebrate fossils. Our detailed sedimentological, geochemical and palaeontological investigations around Vălioara contribute to a deeper understanding of the distribution, evolution and palaeoecology of the Hateg vertebrate faunas during the latest Cretaceous and help the comparison to the vegetation of Iharkút.

Publications:

Botfalvai, G ✉ ; Magyar, J ; Gáspár, A ; Kocsis, L ; Bodor, ER ; Makádi, L ; Csiki-Sava, Z Sedimentological, geochemical and paleontological investigations of Late Cretaceous (Maastrichtian) vertebrate fossils from Valioara Valley (Densus-Ciula Formation, Hateg Basin Romania) In: Crespo, VD (szerk.) 2nd Palaeontological Virtual Congress : Book of Abstracts

Csiki-Sava, Z ; Botfalvai, G ; Makádi, L ; Albert, G ; Magyar, J ; Kocsis, L ; Tabara, D ; Bodor, ER A "kincses térkép" - lelőhelyek, dinoszauruszok és ősemlősök nyomában a Hátszegi-medence nyugati sarkában In: Erdélyi, Magyar Műszaki Tudományos Társaság XXII. Bányászati, Kohászati és Földtani Konferencia Kolozsvár, Románia : Erdélyi Magyar Műszaki Tudományos Társaság (EMT) (2021) pp. 57-61. , 5 p.

Botfalvai, G ; Csiki-Sava, Z ✉ ; Kocsis, L ; Albert, G ; Magyar, J ; Bodor, ER. ; Tabără, D ; Ulyanov, A ; Makádi, L 'X' marks the spot! Sedimentological, geochemical and palaeontological investigations of

Upper Cretaceous (Maastrichtian) vertebrate fossil localities from the Vălioara valley (Densuș-Ciula Formation, Hațeg Basin, Romania) CRETACEOUS RESEARCH 123 Paper: 104781 (2021)

3.2.) Insect eggs

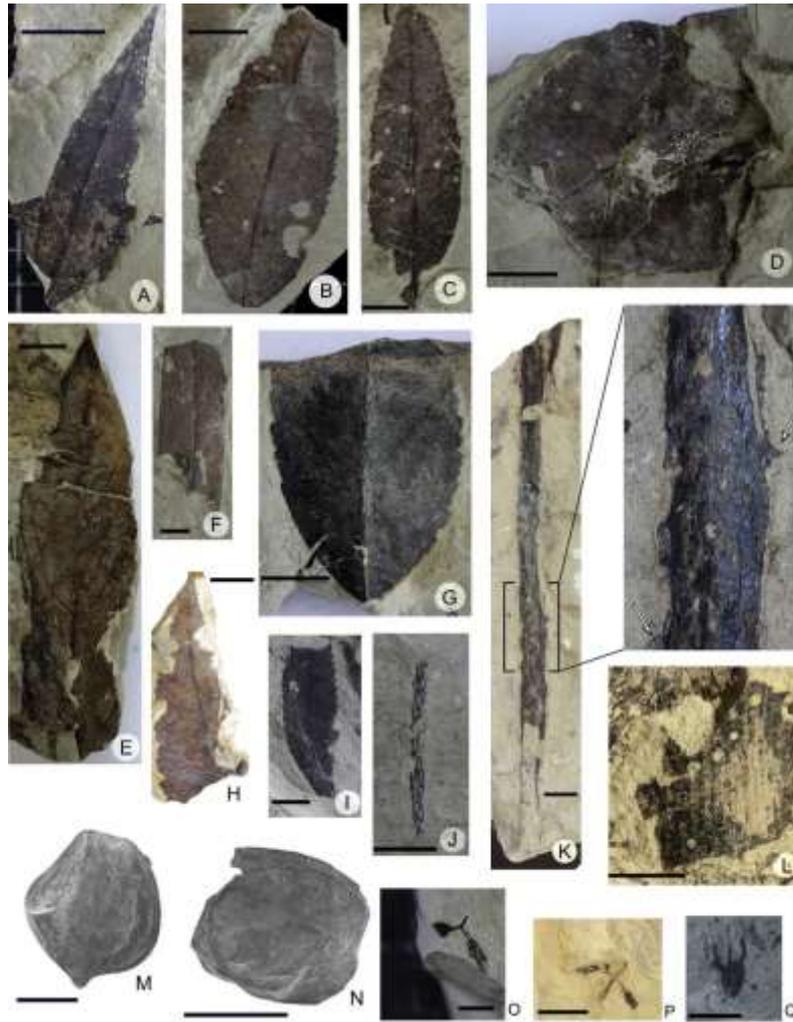
Insects are extremely important elements of ecosystems, yet are rare in the fossil record because of their low fossilisation potential. The known diversity of fossil insects has been grown during the last years according to exploring their eggs. In the case of ichnofossils, however, the distinction of different taxa has always been questionable. In this study, a combination of statistical analyses was employed to investigate the variability of several parameters measured in Late Cretaceous fossil insect eggs from the Hațeg Basin (Romania) with the aim of improving the algorithms used in morphometric data analysis. The proposed combination of methods may also serve as a case study for other similar investigations. The analysis lends support to the identification of a new insect egg ichnogenus. Furthermore, a new ichnospecies of genus *Knoblochia*, is also described, and the analyses employed herein were also able to identify, for the first time in the fossil record, different developmental phases.

