

24th Czech - Slovak - Polish Paleontological Conference

Abstract Volume



Edited by:

**A. Wařkowska
J. Kowal-Kasprzyk
M.A. Kaminski
& S. Bębenek**

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Preface

Welcome to Kraków and to the 24th Czech–Slovak–Polish Paleontological Conference. The conference Organizing committee welcomes everyone to the AGH University of Kraków. We strongly believe that this event will provide an opportunity to discuss novel ideas and share our experience with specialists from all parts of the globe.

We hope you enjoy your stay in Kraków, European capital of culture and former capital of Poland. The city, first mentioned in the diary of an Arab traveller, Ibrahim ibn Jacob in 965, is considered as one of the most famous in this part of Europe. It is the top tourist destination in Poland, famous for the XIIIth century Old Town with Market Square and the Cloth Hall (Sukiennice), the Wawel Royal Castle as well as Kazimierz – The Old Jewish Quarter. Kraków is also called a centre of science and higher education because of the seven universities located here, including the oldest in Poland – the Jagiellonian University and the largest technical university – the AGH University of Krakow. Today, AGH has more than 20,000 students, 16 departments, several didactic and scientific centres, student associations and foundations. One of them is Micropaleontological Foundation Micropress Europe, whose headquarters is in the main building.

We are grateful to more than 90 scientists who have registered for the 24th Czech–Slovak–Polish Paleontological Conference, and who submitted 41 abstracts that are included in this volume. These papers are fundamental to the furtherance of paleontological investigations in this part of Europe, and they will certainly form the basis of numerous discussions. The programme of our meeting has been carefully planned and divided into two oral and poster sessions, as well as viewing the amazing collections in the European Micropaleontological Reference Centre housed in the office of Micropress Europe.

The committee enthusiastically supports the 24th Czech–Slovak–Polish Paleontological Conference to make it interesting and highly inspiring for further research. We sincerely hope the conference will be beneficial for every participant. In particular, we believe that young researchers taking a part in the 24th Czech–Slovak–Polish Paleontological Conference will achieve satisfactory results and have a valuable learning experience.

The 2025 Grzybowski Award to Prof. Ján Soták



The 2020 Grzybowski Award of the Grzybowski Foundation is presented to Prof. Ján Soták, Dr.Sc., a Senior Research Scientist at the Earth Science Institute of the Slovak Academy of Sciences (*Slovenská Akadémia Vied – SAV/SAS*), Banská Bystrica branch.

Ján is a renowned expert in the stratigraphy, micropaleontology, lithology, and sedimentary geology of the Western Carpathians. He has extensive experience in micropaleontological research, including biostratigraphy, facies analysis, dynamic sedimentology, sequence stratigraphy, interpretation of paleoclimatic changes, paleoenvironment, and hydrographic regimes of sedimentary basins, as well as the tectogenesis of sedimentary basins.

Ján's research has primarily focussed on the micropaleontology and biostratigraphy of Mesozoic and Cenozoic formations in the Western Carpathians. He has described Silurian species of agglutinated foraminifera from lydite rocks of the Western Carpathians (Vozárová et al., 1998; Soták et al., 1999), Triassic foraminifers of basinal and reefal limestones (Michalík et al., 1993; Sýkora et al., 1998, etc.), the first occurrences of agglutinated foraminifera of the family *Pfenderinidae* (Soták, 1989), peneropliid foraminifers from the Štramberk Limestones (Soták, 1987), Jurassic and Cretaceous dasycladalean algae (Soták & Mišík, 1993), planktonic foraminifera from the “Selli Event” (Michalík et al., 2008), agglutinated and planktonic microfauna from the Middle Váh Valley (Soták et al., 2017; IWAF-10 Monograph), the extinction and recovery of planktonic foraminifera at the Cretaceous–Paleogene boundary (Soták et al., 2021; Elbra et al., 2023), and at the Eocene–Oligocene boundary (Soták, 2007, 2010), as well as the presence of claviform and digitate foraminiferal species in the Paratethyan basins (Soták & Antolíková, 2024), among many others.

Ján Soták is the author of 162 scientific articles published in magazines and international journals, 115 contributions in conference proceedings, 4 chapters in scientific monographs, and he is the co-author of 6 books. His scientific work has received more than 1,000 citations. He has been the principal investigator of numerous grants and projects from Slovak research agencies, and he is the recipient and project manager of the Centre of Excellence for integrated research of the Earth Geosphere (ITMS 262201200064), which was a major geoscientific project funded by EU structural funds in Slovakia. He has actively participated in international scientific collaboration as an investigator and national coordinator of international IGCP/UNESCO projects (e.g., IGCP Project no. 362 – *Tethyan and Boreal*

Correlation, no. 463 – *Upper Cretaceous Oceanic Red Beds: Response to Ocean/Climate Global Changes*, no. 555 – *Rapid Environmental/Climate Change in the Cretaceous Greenhouse World: Ocean-Land Interaction*), as well as in projects like EUROPROBE, GAČR project no 19-07516S – *Cretaceous–Paleogene boundary in Carpathians* – multidisciplinary research, an NERC project in cooperation with Oxford University – *Response of Global Ocean Oxygenation to early Cenozoic Climate Extremes*, among others. He has carried out numerous interships and conference visits abroad, including at institutions in Perugia, Naples, Urbino, Padua, Geneva, Neuchâtel, Kraków, Wrocław, Lviv, Vienna, Alicante, Bilbao, Nancy, Nice, Angers, and others. Ján Soták has been actively participating in organizing both national and international scientific events. He was the main organizer of the IWAF-10 conference in Smolenice in 2017, a major event attended by over 80 micropaleontologists from around the world. He also organized three Czech-Slovak-Polish Paleontological Conferences in Banská Bystrica in 2009, 2014, and 2024, and participated on scientific committees of numerous international conferences.

Ján's achievements in the field of education are equally impressive. Ján has participated as a member of doctoral committees in the fields of Paleontology, Sedimentology, and Tectonics. He is currently a PhD supervisor at the Earth Science Institute of SAS and at the Faculty of Natural Sciences, Comenius University in Bratislava. Under his supervision, eight PhD students have successfully defended their doctoral degrees. Based on his long-term college education and achieved qualification criteria, he was habilitated as an Assoc. Professor at Comenius University in Bratislava. Currently, he teaches at the Faculty of Natural Sciences at Comenius University in Bratislava and at the Faculty of Education at the Catholic University in Ružomberok. He was a member of several scientific boards (Earth Science Institute SAS, State Geological Institute of Dionýz Štúr, State Nature Conservancy), a member of the National Geological Committee, and Chairman of the Dr.Sc. committee for Earth and Environmental Sciences at the Slovak Commission for Scientific Degrees. He is a member of the editorial boards of international scientific journals including *Geologica Carpathica*, and the *Geological Quarterly*. He is a recipient of the Ján Pettko Award of the National Geological Committee for scientific contributions to Slovak Geology abroad (2023), the Slovak Geological Society Award for the best scientific publication in years 2018–2021, the Medal of the Ministry of the Environment of the Slovak Republic for advancement of Geology (2024), among other honors.

Based on his outstanding record as a researcher and educator in the field of Micropaleontology in Central Europe, it is clear that Jan has continued the work initiated over a hundred years ago by Józef Grzybowski. It is our pleasure to nominate him as the recipient of the 2025 Grzybowski Award of the Grzybowski Foundation.

Michael A. KAMINSKI (KFUPM, Saudi Arabia)

Anna WAŚKOWSKA (AGH, Poland)

Jarosław TYSZKA (ING PAN, Poland)

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Eocene/Oligocene transition between the Domaniža and Huty fms in the Turie TR-1 borehole: stratigraphic data, paleoecology and water paleodepth inferences from foraminifers and calcareous nannofossils

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The Žilina depression is filled up by the middle Eocene sediments of the Domaniža Basin and the upper Eocene and Oligocene sediments of the Central-Carpathian Paleogene Basin (CCPB = Sub-Tatra Group). The Domaniža Fm. consists of deep-water claystones with distal turbidites, which are weakly calcareous and rich in benthic foraminiferal fauna. Higher-up the sequence passes to calcareous-rich claystones to marlstones of the basal formation of the CCPB, which are dominated by planktonic foraminifera and nannofossils. The transitional section of the Domaniža and CCPB formations was studied in the Turie TR-1 borehole.

The microfauna from the lower part of the Domaniža Fm. consists of bathyal assemblages of the benthic calcareous foraminifera like *Cibicidoides*, *Nuttallides*, *Stilostomella*, *Oridorsalis* and others. Upward deepening is recorded by calcareous-free microfauna of agglutinated foraminifera like *Ammodiscus*, *Trochamminoides*, *Reophax*, *Repmanina*, etc. in the middle part of Domaniža Fm. The middle Eocene age of this formation is evidenced by the presence of *Ammodiscus latus* (see: Waśkowska & Kaminski, 2017).

Planktonic foraminifera of the Domaniža Fm. are impoverished in size, diversity and muricate species, consisting of globigerinathekids, subbotinids, globoturborotalids and others. The most frequent species *Globigerinata theka index*, which is known mainly from the late Eocene (E 15 Zone), is here still associated with middle Eocene acarininids (e.g. *A. praetopilensis*) and globigerinathekids (e.g. *G. kugleri*). Therefore, the foraminiferal species from the Domaniža Fm. provide stratigraphic data for the middle Eocene age. This is also supported by the study of the calcareous nannofossils, which dated the Lutetian age of the lower part of the Domaniža Fm., based on the species *Reticulofenestra umbilicus* and *Helicosphaera compacta* (NP 16 Zone), and *Coronocyclus nitescens* (NP 15 Zone). The calcareous nannofossils of this formation are also rich in discoasterids such as *Discoaster saipanensis*, *D. barbadiensis*, *D. deflandrei* and *D. tani*. Besides the Lutetian nannofossils, the uppermost part of the Domaniža Fm. also contains very rare species *Isthmolithus recurvus*, which occurrence was already introduced from Bartonian in the NP 17 Zone (Young et al., 2022).

The upper section of the Turie TR-1 borehole differs from the Domaniža Fm. significantly by sharp passage to *Nummulites*-bearing marls and later to eupelagic calcareous marlstones. Such passage indicates a shallowing of the Domaniža Basin and transgressive onlap of the basal formation of the CCPB. Basal marlstones contain a large amount of lens-shaped foraminifera like *Nummulites*, *Discocyclina*, *Heterocyclina*, etc. Planktonic foraminifera became dominant in superposed marlstones with a maximum abundance of large-sized specimens of *Globigerinata theka index*. An acme of this species marked the E15 Zone, which corresponds to late Priabonian (Berggren & Pearson, 2006). In the higher part of the marly sequence, the foraminiferal microfauna rapidly changes due to deterioration of climatic and environmental conditions at the Eocene/Oligocene boundary. The globigerinathekid species were reduced, and replaced by dwarf forms of chiloquembelinid, tenuitellid and globigerinid species. Besides of last occurrences of the globigerinathekid species at the E/O boundary, there is also

the last muricate species in the uppermost part of the TR-1 sequence (e.g. *Acarinina medizzai*).

The calcareous nannofossils in the upper section of the TR-1 borehole are dominated by species *Cyclicargolithus floridanus*, *Coccolithus pelagicus* and *Coccolithus formosus*. Their monoassociation indicates a temperate water and eutrophic environment (de Kaenel & Villa, 1996; Bown & Dunkley Jones, 2012). In the topmost sequence, cold-water nannofossils such as *Reticulofenestra* and *Isthmolithus* increased. The Eocene–Oligocene transition is inferred from the youngest species *Isthmolithus recurvus*, which occurred in the Zone NP 19/20 Zone and disappeared in the NP22 Zone (zonation according to Marini, 1971, revised in Young et al., 2022).

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The genus *Zittelia* Gemmellaro, 1869: a possible ancestor of cowries

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Zittelia is an extinct genus of marine gastropods belonging to the family Colombellinidae Fischer, 1884. It was originally described by Gemmellaro (1869) from the Upper Jurassic–Lower Cretaceous (Tithonian–Valanginian) carbonate deposits of Sicily, Italy and has since been recorded in several localities in Europe, including France, Switzerland, Germany, Czechia, and Poland. Despite their relatively thick shells, which could be expected to preserve well, the fossil record of *Zittelia* remains scarce and limited both spatially and stratigraphically.

Our revision of the genus *Zittelia* is based on a comprehensive analysis of all published data on the family Colombellinidae, as well as examination of original collections described by Guirand & Ogérian (1865), Gemmellaro (1869), and Zittel (1873), which had not been critically re-evaluated since their description. We confirm the validity of ten species of *Zittelia*, all of which are represented in these collections except for one species, which is retained within the genus with some reservations. The examination of the type series also enabled us to designate lectotypes for six species and to emend the generic diagnosis.

A detailed morphological comparison between *Zittelia* and early cypraeids reveals a gradual evolutionary transition between these taxa, occurring during the latest Jurassic (Nützel et al., 2025). The oldest species of *Zittelia*, from the Oxfordian–Kimmeridgian, exhibit shell morphology similar to those of *Colombellina* d'Orbigny, 1842—a genus belonging to the same extinct family Colombellinidae, which commonly co-occurs in similar facies and is known from a broader stratigraphic and geographic range. In contrast, younger species of *Zittelia*, particularly the type species from the Tithonian–Valanginian, display a combination of shell features that closely resemble those of cypraeids.

The distribution of *Zittelia* indicates its restricted occurrence in peri-Tethyan carbonate facies. All the confirmed records to date are of late Jurassic age, although poorly stratigraphically constrained occurrences from Sicily, Italy and Štramberk, Czechia may extend it into the earliest Cretaceous when better researched. All findings of *Zittelia* are associated with shallow-water limestones deposited on carbonate platforms. The co-occurrence of *Zittelia* and the earliest cypraeids in the latest Jurassic of Sicily (Nützel et al., 2025) suggests that the late Jurassic reefs and associated lagoonal environments of the Tethys may have served as a centre of diversification for the Colombellinidae and emergence of Cypraeoidea.

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Exceptionally preserved pollen in Miocene fossil resins from Sumatra (Sarolangun mine) as indicators of environment and climatic conditions

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Different types of pollen grains collected in complete pollen bags were found from the first time in fossil resin derived from the Miocene brown coal deposits in Jambi Province (Sumatra, Indonesia). The palynological material was studied in thin sections because both pollen and pollen bags are preserved in a unique way - as molds with very detailed ornamentation, therefore they cannot be separated from the resin. The identifiable diagnostic features showed that the pollen grains were produced by plants from the families Potamogetonaceae and Sciadopityaceae. Both groups as well as resin-bearing trees which represent the family Dipterocarpaceae indicate burial conditions in swamps of rainforests and confirmed warm and humid climate during the period of their vegetation.

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Sedimentation cycles of radiolarian microlaminas as an indicator of changes in climatic oscillations related to OAE 2 in the Western Tethys

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Radiolaria are common and abundant in the deep-water Cretaceous formations of the Western Tethys. Particularly numerous assemblages characterize the sediments of the global oceanic event that occurred at the end of the Cenomanian (the so-called "Oceanic Anoxic Event 2" – OAE 2), as well as in the sediments below and above it. During OAE 2, the species diversity of radiolarian assemblages decreased significantly compared to the number of species present before this event. Simultaneously, the abundance of radiolaria skeletons in the sediment increased significantly (Bąk, 2011).

The study was conducted on samples from the Scaglia Bianca Formation in the Umbria-Marche sedimentary basin in the Apennines. Within this formation lies the Bonarelli Level, containing dark shales representing the so-called Anoxic episode OAE 2. Thin sections of rocks were subjected to an estimation of the percentage of radiolarian skeletons in microlaminae, with a minimum thickness of 0.2 mm. Radiolaria were divided into three groups based on individual size: a) small forms: <50 µm, b) medium forms: 50–150 µm, c) large forms: >150 µm. Previous studies of radiolarian assemblages in these deposits indicate that the size of individuals varied depending on physical and chemical changes in the water column (Bąk, 2011).

Throughout the entire sequence, radiolaria occur within 1–3 mm of continuous microlaminae, where their content ranges from 30 to almost 100% (first-order cycles). Laminae differ in the percentage of forms considered characteristic of surface waters and forms occurring in deeper waters. Individual taxa exhibit intraspecific variability. Furthermore, radiolarian laminae occur in larger, cyclically repeating packages (second-order cycles), separated by sequences of laminae containing coccolith mud and planktonic foraminifera (below and above OAE 2 sediments) or organic matter and fecal pellets (within OAE 2).

Individual laminae containing radiolarian skeletons may represent brief episodes of changes in ocean water conditions caused by climatic oscillations similar to modern La Niña and El Niño events. Laminae groups containing surface water taxa indicate prolonged periods of El Niño-type oscillations. However, the predominance of small individuals in individual laminae may indicate the impact of La Niña-type oscillations. Sedimentation cycles of second-order radiolarian microlaminas lasted approximately 3,500 to 5,000 years during periods before and after the sedimentation of the Bonarelli Level organic deposits. During OAE 2, these periods extended to 12,000 years. They may have been caused by changes in the distribution of ocean currents, particularly around the equator, which forced changes in the circulation of surface waters in the Tethys Ocean basins.

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Tournaisian (Mississippian) anoxic events in the Moravian Karst, Czechia

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The Mississippian (early Carboniferous) was a time of profound climactic changes, widespread anoxia, continental collisions, and extinction events. Several anoxic events and glaciations occurred during the Tournaisian age and had a global impact on life and geochemical cycles (e.g. Siegmund et al., 2002; Qie et al., 2019).

We studied a section in the Mokrá quarry in the Moravian Karst (Czechia), which exposes Tournaisian limestone strata of the Líšeň Formation. The Mokrá-west MZ1 section is a newly uncovered section preserving a uniquely tectonically undisturbed succession with a presence of a black limestone interval. Methods of conodont biostratigraphy, sedimentology, petrophysics (gamma-ray spectrometry), and carbonate carbon isotope chemostratigraphy have been used to provide a correlation of the black limestone interval with the Carboniferous global events.

