

20th Czech-Polish-Slovak Palaeontological Conference

Abstracts



20th C-P-S PC

Chęciny, Poland

20-23 October, 2019

20th

CZECH-POLISH-SLOVAK
PALAEOLOGICAL
CONFERENCE

CHĘCINY

POLAND, 2019



20th CZECH – POLISH – SLOVAK PALAEONTOLOGICAL CONFERENCE

Chęciny, 20 – 23 October 2019

ABSTRACTS

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Faculty of Geology, University of Warsaw

Warszawa 2019

Żylińska, A. (Ed.) 2019. 20th Czech–Polish–Slovak Palaeontological Conference, Chęciny
20-23 October 2019, Abstracts. Warszawa, 1–54 pp.

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Conference logo: Mariusz Niechwedowicz, Bogusław Waksmundzki

Cover design: Zofia Dubicka

Layout: Daniel Zaszewski

Print: UNIPOSTER, Pracownia Wydział Biologii UW,
ul. I. Miecznikowa 1, 02-096 Warszawa

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ISBN: 978-83-945216-9-1

Foreword

The 20th edition of the Czech–Polish–Slovak Palaeontological Conference (CPSPC) shows that this international paleontological society is creative, ambitious and timeless. The CPSPC has been gathering palaeontologists from the Czech Republic, Poland and Slovakia for 20 years. Recently, scientists from Russia, Ukraine, the Baltic countries and Western Europe have also been actively participating in our gatherings. Each conference is focused on the latest research and discoveries in the field of broadly understood palaeontology and related topics. By the lively discussion on a wide range of subjects from different fields we demonstrate that palaeontology is an integral part of geology and Earth sciences. In addition to information exchange, during this event scientists from Central Europe share their experience and establish international and interdisciplinary collaboration, often proliferating in joint research projects.

For the jubilee conference we invite you to the European Centre for Geological Education, a winner of The Best Public Facility Award within the framework of European Property Awards. The Centre is a research and conference facility operating within the structures of the University of Warsaw – Faculty of Geology. Beautifully located within a closed-down dolomite quarry near the historical town of Chęciny, in the Świętokrzyskie voivodeship, it offers the charm of the nearby medieval castle, and a perfect research and educational environment for geologists.

Our conference has attracted almost 50 scientists from 6 countries, including a considerable number of doctoral and graduate students. The meeting will begin with two key lectures, followed by over 20 oral presentations and almost 20 posters presented during special poster sessions. The last day of the conference will be devoted to workshops and field trips.

The Holy Cross Mountains have a long tradition of palaeontological research of macro- (e.g. trilobites, cephalopods, brachiopods, corals) and microfossils (e.g. conodonts, foraminifers, palynomorphs) in rocks of all systems of the Phanerozoic. We can admire and study here rocks of the Palaeozoic succession, which build the central part of the mountains, Mesozoic strata surrounding the Palaeozoic ‘core’ from the north, west and south-west, and Cenozoic (Miocene) deposits of the Carpathian Foredeep to the south of the area. Being situated at the junction between the Meta-Carpathian arc and the Mid-Polish Swell, the Holy Cross Mountains are a link between the Central European Variscides and the East European Craton, and represent one of the very few areas in Europe where Palaeozoic rocks are exposed in direct neighbourhood of the Teisseyre-Tornquist Line.

During the field trip we will introduce a thick Devonian to lower Carboniferous continuous succession formed during almost 50 million years of Earth’s history. The evolution of a basin induced by fluctuating sea levels and changing tectonic regimes in a tropical setting will be presented. The growth and demise of the Devonian carbonate platform, and later substitution by the clay-siliceous Culm facies will be examined in abandoned quarries on hills surrounding the Chęciny Valley and in the impressive active Ostrówka Quarry.

We sincerely hope that our meeting will contribute to exchange of ideas, promote future scientific collaboration and give you a perfect opportunity for interesting scientific discussion. Support from the Institute of Geology of the Faculty of Geology, University of Warsaw, the Grzybowski Foundation, and all sponsors of the meeting is warmly acknowledged.

On behalf of the Organizing Committee

Marcin Barski

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ABSTRACTS OF KEY LECTURES

The search for Devonian phoebodont sharks: from teeth to skeletons

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The articulated skeletons of Devonian chondrichthyans are extremely rare, due to the low fossilization potential of cartilage. From among fifty well-established species and many more left in open taxonomy, only ten are known from something else than isolated teeth, scales or fin spines. However, the continuous search for fossils in various regions of the world is gradually narrowing this gap. The history of investigations on a family of stem-chondrichthyans, the Phoebodontidae, is a good example supporting optimism in this matter.

Currently, the phoebodontids include three genera: *Phoebodus* St. John and Worthen, 1875, *Thrinacodus* St. John and Worthen, 1875, and *Diademodus* Harris, 1951. Of these, only *Diademodus hydei* was originally described by Harris (1951) with a body outline and articulated tooth families in place on a slab of Upper Devonian Cleveland Shale from Ohio. However, the morphology of its minute teeth was incorrectly interpreted and a suggestive drawing of a comb-like tooth crown with a double median cusp for a long time precluded any idea of phylogenetic relationships of *Diademodus* with *Phoebodus* or *Thrinacodus*.

The teeth of *Phoebodus* are delicate, symmetrical, with three sigmoidal cusps, equal in size, and often with minute intermediate cusplets between them. These teeth are very similar to those of the recent frilled shark, *Chlamydoselachus anguineus* Garman, 1884, and the dentition of the latter can serve as a model for the dentition of *Phoebodus*. Turner (1982) was the first to observe this similarity and its usefulness for understanding the function of Palaeozoic shark teeth in general. She also re-studied the original material of *Thrinacodus* and suggested the relationships between *Phoebodus* and *Thrinacodus*, despite all the dental differences.

The teeth of *Thrinacodus* look a little like those of *Phoebodus*, but their crowns are strongly asymmetrical, with one of the lateral cusps enlarged and the other two reduced. The base is twisted and very long, so the tooth looks like a grappling hook or a hoe. A series of lucky discoveries in the middle Famennian (one of them in the Algerian desert) confirmed Turner's intuition: a slightly asymmetrical *Phoebodus* (*Ph. gothicus transitans* Ginter, Hairapetian and Klug, 2002) and a not-so-asymmetrical *Thrinacodus* (*Th. tranquillus* Ginter, 2000) form an evident link between the two genera.

The inclusion of *Diademodus* in the Phoebodontidae was possible only after the re-study of the original of *D. hydei* in 2003. It turned out that the median cusp is by no means double, but the teeth look exactly like those of *Phoebodus*, only wider and with multiplied intermediate cusplets (sometimes up to 17 cusps altogether). A collection of very similar teeth from the Confusion Range (Utah; Ginter 2008) helped in understanding the morphology of *Diademodus*.

The first information on the complete *Thrinacodus* came at the beginning of this millennium, from Montana. There, in the Serpukhovian (Mississippian) Bear Gulch Beds, Eileen Grogan and Richard Lund discovered an eel-like shark, with extremely narrow, sharp-ended jaws, reduced pectoral and pelvic fins and no trace of dorsal fin spines. Its teeth are very similar to those from the Devonian, only the bases are somewhat thicker. The final description was published in 2008, and thus only the articulated *Phoebodus* was missing.

This has changed only recently. An expedition around 2015 from the University of Zurich, led by Christian Klug, to the Anti-Atlas in Morocco investigated the so-called Thylacocephalan Layer (middle Famennian) at the Madène el Mrakib in the Maïder Basin. The expedition and collection in the subsequent years led to

the discovery of tens of complete or partial articulated skeletons of sharks, and among them unmistakable phoebodonts. The body of *Phoebodus* turned out to be rather elongated, as in *Chlamydoselachus*, but not as drastic as in *Thrinacodus* from Montana, and the jaws are normal, U-shaped. There are two ctenacanth-like, ornamented dorsal fin spines. The fish is rather large: the estimated length of the largest specimen reaches 3 m and its skull is almost half a metre long. The teeth are typical of the phoebodonts from the Famennian, but slightly different from all hitherto established species, therefore the shark received its new name and the description of the material will be published soon (Frey *et al.* 2019, in press).

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Early Palaeozoic Foraminifera from Gondwana – an early origin for the multichambered foraminifers?

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New foraminiferal research in the lower Palaeozoic formations in Saudi Arabia reveals diversified assemblages of agglutinated foraminifera that contain some rare multichambered forms. Early Palaeozoic Foraminifera until now have been regarded to consist of simple single-chambered monothalamids and two-chambered tubothalamids with an agglutinated wall. Although pseudo-multichambered agglutinated foraminifera first appeared in the mid-Ordovician (Kaminski *et al.* 2009), the origin of true multichambered forms was not believed to have taken place until the early or middle Devonian at the earliest (Holcová 2002). Our new findings now challenge this view.

New discoveries from the Upper Ordovician Ra'an Member and the lower Silurian Qusaiba Shale Member in Saudi Arabia point to an earlier origin of the multichambered globothalamid Foraminifera than the currently accepted estimate of 350 Ma (Pawłowski *et al.* 2003). The agglutinated foraminiferal genus *Reophax* has been recovered from the Ra'an Formation of Katian age exposed near the campus of Qassim University, and the genera *Ammobaculites* and *Sculptobaculites* have been found in dark graptolite-bearing claystones of Telychian age from the transitional facies between the Qusaiba and Sharawa Members of the Qasim Formation at the type locality near Qusaiba town, Saudi Arabia. The multichambered hormosinids and lituolids occur as rare components (<1%) in a foraminiferal assemblage strongly dominated by monothalamids and simple tubothalamids. Our new finding revises our understanding of the early evolution of the multichambered globothalamid Foraminifera. The fossil record now shows that multichambered globothalamids were already present on the Gondwanan shelf by the Late Ordovician.

A significant diversification event is observed in the early Silurian. Only 18 species of agglutinated foraminifera were recovered from the Upper Ordovician, while the lower Silurian record in Saudi Arabia reveals over 75 species. It is possible that the diversification of the Foraminifera in the Telychian was a response to anoxia in the early Silurian ocean.

Acknowledgements. We are grateful for the support provided by the King Abdulaziz City for Science and Technology (KACST) through the Science and Technology Unit at KFUPM for partially funding this work under project no. 13-OIL-303-04 as part of the National Science, Technology, and Innovation Plan.

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ABSTRACTS OF ORAL AND POSTER
PRESENTATIONS

Phylloid algae in the Lower Triassic (Roetian) limestones from the Holy Cross Mountains, Poland

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Phylloid algae are plate-like calcareous green and red algae that commonly formed Carboniferous and Permian reef mounds; they are extremely rare, however, in the Triassic sedimentary record. This report provides an insight into the occurrence of phylloid algae in the upper Lower Triassic (upper Olenekian; Roetian) limestones near Piekoszów in the western Holy Cross Mountains (HCM). The studied section (up to 10 m thick) is composed of thick to thin-bedded calcarenites and calcisiltites with low-angle and hummocky cross stratification, scattered clasts in some layers and rare current ripples. They consist of numerous fragments of phylloid algae, accompanied by subordinate gastropods, bivalves, ostracods, crinoids, peloids and rare initial ooids. The studied limestones represent the algal grainstones (subordinate mixed grainstones/packstones) microfacies comprising densely packed thalli composed of abraded and rounded grains, as well as curled and flat-lying undulatory forms. The structure of the algal bioclasts is largely obliterated due to pervasive calcite recrystallisation and micritisation. Moreover, they are covered with conspicuous syndimentary marine cements including thin rims of fibrous to bladed calcite crystals. Sedimentological features indicate that the studied Roetian limestones were deposited within a shallow carbonate platform subjected to intense seawater circulation due to wave and storm activity. A high frequency of phylloid algal fragments in the Piekoszów limestones suggests that the late Olenekian marine ecosystem in the HCM was similar to modern submarine meadows with a specific benthic community and unique trophic structure. The lateral extent of limestone beds in the quarry and their skeletal composition suggest that the Roetian succession in Piekoszów may represent a few meter-scale build-up (or its marginal part) formed by the hydrodynamic accumulation of algal debris. This build-up might have been similar to the late Palaeozoic and modern algal mounds developed at platform margins.