Publications:

The paper is finished, after the acceptance of coauthors it can be submitted to Cretaceous Research. Emese Réka Bodor, Ștefan Vasile, József Kovács, Zoltán Csiki-Sava, Zuzana Heřmanová (in prep.): New morphometrical algorithm on Cretaceous insect eggs. - Fossil insect eggs from the uppermost Cretaceous of Romania as a case study for morphometrics

3.3.) Tiefengraben near St. Wolfgang, Austria

The comparison with different Gosau localities was also planned for year 2021, but due to pandemics these studies were also done in 2020 and finished in 2021. The Turonian–Coniacian continental fossil record in Europe is less known. Here we present a new early Coniacian fossil assemblage that was systematically collected from the coal-bearing Gosau Group of the Tiefengraben near St. Wolfgang, Austria. The diverse assemblage is composed of more than 50 taxa including sporomorphs and Normapolles-related pollen, seeds and leaves of angiosperms and gymnosperms, gastropods, bivalves, ostracods, termites, fish, crocodiles and dinosaurs. The discovered remains of algae, molluscs, ostracods, calcareous nannofossils and lepisosteid fish represents a mixed faunal assemblage from different paleohabitats from the low salinity to the freshwater or terrestrial environments. As Normapolles-related angiosperm plants dominate the flora, a slightly cooler microenvironment compared to other Turonian–Coniacian Central European localities is indicated. The fossil assemblage of this early Gosau Group occurrence is of great importance for our understanding of the continental floristic and faunistic composition of the western Tethyan archipelago during the Cenomanian–Campanian hiatus.



Most interesting fossil plants from Tiefengraben

Publication:

Ósi, A ✉ ; Szabó, M ; Tóth, E ; Bodor, E ; Lobitzer, H ; Kvaček, J ; Svobodová, M ; Sente, I ; Wagneich, M ; Trabelsi, K et al. A brackish to non-marine aquatic and terrestrial fossil assemblage with vertebrates from the lower Coniacian (Upper Cretaceous) Gosau Group of the Tiefengraben locality near St. Wolfgang im Salzkammergut, Austria CRETACEOUS RESEARCH 127 Paper: 104938 (2021)

3.4. Ajka Coal Formation

The present distribution of the Ajka Coal Formation indicates that it was deposited at least in three different subbasins (Ajka, Magyarpolány-Devecser, Gyepükaján, Császár and Góczán 1988). The Ajka and the Magyarpolány-Devecser Subbasins sedimentological evidence suggest similar processes, with sequences starting with freshwater, shallow swamp sediments deposited during the palynological zones A or B. In the macrospore flora the Isoetaceae related forms are common. By the time of zone C the environment turned into a lacustrine, nutrient-rich marsh in the Ajka Subbasin, while in Magyarpolány the fluvial influence became more dominant, and the area was filled up by fluvial

sediments (Siegl-Farkas 1988). Frequent remains of seeds and fruits from this subbasin suggest an arboraceous environment (Rákosi and Barbacka 2000). By the time of zone C a freshwater marsh environment became dominant also in the Gyepükaján area. Based on ostracods (MONOSTORI 1988) and mollusk studies (CZABALAY 1988) the water became brachyhaline to mesohaline, but reports of RÁKOSI on algae suggest freshwater forms. Regina Mizsei, a BSc student at ELTE Palaeontology Department, started ostracod studies of the area under supervision of Emőke Tóth to reconstruct the paleoenvironmental conditions. I was involved in the project to help the chronostratigraphy based on palyno zonation and make palaeoenvironmental interpretation based on plant remains.