A detailed conodont biostratigraphy was established using sixteen samples. The Mokrá-west MZ1 section spans a stratigraphic interval from the lower Tournaisian *Siphonodella quadruplicata* conodont Zone to the upper Tournaisian *Scaliognathus anchoralis anchoralis* Zone. Gamma-ray spectrometry was employed to investigate compositional changes in limestone and provided data for the interpretation of hypoxic to anoxic conditions during the deposition of the black limestone. The paleoenvironmental and carbon cycle disruptions were assessed using stable carbon isotope analysis showing a positive $\delta^{13}\text{C}_{\text{carb}}$ excursion in the upper part of the black limestone interval.

The integration of data from conodont and lithological analysis, gamma-ray spectrometry, and stable carbon isotope geochemistry supports the correlation of the examined strata with global anoxic events, specifically the Lower Alum Shale Event (*Siphonodella crenulata* conodont Zone; preliminary correlation due to the scarcity of conodonts) and an overlying anoxic event linked to the glacial mid-Tournaisian $\delta^{13}\text{C}_{\text{carb}}$ excursion, reaching up to 3.7 ‰ $\delta^{13}\text{C}_{\text{carb}}$ within the lower *Gnathodus typicus* conodont Zone. This period was followed by a transition back to warmer, oxygenated conditions in the late Tournaisian.

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Lost and found: Wilhelm Friedberg's Miocene brachiopod collection

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Wilhelm Friedberg (1873–1941) (Fig. 1) was a prominent scientist who during the most of his career was associated with the Dzieduszycki Family Natural History Museum (now the State Museum of Natural History) in Lviv, Ukraine (Bakayeva & Kaim, 2024). His scientific interests were mainly focused on Miocene molluscan faunas both of Poland and Western Ukraine. Friedberg's most outstanding work was a two-volume monograph on Miocene gastropods and bivalves, published in two parts (Friedberg 1911–1928, 1934–1936). Another fossil group with which Friedberg essentially began his scientific career was Cretaceous Foraminifera (Friedberg, 1901).



Figure 1. Wilhelm Friedberg (1873–1941)

However, few people are aware that Friedberg also published a paper on Miocene brachiopods from Western Ukraine (Friedberg, 1921). For many years, this collection was believed to be lost, but it was recently rediscovered at the State Museum of Natural History in Lviv. In his paper, Friedberg described 13 brachiopod species and subspecies. We have examined 82 specimens preserved in this collection that originate from 24 localities. The smaller specimens are stored in glass vials sealed with cork stoppers, while the larger specimens are housed in small boxes.

Following the revision, eight species were recognised as valid. The inarticulate brachiopods are represented by *Lingula dregeri* Andreae, 1893 and *Discinisca leopolitana* (Friedberg, 1921). There are two species of short-looped terebratulides, *Terebratula styriaca* Dreger, 1889 and *Gryphus* cf. *miocaenicus* (Michelotti, 1847). The remaining species belong to the long-looped terebratulides, namely *Megathiris detruncata* (Gmelin, 1791), *Argyrotheca cuneata* (Risso, 1826), *Joania cordata* (Risso, 1826), and *Megerlia truncata* (Linnaeus, 1767). The species *M. detruncata* and *M. truncata* are the most abundant in the collection (Fig. 2).

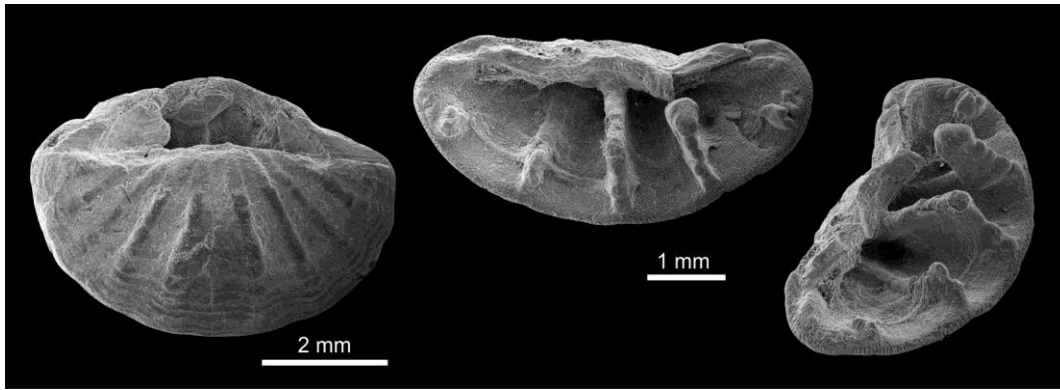


Figure 2. *Megathiris detruncata* (Gmelin, 1791), Middle Miocene, Pidhaisi (Podhajce), Ukraine

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A first look at the calcareous dinoflagellate cysts from the 'Faraoni' Oceanic Anoxic Event (latest Hauterivian) in the Umbria-Marche Basin: a record from the Fiume Bosso section

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The 'Faraoni Event' was a short-lived anoxic event that occurred in the Western Tethys during the latest Hauterivian, recorded as a thin sequence of deep-marine limestones and black shales, (e.g., Cecca et al., 1994; Faraoni et al., 1996; Bodin et al., 2006). Here we present for the first time the record of this oceanic event in the calcareous dinocyst assemblage from the Umbria Marche Basin, studied in the Fiume Bosso section. The sediments from this region came from a pelagic environment of the central Western Tethys. We collected 41 samples of black shales and various types of limestones from a 170 cm profile; the Faraoni Level (28 cm thick) is represented there by thin black shale and limestone layers (Cecca et al., 1994).

The calcareous dinocysts were recognized in thin sections of the rocks based on their shape, size, structure and optical features of cysts. The observation was made under transmitted and plane-polarized light using a Nikon Eclipse LV100N POL microscope with a digital camera. Calcareous dinocysts were found in 24 samples; their state of preservation is good to poor. The following genera were recognized: *Cadosina* Wanner, *Colomisphaera* Nowak, *Committosphaera* Řehánek, *Crustocadosina* Řehánek, *Stomiosphaera* Wanner. The following species were detected: *Cadosina fusca fusca* Wanner, *Colomisphaera conferta* Řehánek, *Colomisphaera heliosphaera* Vogler, *Colomisphaera lucida* Borza, *Colomisphaera vogleri* Borza, *Committosphaera sublapidosa* Viogler, *Crustocadosina semiradiata semiradiata* Wanner, *Stomiosphaera echinata* Nowak, *Stomiosphaera polygona* Vogler. All these taxa are known from the Upper Jurassic–Lower Cretaceous pelagic sediments of the Western Tethys. The recognized assemblage represents the *Echinata* dinoflagellate Zone that spans from the late Valanginian to the early Aptian according to Lakova et al. (1999) and Řeháková (2000). Quantitative changes were observed in the calcareous dinocysts assemblage within the Faraoni Event. The number of specimens is clearly lower here, and this decrease is greater compared to younger rocks.

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Preliminary conodont biostratigraphy and gamma-ray spectrometry of the Famennian calciturbidites of the Líšeň Fm, Brno, Czechia

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The Líšeň Formation of the Moravian Karst features well-preserved Famennian to Viséan slope carbonate sequences. The “lower” Hády-Říčka Limestone is a member of the formation, which represents deposits of a carbonate turbiditic system that developed on the slopes of the Moravosilesian Basin (south-eastern Laurussian margin) between the two major Devonian mass extinctions (the Kellwasser and the Hangenberg events). This study examines the conodont biostratigraphy of the “lower” Hády-Říčka Limestone exposed in the Lesní and Hády quarries in Brno, Czechia, as well as their facies associations, gamma-ray spectrometry, and provides relative sea-level change, paleoenvironmental and biofacies interpretations.

The Hády quarry section is over 100 m thick and features a rich palmatolepid and polygnathid conodont fauna spanning from the *Palmatolepis minuta minuta* Zone (lower Famennian) to the *Bispathodus costatus* (upper Famennian) Zone. The main section of the Lesní quarry is up to 44 m thick and is characterised by rich bispathodid, palmatolepid and polygnathid conodont fauna. The stratigraphic range of this section spans from *Palmatolepis gracilis expansa* Zone (upper Famennian) to *Bispathodus ultimus* Zone (uppermost Famennian). Conodont biofacies, such are the polygnathid-icriodid, palmatolepid-polygnathid, palmatolepid and palmatolepid-bispathodid biofacies, were described and interpreted in terms of depositional environment.

Based on the changes in lithology and sedimentary textures and structures, the following lithofacies were defined: calcareous black shales and marls, often bearing boudins and nodules from carbonate material, defined as hemipelagic sediments; silty shales, calcilutites to calcisiltites, calcisiltites to very fine calcarenites and fine to coarse grained calcarenites, interpreted as distal to proximal calciturbidites; and thin-bedded calcisiltites to very fine calcarenites and limestone breccias, interpreted as storm deposits of the middle carbonate ramp.

Measured concentrations of potassium (K), thorium (Th), and parameter of computed (or “clay”) gamma-ray (CGR) reveal an initial increase in content of detrital material and decrease in carbonate input in the lower part of the Hády section in *Palmatolepis minuta minuta* to *Palmatolepis marginifera marginifera* zones. This is followed by a continuous decrease in CGR from *Palmatolepis marginifera marginifera* to *Bispathodus costatus* zones, interpreted as a decrease in detrital input and increase in input of carbonate material. In the Lesní quarry section, the decrease in CGR continues up to the *Bispathodus ultimus* Zone but shifts to the increase in the upper part of the measured section higher up in the same zone.

Furthermore, the ratio between uranium and thorium (U/Th) was used as a proxy for environmental redox conditions (Nath et al., 1997; Wignall and Twitchett, 1996). The lowest part of the Hády section indicates a dysoxic to anoxic interval, while the rest of the lower Famennian features predominantly oxygenated environment (*Palmatolepis minuta minuta* to *Palmatolepis marginifera utahensis* zones). The upper part of the Hády section is characterized by mostly oxic to dysoxic environment with two brief anoxic intervals (*Palmatolepis rugosa trachytera* to *Bispathodus costatus* zones). The Lesní quarry section is primarily dysoxic to anoxic in nature from the *Palmatolepis gracilis expansa* Zone to the *Bispathodus ultimus* Zone.

Based on the facies associations, gamma-ray spectrometry, conodont biozonation and biofacies, changes in depositional environment were interpreted as follows: during the earliest Famennian the deposition was situated in the middle carbonate ramp. The ramp was drowned during the *Palmatolepis minuta minuta* and *Palmatolepis crepida* zones, as the depositional environment shifted to a deep-marine setting of the lower slope or possibly even the base of the slope. Deep depositional environment lasted until the *Palmatolepis marginifera marginifera* Zone, correlating well with the lower Famennian global transgression (Becker et al., 2020). During the *Palmatolepis marginifera marginifera* to *Palmatolepis gracilis manca* zones, the depositional environment shifted to the middle and/or upper part of the carbonate slope, represented by progradation of the carbonate turbiditic system. Progradation peaked between the *Palmatolepis gracilis expansa* and *Bispathodus ultimus* zones, when the most proximal calciturbidites were deposited. When compared to the global T-R cycles the correlation between the described development and global regression during middle to upper Famennian becomes apparent. Correlation of the two short anoxic intervals in the *Palmatolepis rugosa trachytera* to *Bispathodus costatus* zones with the global events needs additional higher resolution biostratigraphic analysis which will be carried out in the following research.

Acknowledgement:

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***Elegantilites* Marek, 1966, its palaeogeographic and stratigraphic distribution (Ordovician, Hyolitha)**

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Hyoliths are Paleozoic animals with small calcium carbonate shells composed of the conch (= oblong, conical and bilaterally symmetrical shell of diverse cross section and aperture at its wide end) and the operculum (= cap closing the conch aperture). In Cambrian to Devonian sediments of the classical Barrandian area, well-preserved, locally abundant remains of hyoliths have been known since the middle of the 19th century (e.g. Barrande, 1847, 1879).

Marek (1966, 1967) reviewed the large institutional collection of late Ordovician hyolithids and selected *Pugiunculus elegans* Barrande, 1847 from the Katian Zahořany Formation of the Barrandian area as the type species of a separate genus *Elegantilites* Marek, 1966

Detailed analyses of published data show the presence of at least ten species of *Elegantilites* at numerous outcrops in Lower to Upper Ordovician sediments in Morocco. The genus ranges from the Lower Ordovician to the middle Ordovician in France and the Czech Republic. It is also known from the middle Ordovician of Spain and Portugal. One species in France and four species in the Czech Republic survive into the Upper Ordovician (see Valent et al., 2025).

After Valent et al. (2025), specimens of the hyolithid genera *Elegantilites* and *Gompholites* have been established exclusively in the Ordovician of Western Gondwana (Fig. 1).

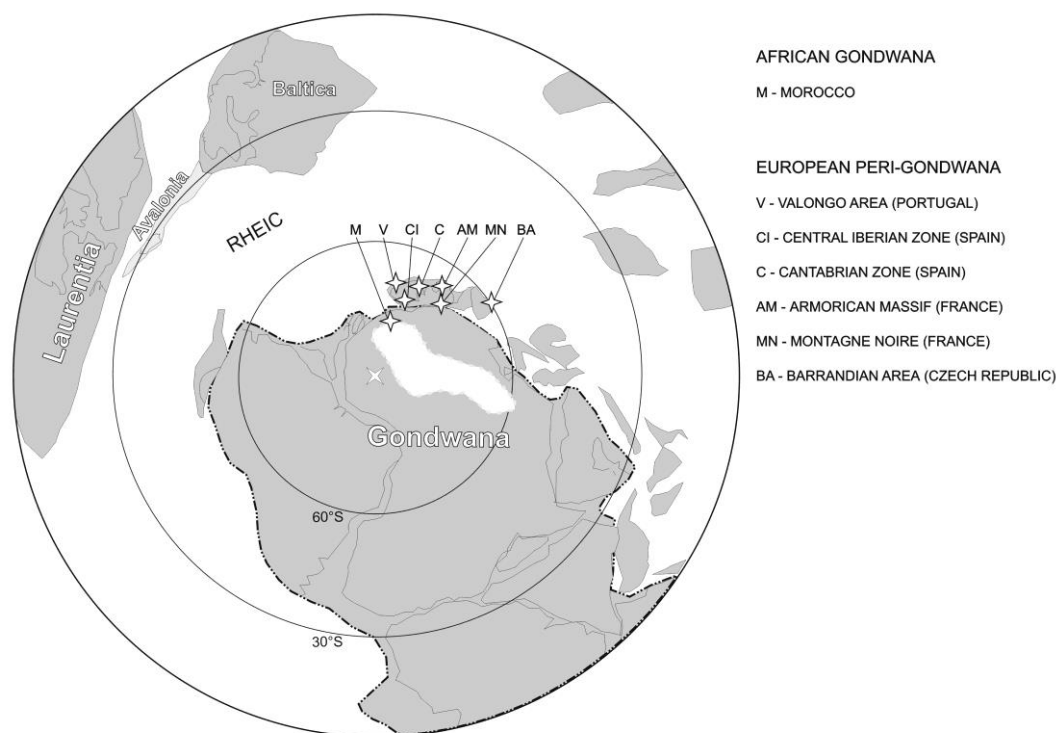


Figure 1. Palaeogeographic map of the middle Ordovician World (460 Ma) after Cocks & Torsvik (2006) showing the position of outcrops which produced *Elegantilites* in African Gondwana and European peri-Gondwana.

Preliminary results show a comparable pattern of stratigraphic and palaeogeographic distribution also in another Ordovician hyolithid genus *Gompholites* Marek, 1966 (see Valent et al., in preparation).

Injured specimen. Several tens specimens of malformed invertebrates such as trilobites, cephalopods and gastropods have been collected and documented from Cambrian to Devonian clastic sediments and carbonates in the Barrandian area. However, no malformed hyolith specimen has yet been recorded. An operculum of *Elegantilites custos* showing regeneration after a non-lethal predatory attack is the first record of regeneration in a hyolith operculum that has been repaired after a failed durophagous attack. Epibenthic/infaunal predatory echinoderms, such as ophiuroids, are considered as potential culprits by Fatka et al. (2023).

Acknowledgement:

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Subfossil Cladocera as indicators of environmental change: A palaeoecological reconstruction from Lake Piaski (NW Poland)

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One of the main components of the lake ecosystem is aquatic fauna, which constantly needs to adapt to ongoing ecological and environmental changes. One group particularly sensitive to these changes is the Cladocera superorder. Cladocera are small invertebrates (1–2 mm in size), living mostly in freshwater as zooplankton. After they die, their soft tissues decompose, while their hard chitin shells are deposited in the sediment. As a result, Cladocera shells can last for tens of thousands or even hundreds of thousands of years, creating fossil data archives. Since Cladocera ecological needs are stable and we have knowledge of the preferred habitat for each species, it is possible to reconstruct the features of the reservoir that were present during their lifetime.

The research material was obtained from the bottom of Lake Piaski in northwestern Poland. The core analysis allowed for: (1) tracking changes in the species composition and abundance of Cladocera to determine differences in lake trophic status and depth and (2) correlating these changes with potential impacts of human activity and climate. Additionally, to obtain the absolute age of the sediments, radiocarbon dating analysis was performed. By combining the analysis of subfossil Cladocera remains with the ^{14}C method, it was possible to reconstruct the last stage of development of Lake Piaski and answer questions about its evolution. This study represents one of the first investigations of this lake and is among the few conducted in this region of Poland.