New data on non-dimerelloid brachiopods from chemosynthesis-based communities

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-

Dimerelloid brachiopods are most common and characteristic for ancient hydrocarbon seeps and hydrothermal vents. They commonly occur in mass accumulations and thus could have lived in some form of relationship with chemosynthesizing bacteria. Other brachiopod groups are much less common and in several instances they occur seemingly fortuitously at hydrocarbon seeps. So far, the best known association is that reported from the Upper Cretaceous (Campanian) Omagari site in Japan with the terebratulide *Eucalathis* occurring in significant quantities. Brachiopods were also found in the Oligocene seeps in Japan, being represented by the rhynchonellide *Frieleia* sp. and the cancellothyrid *?Terebratulina* sp. An exceptionally taxonomically diverse brachiopod fauna occurs in the shallow water Late Jurassic–Early Cretaceous seeps in Spitsbergen with the dominance of short-looped terebratulides.

Recently, a new species *Neoliothyris nakremi* has been described from the Palaeocene hydrocarbon seeps in Spitsbergen. This species was initially tentatively assigned to *Pliothyris*, however, investigations of internal structures have proved that it represents the genus *Neoliothyris*. *Neoliothyris* is a short-looped terebratulide, characterised by the presence of inner hinge plates, a feature rarely present in terebratuloids. It was known so far from the Upper Cretaceous of Europe, thus it is another example of Cretaceous survivors at generic level.

Brachiopods were also found in the wood-fall communities in the Palaeocene deep-water deposits of the Katsuhira Formation in Hokkaido, Japan. They are represented by the rhynchonellide *?Hemithiris* sp. and the short-looped terebratulide *Abyssothyris* sp.

There are no extant brachiopods that are members of the chemosynthesis-based communities, though some species are recorded in their vicinities and considered rather as primary opportunistic colonisers of available hard substrates.

Ammonites from the Kościeliska Marl Formation (Cretaceous, Polish Tatra Mountains)

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The Kościeliska Marl Formation is a characteristic element of the lower Sub-Tatric Unit, western part of the Tatra Mountains, and a typical component of the Neocomian facies, widely distributed in the Western Carpathians. It mostly comprises light- to dark-grey marlstones and calcilutites, subordinately calcarenites and sandstones. A new collection of fossils from the unit includes external moulds and imprints of 25 ammonites, sometimes with limonitised rests of preceding whorls. Fossils are often preserved fragmentarily and strongly deformed, nevertheless the association represents the best so far collection from the area.

Two semi-involute and several evolute specimens represent *Olcostephanus densicostatus*, *Spitidiscus* cf. *cankovi* and *Criosarasinella* cf. *subheterocostata*. The most interesting are the free coiled (crioceratid) large shells of heteromorphic ammonites representing *Crioceratites primitivus* and *Crioceratites coniferus*. Remarkable are the valves of oysters preserved on one *C. primitivus* body chamber. The association contains also the remnants of calcitic valves of the aptychus *Didayilamel-laptychus seranonis*. The composition of the ammonite association is similar to that from the Mrázňica Formation in the Butkov Quarry in Slovakia.

The ammonites were found in strata from the Valanginian/Hauterivian boundary interval, with *Criosarasinella* characteristic only for the upper Valanginian. Based on the latter, the faunal horizon in the studied locality is considered to represent the uppermost Valanginian.

The body chambers of the heteromorph ammonite *C. primitivus* are frequently encrusted by evenly spaced and concentrated sessile anomiid bivalves. Although the phragmocones are well-preserved, anomiiids are not observed on their surfaces. Thus, the encrustation by anomiiids might have occurred on live conchs and not on ammonite shells lying on the sea bottom (post-mortem floating or sunken carcasses), suggesting that the anomiiids lived in close commensal (host-specific) relationship with heteromorph ammonites.



Fig. 1. The heteromorph ammonite *Crioceratites primitivus* Reboulet, 1996 from the Kościeliska Marl Member.

Ordovician trilobites with soft parts in African West Gondwana and European peri-Gondwana: a review

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A review of all currently known Ordovician trilobites with soft parts described or figured from West-Gondwana and European peri-Gondwana is presented. Remains of the digestive system were found in nineteen species. In comparison, remains of antennae and/or walking legs are known only in five species. From the taxonomical point of view, the soft parts are known in the Asaphidae, Bathychelidae, Calymenidae, Cheiruridae, Dalmanitidae, Harpidae, Lichidae, Nileidae, Odontopleuridae and Trinucleidae. Exceptionally preserved trilobites originate from the Tremadocian Milina Formation (Czech Republic) and Fezouata Shale (Morocco), Darriwilian Šárka (Czech Republic) and Llanfallteg (UK) formations, Sandbian Tafilalt (Morocco) and Letná (Czech Republic) Lagerstätten, and Katian Bohdalec Formation (Czech Republic). Levels containing exceptionally preserved trilobites in these units are dominated by fine-grained sediments with the exception of the Sandbian Tafilalt and Letná Lagerstätten.

Acknowledgements. The Czech Science Foundation (GACR) supported the contribution through project no. 18-14575S and PROGRES Q45 of the Ministry of Education, Youth and Sports of the Czech Republic (OF).

Comparison of recent benthic foraminiferal assemblages along the east and west coast of India

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The present study examines the taxonomy, abundance and diversity of the foraminiferal population along the east and west coast of India within the latitudinal domain of 20°N to 22°N. Surface sediment samples were collected from sixteen stations during one year from both regions. A total of thirty five species from the west coast and twenty species from the east coast have been identified. The most dominant species of the west coast are *Rotalidium annectens*, *Elphidium crispum*, *Pararotalia nipponica*, *Eponides repandus*, *Cibicides refulgens*, *Quinquelouina seminulum*, *Nonion* cf. *commune* and *Ammonia tepida*. The east coast is dominated by *Criboelphidium* spp., *Asterorotalia trispinosa*, *Ammonia dentata*, *Haynesina germanica*, *H. depressula*, *Nonionella* sp., *Quinqueloculina seminulum*, *Ammonia beccarii* and *A. tepida*. Agglutinated species, e.g. *Trochammina* spp. and *Haplophragmoides* sp. are present in the east coast, whereas the west coast lacks agglutinated species. The taxonomic comparison of both assemblages show that only seven species are common. They include *Quinqueloculina seminulum*, *Rotalidium annectens*, *Nonion* cf. *commune*, *Ammonia beccarii*, *A. tepida*, *Elphidium advenum* and *Haynesina germanica*.

The Total Foraminiferal Number (TFN) was standardised to one gram for relative abundance study. The TFN shows an overall higher abundance of the foraminiferal assemblage in the west coast. Benthic foraminifera are greater in diameter in the west coast (>125 μ m) than in the east coast (< 125 μ m). Various physical parameters such as salinity and temperature, sediment type and load were taken into consideration to observe the role of abiotic factors on the abundance and diversity of the foraminiferal assemblages. The abundance of the reworked foraminifera in the west coast indicates higher energy conditions as compared to the east coast.

This study of seasonal variation of the foraminiferal assemblages should help to improve our knowledge on the distribution pattern of recent benthic foraminifera in coastal settings.

Foraminiferal assemblages in the context of lithological and geochemical cyclicity in upper Turonian sediments from the Bohemian Cretaceous Basin, Czech Republic

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Upper Turonian hemipelagic deposits in the central part of the Bohemian Cretaceous Basin (Czech Republic) show lithological cyclicity caused by rapidly changing depositional conditions. This cyclicity has been attributed to orbital control. Short-term palaeoenvironmental changes corresponding to these lithological variations are not well understood. Here we present a study of foraminiferal assemblages performed on 68 samples from the Bch-1 drillcore, in which such analysis has not been performed yet. Sampling in depth interval 109.75–253.5 m was made in correspondence with the core lithology. 42 benthic and 19 planktonic foraminifera species were determined in the samples, and their abundances, diversity and P/B ratio were compared to the lithological proxies and to previous interpretations of the longer-term depositional history.

The foraminiferal data are compared to the following geochemical proxies: CaCO₃ content, Al and Si contents, and Al/Si and Zr/Si ratios measured continuously in the entire core. The cyclicity displayed by foraminiferal assemblages seems to be different than the cyclicity observed in geochemical proxies.

In the vast majority of the samples, alternation in abundance is observed between *Heterohelix globulosa* on one side and representatives of *Whiteinella* and *Dicarinella* on the other side. Spearman correlation of foraminifera species and geochemical data reveals two distinct groups in relation to the lithological proxies. Group 1 is represented by *Cassidella tegulata*, *Praebulimina* sp., *Gaudrinella*, *Whiteinella paradubia* and *Dicarinella imbricata*, and shows affinity to relatively carbonate-poor, and partly mud-enriched lithologies. Group 2, represented by *Lenticulina* sp. and *Gyroidina nitida*, correlates with carbonate-enriched samples with higher Si/Al and Zr/Al ratios.

Acknowledgements. The work was supported by GAUK project no. 204217, project SVV-2017 UK and GAČR project no. 17-10982S.

New vertebrate material from the Upper Cretaceous Kem Kem Beds of Morocco

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Deposits of the lower Upper Cretaceous (?Cenomanian) Kem Kem Beds in south-eastern Morocco are rich in vertebrate remains. About 90 taxa of terrestrial, freshwater and brackish vertebrates were recognised so far in these generally fluvial deposits.

Here we present the preliminary results of excavations performed in 2019. The collected specimens belong mainly to archosaurs and bony fish. The abundant material collected includes: teeth of theropods (Spinosauridae, Carcharodontosauridae, Abelisauridae), sauropods (Rebbachisauridae) and pterosaurs, turtle (Bothremydidae) shell fragments, scales of polypterids and neopterygians (Lepisosteidae, Obaichthyidae), vertebrae of teleosts (Tselfatiiformes) and dental plates of lungfish (Ceratodontidae). Particularly interesting material includes enigmatic vertebrae with a peculiar morphology and unknown affinities, cranial material of crocodiles and small-sized vertebrae of snakes and archosaurs. The newly collected specimens will be the subject of future investigations, which should increase our knowledge on the diversity of the Cretaceous Kem Kem fauna.

Cluster of middle Cambrian trilobites: a case of “frozen” behaviour from the Barrandian area, Czech Republic

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An exceptionally preserved, fully articulated carrion of the large paradoxiid trilobite *Paradoxides* (*Rejkocephalus*) *rotundatus* associated with fifteen articulated specimens of much smaller ellipsocephalid trilobites representing *Ellipsocephalus hoffi* from the middle Cambrian of central Bohemia provides an unequivocal and unique example of preserved mutual interactions in the invertebrate fossil record. The small ellipsocephalids are closely spaced and fourteen of them are positioned with their dorsal exoskeleton dorsum down in relation to the large *Paradoxides*. The small trilobite specimens are interpreted to represent moults. Analyses of distribution and orientation of these fifteen trilobites combined with missing librigenae demonstrate an exceptionally preserved “frozen” behaviour illustrating either a feeding or a cryptic shedding strategy in Cambrian trilobites. We argue that the small trilobites were attracted to the ventral side of the large trilobite carrion (i.e. below the exoskeleton) to find refuge for ecdysis, or to feed either directly on deteriorating soft parts or on the fungal/bacterial consortia developed on the ventral surface of the large carrion. This find of a polyspecific size-segregated cluster of trilobites provides additional evidence of feeding relationships in the middle Cambrian.

Acknowledgements. The Czech Science Foundation (GACR) supported the contribution through project no. 18-14575S and PROGRES Q45 of the Ministry of Education, Youth and Sports of the Czech Republic (OF).

Biostratigraphy of the Aptian–Albian platform carbonates in the Manín Unit (Western Carpathians, Slovakia)

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The upper part of the Lower Cretaceous succession in the Manín Unit is built of neritic limestones of the Urgonian facies *s.l.* (the Podhorie and Manín formations). Microfacies analysis has allowed to identify several dominant facies associations within the sections studied (the Manín Straits and the Butkov Quarry). The study of microbiostratigraphy (which due to lack of macrobiostratigraphical indexes represents the only stratigraphical tool for age determination) brought some more surprising results.

