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From Early Life to the Neandertals

Editors: Silvia Kolomaznik, Peter Frenzel, Rebecca Lellau, Anna Pint, Ella Quante, Deon J. Janse van Rensburg, Olga Schmitz

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Vom frühen Leben zum Neandertaler/From Early Life to the Neandertals

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Keynote Speaker

Talk: Countering biases in the fossil record by incorporating Konservat-Lagerstätten

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Roughly 60% of animals are soft-bodied and rarely fossilized. However, knowledge of their first appearance and early evolution is critical to understanding the diversification of animal life in the Earth's early oceans. Konservat-Lagerstätten, characterized by exceptional preservation, are rarely unique. New discoveries often extend classic examples to multiple localities – the Burgess Shale of British Columbia is an obvious example. Research on mechanisms of fossilization can provide a basis for identifying geochemical markers that have the potential to aid in the search for further examples. These signatures include minerals that play a role in limiting decay and facilitating fossilization of non-biomineralized materials. Experiments on inhibiting decay processes remain an important tool in understanding such processes. In the meantime novel techniques applied to classic collections, together with newly discovered unusually preserved fossil specimens, are revealing anatomical details long considered out of reach. These three complementary approaches, experiments, specimen analyses and field exploration, are a powerful strategy for filling gaps in our knowledge of the history of life.

Tilly-Edinger-Symposium

Talk: Decoding Deep-time Biodiversity: Environmental, Physical, and Historical Drivers of Biodiversity in the Fossil Record

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The fossil record is central to our understanding of species' long-term responses to environmental crises and climate change. Yet, deciphering 'true' patterns of biodiversity and evolutionary change in the fossil record can be challenging due to fossil record biases. These biases stem from various interconnected factors, such as fossil preservation, geological processes, heterogeneous fossil sampling, varying methodological approaches, and anthropogenic biases.

This presentation will focus on terrestrial vertebrate species biodiversity during the late Paleozoic–Mesozoic, beginning with the impact of the rainforest collapse on the first terrestrial tetrapod communities and ending with the influence of climate change on the ecological ascendency of the dinosaurs. Deeper insights into these, and other, key events in the history of vertebrate evolution have been made possible by cutting edge 'Big Data' approaches and a novel integration of methods from paleobiology, ecology, paleoclimatology, and data science.

The focus will then extend to an exploration of the various fossil record biases impacting estimates of biodiversity, as well as the various ways paleobiologists are working to mitigate these biases. These include not only statistical and modelling approaches, but also community-led initiatives that are interrogating paleontology's history and paving the way for a more equitable, sustainable, and diverse future.

Talk: The evolution of insect lifestyles - Reconstructing behavioral aspects based on fossils

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Insects today comprise about 60 % of all described species. Due to their enormous number of individuals and biomass, they have a crucial impact on all ecosystems and are an essential part of food webs, both as prey and predators. Insects today are not only highly diverse in morphology, they also possess an extremely wide range of life styles and strategies concerning, e.g., reproductive strategies, raptorial or predator-avoiding strategies and several degrees of aggregational or social behavior. The evolution of these strategies in insects are only partly understood. This topic is recognized with growing attention and thus subject of many investigations, mainly based on extant species. However, by including fossils in the investigations allows for gaining crucial knowledge about the evolutionary changes of lifestyles and strategies in deep time and are indispensable for the reconstruction for the origin of certain key features.

The investigation of behavioral aspects based on fossils is challenging, as behavior cannot be observed directly. However, several approaches can be used to reconstruct aspects of behavior. Most important are implications based on the morphology in comparison with extant groups, where behavior is observable. Therefore, a detailed documentation with different imaging methods of fossil and extant animals is crucial. Further important aspects are, e.g., the phylogenetic position, fossilization of several individuals together (fossilized groups) and cases of the so called 'frozen behavior'.

Within this talk, I will give an overview of the several approaches I used and will show results of reconstructions regarding reproductive strategies, aggregational behavior, specializations to raptorial lifestyles and defensive strategies within insects. As example, I will focus on results regarding the insect group Dictyoptera. Today, Dictyoptera contains the group of praying mantises (Mantodea) and the group of cockroaches and termites (Blattodea) and are nearly worldwide distributed.

The overall project including the presented results aims at contributing to a better understanding of evolutionary changes of lifestyles and strategies, phylogenetic implications and the ecological impact of insect groups, food webs and their changes over time.

Talk: Paleoecosystem research: a modern approach to decipher "lost worlds" in deep time, with case studies from the late Paleozoic

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Fossil terrestrial ecosystems provide intriguing insights to ancient biota and their interactions with the physical environment. They are basically characterized by covering a geologically short time interval ranging from weeks or months to 10^5 years, a locally restricted (paleo-)geographic area, and a steady general environmental setting (e.g., alluvial plain, swamp, lake, fluvial system). For understanding interactive processes between geosphere, atmosphere, hydrosphere, and biosphere in deep-time ecosystems, a multi-disciplinary research strategy is mandatory. Paleoecosystem research therefore

unites various geoscientific disciplines, such as sedimentology, geochemistry, geophysics, mineralogy, all contributing to a central paleontological issue.

Here, I present two case studies regarded from a paleobotanical perspective, mainly dealing with the reconstruction of vegetated habitats of the late Paleozoic, both located in post-Variscan intramontane basins of Germany. Major emphasis is dedicated to the early Permian autochthonous flora of the Chemnitz Fossil Forest that has been buried by volcanic ash of a nearby Plinian style eruption, and thus represents a snapshot of an alluvial-plain forested landscape. The 291 ± 2 Ma old ecosystem was growing on a wet locality, but was influenced by a seasonally-dry paleoclimate. Woody plants were reacting on these conditions by forming seasonal growth rings, which provide insights to the last 80 years of the ecosystem before it was buried. These include plant-group-specific growth ring formation, severe individual growth disturbances and a super-ordinated 10.6-yr cyclic growth pattern. The nearly completely preserved fossil plants, e.g., of medullosan seed ferns, are aimed to be used as environmental markers by modelling their physiological adaptations to better constrain the hydrological conditions in the ecosystem. A taxonomic revision of existing fossil taxa of seed plants and first description of new fossil taxa, such as one of the oldest-known cycads, contribute to a better understanding of the true floral diversity of this specific habitat, but also of early Permian wetland habitats, in general.

The second case study reveals preliminary insights to paleoecosystem research in the Thuringian Forest Basin, the Bromacker ecosystem that is recently excavated and studied in a joint project of several institutions. In contrast to the Chemnitz Fossil Forest, the Bromacker ecosystem reflects a longer period of dynamic sedimentation in a proximal fluvial setting. Vegetation is rarely preserved but leaves allochthonous and autochthonous traces that point to a sparsely and less diverse vegetated landscape, supposedly due to dominating dry conditions.

In conclusion, both ecosystems are of widely similar stratigraphic age, but reveal major differences concerning taphonomy, environmental conditions, and vegetation composition. Therefore, together they reflect the heterogenic landscape patterns of seasonally-dry intramontane basins during the lower Permian. Finally, each well-investigated ecosystem represents a single data point in the temporal framework of significant global change in the late Paleozoic world.

Talk: What is a “nautiloid” cephalopod? A modern perspective

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Cephalopod evolution is often summarized by a comparatively simple model: The modern *Nautilus* is cited as a living fossil that has remained relatively unchanged in the past 500 million years and from these “nautiloids”, other groups such as the ammonoids and coleoids (i.e., squid, cuttlefish and octopus) have evolved. A closer look at this model reveals that “nautiloids” represent a very heterogeneous, morphologically diverse group and that the early evolutionary history of cephalopods is more complex and, in many areas, poorly understood. In its classical definition, nautiloids include all cephalopods except for the ammonoids and coleoids. In other words, it includes the total group Nautilida (in the strict sense), as well as stem group Cephalopoda and stem group Coleoidea – in addition to many taxa where the phylogenetic position is highly uncertain. Under this concept, the group is not only paraphyletic, but also contains a mix of crown and stem group taxa. Here, I present an overview of some of the research I have been carrying out in the last couple of years, while also outlining possible future directions. The central theme of the talk is to provide a better idea of what

actually constitutes a “nautiloid” from a modern phylogenetic perspective, but also in terms of anatomy and paleoecology. This includes the term “nautiloid” itself and why it is problematic and what are possible alternatives. I show examples from the Cambrian to the Devonian and how different methods can provide new insights into this classical, though somewhat neglected topic in Paleontology.

Talk: Resurrecting the extinct: dinosaur skulls and their implications for paleobiology

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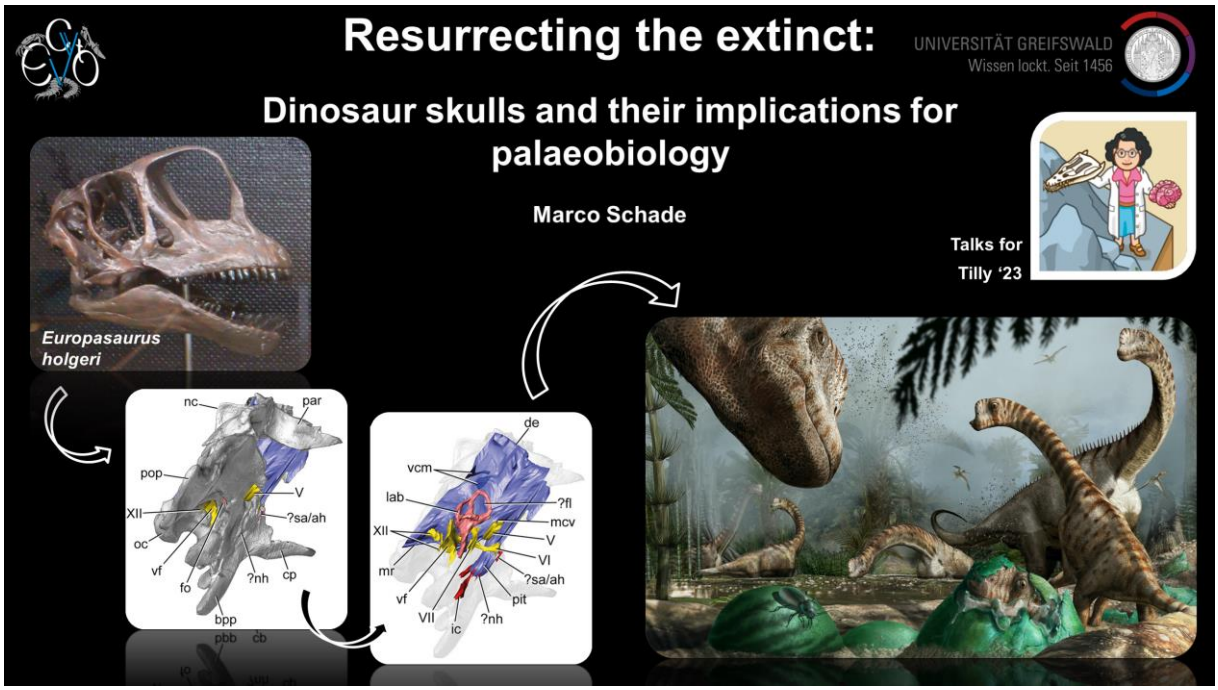

(Neuro)anatomy of non-avian dinosaurs, exemplified by the Jurassic sauropod Europasaurus, investigated by modern techniques, including µCT, provides insights into paleobiology. (pictorial sources: Schade et al. 2022; Davide Bonadonna; Christoph Hoppenbrock)

The skull is an extremely informative part of the vertebrate body. Skulls are involved to hunt, feed and drink, to nurse, fight, dig, and to many other activities. Also, main sensory organs are situated on the head in order to enable a given animal to see, smell, taste, feel, listen, equilibrate and think; hence, the head is the main connection to the external world. It follows that a skull, with and without soft tissue, can tell a lot about its owner; a plain fact that already led scientists of the past centuries, like Franz von Nopcsa and Johanna “Tilly” Edinger, to comparative and actualistic considerations about brain evolution in extinct and extant taxa.

Each skull consists of many individual bones constituting regions (e.g., the snout and braincase) that represent different aspects of an anatomical mosaic, which in turn allows deeper (paleo)biological insights. For example, the size, morphology and orientation of certain cavities inside the braincase (e.g., the endosseous labyrinth or inner ear) can deliver manifold implications including potential sensory capacities (smell, equilibration, audition, etc.), head posture or physiological (blood supply and thermoregulation) and ontogenetic affinities. Additional aspects of fossil skulls potentially reveal hints for foraging, food preferences (e.g., through tooth replacement and jaw biomechanics) or niche partitioning, and add to our knowledge about the evolution and phylogeny of the respective owner.

To further enlighten our understanding of paleoecological, physiological and phylogenetic tendencies of dinosaurian representatives with disparate spatiotemporal backgrounds belonging to different groups, and in order to reveal new aspects on their (neuro)anatomy, behavior, ontogeny and evolution, a thorough examination with modern techniques is the aim of my research.

Reference:

Schade, M., Knötschke, N., Hörnig, M.K., Paetzel, C. & Stumpf, S. 2022. Neurovascular anatomy of dwarf dinosaur implies precociality in sauropods. *eLife* 11, e82190, https://doi.org/10.7554/eLife.82190

Talk: Was it humid, was it hot? Paleohistology reveals it *ad hoc*! – Unique climatic conditions during the Upper Triassic in Krasiejów (SE Poland) indicated by an uniform bone growth pattern

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Paleohistology, although a destructive method, is a powerful tool that sheds light on the paleobiology of long extinct animals and helps to reconstruct their mode of life, metabolic rate or even environmental conditions. The Upper Triassic Krasiejów locality is remarkable in terms of the quality and quantity of fossil finds that enable paleohistological studies. The taxonomic assemblage from Krasiejów consists of fossils of both, non-amniotes (temnospondyl amphibians: metoposaurids and cyclotosaurids) and amniotes (silesaurids, phytosaurs, aetosaurs, potential tanystropheid). The high fossil abundancy allows to perform analyses on long bones. Although there are many paleohistological studies on a global scale, so far there is no study that examines multiple taxa originating from one locality. Due to its fossil richness, Krasiejów offers an excellent opportunity to test whether and to what extent the external factors e.g., climatic and/or environmental conditions influence the phylogenetic precursor. Since the distribution of taxa during the Triassic was widespread, the growth of similar taxa but from different regions of the Pangea is very likely to be an useful source of information about the local conditions and its influence on the histological framework. Therefore, additional taxa (phytosaurs, aetosaurs, metoposaurids) from Germany and India were sampled and literature data (Austria, Argentina, USA, Morocco) was used for comparison.

In general, growth marks can be determined in form of zones, annuli and Lines of Arrested Growth (LAGs). Zones are correlatable with seasons of growth during a favorable season, annuli can be linked with seasons of slowed-down growth during an unfavorable season, while LAGs imply a complete cessation of growth.

Despite being phylogenetically distant, metoposaurids (*Metoposaurus krasiejowensis*) and cyclotosaurids (*Cyclotosaurus intermedius*) expressed a uniform growth pattern consisting of broad zones and rather thick annuli but lacking the deposition of LAGs. The Indian metoposaurid *Panthasaurus maleriensis* shows a very similar pattern to the Polish specimen, while the Moroccan metoposaurid *Dutuitosaurus ouazzoui* deposits thin zones and very pronounced LAGs, it has even been hypothesized that *Dutuitosaurus* LAGs might indicate hibernation to overcome the unfavorable season. The first-hand studied pseudosuchian long bones (humeri and femora) from Krasiejów, *Stagonolepis olenkae* and *Parasuchus* cf. *arenaceus*, again, being not closely related, express the same growth pattern, like the even more distant temnospondyls. It is remarkable that animals phylogenetically distant from each other and occupying different niches, but originating from the same geographic area, nevertheless express the same growth pattern and, above all, lack the deposition of LAGs. Moreover, the same animal groups e.g., aetosaurs from Poland and Germany vs. aetosaurs from

the USA and Argentina, show different growth strategies, with the former growing with an interrupted lamellar-zonal bone complex, while the latter deposits form an almost uninterrupted fibro-lamellar bone complex with the presence of LAGs.

After comparison to the same taxa, from equivalent stratigraphic period but from different geographical areas, a unique growth pattern can be observed for taxa excavated in Krasiejów, which furthermore sheds light on the special environmental conditions in Krasiejów during the Upper Triassic (Norian). Thus, paleohistology informs on the influence of external factors on bone growth e.g., climatic and/or environmental conditions to a much greater extent than previously assumed.

Talk: Anatomy, ontogeny, and ecology of Mesosauridae: what the first secondarily aquatic reptiles can tell us about amniote evolution.

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The enigmatic mesosaurs are the earliest known reptiles to return to the water 280 million years ago. Despite their temporal brevity and limited geographical distribution, mesosaurs provide invaluable insights into early amniote evolution and the secondary colonization of aquatic habitats. Here, I present a body of work from my doctoral dissertation and parallel projects that addresses aspects of the anatomy, ontogeny, and ecology of Mesosauridae and sheds light on early amniote evolution. This research focuses on topics as diverse as microanatomy, morphometrics, caudal autotomy, axial ossification, and biomechanics. Morphological and histological changes in mesosaurs as well as a changing environmental distribution of individuals throughout ontogeny suggests that mesosaurs underwent dietary and habitat change as they grew. Further research examines the presence of caudal fracture planes in the clade and proposes a more limb-driven locomotion than previously considered for mesosaurs. These results also suggest that caudal autotomy was ancestral to in a large radiation of reptiles, rather than a trait that evolved convergently in multiple lineages. Based on data from mesosaur specimens, I describe four fundamental axial developmental patterns in amniotes and reconstruct their ancestral condition in the clade. This analysis attests to the relative stability of these patterns throughout time, albeit noting a potentially influenced by regionalization. Finally, I present a model for undulatory ability of the vertebrate column in mesosaurs as well as other aquatic animals. Results reveal that the flexibility profile of an animal strongly correlates with the type of undulation used. The model suggests that the mesosaur swam like the modern marine iguana. Furthermore, this model has important implications for inferring swimming modes in fossil taxa. Collectively, these results advance the understanding of mesosaur paleontology and underscore this clade's importance in unraveling the evolutionary intricacies of early amniotes.

Talk: The Phylogeny of Rays and Skates (Chondrichthyes: Elasmobranchii) Based on Morphological Characters Revisited

Villalobos-Segura, E. *[1], Marramà, G. [2], Carnevale, G. [2], Claeson, K.M. [3], Underwood, C.J. [4], Naylor, G.J. P. [5], Kriwet, J. [1]
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Elasmobranchii are a relatively well-studied group. However, numerous phylogenetic uncertainties about their relationships remain un-answered. Recently, molecular analyses have shifted long-standing conceptions regarding their taxonomic and phylogenetic relationships. Here, we revisit the phylogenetic evidence based on a detailed morphological re-evaluation of all the major extant batomorph clades (skates and rays), including several holomorphic fossil taxa from the Mesozoic and Cenozoic, and an extensive outgroup sampling, which includes sharks, chimaeras, and several other fossil chondrichthyans. The parsimony and maximum-likelihood analyses found more resolved but contrasting topologies, with the Bayesian inference tree neither supporting nor disfavouring any of them. Whilst these analyses do not provide the ultimate truth regarding the phylogenetic relations of the batomorphs they represent an important steppingstone for future phylogenetic works involving elasmobranchs, batomorphs and morphological data. Overall, the analyses result in similar clade compositions and topologies, with the Jurassic batomorphs forming the sister clade to all the other batomorphs, whilst all the Cretaceous batomorphs are nested within the remaining main clades. The disparate arrangements on the deeper nodes recovered under the different criteria suggest that a detailed study of Jurassic taxa is of utmost importance to present a more consistent topology on those nodes, as issues continue to be present when comparing some clades recognized only by molecular analyses (e.g., Rhinopristiformes and Torpediniformes). However, the consistent placement of fossil taxa within specific groups by the different phylogenetic criteria is promising and indicates that the inclusion of more fossil taxa in the present matrix will likely not cause loss of resolution, therefore suggesting that a strong phylogenetic signal can be recovered from holomorphic fossil taxa. With a similar composition of the major clades between a time scaling analyses were carried out, with the objective of stablishing a possible divergence time for batoids groups.

Public Lecture

Talk: Of tracks, skeletons, and robots: multidisciplinary approaches to the reconstruction of a stem amniote's locomotion

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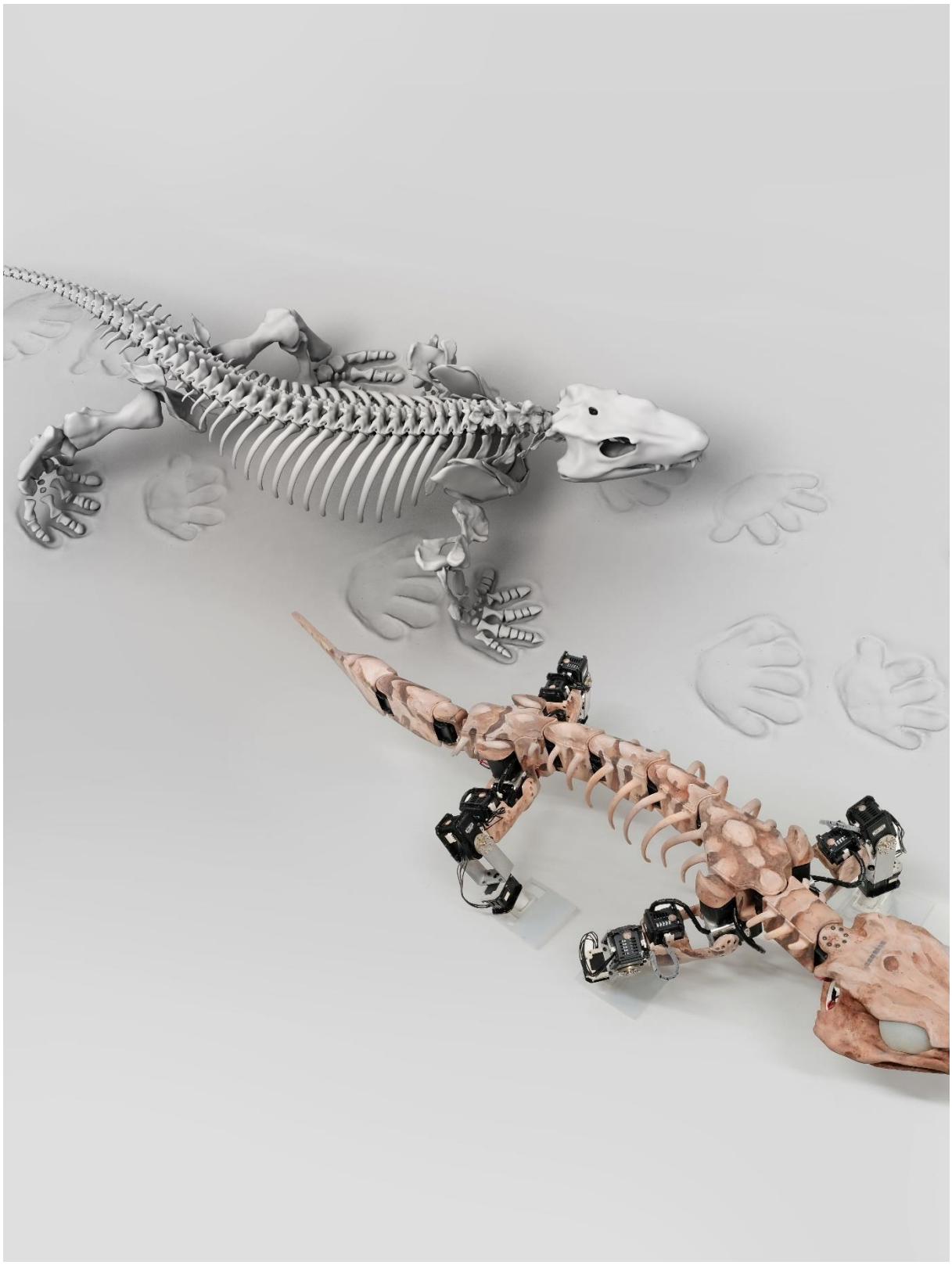
Reconstructing the locomotion of key vertebrate fossil specimens offers insights into their paleobiology and helps to conceptualize major transitions in vertebrate evolution. Estimating the locomotor behavior of a fossil species, however, remains a challenge because of the limited information preserved and the lack of a direct correspondence between form and function. *Orobates pabsti* from the Bromacker quarry in Thuringia, central Germany, is a representative of the diadectids, i.e., the likely fossil sister taxon to modern amniotes. Also, hundreds of tetrapod tracks have been recovered from the same site and some of these were assigned to *Orobates* as the trackmaker. This unique combination of an articulated nearly complete early tetrapod specimen and fossilized evidence of the same species' locomotor behavior was the starting point for an in-depth reconstruction of the locomotion. The reconstruction involved experimental as well as computer-aided modelling approaches ('virtual paleontology'). Starting from a large space of potential solutions, unlikely postures

and gaits were step-wise excluded based on quantitative data. Research into the fossil's anatomy, the fossil's potential joint mobility and simulated potential movements within fossil tracks, a comparative analysis of extant tetrapod locomotor biomechanics using x-ray motion analysis, and finally into a bio-inspired walking machine (OroBOT) will be summarized. The locomotor reconstruction demonstrates that *Orobates* exhibited more advanced locomotion than has been assumed for earlier tetrapods, which suggests that advanced terrestrial locomotion preceded the diversification of crown amniotes.



(S0) Free topics (Organization: Silvia Kolomaznik, Anna Pint, Peter Frenzel, Rebecca Lellau, Ella Quante, Deon J. Janse van Rensburg)

Talk: An acquired taste for blood: the early times of hematophagy in Diptera

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Originating around 250 Ma, by the end of the Permian or Early Triassic, flies (Diptera) underwent a remarkable radiation during the Mesozoic. Five of its six major lineages (often regarded as infraorders) have fossil representatives in deposits from the Late Triassic. While the oldest fossils only consist of isolated wings, well-preserved compressions of adult individuals are present in Late Carnian deposits (ca. 220 Ma). These already show diverse variation of mouthparts, including a long-proboscid culicomorphan (the group of midges, black flies, and mosquitoes), possibly hemolymph- or blood-feeding. Hematophagy in insects is usually hypothesized as having evolved from a prolonged association with vertebrates or derived from hemolymph-sucking or predatory habits. Some authors have also suggested a transition from nectarivory, exapted from previous specializations of piercing mouthparts. Further possibly blood-feeding culicomorphans, those representatives of the Chironomidae (non-biting midges), are recorded from Jurassic deposits. Finally, from the Cretaceous fauna, most notably specimens preserved in amber, a diverse array of hematophagous lineages of dipterans is represented, with exceptional evidence of hematophagous habits, including well-preserved blood cells and haemoparasites. Although this temporary ectoparasitic interaction (sometimes regarded as micropredation) between dipterans and vertebrates has strongly influenced the evolution of both groups, its origins are still poorly understood. A more focused investigation of the fossil record, as well as comparative morphological and phylogenetic studies, are necessary to elucidate such a complex and interesting evolutionary history.