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Cretaceous bryozoan biota of the northern Tethyan carbonate platform (Alpstein area, northeastern Switzerland)

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During the early Cretaceous, major palaeoceanographic changes are mirrored on the northern Tethyan carbonate platform by changes in the carbonate factory and by platform drowning. The central European portion of the platform – presently locked up in the northern Helvetic Alps, which extend from SE Germany through Switzerland to E France, is connected with the shallow water carbonate successions of early Cretaceous age (Follmi et al., 2006)

The early Cretaceous is the period in which bryozoans are still considered as an artefact caused by the incompleteness of the fossil record until their sustained radiation commenced in the late Cretaceous. The cyclostomes form a well-diversified and distinctive fauna in the early Cretaceous until the significant radiation of cheilostomes commenced in the late Albian-early Cenomanian. The newly described bryozoan fauna from the Alpstein area in the northern Alpine Helvetic thrust and fold belt (see Hara and Furrer, 2018) ranges from the middle-late Berriasian (Öhrlí Formation) to the late Barremian/early Aptian Schratenkalk Formation. The scarce bryozoan fauna of the middle-late Berriasian is characterized by the presence of the thick, branched colonies of the *Multizonopora* d'Orbigny, 1853. The richest early Valanginian fauna from the marly facies of the Pygurus Member (Betlis Formation) is characterized mainly by the presence of large branched colonies and the spherical multilamellar sturdy colonies. This assemblage is represented by a few genera belonging to a few families such as Cavidae, Cytitidae, Cerioporidae, Tretocycloeciidae and *incertae sedis* represented by the following genera *Chartecytis* Canu and Bassler, 1926, *Multizonopora* d'Orbigny, 1853, *Diplocava* Canu et Bassler, 1926, *Tretocycloecia* Canu, 1919 i *Reptomulticava* d'Orbigny, 1854. Beltis Fm. which is overlain by the Altmann Member (Tierwis Formation) of the age latest Hauterivian–early Barremian is mostly represented by two taxa: *Reptomulticava* d'Orbigny and *Defranciopora* Hamm (Cerioporidae) both building strong multilamellar colonies, however, branched colonies of *Chartecytis* also occur. The youngest assemblage of the studied early Cretaceous material belongs to the late Barremian–early Aptian of the Schratenkalk Fm. among which only one taxon belonging to the *Reptomulticava* has been distinguished. *Reptomulticava* (see Fig. 1) in its internal structure, shows layering, which varies from a few up to so dozen or so mm. The layers vary also in width and they are arranged parallelly or transversally to each other, what may be connected with a hydrodynamism of the environment.

The distinguished fauna in the northern part of the Tethyan margin in the Alpstein area, of the northeastern Switzerland, should be compared with the similar fauna from the SE Germany, W Austria, E France (see Hillmer, 1971; Walter, 1989; 1991), but also with the bryozoans from the southern part of Switzerland (region Vaud), see Canu & Bassler, 1926. The bryozoans from the Alpstein shows the four distinctive assemblages, which are mostly differentiated in the biodiversity. Two of them such as middle-late Berriasian and late Barremian–early Aptian are only represented by a scarce individuals (*Multizonopora* and *Reptomulticava*). The Alpstein assemblages composed mostly of a free-walled taxa, which show strong branched or spherical colonies may prefer the shallow-water conditions, moderate to strong hydrodynamism and warm to temperate climate. Usually this fauna may

indicate the base of the transgressive facies in the middle Berriasian, the early Valanginian, early Hauterivian and in the early Aptian.

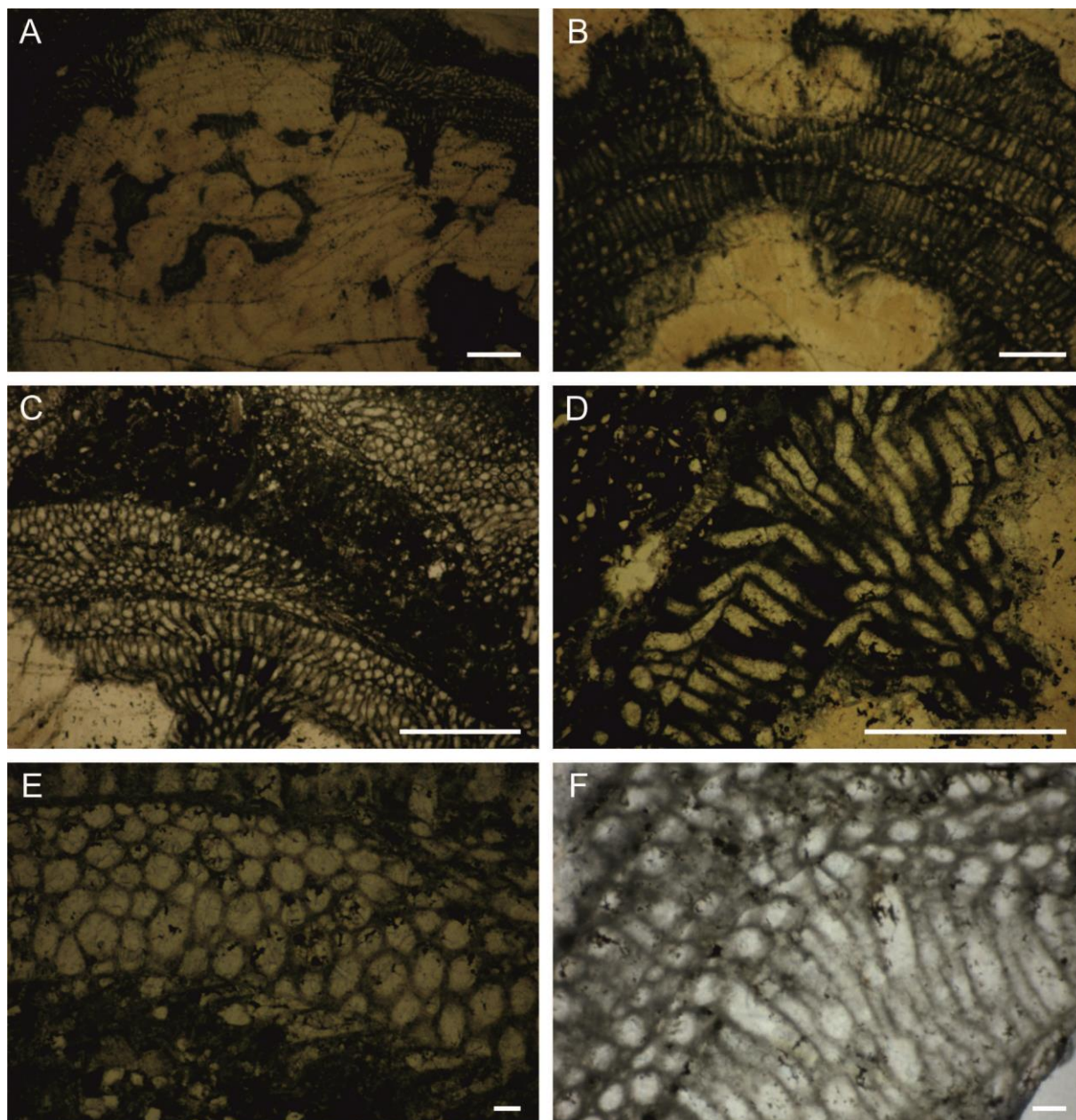


Figure 1. A-F. *Reptomulicava* sp. thin-sections through the colonies, where the multilamellar structure is seen, A. scale bar 0.1 mm; B. 0.15 mm; C. 0.025 mm, D. 0.1 mm; E. 0.2 mm, F. 0.1 mm. Altmann Member, latest Hauterivian–early Barremian, Alpstein area, NE Switzerland.

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Transfer of the William A. Berggren collection of microfossils to the European Micropaleontological Reference Center in Kraków

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During the summer months of 2024 and 2025, the microscope slide collection of William A. Berggren was transferred from the Geology Department at Rutgers University in New Jersey to the collections of the European Micropaleontological Reference Center (EMRC) in Kraków. This follows a decision by the Rutgers Geology Department not to continue research in the subject of Micropaleontology after the retirement of M.-P. Aubry. This decision necessitated the relocation of the micropaleontological collections that had been housed in the offices of W.A. Berggren and M.-P. Aubry. The Berggren microslide collection is currently housed in four mahogany slide cabinets at the EMRC, and additional cabinets have been ordered. The collection is currently being curated.

The majority of the collection currently housed in cabinets consists of shipboard and shore-based samples from the early phase of the Deep Sea Drilling Project expeditions. The slides from the JOIDES Expedition (the test expedition for the Deep Sea Drilling Project) and DSDP Expeditions 1 to 15 are now housed in cabinets, as well as the picked slides from DSDP Site 516, which were used to establish the so-called “M-Zonation” of Miocene planktonic foraminifera (Berggren et al., 1983). Bill Berggren served as co-chief scientist on board the *Glomar Challenger* on DSDP Expedition 12, and his collection contains the shipboard samples that were used to establish the biostratigraphy for site reports for DSDP Sites 111–117 (Laughton & Berggren, 1972). The Leg 12 collection also contains a collection of identified benthic foraminifera published by Belanger & Berggren (1986), and paratypes of the planktonic foraminiferal species *Neoglobobulimina atlantica* (Berggren, 1972) which was originally described from DSDP Site 116. The core collection from the early DSDP expeditions in the North Atlantic was listed by Berggren (1978, table 1) in his review of the Cenozoic planktonic foraminiferal biostratigraphy of the North Atlantic region.

The W.A. Berggren Collection of microfossil slides will be placed on display during the 24th Cz-Sk-Pl Paleontological Conference. The collection can be viewed during office hours by appointment with the EMRC curator. A comprehensive listing of the DSDP cores will be published once the collection is fully curated.

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The 2025 Phanerozoic Index Fossil Timescale: A Reference for Research and Teaching

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The 2025 Geological Timescale has been updated and illustrated through the addition of carefully selected images of the principal Phanerozoic index fossils, providing a clear and visually engaging representation of Earth's biostratigraphic history. This wall chart summarizes the currently accepted definitions of all "golden spikes" (GSSPs), which establish the formal stage boundaries of the international chronostratigraphic framework. These GSSPs are primarily defined using (micro)fossil index taxa, but may also rely on other stratigraphic markers. Altogether, 70 index species are depicted, spanning a wide spectrum of fossil groups, including trilobites, graptolites, conodonts, ammonoids, foraminifera, and calcareous nannofossils, thereby illustrating the broad taxonomic diversity employed in global stratigraphy.

Beyond fossil markers, the new chart also includes the golden spikes defined by magnetic polarity reversals, geochemical anomalies, stable isotope excursions, and major climatic transitions. By combining paleontological and geological criteria, the chart provides a integrated view of the Phanerozoic record and reinforces the multidisciplinary basis of modern stratigraphic calibration. Numerical ages of all period and epoch boundaries are based on the most recent (2024/12) edition of the International Chronostratigraphic Chart compiled by the International Commission on Stratigraphy.

The 2025 Phanerozoic Index Fossil Timescale is designed as both a practical research reference and an effective educational resource, linking iconic fossil taxa with formally defined stage boundaries and illustrating the evolution of organisms across Earth's history. Copies of the new chart will be distributed to conference participants.

Reference:

International Commission on Stratigraphy (2024/12). *International Chronostratigraphic*
<https://stratigraphy.org/chart#latest-version>

Radiolarian morphogroups as indicators of water column parameters during the Cenomanian-Turonian Anoxic Event (OAE2) in the Umbria-Marche Basin of the Western Tethys

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The frequency of 184 radiolarian species from deep-water settings in the Umbria-Marche Basin of the Western Tethys were used for interpretation of environmental changes during the 1.8 Ma period including the OAE 2 interval, from the late Cenomanian through the early Turonian time interval (Bąk, 2011).

The whole radiolarian set has been subdivided into morphogroups related to specific water masses. The assembled species represented various feeding preferences and ecological strategies. The most important were two morphogroups of particular ecological importance. (M1) Forms with cytoplasm stretched on skeletal elements arranged in one plane and thus adapted to symbiosis with photosynthetic algae; (M2) assembled radiolarians living in deeper waters, near the thermocline, adapted to life in fertile waters and feeding on small bacterial cells.

M1 morphogroup is very diverse morphologically and species-wise. It includes taxa from genera such as *Acanthocircus*, *Crucella*, *Alievium* and *Halesium*. These were forms living in warm surface waters cut off from the deep thermocline, as during the El Nino-type condition. Morphogroup M2, on the other hand, contains cryptothoracic and cryptocephalic nassellarians, which were not differentiated, but individual species such as *Holocryptocanium barbui* Dumitrica, occurred very abundantly in the sediment. This morphogroup characterized the state of the water column with a relatively thin layer of surface water and a shallow thermocline characteristic of the upwelling period during the La Nina condition. Considering the content of species belonging to morphogroups M1 and M2 in the sediment, it was possible to interpret the changes in the water column in the Tethys Ocean over the period of 1.8 million years, including the sedimentation of the Bonarelli Level (BL).

The stepwise changes of radiolarian assemblages started 330 ka before the OAE 2 onset by an increase in the content of M2 morphogroup. This was a period of climatic oscillations with a dominant upwelling state. Between 330 and 150 kyr before the BL was a period of predominance of stratification of surface waters with a deep thermocline as during modern El Nino periods. This was a period of stepwise environmental changes, which created the new ecological niches for the radiolarian proliferation, and supported different life strategies. The period from 150 ka before the OAE 2 onset is marked by much intensive radiolarian productivity connected with mesozooplankton activity. A significant increase of radiolarian content representing M2 ecological groups indicates propagation of eutrophic waters in time immediately preceding the sedimentation of the black shales of the BL. The same water regime in the Tethys Ocean continued during the sedimentation of the so-called clayey part of the Bonarelli Interval (Bąk, 2011).

The Bonarelli Interval was the most changeable in respect to radiolarian communities. The continuing period with dominant upwelling led to the highest P values, recorded in the sediments of the Umbria-Marche basin, and the stepwise increase of $\delta^{13}\text{C}$ values. The maximum of eutrophication and expansion of the OMZ is supported by a high fecal pellet volume, accompanied by flocks of organic matter and bacterial remnants, and drastic drops of radiolarian species diversity. In the middle part of the Bonarelli Level, radiolarian species

started to recover, marking gradual reconstitution of the “pre-Bonarelli” ecological conditions. The increase in the content of taxa from the M1 morphogroup indicates the dominant stratification of surface waters and El Niño-type conditions at that time. The subsequent high content of diatoms coincides with a stepwise dropping of radiolarian content, which indicates a return to the dominance of the M2 group and upwelling conditions. In the interval above the BL, the uppermost part of the grey Scaglia Bianca Formation and the lowermost part of the Scaglia Rossa Formation are dominated by a diverse assemblage of M1, indicating that El Niño-type conditions were dominant in the Tethys Ocean during the sedimentation change from white and grey limestones to red ones, representing the Cretaceous Oceanic Red Beds facies (Hu et al., 2005).

Acknowledgements:

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First Eocene occurrences of the Pavonitinae (Foraminifera) in Saudi Arabia: implications for their origins

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Agglutinated foraminifera of the subfamily Pavonitinae, characterized by their distinctive fan-shaped septula and complex internal structures, have traditionally been regarded as an Oligocene–Miocene group, with well-documented occurrences in the Paratethys, West Africa, and Atlantic margins. Here we present the first stratigraphically well-constrained Priabonian (E14 Biozone) occurrence of Pavonitinae from the Rashrashiyah Formation of the Sirhan–Turayf Basin, northwestern Saudi Arabia. The recovered assemblage includes *Pavonitina styriaca*, *P. biarritzensis*, *P. kiscelliana*, and *Pavopsammia flabellum*. Their chamber arrangements, which evolve from triserial to biserial and uniserial stages, along with the development of flabelliform septula, document key evolutionary transitions within the group. The co-occurrence of these taxa in a well-dated late Eocene succession challenges the established stratigraphic range of Pavonitinae, pushing their origin back by several million years. This discovery suggests that their evolutionary radiation was already underway during the Priabonian, likely linked to paleoceanographic changes such as deepening of the carbonate compensation depth and the expansion of oxygen-minimum zones. The paleogeographic setting of the Sirhan–Turayf Basin along the southern Tethyan margin provided favorable conditions for their diversification and dispersal. Our findings not only extend the stratigraphic record of Pavonitinae into the late Eocene but also raise new questions regarding their evolutionary history, paleobiogeographic pathways, and role as paleoenvironmental indicators in Paleogene deep-marine settings.

A new record of *Pentaditrupe* (Polychaeta, Serpulidae) from the Paleocene of Denmark

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The annelid family Serpulidae Rafinesque, 1815 is a highly specialised group of marine segmented worms (class Polychaeta, subclass Sedentaria; see Kupriyanova et al., 2023) adapted to inhabiting self-secreted calcareous tubes (hence the common name “*calcareous tubeworms*”). The serpulid tubeworm genus *Pentaditrupe* Regenhardt, 1961 is characterised by its gently curved tube with pentagonal cross-section, formed by five longitudinal edges or keels. Unlike most serpulid genera and unlike Jurassic species of *Pentaditrupe*, Cretaceous and Paleocene species of *Pentaditrupe* are never found attached to solid substrates, but instead inhabited soft-bottom environments of fine-grained seafloors that later lithified into chalk, limestone, or marlstone. Here, we report new specimens of *Pentaditrupe* from the lower part of the Kerteminde Marl Formation (Selandian, middle Paleocene) of the Gundstrup gravel pit on Fyn, Denmark. These findings represent the first occurrence of the genus *Pentaditrupe* from the Selandian, thus extending the stratigraphic range of this genus and its temporal overlap with its presumed descendant *Ditrupe* by several hundred thousand years. Previously, the youngest known *Pentaditrupe* tubes were dated to the late Danian (early Paleocene).

In the past two decades, increasing attention has been devoted to the study of the microstructure of serpulid tubes (e.g., Vinn et al., 2008; Vinn & Kupriyanova, 2011; Vinn, 2013, 2020). Comparative studies on the microstructure of an early Danian tube from Holtug quarry, Sjælland, Denmark, resulted in “revival” of the species *Pentaditrupe interjuncta* (Jessen & Ødum, 1923). *P. interjuncta* was originally introduced for early Danian tubes from Voxlev, Jylland, Denmark, but for decades was regarded as a junior synonym of the late Cretaceous *Pentaditrupe subtorquata* (Münster in Goldfuss, 1831). While in the outer aspect the tubes of Cretaceous *P. subtorquata* and Danian *P. interjuncta* are indistinguishable, there are small but distinct differences in microstructure. The new specimens of early Selandian *Pentaditrupe* differ from both of these geologically older species by their larger tube diameter, sharper longitudinal edges or keels, and details in microstructure.