Publication:

Késő-kréta növényi mezofossziliák szerepe az üledékképződési környezetek szalinitásviszonyainak meghatározásában In: Virág, Attila; Bosnakoff, Mariann (szerk.) 21. Magyar Őslénytani Vándorgyűlés: program, előadáskivonatok, kirándulásvezető Budapest, Magyarország : Magyarhoni Földtani Társulat (2018) 56 p. p. 6

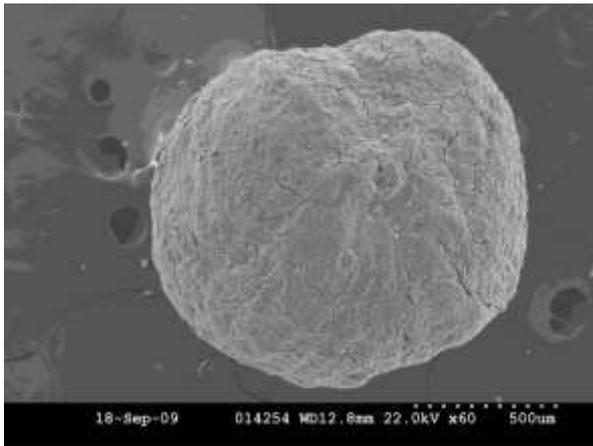
Bodor, Emese ; Ősi, Attila ; Püspöki, Zoltán ; Botfalvai, Gábor ; Sári, Katalin ; Makádi, László ; Barbacka, Mária ; Rákosi, László The plant mesofossil flora of the upper cretaceous Ajka coal formation – preliminary results In: 10th European Palaeobotany and Palynology Conference (2018) p. 225

Mizsei Regina Ágnes, Bodor Emese Réka, Tóth Emőke: Édesvízi ostracodák a Bakony felső-kréta rétegeiből.. In: Virág, Attila; Bosnakoff, Mariann (szerk.) 23. Magyar Őslénytani Vándorgyűlés: program, előadáskivonatok, kirándulásvezető Budapest, Magyarország : Magyarhoni Földtani Társulat (2020)

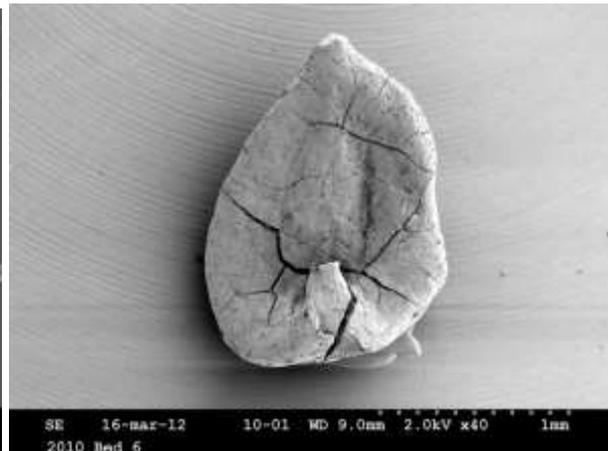
4. The mesofossil flora of Iharkút

Plant mesofossils (mainly seeds and fruits) are usually studied for terrestrial palaeoenvironment reconstruction. In the Late Cretaceous terrestrial (swamp and fluvial) formations of the Bakony Mts. (Hungary) plant mesofossils are common. Recent studies are focused on two formations: Ajka Coal Fm. and the heteropic fluvial Csehbánya Fm.

The aim of first plant study is to identify the dominant forms and propose a preliminary palaeoenvironment reconstruction. Based on these preliminary results on plant remains, Normapolles-related forests with herbaceous angiosperm- and fern-dominated underwood under tropical or subtropical climate can be reconstructed in this locality. The salinity of the localities is still questionable because of the pyritised bones. Within the plant mesofossil material also aquatic forms were detected. Strictly fresh water resistant Charales oogonia were found in the paleosol layers of the locality. From the bonebed layers Nymphaeales seeds were also found.



Sphaeracostata barbackae



Padragkutia haasii

Publications:

Emese, Bodor ; Gábor, Botfalvai ; Maria, Barbacka ; Attila, Ósi Palaeoenvironmental reconstruction of the late cretaceous Iharkút (Hungary) dinosaur locality based on angiosperm mesofossils In: 10th European Palaeobotany and Palynology Conference (2018) p. 258

Bodor, ER ; Botfalvai, G ; Szabó, M ; Barbacka, M ; Ósi, A ; Rákosi, L ; Makádi, L The mesofossil flora of Iharkút (Late Cretaceous Hungary) including aquatic elements In: Crespo, VD (szerk.) Palaeontology in the virtual era. Book of abstracts. Valencia, Spanyolország : University of Valencia (2018) 212 p. p. 160 , 1 p.