Talk: Larval diversity of Neuropteriformia over geological time periods

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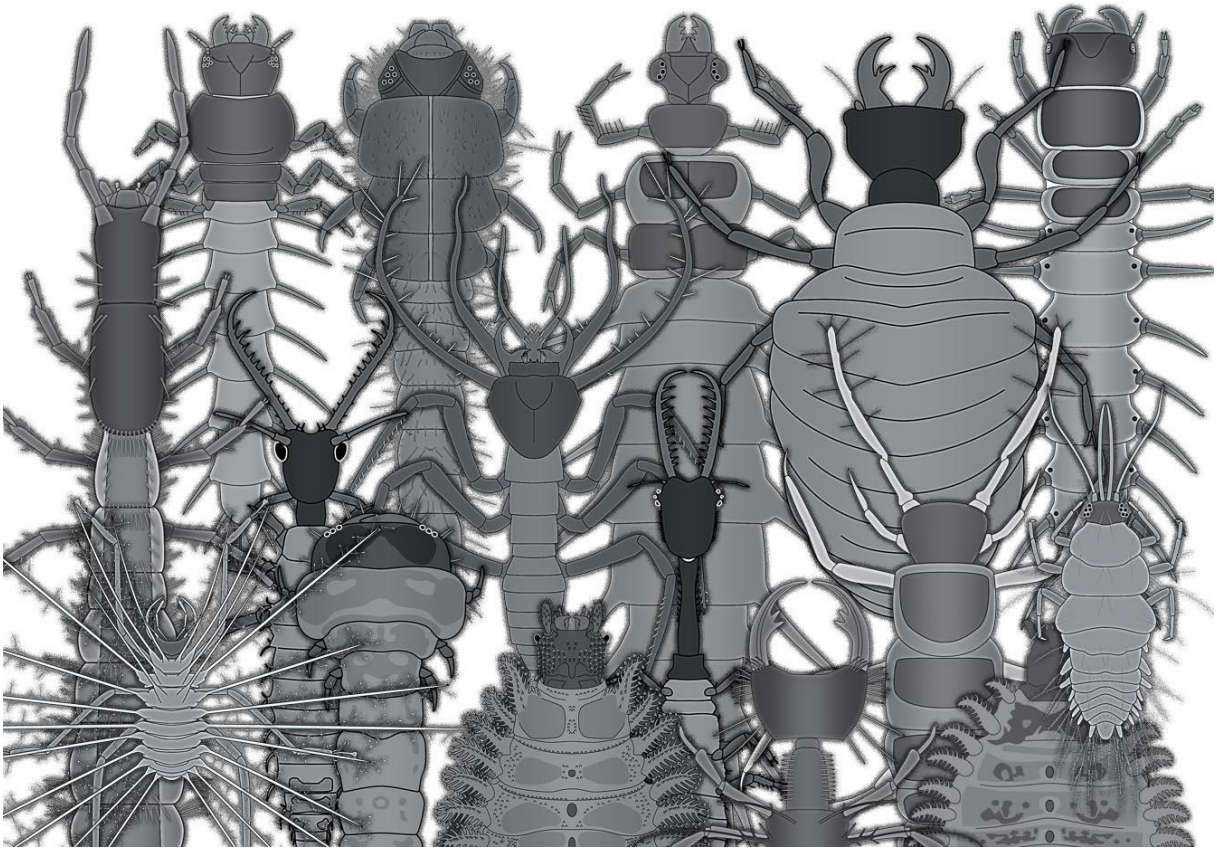
Since we face a human-induced decrease in biodiversity today, it is important to understand the evolution of diversity over time. Within Insecta, Neuropteriformia is an ingroup of Holometabola containing five larger ingroups: Strepsiptera (twisted wings), Coleoptera (beetles), Megaloptera (fishflies, alderflies, dobsonflies), Raphidioptera (snakeflies) and Neuroptera (lacewings). Especially the beetles are nowadays considered as one of the big four groups concerning biodiversity along with Lepidoptera, Hymenoptera and Diptera. In contrast, lacewings are considered as having been more diverse in the past. For many holometabolans, the larval phase occupies a larger share of the lifetime of an individual than the adult phase. Thus, larvae fulfil ecological functions for a longer time than adults and can hence be considered as playing an important role in the ecology. It seems therefore useful to investigate the diversity of larvae of Neuropteriformia over time. These larvae are relatively well represented in amber of different geological ages, which provides us with the unique opportunity to analyse diversity with a quantitative method. We performed a quantitative shape analysis of the

morphology of entire bodies, but also of ecologically important structures such as head and mandibles of specimens from amber of different ages and from the extant fauna. The total dataset included about 3000 specimens of neuropteriformian larvae. Some lineages declined in their morphological diversity over time, while others remained unchanged or even diversified, revealing a complex pattern of losses, replacements, but also stability. The method applied resolves details not accessible with classical taxonomic approaches.



Drawings of different neuropteriformian larvae.

Talk: Using Quantitative Morphology to Compare Adults and Larvae of Extant and Fossil Mantis Shrimps

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Mantis shrimps, representatives of the group Stomatopoda, are predatory marine eucrustaceans. They are most common in tropical to subtropical regions like Southeast to East Asia or Australia. They start their life as planktic larvae in pelagic habitats. As adults, they can be found in rock cavities, corals, or in self-built burrows in the mud after changing to a benthic lifestyle. Due to their complex behavior and their peculiar morphology and anatomy, mantis shrimps have received much attention in research, especially concerning their well-developed visual system or their raptorial appendages. Different other morphological features exhibit a high diversity, like the shield and the telson, which are thus often used for species differentiation based on the adult representatives. Consecutively, most research on mantis shrimp diversity has focused on adult representatives. Only a few prior studies have addressed larval representatives of mantis shrimps. In this study, we quantitatively analyzed three key features of

numerous mantis shrimp species, including telson, shield, and major raptorial appendage. The analyzed specimens comprised extant adults and larvae as well as those from the fossil record. Mantis shrimp larvae show a larger morphological diversity in the shield and the telson, most probably due to the relevance of these structures for surviving in the pelagic realm. In comparison, the adults display larger morphological diversity for the major raptorial appendages. Hence, ontogeny appears to have a strong influence on morphological diversity. The latter seems to be influenced by habitat shifts, both during individual development and over evolutionary time. The adult major raptorial appendages had a similar morphology during the Paleozoic as they have today. The adult morphology of the raptorial appendages from the Mesozoic resembles that of larval representatives today. The reason could be the external ecological changes during the Mesozoic era. Telsons changed from a slimmer triangle form during the Paleozoic to a broader square-shaped morphology today.

Talk: New sea urchins (Echinodermata: Echinoidea) from the Famennian of Velbert (W Germany): Evidence for echinoid faunal turnover in the Late Devonian

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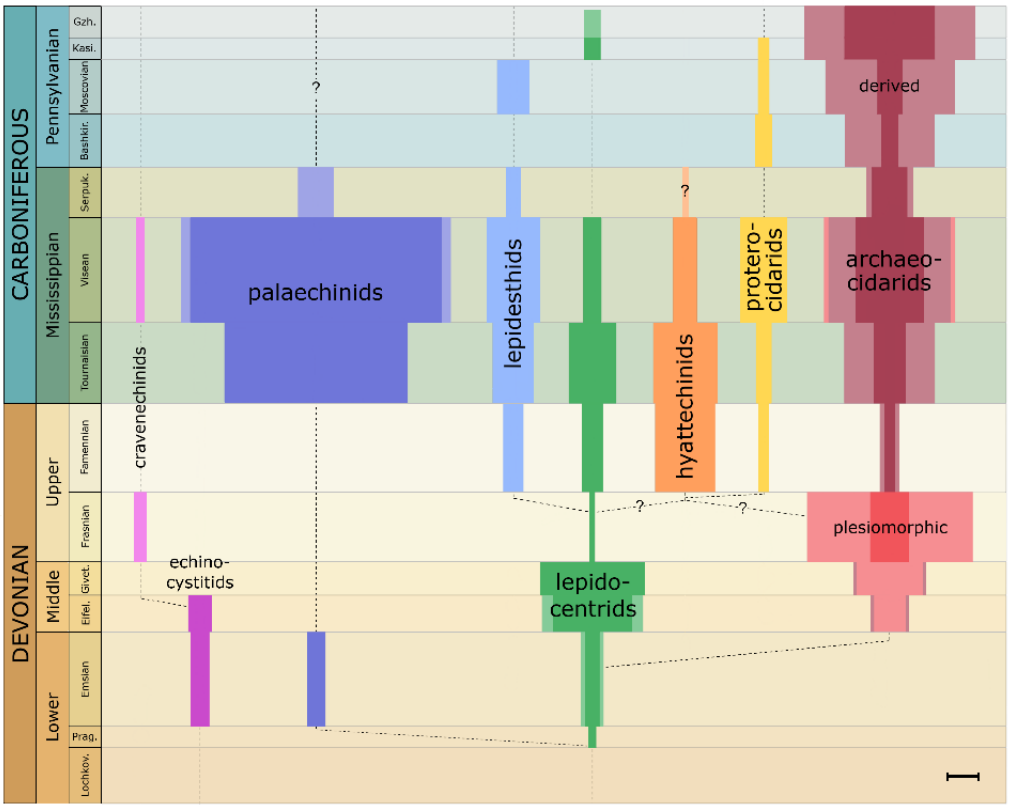
The Paleozoic fossil record of sea urchins (class Echinoidea) is limited due to the low preservation potential of most stem-lineage members. Still, an Early Carboniferous radiation of echinoids marks a first brief "golden age" of sea urchin diversity, featuring distinct and specialized groups compared to those of the Devonian. These include derived members of the archaeocidarid lineage which constitute the direct stem group of all later echinoids. This suggests important evolutionary changes during the Late Devonian, although the role of biotic crises like the Kellwasser and Hangenberg Events in these changes remains unknown. This study presents an exceptionally well-preserved echinoid fauna from the middle to upper Famennian of Velbert near Düsseldorf, Germany. Description of five new species belonging to four families greatly add to the known diversity of Late Devonian echinoids. Moreover, the fossils offer new insights into the phylogeny, ontogeny, and test growth of the hyattechinid, proterocidarid, and archaeocidarid lineages. To better understand Late Devonian changes in echinoid faunas, a dataset encompassing all known Devonian and Carboniferous species, including the new findings, was analyzed. The Hangenberg event seemingly had little negative impact on echinoid diversity and was followed by a strong radiation in the Tournaisian and Visean, primarily driven by the diversification of the specialized family Palaechinidae. In contrast, crucial qualitative changes occurred from the Frasnian to the Famennian, including the appearance of several lineages that would become important in the Carboniferous. Famennian echinoid faunas are therefore more similar to Carboniferous than to earlier Devonian faunas. Importantly, the archaeocidarid lineage apparently saw a faunal turnover from more plesiomorphic Frasnian forms to derived forms closer to the echinoid crown group. This transition might be linked to global changes associated with the Kellwasser Event, particularly the collapse of metazoan reef systems. These findings show that the Devonian extinction events may have played a pivotal role in the establishment of the body plan of modern sea urchins.



Diversity of echinoids during the Devonian/Carboniferous interval. Scale bar represents one species per Ma.

Talk: The missing link of Pterosauria and the wading revolution

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The morphological gap between more ancient pterosaurs (long-tailed rhamphorhynchoid-grade) and derived forms (stubby-tailed Pterodactyloidea) is bridged by forms with a derived skull and overall conservative postcranium (e.g. Wukongopteridae). This modular evolution was further underpinned when Tischlinger & Frey (2013) introduced the so-called Painten pro-pterodactyloid, a transitional pterosaur from the latest Kimmeridgian of Painten, Bavaria. The complete and articulated skeleton exhibits a perfect mix of characters from all major types of pterosaurs: The cervicals and metacarpals are initially elongated like in wukongopterids, whereas the tail is short as in pterodactyls; the caudals are rhamphorhynchoid-like in their interlocking pattern, while the nasoantorbital foramen excludes it from this grade. There is a small but functional fifth toe, indicating a sister-group position to the four-toed Pterodactyloidea. The now conducted formal description found a similar adaptation with early ctenochasmatoids, known for leggy and longirostrine filtering species. Instead of improved flight abilities, the pterodactyl transition is explained by enhanced terrestrial or wading lifestyles. The long jaws with relatively posterior nares, the ventral articulation of an elongated neck, along with elevated stance and loss of the long tail form a prototypic wading pterosaur. This newly emerging ecotype can be dated back to the Middle Jurassic, a phase of increasing diversity of flying or gliding mammals and paravian dinosaurs. It is hypothesised that the pterodactyl transition was a reaction to competition among hawking insectivores, a then fading ecotype within Pterosauria, while at the same time fishing rhamphorhynchids remained in evolutionary stasis.

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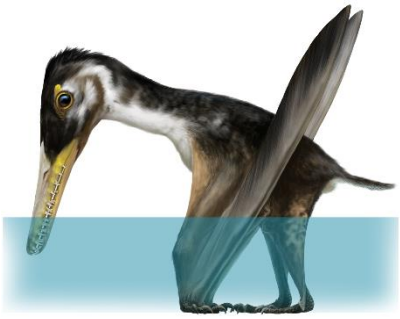

Talk: The Crab Begins - morphological diversity of the earliest brachyurans

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Crabs, representatives of the group Meiura (Anomala + Brachyura), are prominent crustaceans with a global distribution. They show a large biological and morphological diversity, counting almost 10,000 species, and conquered different habitats around the world. Earliest representatives of the group are known from the Triassic. From this point on, by a process called carcinization, different lineages of Meiura have seemingly convergently evolved the same body shape with a broad shield and the tail flipped under the body ventrally. Especially in Brachyura, the group of true crabs, this process is abundant. To investigate the morphological changes along the process and to better understand evolutionary advantages of the crab body organization, we here explore the morphological diversity of the earliest representatives of Brachyura. We focus on the earliest representatives of the group, fossils from the Lower Jurassic, and modern representatives of phylogenetic groups that these fossils have been assigned to. Specifically, we investigate how the shield morphology changes over time in these groups. We also compare fossil specimens with different extant developmental stages (megalopa, juvenile, adults). To that end, we reconstruct one half of the shield outlines of specimens as black and white drawings. Using elliptic Fourier transformation for outline analysis, we quantify

these shield shapes. The results are then analyzed with a principal component analysis and multivariate statistics. We find that fossil specimens show a smaller morphological diversity than extant representatives. Furthermore, fossils plot between extant adult and juvenile specimens, showing a somewhat intermediate position. Some fossils show similarities to their extant counterparts, but not all. Ecological implications of our findings are discussed.

Talk: Late Jurassic (Kimmeridgian) and Early Cretaceous (Barremian-Aptian) mammals from Germany

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One key period for the evolution of early mammals is the Late Jurassic to Early Cretaceous transition. The Jurassic mammal faunas were dominated by stem mammals such as docodontans and morganucodontans, as well as typical Mesozoic crown mammals such as eutriconodontans, multituberculates, and dryolestidans. Except for the multituberculates, most Jurassic groups started to decline with the beginning of the Cretaceous era and were successively replaced by "symmetrodontans" and tribosphenic stem therians (predecessors of modern mammals) in the Northern Hemisphere. European localities yielding Late Jurassic and Early Cretaceous mammals are rare, and were until recently restricted to the western and southwestern part of that continent. The recently discovered mammalian teeth and mandibular remains from the Late Jurassic of the Langenberg Quarry and the Early Cretaceous of the Balve-Beckum locality in Germany make new information on mammalian evolution during this important time interval in Central Europe available.

The Süntel Formation, spectacularly exposed in the Langenberg Quarry near the town of Goslar (Lower Saxony) with near shore fossiliferous marls and limestones is well-dated to be of late Kimmeridgian age by the presence of marine invertebrates. Morganucodontans are represented by large molars of *Storchodon*, being less than 10% smaller than the largest known morganucodontan specimen from the Early Jurassic of Wales. Docodontans are represented by two lower molars of cf. *Haldanodon* and cf. *Docodon*. Multituberculates are most abundant with more than two dozen isolated teeth. Three taxa of the paulchoffatiid lineage (Pinheirodontidae) have been identified. Cladotherians are represented by molars of the small (*Amblotherium*-sized) dryolestid *Hercynodon*. The large size of the new morganucodontan taxon likely is a phenomenon of island gigantism caused by isolation within the Late Jurassic European archipelago. Pinheirodontid multituberculates represent an endemic European clade that probably evolved on the Rhenish-Bohemian Massif and reached the Iberian Plate only in the Early Cretaceous.

The Balve-Beckum locality in the Sauerland area (North Rhine-Westphalia) provides insight into a former Early Cretaceous upland environment. The fossiliferous sediments were deposited within a deep paleo karst system in Devonian limestones (Massenkalk) and are well-dated as Barremian-Aptian age by pollen and sporomorphs. Three major mammalian clades had been reported so far: pinheirodontid and eobaatarid multituberculates, "symmetrodontans" (*Cifellitherium*), and dryolestids (*Beckumia* and *Minutolestes*). The dryolestids are among the youngest in the Northern Hemisphere and demonstrate that they were more diverse in Europe in the Early Cretaceous than anticipated.

According to the current hypothesis, the predominant pre-tribosphenic dryolestidans delayed the emergence of tribosphenidans (stem lineage representatives of modern mammals with crushing tooth function) in Europe. The discovery (in summer 2022) of a tribosphenic mammalian lower molar with a fully developed and deep talonid basin demonstrates that tribosphenidans co-existed with non-tribosphenic cladotherians in Central Europe in the Early Cretaceous.

For the first time, the mammalian fossils from the Langenberg Quarry and from Balve-Beckum provide insight into the Late Jurassic–Early Cretaceous turnover of mammal faunas in Central Europe.

Talk: Diversity and convergencies in the anterior dentition in Mammalia

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The mammalian dentition is composed of two functional areas: the anterior part for grasping food, and the molar region for mastication. The anterior dentition experienced much less attention in paleontological studies than the molar dentition. The morphology of molars is very indicative for systematic and phylogenetic relationships.

The highly diverse anterior dentition is rich in cases of convergent evolution, by which phylogenetic reconstructions are made more difficult. The obvious way for explaining convergences is postulating the adaptation for a similar function. This has to be reconsidered. For an easier comparison of fossil and recent mammals (Placentalia, Marsupialia and some Metatheria), the anterior dentitions were classified in about 20 anterior dentition types (ADT). These types are not related to systematic units. They are based on the composition, size, and modifications of lower and upper teeth. But creating types should never be an end in itself. It is of interest what kind of morphological characters and/or reductions are shared by the taxa of very different background united in such a type.

Examples for taxa with enlarged lower incisors, or differentiated canines will be presented. The famous saberteeth, which are celebrated in films as crucial weapons, also occur in herbivores obviously serving other functions. Many herbivores reduced anterior teeth continuously, although in earlier stages these teeth were helpful in gathering food. Such a reduction certainly was no disadvantage. Other organs, such as the tongue, lips, and a potential trunk were better suited for selective feeders. Only if the entire functional complex is considered can the anterior dentition be understood in greater detail.

Talk: Carnassial functional morphology in the Carnivora, Hyaenodonta and Dasyuromorphia

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The Carnivora, Creodonta (e.g., Hyaenodonta) and carnivorous Marsupialia such as Dasyuromorphia evolved carnassial teeth, which are specialized for slicing meat. While the Carnivora are highly diverse in terms of species and ecomorphology, the Hyaenodonta went extinct in the Miocene and the carnivorous marsupials are restricted to just a few extant species. It has previously been hypothesized that differences in carnassial functionality may have had an influence on the differing diversity

between the three clades. To investigate the form and function of carnivoran, hyaenodont and dasyuromorph carnassials, we used virtual 3D models based on µ-CT scans.

A dental topographic analysis using ariaDNE, which quantifies the crown curvature, shows a decrease of curvature correlated with increasing carnassialization in the lower carnassial teeth of all three clades. This decrease of curvature is explained by a decrease of crown complexity, as the convergent trend of carnassialization is characterized by the reduction of crown structures, such as crests and cusps. A 3D geometric morphometric analysis with a subsequent principal component analysis also points to a general convergent trend of carnassial specialization in the Carnivora, Hyaenodonta and Dasyuromorphia. This trend is characterized by carnassial blade enlargement and reduction of the crushing talonid basin in the dimension of PC1. The distribution of values in the dimension of PC2, however, points to a specific carnassial shape only present in the Carnivora. Shape deformation within the dimension of PC2 indicates a longitudinal elongation of the caniform carnassials and the unspecialized feliform carnassials seen in herpestids and viverrids. An additional ancestral state reconstruction points to a hypothetical ancestral carnivoran carnassial shape, which is characterized by this elongation, in contrast to the hyaenodont and dasyuromorph ancestral condition, which is characterized by a shortening of the carnassials.

Measurement of the carnassial blade alignment, as approximated by the angle formed between the blade and the longitudinal axis of the tooth, shows a general trend of a transversal blade alignment in unspecialized carnassials and a parallel alignment in specialized carnassials. However, within some unspecialized carnivoran carnassials, a parallel blade alignment is also present. These carnassials show a combination of primitive features, such as the presence of a crushing talonid basin, together with a blade alignment which is typical for specialized carnassials. For these teeth, multifunctionality and effective meat slicing capability is inferred. This combination is not present in hyaenodont and dasyuromorph carnassials, and is probably linked to the elongation of unspecialized carnivoran carnassials.

Generally, a higher adaptive potential is assumed for carnivoran carnassials, as the parallel blade alignment can be combined with the functional versatility of unspecialized carnassials. In the Hyaenodonta and the Dasyuromorphia, there may be a higher selective pressure on the reduction of the talonid crushing basin, as increasing carnassialization with a longitudinally aligned blade approximates a condition where the multiple carnassials of the tooth row form a continuous blade. Thus, although carnassialization generally shows convergent adaptive trends, differences in form and function are present and may have resulted in different adaptive potentials. This may have made hyaenodonts more susceptible to end up in evolutionary “dead ends” due to an incapability to adapt to changing conditions.

Talk: A collection of ideas how taxonomy could better integrate the needs of the paleo-community and become a well-delineated scientific discipline

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Taxonomy is usually considered a scientific discipline. Yet, when exploring this aspect it becomes clear that some practitioners consider taxonomy as a set of rules, a number of conventions or even an art form. Scientific disciplines can be recognized based on specific sets of epistemological tools inherent to the discipline that provide a sound philosophical frame that ultimately outlines this specific

discipline. Taxonomy suffers in this aspect from the fact that it is a conglomerate of scientific (and possibly some non-scientific) practices. Therefore, it is necessary to formulate epistemological tools for each of these aspects. In its current state, taxonomy is in some aspects very challenging to apply to organisms exclusively from the fossil record, at least it appears so to many practitioners. I will outline some epistemological tools used in different aspects of taxonomy, and how they can be applied to fossils. A comparison shows that fossils are not necessarily more challenging to deal with than extant organisms. Yet, it also demonstrates that it is important to differentiate which statements are made based on which data set, or better which epistemological tool can be applied when. Some of these examples relate to classical discussions such as the famous one between Mayr and Hennig. Their dispute stems from the fact that they were referring to different epistemological tools, and both are in fact right. Using the right taxonomic epistemological tool for the right question allows 1) to emphasize that scientific basis behind taxonomy and 2) improves the applicability of taxonomy to fossil organisms.

Talk: Fossil coleoid cephalopods: The role of morphological character definitions in phylogenetic inference

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Despite the iconic status of cephalopods in the field of Paleontology owing to their rich fossil record, phylogenetic approaches on this group have since long been lagging behind many other taxa such as vertebrates or arthropods (Neige et al. 2007). Only recent years have shown increased interest and a rising number of phylogenetic studies focusing on fossil cephalopods (e.g., Sutton et al. 2016; Bardin et al. 2017; Pohle et al. 2022). In particular, coleoids are comparatively well-studied in this regard (at least for cephalopod standards), with repeated attempts to resolve relationships at different taxonomic levels (e.g., Sutton et al. 2016; Fuchs et al. 2020; Stevens et al. 2023). Despite this progress, many controversies and uncertainties remain. Here, we take a detailed look at the nature of the involved characters, revealing recurrent problematic coding practices in previous studies that potentially impact the reliability of these analyses. The problems include inadequate logical dependencies between characters ("inapplicable" states), *a priori* homologisations where evidence is equivocal, or artificial character splitting. We show examples of how to solve these problems and demonstrate how alternative coding schemes can impact inferred tree topologies. In light of recent advances in Bayesian phylogenetic techniques allowing to choose between a wide array of available models, we raise the question whether model choice or alternative coding schemes matter the most when the main interest is tree topology. Finally, we give recommendations on how to make character definitions comprehensive and detailed while being presented in a well-organised manner. We argue that this will help with transparency, applicability, and reproducibility of character definitions, particularly for taxonomic groups that have little previous morphology-based phylogenetic work.

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Talk: Redescription of the holotype of Olivierosuchus parringtoni (BP/1/3849)

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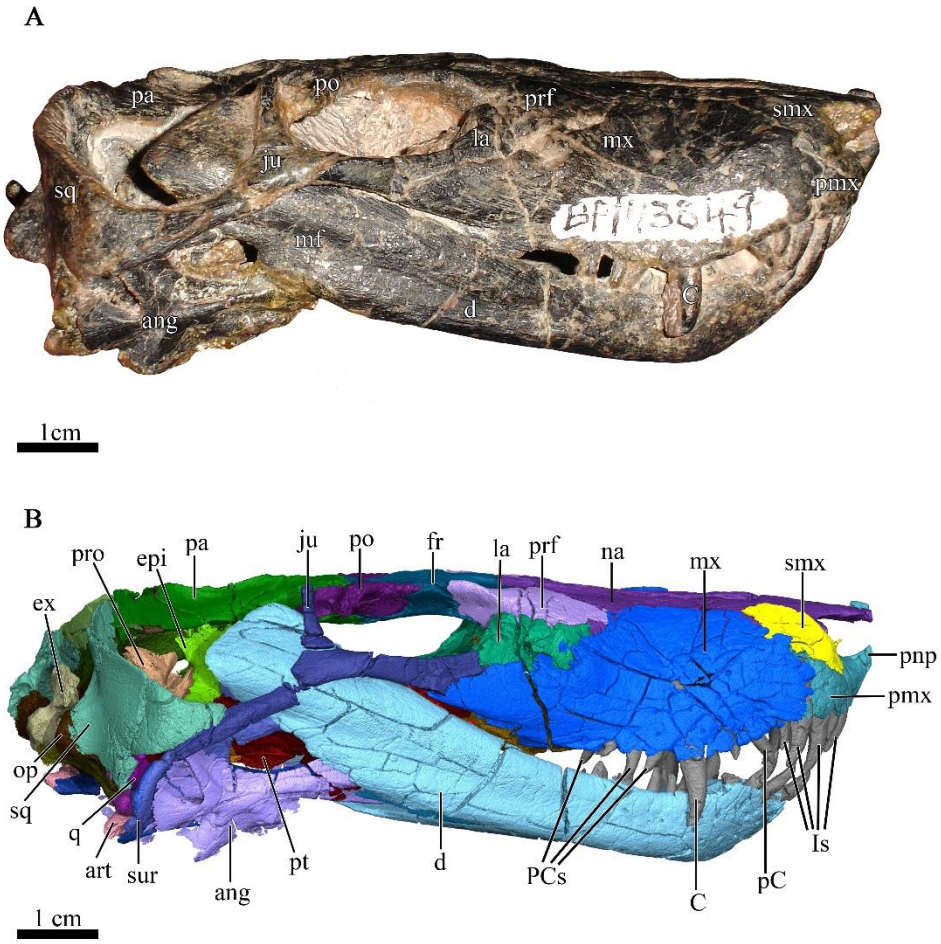
Therocephalians were an ecomorphologically varied and diverse-sized group of therapsids with widespread distribution during the late Permian and earliest Triassic periods. Here, we redescribe the holotype of the therocephalian *Olivierosuchus parringtoni* (BP/1/3849) from the Early Triassic *Lystrosaurus declivis* Assemblage Zone in the main Karoo Basin of South Africa. The specimen includes a complete skull, mandible, and the anterior portion of the skeleton. Previously unknown endocranial features are described using high-resolution computed tomography (CT), including internal surfaces of braincase and palatal bones, as well as soft tissue structures such as the brain and inner ear endocasts. Comparisons with closely related therapsids permit a detailed comparative analysis of the brain and inner ear morphology of *Olivierosuchus*.



Skull of BP/1/3849, the holotype of Olivierosuchus parringtoni*, in right lateral view. (A) Photograph and (B) 3D reconstruction of the skull.*

Talk: MolluscaBase, a way to treat taxonomic and nomenclatural challenges in a species revision

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Reviewing species is faced with several challenges. Besides finding the type specimens, historical literature is essential. A chresonymy, a list of all occurrences of your considered species in the literature, would be an essential starting point for a revision.

During the work for the gastropod chapter of the book „Fossilien aus dem Campan von Hannover“ (Schneider & Girod 2023), the authors realised that a revision of the Campanian gastropod fauna of Northern Germany was needed, but it was not possible to do this within the framework of the book chapter. Besides searching for more collection material, the first steps included building a chresonymy for each considered species. A chresonymy encompasses a vast range of information about a species: Original name, the original author, year of publication, relevant references, interpretation and misinterpretations of other authors, potential genera where to put the species, and locality information.

Building up a chresonymy is a challenging task. The needed information is usually hidden in the full text. But only a few sources allow us to search the full text.

An analysis of a test chresonymy of *Chenopus buchii* Münster, 1839 shows that only very few references are found between 1930 and 1970. An extensive digitalisation of literature from before 1930 and after 1970 might explain that. But to support and as a good starting point for building a chresonymy for molluscs, an authoritative database curated by experts does exist: MolluscaBase (MolluscaBase eds. 2023), a member of the WoRMS (**Wo**rld **R**ecord of **M**arine **S**pecies; WoRMS Editorial Board 2023) family. It tries to contain all Mollusc taxon names: marine, fresh water, and land; fossil and recent; original name, actual taxon status, type locality, type stratum, original reference, status reference, photos, and more facts. Available and missing information on MolluscaBase is discussed. The case of *Chenopus buchii* is resolved.