We also document new occurrences of the serpulid *Neovermilia gundstrupensis* Kočí, Milàn & Jäger, 2023 in the Gundstrup gravel pit. *Neovermilia* and *Pentaditrupe* were characteristic faunal elements already in the late Cretaceous and Danian limestones. Their presence in the Kerteminde Marl Formation somewhat mitigates the otherwise significant faunal turnover observed between the Danian and the Selandian.

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Macrobenthic organisms - trace fossil interactions in the Lower Carboniferous Culm Basin (Drahany Upland and Nížký Jeseník Mts. of the Czech Republic)

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The Lower Carboniferous Culm facies of the Moravo–Silesian Unit (Bohemian Massif) preserves thick siliciclastic turbidite successions of the Rhenohercynian Variscan Culm Basin. In the Drahany Upland the most fossiliferous beds are in outcrops of the Myslejovice Fm. (upper Viséan). The Moravice Fm. (upper Viséan) of the Nížký Jeseník Mts. could be the sedimentary basin equivalent for the Myslejovice Fm. in similar fauna and ichnofauna findings but with some differences in the composition of fossil fauna associations. From the Myslejovice Fm. was described and revised groups of fossil taxa: Anthozoa (1 species), Bivalvia (27 species), Brachiopoda (17 species), Crinoidea (1 species), Coleoidea (3 species), Gastropoda (11 species), Goniatitoidea (39 species), Nautiloidea (7 species), Trilobita (1 species); see more in Kováček and Lehotský (2014, 2018, 2022, 2025), Jančíková (2023), Lehotský et al. (2020), Lehotský (2008). The ichnofossils were studied by Kováček and Lehotský (2016), so far 13 ichnospecies in 10 ichnogenera was described. Lehotský (2016) studied ichnofossils from Moravice Fm. (Nížký Jeseník Mts.) and described 26 ichnospecies. For research purposes was used 606 specimens of ichnofossils from Moravice Fm. (collection of Regional Museum in Olomouc and Department of Geology at Faculty of Science, Palacký University in Olomouc), 615 trace fossils from Myslejovice Fm., 2,660 specimens of benthic fossils from the collection of Regional Museum in Olomouc. Recent field surveys (Kováček, 2023; Kováček & Lehotský, 2025msc.) have revealed more findings of microbial mats. These occurred as a wavy lamination in deep-water black shales. Mats in the Culm facies could have stabilized some muds against erosion between turbidity pulses. Lehotský (2016) described a targeted interaction between the fossil track originator and the fossil (Fig. 1). The aim of this short study is to test whether fossil tracks and macrofossils are often found in close proximity and whether there was direct exploitation and use of the organic matter of dead and buried organisms by the originators of the fossil tracks.

Microbial coatings, or biofilms, are often poorly associated with impacts on trace fossils or fossil associations due to the lack of paleontological record. Both in the Drahany Upland and in the Nížký Jeseník Mts. (specifically in the Moravice Fm.) there is only indirect evidence of the dependence of macroorganisms on bacterial coatings. These may be some irregularities occurring in the clay and dusty layered surfaces, which may have been misinterpreted in the past and may belong to microbial coatings based on the similarity of morphology. Bacterial activity often contributes to sediment stabilisation (Gerdes et al., 2000), which could explain the highly diverse communities of trace fossils and fossil remains found at certain sites in the Moravian-Silesian Culm Basin.

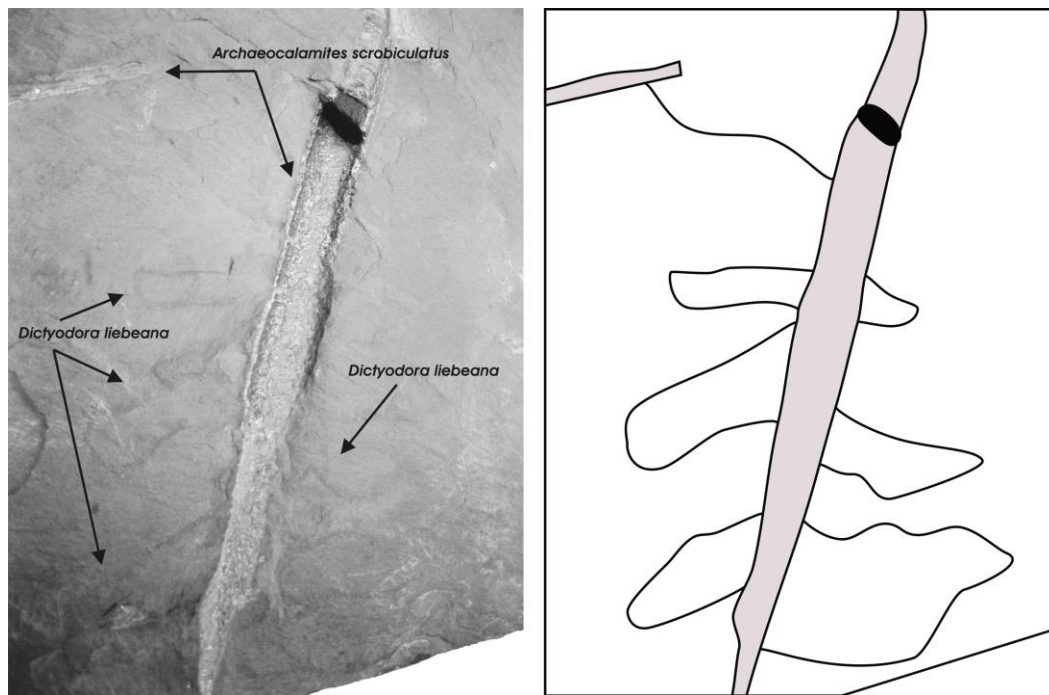


Figure 1. Fossil core of typical Lower Carboniferous horsetails of the genus *Archaeocalamites* and finger-like meander traces of *Dictyodora liebeana*. Site Svobodné Heřmanice, VMO 27895. Lehotský, 2016 (original interpretation).

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Palaeophotosymbiosis of giant bivalves in the Phanerozoic record – a critical review

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All the modern hermatypic corals are the best known non-photosynthetic organisms which live in symbiotic (mutualistic) relationship with brown-coloured algae (zooxanthellae) placed recently in the unicellular dinoflagellate genus *Symbiodinium*. Only rare, selected bivalves use currently the same method for living and are represented by genera of the superfamilies Tridacnacea and Cardicea closely related to each other: *Tridacna*, *Corculum*, *Hippopus* and *Fragum* which are Indo-Pacific tropical shallow-water dwellers (Yonge, 1936; Cowen, 1983; Seilacher, 1990; Ohne et al., 1995; Vermeij, 2013, 2016). Therefore, such symbiosis between non-photosynthetic bivalves and photosynthetic microbes are termed as photosymbiosis where zooxanthellae usually occupy intercellularly the host bivalve's soft tissues. These bivalves etologically belong both to epifaunal (*Tridacna*) and infaunal (*Fragum*) animals, which need sunlight physiologically for photosynthesis and used it directly on their mantle edges or by translucent thin posterior parts of valves – even closed – with transparent spots ("windows") which are exposed to the light [e.g., *Corculum cardissa* (Linnaeus, 1758)] (Vogel, 1975). In the fossil record, when we haven't any direct evidence for such palaeophotosymbiosis within bivalves, we have to use indirect criteria which reflect analogies with modern taxa and could be follow: typologically – great size, thick shells, aberrant shell morphologies; ecologically – epifaunal–reclining–mud-resting habit; palaeoenvironmentally – inhabiting shallow waters in tropical regions.

Giant bivalves occurred at least six times in the Phanerozoic: (i) Silurian–Devonian megalodontoids („*Megalodont I*” – *sensu* Isozaki & Aljinović, 2009: Fig. 7), (ii) Permian alatoconchids („*Alatoconchidae*” – op. cit.), (iii) late Triassic–early Jurassic megalodonts/lithiotids („*Megalodont II*” – op. cit.), (iv) late Jurassic–Cretaceous rudists/inoceramids („*Rudist*” – op. cit.), (v) Miocene oysters and (vi) Miocene-modern tridacnids („*Tridacna*” – op. cit.). Based on their presumable ecological/environmental conditions my doubts of interpretation of all aforementioned taxa as palaeophotosymbiotically organisms are *in brackets* and correspond to hot discussion on this topic in the literature (Accorsi Benini, 1985; Jones et al., 1988; Asato et al., 2017).

i & iii (partly) – both Silurian–Devonian (the first episode of gigantic bivalves) (de Freitas et al., 1993) and late Triassic megalodontoids were easily recognizable for their large size, shape and unique shell features (*as infaunal animals with thick valves they didn't have translucent thin shells; additionally – some Triassic palaeogeographical position of the megalodont-bearing carbonates were out of the tropical belt*);

ii & iii (partly) – gigantic Permian alatoconchids and early Jurassic *Lithiotis*-facies bivalves were one of the biggest shelled organisms of these ages – extraordinarily in size (longer even than 1 m) – and presumable as epifaunal and mud-sticker (*in situ* in vertical position) animals respectively (Fraser et al., 2004; Udchachon et al., 2024) (*maybe not all shells of these taxa were transparent to sunlight – even with 1 cm-thick prismatic calcite of their valves, which can served as optic fibers that light penetrate into the interior of bivalves even when closed; maybe exceptionally – thin (2–3 mm) left valves of Lithiotis genera were translucent to sunlight*);

iv – late Cretaceous inoceramids (*they were cosmopolitan and occupied different kinds of palaeoenvironments and it is unlikely in general that they had symbionts*) and Jurassic–early

late Cretaceous rudists of several carbonate platforms, and the largest rudist had valves reaching 2 m in length (*maybe some of rudists had symbiotic algae*);

v – Miocene oysters had valves that could reach over 0.5 m in length (*Crassostrea gryphoides*) (Miocene oyster buildups – biostromes and/or reefs – of the Paratethys realms occupied brackish palaeoenvironments mainly) (*no living oysters have algal symbionts, and most likely neither did their fossil counterparts*)

vi – modern tridacnids are one of the best examples of giant photosymbiosis bivalves of the tropical regions and their fossil counterparts were presumably the same.

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Famennian (Upper Devonian) ammonoid bearing horizons of the Moravian Karst, Czechia

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Ammonoids represent one of the most biostratigraphically important groups of marine animals starting from their early Devonian appearance to their end-Cretaceous extinction. They underwent significant evolutionary development during the late Devonian Famennian age, between the Kellwasser and Hangenberg biotic crises. Their diversity drastically decreased during these crises. Conversely, their diversity increased during several anoxic events like the Annulata and Dasberg events, which caused extinctions in other groups.

Ammonoids are surprisingly scarce in the open marine carbonate rocks of the Famennian Líšeň Formation exposed in the Moravian Karst, Czechia (Moravosilesian Basin, southeastern Laurussia). Consequently, the biostratigraphy of the Líšeň Formation relies primarily on conodonts and foraminifera. However, several ammonoid-rich horizons have been reported, mostly from event beds in the Křtiny Limestone. Ammonoids in the "background" outer ramp to upper slope facies are typically rare and have been found only in thin sections. The taxonomy of ammonoids was studied by Oppenheimer (1916) and Chlupáč (1966) in selected horizons, but modern systematic studies are lacking.

The number of known ammonoid-bearing horizons and their localities remained limited. To date, ammonoid faunas from the Lower Famennian „*Cheiloceras* limestone”, middle Famennian black limestone nodules of the Annulata Event, Upper Famennian grey „clymeniid limestone”, and uppermost Famennian „*Acutimitoceras* limestone” nodules have been reported from the Moravian Karst.

During the last decade, the second author discovered several new ammonoid-bearing horizons. The stratigraphically lowest occurrence was found in highly atypical facies for Devonian ammonoids: whitish, coarse-grained limestone. The ammonoid fauna was found in an isolated limestone boulder (volume approximately 1 m³) on the slope formed by typical micritic Křtiny Limestone nearby Jedovnice. The formation of coarse-crystalline limestone around a cold seep is speculated. Conodonts indicate a stratigraphic range between the middle Famennian *Scaphignathus velifer velifer* and *Palmatolepis rugosa trachytera* zones.

Another abundant ammonoid occurrence was found in two calcareous shale layers in the Hády-Říčka Limestone in the Hády quarry in Brno, from the middle Famennian *Palmatolepis marginifera marginifera* conodont Zone. Fauna consist of abundant small shells up to 2 cm in diameter, among which representatives of the genus ?*Flexiclymenia* were tentatively identified (T.R. Becker, oral communication).

Perhaps most significant are ammonoids from an approximately 0.7 m thick bank of dark grey laminated limestone of microbial origin from the Říčka valley. In several levels of this laminite, clymeniid (*Postclymenia*) mandibles (aptychi) and less frequent clymeniid and tornoceratid shells occur abundantly. The same laminite with mandibles was also found in a small outcrop of the Hády-Říčka Limestone near Anaklety and near Cemetery Líšeň in loose boulders. The microfacies coincides with laminite deposited during the Devonian/Carboniferous Hangenberg Biotic Crisis, documented from the nearby well-studied Lesní lom and Mokrá quarries, where ammonoids were not discovered. Famennian mandibles are extremely rare globally, known only from a few localities in Ohio, Germany, and Morocco. The community from localities around Madene El Mrakib in Morocco occurring in

black shales deposited during the Hangenberg Biotic Crisis (Klug et al., 2016), shows remarkable similarity to the community from the laminite.

The Hangenberg Laminite is overlain by alternating calcareous shales, marlstones, and limestones of the Hangenberg Sandstone and Stockum events in the Lesní lom quarry. At the top of this interval, in the uppermost Devonian *Protognathodus kockeli* conodont Zone, limestone nodules contain abundant small ammonoids (e.g., ?*Acutimitoceras* sp.) with diameters up to approximately 1 cm.

These new discoveries significantly expand knowledge of Famennian ammonoid distribution in the Moravian Karst, which can be used for refining late Devonian ammonoid biostratigraphic frameworks and understanding ammonoid responses to major biotic crises.

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Environmental diversity of the southern part of the Kraków-Częstochowa Upland in the light of malacological analysis

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Mollusks are a group of animals frequently used for the reconstruction of palaeoenvironments and their changes under the influence of natural and/or anthropogenic factors. Snails (in most cases), by producing a hard calcareous shell, are well preserved in Quaternary deposits, particularly those rich in calcium carbonate, which reduces chemical dissolution, and deposited in low-energy environments, which limits the mechanical destruction of shells (Wiktor, 2004). Mollusks are found in various genetically distinct types of deposits, including karstic infillings, both large (caves) and small (niches, rock shelters, and widened karstic fissures). Nearly 300 species of mollusks (*Mollusca*) are recorded in Poland. They are divided into gastropods (*Gastropoda*) and bivalves (*Bivalvia*). The first of these classes, which is the subject of this study, includes 182 species of terrestrial snails, 54 freshwater species, and 9 marine and brackish-water species (Riedel, 1988; Wiktor, 2004). In the present research, only shelled terrestrial gastropods with shells permanently attached to their bodies were considered. Their shells are composed of calcium carbonate in the form of aragonite. Each taxon produces shells with specific conchological characteristics (e.g., size, shape, details of shell elements, sculpture, coloration), which allows identification to species level. Complete shells can be identified using keys (Wiktor, 2004), whereas fragments can only be identified when they preserve distinctive features such as the aperture. In the case of the internal plates of slugs, species-level identification is impossible, and they are classified into the family Limacidae. Among the terrestrial gastropods inhabiting Poland, 152 taxa are shelled snails and 30 are slugs (Riedel, 1988; Wiktor, 2004).

In recent sediments, snail remains are very abundant. This is highly advantageous for palaeogeographic research, including stratigraphic interpretations, environmental reconstructions, and analyses of anthropogenic impacts. Malacocoenoses are closely related to the biotic and abiotic characteristics of the habitat in which they live. Shells, once buried by sediments, undergo little chemical alteration. Fossil mollusk assemblages are termed subfossil faunas.

The aim of the present study was to reconstruct environmental changes based on mollusk assemblages preserved in the infillings of small karst forms within limestone outcrops in the Jerzmanowice and Alwernia areas of the southern Kraków-Częstochowa Upland. The main subject of the research was the analysis of infillings and their malacological content collected from several isolated limestone outcrops: Witkowie Skały, Wilisowe Skały, Chochołowe Skały, Sokołowe Skały, and Ostatnia Skała in Jerzmanowice, as well as Gaudynowskie Skały near Alwernia.

Malacological studies carried out on ten profiles of small karst infillings in the southern Kraków-Częstochowa Upland lead to several conclusions:

The individual profiles contain distinctly different mollusk assemblages, indicating that the sediments were deposited during various Holocene periods characterized by different climatic conditions and plant formations.

The oldest sediments are those in the basal sections of the Witkowie Skały profiles, where cold-adapted species typical of the Late Glacial and early Holocene (*Semilimax kotulae*, *Vertigo geyeri*, *Columella columella*, *Vertigo ronneyensis*) were found. Except for the first, these taxa are no longer present in the study area. Younger sediments, probably of early

Holocene age, were found in the upper intervals of the other sites and are characterized by abundant *Discus ruderatus*. Mid-Holocene deposits, dominated by forest taxa including thermophilous species (*Discus perspectivus*), were found in some profiles. Late Holocene and historical deposits exhibit significant faunal variability: shade-loving species dominate north-facing slopes, while xerophilous open-country snails dominate south-facing slopes.