5. Amber fossils of Ajka coal formation and Iharkút

The paleobotanical origin of ajkaite has troubled scientists during the last decades. The paleoflora of the Ajka Coal and Csehbánya Formations are well-known, these biomes were dominated by angiosperms. The newest results on the paleobotanical origin of ajkaite that the producer of ajkaite should be searched among araucarians (documented from both the Ajka Coal and the Csehbánya Formations) or members of extinct Cheirolepidiaceae.

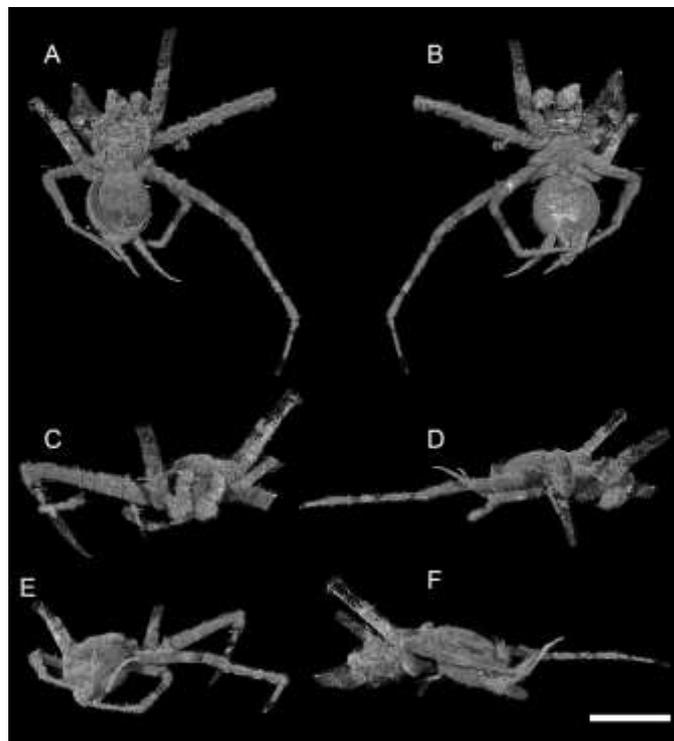
The presence of Hersiliidae in the ajkaite arachnofauna corresponds well with the estimated paleoclimate and vegetation of the Ajka Coal paleoenvironment. Extant members of the family are medium-sized, often cryptic spiders that occur in warm climates and have the highest diversity in the tropics or subtropics. Based on drill core samples (Siegl-Farkas, 1988), the climate for the Ajka Coal Formation is estimated to be tropical monsoon climate with high precipitation (2000–2500 mm per year). The later palynological and paleocarpological studies suggest Normapolles-related forests with fern-dominated underwood, but gymnosperm pollen and branches can be also found in the fossil record (Bodor and Baranyi, 2012). The climate might have been tropical or subtropical according to the ecological needs of the nearest living relatives of the fossil plant forms (Bodor et al., 2012). Seasonality of the precipitation can be presumed based on the tree rings of fossil woods (L. Rákosi pers. comm.). The swamp where the Ajka Coal was formed was arboreous and dominated by large angiospermes with possible affinity to Fagales (Normapolles-related; compare Friis et al., 2006). However, Platanaceae-related leaf fragments have also been found in the drill cores from the Ajka Coal Formation and Magnoliaceae-related Padragkutia and Operculispermum seeds were found in several layers of Ajka Coal Formation (Rákosi unpublished reports; Bodor et al., 2013). Rákosi also reported Araucariace trunks from the formation and recent relatives of this gymnosperm group have large trunks (reaching a height of 5–80 metres) with deeply seamed bark (Stockey et al., 2020) which could

have been a potential habitat for this species. This variety in the floral assemblage indicates a complex ecosystem in which *Hungarosilia verdesi* gen. et sp. nov. may have found a suitable habitat.

Publications

Szabó, M ✉ ; Hammel, JU. ; Harms, D ; Kotthoff, U ; Bodor, E ✉ ; Novák, J ✉ ; Kovács, K ✉ ; Ósi, A First record of the spider family Hersiliidae (Araneae) from the Mesozoic of Europe (Bakony Mts, Hungary) CRETACEOUS RESEARCH 131 Paper: 105097 (2022)

Szabó, M ; Kunderata, R ✉ ; Hoffmannova, J ; Németh, T ; Bodor, ER ; Szenti, I ; Prosvirov, AS. ; Kukovecz, Á ; Ósi, A The first mainland European Mesozoic click-beetle (Coleoptera: Elateridae) revealed by X-ray micro-computed tomography scanning of an Upper Cretaceous amber from Hungary SCIENTIFIC REPORTS 12 : 1 Paper: 24 , 11 p. (2022)



Hungarosilia verdesi gen. et sp. nov.