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Talk: Extant crocodilian bone pathologies as a window to phytosaur paleopathology

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Paleopathology is a powerful tool to reconstruct aspects of the physiology and paleoecology of long-extinct animals. However, diagnosing ancient diseases is often not straightforward. Most studies on bone physiology in extant vertebrates have been performed in humans or in domesticated animals only. Nonetheless, physiological and ecological differences should be considered between phylogenetically remote groups.

The middle to late Triassic phytosaurs have an abundant and well-sampled fossil record making them well suited for a large-scale paleopathological study. Their striking ecomorphological similarities with extant crocodilians, and their phylogenetic position as the sister group of archosaurs or as basal pseudosuchians, make extant crocodilians an ideal analogue model. Here we present the first results of an epidemiological survey of skeletal pathologies in extant crocodilians.

This survey is based on first hand studies of 845 crocodilian specimens composed of 683 skulls, 92 isolated crania, 8 isolated mandible rami, and 65 skull fragments. The post-cranial skeleton is represented by at least one isolated bone in 127 specimens. A minimum of one bone pathology has been found in 349 specimens from which 57 % belong to the skull. Preliminary diagnoses show a dominance of trauma in 42 % of cases from which 16 % are bone fractures. Infectious diseases make up to 21 % of cases, joint disorders 15 %, dental diseases 6 %, congenital malformations and metabolic diseases represent 5 % each, possible neoplastic diseases 3 %, and the rest are ankylosed vertebrae. The main pathologies of the cranium and mandibles are traumatic injuries, representing 50 and 43 % of cases respectively, and interpreted as a consequence of intraspecific fighting and feeding behavior. The appendicular skeleton shows 33 % of trauma (64 % being bone fractures), and 30 % of infectious

diseases. Joint disorders and infectious diseases each affect the spine in 29 % of cases. Rib traumata represent 42 % of observed pathologies, of which 91 % are fractures. The girdle structures show 43 % of joint disorders and 39 % of infectious diseases. Finally, 94 % of osteoderm pathologies are traumatic injuries.

This review will provide comprehensive comparative data for a paleopathological study of phytosaurs. Moreover, the presented data on crocodilian osseous pathologies will certainly be useful for future paleopathological studies of archosaurian clades including dinosaurs.

Talk: ELECTRUM MUNDI – a sneak peek

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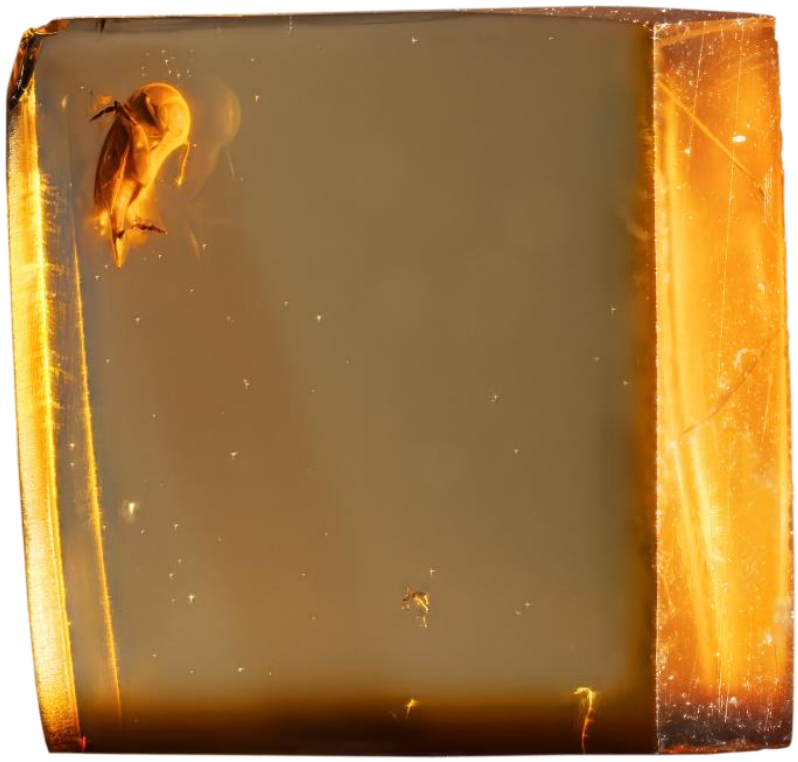

Holotype of †Baltistena PMJ-02** preserved in Baltic amber.*

Fossils represent the only direct evidence of the evolutionary history of organisms; therefore, it is critical to determine the geological source of biota bearing fossils. In 2020 the Phyletisches Museum was closed during the Covid crisis and thus offered the opportunity to reorganize material and clean storage space extensively, which lead to a surprising discovery: An amber collection that had been unrecognized for several decades. Through the application of modern morphological methods such as synchrotron-radiation-micro-computed tomography (SR-µ-CT) and computer based 3D reconstructions, and chemical analyses such as Fourier-transformed infrared-spectroscopy (FT-IR), and radiocarbon dating (^{14}C quantification), we were able to identify and sort 160 numbered and mostly mislabeled pieces of East African defaunation resin (~145 years old), copal (~390 years old), as well as Baltic amber (~35 million years old) from the museum collection. Within the re-identified material, we define two new species, †*Amphientomum PMJ-01** Weingardt, Bock & Boudinot **sp. nov.** (Psocodea: Amphientomidae) from copal, †*Baltistena PMJ-02** Batelka, Tröger & Bock **sp. nov.** (Coleoptera: Mordellidae) from Baltic amber (Fig.), as well as an ant neotype from copal source. Furthermore, we provide systematic reviews of the fossil record for selected taxa, such as Nevrorthidae (Neuroptera), Curculionidae (Coleoptera) and especially

Formicidae. For Amphientomidae (Psocodea) a key to all extant and extinct species of *Amphientomum* Pictet, 1854, as well as a taxonomic revision is provided. To draw attention to the often-ignored problem of distinguishing between amber and other resins, we performed a series of qualitative and quantitative common tests and discuss the history of amber. The neotype and all new species are available as 3D cybertypes from our µ-CT scan data, to further demonstrate the significance of µ-CT for phylogenetic paleontology.

* a placeholder is used for the species epithet, to not create a *nomen nudum*

Talk: Multi Light Imaging as a tool to capture fine details of compression fossils – dedicated hardware and a convenient alternative

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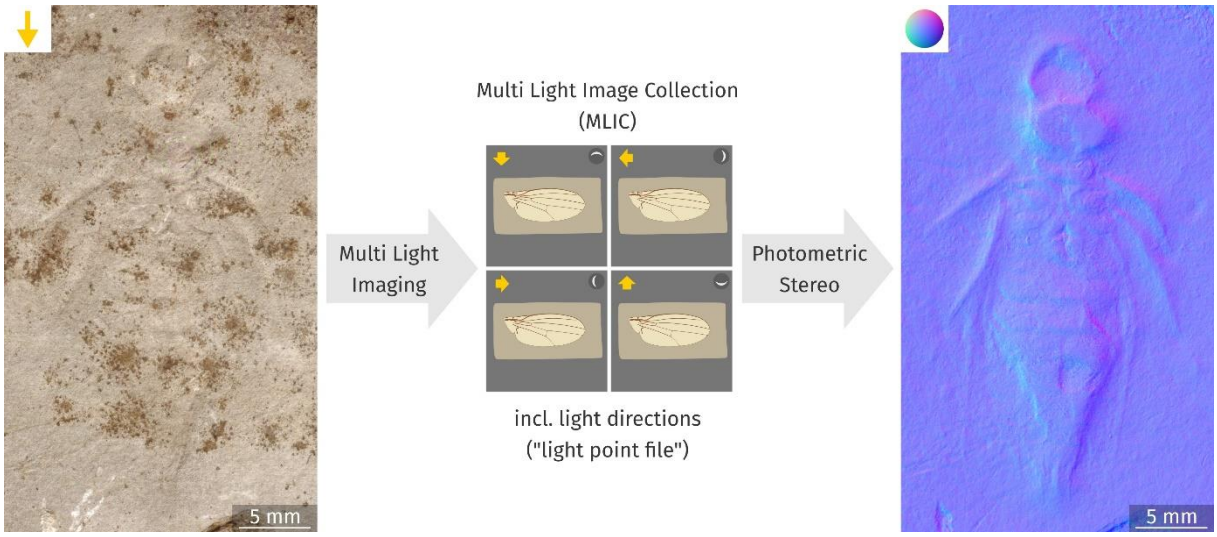

High level overview of a Multi Light Imaging workflow: capturing multiple images with different illumination settings (left side), processing using Photometric Stereo and visualization in form of normal maps (right side).

In compression fossils multiple structures frequently overlie each other, making them difficult to interpret. Therefore, one photographic image alone is often not sufficient to document every detail. Grazing light has long been used to highlight features that are not apparent from the color of the fossilized material. In more complex fossils, multiple images using different illumination directions ("Multi Light Image Collections") might be needed to illustrate every such detail and often an interpretative drawing is used to combine the morphological features in one view. However, aside from producing a drawing, there are also digital techniques that can combine features from multiple illumination settings into a single image. One such set of techniques is Reflectance Transformation Imaging (RTI), which focusses on creating precise models of the reflective properties of surfaces, in order to virtually relight scenes. Another technique is limited to recovering the shape of the surface (Photometric Stereo). Both approaches have been used to document fossils for more than 20 years, yet they have never seen a widespread adoption. This is likely linked to the technology needed to produce and process Multi Light Image Collections in an effective manner. With the aid of easy-to-use microcontrollers and 3D printers it is possible to construct custom hardware for macro photography optics that allow to document even small fossils such as those of insects or other arthropods. However, commercially available hardware can be expensive and the construction of custom solutions can pose a technological hurdle. Fortunately, it is possible to achieve similar results by changing the orientation

of the fossil relative to the light source, which can be performed on a consumer grade CCD-type flatbed scanner. While being limited by the optics of the scanner, this can be an inexpensive and convenient alternative to custom or commercially available dedicated hardware.

Poster: Can we stay in touch? The importance of claws in reconstructing fossil behavior

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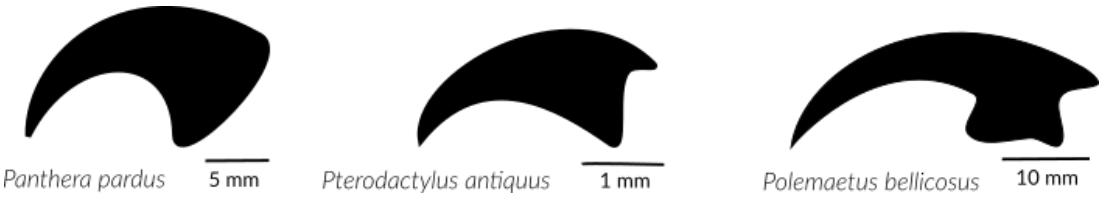

Visual Comparison of three claws from Panthera pardus *(Felidae),* Pterodactylus antiquus *(Pterosauria) and* Polemaetus bellicosus *(Neoaves).*

The way extinct animals interacted with their environment and other animals, how they moved, caught prey, etc. fascinates many scientists, but also the public. However, reconstructing the behavior of extinct animals is challenging because it cannot be directly observed. Cases of "frozen behavior", where a fossil preserves a specific moment in an animal's life, such as predation, are rare and often difficult to interpret. Another approach of reconstructing behavioral aspects of extinct organisms is to compare the morphology of fossils with extant specimens in which behavior can be observed. Structures that are firm enough to stand the test of time, but soft enough to shape through individual use are particularly interesting for this approach.

A body part that can provide this are claws. Claws are present in most terrestrial and semi-aquatic animals. Even some fully aquatic animals such as specific isopods have well developed claws. They are a part of the body found in both fossils and extant animals. Claws that are exposed to strong forces grow along the logarithmic spiral (Mattheck and Reuss 1991) to a certain point to prevent fracture. To investigate whether the shape of the claws can be used as a proxy for behavioral reconstructions, the claws of different animal groups, including birds (Aves) and cats (Felidae), were analyzed. Based on the results, we conclude that claws that do not have to withstand strong forces tend to grow less along the logarithmic spiral. So what forces act on a claw? The force equation is mass times acceleration. For example, amniotes that climb walls and pull their body weight up, or lightweight animals that run very fast, show logarithmic claw growth. Non-logarithmic claw growth can be seen in animals where the claws are not subjected to strong forces, such as semi-aquatic birds like ducks (Anatidae). This close association between claw function and claw shape suggests that claw shape could serve as an indicator of behavior. A fossil's claw shape could indicate a specific behavior or environmental preference. This can be an indication of flight, climbing, hunting or even running behavior. To apply this approach, pterosaurian claws from 5 species were analyzed. This analysis shows that the curvature of pterosaur claws is more similar to the claw curvature of big cats such as lions than that of birds of prey such as eagles. Lions use their claws especially for hunting larger prey, pulling themselves up their bodies to

reach their throats. This indicates that a directed pulling force was applied to these claws. Some pteroaurians may have used their claws for an equal pulling motion to climb cliffs or trees. This poster shows how forces operate onto claws and how logarithmic growth can prevent fractures. This includes different examples of claws and their observed use and also how this could provide new insights into fossil behavior.

Reference:

Mattheck, C. & Reuss, S. 1991. The claw of the tiger: An assessment of its mechanical shape optimization. *Journal of Theoretical Biology* 150 (3), 323–328.

Poster: Morphological diversity of polychelidan lobsters over time – larva-adult differentiation

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Representatives of the group Polychelida, commonly referred to as deep-sea blind lobsters, are nowadays only found in the deep sea, as the name suggests. However, the fossil record of the group, reaching back into the Triassic (230 mya), presents a global distribution with specimens from shallow water habitats. Since the late Mesozoic, the group has lost most of its species diversity and its shallow water living representatives. Here, we investigate whether the loss of species diversity within the group is correlated with a loss of morphological diversity. We use outline analysis on the shield and chela (propodus and dactylus respectively) of polychelidan lobsters as a proxy for their morphological diversity. We conduct elliptic Fourier Analysis and analyze its results with principal component analyses. We then test fossil and extant groups for their differences in morphological diversity. Our results show that morphological diversity decreased significantly within the group over time. Furthermore, morphospace occupation shifted significantly from wide and bulky to slim morphologies. This shift was likely coupled to a change in habitat use from shallow waters to the deep sea. The different lifestyle of modern forms is therefore represented morphologically. Furthermore, a distinct difference in larval versus adult morphology can be recognized in modern forms, while we did not find such a pronounced difference of morphology in the fossil record. We therefore conclude a more expressed ecological differentiation between extant larvae and extant adults, compared to the differentiation between fossil larvae and fossil adults. This increased disparity may be coupled to the giant “eryoneicus-type” larvae found in modern forms.

Poster: Not quite Edward Scissorhands – Quantitative morphology of crustacean chelipeds

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Crustaceans evolved already in the early Cambrian, but it took until the late Paleozoic before crustaceans evolved that will be easily regarded as such by the non-expert, namely the lobster-like crustaceans. Their most striking features are the chelipeds, trunk appendages that distally form a

grasping structure. These chelae, the distal part of the chelipeds, consist of a proximal part with a fixed finger and a distal movable finger. Not only lobster-like crustaceans, but also some other lineages evolved such grasping structures, for example, tanaidaceans, which are closely related to woodlice. We here explore the morphological diversity of chelae through time including lobster-like crustaceans, crabs, but also tanaidaceans. We aim at identifying major factors that cause diversification. Major factors seem to be ontogeny, functional coupling of the two different fingers, but also certain aspects of ecology and phylogeny. Also the geological age seems to be an important factor as cheliped-bearing crustaceans did just start to diversify in the Mesozoic and also went through major turnover events. Substitutions during turnover events seem to be coupled to repetitive events of convergent evolution. As the chela is an important "tool" for gathering food, for altering the environment, but also for mating, it represents an important factor for reconstructing trophic interactions (and ultimately food webs), functional morphology and behavioral aspects. The advantage of the here presented approach is that it allows to include rather incompletely preserved fossils that are challenging to treat with a taxonomic frame.

Poster: Fish remains from the Rhaetian (Late Triassic) of Winterswijk, the Netherlands (Pisces: Chondrichthyes and Actinopterygii)

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In the active limestone quarry of Winterswijk (Eastern Netherlands) micritic limestone of Anisian (Middle Triassic, c. 247.2–242 mya) age is being commercially exploited. In order to reach the Anisian strata, an overburden of respectively Rhaetian (Late Triassic) claystone, Rupelian (Early Oligocene) clay and Late Pleistocene boulder clay has to be removed; it is mostly discarded. In 2004, a large Rhaetian (c. 208.05–201.36 mya) or perhaps Late Norian deposit consisting of black claystones was found in-situ in the northern face of the quarry. We sampled it in 2018/2019. The sediment appeared to contain an abundancy of (very) small chondrichthyan and actinopterygian fish remains, viz. teeth (ichthyoliths) and scales. It is the first in-situ find of Late Triassic fossils in The Netherlands.

Here, we describe this material. The most abundant taxon is the actinopterygian *Gyrolepis albertii* (both teeth and ganoid scales), followed in quantity by the chondrichthyan *Lissodus minimus*. Furthermore, the paleopterygian actinopterygians *Saurichthys longidens* and *Birgeria acuminata*, and some teeth of neopterygians *Sargodon tomicus*, '*Lepidotes*' sp. and indeterminate pycnodontiforms are recorded in addition to the chondrichthyans *Rhomphaiodon minor*, *Parascylloides turnerae* and some '*Hybodus*' cf. *cuspidatus* (senior synonym of *H. cloacinus*). Chondrichthyan dermal denticles, actinopterygian scales and gill rakers, tooth plates, and some fish bones were also found.

There is considerable faunal resemblance to the various localities from the Rhaetian of the British Penarth Group, although it depends on the location whether chondrichthyans or actinopterygians prevail in the samples. On average there are more chondrichthyan teeth present in the British samples than actinopterygian teeth, which is opposite to the situation in Winterswijk. That might be explained by different ecological circumstances, such as lower oxygen levels in bottom waters in Winterswijk and freshwater input and/or changes in salinity in the UK.

Poster: The morphology of mandibles of wood-associated beetle larvae

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A single tree provides a variety of living habitats to different beetles, both adult and immature, at the same time. They can inhabit a living or a dead tree, a fallen or a submerged tree, live under the bark, in the softwood, or the hardwood. Therefore, in modern ecosystems, multiple trophic groups live within a tree, and wood-feeding beetle larvae lead lifestyles of softwood borers, hardwood borers, fungus-infected-wood feeders, and submerged-wood borers. Representatives of each trophic group feed on different substrates with different chemical, nutritional and physical properties and are exposed to different selective pressures. Therefore, wood-associated beetle larvae differ from each other in certain morphological characteristics. To be able to feed on the different types of wood, different shapes of mandibles evolved. For example, some fungus-feeding larvae have additional setae on the mandibles that help collect spores and hyphae. The hardwood borers have chisel-like mandibles used for boring the tunnels in the living hardwood.

We performed a quantitative analysis of mandible shapes to analyze the differences between representatives of previously named wood-feeding trophic groups, both extant and fossil. Possibly different trophic groups in wood already existed in the past. Based on the existing literature and images of fossil specimens, we outlined the mandibles in the vector-graphic program Inkscape. Additionally, we added the outlines of mandibles of in-wood predators feeding on wood borers, as well. Furthermore, the pipeline of SHAPE processed and analyzed the outlines. Here, we present the results of the SHAPE analyses.

Poster: First larvae resembling those of modern water crawling beetles in 100-million-years-old amber

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Coleoptera (beetles) is a very diverse ingroup of Insecta, more exactly of Holometabola. Together with other ingroups of Holometabola, more exactly Diptera, Lepidoptera and Hymenoptera, it is considered as one of the “Big Four” concerning species diversity.

Of special importance is the larval phase, which all holometabolan insects need to go through before reaching adulthood and which often lasts much longer than the time the animals spend as adults. Beetles are nowadays abundant in almost every ecosystem. They also occur in aquatic environments such as lakes, ponds, or rivers. One group of aquatic beetles is Haliplidae (water crawling beetles), an ingroup of Adephaga. The larvae and the adults spend most of their lifetime in the water. Larvae and adults are both feeding on algae. While the adults are usually swimming, the larvae are mostly walking over the surface of the ground. Larvae of water crawling beetles can be easily recognized by the elongated trunk end. Up to now, these larvae have not been reported in the fossil record. We herein present the first larvae with close resemblance to modern water crawling beetles preserved in 100-million-years-old amber and additionally review all extant larvae. Based on dorsal illustrations we

performed a quantitative shape analysis of the complete body with a total number of 41 specimens. The results indicate a significantly larger morphological diversity in the extant fauna than in the past. Furthermore, the occupied area of the morphospace of the fossil forms lies fully within that of the extant specimens.

Poster: Resurrection of the European Late Cretaceous ankylosaur, *Struthiosaurus austriacus* Bunzel, 1871

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Struthiosaurus is a widespread European Late Cretaceous ankylosaur, with a stratigraphic range extending from the Campanian to the Maastrichtian. Traditionally included in the family Nodosauridae, *Struthiosaurus* is considered an example of insular dwarfism and is predicted to have reached a maximum body length of up to three meters. As currently accepted, there are three species in the genus: *S. austriacus*, S. *languedocensis* and *S. transylvanicus*. The types species *S. austriacus* from the Campanian of Austria is based on cranial and postcranial remains of at least three individuals of different ontogenetic stages and has attracted considerable research interest since its initial description in the 19th century. Nevertheless, many questions still need to be clarified by future research. Here, we present preliminary results from an ongoing study that suggest that *S. austriacus* could have reached a much larger adult body size than previously assumed. Together with hitherto unknown morphological details, this has far-reaching implications for better understanding Late Cretaceous ankylosaur evolution and diversity.

Poster: A persistent misnomer: The curious case of the Paleozoic cephalopod *Orthoceras*

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The genus name *Orthoceras* is widespread and well-known in the scientific literature and commonly used to refer to museum specimens and material in private collections. However, the vast majority of these identifications is likely incorrect and refers to a taxonomic concept that has been officially abandoned almost fifty years ago (Melville 1970; ICZN 1974). *Orthoceras* (and its many invalidated alternative secondary spellings such as *Orthoceros*, *Orthocera*, *Orthoceratites*, etc.) has a very long and complex taxonomic history and was intensely discussed already a hundred years ago (e.g., Troedsson 1931; Teichert and Miller 1936). Due to the originally much looser scope of *Orthoceras*, the genus has been used as a wastebasket taxon throughout much of its history, a practice that was intended to be terminated with the fixation of *O. regulare* Schlotheim, 1840 as type species by the International Commission of Zoological Nomenclature (ICZN 1974). Ironically, the type species is unique and peculiarly specialised among ectocochleate cephalopods, as it is characterised by three longitudinal impressions on the mature body chamber. The function of these impressions is unclear and the suggestion that it may have helped the attachment of the soft body is unconvincing, as it would leave the question why this feature is absent and thus not needed in all other ectocochleate cephalopods. In any case, this means that only species that bear these impressions can be assigned to *Orthoceras*, which reduces the number of valid species in the genus to only three, all only occurring within a short

time interval in the Darriwilian (Middle Ordovician) of Baltoscandia and corresponding erratics (Kröger 2004). Although this information is not new, it is here presented as a reminder to the paleontological community to motivate updating museum exhibits and to reduce incorrect literature references to *Orthoceras*. A Google Scholar search returned almost 1000 hits for the term "Orthoceras" since 2018, but in most cases, these mentions can easily be replaced with higher level names. Specimens outside the Middle Ordovician of Baltoscandia can most commonly be referred to as Orthoceratoidea indet. or Orthocerida indet. To put it into perspective: the current practice would essentially equate to calling every bipedal non-avian Dinosaur "*Tyrannosaurus*".

References:

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Poster: Biotic Interactions in Deep Time - introducing BITE (PaleoSynthesis) project. Case study of bivalves.

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Biotic interactions – positive, negative, or neutral – are constant and unquestionable drivers in the evolution of organisms, taxonomic groups, and ecosystems since the origin of life. Unfortunately, such behavioral interactions between organisms are difficult to infer in the fossil record. Additionally, the organism-level associations or characteristic traces of fossilized interactions are the only direct evidence of biotic interactions in deep time. Due to the complexities of identifying and recording biotic interactions, the data available through existing databases of the fossil occurrences, although extensive and accessible, commonly do not allow for exploiting the interaction information potentially available.

Here we introduce the Biotic Interactions in Deep Time - BITE initiative, through the support of the PaleoSynthesis Project, a collaborative venture to develop a standardized way to compile and manage the accessible data on ancient biotic interactions of all types, from continental and marine settings in the fossil record. Such efforts will lead to increased possibilities for quantitatively evaluating the relative role of abiotic and biotic drivers of evolution through time. This database will be publicly accessible and open for contributions from the broader scientific community after publication.

Bivalves are used as illustrative examples from BITE for tracing the biotic interactions in deep time, due to their high fossilization potential and diverse functional roles in aquatic ecosystems. We review examples of bivalves preserved in various forms in both antagonistic (prey and predators, parasites and hosts, competitors) and non-antagonistic interactions (symbionts and commensals).

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Poster: Early Mesozoic evolution of Madygen (Kyrgyzstan, Central Asia)

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The Madygen Geopark located in the Batken Region in southwestern Kyrgyzstan (Central Asia) presents a tremendous geological and paleontological record spanning from the Cambrian to the Neogene. It is most famous for the mid-Triassic Madygen Formation, a unique conservation/concentration Lagerstätte for Early Mesozoic fossil plants, insects and vertebrates (Voigt et al. 2017). This up to 560 m thick succession of mostly fine-grained siliciclastics has been deposited in a fluvio-lacustrine environment during four sedimentary sequences showing distinct fining/coarsening-upward trends. It preserves Eurasia's most diverse assemblage of Triassic non-vascular and vascular plants, partly with evidence of animal-plant interaction; a wide variety of invertebrate body and trace fossils; the richest insect fauna of the Triassic with over 500 species from over 100 families in 20 orders, frequently showing wing pigmentation patterns; a nursery ground for two types of freshwater sharks; several actinopterygian and sarcopterygian taxa, being one of four Triassic localities worldwide yielding complete skeletons of dipnoans; and at least six taxa of tetrapods including the oldest stem salamander, a chroniosuchian and puzzling diapsids. Altogether, the Madygen Formation provides a singular insight into the complexity or Early Mesozoic non-marine ecosystems, both aquatic and terrestrial.

In places, the Madygen Formation is unconformably overlain by fluvio-palustrine deposits of the Kylötok Formation, which so far has yielded a typical Late Triassic flora and actinopterygian fish scales. The following Kamysh-Bashi Formation, which may encompass the Triassic/Jurassic boundary, contains abundant fossils of plants, bivalves, crustaceans and insects, partly also with pigmentation patterns preserved, and a rich trace fossil assemblage.

Paleosoil horizons have been documented in the Madygen, Kylötok and Kamysh-Bashi formations. They generally become more abundant and less indicative of permanently waterlogged conditions towards the top of the section, suggesting fluctuating water supply within a general aridization trend.

Reference:

Voigt, S., Buchwitz, M., Fischer, J., Kogan, I., Moisan, P., Schneider, J.W., Spindler, F., Brosig, A., Preusse, M., Scholze, F. & Linnemann, U. 2017. Triassic life in an inland lake basin of the warm-temperate biome - the Madygen Lagerstätte (Southwest Kyrgyzstan, Central Asia). *In:* Fraser, N.C. & Sues, H.-D. (eds.) Terrestrial Conservation Lagerstätten: Windows into the Evolution of Life on Land, 65–104. Edinburgh: Dunedin Academic Press.

Poster: Neue Fundhorizonte außergewöhnlich gut erhaltener Pflanzenfossilien in der Obertrias des Transantarktischen Gebirges

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Das Transantarktische Beckensystem überliefert eine bis zu 4 km mächtige Abfolge paläozoischer und mesozoischer Sedimentgesteine, die einige bedeutsame Fossilvorkommen enthalten. Von besonderem Interesse sind permische und triassische Pflanzenfossilien, die sowohl in Form von Verkieselungen wie auch in Kutikularerhaltung überliefert sein können. Dies erlaubt besonders detaillierte Untersuchungen zur Systematik, Biologie und Ökologie der permischen und triassischen Vegetation in den hohen Breiten Gondwanas. Dennoch sind wegen des enormen logistischen Aufwandes und der herausfordernden Geländearbeiten vor Ort nach wie vor viele Aufschlussgebiete des Transantarktischen Gebirges nur unzureichend erforscht. Im Rahmen der 13. German Antarctic North Victorialand Expedition (GANOVEX XIII) 2018/2019 wurden bei geologischen und paläontologischen Geländearbeiten in verschiedenen Gebiete der Prince Albert Mountains neue Vorkommen triassischer Pflanzenfossilien entdeckt und beprobt. Die meisten dieser neuen Fundstellen befinden sich rund um den Timber Peak am Priestley Gletscher in den nördlichen Prince Albert Mountains.