The ecological and chronological variability of malacocoenoses allows reconstruction of environmental changes in the area from the end of the Late Glacial through the Holocene. Initially, open and moist habitats with a high share of cold-adapted taxa prevailed. In the early Holocene, forest expansion began, initially with coniferous stands typical of a cool continental climate, accompanied by assemblages rich in *Discus ruderatus*. As the climate warmed and became more oceanic, mixed and deciduous forests developed, and shade-loving and thermophilous taxa (*Discus perspectivus*) became more common, representing the Mid-Holocene climatic optimum. In the late Holocene, drier conditions led to habitat diversification depending on slope exposure: shaded northern and western slopes retained forests and their associated malacocoenoses, while southern and eastern slopes experienced forest decline and the spread of open grasslands and exposed rock faces. Human activity, particularly deforestation in the Middle Ages, may also have played a role.

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A new occurrence of Carboniferous (Pennsylvanian) petrified wood in Quaternary deposits, SW Poland

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During renewed geological mapping of the Sudetes in SW Poland, several dozen specimens of silicified wood were discovered. The fossil material was recovered from the Metuje River valley, near the town of Kudowa-Zdrój, where it occurs as clasts embedded in coarse-grained fluvial deposits. These remains are preserved within a river terrace approximately 18–25 meters above the current river level and consist primarily of horizontally oriented, elongated trunk fragments ranging from 5 to 40 cm in length. The lithological context and preservation state suggest that the wood was redeposited during Quaternary fluvial processes.

The anatomical features of the fossil wood were investigated through macroscopic examination, standard transmitted-light petrography, cathodoluminescence (CL) imaging, and scanning electron microscopy (SEM). The internal structure is generally well preserved, with cellular details such as tracheids (both thick- and thin-walled) retaining their original fibrous-linear arrangement. The primary organic material has been almost entirely replaced by silica, resulting in highly detailed fossilization. In some areas, the lumens of the fossil cells are filled with opaque secondary mineral phases. In addition to silica, traces of iron oxide pigments (Fe_xO_y) were detected, which may account for the reddish coloration observed in some specimens.

The presence of fragmented and abraded wood clasts within unconsolidated Quaternary sediments strongly supports the interpretation of secondary redeposition from older bedrock sources. Paleocurrent data derived from the orientation of gravel and sand layers indicate sediment transport from the north. Based on this evidence, it is proposed that the silicified wood originated from eroded Carboniferous strata exposed in the eastern part of the Czech Intra-Sudetic Basin. In particular, abundant fossil wood is known from the Jívka Member of the Odolov Formation (Upper Pennsylvanian), previously described by Mencl et al. (2009).

It is likely that the trunks and stems were eroded from these Carboniferous layers by the downcutting activity of the Metuje River in the Hronov area (Czech Republic), transported southward as coarse woody debris—most likely during high-energy flood events—and ultimately deposited 5 to 10 km downstream within the present-day Quaternary alluvium. This unique taphonomic setting provides valuable insights into the processes of fossil wood transport, redeposition, and preservation within fluvial environments, as well as the paleoenvironmental evolution of the Intra-Sudetic Basin during the late Quaternary.

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Larger Benthic Foraminifera in exotic limestone from the Bystřice locality (Menilite formation of the Subsilesian unit, Outer Western Carpathians) and their biostratigraphical significance

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Exotic limestones with larger benthic foraminifera are in outcut banks of the Olše river. Previous studies of sites with larger benthic foraminifera in the Jablunkov pass were conducted by Bouček and Příbyl (1954), Bieda (1968) and Köhler (1981, msc.). The site in Bystřice, which was the subject of this survey, is located on the left outcut bank of the Olše river, 1 km southeast from the Bystřice railway station and about 100 m west from the bridge over the Olše river. The profile measures approximately 12×7 m and consists mainly of mudstones, siltstones, sandstones, and conglomerates. On these layers is a thick attitude of dark gray mudstones called “formation of pebbly mudstones“. This formation contains blocks of exotic rocks such as gneisses, mica schists, sandstones and limestones. Some blocks are up to 100 cm in diameter. Exotic limestone is light grey, massive and full of large benthic foraminifera tests (Fig. 1). Tests are well preserved.



Figure 1. Tests of Large Benthic Foraminifera in exotic limestone from Bystřice locality.

Determination of larger foraminifers was studied in thin sections and polished sections. The association from exotic limestone is represented by: *Nummulites* gr. *partschi* (De La Harpe, 1880), *Orbitoclypeus* cf. *varians* (Kaufmann, 1867), *Discocyclina* sp., *Assilina* sp., A. cf. *schwageri* (Silvestri, 1928) and *Asterocyclina* cf. *stellata* (D'Archiac, 1846). For the Tethyan Paleocene and Eocene the Shallow Benthic Foraminiferal biozones (SBZ) of Serra-Kiel et. al (1998) was used. The large benthic foraminifera from Bystřice could be classified into these SBZ biozones: *Nummulites* gr. *partschi* SBZ 10–11, *Asterocyclina* cf. *stellata* SBZ 10–20, *Orbitoclypeus* cf. *varians* SBZ 12–20 and *Assilina* cf. *schwageri* SBZ 17–18. The association

of LBF from the Bystřice locality indicates the Eocene epoch, specifically the Bartonian and Priabonian ages. The association found is not isochronous, so it was most likely redeposited.

Acknowledgement:

The identification of LBF was consulted with Dr. Elżbieta Machaniec (Jagiellonian University in Krakow), whom we thank for her determination and help with description of the thin sections.

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High-resolution stratigraphic analysis of lorica size of calpionellids across the late Tithonian–early Berriasian transition in the Pieniny Klippen Belt

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Near the Tithonian/Berriasian boundary, it was hypothesized that *Calpionella alpina* exhibits a significant decline in lorica size and ellipticity and that this shift is accompanied by a shift from *Crassicollaria* to *Calpionella* dominated-assemblages. Our high-resolution data from the Brodno section (Pieniny Klippen belt) show that that this transition occurs already in the upper part of the Intermedia Zone and is associated with a ~10–20 µm reduction in median lorica length and with the increased sphericity. Size and shape analyses at species, genus, and community levels reveal that this change in lorica size and shape is visible at the scale of whole calpionellid assemblages and affects also crassicollarians, and can thus serve as a sensitive indicator of paleoceanographic change at the Jurassic–Cretaceous boundary.

To evaluate stratigraphic changes in the size and shape of calpionellid loricae across the late Tithonian–early Berriasian interval and to test whether the bloom of small *Calpionella alpina* (~60 µm) aligns with the *Crassicollaria*/*Calpionella* zonal boundary, we analyzed 99 samples collected from the Czorsztyn and Pieniny limestone formations from the Brodno, section in the Pieniny Klippen Belt (Western Carpathians). Each thin section was subdivided into a grid of 0.4×0.4 cm squares, to capture spatial variability in microplankton abundance and size. Using this standardized method, we measured more than 15,000 calpionellid loricae. Lorica ellipticity was calculated as the length-to-width ratio excluding the collar.

We find that lorica size remained stable and small (<70 µm median) from the chitinoideid and *Praetintinnopsella* assemblages to assemblages dominated by early *Crassicollaria* up to bed 7 at Brodno. Notably, lorica size increased markedly in the upper Remanei Subzone for both *Crassicollaria* and *Calpionella*. The lorica size increases from ~50–60 µm to ~80 µm in the upper Remanei Subzone (coinciding with the transition from red nodular limestones to light-gray Biancone/Maiolica facies), then markedly declines near the Intermedia/Colomi boundary (coinciding closely with the boundary between beds 15–16, without any associated changes in microfacies) rather than at the expected Colomi/*Alpina* boundary. The size decline thus does not coincide with the replacement of crassicollarian by calpionellid-dominated assemblages (and rather agrees with the definition of the Tithonian/Berriasian boundary as proposed by Houša et al., 1996). The rise in size in the upper part of the Remanei Subzone and the subsequent decline in size near the Intermedia/Colomi boundary, including reduced ellipticity, occurred within relatively narrow stratigraphic intervals, suggesting a complex and stepwise ecological or environmental response rather than a single abrupt event. However, analyses of Mg/Ca ratio in loricae indicate that seawater temperature did not change during these events.

Morphological convergence in lorica length and width between *Crassicollaria* and *Calpionella* suggests shared environmental preferences and selective pressures.

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Plant-animal interactions in the late Triassic of Upper Silesia (Poland)

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Several fossiliferous late Triassic localities have been discovered recently in Upper Silesia. They have yielded numerous vertebrate, invertebrate, and macro- and microplant remains. However, only two of these localities (Patoka and Poręba) have provided evidence of plant–animal interactions. The strata exposed at these sites belong to the upper part of the Patoka Member of the Grabowa Formation. Sporomorphs found in the fossil-bearing levels are typical of the local palynological zone *Classopollis meyeriana* subzone b, indicating middle–late Norian age.

The plant macroremains belong almost exclusively to conifers and are preserved as coalified compressions with well-preserved cuticles. Leafy shoots and isolated leaves of *Brachyphyllum-Pagiophyllum*-morphotype dominate the material, while bract scale–seed scale complexes and male cones are rarer (Pacyna et al., 2017). The compressed remains were separated from the sediment by treatment with 40% hydrofluoric acid, then washed with distilled water and examined under a stereomicroscope in water.

While examining the leafy shoots and isolated leaves, characteristic damage was detected on some of them, most likely resulting from arthropod activity. Some leaves exhibit mining and contain elongate masses of frass within the mines, composed of very small, ovoid coprolites measuring approximately 36×45 µm. The Triassic fossil record of leaf mining is based primarily on impressions of galleries and frass on fossil leaves (e.g., Labandeira, 2002; Labandeira et al., 2016). The Silesian material provides, for the first time in the Triassic, frass preserved within isolatable coalified leaf cuticles. However, its state of preservation makes it difficult to determine the shape of the tunnels and classify them according to the types defined by Labandeira et al. (2007). Nonetheless, this type of preservation allows for more detailed observations of leaf mining, which first appeared in the fossil record during the Triassic. The small size of the tunnels and coprolites may indicate that they were produced by mites.

Round holes smaller than 1 mm in diameter are present on several isolated leaves, although they are absent from mined specimens. These holes represent hole feeding: damage type DT01, according to the classification by Labandeira et al. (2007).

Several shoot apices are atypical, differing from the normal condition: they are shortened, swollen, and have very densely arranged leaves. This alteration could be the result of galling by an arthropod, possibly a mite, similar to galls found in modern *Picea*. However, this is difficult to confirm based on the available material.

Additionally, several leaves from Poręba exhibit enigmatic modifications in cuticle micromorphology. Their origin and function remain uncertain; they may represent oviposition traces or stomatal modifications caused by an unknown agent. These structures are elongated ovoid or circular bodies that, when observed under light microscopy, appear to resemble oviposition traces—closed egg capsules containing the remains of lenticular eggs—and may be attributed to the activity of odonates. However, observations of the same specimens under scanning electron microscopy (SEM) revealed a markedly different picture. On the outer surface of the cuticle, these structures appear as distinct grooves into which characteristically enlarged papillae of the surrounding cells protrude. On the inner surface, they appear as accumulations of amorphous or finely spherical material. The composition of this material (identified as pyrite) and its shape suggest that these could be coprolites. The lenticular structures within the larger bodies, which are clearly visible under light microscopy and

initially interpreted as putative egg remains, are either not visible or only poorly preserved in SEM images. The characteristic papillae of the cells surrounding the grooves visible in SEM resemble those found on stomata subsidiary cells of morphologically similar leaves that lack any signs of interaction. In contrast, leaves displaying these interactions are almost entirely devoid of stomata.

Traces of plant–animal interactions are present on a relatively small number of leaves, suggesting either that few types of interactions occurred and arthropod herbivory was minimal, or that conifers were not commonly exploited by arthropods. According to Labandeira (2006), the Triassic marks the beginning of the third phase of plant–arthropod interactions. This phase already includes almost all types of interactions known today, although they involved ferns and gymnosperms, as angiosperms had not yet evolved. The fossil sites from Upper Silesia contribute to our understanding of what the early stages of this phase may have looked like.

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Old collections studied with new methods: Naturalia of the woolly rhinoceros and forest elephant in the spotlight

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The museums have rich natural collections among which, according to the older nomenclature, were specimens of natural origin such as bones, teeth, skins, geological specimens ('naturalia') and specimens of rare species brought from other countries ('exotica'). The third category consisted of specimens with marks of human influence, such as processing ('artificialia').

In this work, we will focus on specimens of natural origin and in particular the remains of the woolly rhinoceros (*Coelodonta antiquitatis* Blumenbach, 1799) and the forest elephant (*Palaeoloxodon antiquus* Falconer & Cautley, 1846). The remains of the woolly rhinoceros are often present in museum collections (Pawłowska et al., 2024) but also often have not been studied at all. Therefore, first a revision of the identifications was done and then selected specimens were used for research. We examined the state of collagen preservation depending on the methods used to conserve the specimens. This relationship is important for sampling for specialized studies, such as genetic and radiocarbon studies among others. We examined the effect of the consolidating agent on the composition of the bone material by performing a series of measurements by Fourier infrared spectroscopy.

Details of the research conducted and the results obtained, for the skull of a woolly rhinoceros and the skeleton of a forest elephant, both from the collection of the Konin District Museum, will be provided.

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Exceptional sedimentary marks and trace fossils from early Permian non-marine red-beds (Mieroszów site, Intrasudetic Basin, Poland)

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In the northern part of the Intra-Sudetic Basin, specifically in Mieroszów, cm-sized ice crystal marks have been discovered in Permian sediments. These marks are preserved in reddish-brown mudstones that is part of a fluvial siliciclastic sequence consisting of mudstones, sandstones, and conglomerates from the upper Słupiec Formation. The same also yielded typically early Permian tetrapod footprints assigned to the ichnogenera *Dromopus* and *Ichniotherium*, as well as rare specimens of invertebrate traces comparable to *Tambora spiralis*. Despite the excellent preservation of the ice crystal imprints, which exhibit various forms including straight, acicular, single, branched, and rosette shapes, an experiment was conducted using the same type of sediment to rule out alternative origins for the imprints. The hydrated sediment was subjected to freezing, and the resulting ice crystal imprints exhibited the same forms and shapes as those found in the Słupiec Formation.

Although the Intra-Sudetic Basin was located near the equator during the early Permian, the presence of ice crystal imprints suggests the occurrence of night frosts. Similar findings have been reported in other Permian basins near the equator, including the Maroon Formation in northwestern Colorado (Voigt et al., 2021). These observations indicate that the palaeoenvironment at that time was characterized by climatic extremes, which may have influenced the evolution of terrestrial fauna.

Voigt, S., Oliver, K., Small, B.J., 2021. Potential ice crystal marks from Pennsylvanian-Permian equatorial red-beds of Northwest Colorado, U.S.A. *Palaios*, 36, 377–392 DOI: <http://dx.doi.org/10.2110/palo.2021.024>

Microanatomy of trilobite exoskeletons: a case study of *Morocops? degener* (Devonian, Czech Republic)

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With more than 20 000 described species, trilobites are one of the most diverse groups of arthropods in the fossil record. They were a key component of Paleozoic marine ecosystems and occupied various ecological niches throughout their long evolutionary history. Despite the extensive research devoted to trilobites, the internal and external microanatomy and paleobiology of their exoskeletons still remains understudied. Some key unexplored aspects in this topic include the original composition of trilobite exoskeleton, function of various observed structures and their homology or analogy to those found in recent arthropods, as well as the effect of diagenesis on commonly observed features. Addressing these gaps in our knowledge is essential for a more comprehensive understanding of trilobite palaeobiology and evolution.

In the past, several techniques have been employed to study the internal microscopic structure of trilobite exoskeletons. Among them, the method involving the careful etching of oriented sections of the exoskeleton using the EDTA (ethylenediaminetetraacetic acid) has proven to be particularly effective. In our study, this method was for the first time applied also to trilobite samples collected from various Silurian and Devonian carbonates in the classical Barrandian area. Cephalae of *Morocops? degener* (Barrande, 1852) from the Lower Devonian Zlíchov Formation were selected as the most suitable for a detailed study of the microscopic structure of the exoskeleton. Microanatomical features observed in etched sections were documented and compared with surface structures using both institutional specimens and newly collected material.

The conical tubercles on the glabella of *M.? degener* have proved to be particularly interesting, as they show distinct and previously undescribed microstructural variations. These findings provide new insights into the development and possible biological function of tubercles on the trilobite exoskeleton and thus contribute to a broader understanding of trilobite functional morphology.

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Preliminary study of the flora and mesofossils from the Kounov Coals (Stephanian) discovered near Hořesedly, Kladno-Rakovník Basin, Czech Republic

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The Kounov coal seam was recently discovered during the highway construction near Hořesedly between Děkov and Hokov. It is located in a reduced development at the western edge of the Kladno–Rakovník Basin. The section, 4 m high, contains the Kounov coal seam split into three benches less than 10 cm thick. The flora was obtained from the partings, mainly above the lower and middle benches. The mesofossils – dispersed cuticles and vascular tissues have been obtained from all three benches of the coal seam.

Up to now, only a few species were known from this region (Němejc & Šetlík, 1950). However, a relatively rich plant assemblage has now been obtained from this new excavation. The excavation yielded about 30 fossil-species from about 250 evaluated specimens up to now. Samples of three benches of the Kounov coal seam were macerated for mesofossils. Dispersed conducting tissues have been obtained from 3 samples from the lower and middle bench and dispersed cuticles from four samples from the middle and upper bench. 126 microscopic slides and 7 SEM stubs have been prepared.

The flora composition is as follow:

Lycopsids are extremely rare, preserved as barks beneath the coal seam and in the second intercalation. Lycopsids are represented by stems (barks) *Asolanus camptotaenia*. New for the Czech Republic are new *Viatscheslavia vorcutensis* Zalesky (previously only known from the Pechora Basin of Russia) and *Bumbodendron* sp. (previously only known from Argentina in the Gondwana). These last two species are exotic for the Stephanian of the Bohemian Massif and need to be further investigated.

Sphenopsids dominate in the first intercalation with calamitalean trunks with several species of pith casts: *Calamites cistii*, *C. gigas*, *C. suckowii* and *C. cf. undulatus*. Calamitalean foliage is also represented by *Annularia sphenophylloides*, *A. spinulosa* and *Asterophyllites equisetiformis*. Rare herbaceous and liana sphenophylls are represented by *Sphenophyllum oblongifolium* and *S. verticillatum* in the first and second intercalation.