The Podhorie Formation in the Manín Straits section is characterised by planktonic foraminifers *Ticinella primula*, *T. roberti*, *T. cf. madecassiana*, rare calcareous dinoflagellate cysts *Calcisphaerula innominata*, and colomiellids *Colomiella recta* and *C. mexicana* of Early–middle Albian age. In contrast, Late Aptian–Early Albian planktonic foraminifers *Globigerinelloides aptiensis*, *G. ferreolensis*, *G. algerianus*, *G. barri*, *Hedbergella trocoidea*, *Ticinella roberti* and *Muricohedbergella* sp. in association with rare colomiellids and calcareous nannofossils were obtained from the Podhorie Formation in the Butkov (IE) section.

In both sections, the highest part of the Lower Cretaceous limestone sequence formed by the Manín Formation with rudists contains redeposited orbitolinids *Mesorbitolina* gr. *parva-texana* and *Palorbitolina* gr. *lenticularis*. In the Manín Straits, we designate the Malý Manín Member within the Manín Formation, representing reef facies. Based on biostratigraphy, shallow-water sedimentation, microfacies and fossil content, sediments of the highest part of the Manín Formation are more or less correlatable with the Nižná Limestone Formation in the Pieniny Klippen Belt.

Formation of the platform carbonate complex in the Manín Unit was accompanied by submarine sliding, redeposition and slope clast accumulation. A hardground formed after collapse of the carbonate platform was overlain by Albian–Cenomanian marls of the Butkov Formation with a thin layer of “calcisphaerulid” limestone characterised by planktonic foraminifers *Planomalina buxtorfi*, *Parathalmanninella appenninica*, and *Pseudothalmanninella ticinensis conica* indicating the latest Albian, and calcareous dinoflagellate cysts of the *Innominata* Acme Zone.

Acknowledgements. This research was supported by the VEGA 2/0034/16 and APVV-14-0118 grants.

A record of the Carnian Pluvial Phase in the Polish microflora

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The prevalent dry climate during the Triassic in the eastern part of the Central European Basin was interrupted by short-time humid events and longer phases. One of them was the Carnian Pluvial Phase, which took place in the Julian (early Carnian) and can be correlated with the *Aulisporites astigosus* palynological zone. It is recorded by the significant change in the composition of spore-pollen assemblages, from dominated by xerophytic species of the *Triadispora verrucata* Subzone in the Upper Grabfeld Formation (“Lower Gipskeuper”), to dominated by hygrophytic forms in the Stuttgart Formation (“Schilfsandstein”). Changes in climate were documented based on quantitative spore-pollen analysis and the Sporomorph Ecogroup (SEG) model of 20 miospore assemblages noted in 51 samples occurring in the material from 15 drillcores from Poland.

In the miospore spectra of the *T. verrucata* Subzone, composed most exclusively of conifer pollen, the hygrophytic/xerophytic H/X ratio varies from 0.03 to 0.9 (0.5 on the average) and the average contribution of the Upland SEG is above 80%. The assemblage was composed of arborescent and herbaceous conifers and arborescent pteridosperms.

Differentiation of miospore assemblages within the *A. astigosus* Zone may be observed. Whereas spectra from its lower part consist almost exclusively of hygrophytic elements – cycadalean pollen and fern spores (above 80% on the average), in assemblages from the upper part, dominated by lycopsid and fern spores, their contribution varies from 40 to 80%. The H/X ratio varies from 1 to 49 (8.3 on the average). The SEG model shows a strong domination of the Lowland and River SEG. The shift from dry to wet climate, observed at the boundary between the Upper Grabfeld Formation and the Stuttgart Formation was documented also in other regions of Europe.

The Early Triassic plant assemblage from Pałęgi (Holy Cross Mountains, Poland)

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Lower Triassic deposits from the Pałęgi clay pit (Holy Cross Mountains, Poland) show a diverse record of fossil plants. The Middle Buntsandstein claystones and mudstones of the Samsonów Formation represent fluvial deposits and yield numerous remains of invertebrates and vertebrates. Recent findings of plant macro- (preserved mainly as impressions) and microfossils have indicated an assemblage dominated by lycophytes and horsetails, with rare ferns and conifers. Most abundant and particularly well preserved are sporophylls resembling *Pleuromeia* – a pioneer lycopsid characteristic for the Early Triassic of the Eurasian province. Less frequently occur Equisetaceae, preserved mainly as fragmented stems and microphylls, although incomplete reproductive organs were also found. They belong to common Triassic genera: *Schizoneura* and *Equisetites*. Isolated fern pinnules of *Neuropteridium* sp., *Anomopteris* sp. and *Cladophlebis* sp. are usually scattered among the plant debris. The presence of conifers remains uncertain. Apart from isolated leaves resembling *Albertia* sp., there are no unequivocal macrofossils of conifers or even gymnosperms, except for abundant conical seeds, 3–9 mm long.

The preservation of miospores varies from light coloured to strongly coalified. Palynological analysis showed the dominance of *Densoisporites* spores, associated with *Pleuromeiaceae*. *Densoisporites nejburgii* spores occur most frequently, whereas *D. playfordi*, *D. holospongia*, *D. sp.*, *Cycloverrutriletes presselensis*, *Cyclotriletes microgranifer*, *C. oligogranifer*, *C. triassicus* and *Punctatisporites triassicus* are less numerous. Other spores, such as aff. *Verrucosisporites* sp., aff. *Guttatisporites* sp., *Baculatisporites* cf. *verus*, *Lundbladispota* sp., *Kraeuselisporites* cf. *apiculatus*, and *K. sp.* occur as single specimens. Bisaccate pollen grains, represented by *Lunatisporites* sp., *Angustisulcites gorpii*, *A. klausii*, *Platysaccus leschiki*, *Triadispota* sp. and *Voltziacaesporites heteromorphus* are scarce. The described spore-pollen assemblage belong to the *Cycloverrutriletes presselensis* Subzone of the *Densoisporites nejburgii* palynozone distinguished in the upper part of the Middle Buntsandstein (upper Olenekian) of Poland.

Acknowledgements. The research was financed by NCN grant no. 2014/15/N/ST10/05142 (ZW).

Fauna and absolute $^{10}\text{Be}/^9\text{Be}$ age of the Volkovce Formation (upper Miocene) in the Danube Basin (Triblavina outcrop, Slovakia)

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In the Danube Basin, the upper part of the upper Miocene (Beladice and Volkovce formations) was deposited in lacustrine, deltaic and fluvial settings. Such epicontinental sedimentary sequences notoriously face the problem of their geochronology because they do not contain stratigraphically significant fauna. The present study was aimed to constrain the chronology of the Volkovce Formation, which represents an alluvial sequence deposited between 10–6 Ma by rivers draining the Eastern Alps and the Western Carpathians to Lake Pannon. We have combined the biostratigraphy of small mammals and molluscs with radiometric dating based on the authigenic $^{10}\text{Be}/^9\text{Be}$ ratio. Deposits of the Volkovce Formation were studied in an exposure on the highway by the Triblavina stream.

The assemblage of rodents from Triblavina is dominated by the murid *Apodemus lugdunensis*. The second most abundant genera is the eomyid *Keramidomys* represented by *K. ermannorum* and *Keramidomys* sp. The interpretation of the age of the rodent assemblage is based mainly on the presence of typical Turolian taxa e.g. *Epimeriones austriacus* (MN 11) and *Vasseuromys pannonicus* (MN 11–MN 12). The biostratigraphic age of the Triblavina fauna may be correlated with confidence with biozone MN 11 and probably represents the beginning of the Turolian close to the MN 10/MN 11 transition.

The mollusc association from Triblavina consists of freshwater (*Anisus*, *Planorbarius*, *Radix*, *Stagnicola* and *Valvata*) and terrestrial (*Carychium*, *Discus*, *Gastrocopta*, *Strobulops*, etc.) gastropod species. Based on the ranges of stratigraphically important freshwater gastropod taxa we assume that the fossiliferous horizon was deposited during the time interval close to the boundary of biozones G and H.

Small mammal biostratigraphy based on rodent assemblages may be correlated with the lowermost part of Zone MN 11 defined in south-eastern Europe at <8.9 Ma, whereas authigenic $^{10}\text{Be}/^9\text{Be}$ dating from seven samples served for establishing the weighted mean age at 9.29 ± 0.28 Ma.

Calcareous nannoplankton and foraminifera from the middle Miocene Skawina Formation in the Kraków area, Poland

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The results of foraminifera and calcareous nannoplankton analysis from the middle Miocene Skawina Formation in the Kraków area are presented. The investigated area covers the northern part of the Carpathian Foredeep. Samples for micropalaeontological studies were taken from two boreholes: Pasternik and Nowy Kleparz situated in the city of Kraków. The sampled deposits of the Skawina Formation include mainly grey and light marly clays in the Pasternik borehole, and grey, sometimes greenish with mollusc shells, single pteropods and plants remains in the Nowy Kleparz borehole. The foraminiferal assemblages represent the *Praeorbulina glomerosa*–*Orbulina suturalis*, *Globigerina druryi*–*Globigerina decoraperta* (in Nowy Kleparz only) and *Velapertina indigena* (in Pasternik) zones *sensu* Cicha *et al.*, which indicate a Middle and Late Badenian age *sensu* Hohenegger *et al.* Calcareous nannoplankton analysis confirms this age. Long-ranging species and those reworked from the Palaeogene and Cretaceous dominate in all samples. Biostratigraphically significant Badenian species, such as *Sphenolithus heteromorphus*, *Helicosphaera walbersdorfensis*, *Discoaster exilis*, *Discoaster variabilis* and *Umbilicosphaera rotula* were also identified. Based on their occurrence, NN 5 and NN 6 nannozone were determined. Based on both groups of microfossils, the boundary between nannozone NN 5 and NN 6, and the *Praeorbulina glomerosa*–*Orbulina suturalis*, *Globigerina druryi*–*Globigerina decoraperta* foraminiferal zones could be established. The last occurrence of *Sphenolithus heteromorphus*, which marks this boundary, was documented in samples from both boreholes.

Barremian gastropods from Veliko Tarnovo region, Bulgaria

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Gastropods are currently the second largest and diversified group of all living metazoan animals and occupy a large number of ecological niches. They are also well represented in the fossil record that helps exploring their evolution and phylogeny. The Cretaceous is considered as one of the most important periods in the gastropod evolution since it was the time of significant mid-Cretaceous turnover in gastropod faunas probably evoked by the arms race of the Mesozoic marine revolution. Barremian gastropod assemblages are uncommon, thus any new data will provide a better understanding of gastropod taxonomy and evolutionary trends shortly before mid-Cretaceous turnover. We examined 464 Barremian gastropod shells, mostly from the town of Veliko Tarnovo and a few from the village of Pushevo (central north Bulgaria). The material from these localities is being examined for the first time. It consists mainly of small-sized specimens (< 1 cm) and only a few larger ones. The shells are of moderate preservation with well-preserved ornamentation that is generally better than the collections of the same age from Barcelonne and Serre de Bleyton (Département Drôme, France). In few cases protoconchs are preserved, but embryonic shells are eroded away. Although the important taxonomic characteristics (protoconch and aperture) often are poorly preserved or absent, we were able to preliminarily determine at least 70 species from 19 families with a predominance of cerithiids, nerineids, and mathildids.

Convergent evolution of spherical tests documented in two lineages of Miocene planktonic foraminifera from Central Paratethys

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The development of a spherical ultimate chamber in planktonic foraminifera of the evolutionary lineage *Globigerinoides trilobus*–*Orbulina universa* is well-documented by several *Praeorbulina* morphospecies. The evolutionary transition leading to the appearance of *Orbulina universa* includes changes in multiple morphological compartments, as areal apertures become to spread over the surface area of the encompassing terminal chamber. The environmental forcing that initialized the sphericity of *Orbulina universa* is, however, less well constrained. In this study we show that simultaneously with the formation of the spherical encompassing chamber in *Orbulina universa*, an identical morphological transition leading towards sphericity occurred in the intercontinental Central Paratethys. This trend is observable among the endemic genus *Velapertina* that repeated the morphological transition of the *Globigerinoides trilobus*–*Orbulina universa* lineage. Due to the ambiguous external test morphology of *Orbulina* and *Velapertina*, resulting from their last chamber and apertures, we have applied a computed tomography microscope SkyScan 1172 in order to assess their relatedness by comparing their internal morphology through reconstructing the species ontogenetic trajectories according to the five stage concept of planktonic foraminifera ontogeny. The presented morphometric analysis displays that the ontogenetic trajectory of endemic *Velapertina* differs from the development pattern documented among *Praeorbulina*–*Orbulina* specimens and therefore showing evidence of a convergent evolutionary transition. The allopatric speciation of *Velapertina* suggests that the spherical test shape evolved independently in two different lineages of planktonic foraminifera in the middle Miocene.