Die artenreichste Abdruckflora stammt von einem kleinen, unbenannten Nunatak westlich Timber Peak, und setzt sich zusammen aus fünf Arten des Samenfarnwedels *Dicroidium* sowie breitblättrigen Koniferennadeln (*Heidiphyllum elongatum*), weiteren Samenfarnblättern (*Dejerseya lobata*, *Linguifolium* spp.) sowie auch den Pollenorganen (*Pteruchus africanus*) und dispersen Samen (*Feruglioa*) der *Dicroidium* Gewächse. Säureaufbereitung eines weiteren, Pflanzenhäcksel-reichen Horizontes von diesem Fundpunkt hat zudem große Mengen hervorragend erhaltener Kutikulen einer *Dicroidium* Art mit nadelartiger Beblätterung geliefert. Weitere Fundhorizonte sind entlang der Geländekante des Polar Plateaus südöstlich des Timber Peak aufgeschlossen; neben stark alterierten Abdruckresten von *Heidiphyllum* und *Linguifolium* gibt es hier ein artenarmes Massenvorkommen von zwei Beblätterungstypen—einer nadelartigen *Dicroidium* Art und einer schmalblättrigen *Linguifolium*—mit den vermutlich dazugehörigen dispersen Samen (*Feruglioa* bzw. *Carpolithus*) und einer winzigen *Pteruchus* Art. Darüber hinaus wurde am Benson Knob in den Ricker Hills, südliche Prince Albert Mountains, eine weitere artenreiche Pflanzenfossilvergesellschaftung gefunden, die sich aus vier *Dicroidium*-Arten, *Heidiphyllum*, *Linguifolium*, sowie Schachtelhalmen zusammensetzt.

Die Studie dieser neuen Fundstellen ist von großer Bedeutung, da sie zeigt, dass die Triasfloren des Transantarktischen Gebirges noch diverser sind als bislang bekannt. Unter den beschriebenen Taxa finden sich Formen, die sich präzise Arten zuordnen lassen können, die erst kürzlich aus der Obertrias Südaustraliens beschrieben wurden (Unverfärth et al. 2022). Darüber hinaus bieten insbesondere die artenarmen Vergesellschaftungen ein großes Potential, Organzusammenhänge zu rekonstruieren und so zu sogenannten „whole-plant reconstructions" beizutragen. Die durch diese Studie gewonnen neuen Ergebnisse liefern uns eine bessere Kenntnis über die polaren Wälder Gondwanas während der mesozoischen Warmzeit.

Referenz:

Unverfärth, J., McLoughlin, S. & Bomfleur, B. 2022. Mummified *Dicroidium* (Umkomasiales) leaves and reproductive organs from the Upper Triassic of South Australia. *Paleontographica Abteilung B* 304 (5-6), 149-225. https://dx.doi.org/10.1127/palb/2022/0079

(S2) Jurassic and Cretaceous Oceanic Anoxic Events — faunal and floral response (Organization: Jörg Mutterlose, Alexander Nützel)

The marine sedimentary sequences of the Early Jurassic and Late Cretaceous are characterized by the widespread occurrence of black shale deposits, caused by perturbations of the ocean system. The perturbations, commonly addressed as oceanic anoxic events (OAEs), are linked to warm and humid greenhouse conditions. These in turn are related to increased volcanic activity and related high CO_2 concentrations, exceeding our current levels of ca. 400 ppm by a factor of 1.5 – 3x. In this session we want to address the response of marine and continental ecosystems related to the environmental disturbances of the OAEs. We therefore suggest a session which is focussed on the course and the timing of environmental and biotic changes, across OAEs.

The following topics are of specific interest: a) Do we see major shifts in organisms with specific habitats? b) What are the evolutionary patterns of planktonic and benthic organisms? c) Which groups became extinct, which survived? d) Are the shifts and modifications permanent? e) Are there specific organism with a higher resilience? Contributions covering both continental and marine biota are welcome.

Talk: Cretaceous Oceanic Anoxic Events – faunal and floral response of marine calcifiers

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The marine sediments of the Cretaceous are characterized by the widespread occurrence of black shale deposits, caused by perturbations of the ocean system. Commonly addressed as oceanic anoxic events (OAEs) these perturbations are linked to increased volcanic activity. The resulting high CO_2

concentrations exceed our current levels of ca. 400 ppm by a factor of 1.5–3 x. Here we address the response of the marine calcifiers related to the environmental disturbances of the Cretaceous OAEs.

Diversity patterns of calcareous nannofossils, calcispheres, planktonic foraminifers and corals trace the evolution of Cretaceous sea-level. Dasycladalean algae, larger benthic foraminifera, corals and rudist bivalves document significant reductions at the level of the OAEs. Aragonitic or aragonite-dominated benthic carbonate producers are most affected during extinction events related to OAEs, and a general trend of decreasing aragonite dominance throughout the Cretaceous has been observed. The demise of aragonitic or aragonite-dominated carbonate producers at OAE1a (early Aptian) and OAE2 (Cenomanian–Turonian boundary interval) may be related to short episodes of reduced seawater carbonate-saturation caused by short-lived injections of CO from large igneous provinces that initiated the OAEs. The expansion of suitable habitats during episodes of high sea level and high temperatures is thought to have controlled diversity patterns of calcareous nannofossils, planktonic foraminifers, and corals rather than changes in seawater chemistry. An increase in the relative number of azooxanthellate coral genera following OAE1a and OAE2 suggests a disruption of photosymbiosis due to high temperatures, although the relative numbers of azooxanthellate genera continued to increase during the Late Cretaceous, when global temperatures declined. Due to the short residence time of major nutrients in seawater, these may have affected carbonate-producing ecosystems regionally, but not on a global scale.

Talk: Ecological adaptation of marine biota across the Early Jurassic Toarcian Oceanic Anoxic Event

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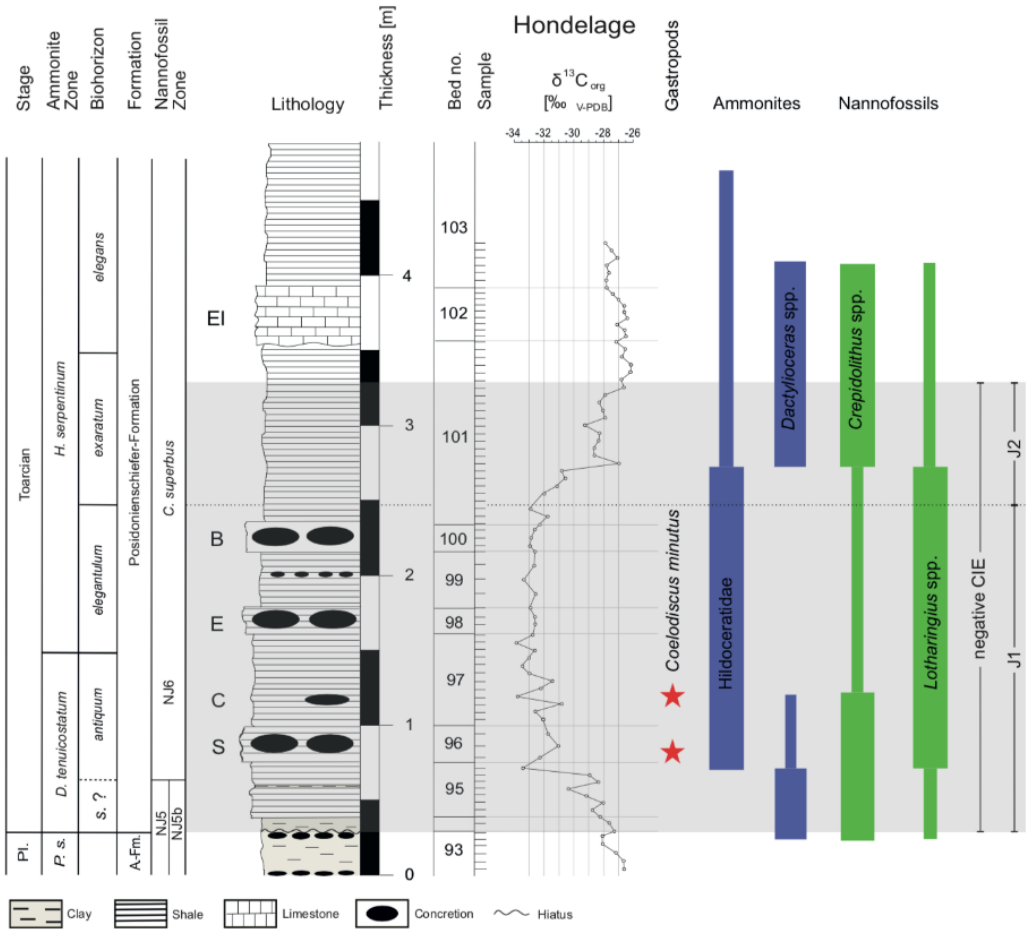
We present new, high resolution bio- and chemostratigraphic data (calcareous nannofossils, ammonites, $\delta^{13}C_{org}$) of the Early Toarcian from an outcrop (Hondelage) in northern Germany. The three data sets, which cover lithostratigraphically the uppermost Amaltheenton Formation (Upper Pliensbachian) and the lower part of the Posidonienschiefer Formation (Lower Toarcian), allow a calibration of the different stratigraphic schemes in ultra high resolution.

The base of the negative $\delta^{13}C_{org}$ excursion, which defines the Early Toarcian Oceanic Anoxic Event (T-OAE), coincides with the first occurrence of the calcareous nannofossil species *Carinolithus superbus crassus* and *Diductius constans*. These events are biostratigraphically assigned to the *Tiltoniceras antiquum* ammonite Biohorizon, the uppermost unit of the *Dactylioceras tenuicostatum* ammonite Zone. The top of the T-OAE has been assigned to the *Cleviceras exaratum* ammonite Subzone (*Harpoceras serpentinum* ammonite Zone) of the Lower Toarcian.

The extreme impoverished nannofossil and ammonite assemblages of the latest Pliensbachian are interpreted in the context of a cooling event, primarily effecting the calcareous shelled primary producers. The onset of the T-OAE in the Early Toarcian post-dates this cooling and is related to a subsequent warming. This climatic shift caused a bloom of diverse and rich opportunistic nannofossil and ammonite taxa in the Early Toarcian. Nannofossil abundances were controlled by an increased nutrient availability. The rapid evolution of hildo-ceratid ammonites, which started in the lowermost part of the T-OAE, is related to their adaptation to a shallow water dwelling habitat. The mass occurrence of the earliest ho-loplanktonic gastropods in the lowermost part of the T-OAE is interpreted in the context of impoverished ocean water oxygenation, which in turn triggered the evolution of a new ecological strategy.



The basal part of the T-OAE is marked by a) the evolution of holoplanktonic gastropods, b) the radiation of hildoceratid ammonites, and an abundance decrease of the ammonite Dactylioceras *spp. and c) an increase of shallow dwelling calcareous nannofossils (*Lotharingius *spp.). After Mutterlose et al. (2022).*

Reference:

Mutterlose, J., Klopschar, M. & Visentin, S. 2022. Ecological adaptation of marine floras and faunas across the Early Jurassic Toarcian Oceanic Anoxic Event – A case study from northern Germany. *Paleogeography, Paleoclimatology, Paleoecology* 602, 111176. https://doi.org/10.1016/j.paleo.2022.111176

Talk: Biotic response to the Toarcian anoxic event - the evolution of holoplanktonic gastropods

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The evolution and origin of holoplanktonic gastropods (spending their entire life in the plankton), which are common in Cenozoic marine sediments, is poorly understood. The putative holoplanktonic species *Coelodiscus minu*tus has been described from Early Jurassic sediments from Germany. The stratigraphic interval under discussion is characterised by a distinctive, negative $\delta^{13}C_{org}$ excursion, which defines the Early Toarcian Oceanic Anoxic Event (T-OAE) on a global scale.

The diagnosis of a holoplanktonic lifestyle is based on circumstantial evidence: Putative holoplanktic fossil gastropods are small, thin-shelled, they commonly appear in anoxic or dysoxic facies devoid or largely devoid of benthic faunas. They are commonly forming monospecific assemblages or are the dominant species in impoverished assemblages. The best example for such a gastropod is *C. minutus* that is missing in the Pliensbachian of Germany but becomes highly abundant, sometimes rock-forming, in the Early Toarcian anoxic Posidonia Shale. This species is still abundant in the Upper Toarcian of southern Germany and becomes less abundant in the Aalenian when benthic assemblages became more diverse indicating the cessation of anoxia. Further putative holoplanktonic genera (*Tatediscus*, *Pterotrachea*, *Globuliropsis*, *Simoniceras*, *Freboldia*) have been reported from the Pliensbachian/Toarcian-transition of Germany, England, Luxembourg, and the Canadian Arctic. Only *Freboldia* has a pre-Jurassic fossil record (Middle Triassic).

We hypothesize that the T-OAE triggered the evolution and proliferation of the holoplanktonic lifestyle in gastropods. The evolution from benthic predecessors via heterochrony was most likely related to increasingly dysoxic conditions causing hostile conditions for benthic organisms. A taphonomic bias cannot be excluded, especially low grade bioturbation or the absence of bioturbation in the Posidonia Shale may have favoured the preservation of these extremely thin-shelled, fragile gastropods. Independent evidence for this scenario comes from the calcareous nannofossil record in a section in southern Germany, where nannofossils are absent in the Upper Pliensbachian, but very abundant in the Lower Toarcian - the same pattern as recorded for the gastropod *C. minutus*.

Poster: Late Jurassic elasmobranch fishes

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Elasmobranchs (sharks, rays, skates) represent one of the most successful vertebrate groups, spanning a long geological time and continuously occupying essential roles in the food chain as predators and regulators of other groups. Notwithstanding recent attempts to improve our knowledge of shark and batoids (rays and skates) paleobiodiversity patterns, our understanding of phylogenetic relations of fossils taxa during extended times of their evolutionary history remains inadequate. Although the Late Jurassic-Early Cretaceous interval (164-100 Ma) represents one of the main transitional periods in life history, this interval has received little attention in the case of elasmobranch fishes. Based on the fossil record, both sharks and batoids were already easily recognizable by this time, and representatives for both clades were already present, seemingly undergoing a phase of increasing diversification during this period, eventually displacing more plesiomorphic groups like the hybodonts, but also supposed stem group members such as the Synechodontiformes.

We present a comprehensive morphological revision of several fossil taxa with relatively well-preserved remains (skeletal remains) within a systematic framework and, for some of the fossil taxa, the first attempt to place them within a phylogenetic context. Our study is based on a new morphological character matrix produced from the revision of several holomorphic specimens housed in different European collections and expands with the inclusion of previously published matrices, including not only Mesozoic taxa but also Paleozoic and Cenozoic taxa. Parsimony, maximum

likelihood, and Bayesian approaches are used, aiming to provide a fresh outlook and a complete picture of the phylogenetic relations of these extinct elasmobranchs.

This research was funded in part, by the Austrian Science Fund (FWF) [P 33820, P 35357B].

(S3) Closing biostratigraphical and paleobiogeographical gaps: Cenozoic fossil evidence from Central Germany and adjacent regions (Organization: Martina Stebich, Lutz Christian Maul, Dana Höfer und Peter Frenzel)

The Cenozoic floral and faunal history in Central Europe is documented by a wealth of fossil records providing key information on the evolution of continental ecosystems, biodiversity and climate change.

The fossil assemblages of this region are particularly valuable for the study of past biotic turnover and relationships among the floristic and faunistic regions of Europe. Special significance of this region arises from the shifting influences of the North Atlantic maritime and the Eurasian continental climate during the Cenozoic environmental changes. In addition, the widespread occurrence of Pleistocene landforms, glacial deposits, and river terraces allows direct relationships to be established between the fossil record, landscape history, and specific glacial cycles.

However, spatially and temporally highly variable depositional environments, including the erosive impact of Pleistocene ice sheets, have left a complex and fragmentary record of fossil assemblages in this region. The resulting gaps in the fossil record constitute a major challenge for the stratigraphic classification of individual fossil assemblages as well as their paleobiogeographical linkage.

We invite contributions for a session on Cenozoic fossil assemblages from Central Europe to discuss their evolution in the context of shifting climate and biogeography. We appreciate contributions on the following topics: Biostratigraphy, paleoecology, evolution and biostratigraphy of special fossil sites or special groups of animals, plants and other biotic remains, based on various analytic approaches.

Talk: Palynological studies on biostratigraphy and paleoenvironment of the Pleistocene in Thuringia

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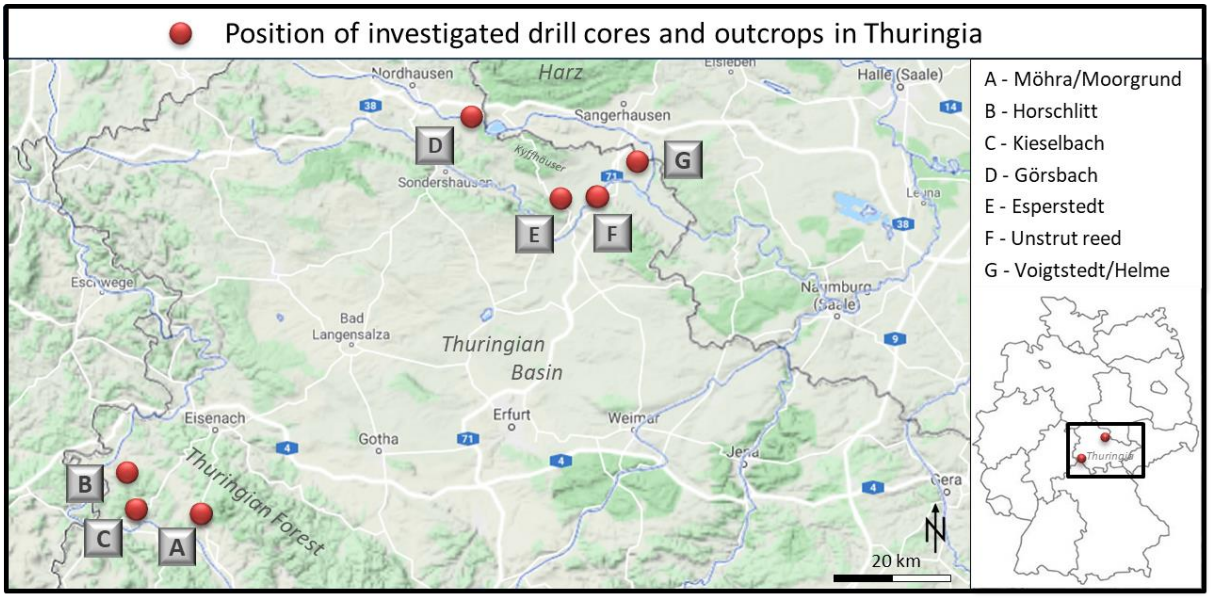
A joint project at the Senckenberg Research Station of Quaternary Paleontology funded by the Thuringian State Office for Environment, Mining and Nature Conservation provides new insights into the biostratigraphic classification of Lower to Middle Pleistocene vegetation successions. The aim of this work is a better understanding of Quaternary vegetation dynamics and climate variability as well as spatial and temporal subrosion events within the biogeographic-climatic bridge region of Central Germany. Furthermore, the investigations intend to clarify existing uncertainties in the correlation of local stratigraphically recorded warm and cold phases of central Germany with supraregional standard profiles.

The majority of the investigated sediments are located in northern Thuringia in the Unstrut (E, F) and Helme (D, G) catchment areas. In total, 23 partly fragmentarily preserved interglacial sequences were

found, which in parts can be assigned to the same time periods. Highlights of the palynologically investigated cores of Möhra (A), Voigtstedt (G) and Esperstedt (E) could be correlated to the pollen data of the interglacials of Osterholz, Augustovian, and Holsteinian. In the alluvial zones of the Unstrut and Helme rivers numerous exploratory drill cores were palynologically studied and assigned predominantly to the Saalian complex. The most complete core of FB Art 1/2020 (F) resulted in a total of three post-Elsterian interglacial sections. Eight infrared radio fluorescence dating results support the biostratigraphical assignment of the two younger interglacial sections to MIS 7a and c and suggest a classification of the oldest warm phase preserved in the core to MIS 9. Clear parallels can also be seen by comparing with the pollen data of the Neualbenreuth Maar, whose sediments comprise a complete sequence from MIS 8 to MIS 5 in superposition. Thus, the profile of the core FB Art 1/2020 is the first evidence of the interglacials of MIS 9 and MIS 7 in stratigraphic superposition in Thuringia.

The synopsis of the collected palynological data enables a classification of the investigated sediments ranging from younger Lower Pleistocene through Cromerian, Holsteinian, and Saalian archives to the Holocene. In addition to the palynological results providing new insights on Quaternary vegetation and climate history, the new data shed some light on the spatial and temporal heterogeneity of the subrosion processes in the Werra valley and the large subrosion depressions, which overlay the salt slope south of the Harz and Kyffhäuser mountains.



Talk: Did the Arternian interglacial immediately follow the 0.9 Ma event within the Early-Middle-Pleistocene transition? – clues from the Muscheltone macroflora of Voigtstedt, Thuringia

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At a site near Voigtstedt in the Northern Thuringian Basin, two interglacial sedimentary sequences are preserved in superposition. Pollen data allowed for the determination of a distinct 'Arternian' interglacial, represented as type sequence by the so-called '*Muscheltone*' (shell clay) deposits, and of a younger 'Voigtstedtian' interglacial preserved in the overlying '*Lehmzone*' (loamy zone) sequence (Erd 1965). The *Lehmzone* sequence revealed, in its lower part, a rich early Middle Pleistocene vertebrate assemblage and is regarded as a reference for this stage in Europe (Kahlke 1965). For the Arternian sequence, more recent multi-disciplinary studies suggested a late Early Pleistocene age, i.e.,

as old as or older than MIS 21 based on biostratigraphical findings and a magnetization dominantly inverted throughout the sequence placing it into the Matuyama chron of the paleomagnetic record (Maul et al. 2013).

The here presented paleobotanical results draw upon macroscopic plant remains preserved in the *Muscheltone* sequence, which consists of clayey and silty sediments indicating lacustrine sedimentation with temporal fluvial influence (Maul et al. 2013). Altogether 135 plant taxa were identified from a total of about 16,000 macrofossils mainly originating from aquatic and marshland plants with only a small input of terrestrial taxa. Considering the Early Pleistocene age of the Arternian macro-flora, the relative low percentage of extinct species such as *Alisma plantago-minima, Stratiotes brevispermus, Scirpus atroviroides*, *Eleocharis praemaximowiczii, Ranunculus gailensis,* and *Oenanthe mazovica* is remarkable. Erd (1965), in his first analysis of the Voigtstedt pollen record, concluded from the sparsity of Tertiary relict taxa that a prolonged and profound cold stage must have occurred prior to the deposition of the *Muscheltone* sequence resulting in a large-scale extinction of thermo-philous plant taxa. Macrofloras with corresponding stratigraphic position are preserved in Augustovian deposits in NE-Poland (Stachowicz-Rybka 2011) and in a clay quarry near Korchevo in Belarus (Mamakova & Rylova 2007), both resting on the oldest till in the respective study area – the Nidanian in Poland and the Narevian in Belarus. Consequently, both floras formed during an interglacial that immediately followed the first profound glaciation in Eastern Europe correlated with MIS 22. Similar species compositions at the three sites suggest a more or less coincident time range of deposition. All the extinct species recovered in the Arternian assemblage were also detected in the Augustovian and partially in the Korchevian macrofloras with few other extinct species not present in the Arternian record. The scarcity of Tertiary relict taxa in both, the old pollen and the recent macrofossil data of the Arternian sequence and the analogy with East-European macrofloras assumed to have formed directly after MIS 22 make it reasonable to correlate the Arternian Interglacial with MIS 21 and place the studied assemblage into a pivotal period of the Quaternary environmental evolution – the culmination of the Early-Middle Pleistocene transition. Spanning marine isotope stages 24-22, the period directly prior to MIS 21 was the longest and harshest cold phase hitherto as it was the first cold stage that followed the 100 kyr cyclicity. Corresponding with the cold maximum of MIS 22 (about 880-870 kyr), the 0.9 Ma event was characterized by the first major build-up of global ice volume. As result of the large-scale extinction of thermophilous plant taxa during this event, the Arternian flora was considerably depleted in comparison to earlier warm stages.

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Talk: Paleobiogeographic relationships between the Eocene Fossillagerstätten Messel (Germany) and Green River (USA)

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The Eocene Fossillagerstätten Messel in Germany and Green River in the USA have each yielded numerous well-preserved fossils, among them many thousands of insects (e.g., Grande 2013, Wedmann 2018). Insects offer insights both into the evolution of the diversity of different insect groups and into paleobiogeography (e.g., Archibald et al. 2011; Wedmann 2018; Wedmann et al. 2021). Both Eocene fossil sites had a warm climate at mid-latitudes and could serve as natural analogs of our future climate with high levels of CO_2 (compare Burke et al. 2018). Until now, two insect genera have been identified that occur in Messel as well as in Green River. The extinct giant ants belonging to the genus *Titanomyrma* (Hymenoptera: Formicidae) have been found to be present both in Messel and in Green River (Archibald et al. 2011). Giant ants were shown to be thermophilic and the distribution in North America and Europe implies that migration took place during a hyperthermal episode in the beginning of the Cenozoic (Archibald et al. 2011). Only recently, the peculiar, extinct genus *Eospinosus* belonging to the stink bugs (Heteroptera: Pentatomidae) was recorded in both fossil localities. These bugs have prominent spines on the body which function might be defense against predators (Wedmann et al. 2021). These taxa document - together with some other records - strong biogeographic ties between Green River and Messel. Brikiatis (2014) outlined scenarios for the biogeographical development among the Northern hemisphere landmasses during the early Cenozoic. Archibald et al. (2011) inferred that for thermophilic insect taxa like giant ants intercontinental migration might have been possible during hyperthermals of the early Paleogene.

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(S4) Paleoichnology — new occurrences, methods, applications, data (Organization: Michael Buchwitz, Anna Pint)

Modern trace fossil research has profited, among others, from more rigorous documentation by means of surface models, application of quantitative approaches, detailed investigation of trace-tracemaker relationships and new actualistic studies (neoichnology), but also from new ichnofossil discoveries, re-investigation of known occurrences and improved accessibility of ichnological data through digital data collections. This PalGes session is open for invertebrate and vertebrate ichnology studies and those of related fields (paleoecology, sedimentology, functional morphology and ethology) that also include ichnological data.