Ferns dominate in this section, together representing 28% of the assemblage. Marattiales are the most common, the commonest species being *Cyathocarpus cyatheus* in the second intercalation. Also, well represented are *Cyathocarpus arboreus*, *C. densifolius* and *C. hemitellioides*. Also, probable *Lobatopteris geinitzii* have been identified. A few specimens of *Nemejcopteris feminaeformis* from Zygopteridales have been obtained. The other fern orders are very rare – Botryopteridales with family Tedeleaceae and fossil-species *Senftenbergia plumosa* and the order Gleicheniales with a species *Oligocarpia grigorievii*. The fossil-species *Sphenopteris mathetii* from Sphenopterides is of uncertain systematic affinity.

Pteridosperms are very rare represented only by the medullosalean *Alethopteris bohémica* from the second intercalation. Their leaves represent the most widespread group in the section, occurring in all intercalations and in the roof-shales. When only large fragments are counted, the cordaitaleans represent 27% of the assemblage. Based on the venation, it is possible to distinguish at least three *Cordaite*s species. Unfortunately, it is not possible to verify this from their cuticles, which is the only reliable way to verify their identification (Šimůnek, 2024).



Figure 1. *Annularia sphenophylloides*, upper intercalation of the Kounov coal seam, Hokov-Děkov locality, scale bar = 1 cm.

Drought-tolerant Walchian conifers are represented only by a twig.

A dispersed cuticular assemblage from the coal contains cordaitalean cuticles that differ from *in situ* cuticles described from the Slaný Formation, to which the Kounov group of coal belongs (Šimůnek, 2024). A new species within the dispersed cordaitalean cuticular system needs to be described. Also present in the dispersed cuticles are lycopsids, possible ferns, and pteridosperm rachises or seeds.

Three types of conducting tissues were found with the disperse cuticles.

The 1st type: Conducting elements show tracheids 20–60 µm in diameter with round or oval uni- to multiseriate bordered pits, usually up to 5 µm in diameter. Some tracheids have reticular or scalariform wall thickening. Similar conducting tissue has been described by Batenburg (1982) in *Sphenophyllum*. Scalariform wall thickening is also known from a sphenopsid *Arthropitys bistriata* (Mencl et al., 2013).

The 2nd type is represented by tracheids 100–200 µm in diameter. Bordered pits are round or oval, usually arranged in 2–5 rows and they have 2–10 µm in diameter, often became reticular or scalariform thickening. This type could belong also to *Sphenophyllum* (Boureau, 1964, Šimůnek & Bureš, 2015).

The 3rd type shows small fragments of conducting tissues include metaxylem tracheids 20–50 µm wide with multiseriate bordered, oval-round pits up to 5 µm in diameter and protoxylem tracheids with reticular thickening up to 70 µm wide. The structure is similar to some Carboniferous ferns.

Conclusion

The relatively rich floral assemblage of the Kounov coal seam (Saberian) contains 30 fossil-species. A few lycopsid fragments have been found beneath the Kounov coal seam, however, calamitalean stems and cordaitalean leaves are relatively common in the lower intercalation. The upper intercalation is rich in cordaitaleans and ferns, however, other plant groups are also present: calamitalean and sphenophyll foliage and pteridosperm pinnules (*Alethopteris bohémica*). The roof-shales are very poor on floral remains, only ferns and cordaitaleans.

The dispersed cuticles belong to lycopsids and cordaitaleans, the other cuticles are of the unknown affinity. The conducting tissue are classified to three types. They are compared with sphenopsids, ferns and perhaps some gymnosperms.

The Hořesedly locality represents the Siberian Kounov coal seam in its very reduced development in the most western occurrence of the Kladno–Rakovník Basin.



Figure 2. Abaxial cuticle of new cordaitalean cuticular morphotype with a stomatiferous band and papillose cells. Upper bench of the Kounov coal seam, Hokov-Děkov locality, scale bar = 100 μ m.

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Líšeň-Podolí I – the oldest intentionally modified fossil mollusc shells in the Czech Republic

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Modified recent and fossil mollusc shells (gastropods, bivalves, scaphopods) belong to the earliest objects used mostly as personal ornaments in the Palaeolithic. They represent an important element of the material culture of early humans, and, generally, indicate the emergence of their modern social behavior (aesthetic perception, shared symbolic language etc.). Although the use of modified shells for symbolic expression is not confined to modern humans, its presence in Neanderthal contexts is generally sporadic.

The present-day archaeological literature related to the middle to upper Palaeolithic sites, above all in Africa, Europe or Levant, offers plentiful evidence of mollusc shells, including the fossil ones, both naturally and artificially perforated, and used as adornments. Detailed analyses of this material can help to understand the evolving role of shell ornaments, the changes in their qualitative and quantitative compositions through time (for example, a dramatic increase in their numbers and diversities in the Upper Palaeolithic), as well as in their geographical dispersal.

The oldest known example of sophisticated symbolic behavior in the Czech Republic and one of the oldest known in Europe comes from the site Líšeň-Podolí near Brno, South Moravia, Czech Republic. This locality (minimum age of 40–44 ka BP) represents a specific new early upper Paleolithic lithic industrial type, namely the Lincombian–Ranisian–Jerzmanowician (LRJ) Industry, connected with the activity of *Homo sapiens* (Demidenko & Škrdla, 2023). At the locality, 36 specimens and fragments of Miocene (predominantly marine) mollusc shells were found. Among them, gastropods *Granulolabium bicinctum*, *G. nodosoplicatum*, *G. sp.* dominate, *Amalda glandiformis*, ?*Turritella sp.*, ?*Euthria sp.*, ?*Nassarius sp.*, ?*Cepaea sp.* are less frequent, only one fragment of Bivalvia indet. occurred. *Granulolabium bicinctum* and *G. nodosoplicatum* are of Sarmatian age, *Amalda glandiformis* of Badenian age. Generally, intentional collecting, of fossils can be assumed at the locality. Their possible source areas are the Vienna Basin (ca. 40 km to the SE from Brno, sediments of Badenian and Sarmatian ages), and the Carpathian Foredeep (the Brno area and its wider vicinity, sediments of Badenian age).

On the shells, diverse traces of human modifications (especially artificial perforations and occurrences of red and black pigments) can be observed (Škrdla, 2017). Whereas the black substance (manganese oxides) is precipitated from surrounding sediments, the red substance (hematite) is not of local origin (probably from the nearby Stránská skála site).

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Definition of the Eocene/Oligocene boundary based on biostratigraphy and tuffite geochronology: a case study of the Central Western Carpathians

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A high-resolution planktonic biostratigraphy and tephrochronology has been integrated to define the Eocene/Oligocene boundary in the Central-Carpathian Paleogene Basin (CCPB). The study was focused to boundary sections with planktonic bioevents and volcanic ashes for geochronological dating. Such pronounced boundary section with tuffite horizons occurs near Istebné in Orava region. The lower part of the Istebné section is dominated by non-calcareous claystones with deep-water agglutinated foraminifera. Their middle Eocene age is constrained by the presence of *Ammodiscus latus* (see Waśkowska & Kaminski, 2012). Plankton-rich hemipelagic intervals contain the foraminiferal species *Hantkenina alabamensis*, the last occurrence of which marks a E/O boundary (cf. Coccioni, 1988). The tuffite horizons in the Istebné section provide the U–Pb zircon age of 32.98 ± 0.18 Ma (Fig. 2), which corresponds to the E/O boundary in the GTS2020 (33.9 Ma, cf. Speijer et al., 2020). Moreover, the boundary tuffite beds also correspond to “Tuff 25” dated around 32.8–34.6 Ma in the Outer Western Carpathians (cf. Van Couvering et al., 1981).

Above the E/O boundary, the Istebné section reveals considerable changes in productivity and dwarfing of planktonic foraminifera. Beside rich small-sized forms of *Globigerina*, *Tenuitella* and *Chiloguembelina*, a new species of *Dentoglobigerina* (*D. tapuriensis*), *Turborotalia* (*T. ampliapertura*) and *Paragloborotalia* appear. Simultaneously, the agglutinated foraminifera were highly impoverished in response to the Oligocene climatic cooling (see Ortiz & Kaminski, 2012).

The E/O boundary is also indicated by calcareous nannofossils. This boundary is predated by the first appearance of *Isthmolithus recurvus* in the NP19/20 zone and characterized by the co-occurrence of *Lanternithus minutus* and *Zygrhablithus bijugatus* (Nyerges et al., 2021). The base of the Rupelian is marked by nannofossils of the NP 22 zone, including the species *Helicosphaera bipuncta* and *H. recta*, and appearance of *Reticulofenestra ornata* in the NP 23 zone. The climatic index taxa of the calcareous nannoplankton imply a decrease of species with warmer preferences (e.g., *S. moriformis*) to species with colder preferences (e.g., *Z. bijugatus*, *L. minutus*).

The results from the Istebné section provide a good correlation with E/O boundary events, like the last occurrences of hantkeninids in the Turie section, and tuffite ages of 34.76 ± 0.25 Ma in the Revištné section and 30.76 ± 0.20 Ma in the Šutovo section.

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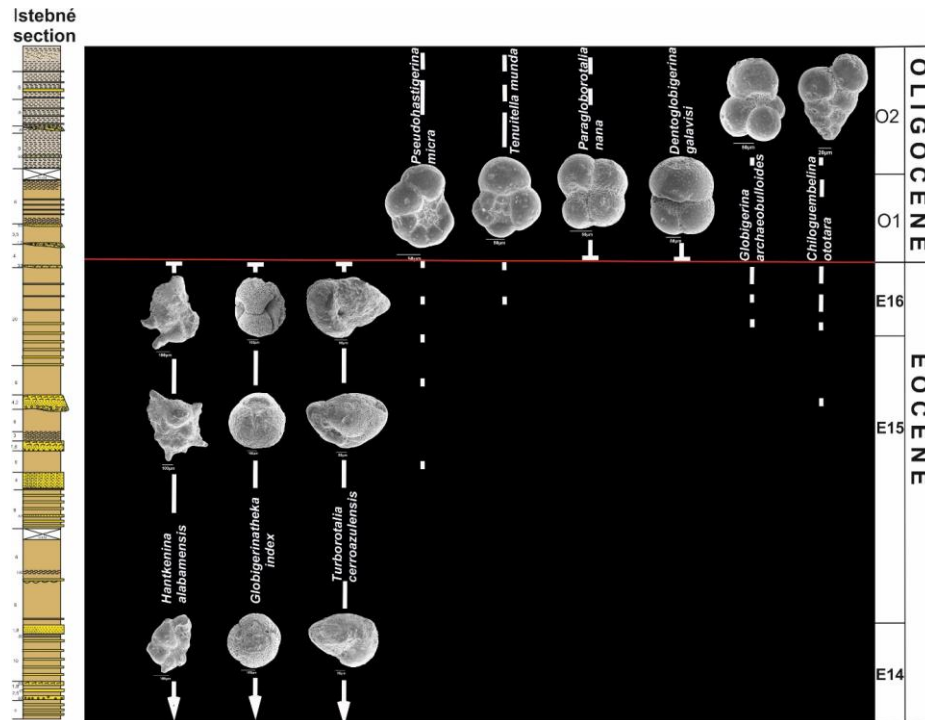


Figure 1. Eocene–Oligocene boundary defined by highest and lowest occurrences of planktonic foraminiferal species in the Istebné section.

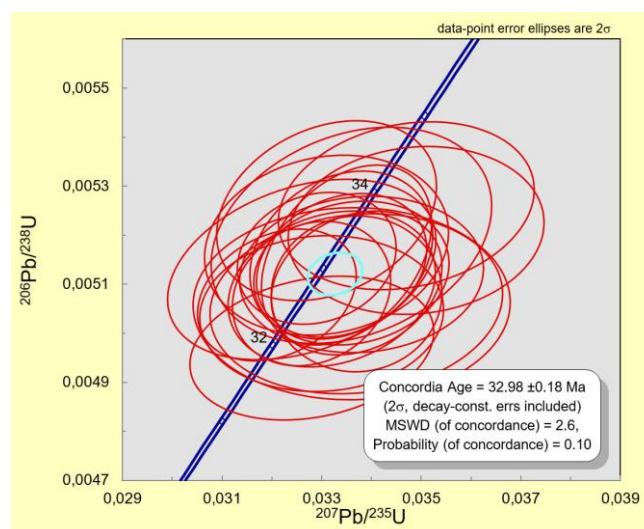


Figure 2. The U-Pb zircon dating of tuffite bed in the Istebné section providing the concordia age of 32.98 ± 0.18 Ma.

Foraminiferal microfauna across the Cretaceous/Paleogene boundary in the Western Carpathians: extinction, recovery and radiation bioevents

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K/Pg boundary has been previously constrained in Western Carpathians, but its existence has been questioned due absence of lowermost P-serie biozones. New evidence of the K/T boundary has been gathered from the high-resolution study of drill-core sections in the Horná Nitra Depression (KRS–3 section) and Middle Váh Valley area (ZA–1 section).

The K/Pg transition is most properly marked in the Kršteňany KRS–3 section, and that by the LO of *Abathomphalus mayaroensis*. Post-K/Pg recovery is recorded by the appearance of microperforate species *Globoconusa daubjergensis*, *Eoglobigerina simplicissima* and *Parvularugoglobigerina eugubina* (P0–Pa Zone). The section grades upward to the Selandian formation with praemuricid species and the latter radiation of morozovellids, igorinids and fasciculiths. Thanetian formation is dated by *Globanomalina pseudomenardii*. The PETM interval is marked by excursion taxa (*Acarinina sibaiyensis*, *Discoaster araneus*) in magnetic reversal Chron C24r, followed by Ypresian formations with rich and diversified hispid morozovellid species (*M. formosa*, *M. subbotinae*, *M. aragonensis*, *M. lensiformis*, etc.), and higher up in Lutetian formations by an association of *Morozovella gorrondatxensis*, *Turborotalia frontosa*, *Globigerinatheka kugleri*, *Acarinina topilensis*, *Morozovelloides cf. coronatus*, etc.

The Žilina ZA–1 section (Fig. 1) exhibits a continuous K/Pg boundary sequence, passing through the light gray Maastrichtian marlstones with rich globotruncanid and heterohelicid microfauna, across the dark grey bioturbated marls of the lowermost Paleocene formation with disaster species like *Guembelitra* and *Globoconusa*. Beside abrupt biotic changes, the K/Pg boundary is marked by elevated Hg concentrations. Planktic foraminiferal microfauna is enriched during the late Danian by species of parasubbotinids, eoglobigerinids and praemuricids. The Lower Selandian microfauna is rich in morozovellid foraminifers like *M. angulata*, *M. acuta* and *M. conicotruncana* (P3b Zone). Globanomalinid foraminifers belong to species *G. ehrenbergeri* (P3 Zone) and its descendant species *Globanomalina pseudomenardi* (P4 Zone). Since the disappearance of *pseudomenardii*, younger species of globanomalinids like *G. chapmani* and *G. australiformis* appeared during the late Thanetian. Morozovellid foraminifers occur as large-sized discoidal and biconvex species belonging to the *Morozovella velascoensis* Zone (P5). The Paleocene/Eocene boundary in the Žilina-Hradisko section is approximated by species *Morozovella marginodentata* and *M. gracilis*, which first appeared in the P5 Zone and terminated in the E1–E3 Zones (Ypresian).

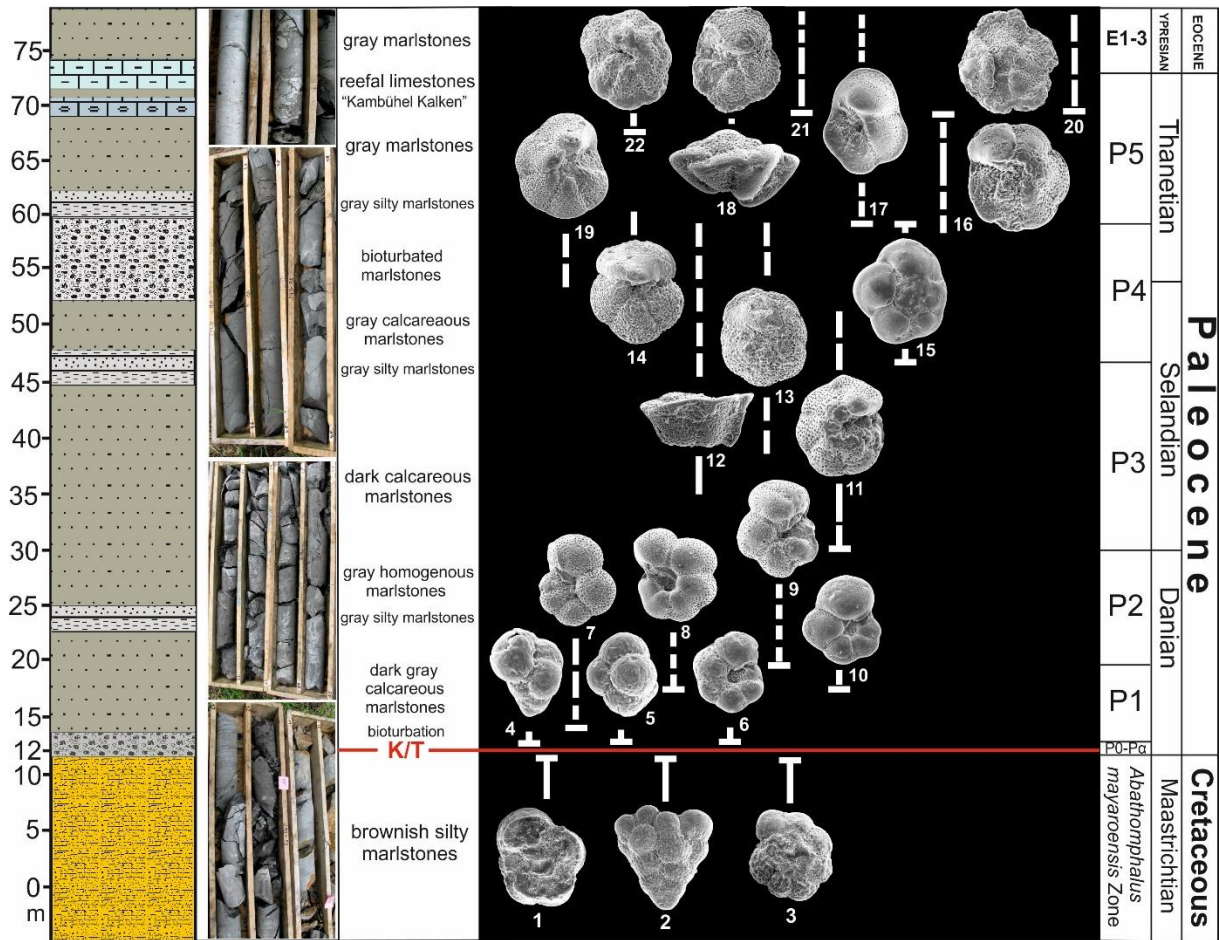


Figure 1. Lithology and biostratigraphy of the Žilina ZA-1 section. Vertical distribution of marker species of planktonic foraminiferal zones and stratigraphic stage boundaries. Numbers of indicated species: 1 – *Abathomphalus mayaroensis*; 2 – *Racemiguembelina fructicosa*; 3 – *Rugoglobigerina pennyi*; 4 – *Guembelitra cretacea*; 5 – *Globoconusa daubjergensis*; 6 – *Parvularugoglobigerina eugubina*; 7 – *Parasubbotina pseudobulloides*; 8 – *Praemurica inconstans*; 9 – *Praemurica uncinata*; 10 – *Globanomalina compressa*; 11 – *Morozovella angulata*; 12 – *Morozovella conicotruncana*; 13 – *Igorina albeari*; 14 – *Morozovella apantesma*; 15 – *Globanomalina pseudomenardii*; 16 – *Morozovella velascoensis*; 17 – *Morozovella subbotinae*; 18 – *Morozovella occlusa*; 19 – *Morozovella acuta*; 20 – *Morozovella marginodentata*; 21 – *Morozovella gracilis*; 22 – *Planorotalites pseudoscitula*.