Acknowledgements. This work was supported by research grants APVV I5-0575, APVV I4-0118, APVV I6-0121 and by the Comenius University grants for young scientists UK/214/2019.

Lower Badenian *Stenocyathus* Portales, 1868 from Borač locality, Moravia, Czech Republic (southern Carpathian Foredeep, Central Paratethys)

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The Borač locality (southern Carpathian Foredeep in Moravia) is situated in the Upper Svratka Highlands approximately 7 km northeast of Tišnov (Brno-venkov). The locality lies about 800 m northwest of Borač village and comprises the denudation remains of Miocene strata, representing the Lower Badenian “Tegels” abundant with marine micro- and macrofossils.

The Borač locality is known for rich findings of coral fauna. Specimens representing 15 genera have been studied in 2015–2019: *Caryophyllia* (*Acanthocyathus*), *Caryophyllia* (*Ceratocyathus*), *Paracyathus*, *Ceratotrochus*, *Trochocyathus*, *Flabellum*, *Stylocora*, *Stylophora*, *Porites*, *Balanophyllia*, *Deltocyathus*, *Peponocyathus*, *Enallopsamia*, *Dendrophyllia* and the newly found *Stenocyathus*.

This contribution focuses on the findings and examination of *Stenocyathus*, a fossil coral genus so far not known from this locality. *Stenocyathus* is a rare solitary coral from the azooxanthellate group of scleractinians. The bathymetrical range of this genus is highly variable (155–1500 m). *Stenocyathus* lived attached to the hard substrate in its juvenile stage but later broke down and grew freely lying on the sea bottom. The basal plate and base of these corals are reinforced with coenostum. The corallites are cylindrical to ceratoid with longitudinal rows of white thecal spots and pores in the wall. The calice consists of trabecular columella, 3 septal cycles (S1–S3) and 1 pali (opposite S2). The presence of this coral confirms a deeper marine environment for the Lower Badenian deposits at the Borač locality.

The coral specimens studied in this research project were collected in 2015–2019 and are housed in the Department of Geological Sciences, Masaryk University, Brno, and several private collections.



Fig. 1. A specimen of *Stenocyathus* from Borač locality, Moravia, Czech Republic.

Sclerobionts on tubes of the serpulid *Pyrgopolon* (*Pyrgopolon*) *deforme* (Lamarck, 1818) from the Cenomanian of Le Mans region, France

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The fossil record of sclerobionts on shell-bearing invertebrates includes primarily molluscs, echinoderms and brachiopods as hard substrates for infestation. Serpulid polychaetes are described as common encrusting organisms inhabiting various substrates, but still limited studies deal with tube-dwelling polychaetes as substrates for encrusters and borers. We focus here on *Pyrgopolon* (*Pyrgopolon*) *deforme*, a serpulid species common in the Cenomanian of Le Mans region. *Pyrgopolon* tubes acted as small solid benthic islands for colonization by invertebrate fauna on a typically soft sandy/marly bottom. A relatively rich assemblage of 88 individuals was studied (binocular lenses, SEM, CT, vacuum epoxy casts). Borings found in tubes show relatively low diversity; nevertheless, several different, recurring shapes were recognised. Borings of *Rogerella* isp. are among the best preserved. The examined tubes represent the second known case of interaction between boring barnacles (*Rogerella* tracemakers) and serpulids. Short shafts perpendicular to tube surfaces are attributable to *Trypanites heckeri* (n.n.). Longer, irregularly meandering tunnels resemble *Trypanites* isp., but usually display more than one aperture, suggesting *Maeandropolydora*. Another characteristic boring is a drop-shaped chamber with a relatively large aperture and several narrower side openings, and preliminarily attributed to unicamerate entobians. Poorly preserved microborings found accidentally on epoxy casts are other borings for further study. Among the sclerozoans, encrusting oysters, and cheilostome and cyclostome bryozoan colonies are the most abundant group. Due to high density of infestation, random distribution of boreholes and no signs of reparation (healing) of the penetrated tube walls by the host organism, post-mortem infestation of *Pyrgopolon* (*P.*) *deforme* in Cenomanian strata from Le Mans region is suggested.

Acknowledgements. The research was supported by the Czech Science Foundation (grant project no. 18-05935S), by the Institute of Geology, Czech Academy of Sciences (project no. RVO 67985831), and by the Ministry of Culture of the Czech Republic (IP DKRVO project no. 2019/2.III, National Museum, 00023272).

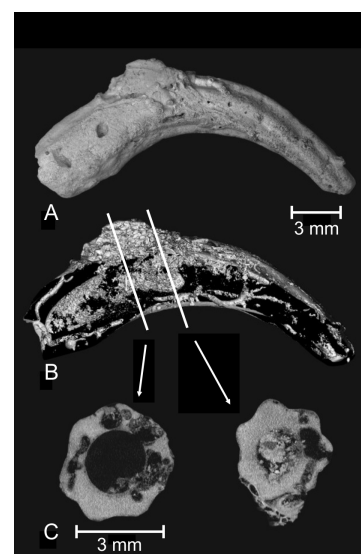


Fig. 1. *Pyrgopolon* (*Pyrgopolon*) *deforme* from Le Mans region, France, specimen MHNLM EMV 2016.3.14 deposited in the collection of the Musée Vert, Muséum d'histoire naturelle du Mans. A – SEM image; B – micro-CT image; C – cross-sections showing encrusting bryozoan colonies and tunnel systems of *Entobia* isp.

Age and synchronicity of planktonic foraminiferal bioevents across the Cenomanian–Santonian interval (Crimea–Caucasus area)

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All Cretaceous sections of the Crimea–Caucasus area contain diverse assemblages of spiral-conical planktonic foraminifera (PF), which generally allow for the correlation of their zonal subdivisions with other territories of the Tethys area.

The *Parathalmanninella globotruncanoides* Zone coincides with the Early Cenomanian. It includes the interval from the lowest occurrence (LO) of the zonal species to the LO of *Thalmanninella deeckie*. PF assemblages are rather monotonous throughout this zone. The *Thalmanninella deeckie* Zone is limited by the LO of the index species and the LO of *Rotalipora cushmani* (Middle Cenomanian). This is the shortest zone in the entire range of Cretaceous planktonic foraminifera, because the “Mid-Cenomanian nonsequence” is present here. The *Rotalipora cushmani* Zone is characterised by the occurrence of the zonal marker (late Middle to latest Cenomanian). The *Whiteinella archaeocretacea* Zone is limited by the highest occurrence (HO) of *Rotalipora cushmani* and the LO of *Helvetoglobotruncana helvetica* (latest Cenomanian – Early Turonian). The extinction of thalmannellids *s.l.* and the flourishing of whiteinellids characterise this Zone, which coincides with Ocean Anoxic Event 2. The *Helvetoglobotruncana helvetica* Zone is characterised by the total range of the zonal marker. It corresponds to the late Early Turonian up to the Middle Turonian. The zonal marker is very rare in Crimea and common in Caucasus.

The mentioned zones are almost identical in the Tethys and the Crimea–Caucasus areas. In the subsequent interval, starting from the Middle Turonian to the end of the Santonian, PF taxonomic diversity and levels of important biological events begin to differ significantly between both areas. This is due to the later appearance, and sometimes absence, of some index species in the Crimea–Caucasus area. However, the Santonian–Campanian boundary can be precisely defined by two bioevents: HO of *Dicarinella concavata/asymetrica* and LO of *Globotruncanita elevata*.

Acknowledgements. Financial support for the research was provided by RFBR 18-05-00503a and 18-05-00495a.

***Guembelitra cretacea* Cushman, 1933 (Foraminifera) from the Skole Nappe in the Polish Outer Carpathians**

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Guembelitra cretacea is a small-sized (around 100 μm) foraminiferid, which is an important biotic component of the late Maastrichtian–early Palaeocene planktonic foraminiferal assemblages. It is an undisputed survivor of the K–Pg boundary event. *Guembelitra cretacea* first appeared during the Maastrichtian (within the *G. elevata* Zone), but its radiation falls on the time just after the K–Pg boundary event. On the basis of foraminiferal blooms, the youngest Palaeogene foraminiferal biozone P0 is distinguished worldwide. Until now, *G. cretacea* has not been described from the Polish Flysch Carpathians. In this study we document the K–Pg transition interval from a section located along a small stream in Hyżne village, Skole Nappe, Polish Outer Carpathians. The interval consists of three samples (Hy6, Hy4 and Hy5), in which *G. cretacea* was identified. In this interval two different types of low-diversity assemblages can be distinguished. The first is composed mainly of poorly preserved, small, non-keeled epipelagic forms such as heteroheliciids and *G. cretacea*, as well as a few keeled trochospiral forms and benthic agglutinated foraminifers. The second assemblage is composed of very small planktonic specimens (<64 μm fraction) of *G. cretacea*, heteroheliciids, *Globigerinelloides* spp. and benthic forms consisting of calcareous and large agglutinated foraminifers representing epifaunal and infaunal morphotypes. On the basis of nannofossil analysis and documented differences in the foraminifers, the interval records environmental changes that took place at the turn of the Cretaceous and the Palaeogene.

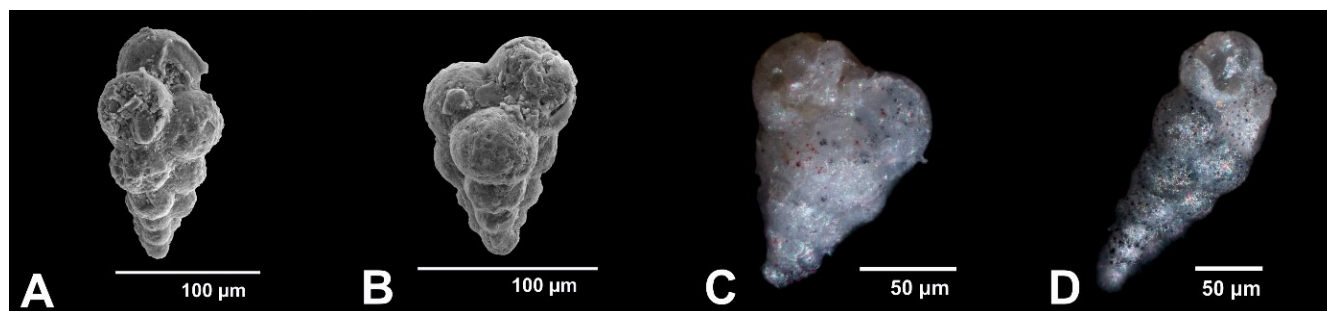


Fig. 1. *Guembelitra cretacea* Cushman, 1933 from Hyżne section, Polish Outer Carpathians. A, B – SEM micrographs, sample Hy6; C, D – Reflected-light photographs, sample Hy4.

Exotic clasts of the Oxfordian–Kimmeridgian limestones and their relation with the southern part of the North European Platform and the oldest stages of the Outer Carpathian evolution

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In the Late Jurassic, rifting processes led to disintegration of the southern margin of the North European Platform and opening of the Outer Carpathian flysch basins. Sedimentary successions of this pre-flysch phase are not preserved, being consumed during Miocene subduction. Their only remnants are clasts preserved as exotic rocks in the succeeding flysch series.

Our analysis of foraminifera, and calcareous and organic dinoflagellate cysts from these exotics generally suggests an Oxfordian–Kimmeridgian age. For the majority of them a late Oxfordian–early Kimmeridgian age is the most likely. The exotics represent three facies types. The sedimentary setting was related to mid-ramp to outer-ramp, rather without intense land influences, with prevailing pelagic/hemipelagic accumulation. Sponge-microbial limestones can be interpreted as mid-ramp facies, i.e. deposited mostly in low-energy nutrient-rich environments. The oncoid-intraclast-*Crescentiella* limestones are related to mid-ramp settings. The fine-grained biodetrital limestones with *Saccocoma* were possibly deposited in deep-shelf or toe-of-slope environments belonging to the outer ramp setting. The facies types are similar to those widely distributed over the northern shelf of Western Tethys (e.g. extra-Carpathian southern Poland, southern Germany).