Talk: The beetle boring Pectichnus multicylindricus – formation, host response, and distribution

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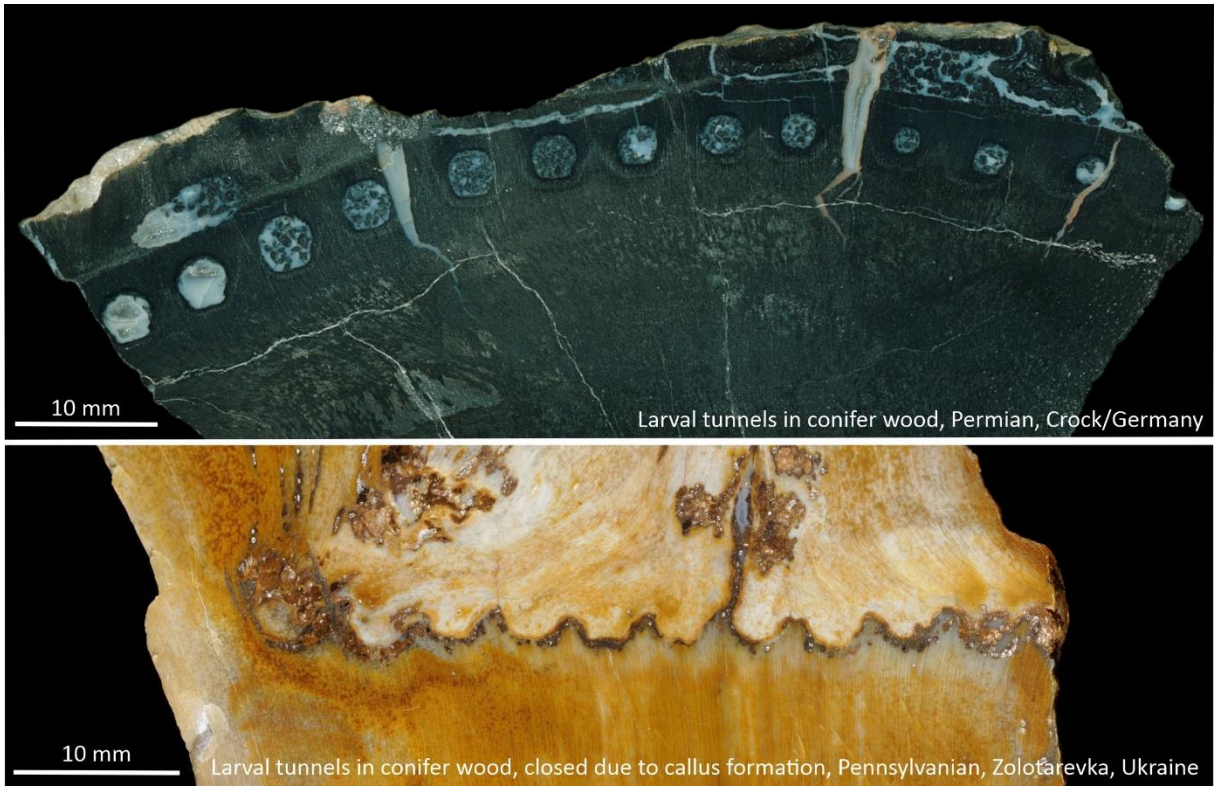

The feeding trace *Pectichnus multicylindricus*, known from the wood of Late Paleozoic conifers and caused by the larvae of early beetles, is documented with new finds for three more occurrences of Carboniferous–Permian sedimentary basins in central and southeast Europe. As a result, we can trace the stratigraphic range of its first occurrence to the late Carboniferous (Stephanian, Gzhelian). The results underscore the ecological importance of insects even in very distant terrestrial habitats in Earth's history. Since both conifers and beetles first appeared in the late Carboniferous and the feeding track seems to be restricted to conifers, the late Carboniferous is probably close to the highest age of their appearance in Earth's history. Furthermore, the new finds extend the paleogeographic distribution from Rhineland-Palatinate over central Germany, Northern Bohemia, Southern Poland, and Eastern Ukraine to the Northwest of China. The recognition value of the typical feeding track gives reason to hope for further evidence in petrified wood collections of other geological periods and

regions. The conifers living during the formation of the boreholes show multiple reactions, such as the formation of callus tissue from the vascular cambium or from the medullary rays, which can lead to the partial or complete closure of the wound and the individual boreholes. Furthermore, the tracheids adjacent to the borer ducts show intense swelling and lumen reductions, which indicate fungal infestation leading to selective delignification of the wood's tracheids.

References:

Feng, Z., Wang, J., Rößler, R., Ślipiński, A. & Labandeira, C. 2017. Late Permian wood-borings reveal an intricate network of ecological relationships. *Nature Communications* 8, 556.

Feng, Z., Bertling, M., Noll, R., Ślipiński, A. & Rößler, R. 2019. Beetle borings in wood with host response in early Permian conifers from Germany. *Paläontologische Zeitschrift* 93 (3), 409–421.

Talk: First record of dinosaur trackways from Kyrgyzstan, Central Asia

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Jurassic and Cretaceous sedimentary successions of Central Asia have yielded a variety of dinosaur fossils. In particular, body remains of theropods, sauropods and ornithopods have been identified in the Cretaceous deposits of Kyrgyzstan. In contrast, dinosaurian tracks that provide further insight into the biogeography and behavior of their producers have previously been described only from the neighbouring countries.

We report on the first evidence of dinosaurian footprints from Kyrgyzstan found in the surroundings of Mayluu Suu (Jalal-Abad Region, Southwest Kyrgyzstan). The area is characterized by large-scale folding of Mesozoic and Cenozoic sediments and, as a result, by frequent landslides along the dipping unit boundaries. This leads to periodic appearance of new outcrops including potential trackway surfaces.

The studied surface is referred to the Nichkesai Formation, which is dated as Campanian–Maastrichtian by bivalves. It is formed by sandy limestone and interpreted as tidal flat deposits subject to periodic subaerial exposure. The surface has been exposed by a landslide that removed Cenozoic cover and was discovered by the last author in 2001. Measurements, stratigraphic and photogrammetric documentation were undertaken in 2022 (Flannery-Sutherland et al. 2023).

The 100 m long and maximally 15 m wide slope dipping 30° to the north exhibits at least five longitudinal series of regularly distributed pairs of impressions. The better-preserved imprints show tridactyl morphology. Trackway 1 consists of nine 32–43 cm long impressions that are removed from one another by about 80 cm longitudinal distance. Trackways 2 to 5 are composed of 14–22 (maximally 27) cm long imprints longitudinally spaced by about 60 cm. The anatomical fidelity of the imprints is

insufficient as to conclude whether the larger tracks derive from another taxon or conspecific larger individuals. Body length is estimated to about 4 m in the case of trackway 1 and 3–3.5 m in the case of trackways 2–5. We consider large non-avian theropods or ornithopods to be the possible trackmakers, with a preference for theropods because of the diverging orientation of the footprints.

Reference:

Flannery-Sutherland, J.T., Kogan, I., Trubin, Y.S., Falkingham, P.L., Winkler, A., Donner De Sousa, D., Krylov, K.D., Pokhaznikova, A.A., Derbisheva, M., Kapitany, T. & Dudashvili, A. 2023. Dinosaur trackways from the Upper Cretaceous Nichkesai Formation near Mayluu Suu City, Southern Tien Shan Mountains, north-western Kyrgyzstan. *Royal Society Open Science* 10, 230311. https://doi.org/10.1098/rsos.230311

Talk: Revision of a most diverse tetrapod ichnoassemblage from the Buntsandstein (early Anisian, Middle Triassic) of Germany

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The Anisian is characterized by the definitive recovery of terrestrial faunas after the end-Permian mass extinction. One of the most significant examples is the tetrapod ichnoassociation from the Chirotherien-Sandstein Member of the Solling Formation, Middle Buntsandstein, central Germany, dated as early Anisian. This unit includes the famous Winzer quarry near Hildburghausen, which is the type locality of *Chirotherium* and a subject of numerous studies and analyses of this footprint assemblage, a worldwide reference for ichnological research. Conversely, a different locality at Hildburghausen belonging to the same unit, the "Badeanstalt", has never been re-studied after the first description and documentation by Rühle von Lilienstern (1939). We revise the original material, a 14 m^2 composite marly surface with footprints preserved in convex hyporelief, sorting the trace fossils by means of morphological preservation and employing digital photogrammetry. Results evidence the presence of a diverse archosauromorph ichnofauna with *Chirotherium barthii*, *C. sickleri*, *Isochirotherium herculis*, *I. soergeli*, *Synaptichnium pseudosuchoides*, "*Brachychirotherium*" and *Rotodactylus matthesi*. Another abundant diapsid footprint is *Rhynchosauroides schochardti*, while those of therapsids, such as *Dicynodontipus geinitzi* and cf. *Procolophonichnium* as well as the probable footprints of stem turtles assigned to *Chelonipus torquatus*, are less common. This is the most diverse tetrapod ichnoassociation from the Middle Buntsandstein. Moreover, its composition differs from the Winzer quarry ichnoassociation, because of the occurrence and abundance of *Rhynchosauroides*, *Chelonipus* and swimming traces, which are absent at the latter locality. Also, chirotheriid footprints are more diverse at the "Badeanstalt" locality. Interestingly, the footprint preservation differs significantly, because of the larger number of deformed tracks and sliding traces at the "Badeanstalt" locality. This may be due to a different depositional environment. The main track surface at the Winzer quarry locality represents a characteristic fluvial environment, whereas that from the "Badeanstalt" could possibly be indicative of a more distal environment, more similar to the overlying Muschelkalk facies. The tetrapod ichnoassociation clearly evidences a complete recovery and reconstruction of the fauna after the end-Permian mass extinction, and is of exceptional interest because of its diversity,

paleoecology and one of the first ichnological records suggesting a purported occurrence of stem turtles, which will be subject of further studies.

Reference:

Rühle von Lilienstern, H. 1939. Fährten und Spuren im Chirotherium-Sandstein von Südthüringen. *Fortschritte der Geologie und Paläontologie* 12, 293–387.

Talk: The archosaur ichnogenus *Brachychirotherium* (Chirotheriidae) – a reappraisal of purported Middle Triassic representatives

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Brachychirotherium *(A–B) and new ichnogenus (C–E) for comparison. (A)* B. hassfurtense*. (B)* B. thuringiacum*. (C)* "B." hessei*. (D)* "B." paraparvum*. (E)* "B." circaparvum*. (A–B) Hassberge Fm. (Upper Triassic, Carnian), Germany. (C) Roet Fm. (Middle Triassic, Anisian), Germany. (D) Vossenveld Fm. (Middle Triassic, Anisian), The Netherlands. (E) Grés Inférieurs (Middle Triassic, Anisian-Ladinian), France.*

The ichnogenus *Brachychirotherium* was introduced by Beurlen (1950) based on pes and manus imprints from the Coburger Sandstein (Hassberge Formation, Upper Triassic, Carnian) of northern Bavaria. It has a characteristic morphology including a wide pentadactyl pes imprint with short, broad digits and small claw traces, an oval impression of the digit V basal pad and digit proportions with pedal digit IV < II (Fig. A–B). Subsequently, different authors identified *Brachychirotherium* from Lower-Middle Triassic deposits of the Germanic Basin, but these earlier occurrences were controversial among ichnologists.

A comprehensive revision of material from Germany, France, The Netherlands, and Italy reveals significant morphological differences between the Upper Triassic type specimens and purported Lower-Middle Triassic *Brachychirotherium* specimens. It appears that several ichnospecies formerly assigned to *Brachychirotherium*, such as *B. hessei*, *B. paraparvum*, *B. praeparvum*, *B. paeneparvum*, *B. circaparvum*, and *B. pachydactylum* constitute a distinct chirotheriid ichnogenus that will be formally described and introduced by the authors in a paper in preparation (Fig. C–E). Significant morphological differences from *Brachychirotherium* are the more plantigrade pes imprint, which shows similarities with *Synaptichnium* by its tendency towards ectaxony and the presence of an elongated pedal digit V impression showing a phalangeal portion. In contrast, Late Triassic *Brachychirotherium* is mesaxonic, with a functionally tridactyl appearance and has a short oval pedal digit V impression lacking a phalangeal portion. Furthermore, the latter has a relatively smaller manus imprint.

Potential trackmakers of the new ichnogenus are non-crown group or crown group archosauriforms with a conservative pes morphology. Biostratigraphically, the new ichnogenus overlaps the stratigraphic range of the *Chirotherium barthii* and *Atreipus-Grallator* biochrons (Nonesian-Berdyankian) that can be cross-correlated with the Anisian-Ladinian.

Reference:

Beurlen, K. 1950. Neue Fährtenfunde aus der fränkischen Trias. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* 1950, 308–320.

Talk: *Procolophonichnium* from the middle to late Permian of the North German Basin

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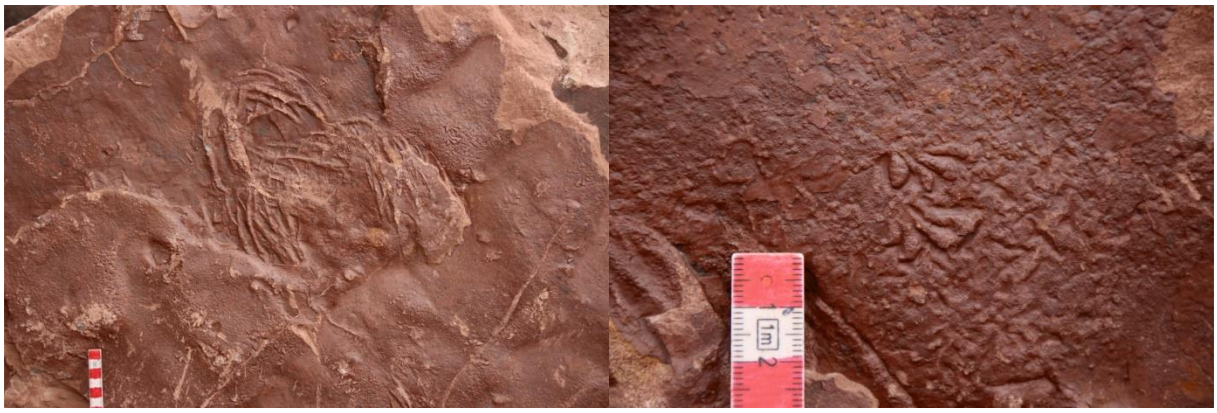

Co-occurrence of large burrows with notable claw marks and small reptile footprints on a bedding plane from the late Middle Permian succession exposed in Mammendorf quarry, Hohe Börde, central Germany.

Here we describe trackways, trample grounds, couples and individual footprints of a small reptilian trackmaker from the Mammendorf Quarry tracksite close to the city of Magdeburg (Saxony-Anhalt, Central Germany). The tracks occur within a succession of light-grey and red siliciclastic rocks which represent a wadi-like deposition system and are assigned to the Elbe Subgroup of the North German Basin. The small footprints quite commonly co-occur with 10 to 28 cm wide scratches and burrows of a larger trace producer on the same bedding plane. In their morphology, the footprints are largely similar to reptilian tracks of the nearby Eisleben Formation outcrop area (SE margin of the Harz Mountains) and can be assigned to the ichnogenus *Procolophonichnium*. We compare the trackway patterns of *Procolophonichnium* from Mammendorf to those of similar-sized Permian reptile track types and note a certain similarity to *Varanopus* and *Erpetopus* trackways that might be explained by a (remote) phylogenetic relationship of their producers.

Poster: An exceptionally diverse tetrapod track assemblage from the late Permian of SW Germany

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In the late Paleozoic late Permian (Wuchapingian/Changsingian) the subtropical shallow Zechstein Sea covered large parts of northern and central Europe. While its aquatic fauna is well known, our knowledge of the associated terrestrial fauna of the coastal lowlands is mainly restricted to washed-in body fossils in nearshore marine deposits (Haubold & Schaumberg 1985). Remains of autochthonous to parautochthonous faunal and floral elements, on the other hand, are extremely rare. In 2020, a hiker discovered a well-preserved fossil footprint measuring almost 22 cm in length in Zechstein red-beds from the boundary of the Rothenberg and Annweiler formations near Eschbach, southern Palatinate (Rhineland-Palatinate, SW Germany). It was the first evidence of its kind in Germany and led to systematic fossil exploration in the area. During three years of excavation abundant trace fossils and sedimentary marks could be uncovered. Besides plant remains such as conifers and plant roots, and invertebrate trace fossils like feeding traces and dwelling structures of insects, worms and crustaceans, especially the tetrapod ichnofauna of the terrestrial Zechstein could be considerably extended. The trace fossils of the Eschbach Zechstein are predominantly preserved in very fine-grained red-beds representing deposits of slowly flowing water, which headed in narrow and shallow channels towards the nearby Zechstein Sea. The muddy substrate preserved the tracks of a diverse tetrapod fauna that frequented such freshwater sites. Five morphotypes and footprint taxa can be distinguished so far. Track type I belongs to *Pachypes* and is the first evidence of the presence of large pareiasaurian parareptiles in European Zechstein coastal lowlands (Voigt & Fischer 2020). Until now only the dwarf form *Parasaurus* was known from skeletal fragments. Track type II can be assigned to *Dolomitipes*, whose producers are considered to have been meter-sized dicynodont therapsids. Track type III is *Paradoxichnium*, the putative track of the archosauromorph *Protorosaurus*. While more than 100 skeletal remains are known so far, tracks from the Zechstein are only known from the regions of Gera, Thuringia, and Neustadt/Weinstraße, Rhineland-Palatinate, in Germany (Voigt et al. 2021). Track type IV can be assigned to *Hyloidichnus* and is represented by meter long step cycles. It is attributed to capthorhinids such as *Moradisaurus*, which is so far only known by a few tracks and incomplete skeletal remains from W and NW Africa. The Eschbach *Hyloidichnus* footprints are therefore the first evidence of large capthorhinids in the Lopingian of Europe. Track type V belongs to *Batrachichnus*, the track of temnospondyl and potentially lepospondyl amphibians. It is a possible evidence for the occurrence of branchiosaurid temnospondyls, which was considered doubtful so far (Haubold & Schaumberg 1985). Ongoing analyses of the extensive fossil tetrapod ichnofauna collected to date and future excavation campaigns may most likely extend the faunal list, in general for the coastal lowlands of the Zechstein Sea and especially for the Eschbach locality.

References:

Haubold, H. & Schaumberg, G. 1985. *Die Fossilien des Kuperschiefers*. Die Neue Brehm-Bücherei #333. Wittenberg Lutherstadt: A. Ziemsen Verlag.

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Poster: Large trace fossils from the Upper Cretaceous of the Fergana Basin (Kyrgyzstan, Central Asia)

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The Fergana Basin is an intermontane depression in Central Asia, located between the Tien Shan in the north and the Alay mountains in the south. It extends from eastern Uzbekistan to southwestern Kyrgyzstan and northern Tajikistan and exhibits a wide range of Paleozoic, Mesozoic, and Cenozoic deposits. The Mesozoic succession is represented by predominantly continental siliciclastics and coals and is rich in body and trace fossils of various types of organisms. Aiming at a better understanding of the sedimentological and paleontological conditions in the basin during the Late Cretaceous as well as the diversity of benthic communities that colonized and dwelled in the substrate, we here report on previously undescribed giant trace fossils from the Cenomanian-aged Kyzylpilyal Formation that are exposed close to the Madygen settlement within the area of the Madygen geopark (Batken Region, SW Kyrgyzstan).

The sediments of the outcrop are poorly stratified to massive sandstones and sandy siltstones of predominantly red color with white mottles. A complex of vertical columnar structures interpreted as burrows occurs near the base of the outcrop. The burrows have elongated non-dichotomous shape, irregular bulbous surfaces and nearly circular cross-sections of 10 to 16 cm diameter. Individual burrows can be traced for up to 1 m of vertical extent. The enclosing rock of the trace fossils is represented by moderately sorted medium sandstone that is cemented by micritic carbonate with rare small-sized crystals. The infilling rock is characterized as sandy siltstone that is cemented by micritic carbonate with coarse-size calcite crystals. Inside some burrows we found poorly preserved crab remains, which are about 6 to 10 cm in diameter. Based on size, orientation, surface markings and the branching pattern, the burrows can be referred to *Camborygma eumekenomos* Hasiotis & Mitchell, 1993.

We assume that the burrows have been produced by the crabs found in the same rock layers. The burrow size corresponds well to the size and shape of the crab fossils. The ichnia are well comparable to modern crab burrows and indicate a floodplain or deltaic-lacustrine setting. Further studies will deal with a more comprehensive reconstruction of the burrowing behavior and the burrow distribution across the basin.

Reference:

Hasiotis, S.T. & Mitchell, C.E. 1993. A comparison of crayfish burrow morphologies: Triassic and Holocene fossil, paleo- and neo-ichnological evidence, and the identification of their burrowing signatures. *Ichnos* 2 (4), 291–314.

(S5) Late Paleozoic terrestrial ecosystems (Organization: Jörg Fröbisch, Lorenzo Marchetti, Philipp Knaus)

The late Paleozoic was a time of profound changes in the terrestrial realm, shaping the evolution of all recent major plant and animal taxa. Key events and innovations include the terrestrialization of vertebrates, the radiation of amniotes (including reptiles and synapsids), the evolution of new ecological guilds (e.g. high-fibre herbivory, climbing, gliding, burrowing), and the origin of elevated metabolic rates. Moreover, new plant groups arise (such as seed plants), develop novel features, defy new insect damage types, diversify and form extensive swamps and forests.

Also, terrestrial invertebrates radiate, with regards both to diversity and occupation of ecological niches. This is also a key time interval for the study of ecosystem response to climate change, including the Late Paleozoic Ice Age, the Artinskian Warming Event, as well as the end-Guadalupian and end-Permian mass extinctions. The purpose of this session is to investigate through innovative methods the late Paleozoic biota and the exceptional amount of key information it can provide us, also in light of modern ecosystem crises.

Talk: Morphometric analysis of Paleozoic immatures of the group Insecta

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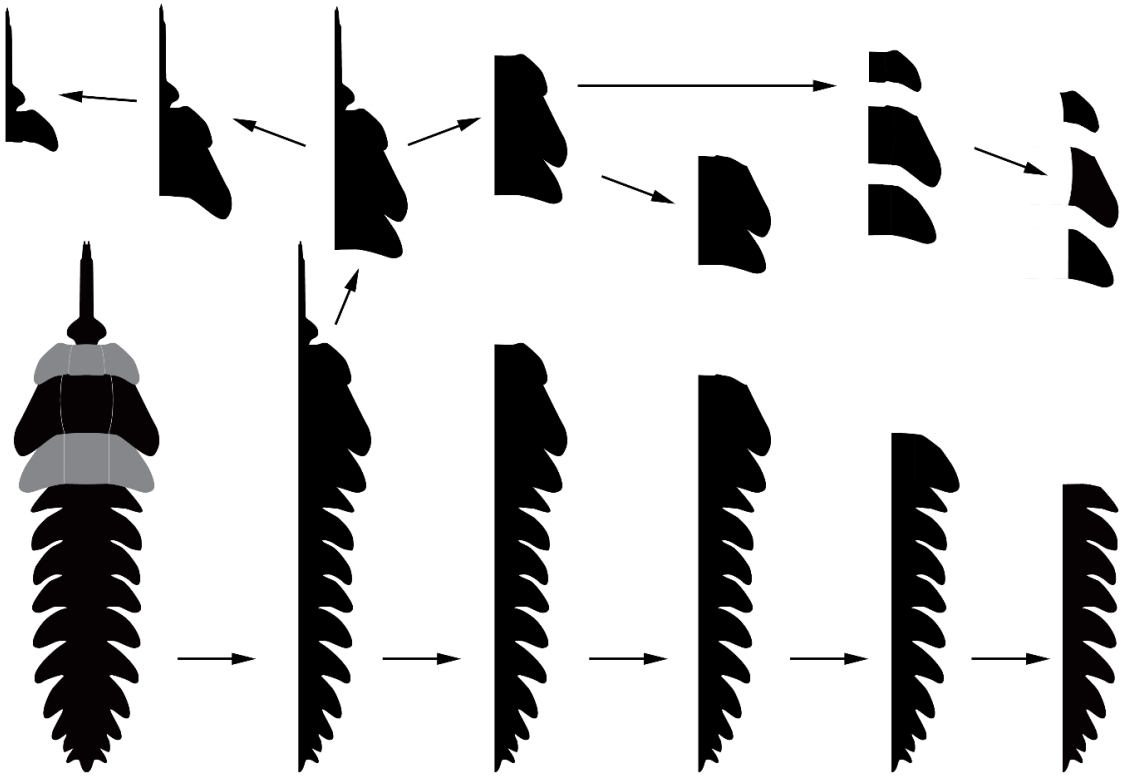

Method of splitting the body regions of the insect outline for different comparisons.

The group Insecta is dominating modern terrestrial and freshwater ecosystems. First fossils occur in the Devonian, the group starts to diversify in the Carboniferous. A generally accepted important factor for the success of Insecta is their ontogeny. Immatures are much rarer than adults in the fossil record

and challenging to interpret from a taxonomic perspective. Yet, it is still possible to compare the morphological diversity of Paleozoic immatures of Insecta. We here focus on comparing the Carboniferous and Permian period in a quantitative manner. Shape analysis was used to compare the overall diversity, taking into account the entire body, but also different body regions. This approach was especially necessary due to the fragmentary nature of some of the fossils. Outlines were drawn in dorsal view in the vector graphics program Inkscape based on literature and own images of the fossil specimens. In order to reduce the shape variation due to positioning and damage of fossil specimens, appendages such as antennae, mouthparts, walking legs, cerci and the terminal filament were excluded. In some cases the orientation of certain body parts needed to be aligned to the rest of the body, e.g. when the abdomen became curved during fossilization. Due to the bilateral symmetry only the right halves of the outlines were later compared with the program package SHAPE. To specify which body regions hold the largest diversity first the entire body was compared then certain body regions were excluded from the shape (Fig.). The excluded body regions were then compared to each other. The results indicate that there are indeed evolutionary quantitative changes from the Carboniferous to the Permian.

Talk: Giant arthropods of the Late Paleozoic and the oxygen story

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In the Late Paleozoic, some unusually large arthropods appeared. These include the largest ever land-living arthropod, Arthropleura, the almost iconic giant insect Meganeura, and, as we have recently published, giant cockroaches. Arthropleura was reconstructed from isolated exoskeleton finds from the early Permian of the Thuringian Forest Basin, Germany, and is about 2.20 m long and nearly 0.5 m wide (Schneider & Werneburg 2010). This size agrees with arthropleurid tracks up to about 50 cm width from various sites in the early Carboniferous of Scotland and the late Carboniferous of Nova Scotia, in Canada, and New Mexico, USA. The oldest body remains so far, from the Visean of Chemnitz-Borna, Germany, point to 0.8 m to 1 m body length. We, therefore, assumed an evolutionary increasing body size from the Visean to the early Permian. All the more surprising was a relatively complete find of 12 to 14 articulated tergites and paratergites from only slightly younger Visean strata of England (Davies et al. 2021). As a result, Arthropleura reached body lengths of 2.60 m already in the Visean. Gallery forests along rivers were the habitat of Arthropleura throughout the Euramerican paleotropical belt.

Late Paleozoic cockroaches have a mean forewing length of about 2 to 3 cm. Among them, the families Necymylacridae, Gyroblattidae and the Mylacridae genus Opsiomylacris exhibit the largest pre-Cenozoic blattoids with forewing lengths up to 7.5 cm (Schneider & Rößler 2023). The large gyroblattid wings typically co-occur with macrofossils of meso- to xerophilous habitat preferences, so so-called hinterland floras. The sudden appearance of these large-winged blattoids in the fossil record might have resulted from the decreasing differences between basinal wetlands and better-drained hinterlands by increasing climate seasonality since the latest Westphalian. The disappearance of the large-winged gyroblattids and necymylacrids before the end of the late Carboniferous is, at present, hard to explain because the associated mesophilous and xerophilous floras, with which they are associated, just started to flourish and became more common during the increasing dryer cycles in the early Permian. Opsiomylacrids disappear as far as known in the middle of the early Permian as the meganeurids, too.

The origin of giant arthropods is frequently linked to the increased atmospheric oxygen during the late Carboniferous and Permian. Their extinction should be connected to the fast decline of the oxygen content at the Permian–Triassic transition. However, the known stratigraphic range of giant arthropods is essentially discordant with the Paleozoic oxygen peaks. The first occurrence of those large arthropods predated significant increases in atmospheric oxygen, and the last occurrences predated the oxygen decline at the end of the Permian.

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Schneider, J.W. & Rößler, R. 2023. The Early History of Giant Cockroaches: Gyroblattids and Necymylacrids (Blattodea) of the Late Carboniferous. *Diversity* 15 (3), 429. https://doi.org/10.3390/d15030429

Talk: Sclerotic rings in Lower Permian diadectomorphs and Seymouria reveal diel activity patterns near the origin of amniotes

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Diel activity patterns are a fundamental factor of tetrapod ecology. Hence, tetrapod visual systems show specific adaptations to low- or bright light conditions, reflecting diverse diel activity patterns, such as nocturnality, cathemerality, crepuscularity, and diurnality. Sclerotic ring measurements have been established to allow reconstruction of light regime adaptation, (i.e., scotopic, mesopic, and photopic) in extinct dinosaurs and non-mammalian synapsids. Previous work suggests that synapsids were adapted to low light conditions (scotopic) since the bird-mammal split and nocturnal habits for the base of the mammalian branch of amniotes. Yet, the origins of low-light adaptations in amniote eyes remain unknown since neither their closest outgroups nor early sauropsids have been studied to date. Here we present the first 3D-reconstructed sclerotic rings of three diadectomorphs and a seymouriamorph, Carboniferous to Permian aged tetrapods close to the origin of amniotes. We used high-resolution CT-scans of skulls from the lower Permian Bromacker locality, Thuringia, Germany, to reveal sclerotic ring plates deep within the skulls of these taxa. 3D retrodeformation and reconstruction of the sclerotic rings allowed us to measure or approximate the sclerotic ring diameters. Employing phylogenetic flexible discriminant analysis and comparisons with previously published data, our data enabled us to reconstruct the plesiomorphic condition for light adaptations in amniotes. Since diadectomorphs represent some of the earliest high-fiber herbivores and considering herbivores are more commonly diurnal in recent taxa, our data sheds light on the emergence of this pattern in the earliest modern terrestrial ecosystems. Further study of additional anamniote and early sauropsid sclerotic rings will allow to more comprehensively track the emergence of diel activity patterns across the anamniote-amniote transition and within the second branch of amniotes.