Biostratigraphy and paleoecology of borehole Dunajovice 2140 01T1, Třeboň Basin (Klikov Formation) based on palynological investigation. Preliminary results

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Borehole sampling of the Upper Cretaceous non-marine strata of the Klikov Formation in the central part of the Třeboň Basin in southern Bohemia provided 70 m thick alluvial strata of alternating sandstones and mudstones. In the uppermost part of the borehole, 50 m of sediments of Miocene age of the Mydlovary Fm. are deposited. Angiosperm pollen prevail in most of the terrestrial paleoenvironments in late Cretaceous strata in central Europe. They dominate particularly alluvial plains, where lauroid and platanoid angiosperms prevailed during the Cenomanian, while angiosperm pollen of the Normapolles complex are dominant in the Coniacian–Santonian. Of 14 samples studied from the palynological point of view, only 4 contained sporomorphs (depth – interval of 133.4–142.4 m), 10 slides from every single sample were examined, 100 specimens counted for the relative percentage of sporomorph groups. Palynofacies of all 4 samples are dominated by black and brown phytoclast debris. Bryophyte spores prevail in a sample from the depth of 142.4 m (89%), gymnosperm pollen (2%) as well as angiosperm pollen (7%) are rare. On the contrary, triporate angiosperm pollen from the biostratigraphically important group of Normapolles complex (60%) prevail in samples from mudstones at 133.4–138.15 m. Normapolles are represented by numerous species mainly of the genus *Plicapollis* Pflug (*Plicapollisserta*), *Pseudoplicapollis* (*Pseudoplicapollis peneserta*) and *Trudopollis* Pflug, less common are *Vacuopollis* Pflug, *Minorpollis* W.Kr. *Complexiopollis* W.Kr., *Oculopollis* Pflug. Besides the Normapolles pollen, also small tricolpate and tricolporate angiosperm pollen are present. As for biostratigraphy, *Vacuopollis* pollen first appear in the Coniacian. No pollen of younger age have been identified yet. Palynofacies from the depth 142.4 m differs from other ones, bryophyte spores form up to 70% of the assemblage. This composition can correspond to swampy environment while the assemblage from samples in upper part consist of prevailing angiosperm pollen. It could characterize little drier conditions during the sedimentation.

Microfossils from Oligocene flysch deposits in the Baligród area (Outer Carpathians, SE Poland): origin and palaeogeographical significance

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This study discusses microfauna from dark sediments consisting of clay-sandy shales, sometimes conglomerates with exotic elements, which form the lower part of the Krosno Formation in the Polish Outer Carpathians (Silesian Unit, lower Oligocene). These rocks are exposed in the southeastern part of this region (Baligród area). They were initially studied by Bieda (1963) based on the larger benthic foraminifera (LBF). Our study additionally identified microfossils such as planktonic and small benthic foraminifers (SBF) along with ostracods as well as bryozoans, bivalves and gastropods. In addition, calcareous nanoplankton was identified. Foraminifers occur in turbidites and debris flows delivered to the sedimentary basin. The most complete profile, exposed along the Mchawka stream, reveals multiple occurrences of gravity flow deposits. These series include both turbiditic sandstones and shales containing small planktonic foraminifera, as well as exotic blocks rich in LBF. One particularly notable exotic block consists of Globigerina marl. In these deposits isolated specimens of LBF (miliolids) occur in the flows, along with ostracods, which document the shallower conditions while the LBF environments are associated with the littoral area. The LBF assemblage includes taxa such as *Nummulites* spp., *Heterostegina*, orthophragminids, *Spiroclypeus carpathicus*, and *Operculina* cf. *complanata*, frequently accompanied by abundant and taxonomically diverse the SBF. These deposits include species: *Fabiania cassis*, *Spirolina striata*, *Chapmanina gassinensis*, *Angulogerina muralis*, *Sphaerogypsina globulus*, and *Asterigerina* sp. The stratigraphic ranges of these foraminifera confirm that most of the shallow-marine deposits formed from the late Eocene to the early Oligocene. Moreover, these deposits also contain bryozoans and fragments of red algae, a key component of Eocene reef and peri-reef environments. Furthermore, the presence of polychaete fragments within the exotic blocks suggests that the detrital material was transported from shallow-water settings into deeper parts of the basin. In the vicinity of Rabe and Kielczawa localities microfossils were documented in debris flows. In the Rabe site, crystalline and metamorphic rocks predominate, but in the Kielczawa locality, carbonate rocks are more common. They are accompanied by numerous, isolated LBF ("nummulites") and very scarce bryozoans. In turn, in the Roztoki Dolne region, rock blocks are washed out by the stream and are often located outside the sequence of flysch sediments. The blocks are composed of organodetrital limestones, which also contain LBF. Overall, the shales in the Baligród region contain species known from the late Eocene, which are also identified in carbonate exotics (Bieda, 1963), suggesting that many of these fossils are reworked. Only *Nummulites fichteli* and *N. vascus*, are considered as index taxa for the Oligocene (SBZ 21), and appear to be autochthonous. Other species, such as *N. fabianii*, *N. incrassatus*, *N. chavanensis* and *N. cf. fichteli*, indicate a latest Eocene–early Oligocene (SBZ 19–SBZ21) (Serra-Kiel et al., 1998; 2016; Less et al., 2011; Okay et al., 2019).

In addition to LBF, miliolids associated with shallow-marine Eocene environments, the assemblage includes opportunistic plankton (*Globoturborotalita ampliapertura*, *G. ouachitaensis*, *G. leroyi*, *G. praebulloides*), and SBF (e.g., *Lenticulina*, *Uvigerina*) from the

Eocene–Oligocene transition. Some taxa, such as *G. selli* and *Tenuitella munda*, suggest early Oligocene conditions. Most foraminiferal plankton are preserved as sediment-filled tests, whereas SBF commonly retain calcareous walls.

Calcareous nannoplankton are similarly diverse. While many taxa evolved in oligotrophic Eocene waters, evidence of increasing eutrophication in the early Oligocene led to the decline of some groups. This is indicated by the presence of genera such as *Braarudosphaera*, *Cyclicargolithus*, *Coccolithus*, *Dictyococcites*, and *Zygrhablithus*, which favor nutrient-rich environments. The occurrence of *Helicosphaera* species further suggests input from shallower shelf settings.

The bryozoan assemblage of the studied flysch sequences is remarkably rich and taxonomically diversified, particularly in the Mchawka stream. This assemblage includes a wide range of the cyclostomes along with the dominant ascophorine cheilostome taxa. The cyclostomes belong to Tubuliporidae (*Bitubigera*, *Idmonea*, *Pleuronea*), Terviidae (*Tervia*), Entalophoridae (*Entalophora* and Horneridae (*Hornera*). The most common anascan cheilostomes are represented by *Smittipora*, *Steginoporella* and *Micropora*. Ascophorines is dominated by such genera as *Escharoides*, *Tubucella*, *Smittina*, *Adeonellopsis*, *Celleporaria*, *Batopora* and *Orbitulipora*. The studied bryozoan assemblage of the Polish Carpathians is mostly connected with the Eocene turnover. They were previously documented in the Mnilite Fm., which in the Baligród area corresponds in age to the studied sediments of the Krosno Fm. (Pazdro, 1929; Małecki, 1963). The occurrence of the round-shaped colonies of *Batopora* and *Orbitulipora* in the Carpathians are valuable survivals of the Eocene–Oligocene boundary. The relationship between the dominant colonial growth-forms of the vinculariiform represented by the erect, branching either cylindrical and bilamellar colonies accompanied by some massive round-shaped celleporiform bryozoans suggest an open shelf paleoenvironment with a strong role of the currents resulted in a great disarticulation and poor state of the preservation of the colonies.

The preservation, stratigraphic distribution, ecological preferences of the microfauna point to intensive geotectonic process and paleogeographical reorganization in the northern Carpathians across the Eocene–Oligocene boundary. These processes led to reduced distribution ranges for many taxa. Eustatic sea-level fluctuations and the progressive isolation of the basin triggered the collapse of carbonate platforms, whose components were subsequently redeposited in deeper settings by submarine gravity flows.

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Axis coiling as a growth pattern of some terrestrial plants in the Silurian of the Prague Basin

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During the early Paleozoic, the earliest land plants encountered challenging terrestrial conditions that required the development of various adaptations. Their plant body structure was probably very simple in the beginning, having a uniform morphology of dichotomously branched, leafless axes with terminal sporangia. However, it allowed the plants to settle in and thrive on the land. Other necessary adaptations were gradually developed by plants in response to different ecological conditions.

An unusual growth pattern has been observed in an upper Silurian plant from the Prague Basin, the Czech Republic. The specimen comes from the Požáry Formation (Přídolí) at the Kosov quarry near Beroun. A specimen of a plant of undetermined taxon possesses distinctive trilobed structures at axial tips. After considering all possible scenarios, these structures were interpreted as coiled distal ends of fertile axes, resembling circinate vernation. This unique specimen was used to create a suggested reconstruction of the plant, along with a proposed growth model. This model seems to be applicable not only to this specimen but also to a few others from the genus *Tichavekia* Pšenička et al. (Kraft et al., 2019; Uhlířová et al., 2022). Similarly, coiled axial tips are also present in representatives of the basal lycophytes, the zosterophylls (Gensel, 1992). The taxonomic classification of one specimen is currently uncertain. Therefore, it cannot be determined whether this model is related to only a single taxon or not. There is also a possibility that it is an adaptation, that may appeared multiple times and is present in some other plant representatives as well.

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A prasinophycean alga *Tasmanites* Newton from the Ordovician of the Barrandian – stasis in evolution as a key to survival

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Diversity of life reflects the resilience and adaptability of various groups of organisms. Evolutionary changes a taxon undergoes can be clearly traced in the fossil record. The adaptability of organisms is generally determined by environmental conditions. It is also determined by the initiative of organisms to colonise new ecological niches. Consequently, the environment directly influences the phenotypes of organisms (Torday, 2018). However, there are also groups of organisms that are content with their life history strategy with a conservative mode of evolution (McFadden & Knowles, 1997). In such cases, any alterations in morphological or anatomical characteristics are inconspicuous. This conservative mode of development, or static evolution, is primarily observed in prokaryotic and unicellular eukaryotic organisms.

In this study, we focus on prasinophyte algae of the genus *Tasmanites* Newton. These are unicellular forms of green algae. During their life cycle, they alternate between a motile flagellate stage and a non-mobile resting stage called phycoma. The first occurrence of the genus *Tasmanites* dates back to the Precambrian (Dutta et al., 2006), with two species, *Tasmanites pelagica* (Ostenfeld) Boalch & Guy-Ohlson and *Tasmanites marshalliae* (Parke) Boalch & Guy-Ohlson, living to the present day. In the fossil record, phycoma stage can be preserved as it contains resistant organic compounds (Wall, 1962). Although the internal organisation cannot be examined in fossil representatives, the proportions and structural characteristics of phycoma remain consistent, with only slight variations (related to the wall composition and thickness, see Dutta et al., 2006), and so are approximately equivalent to those seen in recent specimens. In this study, we discuss the life history strategy and putative evolutionary stasis of the genus *Tasmanites* by presenting fossil material from the Upper Ordovician of the Bohdalec Formation of the Barrandian, the Czech Republic.

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Palynology of an Upper Triassic site in Siewierz (Upper Silesia, Poland)

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The late Triassic epoch attracts scientific interest for several reasons, including the first appearance of dinosaurs and the evolution and diversification of gymnosperms, especially conifers, which contributed to a transformation of trophic structures toward those more similar to modern ecosystems.

One valuable source of information about climatic changes during the late Triassic is the palynological record. Palynological data are particularly advantageous due to the sporomorph widespread occurrence. Palynomorphs can often be found in sediments where other macro- or microfossils are absent or nearly absent.

Such a case can be observed at the Siewierz site. Despite the lack of other fossil remains, a significant number of palynomorphs—both spores and conifer pollen—have been identified in the sediments.

Siewierz is of particular interest due to its stratigraphical position. During the site inspection, the Woźniki Limestone was identified. This member of the Patoka Formation is not only rare but also corresponds to the palynological meyeriana c subzone, which is seldom observed in Poland (Fijałkowska-Mader et al., 2015).

Preliminary palynological analysis indicates that the Siewierz site contained both conifers (*Brachysaccus neomundanus*, *Classopollis meyerianus*) and spore-producing plants (*Nevesisporites limatulus*, *Densosporites* sp.) in quantities suggesting that the site was located near a water reservoir.

These observations lead to the conclusion that the Siewierz site represents a rare subzone with a unique geological context. As such, palynological studies from this locality may provide valuable insights for future research.

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The age of mass gravity movements in the Skole Basin in the light of foraminiferal biostratigraphy (Popeli Beds, Outer Carpathians)

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The Popeli Beds represent a lithostratigraphic unit of the Skyba (Skole) Nappe, developed in the marginal, platform-adjacent zone of the Outer Carpathians, mainly within the Eastern Carpathians. The succession is dominated by deposits related to submarine mass-transport processes. At Pobuk village, near the town of Skole (Skole Beskids, Oriv Skyba, Pobuk Syncline), an olistostrome succession is well exposed and has been the focus of structural studies. As part of this research, a biostratigraphic investigations were undertaken to constrain both the age and the depositional setting of the olistostrome. The study revealed a complex internal architecture of olistostrome succession, comprising at least six individual olistostrome complexes. The first five consist of gravelly mudstones with oversized clasts, whereas the final complex is built of deformed packages of thin-bedded turbidites. These complexes are separated by medium-bedded mudstone and sandstone intercalations (Waśkowska et al., in review).

To determine the timing of deposition, age analyses were carried out on the strata overlying and underlying the olistostrome, as well as on its matrix and deposits separated olistostrome complexes.

Underlying deposits

Beneath the olistostrome the Vyhoda Sandstone occurs, overlain by a thin package of the Bystrytsia Formation. Foraminiferal assemblages from the Vyhoda Sandstone indicate an early Bartonian age and represent a deep-water agglutinated fauna, typical of a lower slope setting. The early Bartonian age is indicated by the presence of “*Ammodiscus*” *latus* (Grzybowski), the acme of *Reticulophragmium amplexans* (Grzybowski), and the acme of *Spiroplectammina spectabilis* (Grzybowski). The Bystrytsia Formation yielded a very poor paleontological record, containing only a few planktonic foraminifera and a non-diagnostic deep-water assemblage composed of long-ranging opportunistic taxa. However, the occurrence of *Turborotalia cerroazulensis* (Cole), *Globigerinatheka index* (Finlay), *Subbotina angiporoides* (Hornibrook), and *Subbotina corpulenta* (Subbotina) indicates deposition within the late Lutetian to early Priabonian interval.

Olistostrome

Samples were collected from different levels within the olistostrome matrix. These contain foraminiferal assemblages dominated by benthic taxa, with both agglutinated and calcareous forms, together with co-occurring planktonic foraminifera. An early Bartonian foraminiferal assemblage was identified, with *Subbotina gortanii* (Borsetti) – a species known since the early Bartonian (Pearson et al., 2006) – occurring with the acme of *Reticulophragmium amplexans* (Grzybowski). In the upper part of the olistostrome sequence, the abundance of planktonic and calcareous benthic forms decreases, and deep-water long-ranging taxa become dominant. Assemblages from this interval do not allow precise dating; however, the

occurrence of *Acarinina bullbrooki* (Bolli), a species ranging from the Lutetian to the early Bartonian, provides a broad chronological constraint. Given the origin of the matrix, composed of redeposited and reworked material, potentially containing elements derived from different stages of sedimentation, it is assumed that deposition of the olistostrome matrix was younger than, or at most coeval with, the ages indicated by the foraminiferal assemblages within the matrix.