Comparison of our data with coeval material from the surrounding areas shows that in the Oxfordian–Kimmeridgian the carbonate platform extended to the adjacent Fore-Carpathian Foredeep basement and the Kraków–Częstochowa Upland. Data from southern Poland indicate that in the late Oxfordian and Kimmeridgian synsedimentary tectonic movements sub-divided the northern Tethys shelf into ridges and grabens. Later, these structures gradually evolved in the Outer Carpathian flysch basin system.

The limestones were possibly deposited within the Silesian and Baška–Inwałd ridges. They originated when differentiation of the south margin of the North European Platform began, which resulted in the opening of the proto-Silesian Basin.

The retiolitine *Gothograptus* (Graptolithina): a significant indicator of the *lundgreni* environmental crisis, upper Homeric, Silurian

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New *Gothograptus* species have recently been described from the *lundgreni* and post-*lundgreni* biozones of Baltica. They have become an additional stratigraphic tool as well as indicators of the environmental changes related to the *lundgreni* event. *Gothograptus* belongs to the retiolitids, a group of graptolites having a complex tubarium with very thin fusellar walls, lists built of bandages, and an additional outer layer, the ancora sleeve, being an extension of the ancora umbrella growing upwards from the virgella. Evolution of the *Gothograptus* lineage began in the *lundgreni* Biozone, with four species, and two in the succeeding *parvushnassa*, *dubiushnassa* and one species in the *praedeubeli*–*deubeli* Biozone. The elongated narrow tubarium of *Gothograptus*, terminated by a tubular appendix, was built of strong lists and a dense meshwork of thinner lists. There are two types of the structures: reticulated and solid, with *nassa* type of hoods. Reticulated genicular structures are common in the *lundgreni* Biozone forms. They are developed as reticulated hoods as in *G. kozłowskii*. The most developed reticulated covering of the thecal orifices are veils, which can also cover a significant part of the ventral walls in *G. obtectus* and *G. velo*. The *nassa* type of hoods were strong and solid, built not by the thin reticulum lists, but by densely packed parallel bandages, and additionally covered by different, pustule-bearing bandages running irregularly across the hoods' surfaces. Significantly, only *Gothograptus*, with its massive, finite growth colonies, mostly short tubaria with the covered thecal orifices, dense reticulum indicates of its good protection against significant changes of the marine environment linked with strong fluctuations of the sea-level during and after the *lundgreni* crisis.

Is there any connection between the Early Jurassic (Pliensbachian) *Lithiotis*-type bivalve facies of mangrove-type environments (Albanian Alps) and the origin of primitive crabs (Decapoda, Brachyura)?

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Lithiotis-type bivalves (*Lithiotis*, *Cochlearites*, *Lithioperla*, *Mytiloperla*, and *Gervileioperla*), are the most significant constructors of shallow marine/lagoonal bivalve mounds (“reefs”) in numerous sites around Pangaea during the Pliensbachian–Early Toarcian. In Europe they are known from Alpine countries and constitute the Early Jurassic Alpine–Adriatic–Dinaridic–Hellenidic carbonate platforms with peritidal to subtidal sedimentation regimes. A continuous succession of Upper Triassic (shallow-water Lofer-type facies) to Lower Jurassic carbonates occurs in the Albanian Alps. Lower Jurassic (Pliensbachian) bivalve-rich limestones are intercalated with oolitic/oncolitic layers representing subtidal/peritidal high-energy environments. Moreover, at least five coal-bearing layers full of aired root systems representing coastal swamps of mangrove-type environments intercalate the intertidal carbonate rocks of the full-marine–lagoonal–land transition. Several tempestite horizons occur directly above the root-bearing deposits and indicate catastrophic events that destroyed mangrove-type plants occupying near-shore environments.

Most Early and Middle Jurassic crab species (ca. 70%) are known from holotype specimens only (including the oldest unequivocal and most “primitive” crab, the Pliensbachian *Eoprosopon klugi* Förster, 1986 – the so-called *Brachyuran Pliensbachian* Origin Event) and therefore knowledge about them is limited both with regard to taxonomy and palaeoenvironmental preferences. Due to the lack of Toarcian–Aalenian crab fossil record, the key moment of their history was connected with the *Brachyuran Bajocian Expansion Event* when new species appeared in shallow-marine environments (oolitic, including ferruginous, and/or oncolitic bars/dunes of carbonate platforms; sponge-bearing facies with ooids and coralliferous carbonates; isolated lagoon and/or mangrove-type gulfs) – e.g., *Coelopus bigoti* Hee, 1924. Therefore, roots of the “Brachyuran evolutionary tree” were generally related with carbonate, extremely shallow-marine sedimentation. Therefore, the Albanian Alps succession seems perfect for the fossil record of first steps/origins of crab evolution.

Campanian flora from the Gosau Group in Austria

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The Campanian Grünbach flora from the Gosau Group in the Neue Welt Basin, Austria comprises 53 taxa, representing the Equisetopsida (*Equisetites*), Polypodiopsida (*Cladophlebis*, *Coniopteris*, *Gosauopteris*, *Marsilea*, *Microtaenia*, *Monheimia*, *Raphaelia* and *Sphenopteris*), Cycadopsida (*Nilssonia*), Pinopsida (*Podozamites*, *Geinitzia* and *Pagiophyllum*), Liliopsida (*Orontiophyllum*, *Pandanites*, *Gruenbachia*, *Sabalites*, *Theiaiphyllum* and *Monocotyledon*), and Magnoliopsida (*Brasenites*, *Celastrorphyllum*, *Compositiphyllum*, *Debeya*, *Ettingshausen*, *Grebenkia*, *Juglandiphyllites*, *Leguminosites*, *Menispermites*, *Myricophyllum*, *Quereuxia*, *Rogersia*, *Dicotylophyllum* and *Ceratoxylon*). The most characteristic feature of the palynoflora is pollen from the “Normapolles” group. The Grünbach Flora represents one of the few known Late Cretaceous mire floras in Europe. Due to palaeoecological conditions of a peaty swamp habitat, the flora represents a unique case with few counterparts in the Late Cretaceous. Although there is no direct equivalent of the Grünbach Flora, assemblages with a similar plant content occur in the Maastrichtian of Romania and Spain, and the Senonian and Cenomanian of the Czech Republic. The Grünbach Flora includes pandans, palms and numerous angiosperms with narrow entire-margined leaves, which can be interpreted as typical of the Euro-Sinian phytogeographic region. The presence of relict plants (*Nilssonia*, *Podozamites*) probably reflects the existence of an ‘island refuge’.

Palaeoecology of the Grünbach wetlands is reconstructed based on fossil plant morphology, anatomy and taphonomy. Five plant communities were recognised: aquatic plants, swamp-semiaquatic plants, juglandaceous and palm wetland forests, riparian forests and mesophytic forests. Physiognomic CLAMP analysis of the Grünbach Flora shows that its plants experienced humid sub-tropical to oceanic mesothermal frostless climate with warm/hot summers and short, relatively dry, but not arid, seasons. High humidity levels are confirmed by extensive coal accumulation in the Grünbach Formation and lack of sclerophyllous plants. Accumulation of the plant-bearing deposits in the Grünbach Formation took place on a large island with an unknown relief, at least temporarily connected to the continent.

Origin and geochemistry of the bone-bearing beds in Miedary, Upper Silesia, Poland

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We have investigated a former clay pit in Miedary (Upper Silesia, Poland), best known for numerous vertebrate remains. The succession begins with red and green siliciclastics, passing into red, grey and bluish claystones, and terminating with layers of dolomites with thin sandstone interbeds. Bone-bearing horizons were identified within siliciclastic and dolomitic deposits. The recognised invertebrates (*Costatoria* sp., *Modiolus* sp., *Unionites* sp.) and fish fauna (*Polyacrodus keuperianus*, *Serrolepis suevicus*) indicate that the Miedary succession belongs to the Lower Keuper facies (Lettenkeuper). However, its origin and exact stratigraphic position remain unknown. In the first step to obtain more information we have prepared thin sections from the dolomites. Traditional microfacies interpretation was supplemented with geochemical analysis coupled with EDS. Here, we present the preliminary results of our research.

An undescribed locality with carbonate build-ups from the Devonian/Carboniferous transition in the Tafilalt Basin (Anti-Atlas, southern Morocco)

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The best known examples of reefal structures in the Devonian and Carboniferous of the Anti-Atlas in Morocco are those located in the Tafilalt Basin. The main goal of our studies is the presentation of a new, still undescribed locality from the Tafilalt Basin, where several dozens of biogenic carbonate structures are exposed. This locality was discovered in April 2019 during a research field trip. Preliminary observations show that the carbonate structures are generally situated in a narrow, 7 km long belt on the southern margin of the Tafilalt Basin. The build-ups attain different sizes and are from 2 to 15 m high. Most of them are partially eroded, but the overall preservation is good. The analysed build-ups are composed of massive biogenic limestones with stromatactis structures and a high content of crinoidal skeletal debris. Brachiopods, rugose and tabulate corals are also present, but in smaller numbers. A preliminary field study of the macrofossils points to the latest Devonian, whereas analysis of conodont samples has indicated an early Carboniferous (Tournaisian) age for the build-ups. The structures resemble mud mounds – reef-like structures built from skeletal debris with a high content of organic or inorganic carbonate matrix. Mud mounds are well documented in southern Morocco, but in this particular area they were so far unknown. The size, structure, preservation and location of the build-ups resembles the somewhat younger (Visean) mud mounds situated several kilometres to the north of the Tafilalt area.

Future analysis will include detailed studies of the associated fossil fauna and its comparison to associations from Visean mud mounds and Emsian mud mounds in the famous Hamar Laghdad area. Extensive sedimentological and geochemical (stable isotopes and WDS analysis) studies will also be performed.

Colonisation of ancient brackish water systems in the beginning of marine transgressions: Triassic examples from the Western Carpathians

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The colonisation of marginal marine environments was a long term process. Five major phases (based mostly on trace fossils) have been distinguished in estuarine deposits of different ages. They mostly followed a sea-level rise associated with environmental crises. The fossil record of this process was subject to preservation.

Western Carpathian examples of this process are related with Mesozoic and Cenozoic habitats (phases 3-5). Scythian environments developed in areas devastated during the Permian / Triassic Extinction. Although incompletely studied, the clastic complexes of this age have recorded the colonisation of restricted marginal habitats: from torus-shaped structures produced by microbial trapping (like *Intrites* sp.) to aggregates of lingulid burrows. In the hypersaline carbonate mud of an Anisian carbonate ramp (Vysoká Formation), typical burrow galleries were formed.

The Upper Triassic Carpathian Keuper facies was deposited in arid, emerged central West Carpathian zones. In rising humidity preceding the Rhaetian transgression, nearshore swamps and lagoons formed in the Zliechov Basin. They were mostly recorded by black shale beds below the base of the Fatra Formation. In turn, the Kardolina section comprises a several meters thick succession of grey marlstones containing an association of foraminifers (*Agathammina austroalpina*) in its basal part. The bivalves *Modiolus minutus*, *Bakevella praecursor*, *Isocyprina ewaldi*, *Modiolus minutus*, *Neoschizodus?* sp. and *Pleuromya?* sp., shark teeth of *Hybodus minor* and *Lissodus minimus*, and burrows of *Rhizocorallium jenense* indicate a low-energy environment. Thin dolostone layers with condensed bone-bed surfaces enriched in phosphates, fine breccia, the fish *Lissodus minimus*, *Sargodon tomicus*, and *Severnichthys acuminatus*, and bone fragments are overlain by full-marine limestone tempestites.