Talk: The tetrapod footprint association from the Bromacker locality (Tambach Formation, early Permian, central Germany): ichnotaxonomy, paleoecology and evolutionary meaning

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Historically, the Bromacker locality of central Germany (Tambach Formation, Cisuralian) is known for the exceptional preservation and abundance of tetrapod footprints, which in some cases have been also successfully correlated to the extensive skeletal record from the same locality. In the framework of the project "Opening science: new ways of knowledge transfer using the example of the research project Bromacker", funded by the Federal Ministry of Research and Education, a revision of the tetrapod footprint material, coupled with the study of new findings resulting from new excavations, was undertaken. Only well-preserved footprints have been considered for the ichnosystematic assignments and track-trackmaker correlations with taxa from the same locality. Results highlight a more diverse ichnoassociation than previously known, listing footprints of diadectids (*Ichniotherium sphaerodactylum* and *I. cottae*), seymouriamorphs (*Amphisauropus* isp.), temnospondyls (*Limnopus* isp. and cf. *Batrachichnus* isp.), non-varanopid synapsids (*Dimetropus leisnerianus* and *D.* isp.), varanopids (*Tambachichnium schmidti*), araeoscelid diapsids/varanopids (*Dromopus* isp.), captorhinomorphs (*Notalacerta* isp.) and bolosaurian parareptiles (*Varanopus microdactylus*). Four different census methods were applied on the footprint material, evidencing a predominance of diadectid footprints, followed by non-varanopid synapsid and bolosaurian parareptile footprints. All the other ichnotaxa are rarer. Also, the depositional environment has a clear effect on the ichnoassociation and its preservation: the anamniote tracks *Amphisauropus*, *Limnopus* and *Batrachichnus* are found exclusively in the mudstone facies, in which the footprints are generally poorly-preserved and isolated (distal floodplain environment) and not in the sandstone facies, in which the footprints and trackways show optimal preservation (proximal floodplain environment). This tetrapod ichnoassociation clearly belongs to the *Dromopus* footprint biochron, so it is constrained between the late Asselian (295.8 $\pm$ 0.4 Ma, radiometric age on the underlying Rotterode Formation) and the early Artinskian. The predominance of herbivore ichnotaxa is noteworthy because generally different from earlier Paleozoic tracksites, and it seems to be consistent in both the analysed depositional environments, and also in agreement with the skeletal record at the same locality. The Bromacker locality acquires therefore even more importance from an ichnologic perspective, and has the potential to tackle a key moment in the evolutionary history of terrestrial vertebrates, in the framework of the climate change that affected Cisuralian ecosystems.

Talk: Morphology and ontogeny of carpus and tarsus in stereospondylomorph temnospondyls

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Skeletal ontogeny is well known in temnospondyls, the most diverse group of Paleozoic and Mesozoic amphibians. However, the elements of carpus and tarsus (i.e. the mesopodium) were always the last

bones to ossify relative to the other limb bones and with regard to the rest of the skeleton, and are preserved only in rare cases. Thus, in contrast to the other parts of the limb skeleton, little is known about the ontogeny and sequence of ossification of the temnospondyl carpus and tarsus. We intended to close this gap by studying the ontogenies of a number of Permo/Carboniferous stereospondylomorphs, the only temnospondyls with preserved growth series in which the successive ossification of carpals and tarsals can be traced.

Studying the degree of mesopodial ossification within the same species shows that it is not necessarily correlated with body size. This indicates that individual age rather than size determined the degree of mesopodial ossification in stereospondylomorphs and that the largest individuals are not necessarily the oldest ones.

In the stereospondylomorph tarsus, the distal tarsals show preaxial development in accordance with most early tetrapods and salamanders. However, the more proximal mesopodials exhibit postaxial dominance, i.e. the preaxial column (tibiale, centrale 1) consistently started to ossify after the central column (centralia 2-4, intermedium) and the postaxial column (fibulare). Likewise, we observed preaxial development of the distal carpals in the stereospondylomorph carpus, as in most early tetrapods for which a statement can be made. However, in contrast to the tarsus, the more proximal carpals were formed by preaxial development, i.e. the preaxial column (radiale, centrale 1) ossified after the central column (centralia 2-4, intermedium) and before the postaxial column (ulnare). This pattern is unique among known early tetrapods and occurs only in certain extant salamanders. Furthermore, ossification proceeded from distal to proximal in the central column of the stereospondylomorph carpus, whereas the ossification advanced from proximal to distal in the central column of the tarsus. Despite these differences, a general ossification pattern that started from proximolateral (intermedium or centrale 4) to mediodistal (distal tarsal and carpal 1) roughly in a diagonal line is common to all stereospondylomorph mesopodials investigated. This pattern might basically reflect the alignment of stress within the mesopodium during locomotion.

Our observations might point to a greater variability in the development of the mesopodium in stereospondylomorphs and probably other early tetrapods than in most extant tetrapods, possibly mirroring a similar variation as seen in the early phases of skeletogenesis in salamander carpus and tarsus.

Talk: Using finite element analyses to better characterize the complex relationship between limb morphology, microanatomy and posture and draw reliable paleoecological inferences in early amniotes and relatives

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A relationship between limb bone microanatomy and lifestyle adaptations (e.g. terrestrial, aquatic, flying) has been repeatedly demonstrated in extant tetrapods. The resulting inference models are commonly used to decipher the lifestyle of extinct taxa whose ecology is debated. However, such models often yield erroneous reconstructions contrasting with taphonomic and isotopic evidence when applied to early amniotes and relatives. For example, representatives of Diadectidae, basal Synapsida, Therapsida, and Pareiasauria that were most likely terrestrial, show microanatomical patterns consistent with extant pelagic species (i.e. thin to inexistent compact cortices and a medullary cavity filled by a trabecular network). We thus postulate that extant tetrapods are poor morpho-functional analogues to some Paleozoic groups when considering limb microanatomy alone. Here we perform finite element analysis simulations to further explore the complex relationship between limb bone morphology (i.e. stout *versus* elongated), internal three-dimensional microanatomy (i.e. cortical compactness, trabecular network architecture) and the biomechanical constraints associated to

posture in tetrapods (i.e. on the sprawling to parasagittal continuum). A first phase of our project focuses on the stylopodium (humerus and femur) of selected extant and extinct taxa for which we gathered high-resolution CT scans. Ultimately, our results will contribute to improve paleoecological inferences in early amniotes and relatives.

Funding: BMBF Funding - BROMACKER Project (01U02002B)

Talk: A fossil forest from Italy reveals that wetland conifers thrived in early Permian peri-Tethyan Pangea

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In-situ fossil forests are valuable biogenic archives for the structure and setting of paleocommunities and the ecology of their organisms. Here, we present the first trees preserved in growth position in their embedding strata from the Kungurian (lower Permian) Athesian Volcanic Group, Northern Italy—one of the most extensive volcanic successions of post-Variscan Euramerica. We reconstruct the structure, rise and demise, and paleoecology of the forest based on high-resolution documentation of facies architectures and petrography, and the paleontological and taphonomic characters of the fossil content. Generally, the fossiliferous strata record a volcanotectonically controlled base-level rise in a limnic, possibly endorheic wetland basin from a low-relief volcanic landscape. The forest, preserved as calcified stem bases with roots, grew during a short interval of lake-level stasis on a small deltaic sheetflood fan. The forest comprised trees less than 5 m tall with tabular root systems adapted to the waterlogged substrate, and was buried and destroyed by mass flows following rapid submergence. These mass-flow deposits yield parautochthonous woody debris providing anatomical evidence of conifers as the major arborescent plants of the fossil forest. Our results not only elucidate the root architecture of Paleozoic conifers, but also document the ecomorphological plasticity of these plants and substantiate the presence of coniferopsids in wetlands around the Carboniferous/Permian boundary. Further, the evidence of lake perenniality in the studied succession is the youngest known from the Permian of Europe, pointing to the highly differentiated late-icehouse impacts on continental environments in the Euramerican tropics.

Poster: Stable isotope analyses of vertebral bones and teeth from diadectids (tetrapoda), pedogenic carbonates and sediments from the lower Permian Lagerstätte Bromacker

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Within the Bromacker project (https://bromacker.de/), which is funded by the BMBF, the paleobiology of early terrestrial vertebrates and their habitats is being investigated. In addition to research on biodiversity changes through time, the evaluation of biomechanics and physiology of early tetrapods and exploration of their ecosystems, geology and climate, the involvement of the public represents a key aspect of the project.

As a part of a master thesis ("Geochemical and stable isotope analyses of bones and pedogenic carbonates from the lower Permian Lagerstätte Bromacker"), stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope analyses were performed on two vertebral bones of a diadectid, isolated pieces of bones, and four isolated diadectid teeth. In addition, pedogenic carbonates and sediments from the excavation and the drill core "Fb Altenbergen 01/2022" from depth 113-182 m were analyzed. The isotope data will be evaluated for taphonomic alteration and, where appropriate, used for climate reconstruction to complement other sources of data. In this poster, I present the sample collection and preparation, methodology, and preliminary results of this work.

Poster: Elgersburger Becken: Aufschluss-Kartierung und digitale Georeferenzierung mit GIS

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Innerhalb der Rotliegend-Gruppe des Thüringer-Wald-Sedimentbeckens (spätes Karbon bis Perm) befindet sich bei Elgersburg (Ilm-Kreis, Thüringen) ein Teilbecken, das so genannte Elgersburger Becken. Es ist ca. 6,5 km (OSO–WNW) x 1,5 km (SSW–NNO) groß. Dank zahlreicher natürlicher Böschungen sowie auflässiger Steinbrüche, Straßeneinschnitte und Lesesteine sind sowohl Sedimentgesteine und Vulkanite der Elgersburg-Formation (Oberrotliegend-Subgruppe, Perm) als auch darunter liegende Vulkanite (Ilmenau-/Oberhof-/Rotterode-Formationen) aufgeschlossen. Jüngere Sedimente der Zechstein- und Buntsandstein-Gruppen werden am Nordrand des Elgersburger Beckens tektonisch von der Elgersburg-Formation abgegrenzt. Lithostratigraphisch lässt sich die Elgersburg-Formation in sieben Untereinheiten (Members) einteilen: (1.) Schwalbenstein-Konglomerat mit vulkanischen Einschaltungen wie dem (2.) Wolfstein-Rhyolith, (3.) Elgersburg-„Rhyolith" und (4.) Rodaer „Melaphyr"; (5.) Rodaer Sandstein; (6.) Elgersburger Sandstein; (7.) Totenstein-Konglomerat. Im Rahmen der aktuellen Untersuchung wurden die wichtigsten Aufschlüsse im Elgersburger Becken kartiert. Vor Ort wurden die Koordinaten mit einem GPS-Gerät gemessen und anschließend in einem digitalen Geoinformationssystem (GIS) dargestellt. Hierfür wurde die Software qGIS verwendet. Für das digital erstellte, geologische 2D-Modell wurden bereits existierende Daten (tektonische Störungen, Stratigraphie) vom Antares-Kartendienst des Thüringer Landesamtes als Karten-Layer in qGIS importiert, georeferenziert und anschließend in ausgewählte Shapefiles konvertiert. Eine zu jedem Aufschluss angelegte qGIS-Attributtabelle enthält die folgenden Daten: Datum der Geländearbeit; GPS-Koordinaten; lithostratigraphisches Member; Fallrichtung; Fallwinkel; kurzer Vermerk („ja"/„nein") zum Vorhandensein digitaler Aufschlussfotos. Digitale Fotos zeigen Übersichtsaufnahmen (Größe der Aufschlüsse, Lagerungsverhältnisse, Gesteinsfarbe), Detailaufnahmen (Komposition, Korngrößen, Rundung bei Klasten) oder lokale Besonderheiten (Sedimentstrukturen, Fossilführung). Für die Poster-Präsentation wurden 20 Aufschlüsse des

Elgersburger Beckens im qGIS-Modell geplottet und mit einem Aufschlussfoto sowie jeweiligen Angaben der Koordinaten und Lithostratigraphie kombiniert. Die Präsentation reiht sich ein in anhaltende Geländearbeiten (z.B. Scholze, 2022) in Oberrotliegend-Teilbecken innerhalb des Thüringer-Wald-Sedimentbeckens. Zu einem aktuellen Problem einer Isotopen-Altersdatierung des Wolfstein-Rhyoliths südlich von Elgersburg siehe Lützner et al. (2021).

Referenzen:

Lützner, H., Tichomirowa, M., Käßner, A. & Gaupp, R. 2021. Latest Carboniferous to early Permian volcano-stratigraphic evolution in Central Europe: U–Pb CA–ID–TIMS ages of volcanic rocks in the Thuringian Forest Basin (Germany). *International Journal of Earth Sciences* 110: 377–398. https://doi.org/10.1007/s00531-020-01957-y

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Poster: Earth's earliest reconstructable tetrapod – Morphology of Parmastega aelidae

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The presented poster summarizes the article “Morphology of the earliest reconstructable tetrapod Parmastega aelidae” by Pavel A. Beznosov, Jennifer A. Clack, Ervīns Lukševičs, Marcello Ruta, and Per Erik Ahlberg (Springer Nature, Vol. 574, p. 527-531, 2019). This poster has been created in close collaboration and consultation with Dr. Per Ahlberg.

The poster describes *Parmastega aelidae* gen. et sp. nov., a Russian tetrapod from the earliest Famennian age (372 mya). The poster is structured in four sections. Section one shows detailed reconstructions of the skull and shoulder girdle and points out significant characteristics and traits of the fossils like raised orbits and course dermal ornaments. Section two discusses the puzzle of the lost postcranial endoskeletal bones, which are missing in all specimen without any traces of post-mortem movement or selective scavenging. Section three summarizes the chapter of phylogenetic analysis and shows that the majority of trees place Parmastega as a sister group to all other tetrapods. Conclusively the poster features a real life reconstruction of Parmastega with notable features of the animal and its environment pointed out.

(S6) Multidisciplinary Paleontology (Organization: Noel Amano, Maria Antonosyan, Michael Ziegler, Patrick Roberts)

This session aims to bring together scholars working on different fields relating to paleontological research, including archaeozoology, paleoanthropology, and quaternary science to name a few, and who apply multidisciplinary approaches in their research, such as and proteomics, aDNA, and stable isotopes analyses, to gain insights on past hominin/human-animal and animal-environment interactions.

Talk: Jaw mechanics in shrews and the role of the double articulation

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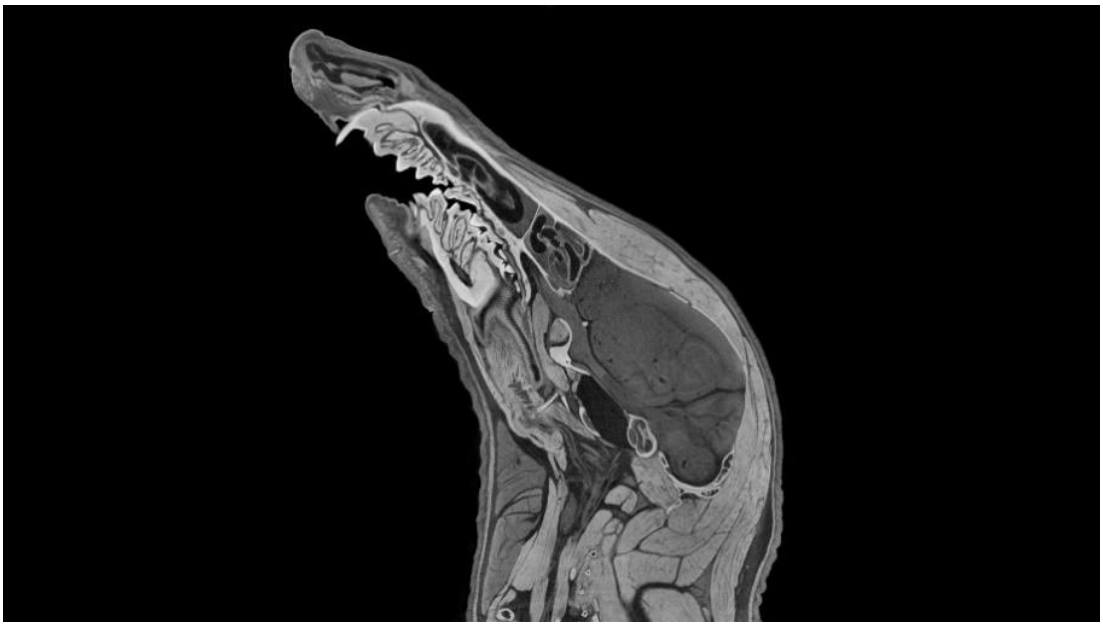
Essential for sustaining a high metabolic rate is the efficient fragmentation of food, which is determined by the molar morphology and the movement of the jaw. The latter is related to the jaw morphology and the arrangement of the masticatory muscles. Already in early Mammaliaformes such as *Morganucodon oehleri* the typical mammalian arrangement of the three masticatory muscles (temporalis, masseter, pterygoid) and their subdivision into two parts were present. The evolution of the angular process which enlarged the insertion areas for the internal pterygoid muscle and the masseter is either linked to an increasing yaw (rotation around the vertical axis) or to an enhanced roll movement (rotation around the longitudinal axis) during the chewing stroke.

Besides the development of a strikingly elongated angular process, the mandible of shrews is unique by its condylar process that has the articulation facet separated into a dorsal and a ventral part. This double articulation is thought to allow a more differentiated movement of the jaw. By study of tooth wear, virtual reconstructions of the chewing paths by the Occlusal Fingerprint Analyzer software, and the application of diceCT, a non-destructive technique for visualizing soft tissue (Fig.), we show that the double articulation allows a combination of yaw and roll rotation. This complex movement is governed by the two muscles inserting on the angular process. In conjunction with the contraction of the temporalis muscle, mainly responsible for the pitch motion (rotation around the transverse axis), the lower jaw gets rolled into occlusion (Phase I). The grinding of the protocone through the talonid basin in Phase 2 is accompanied by an alternation of inversion and eversion of the mandible, which occurs either within one chewing stroke or during subsequent strokes. Responsible for the inward rolling is the masseter muscle while the eversion is induced by the contraction of the internal pterygoid muscle.

These rotational movements provide an enhanced fragmentation of food by induction of a twist motion to the bolus in Phase I and a more varied grinding by additional movement directions of the protocone in Phase II. This allows for a more efficient energy gain and the maintenance of a high metabolic rate which is crucial for small-bodied mammals such as shrews.



*Sagittal diceCT slice through the skull of a Eurasian water shrew (*Neomys fodiens*; SMNS 37658), displaying hard and soft tissues, including the masticatory muscles.*

Talk: Evaluation of skeletal architecture and density banding in the massive starlet coral Siderastrea siderea by using 2D grid-scanning ^{241}Americium gamma densitometry

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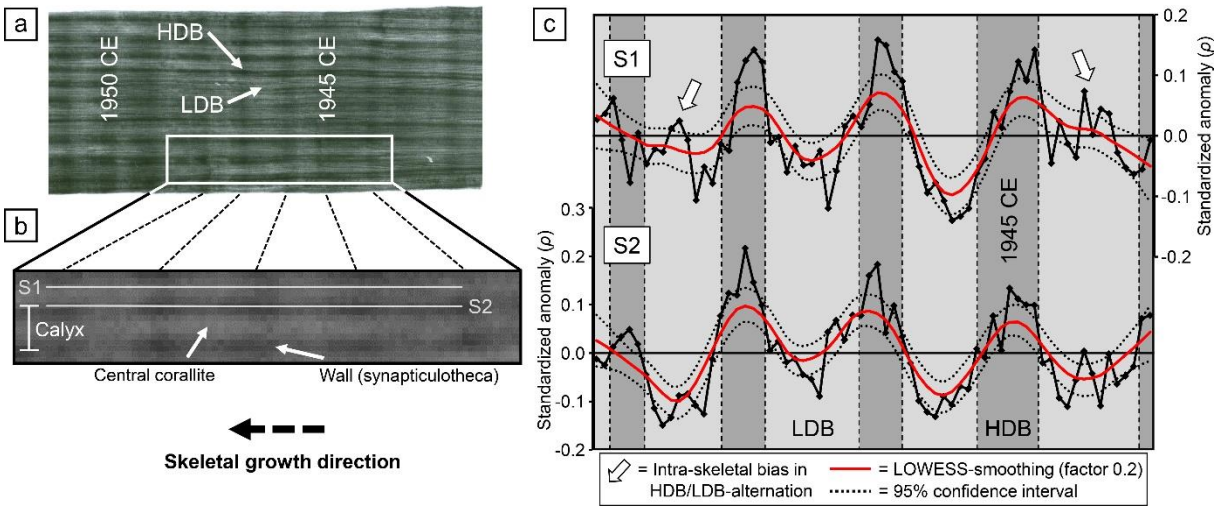
To better understand the skeletal growth in the massive starlet coral *Siderastrea siderea* from the western Atlantic, two-dimensional grid-scanning ^{241}Am gamma densitometry is herein used to quantify intra-skeletal density variations at high temporal resolution within the corallites and their synapticulothecal walls during annual density band formation. Such knowledge on intra-skeletal growth variations in coral calices can be of importance regarding the use of coral skeletons as paleoenvironmental archives. First results of this taxonomic case study showed that annual high- and low-density banding (HDB/LDB) is expressed more clearly within the corallite walls, whereas the central calices are more sensitive to intra-skeletal bias (e.g., influence of the columella, septa, or dissepiments). Variations of intra-skeletal elements forming corallites and their walls are considered herein as the primary source of these differences within *S. siderea*. This pattern of "meso-architecture" after Barnes & Devereux (1988) is widespread in massive corals (Scleractinia), however, taxon-specific differences occur (see for overview in Zoppe et al. 2022). The present results are consistent with previous geochemical sampling traits by DeLong et al. (2016), in that the synapticulothecal walls of *S. siderea* should be preferably used for highly resolved coral growth chronologies.



(a) Coral X-ray image, (b) gamma densitometer scan pattern with measured sections (S1: central corallite, S2: thecal wall), (c) skeletal density (ρ) of both sections as trend-less standardized anomalies.

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Barnes, D.J. & Devereux, M.J. 1988. Variations in skeletal architecture associated with density banding in the hard coral *Porites*. *Journal of Experimental Marine Biology and Ecology* 121, 37–54.

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Zoppe, S.F., Deveaux, M. & Gischler, E. 2022. Quantifying skeletal density at high temporal resolution in massive scleractinian corals by using two-dimensional grid-scanning gamma densitometry. *Geo-Marine Letters* 42, 16. https://doi.org/10.1007/s00367-022-00739-6

Talk: Zanadamu: an African hominin isotopic dataset

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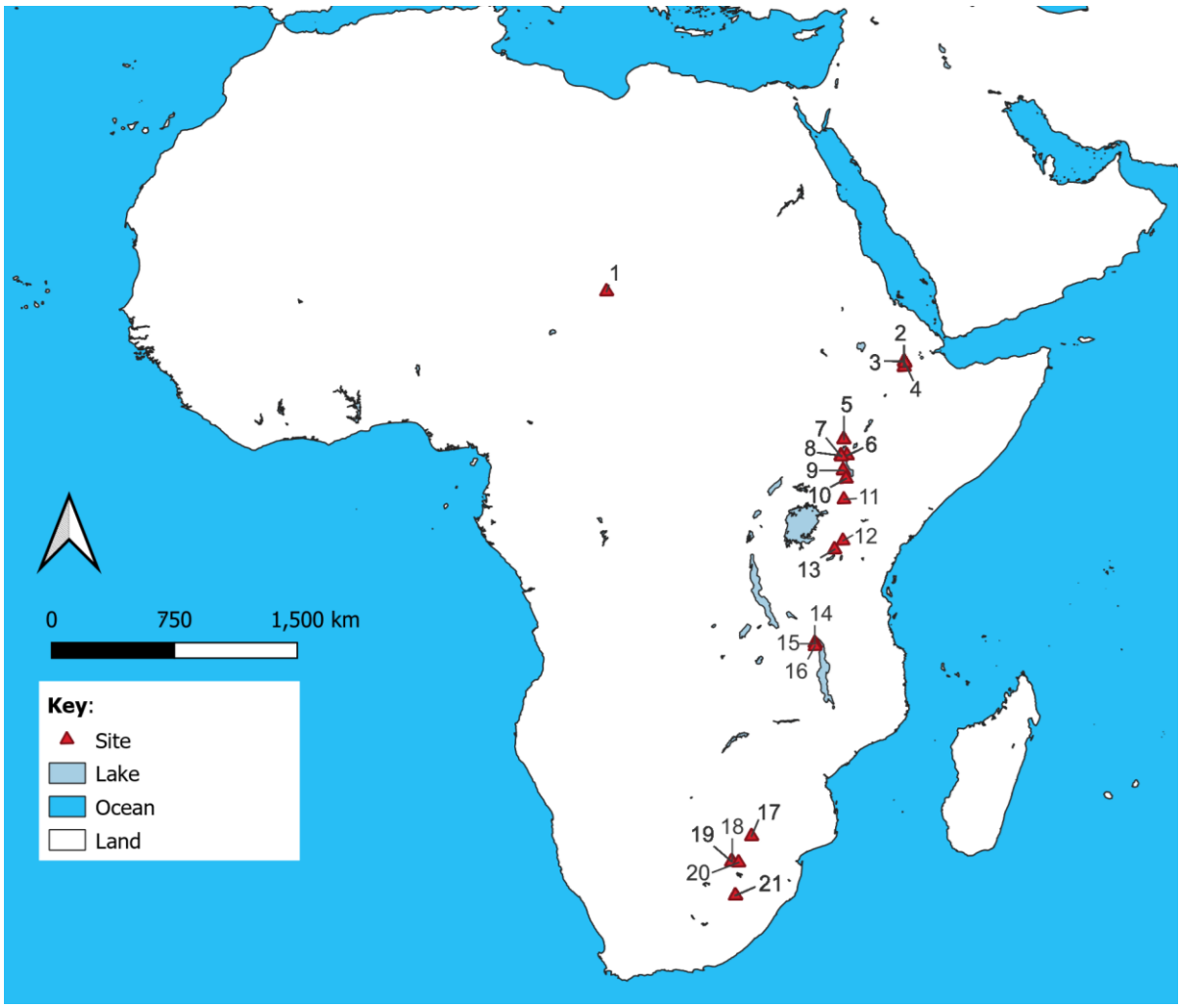
The present study introduces Zanadamu, a comprehensive geo-temporal-referenced dataset that amalgamates all published stable isotope carbon and oxygen measurements on tooth enamel from African hominins, dated between 4.4 and 0.005 Ma. Zanadamu serves as a research tool for investigating hominin evolution by facilitating the examination of how different hominin species explored food resources and interacted with their local paleoenvironments. The dataset is structured in a machine-readable format, and its metadata organization allows for facile statistical analyses and comparisons with other types of isotopic records, including ancient and modern humans and other primates. Zanadamu is part of the AfriArch data initiative, which aims at compiling datasets for the study of ancient Africa. This is an active initiative, and we strive to update Zanadamu as novel data becomes available.



Spatial distribution of ancient hominin sites included in the Zanadamu dataset: (1) Koro Toro, (2) Aramis, (3) Hadar, (4) Dikika, (5) Lower Omo Valley, (6) Koobi Fora, (7) Lomekwi, (8) West Turkana, (9) Lothagam, (10) Kanapoi, (11) Baringo, (12) Peninj, (13) Olduvai Gorge, (14) Uraha-Karonga, (15) Mwenirondo-Karonga, (16) Malema-Karonga, (17) Makapansgat, (18) Kromdraai, (19) Sterkfontein, (20) Malapa, (21) Swartkrans.

Talk: At the gateway of the oriental zone: Assessing evidence of early (Pre-MIS 5) human migrations in Saurastran Peninsula, India

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Emergence and evolution of the Indian Middle Paleolithic (MP) marks the period of major behavioral shift during the onset of MIS 5, possibly related to the expansion of Anatomically Modern Humans (AMH) in the subcontinent. Recent evidence from Southern India paints a contrasting picture, showing much earlier occurrences (~385 ka) of MP assemblages in India. It is critical to understand whether the origin and spread of MP technology in India represent a behavioral marker of early AMH dispersal in South Asia. The current investigation studies the emergence of MP technology in the Saurashtra peninsula. The studied region is crucial as it acts as a geographical corridor connecting the mainland Indian Subcontinent to Middle-East Asia. Here, we report evidence of early MP assemblages associated with the signature of marine transgression. The occurrence of inland shell/molluscan and older mudflats in various fluvial systems across the Saurashtra/Gujarat coast indicates a major transgression episode, possibly occurring at the onset of MIS 5. The current lithostratigraphic study suggests the early emergence of a MP assemblage before the Late Pleistocene.