Deposits separating the olistostrome complexes contain a deep-water foraminiferal assemblage with the *Reticulophragmium amplexans* (Grzybowski) acme, ranging from Lutetian to middle Bartonian.

Deposits above the olistostrome

Samples taken above the olistostrome did not yield satisfactory results, as they do not contain a foraminiferal record. A sample taken about 50 m above the olistostrome contains sparse Eocene–Oligocene planktonic foraminifera, including *Chiloguembelina cubensis* (Palmer) and *Pseudohastigerina nagewichiensis* (Mjatliuk). This allows the deposits to be assigned to the Priabonian–early Oligocene interval.

In conclusion, large-scale mass displacements of material from platform and slope areas took place during the early Bartonian along the northern slope of the Skyba-Boryslav-Pokuttya Basin.

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Biostratigraphic significance of the *Spiroplectammina spectabilis* (Grzybowski) Acme in the Outer Carpathians

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Spiroplectammina spectabilis (Grzybowski) is a cosmopolitan species commonly occurring in the late Cretaceous and Paleogene. It is readily identifiable by its distinct morphological features. Originally described from the Carpathians, it was later reported from deposits of other deep-sea basins worldwide (Kaminski, 1984). *S. spectabilis* (Grzybowski) is a widespread taxon, usually constituting an accessory component of bathyal foraminiferal assemblages. However, in environments with a continuous input of clastic material and organic matter, the species underwent enhanced development, producing acme events. These acmes occurred at different times in different basins.

In the Outer Carpathian basins, assemblages rich in *S. spectabilis* (Grzybowski) were identified in the Paleocene and used in a biostratigraphic scheme, serving as a marker for the Danian–Thanetian zone (Geroch & Nowak, 1984). The base of this zone was defined by the “first frequent appearance of the index taxon.” However, the Paleocene acme of *S. spectabilis* (Grzybowski) proved to be ephemeral; in many sections it was not well expressed. For this reason, in the regional foraminiferal zonation proposed by Olszewska (1997), the species was omitted.

Later biostratigraphic studies of deposits in the western Outer Carpathians revealed that mass occurrences of *S. spectabilis* (Grzybowski) took place in the Eocene. This led to the introduction of the *S. spectabilis* (Grzybowski) acme zone, spanning the Lutetian to lower Priabonian interval (Waśkowska, 2021). Additional analyses of the acme allowed refinement of their regional extent within the Carpathians and clarification of their stratigraphic range.

Results

The *S. spectabilis* (Grzybowski) acme has been identified in deposits of the Silesian and Skole (Skyba) of the Western Outer Carpathians, as well as in the Eastern Outer Carpathians within the Skyba, Silesian, Subsilesian and Boryslav–Pokuttya nappes in Ukraine, and in the Tarcău Nappe in Romania. It occurs in turbiditic deposits, predominantly in thin-bedded turbidites composed of grey and grey-green mudstones, deposited in a bathyal environment. Sedimentation of these deposits took place in marginal, platform-adjacent Silesian–Moldavide basins located north of the Silesian Ridge, and the acme is most likely concentrated in this area. In the internal zones of the Carpathian Tethys (Magura Domain), the *S. spectabilis* (Grzybowski) acme appears only sporadically and is not as distinct.

In the Outer Carpathians in samples from Poland and Ukraine, the *S. spectabilis* (Grzybowski) acme occurs in deposits of Lutetian and early Bartonian age. In many samples rich in *S. spectabilis* (Grzybowski), independent age markers are absent. The biostratigraphic position of the acme was determined through analysis of continuous Eocene sedimentary sequences, which contained Lutetian assemblages with abundant *Reticulophragmium*

amplectens (Grzybowski) and lower Bartonian assemblages with “*Ammodiscus*” *latus* Grzybowski co-occurring with abundant *R. amplexans* (Grzybowski). The *S. spectabilis* acme in Romania has been noted within biozones NP19/NNTe12 (late Eocene) in the northern Tarcău Nappe (Bindiu et al., 2026); the biostratigraphic framework was established based on calcareous nannofossils bioevents: the last occurrence of *Chiasmolithus grandis* and first occurrence of the species *Ismolithus recurvus*.

An abundance exceeding 5% of *S. spectabilis* (Grzybowski) within the assemblage (excluding tubular taxa) is regarded as defining the acme (Waśkowska, 2021). Typically, the proportion of *S. spectabilis* (Grzybowski) ranges between 10% and 25%, with maximum values reaching up to 42% in Romanian sections. Abundant *S. spectabilis* (Grzybowski) usually occurs within typical deep-water agglutinated foraminiferal assemblages or within mixed agglutinated-calcareous benthic assemblages of moderate taxonomic diversity. These assemblages are dominated by *Paratrochamminoides* and *Recurvoides* div. sp., a notable increase the number of *Haplophragmoides* observed in many cases.

A middle–late Eocene *S. spectabilis* acme has been observed as far away as the Labrador Sea (Kaminski et al., 1989). An interval with >20% *S. spectabilis* was observed at ODP Site 647, in Cores 46R to 43R, in fine-grained deposits dated to nannofossil zone NP17.

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Paleoecology of ostracods from Miocene deposits in the Chełm Wielki - Jaworzno area (Carpathian Foredeep; Western Poland)

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The investigated area is located in the western part of the Carpathian Foredeep in Poland. Research material was obtained from the Chełm Wielki 7 and Dąb 4 boreholes, in which the Miocene succession is represented by deposits of the Kłodnica and Skawina Formations.

In the Chełm Wielki 7 borehole, the Kłodnica Fm. is developed as gray-green and light gray sandy mudstones in the lower part of the profile, and slightly marly gray and dark gray clay shales with intercalations of lignite in the upper part. In the lowermost section of the Kłodnica Fm., the epineritic species *Cytheridea paracuminata* occurs, indicating a basin depth of up to 40 m with brackish water conditions and sandy sediments. In contrast, younger sediments of Kłodnica Fm. are dominated by epineritic to epibathyal species such as *Aurila larieyensis* and *Cytherella* sp., which suggest an increase of a basin depth up to ca. 70 m and normal to brackish salinity conditions. Ostracods in samples from the Skawina Fm. deposits were not found.

In the Dąb 4 borehole, the Kłodnica Fm. comprises diverse terrestrial sediments, which in the upper part of the profile change into clayey sediments containing fossils of oysters, gastropods, *Chara* sp. and rare foraminifera. The Skawina Fm. is represented by gray and light gray clays and claystones, slightly marly. These contain exclusively deep-marine species such as *Henryhowella jonesii*, *Parakrithe* sp., and *Krithe* sp., which indicate an epibathyal and/or bathyal zone (depth up to 120 m) and full marine environment.

The foraminiferal assemblages co-occurring with ostracods in the all studied sediments indicate the middle Badenian age (*sensu* Hohenegger et al., 2014) and the *Praeorbulina glomerosa* - *Orbulina suturalis* Zone (Cicha et al., 1975).

The assemblages from both boreholes show analogies to described from the Jaworzno 5902 profile, in which the Kłodnica Fm. contains a shallow-marine *Aurila-Cytheridea* assemblage, while the Skawina Fm. contains a deep-marine *Henryhowella-Parakrithe* assemblage. The succession of these assemblages in the Jaworzno 5902 borehole profile allowed for the interpretation of sea level fluctuations (Ziarek & Pilarz 2024; Ziarek et al., 2024). The obtained results of the Chełm Wielki 7 and Dąb 4 boreholes allow for the correlation of these profiles with Jaworzno 5902. Obtained results suggest migration of the coastline in the Chełm Wielki – Jaworzno area in the *Praeorbulina glomerosa* - *Orbulina suturalis* Zone time (middle Badenian *sensu* Hohenegger et al., 2014). This is probably related to sea level fluctuations found in the geological record of the Kłodnica and Skawina Formations in eastern part of the Upper Silesian Coal Basin in Poland (Alexandrowicz, 1969).

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Kimmeridgian ostracods from Kleszczów Graben (central Poland) - preliminary results

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The investigated area is located in the Kleszczów Graben near the southern border of the Łódź Depression in the central Poland, where the Jurassic deposits are represented mainly by Oxfordian–Kimmeridgian sedimentary succession (Fig. 1; Wierzbowski, 2017; Krajewski et al., 2019; Olchowy et al., 2019). During the late Jurassic, the depositional environment of the northern Tethys shelf was characterised by a ramp-type carbonate to carbonate-siliciclastic platform (Olchowy et al., 2019). Research material was obtained from the B–584 borehole in the Bełchatów Coal Mine.

The studied interval is developed as medium-bedded, light grey, biotrital limestones interbedded by medium- or thin-bedded marly limestones and/or marls. Samples were subjected to standard method preparation. The obtained biotrital residue consists mainly of ostracods, gastropods, foraminifera, detritus of bivalves shells, and at some depths fragments of oysters, echinoids and crinoids. The mineral residue consists of marly limestones clasts, quartz grains, and at some depths, glauconite and pyrite (cf. Olchowy et al., 2019).

The ostracod microfauna is diverse and is dominated by species *Macrodentina intercostulata* Malz, *M. calcarata* Triebel, *M. klingleri* Malz, *Paranatocythere interrupta* (Triebel), *Protocythere furcata* Bielecka et Styk, *Amphicythere confundens* Oertli, *A. plena* (Schmidt), *Schuleridea triebeli* (Steghaus), *Hechticythere sigmoidea* (Steghaus), *Paracypris* sp. and *Eocytheropteron purum* Schmidt. There are many juvenile specimens. The assemblage includes both brackish (genus *Macrodentina*) and marine (genera *Paranatocythere*, *Protocythere*, *Amphicythere*, *Schuleridea*, *Hechticythere*, *Paracypris*, *Eocytheropteron*) taxa (Bielecka & Styk, 1968; Schudack, 1996, 2004), which suggest environmental fluctuations within an unstable marginal marine paleoenvironment, such as a shallow restricted marine setting within the inner-ramp. Quartz grains suggest the proximity of land, and glauconite indicates the shelf zone.

The ostracod assemblage indicates the jwm 1 ostracod zone (*sensu* Klingler et al., 1962). Index species whose first occurrences define the lower boundary of the 11 ostracod zone (*sensu* Schudack, 1994) were identified (FO of *Macrodentina calcarata* and FO of *Eocytheropteron purum*). Therefore, the studied interval cannot be older than the 11 ostracod zone (*sensu* Schudack, 1994), but also cannot be younger than 12 ostracod zone (*sensu* Schudack, 1994), which corresponds to the upper part of the Lower Kimmeridgian.

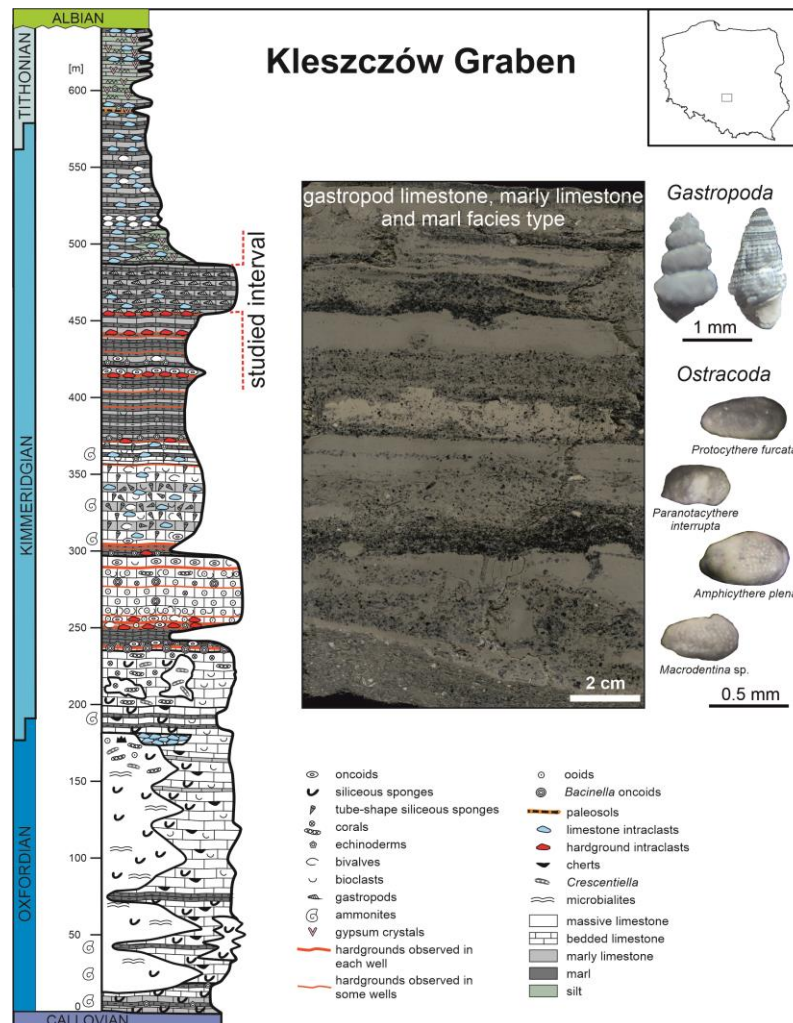


Figure 1. Generalized lithostratigraphic column of Upper Jurassic sediments of the Kleszczów Graben area with the studied interval marked by red lines (on the left), and an example of sediments development and microfossils (on the right) (after Olchowcy et al., 2019, modified and supplemented).

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Comparison of the Upper Badenian and Sarmatian benthic foraminifera assemblages from Kerch Peninsula and Vienna Basin?

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Around 12.65 Ma, the Sarmatian Basin simultaneously replaced the Badenian Basin in the Central Paratethys and the Konkian Basin in the Eastern Paratethys (Ter Borgh et al., 2014; Palcu et al., 2015, 2017). The shift from the stratified, oxygen-depleted Upper Badenian to the restricted, low-salinity Sarmatian represents a major paleoceanographic reorganization within the Neogene Paratethys (Kováč et al., 2017). To compare this transition, micropaleontological and biostratigraphic data were analyzed from boreholes in two key regions: the Vienna Basin (Central Paratethys) and the Kerch Peninsula (Eastern Paratethys). The Sarmatian Stage is regionally divided into *sensu lato* (Eastern Paratethys) and *sensu stricto* (Central Paratethys) according to the RCSSN (1975) classification (Paramonova & Belokrys, 1972; Paramonova, 1994). Understanding its onset provides crucial insight into Paratethyan paleogeography and salinity evolution. This study compares foraminiferal and molluscan assemblages from the Kerch Peninsula Borehole B–20 with data from Vienna Basin boreholes JV19 and MZ93 to assess synchronous paleoenvironmental trends across both basins.

Borehole B–20 (35.7–7.1 m) in the western Kerch Peninsula penetrates lower and upper Konkian and early Sarmatian deposits. Micropaleontological analysis identified 97 benthic foraminiferal species from 43 genera. Cluster analysis (UPGMA, Bray-Curtis index) distinguished seven ecological associations (A1–A5, B, C). For comparison, data from Vienna Basin boreholes JV19 (30 m) and MZ93 (1400 m) were evaluated based on published foraminiferal and molluscan records. In Borehole B–20, the lower Konkian assemblages (A1–A5) are dominated by *Bolivina*, *Bulimina*, *Angulogerina*, and *Varidentella*, indicating dysoxic bottom-water conditions. Upsection, *Elphidium* and *Ammonia* become dominant, suggesting episodic oxygenation and enhanced euryhaline influence. The upper Konkian (association B) contains abundant *Elphidium horridum* and a decline in normal-marine taxa, marking the onset of brackish, shallow-water settings. The early Sarmatian (association C) is characterized by miliolids (*Varidentella*, *Articularia*, *Sinuloculina*) and *Porosononion granosum*, with low species diversity and the disappearance of marine dysoxic taxa, reflecting restricted, variable-salinity conditions.

In the Vienna Basin, grey claystones and silts of the Badenian (Studienka Mb.) and Sarmatian (Holíč Fm.) show comparable trends. Three types of foraminiferal successions were recognized: (1) *Ammonia* acme followed by *Elphidium*, *Porosononion*, *Nonion*, *Bolivina*; (2) *Anomalinoidea* associated with *Bolivina*, succeeded by *Nonion*; and (3) *Porosononion* acme followed by *Nonion* and miliolids. Assemblages are dominated by rotaliids (*Elphidium*, *Ammonia*), with subordinate porcellaneous forms (*Sinuloculina*, *Quinqueloculina*) and rare agglutinated taxa. Reworked Karpatian–Badenian microfauna includes planktonic taxa (*Cassigerinella globulosa*, *Orbulina suturalis*) and benthic forms (*Bulimina*, *Bolivina*, *Cibicidoides*) were excluded from paleoecological interpretation. Boreholes JV19 and MZ93 thus document a shift from planktonic-dominated (*Globigerina*, *Turborotalita*) with low diversified low oxidic (*Bulimina*, *Bolivina*) to benthic-dominated well oxygenated euryhaline

(*Elphidium*, *Ammonia*, *Quinqueloculina*, *Nonion*) assemblages, indicating shallowing and periodic salinity fluctuations.

The parallel evolution of foraminiferal and molluscan assemblages in both basins demonstrates synchronous paleoenvironmental transformations across the Paratethys during the late Serravallian (~12.7–11.6 Ma). The transition from dysoxic marine to brackish euryhaline assemblages records progressive restriction, salinity reduction, and enhanced hydrological instability. These results reinforce the interpretation of a region-wide shift from open-marine Badenian conditions to the shallow, oxygen-variable environments characteristic of the Sarmatian.

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Notes



24th Czech - Slovak - Polish Paleontological Conference Kraków, Poland, October 23–24, 2025

The 24th Czech - Slovak - Polish Paleontological Conference was organised by the Micropress Europe, AGH University of Kraków and the Grzybowski Foundation. The conference in Kraków was the twenty fourth meeting in this series and followed previous meetings held in Banská Bystrica (2024), Ostrava (2023), Bratislava (2022), Chęciny (2019), etc.

This volume includes more than 40 abstracts summarizing the contributions presented at the conference, which was held at the AGH University of Kraków and the office of Micropress Europe in October, 2025.



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