Palaeoenvironmental significance of dinoflagellate cyst assemblages from the Upper Campanian–lowermost Maastrichtian (Upper Cretaceous) in the Middle Vistula River section, central Poland

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The upper Campanian–lowermost Maastrichtian succession of the Middle Vistula River composite section is exposed in a series of natural and artificial outcrops along the Vistula River valley near the town of Solec nad Wisłą, in central Poland. Despite the fact that the Middle Vistula River succession yields rich palaeontological material, previous palaeoenvironmental studies (primarily based on non-cephalopod molluscs, sponges, and foraminifers) have provided only a rather crude characteristics of environmental parameters. Similarly, the generally monotonous lithology of the succession (siliceous marls – opoka) cannot substantially contribute to a refined understanding of the depositional environment. New, more precise palaeoenvironmental data have been generated from palynological analyses from a high-resolution sample set (~25 cm resolution). This study focused on dinoflagellate cysts, acritarchs, and algae.

Dinoflagellate cysts dominate the phytoplankton assemblages. Their abundance and taxonomic / ecological diversity vary throughout the succession. Four palaeoenvironmentally important morphological groups were recognised: (1) the *Areoligera* group (*Areoligera*, *Glaphyrocysta*), characteristic of inner neritic environments; (2) the *Hystrichosphaeridium* group (*Hystrichosphaeridium*, *Kleithriasphaeridium*, *Oligosphaeridium*) characteristic of middle to outer neritic environments; (3) the *Spiniferites* group (*Achomosphaera*, *Hystrichostrogylon*, *Spiniferites*) characteristic of nearshore or outer neritic environments; and (4) an oceanic group (*Cannosphaeropsis*, *Impagidinium*, *Pterodinium*, *Spongodinium*) indicative of outer neritic and oceanic conditions. The mutual relationship in the abundances of these groups form a distinct trend, one potentially sensitive to sea-level changes. In this interpretive framework, inferred sea-level fluctuations based on the dinoflagellate cyst assemblages are quite compatible with the global sea-level curve. This may suggest that the key sea-level changes recorded in the Middle Vistula succession were of eustatic origin.

New echinoderm Lagerstätte from the Letná Formation (Sandbian, Upper Ordovician) of Bohemia

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The Upper Ordovician (Sandbian) Letná Formation of Bohemia (Czech Republic) provides an important insight into the Early Palaeozoic diversification of marine ecosystems. In this formation, several levels can be interpreted as *Konservat Lagerstätten*: they have yielded abundant fossil remains, including exceptionally preserved, non-mineralised and poorly mineralised organisms. Non-trilobite arthropods (e.g. *Duslia*, *Furca*, *Zonozoe*) occur together with well-preserved trilobites, echinoderms, brachiopods and bivalves.

Recently, a new locality at Chrustenice was discovered in the Letná Formation. It is characterised by the mass occurrences of articulated echinoderms, which can be interpreted as storm-induced accumulation levels (*Konzentrat Lagerstätten*) of living or freshly killed individuals. The Chrustenice echinoderm assemblages are particularly diverse and dominated by solutans, associated with various asterozoans, blastozoans, crinoids, edrioasteroids, and stylophorans. The forthcoming description of these new assemblages will bring a wealth of new data on their systematics, functional morphology, taphonomy, palaeoecology, palaeobiogeography, and evolutionary implications. Preliminary investigations of the Chrustenice faunas show the occurrence of several ontogenetic stages among the ophiuroids, as well as examples of ecological interaction, e.g. between solutans and edrioasteroids.

Acknowledgements. This research is supported by the Grant Agency of the Czech Republic, project no. 18-14575S.

Biostratigraphy of middle Miocene deposits in the “Czeczott” Mine pit shaft S-1 and Plac Inwalidów borehole based on calcareous nannoplankton (western part of the Carpathian Foredeep) – preliminary results

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The study area is located in the western part of the Carpathian Foredeep in Poland. The calcareous nannoplankton study was carried out on the samples collected from the Kłodnica and Skawina Formations in the “Czeczott” Mine pit shaft S-1 and the Plac Inwalidów borehole. The thickness of Miocene deposits in the “Czeczott” Mine section reaches at least 175 m; in the Plac Inwalidów section, however, it is only about 45 m, due to the location of the borehole on an elevated structural element described in geological literature as the Cracow bolt, composed of Palaeozoic and Mesozoic rocks.

Biostratigraphic analyses were related to the standard calcareous nannoplankton zones and foraminiferal biozonation patterns. The calcareous nannoplankton assemblage constitutes of species important for middle Miocene stratigraphy, such as *Sphenolithus heteromorphus*, *Helicosphaera walbersdorfensis* and *Discoaster exilis*.

However, the main components of all investigated samples are long-ranging taxa (mainly *Coccolithus pelagicus*, *Cyclicargolithus floridanus*, *Helicosphaera carteri*, *Reticulofenestra pseudoumbilica*, *Pontosphaera multipora*, *Umbilicosphaera rotula*, and small *Reticulofenestra* species) and numerous reworked Cretaceous and Palaeogene forms. In the “Czeczott” Mine section, reworked, especially Palaeogene species, are very numerous.

More diversified calcareous nannoplankton assemblages and better preserved Miocene species were observed in the samples from the Plac Inwalidów section.

The preliminary results of calcareous nannoplankton analysis indicate that the samples from both sections represent Badenian NN5 zone *sensu* Martini. The zone was evidenced based on the occurrence of *Sphenolithus heteromorphus* and the total lack of *Helicosphaera ampliaperta*, whose last appearance marks the NN4/NN5 boundary. Foraminiferal assemblages from the Skawina Formation represent the Middle and Upper Badenian *sensu* Hohenegger *et al.*, with the *Praeorbulina glomerosa*–*Orbulina suturalis* and *Globigerina druryi*–*Globigerina decoraperta* zones in the “Czeczott” Mine pit shaft S-1, and *Praeorbulina glomerosa*–*Orbulina suturalis* Zone in the Plac Inwalidów borehole.

New data on the evolution of lower Miocene snake fauna from the Wintershof-West locality (Germany)

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The high diversity of the well-known late early Miocene (MN 4–MN 5 zones) snake fauna of Central Europe resulted from the warmest stages of the Miocene Climatic Optimum. However, snake communities from MN 1–MN 3 zones, whose composition reflects quick replacement of European Palaeogene snakes by modern colubroids, mostly of Asian origin, are still poorly known. The Wintershof-West locality, Germany (MN 3b; 19.5–18.8 Ma) yields a diverse snake community including representatives of five families: Boidae: *Bavarioboa* sp., Boinae gen. et sp. indet.; Tropidophiidae: *Falseryx petersbuchi*, *Falseryx* sp.; Colubridae: *Coluber hungaricus*, cf. *Telescopus* sp., Colubrinae gen. et sp. indet., *Neonatrix* cf. *nova*, *Natrix* sp.; Elapidae: *Micrurus gallicus*; and Viperidae: *Vipera* sp. – ‘Oriental vipers’ group. Three extinct species (*Falseryx petersbuchi*, *Coluber hungaricus* and *Micrurus gallicus*) have their first known occurrence in the fossil record. Moreover, *Bavarioboa* sp. and *Natrix* sp. represent new species. Numerous large vertebrae of ‘Oriental vipers’ document one of the first occurrences of those large vipers. Based on the palaeobotanic record from the North Alpine Foreland Basin, the Wintershof-West vertebrate assemblage developed under humid climate with a mean annual precipitation of 1000–1300 mm. The known amphibian and reptile taxa indicate the presence of open water reservoirs with overgrown banks and sandy shores, as well as rather dry biotopes covered by low vegetation. Temperatures probably did not drop below 17.4°C, as can be deduced from chamaeleonid presence. Despite numerous booid snakes in Wintershof-West, we assume that the Colubroidea represented a substantial part of the snake community in the site. Similarly, other Central European MN 3 localities, e.g. Merkur-North, Czech Republic (MN 3a), contain diversified colubroids. Therefore, we presuppose that MN 3 zone corresponds to the advanced stage of snake turnover in Europe.

Acknowledgements. This project was supported by the Specific Research Project at the Faculty of Science, Masaryk University in Brno.

Extant and fossil sponges associated with hydrothermal vent and cold seep communities

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Sponge fauna in the present-day chemosynthesis-based communities is dominated by Demospongiae. Hexactinellida are rare, while Calcarea are only exceptionally reported. All extant sponges known from such environments belong to groups with loose spicules, thus their fossilization potential is low. Sponges are considered as 'background' fauna because they do not depend directly on chemosynthesis and can occur in other environments as well. Notable exceptions are *Cladorhiza methanophila* from Barbados and probably *Pseudosuberites thurberi* from New Zealand (both Demospongiae).

The oldest fossil sponges associated with hydrothermally influenced deposits, identified as putative hexactinellids and demosponges, are from the lower Cambrian of China.

The first Mesozoic seep-associated sponges (hexactinellids and demosponges) are reported from the Upper Jurassic of France and the Jurassic/Cretaceous boundary beds in Svalbard. Oligocene fauna, composed exclusively of hexactinellids with fused skeleton (Hexactinosida), was described from the north-western United States.

Campanian sponges from the seep deposits of Japan (Gakkonosawa and Yasukawa) are reported here for the first time. The fauna consists of hexactinellids with fused skeleton (Hexactinosida), but loose spicules of astrophorid demosponges were also found. New fauna of hexactinellids with fused skeleton, accompanied by spicules of astrophorid demosponge, was also found in the Eocene of the north-western United States. No calcareous sponges are known so far from the ancient vent and seep communities.

Hexactinosa dominate in ancient seeps and vents, but they are yet not recorded from modern counterparts that are inhabited by Demospongiae composed of loose spicules. Such sponges are very rarely reported from ancient communities which we interpret as a taphonomic effect: lack of preservation of complete sponges. The dominance of hexactinellids with fused skeleton in the fossil communities over demosponges cannot be, however, exclusively an artefact (taphonomic effect due to their higher preservation potential), because they were not noted so far from present day communities.

The Badenian rocky shore environment of the Kalcit Quarry (South Moravia, Czech Republic)

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The vicinity of Brno city was subjected to several transgressions during the Miocene. The most significant one was the Badenian transgression. Badenian transgressive sediments are usually represented by the Brno Sands Member, but a few examples of a rocky shore type of environment are also known.

The most significant example of a rocky shore environment in the vicinity of Brno city is the Kalcit Quarry (formerly known as the Na Kopanínách Quarry) located about 8 km SE from the Špilberk castle in the Brno city centre. Besides siliciclastic deposits, erosional surfaces with borings, developed on Devonian limestones, are also preserved. The borings are occasionally filled by angular siliciclastic material with a carbonate matrix. A 20 cm thick bed of the same material, overlying the limestone, is developed in the southern part of the outcrop. The observed borings were determined as *Gastrochaenolites* isp. (small and large forms), *Gastrochaenolites lapidicus* Kelley & Bromley, 1984, *Circolites kotouzensis* Mikuláš, 1992 and *Ericichnus* cf. *bromleyi* Santos *et al.*, 2015. *Gastrochaenolites* isp. represent bivalve borings in a high energy shallow marine environment. *Circolites* isp. and *Ericichnus* isp. are borings associated with sea urchins. They used these structures for protection and as a space for gardening. The succession of colonisation is assumed as: large *Gastrochaenolites* isp. → *Circolites kotouzensis* + *Ericichnus* cf. *bromleyi* → small *Gastrochaenolites* isp. → sedimentation of conglomerate with a calcareous matrix.

The studied locality represents a multistage development of hardground communities of boring bivalves and sea urchins with the new locality of *Ericichnus* cf. *bromleyi*.

Non-calcareous dinoflagellate cysts from the Cretaceous–Palaeogene boundary interval, Subsilesian unit (Outer Western Carpathians, Czech Republic)

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The Subsilesian unit of northern Moravia comprises strata ranging from the Late Cretaceous (Turonian–Maastrichtian) to the early Miocene (Egerian) in age. They are sub-divided into the Frýdek, Frýdlant, Menilitic and Ždánice–Hustopeče formations. The Turonian to Palaeocene Frýdek Formation is the oldest formation, about 500 m thick, comprising a monotonous succession of grey laminated silty shales and siltstones. Turbiditic sandstones and slump bodies of conglomerates with coral fragments were observed in this unit. The overlying 800 m thick Frýdlant Formation, i.e. the “Submenilitic Formation”, is lithologically more diverse. The unit includes three distinct facies: anoxic facies of dark-grey shales, prevailing in the late Palaeocene; variegated facies of grey, green and red shales, dominating in the late Eocene; and transitional facies of spotted grey, green, and red shales (spotted facies).