Talk: Biomolecular reconstruction of human dwelling environment in the Late Pleistocene Lesser Caucasus

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Located at the crossroads of out-of-Africa migration routes, the Lesser Caucasus served as a natural passage, so-called Trans-Caucasian corridor, that enabled hominin dispersal out of the Levant and into the rest of Eurasia. Furthermore, it has been suggested that this region being climatically buffered by the Caucasus Mountains and benefiting from the ameliorating effects of the Black and Caspian Seas served as such a biogeographical refugium throughout the Pleistocene. Though the area is now actively being explored by archaeologists, the complete picture characterizing environmental background of the human occupation and the potential role of climatic conditions on population dynamics remain unresolved. In particular, the scarcity of suitable environmental archives within the region hampers the evaluation of the significance of last glacial climate and environmental conditions for Neanderthal to anatomically modern human transitions and population movements in the region. To deepen our knowledge of the Late Pleistocene environmental conditions we endeavored a multidisciplinary exploration to the Karin Tak cave, Lesser Caucasus, which we dated between 48,000 and 22,000 cal BP. In particular, we examined biostratigraphic changes in the site by looking at the taxonomic composition of faunal materials using traditional zooarchaeological approaches combined with novel molecular method of faunal identification: collagen fingerprinting/ZooMS and ancient DNA metabarcoding. To gain further insights into environmental conditions of the region we applied stable carbon and oxygen isotope analyses to faunal tooth enamel (n=90). The obtained results suggest that cold and arid MIS 2 conditions did not cause a dramatic change in regional environment, indicating

that the Lesser Caucasus was a climatically and ecologically stable region despite significant global climatic changes during the last glaciation.

Talk: Exploring the Paleoecology of late Pleistocene – early Holocene Sites in Northwestern South America through Stable Isotope Analysis

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South America was the last continent to be colonized by early *Homo sapiens* and their spatio-temporal presence on the landscape overlaps with one of the largest sets of faunal extinctions witnessed during the Late Pleistocene - Early Holocene transition. As the gateway between the Americas, the northwestern corridor of South America facilitated intercontinental dispersal of early human settlers as well as other animal taxa and represents an important area for exploring early human-animal interactions. Moreover, this region is composed of a diverse environmental gradient (i.e., coasts, savannahs and lowland, Sub Andean and Andean tropical forests) which provides a critical proving ground for exploring the potential impacts of our species on resident fauna living in a variety of different habitats. Although the paleontological record at archaeological sites across South America is growing, direct evidence of human-animal interactions remains fairly limited. Nevertheless, advances in stable isotope analysis and developing chronologies at select localities can help to identify changes in human and faunal diet from these shared environments as well as provide insights into ecological and anthropogenic pressures. Through the ERC-funded LASTJOURNEY project's multidisciplinary approach, this research explores how paleontology, ecological modelling, and biomolecular analyses can add to our current knowledge of the relationship between human dispersals, faunal population dynamics, and environmental changes in the region.

Poster: Morphology and Taphonomy of *Terebralia palustris* from an archaemalacological viewpoint

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The study is concerned with the taphonomy of molluscs in both natural and archaeological preservation. The mangrove gastropod *Terebralia palustris* is selected for an in-depth study due to its wide recent distribution in Mangrove habitats of the Indo-Pacific as well as its common presence within adjoining archaeological sites (e.g. Fratini et al. 2001, Veth et al. 2017). Samples were taken from the recent mangrove Khor Kalba (Sharjah, United Arab Emirates) and among loci within an Iron Age settlement (Muweliah) from the United Arab Republic (Sharjah).

Methods include thin sectioning, scanning electron microscopy, size distribution analysis, individual counts (MNI) as well as semi-quantitative taphonomic analysis of fragmented material analysing taphonomic grades of fragmentation, surface abrasion, the presence of cracks, and color alterations.

The results show that recently collected complete shells show better preserved features on both the exterior, especially towards the apex, as well as internal shell surfaces. Comparison of these features can serve as an indicator for the exposure time after shell destruction. Anthropogenic preservation features are ubiquitous high degrees of fragmentation, surface abrasion and the presence of surface cracks. The presence of these features is indicative of extraction methods, food preparation, trampling and surface exposure. Color alteration or lack thereof allow conclusions to be drawn about the cooking method. Fragmentation patterns reflect higher preservation potentials of thicker shell parts including the columellar, varices and apex remains which are strengthened by internal shell infillings. *Terebralia* finds among different loci show significant variations for crack and color preservation, making them most suitable for differential loci analysis within an archaeological context.

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Poster: Tracking changes of vertebrate trophic ecologies in the Neanderthal altered ecosystem of Last Interglacial (Eemian) lakeland of Neumark-Nord (Saxony-Anhalt, Germany)

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The influence of Pleistocene hunter-gatherers on their ecosystems is a challenging aspect to reconstruct in past hominin ecology. Because of its remarkably rich paleoenvironmental, archaeological and faunal archives over a continuous 11 kyr period, the Last Interglacial (Eemian, ≈125 ka BP) locality of Neumark-Nord (Saxony-Anhalt, Germany) offers a unique opportunity to explore the interactions between Neanderthals and the vegetal and vertebrate ecosystems. Archaeological, palynological and charcoal data notably allowed to demonstrate a clear ecological footprint of hominin activities, including fire use, resulting in a net opening of the Neumark-Nord vegetation landscape (Roebroeks et al., 2021). The widespread occurrence of butchery marks on faunal remains, including straight-tusked elephants (*Paleoloxodon antiquus*, minimally 57 individuals over a period of more than 2 kyr), demonstrates the extensive and long-term exploitation of faunal resources by Neanderthals (Gaudzinski-Windheuser et al., 2023).

To assess the intensity and impact of Neanderthal hunting on herbivores and carnivores, we aim here at reconstructing the feeding ecology of large mammals and ecosystem trophic structure during the different Eemian substages by analyzing the calcium isotopes ($\delta^{44/42}$Ca) of their tooth enamel. In this study, we systematically explored the Ca isotope ecology of the vertebrate faunal assemblage of Neumark-Nord 1 and 2 sites, representing two closely associated shallow paleolake basins. We sampled and analyzed the enamel of teeth that mineralized their crown post-weaning from over 90

individuals of 9 taxa, including herbivores (equidae, cervidae, bovidae, elephantidae, rhinocerotidae) as well as carnivores (canids, ursidae, felidae and hyaenidae).

Overall, we find tight species-specific distributions, in good agreement with previously reported values and diet-related inter-taxon differences observed for other Late Pleistocene vertebrate assemblages. In cervids, which are found across the full duration of the 11 kyr record, we observe a significant decrease of $\delta^{44/42}$Ca values through time, paralleled by decreasing Sr/Ca and Ba/Ca ratios. Such changes support significant changes in trophic ecologies of cervids, that coincide with the extensive use of faunal resources, the dramatic decrease in biodiversity of thanatocoenoses, as well as a remarkable reconfiguration of vegetation cover. We argue that these trophic biomarkers track a change in cervid ecology possibly in response to early anthropogenic alterations of this ecosystem.

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(S7) RG Paleobiology – Fossil preservation of exceptional biological details (Organization: Carolin Haug, Marie Hörnig)

For our understanding of the life habits of extinct organisms, exceptional fossil preservation of biological structures is extremely helpful. Such preservation can include almost life-like preservation of external morphological structures, sometimes even details such as color preservation, but also internal structures such as musculature or nervous system, down to cellular details of tissues. In this session, the preservation of such biological details of all kinds of fossilized organisms will be presented.

Talk: Estranged relationships: Past parasitic associations between mites and flies

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Amber can preserve almost life-like situations of the past. For example, well-preserved syninclusions in fossils help us reconstruct the ecology of past ecosystems. In particular, frozen behavior in the fossil record is of special interest given its scarcity. Mites are one of the most frequently reported organisms found displaying clear signs of parasitic behavior in amber. Mites have a broad parasitic (*sensu lato*) association with their hosts that ranges from phoretic behavior, which only includes transportation, such as in mites of the group Macrochelidae, to parasitic (*sensu stricto*) association when feeding is involved, such as larval mites of the group Parasitengona. Dipterans as hosts for mites have extendedly been reported in the fossil record.

Here we present several examples of the association between mites and their dipteran hosts found in amber pieces. These cases include mite larvae of the group Parasitengona attached to flies of the

groups Ceratopogonidae (biting midges) and Cecidomyiidae (gall midges), and an unidentified mite associated with a fly of the group Atelestidae (*Alavesia* sp.).

In present days, terrestrial mites of the group Parasitengona are not frequently found parasitising biting midges, although it seems to be a common association in the fossil record as already shown in previous studies. To our knowledge, we here show the first record of gall midges hosts for mites of the group Parasitengona, for both the fossil record and present fauna. This is not the first time a host-parasite relationship between mites and dipterans has apparently gone extinct, as this also seems to be the case for flies of the group Chironomidae (non-biting midges) and mites, which association is only represented in the Mesozoic fossil record. This supports the suggestion that the preferential host spectrum of terrestrial parasitic mites of the group Parasitengona has shifted from Dipterans to other representatives of Euarthropoda.

Despite the fact that flies of the group *Alavesia* seem to have been abundant in the Cretaceous, no associations with mites have previously been reported in amber. Recently, relicts of *Alavesia* have been found in the present fauna restricted to Namibia and Brazil. The question remains whether its association with mites prevailed.

Talk: Defensive appendages in 100 million-year-old centipedes: An example of convergent evolution

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Centipedes are well known for their venomous nature, some of them even being able to prey upon mice or bats. The venom is injected into the prey via a specially modified first pair of trunk appendages, the maxillipeds. Still centipedes are not necessarily only armed at the front of their bodies. At the posterior body end, the last pair of trunk appendages is also modified for specific functions, including sensing, stridulation, but in some of them also for defence. While the earliest centipede fossils from the Silurian are still rather fragmented, since the Carboniferous relatively complete specimens are known; the best preserved specimens are younger and have been found in amber of different ages. This three-dimensional type of preservation with (more or less) complete specimens allows for quantitative comparisons of morphological details. We present here a new specimen from 100 million-year-old Myanmar amber, which exhibits the general morphology of one centipede group (Lithobiomorpha), but possesses a last pair of trunk appendages very similar to that of a different centipede group (Scolopendromorpha). Hence, these appendages appear to have evolved convergent in these two groups. This last pair of legs is very large, especially in comparison to the penultimate leg pair, and has presumably been used for defence. So far, fossil centipedes seemed to strongly resemble their modern counterparts. Quantitative morphological, instead of taxonomic, comparisons have the potential to reveal more unusual fossil representatives and provide insights into the diversification of this fascinating group of venomous predators.

Talk: Egg-Case-Report: Almost 125 million years of Cockroach Oothecae

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Reproduction is essential for the persistence and evolution of species, and with species diversity, different reproductive strategies have evolved. Considering only insects, diverse strategies and structures are encountered. However, little is known about the origin and evolution of these individual reproductive strategies, which provide important information about ecological adaptations, behavior, and the evolutionary development of insect reproductive strategies in particular. While adults, larvae, and nymphs give information about reproductive strategies, eggs are also of considerable interest, but scarcely found in the fossil record.

Among these rare finds are the fossil remains of cockroach oothecae, of which a total of only 20 are known in the literature today. Oothecae are egg packages with a protective case and are considered an apomorphy of the group Dictyoptera, which today comprises Blattodea (cockroaches) and Mantodea (praying mantises). Cockroach egg cases exhibit interspecific differences in size, structure, and composition. However, they follow the same structural plan: oval, slightly convex, sclerotized, and with 4 to 50 eggs arranged in two parallel rows. In cockroaches, there are different strategies for depositing oothecae, ranging from direct deposition to entrainment on the abdomen or in a brood sac until the nymphs hatch. Oothecae are likely an important aspect of the wide distribution of cockroaches and their ability to inhabit different types of habitats that persist to the present day.

We examined 16 fossil oothecae using various techniques, including micro-computed tomography (µCT), to determine whether oothecae have changed over time since their presumed first appearance in the Early Cretaceous (ca. 125 mya). To this purpose, fossilized oothecae of different species from Myanmar (100 mya) and Baltic amber (40-50 mya) were analyzed with respect to certain morphological features, such as the number of egg chambers and surface microstructure, and compared to the oothecae of present-day cockroaches.

Talk: Three new lithobiomorph centipedes found in Myanmar amber (Cretaceous period), a clue on their "real" geological records

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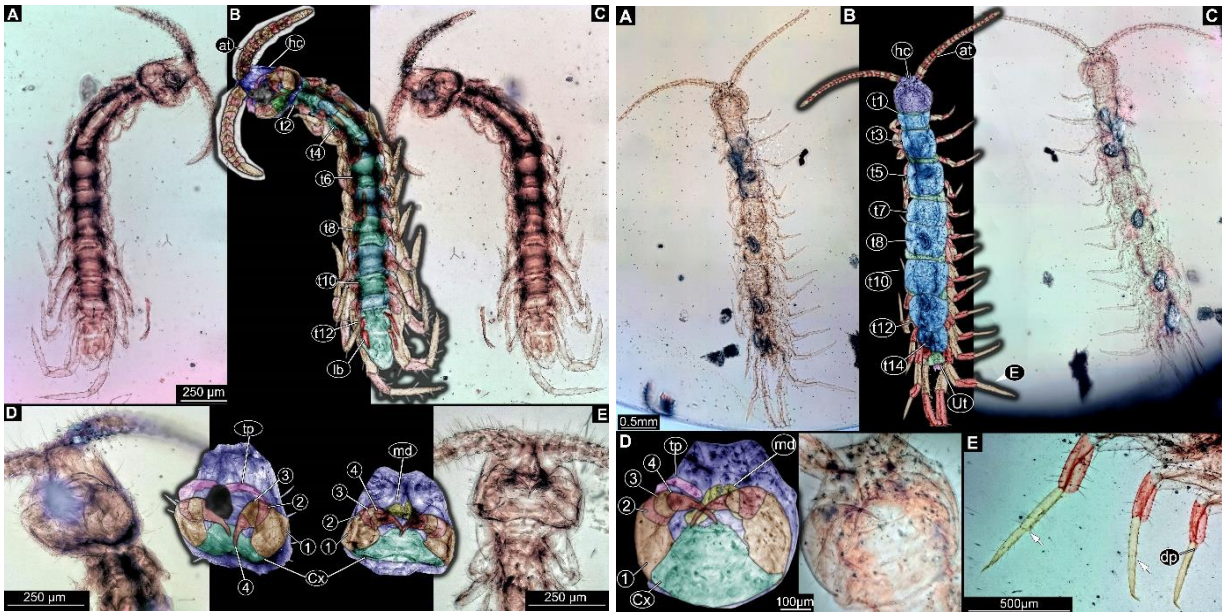
Chilopoda is a species-rich group of ~3500 formally described species of centipedes. Being exclusive predators, centipedes possess a modification of their first pair of trunk appendages transformed into counter-acting venom claws. The rarity of centipede fossils, especially in comparison to the closely related millipedes, is a major challenge for better understanding their evolutionary history. Supposed low fossilization potential, due to their unmineralized exoskeleton and habitat, has been suggested as one reason for scarce fossil record of the groups. In this study we report three new lithobiomorphan centipede immatures from Myanmar amber (~110 million years old). This is the first definite report of lithobiomorphan centipedes and the detailed description of centipede immatures from the Cretaceous period.

Usually, lithobiomorphan centipedes exhibit five distinct larval stages, identified by their number of developed walking legs. Here, we described two specimens with 10 pairs of legs (stage IV) and the last one with a fully developed trunk. Despite being 110 million years old, these specimens carry similarities to extant species due to their exceptional conservation. We recognize similarities to extant species of

the lithobiomorphan ingroup Henicopidae and, with further investigation, to *Lamyctes* (Meinert, 1686). The specimens are probably blind, have translucent setae on the proximal part of the venom claws, absence of leg spurs, presence of tibial projection and undivided tarsi.

We discuss implication of these new specimens, especially concerning the supposed scarcity of centipede fossils.



The two described centipedes.

Talk: The first detailed morphological treatment of a fossil barklouse (Psocodea: 'Psocoptera') from Cretaceous Kachin amber

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the lithobiomorphan ingroup Henicopidae and, with further investigation, to *Lamyctes* (Meinert, 1686). The specimens are probably blind, have translucent setae on the proximal part of the venom claws, absence of leg spurs, presence of tibial projection and undivided tarsi.

We discuss implication of these new specimens, especially concerning the supposed scarcity of centipede fossils.

Undescribed species of Psyllipsocus *from Cretaceous Kachin amber. Lateral view, 3D-render based on SR-µCT data.*

Talk: Interaction based damage in arthropod fossils: Unusual damage on the wing of a new fossil dragonfly

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Dragonflies and damselflies (Odonata) are flying insects that typically live in close association to water and can be found all over the world. Early representatives of Odonata have been around since the early Triassic (ca. 251 mya) and odonatans are common enough finds that they have a rather good fossil record. Two noteworthy fossil Lagerstätten that have yielded many fossils of odonatopterans are the Crato formation (Brazil, Early Cretaceous) and the Solnhofen limestones (Germany, Late Jurassic). Some of the fossils found on the limestone plates from both of these localities also include damaged odonatopteran, that often show damage on their wings. Here we present a new dragonfly fossil with unusual type of wing damage. The specimen is from the Solnhofen limestones and is excellently preserved. The right wing of the third thoracic segment shows sign of damage that differs in shape from that typically expected in wings of insects preserved in similar limestone deposits. Typically wings of insects break in a more irregular way partly corresponding to the wing venation, resulting in more angular breaks along straight lines. This can occur on multiple wings in the same fossil and is often attributed to be a lithographic effect. The fossil dragonfly described here has three fully intact wings and no other discernible damage, except for the one other wing. The wing was damaged at its half length point, and the damage is circular in shape. Based on the unusual nature of the damage we

propose the cause might have been interspecific. Within this study, we review the fossil record of damage in arthropod fossils with a focus on damages that have been suggested to be cause by inter- or intraspecific interaction. These kinds of damage can give us information to date certain behaviors and better understand the ecology of these animals. Based on this we suggest the damaged wing of this dragonfly could have been cause by a failed predation attempt, possibly from a vertebrate predator.

Talk: Specialized morphological characters of wood-associated beetle larvae for hunting or defense in deep time

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Beetles (Coleoptera) are holometabolan insects with a distinct differentiation of life stages. The larvae often lead different lifestyles than their adult counterparts. Such a strategy ensures that larvae and adults of the same species do not compete for the same resources. Therefore, adult females often move before the oviposition of eggs into an environment more suitable for the larvae. The oviposition strategy is a complex trade-off between many factors, for example, the clutch size and the predation risk. Females lay either many eggs in a predator-approachable environment or a smaller number of eggs in a more hidden environment, which is often associated with higher energy costs. For example, the females of longhorn beetles (Cerambycidae) lay eggs under the tree bark, within crevices, or in self-made incisions on the host surfaces. However, even the well-hidden eggs and larvae are not always safe from predators. Some predaceous larvae co-evolved with the wood-associated larvae and developed specialized hunting strategies in narrow spaces. For example, larvae of Texas beetles (Brachypsectridae) have lateral processes on the trunk and spine-like trunk end that help with camouflaging and hunting. The larvae are ambush predators that pin their prey on their dorsal body surface with the trunk end and sickle-shaped mandibles. Many larvae of wood-associated beetles developed urogomphi (dorso-posterior processes of abdomen segment 9). Supposedly, urogomphi help move backward within the narrow tunnels. Some wood- or fungi-infested-wood-feeding larvae also developed processes that help in camouflaging. Such morphologies are also known from the fossils and allow us to make implications about survival strategies in past ecosystems. We discuss the specialized morphologies of in-wood predaceous and other wood-associated fossils of larvae.

Talk: Hairstyles of the Eocene: Structure and distribution of setae in beetle larvae as a measure for morphological diversity

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Modern representatives of Coleoptera are a diverse group, both in their species richness and morphological variation. This diversity is not only observed in adult beetles, but also in their larvae, which is also evident throughout their evolutionary history. However, incompletely preserved specimens and visual clutter in amber pieces can make the interpretation and comparison of these insects difficult. These problems relate to the poor preservation of major identifying characters (such as mouthparts or leg elements), which impedes the comparison especially of closely related groups. In contrast, structures that tend to be preserved even in low-quality samples are setae. These hairs have traditionally been used for the characterization of beetles at the species level. Thus, this project aims to test these structures as an identifying character in fossil specimens among wider groups based on their shape and configuration. We characterized the setae of 46 fossil specimens resembling modern-day beetles representing at least 10 different groups and used these together with setae of modern representatives in a quantitative analysis. The shapes of the setae on mandibles (if present) and abdomen of these specimens were outlined and measured. The resulting outlines of the setae were analysed using an elliptic Fourier transformation and principal component analysis, which was then complemented by the number and organisation of the setae on specific structures. Through this process we aim to compare the morphological diversity of larvae in the different groups of Coleoptera throughout the Eocene and their extant relatives.

Talk: Structurally preserved Osmundaceae and other plants from Triassic silicified peat deposits in North Victoria Land, Central Transantarctic Mountains, East Antarctica

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The Transantarctic Mountains are long known to contain several deposits of silicified peat of Permian and of Triassic age, which are among the most important sources of information on the high-latitude vegetation of Gondwana, especially regarding plant anatomy. While silicified peats from the Beardmore Glacier region have been studied quite extensively over the last 50 years, similar deposits from elsewhere in the Transantarctic Mountains have received hardly any attention. During the 11th and 13th GANOVEX expeditions in 2015/16 and 2018/19, abundant material of Triassic silicified peat has been collected from several new sites in North Victoria Land, but the fossil content still awaits detailed description.

Here, we present a first overview on the composition, state of preservation and diversity of plant fossils at three different sites of Middle to Late Triassic silicified peat from North Victoria Land. Both the abundance and preservation quality of plant fossils strongly vary between individual peat blocks, even within the same deposit. Especially one facies in the northern Helliwell Hills (Rennick Glacier area) is characterized by only limited compaction and high abundance of excellently preserved plant material. The plant remains so far identified in this deposit include foliage (*Dicroidium*) and stems (*Kykloxylon*) of Corystospermales, cycad roots, and a great variety of pteridophyte remains. Most prominent among the latter are several extremely well-preserved rhizomes of Royal Ferns (Osmundaceae). They likely belong to the genus of *Claytosmunda* and show strong affinities to both the extant *C. claytoniana* as well as the fossil *C. beardmorensis* from the Triassic of the Beardmore Glacier area. These new findings hereby link the hitherto poorly known *C. beardmorensis* to a modern-day species and promise to resolve its systematic and phylogenetic position.

Talk: Disc-shaped fossils resembling eldoniids from the early Cambrian (Series 2: Stage 4) Pioche Formation of Nevada

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The Comet Shale Member of the Pioche Formation in southern Nevada preserves non-biomineralized fossil assemblages referred to as the Pioche Lagerstätte. The biota of this Lagerstätte is dominated by panarthropods, both biomineralized and soft-bodied, but also preserves diverse benthic organisms including species of deuterostomes, scalidophorans, halkieriids, and some problematic vermiform taxa. The morphology and affinities of newly discovered disc-shaped, soft-bodied, 2D fossils from the early Cambrian (Series 2: Stage 4) Comet Shale Member are discussed. These specimens show some similarity to the eldoniids, which include the still enigmatic *Eldonia* Walcott, 1911, from the middle Cambrian (Miaolingian: Wuliuan) Spence Shale of Utah and Burgess Shale of Canada. The status of various discoidal taxa from the Cambrian of the Great Basin is considered and their affinities are being discussed.

Talk: A possible beaching site for whales and dolphins in Taiwan

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In-situ whale mandible with a human male for scale.

Currently, more than 150 whales or dolphins, assigned to more than 20 species, beach on the island of Taiwan per year. Taiwan yields an average long-term uplift rate of 5.3 mm/year. Consequently, relatively young Plio-Pleistocene marine sediments are found inland with the potential to record fossil marine mammal beaching events.

In 2022, during geological and paleontological surveying in the Pleistocene Sigou Formation in Hengchun, the southernmost province of Taiwan, we discovered several large rib bones. Subsequent excavations revealed a well-preserved, articulated whale fossil. The cetacean fossil is dated to <260 ka based on the discovery of the nanofossil *Gephyrocapsa lacunose*.

Based on the size of the fossil rib bones and the mandible, as measured in the field, the whale would have been more than 15 meters long, which is the largest vertebrate ever unearthed in Taiwan. Thus far, we have prepared both scapulae and the right mandible. Mandibular morphology indicates that this specimen is a baleen whale, possibly a grey whale based on the morphology of the scapulae. It is unfortunate that the bullae do not seem to be preserved, but morphological analyses of the scapulae are planned, as well as peptide mass fingerprinting, to determine species attribution.

In addition to the large whale fossil reported here, the team also found two other smaller marine mammals, possibly dolphins. These specimens still await excavation.

Poster: An attempt to provide an overview of fossil and not-so-fossil resins from around the world

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Fossil resin is often collectively referred to as amber, yet some authors differentiate amber from other fossil resins. Copal is often referred to as “young amber”, but also here the use of the term is very different and may refer to a specific set of relatively young fossil resins, but can also include non-fossil resins. “Defaunation resin” refers to very young finds (only few hundred years old). Fossil resins have been reported from at least 200 sites around the world. Yet, some authors indicate that it should be at least 300. The most commonly known occurrences are likely those around the Baltic Sea, hence Baltic amber, and the one in the Dominican Republic, hence Dominican amber. Yet, in recent years especially Kachin amber from Myanmar has swamped the literature with findings of spectacular inclusions providing insights into a forest fauna 100 million years ago. Yet, these examples represent only a tiny fraction of inclusion-providing resins, which are quite numerous. There are furthermore deposits that are considered to have fossil resins without inclusions. Yet, as the example of “Indonesian amber” (in fact, several sites on Sumatra, Borneo and Sulawesi) shows, also resin that is generally considered to lack inclusions can provide some when specifically searching for them. Despite all these finds, an overall overview of all these resins is still challenging to achieve. Some findings have been mentioned in older literature, but remain obscure. Terminology has been shifting over the years, and not all similar-appearing names may refer to the same finding. Very rare finds (sometimes a single piece) are especially challenging to interpret. We present here first attempts for providing an overview of occurrences of fossil and non-fossil resins.

Poster: Exploring the evolution of mite shape: Were larvae of long-legged velvet mites always long-legged?

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There are records of mites (Acari) since as far as the Lower Devonian, which comprises 410 million years of geological history. These records show that the general body size and appearance of mites have not drastically changed over time. It has also been suggested that at least for some groups, such as Oribatida, their body shape has stayed fairly stable as well. Erythraeoidea, the group of long-legged velvet mites, like other representatives of Parasitengona, is an ingroup of Trombidiform mites. Adults of Erythraeoidea are active predators, yet, their quite different appearing larvae are parasitic on other representatives of Euarthropoda. Among their diagnostic features, as their name indicates, long-legged velvet mites are characterized by having extremely long legs, which extend for more than half the length of their idiosoma (the functional trunk region of the mite).

In the present study, we applied geometric morphometrics to analyze the variation of shape in larval long-legged velvet mites over time with a focus on fossils from the Late Cretaceous in comparison to the modern fauna. Data was obtained both from photos of fossilized mites in amber and from fossil and modern mites previously reported in the literature. Body outlines were redrawn as vector graphics. By performing an Elliptic Fourier analysis, we obtained the variation in the shape of the body of long-legged velvet mite larvae, but also legs and idiosoma (body without the gnathosoma, the functional head of mites). We later performed a Principal Component Analysis (PCA) to compare the shape of fossil and modern mites.

To our knowledge, this is the first quantitative analysis of the evolution of shape in mites. Although mites are fairly abundant in the fossil record, they are often overlooked since details are usually not accessible given their minute size. Nevertheless, this study demonstrates that despite the fact that identification to lower phylogenetic levels is often not a possible task, mite inclusions in amber can still be informative to deepen our knowledge of morphological biodiversity and its variation through time.

Poster: "Family picture in amber" – Oldest representatives of *Lamyctes* in Myanmar amber and from two different developmental stage

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Lithobiomorpha is a group of species-rich soil-dwelling predators with ~1100 formally described species. Extant centipedes play an important role in controlling detritivore populations and therefore represent a crucial component of the soil and leaf litter fauna. Until recently, its geological records were restricted to the Cenozoic period, but a single and oldest record (Kachin amber, Cretaceous period) of a lithobiomorph-like centipede has been described. Yet, it remained unclear whether this species is a representative of the group Lithobiomorpha, as most characters making it appear like a

lithobiomorphan are in fact plesiomorphies. Here we report an unusual piece with two specimens, an immature with fewer segments and one with a fully developed trunk.