Maastrichtian palynofacies are characterised by abundant sedimentary organic materials, dominated by phytoclasts and a very small percentage of AOM. The studied succession contains also a low percentage of dinoflagellate cysts and a very low percentage of spores and pollen grains.

Assemblages in many samples are rich in species such as *Achomosphaera triangulata*, *Cerodinium diebelii*, *Cleistosphaeridium cassospinum*, *Heterosphaeridium* sp., *Isabelidinium cooksoniae*, *Palaeocystodinium golzowense*, *Palaeohystrichophora infusorioides*, *Palaeoperidinium pyrophorum*, *Spiniferites septatus*, *Stephodinium* sp., *Subtilisphaera cassospinum* and *Systematophora* sp.

Chorate taxa, e.g. *Dapsilidinium*, *Homotryblium*, *Hystrichosphaeridium*, *Hystrichokolpoma*, and *Operculodinium*, dominate in the Palaeocene to Eocene assemblages. This suggests a neritic environment during sedimentation.

Assemblages with *Areoligera volata*, *Achomosphaera alcornu*, *Achomosphaera triangulata*, *Cleistosphaeridium insolitum*, *Deflandrea* sp., *Florentinia* sp., *Glaphyrocysta* sp., *Homotryblium abbreviatum*, *Kiokansium polypes*, *Operculodinium* sp., *Palaeocystodinium* sp., *Spinidinium densispinatum* and *Spiniferites pseudofurcatus* are typical for the Palaeocene.

Eocene assemblages are composed of *Adnatosphaeridium vittatum*, *Charlesdowniea crassiramosa*, *Homotryblium plectilum*, *H. tenuispinosum*, *Hystrichokolpoma fenestratum*, *Hystrichosphaeridium tubiferum*, *Kleithriasphaeridium* sp., *Operculodinium echigoense*, *O. divergens*, *O. microtriainum*, *O. triara*, *Palaeocystodinium bulliforme*, *Senoniasphaera inornata*, *Thalassiphora patula*, *Wetzeliella gochtii* and *W. meckefeldensis*.

Middle Miocene sedimentary sequence of the Voronyaky Hills (western Ukraine, Paratethys)

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Since the 19th century the middle Miocene sands of the Voronyaky Hills (forming the NW border of the Podolia Upland) have been famous for their fossil content. Diverse and well preserved molluscan fauna from Olesko–Biała Góra, Podhorce, Jasionów and Hołubica housed in many European museums led to numerous taxonomic studies. However, no detailed facies investigation, stratigraphic and taphonomic studies were carried out.

Therefore in 2018 we undertook field work with the prime aim of identifying the precise location of these fossiliferous sites, describing their lithology and sedimentary structures, recognising the taphonomy of the shelly assemblages and collecting samples for petrographic and biostratigraphic studies.

Several isolated occurrences of the middle Miocene were examined but our efforts were concentrated mainly on a small sandpit located at Bila Mt. (*Biała Góra*), 3 km to the east of Oles'ko town (49°57'11.4"N, 24°56' 48.3"E) and a natural outcrop observed along a cut of a dirt road, 3 km to the south of Yaseniv village (*Jasionów*, 49°57' 10.9"N, 25°03'05.6"E).

The first section, with an obscure base, attains a thickness of 4.0 m. The fine-grained quartz sands are very rich in molluscs, bivalves in particular. Twenty layers were discriminated based on lithology, sedimentary structures, bioturbations and macrofossil content. Nine samples for the investigation of planktonic foraminifera and calcareous nannoplankton were taken from approximately 0.4 m intervals. The second section has a thickness of 6.0 m. Coralline algal limestones and marls directly overlying there Upper Cretaceous marls were also investigated according to the presented procedure; however, the taxonomic diversity of the bivalves preserved mostly as composite moulds is much poorer.

Altogether about 12 m of both sandy sediments and carbonate deposits have been studied for palaeoenvironmental reconstruction. The contact of sands and overlying marls is still observed in the large abandoned Voluiky quarry (49°56'05.1"N, 24°52'30.2"E).

Acknowledgements. This is a contribution to the Polish–Ukrainian joint exchange project no. 40 for the years 2018–2020 under the agreement on scientific cooperation between the Polish Academy of Sciences and the National Academy of Sciences of Ukraine.

Calcareous nannofossils as a tool for the biostratigraphic correlation of selected Upper Jurassic – Lower Cretaceous sequences of the Tethyan area

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The Jurassic/Cretaceous (J/K) boundary is the last boundary between two stratigraphic systems, which has not yet been conclusively defined by the International Commission on Stratigraphy.

Determining the Global Boundary Stratotype Section and Point (GSSP) for the Berriasian Stage in the Tethys area has been the objective of elaborate research and discussions of the Berriasian Working Group during the past several years. Tethys was the largest depositional area during the Tithonian and Berriasian times that is available for study by diverse stratigraphic methods, i.e. lithostratigraphy, biostratigraphy (based on calpionellids, calcareous nannofossils, dinoflagellate cysts, radiolarians, foraminifers, ammonites and belemnites), as well as magnetostratigraphy, geochemistry and sequence stratigraphy.

In 2016, the base of the Alpina Subzone was chosen as the most consistent marker for the base of the Berriasian. This horizon shows a well-documented turnover of calpionellid taxa, which is a biotic event that has the widest geographical distribution in the J/K boundary interval.

Biostratigraphic analysis based on calcareous nannofossils within the J/K boundary interval contributes to an essential part of this multidisciplinary research. A remarkable radiation of the most important group – nannoconids – during this time period significantly increases their biostratigraphic value and rock-forming potential.

Calcareous nannofossils are excellent biostratigraphic markers that play a key role in the correlation of the J/K boundary interval deposits in the Tethyan area. Moreover, correlation of the results in various localities across the Tethyan area is important for palaeoecologic and palaeoceanographic interpretations. Currently, we have finished a detailed study of a number of important localities and possible GSSP candidates: Kurovice (Czech Republic), Drôme and Haute Alpes plexus of sites: Font de St Bertrand, Haute Beaume, Charens and Tré Maroua (France), and Fiume Bosso (Italy).

Acknowledgements. The research is financially supported by IGCP Project 679 and by the Sepkoski Grant, and is in accordance with research plan no. RVO67985831.

Trace fossils preserved on Upper Devonian vertebrate remains from the Holy Cross Mountains, Poland

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Among the hundreds of collected Devonian vertebrate macrofossils in the Holy Cross Mountains, placoderms dominate and provide data on their morphology, distribution and taphonomy. New studies are also focused on sarcopterygians and chondrichthyans. Seventeen out of more than 500 studied specimens have revealed bones with surfaces covered by sediment-infilled trace fossils. The traces must have been made on the vertebrate remains before their final burial. The burrows, oval in cross-section, include dendroidal networks of shallow tunnels on the bone surface. Their width varies from 0.4 mm to 1 mm and the length ranges from a few millimetres to 2 cm. They are branched and there is no reduction of diameter at the ramifications. The burrows are present on both sides of the bones: visceral and external. Their form suggests a bioerosional origin of all structures. The morphology, dimensions and development were studied and different ichnotaxa were taken into consideration. The most plausible are *Arachnostega* and/or *Talpina*. Such trace fossils were never identified on vertebrate carcasses and may represent a new ichnotaxon. Previous cases were described exclusively on invertebrate remains and carbonates. In the studied collection one tooth reveals microburrows, which probably represent *Mycelites* isp. However, precise specific identification requires additional research.

The presence of such trace fossils in the Upper Devonian (Famennian) of the Holy Cross Mountains may have impact on further interpretations of sea-floor productivity.

Fossil molluscs from a new Miocene locality at Borač-Podolí, Moravia, Czech Republic, and their palaeoecology

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The new locality is situated in the Borač-Podolí village in southern Moravia, Czech Republic, near the Borač faciostratotype locality (Badenian–Moravian). It was uncovered in 2015 by a 2 m deep dug hole. Badenian deposits represented by five beds of green-grey calcareous clays alternating with five beds of yellow-brown, fine-grained quartz sands were recognised in the succession. The sands yielded a rich fossil community of molluscs, corals, and other fauna. In the last few years, coral fauna and ichnofossils were studied. The mollusc fauna (1,010 individuals) is represented by 80 gastropod species and 20 bivalve species. The most abundant gastropod representatives (more than 10 individuals) are of the species *Bittium reticulatum*, *Bittium spina*, *Nassarius badensis*, *Turritella (Zaria) spirata*, *Turritella (Archimediella) erronea*, *Turritella (Archimediella) dertonensis dertonensis*, *Alvania (Alvania) ampulla*, *Hipponix sulcatus*, *Hipponix phlebsi*, *Tricolia (Tricolia) eichwaldi*, *Euspira helicina*, *Rissoina podolica* and *Nassarius spectabilis*. Among bivalves, the prevailing species are *Chama gryphoides* and *Corbula gibba*. Small mollusc fauna is generally well-preserved, whereas larger shells often manifest damaged apertures and spires, and carry signs of abrasion or ichnofossils on their surfaces. Such damage probably indicates longer exposure on/near the bottom surface in a dynamic environment. The bottom was represented by a solid substrate (mostly rocks, fragments of rocks or shells), as well as by a soft substrate consisting predominantly of fine-grained sand. Some species indicate the presence of abundant algae and/or sea grasses. The sea had a normal salinity, it was well aerated and lighted, and with high temperature likely exceeding 20 °C. The water depth was probably within the range of the intertidal to infralittoral zone. Subsequently, the fauna was redeposited from this environment to larger depths.

Rare Lower Cretaceous ammonites from the Butkov Quarry (central Western Carpathians, Slovakia)

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The Butkov Quarry located close to the Ladce municipality belongs to the Manín Unit of the Central Western Carpathians. The exploited pelagic marly limestones are famous for the wealth of fossils, above all cephalopods. A small portion of older collections and our new collections have not been studied yet. This contribution deals with unpublished, usually only sporadic species of Early Cretaceous ammonites from the Butkov Quarry and other localities in the Western Carpathians.

Fossiliferous Lower Cretaceous deposits range from near the base of the Valanginian to the top of the upper Barremian. The oldest sporadic finds representing *Olcostephanus drumensis* come from the base of the Ladce Formation in a section close to the sanctuary. A richer ammonite association is present in the upper part of the Ladce Formation. From among the so far undescribed early Valanginian ammonites, *Vergolicerias salinarium* and *Neocomites neocomiensis* should be mentioned.

The varied spectrum of late Valanginian ammonites includes *Bochianites neocomiensis*, representatives of the genera *Criosarasinella* and *Olcostephanus* and, close to the Valanginian/Hauterivian boundary, representatives of *Teschenites*. The association around the studied boundary interval is accompanied by *Jeanthieuloyites keyserlingiformis*, *Spitidiscus rossfeldensis*, *Crioceratites primitivus* and *C. coniferus*.

In the early Hauterivian, *Olcostephanus hispanicus* and *Lyticoceras nodosoplicatum* occur rarely. *Subsaynella mimica* is present near the base of the late Hauterivian. In the late Hauterivian, the index species *Plesiospitidiscus ligatus* predominates; it is accompanied by *P. cf. canalis*, *Euptychoceras meyrati*, *E. subundulatum*, *Binelliceras binelli* and *Discoidellia mariolae*.

The ammonite spectrum in the Butkov Quarry is similar in composition to the Early Cretaceous ammonites from the Vocontian Trough in France.

Coniacian inoceramid diversification: evolutionary acceleration driven by palaeoenvironmental instability?

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The Inoceramidae underwent a considerable taxonomic diversification during the latest Turonian through Coniacian, characterised by the rapid proliferation of short-lived inoceramid genera and one of the highest (sub)stage-level diversities in the Late Cretaceous history of this group. However, despite an apparent explosion of generic and species diversity, standing inoceramid diversity reached a Late Cretaceous nadir in the Turonian–Coniacian boundary interval. Successive evolutionary assemblages were nearly annihilated during transitory intervals and *Didymotis* bioevents.

In this framework, the dynamic turnover and diversification of Coniacian inoceramids is often, albeit not exclusively, coincident with carbon cycle fluctuations. The question is raised, therefore, if the rapid evolution and turnover of the Coniacian Inoceramidae was potentially driven by sustained palaeoenvironmental instability. To examine this, we conducted a joint palaeontological–geochemical review on three critical turnovers in the Coniacian inoceramid fauna:

(1) The rapid taxonomic turnover from the late Turonian *Mytiloides*-dominated fauna to the latest Turonian to early Coniacian *Cremnoceramus*-dominated fauna occurs penecontemporaneous with the Navigation Event, a globally recognised c. -1‰ $\delta^{13}\text{C}_{\text{carb}}$ excursion. It is of particular interest that the peak Navigation negative excursion coincides with the *Didymotis* II Bioevent, which promptly follows the first appearance of the genus *Cremnoceramus*, and with a major transgression recognised across the entire Euramerican region.

(2) The demise of *Cremnoceramus* and the short-lived dominance of the poorly-known and recognised *Inoceramus gibbous* fauna coincide with a widespread regression/unconformity across the majority of Euramerica. Unfortunately, geochemical data across this interval are rather scarce, hampering the quality of our assessment.

(3) The emergence and diversification of the genus *Platyceramus* occurs slightly before the prolonged onset of Ocean Anoxic Event 3. In the Western Interior, trace metal and phosphorus geochemistry indicate that this interval was broadly characterised by intermittent euxinia and elevated nutrient availability, suggesting that their success may perhaps be related to some degree of dysoxia tolerance.

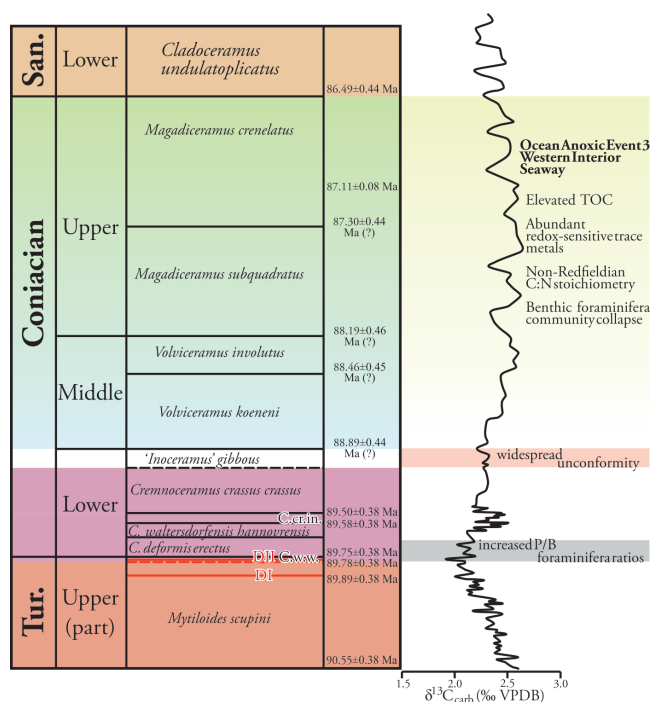


Fig. 1. Inoceramid biostratigraphy, geochronology, and carbon isotope chemostratigraphy of the Coniacian, with major biological, geologic, and geochemical events noted. Colours on the stratigraphic tables correspond to major inoceramid assemblages. Abbreviations: D I – *Didymotis* I event, D II – *Didymotis* II event, C. w. w. – *Cremnoceramus waltersdorfensis waltersdorfensis*, C. cr. in. – *Cremnoceramus crassus inconstans*, Tur. – Turonian, San. – Santonian

Foraminifera from the Furoid Marls of the Ropianka Formation in the Skole Nappe, Outer Carpathians, Poland

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Foraminifera from the Kropivnik Marl in the Ropianka Formation were examined in exposures near Błazowa. The marls are turbiditic in origin and were deposited in the inner part of the basin. The Kropivnik Marl comprises marly and muddy shales, sandstones, and marls in different proportions. About 16% of the studied section is represented by marly-sandy facies dominated by marls and calcareous shales. The occurrence of hard platy marls with trace fossils informally known as “fucoids” is typical. Their frequency is variable, but usually does not exceed 25% of the thickness of a single section. Hard platy marls are in fact marls or clayey marls, with horizons of both T_C and T_{E-1} lamination constituting carbonate-siliciclastic marly siltstones.

Foraminifera are common in the hard platy marls, especially in intervals enriched in siliciclastic grains. Generally, thin, fragmented calcareous tests of planktonic foraminifera are present. Complete foraminiferal tests are much rarer and include *Macroglobigerinelloides* cf. *bollii*, *Globigerinelloides prairiehillensis*, *Planoheterohelix globulosa*, *Muricohedbergella holmdelensis* and *Globortuncanella havanensis*. Other calcareous foraminifera are very rare and belong to much larger benthic forms, mostly *Nodosariinae*.

Foraminiferal plankton in the hard platy marls is represented by fragile biserial, planispiral or low-trochospiral forms only; no keeled forms were found. In the Late Cretaceous such planktonic assemblages occupied inner neritic waters, not deeper than a few metres. Such environment was the source area for sediments transported into inner parts of the basin by turbiditic currents. The redeposited material may be older or of the same age as the hosting deposits. The state of test preservation points to a more or less isochronous age. Very thin and fragile foraminiferal tests were probably redeposited from loose, unconsolidated shelf deposits. Planktonic foraminifera present in the hard platy marls indicate the lower part of the *Gansserina gansseri* Zone and a latest Campanian–early Maastrichtian age for the Kropivnik Marl.

Acknowledgements. This research have been financially supported by grant no. 16.16.140.315 from KGOiG WGGiOŚ AGH.

Morphotypes of epilithic deep-water foraminifera from the middle Pleistocene of the Arctic Ocean

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Mid-Pleistocene deep-sea muds recovered from the Lomonosov Ridge yield an assemblage of agglutinated foraminifera with a significant number and diversity of attached (epilithic) forms. These foraminifera colonised larger (ice-rafted) grains that are found on the Central Arctic sea floor. Following detailed observations, 12 morphotypes of epilithic foraminifera could be distinguished. All recovered individuals belong to monothalamous or simple pseudomultichambered and multichambered forms. Based on morphology and life habitats, they are assigned to: *Rhizammina*, *Hemisphaerammina*, *Ammophemphix*, *Diffusilina*, *Iridia*, *Subreophax*, *Placopsilina*, *Placopsilinella*, *Hormosinelloides* and *Tholosina*, and mat-like and ribbon-like forms of uncertain taxonomic affinity.

The preferred microhabitats for epilithic foraminifera depend on the dimensions of the attached species and the availability of appropriate pre-existing structures on the substrate. We differentiate “internally epilithic” species from “externally epilithic” forms. The majority of large hemispherical forms are externally epilithic – they sit on the exposed substrate surface and their tests form elevations on that surface. We distinguish high hemispheres, with globular or hemispherical shapes that are in contact with the substrate at the periphery of their tests (e.g. *Hemisphaerammina*, *Tholosina*). A second group of externally epilithic forms are the flattened forms that only form low elevations on the substrate. In our material these comprise meandering tubes, and uniserial to multiserial pseudomultichambered or multichambered forms (type A, B), and elongated forms that create an irregular mat, e.g. *Iridia* (type C). Flattened meandering forms are represented by ribbon-like tubular forms such as *Rhizammina*-like types, while serial forms include *Placopsilina*, *Placopsilinella*, *Hormosinelloides*-like and *Subreophax*-like forms.

Internally epilithic forms settle on naturally-occurring dimples, depressions and caverns on the substrate surface. These small forms prefer caverns or depressions, but may also outgrow their chosen space and exit their little cave. These include forms that build a flat roof over their cavern, e.g. *Diffusilina*-type forms, as well as *Ammophemphix* pseudocolonies.

MORPHOTYPE				GENUS
EXTERNALLY EPILITHIC	CONVEX			<i>Hemisphaerammina</i> <i>Tholosina</i>
	A			<i>Rhizammina</i>
	B			<i>Hormosinelloides</i> <i>Subreophax</i> <i>Placopsilina</i> <i>Placopsilinella</i>
	C			<i>Iridia</i> mat- and ribbon-like
INTERNALLY EPILITHIC	CONVEX			<i>Ammophemphix</i>
	FLAT			<i>Diffusilina</i>

Fig. 1. Morphotypes of epilithic deep-water foraminifera (Pleistocene, Arctic Ocean).

Acknowledgements. This research was financed by the research funds of the KGOiG WGGiOŚ AGH no. 16.16.140.315. Participation in the PS87 (ALEX) expedition was supported by the Dean of the Science Faculty at KFUPM.

Bryozoans and brachiopods from the lower Miocene deposits of the Qom Formation in north-east Isfahan, central Iran

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Bryozoans and brachiopods are commonly found as fossils in the Cenozoic deposits of Europe, but they are still poorly known from Iran. So far, fossil bryozoans have been recorded in Iran only from the Abadeh section, encrusting larger benthic foraminifera, and from the Dizlu and Bagh sections, while brachiopods have been only mentioned from the Bagh section of the Qom Formation. The Oligo–Miocene deposits of the Qom Formation developed in the south-eastern margin of the Western Tethys Region. They are represented by marls and marly to sandy limestones. During the Oligocene–early Miocene the investigated area was a part of the Mediterranean–Iranian Province within the Western Tethys Region that comprised also the Eastern Atlantic Province in the west.

We report here a new early Miocene fauna of bryozoans and brachiopods collected from three sections: Varton, Zefreh and Kuh-e-Charkheh of the Qom Formation in the Esfahan–Sirjan Basin. The bryozoans comprise nine cyclostomatous and 21 cheilostomatous taxa, including one new species of the genus *Gigantopora*. Among cheilostomates, *Margaretta cereoides* and encrusting species are dominant. The brachiopods are represented by six species, all reported for the first time from Iran. Megathyridids (*Megathiris*, *Argyrotheca*, *Joania*) and *Lacazella mediterranea* dominate in the studied assemblage. In taxonomic composition the fauna displays affinities to the late Oligocene and Miocene faunas from the Mediterranean and Paratethys. Both bryozoans and brachiopods indicate a warm, shallow water environment.

An exceptionally preserved fossil assemblage from the Terreneuvian (Cambrian) of the Holy Cross Mountains, Poland

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Mudstones and siltstones of the Czarna Shale Formation in the southernmost part of the Palaeozoic of the Holy Cross Mountains, central Poland, have long been considered to yield low-diversity and low-abundance fossil assemblages dominated by vendotaenid algae and hyoliths, with an imprecise age in the basal Cambrian. Based on acritarch assemblages, deposits of the Czarna Formation from exposures around Kotuszów village are now referred to the *Skiagia ornata* – *Fimbriaglomerella membranacea* microfossil zone corresponding to the middle Terreneuvian Series. Therefore, they represent the oldest precisely documented rocks exposed in Poland and some of the oldest Cambrian strata exposed in Europe.

The macrofossil assemblage studied has a slightly higher diversity and abundance than previously considered. It comprises fossils of skeletonised taxa, including the most abundant hyoliths (2 taxa), protomonaxoniid sponges (5 taxa), bradoriids, annelids and other tube-shaped fossils, and a single anomalocaridiid fragment. The alleged vendotaenids are elongated objects, up to 10 mm wide, composed of carbonaceous flakes 1 to 4 mm long; they are now interpreted as compacted faecal pellets filling the burrows of unknown animals.

The fossils usually bear very weak or even no displacement traces caused by bottom currents and/or predation. The fossil-bearing mudstones and siltstones were generally deposited from suspended sediment below storm wave base. This quiet sedimentation was occasionally interrupted by higher-energy, storm-related depositional events. In SEM, all fossils are preferentially covered with pseudomorphs after framboidal pyrite (a few to 20 μm in diameter).

The domination of benthic fauna, periodical acritarch blooms, shallow horizontal ichnofossils, and layers of framboidal pyrite pseudomorphs indicate oxygenated conditions in the water column and on the sea bottom. Localised, oxygen-depleted microenvironments must have developed directly beneath the water/sediment interface, associated with the colonisation of buried organic remains by sulphate-reducing bacteria. These microenvironments favoured the preservation of various organic remains.



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ISBN: 978-83-945216-9-1