The specimens are exceptionally well-preserved, and details suggest a close relationship to *Lamyctes coeculus* Brölemann (1889) within Henicopidae. Among these are: 24 elements of the antennae (antennomeres); translucent setae on the proximal part of the venom claws (porodont on coxosternite margins); presence of a clear tibial projection on leg pairs 1-11; undivided tarsi of the anterior trunk legs and bipartite tarsi at leg pairs 13-14. The exceptional preservation state and availability of such specimens challenge the preconceived idea on the scarcity of lithobiomorphan centipedes before the Cenozoic period.

Poster: Chimeric Diptera larvae from the Cretaceous

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The group of flies, Diptera, represents a major lineage of the group Holometabola, an ingroup of Insecta, which is characterised by a strong morphological and ecological differentiation between larvae and adults. Fly larvae represent a crucial faunal component in many modern ecosystems, performing important functions such as carbon cycling. We can assume that fly larvae also played a major role in past ecosystems, but our knowledge of fossil fly larvae is still very limited. In this study we present two larval specimens preserved in Cretaceous Kachin amber, Myanmar. Both larvae show a so far unknown morphology, with apomorphic features of two distinct, possibly distantly related, lineages of Diptera: Xylophagidae (awl flies) and Athericidae (water snipe flies). A prominent feature of awl fly larvae is their elongated head capsule, which is seen in the fossils. A prominent feature of water snipe fly larvae is the presence of very well developed, leg-like parapods armed with multiple crochets (small hooks around the “foot”), and the fossil larvae similarly have a single distinct hook on conspicuous parapods. In addition, the two specimens have some differences between each other and may represent distinct species. These records stress how much our knowledge on trait evolution in immature dipterans is incipient. Interestingly, comparable cases in which larvae possess distinct characters of only distantly related lineages have also been reported in other lineages of holometabolans, especially in lacewings (Neuroptera). Together these findings reinforce the perception of the Cretaceous as an “experimental” period of insect evolution.

Poster: LEON – an updated member list

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The concept of a superhero relates to fictional characters that, in part, have characteristics of normal humans, but to a superlative degree. The same concept can be applied to non-human animals and fossils. Also here we can identify cases in which certain characters are superlatives compared to other cases. Superheroes are additionally often organized in teams, such as the Avengers, the Fantastic Four

or the Justice League, yet the oldest of such teams is the League of Extraordinary Gentlemen with superheroes from the late 19th century. In reference to this team, we have identified a group of exceptional larvae preserved in Mesozoic deposits that possess superlative characters. The League of Extraordinary Neuropteriformian Larvae, or in short LEON, includes, for example, lacewing larvae with exceptionally elongated mouthparts ("supersting" larva and "superfang" larva) or the oldest larvae for their lineages ("oldest lion"). We report here new finds that also represent new members of LEON, including lacewing larvae with entirely new prey-catching strategies, beetle larvae with extremely large heads, and snakefly larvae with extraordinarily long antennae. The members of LEON demonstrate that the absence of such superlatives in the modern fauna is not caused by possibly mechanical constraints, but more likely by a general loss of diversity, especially of the group Neuropterida (which includes lacewings, snakeflies, fishflies and others).

(S8) RG Micropaleontology – Micropaleontology — an interdisciplinary science (Organization: Ella Quante, Anna Pint, Silvia Kolomaznik, Peter Frenzel)

Microfossils are important tools in Quaternary Geology, Physical Geography, paleoceanography, paleoclimatology and geoarchaeology. Their assemblage composition, environmental induced morphological reactions and shell chemistry signatures enable reconstructing a wide range of environmental factors in aquatic or terrestrial ecosystems.

The small size of microfossils and their high diversity enable studying large associations, often with well preserved and complete individuals even from small samples as typical from sediment cores. Ecological preferences and tolerances of taxa are used for reconstruction of paleoenvironments, their biostratigraphical ranges for bringing strata into a chronological order. The great value of microfossils for geoscience is their application, but as past organisms they are excellent paleontological study objects in their own as well. The session presents geological applications of microfossils as well as paleobiological studies.

Talk: Foraminiferal assemblages from the Upper Paleocene of the Turgai depression (Northern Kazakhstan)

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Upper Paleocene deposits widely cover the Turgai depression and comprise the Sokolovo Formation that is mainly represented by clay and sand. These sediments were deposited in a shallow-water setting. During this time interval, the Turgai Strait connected the tropical epicontinental peri-Tethyan basins to the Boreal semi-isolated basins of Western Siberia. Because of the exchange of water-bodies from both basins, both the structure and composition of Paleogene marine faunas were impacted and studies on Turgai depression sediments can shed new light on the evolution of the marine ecosystems in these regions. We have studied species-richness assemblages of foraminifera from the Sokolovo Formation to provide new information on the role of the Turgai Strait for the evolution and diversity of environments during the Later Paleocene.

The material includes 6 samples from the Sokolovo iron-ore quarry (53° 3'11.93"N; 63° 3'40.59"E) that is located in the Kostanay region of Northern Kazakhstan. The material was collected in 2019 from an outcrop that is considered to be typical for the Sokolovo Formation. The deposits are represented by quartz and glauconitic sand with interlayers of sandstones that contain fossil mollusks, spines of echinoids, and shark teeth. The Sokolovo Formation lies on Upper Cretaceous sands and is overlain by the Eocene siliceous rocks such as diatomite, opoka, and tripolite.

The foraminiferal assemblages recovered, comprise 35 species that were identified from a total 700 specimens. They include several taxa of the Cibicididae family including *Cibicidoides reinholdi*, *C. succedens*, *C. lectus*, *C. incognitus*, *C. proprius*, and *C. favorabilis*. The assemblages also contain abundant individuals of *Reussella paleocenica* and other low-oxygen tolerant species like *Nodosaria spinulosa*, *Dentalina communis*, *Oolina apiculate*, *Lenticulina degolyeri*, *Polymorphina pulchella*, *Protoglobulimina ovata*, *Globulina minuta*, *Pullenia quinqueloba*, *Bulimina rosenkrantzi*, *Loxostoma applinae*, and *Acarinina subsphaerica*. The foraminiferal faunal associations are indicative for somewhat deeper water settings that experienced low-oxygen conditions. The assemblages comprise benthic and planktic foraminifera from the Western Siberian basin and the Peri-Tethyan realm and can be correlated with biotas from the other areas.

Poster: Cave ostracoda from Greece and Germany: The case of the Cave of the Lakes, Kastria, Greece

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Ostracods are by far the most abundant fossil arthropods, living in almost every aquatic environment including groundwater and caves. In cave systems worldwide, their study has not been systematic yet, so our knowledge about their biodiversity and distribution patterns is patchy. However, cave ostracods are incredibly important for biogeography and paleoecology because they can provide detailed information for high impact multidisciplinary studies in research fields such as archaeology and paleoclimatology. Thus, cave ostracod study is a pioneering proxy with enormous potential for new discoveries. The “Program for the Promotion of the Exchange and Scientific Cooperation between Greece and Germany IKYDA 2022” and more specifically the joint project “Cave ostracoda from Greece and Germany: a pilot study for (paleo)ecological and biogeographical collaboration” is a striking example of how scientific research between academic institutions can be combined with the cooperation between two UNESCO Global Geoparks (Chelmos Vouraikos UGGp, Thüringen Inselsberg-Drei Gleichen UGGp). The purpose of this research is to conduct a comprehensive analysis of ostracods and their ecology in selected caves in the two UGGp, aiming to establish a foundation for future paleoenvironmental studies. This study contributes new knowledge to an unexplored field of cave ostracod research and aims to delve deeper into the world of freshwater ostracods, expanding our understanding and analysis. Until now samplings have taken place in the Kastria Cave of the Lakes and Ladon River springs from Chelmos Vouraikos UGGp and in Altensteiner Höhle, Marienglashöhle and Kittelsthaler Tropfsteinhöhle: Grafsche Kammern from Thüringen Inselsberg-Drei Gleichen UGGp. The site that until now has provided by far the best results is the Cave of the Lakes, one of the main geosites

of Chelmos Vouraikos UGGp. In October 2022, sediment samples from five different locations were collected from the floor of the cave and two as box core samples from the bottom of the cave lakes (lakes 1 and 2). In two of the five sampling locations short cores were taken. So far, sediment samples from four out of the seven sampling locations have been processed and studied, giving more emphasis on the samples from the two cores. The samples were wet sieved through 125 µm and 63 µm sieves. The distribution of the samples allowed us to study the sediment sequences temporally, spatially, and climatically. At least six different species of freshwater Ostracods were found in all the studied samples, especially in the sediment samples from the two core samples. In addition, two different species of gastropods and several bones of micro-mammals were also found. Finally, and quite importantly, bits of microplastics were identified in many specimens. Such multidisciplinary research has never been done in the Cave of the Lakes or in other caves of Greece. We intend to continue our preliminary research through a follow-up project reconstructing the Quaternary evolution of environmental conditions and anthropogenic impacts within the Cave of the Lakes.

Poster: Nonmarine Ostracods as Proxies in Geoarchaeology

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Ostracods (Crustacea) have high fossilization potential due to their calcitic carapaces, and as they, in contrast to many other microfossil groups, also occur widespread and with high species richness in fresh water, they are especially useful as paleoenvironmental proxies in nonmarine settings. This makes them valuable for analyses of aquatic sediments in archaeological investigations, but their potential in this field is, however, not fully exploited so far. To promote their application in geoarchaeology, we present a review on how nonmarine ostracods can be used to answer geoarchaeological research questions, based on a paper published by us recently (Quante et al. 2022).

Ostracods live in all types of aquatic habitats, both natural and man-made. Due to their small size (mostly 0.5–2 mm in length) only small volumes of sediment are needed for analyses. Their carapaces allow identification on species level and even ontogenetic stages.

Their applications in geoarchaeological studies can be divided into four categories: 1) Paleoenvironmental and paleoclimatic reconstructions, 2) land use, 3) water works and water use, and 4) provenance studies. The most used application by far are the paleoenvironmental reconstructions and paleoecolological analyses, which are typically based on the ecological information of associations and species-specific preferences and tolerances. Other methods include taphonomy, morphometric variability, stable isotope and trace element chemistry of the valves. Especially at Paleolithic and Neolithic sites climatic changes and changes in human living strategies have been of interest, environmental histories of areas with human occupations have been reconstructed, and the environmental suitability of areas for human settlements have been analyzed with ostracod-proxies. At more recent archaeological sites, ostracods can be used to detect water works such as canals and dams, and reconstruct the usage of those structures, potentially even with a seasonal resolution. Also, they can be used to indirectly detect land use, e.g. by eutrophication, or deforestation with subsequent higher erosion rates and resulting discharge fluctuations in streams or into lakes. Ostracod studies have also been used to interpret climatic changes effecting land and water use, or human impacts on the environments that are reflected in the ostracod faunas through e.g. soil erosion and aridification.

We compiled more than 100 geoarchaeological studies that all in some way used nonmarine ostracods. This promotes ostracod-proxies for various (geo-)archaeological research questions, but also displays the sparsity of detailed nonmarine ostracod studies at archaeological sites. However, regarding the state of research and development of new and better ostracod proxies, the number of studies may further increase in the coming years.

Reference:

Quante, E., Pint, A. & Frenzel, P. 2022. Nonmarine Ostracoda as proxies in (geo-) archaeology—A review. *Geoarchaeology* 37, 711–732.

Poster: Systematics and zoogeography of marine and brackish water ostracods of South Africa

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The ostracods of South Africa have a long (almost 140 years) history of study and a significant number of publications on their taxonomy, ecology, and zoogeography. However, these data require additional systematic studies for an improved information and analytical base for ecological, zoogeographic, and paleogeographic studies. According to our preliminary estimates, the ostracods of South Africa (southern and eastern coast of South Africa from 17°S to 35°S; the eulittoral and the deep-water zones from 32 m to 3059 m water depth, lagoons, estuaries and coastal lakes) are represented by three suborders (Cytherocopina, Bairdiocopina, Platycopina), 49 genera and about 150 species. The material was collected during several field campaigns in 2013-2020. The monographic description of fossil (Quaternary) and Recent ostracods of South Africa (collection in Jena and collection of G. Hartmann, Zoological Museum, Hamburg) contains detailed descriptions of the external and internal morphology of the shell, as well as generalized data on the ecology and zoogeography according to the material and literary sources.

The species diversity of South African ostracods is determined by the geographical location of South Africa between two oceans and was formed under the influence of the cold Benguela Current of the Atlantic Ocean and the warm subtropical Agulhas Current of the Indian Ocean. The system of oceanic and marine currents provides the active migration routes of ostracods in the oceans; the passive route of ostracod transport occurs by birds, floating marine plants, and shipping. The study of the stratigraphy of marine and brackish water ostracods of South Africa was based on the analysis of the geographical distribution and stratigraphic position of ostracods according to the author's data (South African coast) and literary data (World Oceans), as well as on the reconstruction of paleoareas and modern habitats, time and directions of ostracod migration in the oceans in the stratigraphic range "Paleogene-Recent".

According to zoogeographic zoning of the ocean (littoral and pelagic), South Africa belongs to the Antiboreal region (the coast of the southern continents in the transition zone between the Antarctic region and the Tropical region) and the South African subregion. Within the South African ostracods, three zoogeographic groups stand out: North Atlantic, Pacific and endemic. The preliminary statistical estimate of the ratio of the number of species in different zoogeographic groups according to the study is as follows (the list of species is still incomplete): North Atlantic ostracods (e.g., *Aurila dayii* Benson & Maddocks) account for 10 % of the total number of identified species; Pacific (Californian) ostracods

(e.g., *Hemicythere californiensis* LeRoy, *Ambostracon flabellicostatum* (Br.)) account for 18 %; endemic species (e.g., *Urocythereis arcana* Dingle, *Mutilus bensonmaddocksorum* Hartmann, *Mutilus malloryi* Dingle, *Aurila kliei* Hartmann, *Aurila petricola* Hartmann, *Aurila leisurensis*, *Ambostracon keeleri* (Dingle), *Ambostracon frenzeli*) account for 72 % of the total number of identified species revealing a dominance of endemic species.

The study of the ecology (autecology, demecology) of ostracods aims on the adaptive potential of South African ostracods (the range of tolerance to abiotic factors and their manifestations in shell morphology; the dynamics of the structure and density of populations as indicators of optimal and pessimal conditions for the existence of the species, etc.) for bioindication of pollution of modern marine ecosystems and paleogeographic reconstructions of paleowater bodies. The results of these studies will be made public at a later date.

Poster: Exploring Environmental Micropaleontology: Ostracoda and Foraminifera in the protected area of Mlalazi estuary, South Africa, and their exposure to pollution

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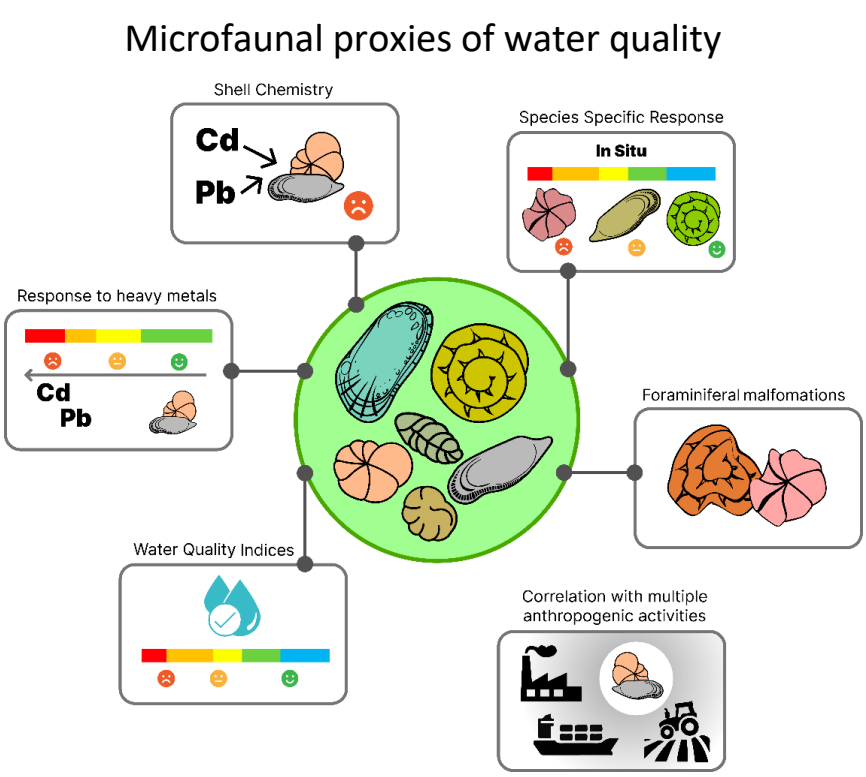
The Mlalazi River flows through a natural reserve at the eastern coast of South Africa and has been regarded as free from contamination. To prove it and assess the ecological state of aquatic life in the reserve, as well as to enhance the indicator value of marginal marine Foraminifera and Ostracoda in South Africa, we conducted an analysis of microfauna in 25 surface sediment samples. These samples were obtained from the Mlalazi estuary, covering a salinity range from oligohaline to euhaline. Except of two samples, all others contained Ostracoda and Foraminifera. Among the identified ostracod species, there were 17 species belonging to 14 genera. Typical taxa are the brackish water species *Perissocytheridea aestuaria, Sulcostocythere knysnaenis,* and *Australoloxoconcha favornamentata*. Our investigation identified 19 Foraminifera species from 16 genera, with dominant taxa such as *Ammonia* sp., *Quinqueloculina* sp., and *Milliolinella* sp. Three distinct assemblages were observed: A) *Ammonia* sp., *Quinqueloculina* sp., with very low diversity and abundances in general, located along the river course and exciding Pollution Load Index (PLI); B) *Ammonia* sp., *Quinqueloculina* sp., *Sulcostocythere knysnaenis* with higher salinity and lower PLI; C) *Ammonia* sp., *Quinqueloculina agglutinans*, *Cribroelphidium articulatum* located in mudflats with the most minimal PLI. Our findings align with the commonly observed diversity trend, which indicates reduced species diversity corresponding to elevated pollution levels. Notably, the examined samples revealed a range of Foraminiferal Abnormality Index (FAI) up to 23 %, exhibiting anomalies such as multiple tests, changes in coiling, and abnormal chamber shapes. Geochemical analysis indicates that the river is subjected to substantial anthropogenic pressure, as evidenced by elevated concentrations of heavy metals, Sulphur, PET, and LDPE. Ongoing investigations in South African estuaries are expanding our dataset and will contribute to a better understanding of the species-specific responses of Ostracoda and Foraminifera to anthropogenic pressure.



Poster: Palynomorphs in Bitterfeld amber - An ongoing project

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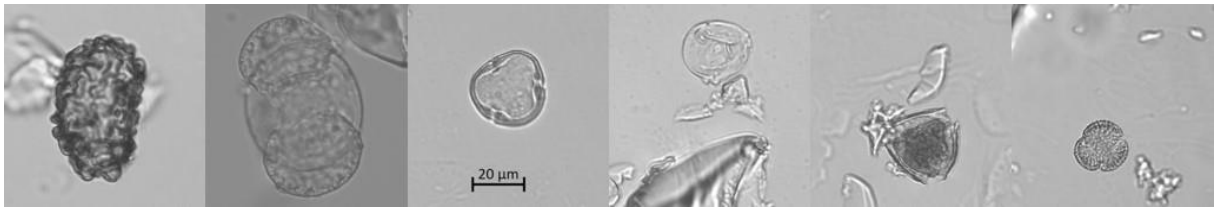
Bitterfeld amber (Saxonian amber, succinite) is known for its diversity of inclusions. Numerous publications consider its faunistic, but only a few its floristic spectrum. References to pollen and spores preserved in amber resin are very rare, mostly in connection with enclosed flowers or pollen grains sticking to insects. However palynological investigations on amber can reconstruct composition of former vegetation and characterize plant communities as well as environmental conditions. They are the key to age determination of amber formation (time of resin flow), which is still in discussion because the Bitterfeld deposit represents a secondary deposit.

According to the methodology developed by Halbwachs (2019), individual amber pieces were dissolved in tetrahydrofuran. Enclosed palynomorphs were enriched by centrifugation and determined at 400-600× magnification. Up till now 36 amber samples were examined and more than 300 pollen and spores (exclusively fungal spores) were detected. The Figure shows some of them.

The pollen spectrum illustrates the mixed forest character with gymnosperms (e.g. *Pinus, Sciadopitys*) as well as angiospermes. Evergreen species (e.g. Ericaceae, *Ilex*) and broad-leafed trees (e.g. Fagaceae, Betulaceae, Juglandaceae) were both present. Additionally the evidence of alnoid pollen and pollen of *Nyssa* indicate the presence of wet to swampy areas or possibly even open water areas. Ferns and mosses are representatives of the herbaceous layer. The occurrence of Poaceae points to the existence (at least in some areas) of more light-flooded areas in the vegetation. Their evidence supports the abandonment of ideas about a closed, dark amber forest. Most of the detected taxa are considered to

be representatives of the arctotertiary floral group with a warm-temperate focus. Paleotropical elements are considered to be part of Eocene climatic favor.

The detected pollen types allow a preliminary dating of the Bitterfeld amber into the Bartonian to Priabonian (SPP 17 to SPP 18, ca. 41.3-33.9 mya). The investigations do not provide a final result. They merely mark the beginning of compellingly necessary, further palynological work on amber of the Bitterfeld deposit.



Different types of palynomorphs isolated from Bitterfeld amber.

Reference:

Halbwachs, H. 2019. Detecting fungal spores and other palynomorphs in amber and copal by solvent treatment. *Palynology* 44 (3), 521–528. https://doi.org/10.1080/01916122.2019.1633436

Poster: Foraminifera in glacial erratics from Northwestern Germany

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Foraminifera in the "Kelloway Geschiebe". Material: Steffen Schneider. Images: Michael Hesemann.

This study is an effort to portray and interpret the foraminiferal faunas in sedimentary glacial erratics of Northwestern Germany. If present fossils and namely macro fossils were commonly used to clarify their origin. So far no systematic study of foraminifera in glacial erratics has been undertaken. If at all their presence was reported only as a group and for a few large species.

Pleistocene glacial erratics including those of a marine sedimentary origin are widely spread in northwestern Europe. They have been sheared off from their original source by glacier-ice and were transported by ice and melt water over a few to up to 1000 kilometers. They are scientifically studied since more than 300 years in order to clarify their genesis and origin.

Glacial erratics of a marine sedimentary origin often contain foraminifera. Their study is hindered though by the compactness of the found pieces and lack of visibility on the outside. Best preservation conditions for foraminiferal specimens and whole faunas are given in locally displaced slabs of material.

So far two papers on foraminifera in the Eocene Heiligenhafener Kieselgestein and in Cretaceous chalk-marl smaers at the Baltic coast have been published (Hesemann and Ketelsen 2017; Hesemann 2020). Two papers on foraminifera of the Oligocene Sternberger Gestein and the Jurassic so called "Kelloway Geschiebe" are in the making. Sampling and processing of Paleocene Kerteminde Marls have been started.

References:

Hesemann, M. 2020. Foraminifera in the glacial erratic rock Heiligenhafener Kieselgestein of northern Germany. *Micropaleontology* 66, 397–418.

Hesemann, M. & Ketelsen, D. 2017. Index Foraminifera in Chalk Marl Smaers at the Brodtener Ufer (Coast of the Western Baltic Sea). *Geschiebekunde Aktuell* 33 (4), 111–117.

Poster: Application of micro-computed tomography on a Miocene sample of Holstein Erratics to identify and assess included snails (Gastropoda) and Foraminifera

Kotthoff, U. *[1], Engelkes, K. [1], Milker, Y. [2], Schmiedl, G. [2], Hesemann, M. [3], Tshibalanganda, M. [4], Beerlink, A. [4]

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Examining fossils in sedimentary rocks often involves the destruction of the sedimentary matrix and even of parts of the fossil assemblage (e.g., via removal and/or dissolution). Destruction-free assessment of fossils in sediments (e.g., sediment core samples) and sedimentary rocks is therefore of great interest to the geoscience community. In addition, the three-dimensional examination of fossils becomes increasingly important to assess and evaluate morphological features and to improve morphometrical analyses. Last but not least, destruction-free analyzing methods allow assessing additional fossils later and to quantify the volume of fossils inside a sample.

"Holsteiner Gestein" is a sandstone and glacial erratic, which is frequently found in northern Germany. The original deposition of this sediment took place during the Miocene, perhaps also the upper Oligocene (Schallreuter et al. 1984). The glaciation-related transport of this material took place during the Pleistocene.

The fossil content inside and paleoecology of the "Holsteiner Gestein" has not been investigated in detail. Particularly after the 1980s, scientific publications on this sediment are rare. If analyzed at all, material like the "Holsteiner Gestein" is generally subjected to destructive methods to isolate fossils such as marine snails or foraminifers, which both comprise taxa with calcareous shells. These fossils contribute to the reconstruction of paleo-ecosystems and depositional environments.

In our case study, a piece "Holsteiner Gestein" was scanned with a Comet Yxlon FF35 CT system employing the directional beam tube: First, an overview scan of the whole sample (210 kV, 160 µA, 1.0 mm Cu filter, 50.00 µm iso-voxel size) was used to identify an area with potentially interesting fossils.

The area of interest was scanned (210 kV, 160 µA, 1.0 mm Cu filter 7.23 µm iso-voxel size) with higher resolution in the following using a scan trajectory with a flexible rotation center that allowed for maximal resolution by adjusting the position of the sample such that it was located as close as possible to the x-ray source, but a collision was prevented. Furthermore, a laminography scan (180 kV, 70 µA, 0. 5 mm Cu filter, 5.02x5.02x9.58 µm voxel size) was performed to achieve the maximum possible sharpness and resolution in cross-sectional images. The software Amira (version 6.0.1) was used to visualize and analyze data.

Our approach enables us to three-dimensionally assess relatively big snail shells and foraminifera of less than 1 mm in size. It also allows quantifying the number of microfossils inside a certain part of the sample. The foraminiferal taxa comprise agglutinating foraminifers which closely resemble the genus *Entzia*. These would imply a former salt marsh environment, but additional scans with even higher resolution may allow to improve the taxonomical attribution.

Reference:

Schallreuter, R., Vinx, R. & Lierl, H.J. 1984. Geschiebe in Südholstein. *In:* Degens, E.T., Hillmer, G. & Spaeth, C. (eds.): Exkursionsführer Erdgeschichte des Nordsee- und Ostseeraumes, Selbstverlag des Geologisch-Paläontologischen Institutes der Universität Hamburg, 575 S.

Poster: Benthic assemblages from Paleogene shallow-water marine facies of Fergana Basin (Central Asia)

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After a predominantly continental development throughout the Mesozoic, the Central Asian Fergana Basin formed a large bay-like structure within the Para-Tethys. In order to reconstruct the evolution, paleoclimatic and environmental conditions of the basin, we have analyzed mollusks and benthic foraminifera. Despite a large amount of geological literature available from this area, studies on the structure and composition of benthic assemblages have received little attention. Our research intends to fill in this gap based on newly collected material and aims to provide a better understanding of the biodiversity and paleoecological conditions in the shallow-water environments of Central Asia during the Paleogene.

Study materials were collected in the Madygen Geopark (Batken Region, SW Kyrgyzstan) during two field campaigns in 2021 and 2022. The material includes 214 rock samples and 284 shells of mollusks. The rock samples include different types of sandstone, siltstone, and clay, and have been prepared for foraminiferal analysis by dissolving the material in hot water. According to previous stratigraphic studies, they have been assigned to four units: Bukhara Formation (Paleocene), Suzak Formation (Lower Eocene), Alai Formation (Middle Eocene), and Rishtan-Hanabad-Sumsar Series (Upper Eocene and Lower Oligocene).

The basal unit of the Paleogene – the Bukhara Formation – contains some small-sized, badly preserved *Ostrea* shells, covered by large gypsum crystals. This points to evaporitic sedimentological conditions. No foraminifera were found in this formation. The Suzak Formation bears mainly agglutinated

foraminifera such as *Spiroplectammina* sp., *Reophax* sp., and *Textularia* sp. and has yielded large-size *Ostrea* and some *Turritella*. Deposition of this formation occurred in a shallow sub-tidal environment. Material from the Alai Formation includes mainly limestones that were devoid of foraminifera but contained some badly preserved shells of *Ostrea* and other small mollusks. This assemblage is considered to represent extremely shallow-water conditions. Foraminiferal assemblages from the uppermost unit – the Rishtan-Hanabad-Sumsar Series – mainly contained the benthic foraminifera *Cribroelphidium rischtanicum* and some miliolids. Mollusks from this series are represented by generally thick-walled *Ostrea*. The faunal assemblages are considered to represent tidal flat conditions.

Poster: The Opuntia of life – illustrating the evolution of cryptogams

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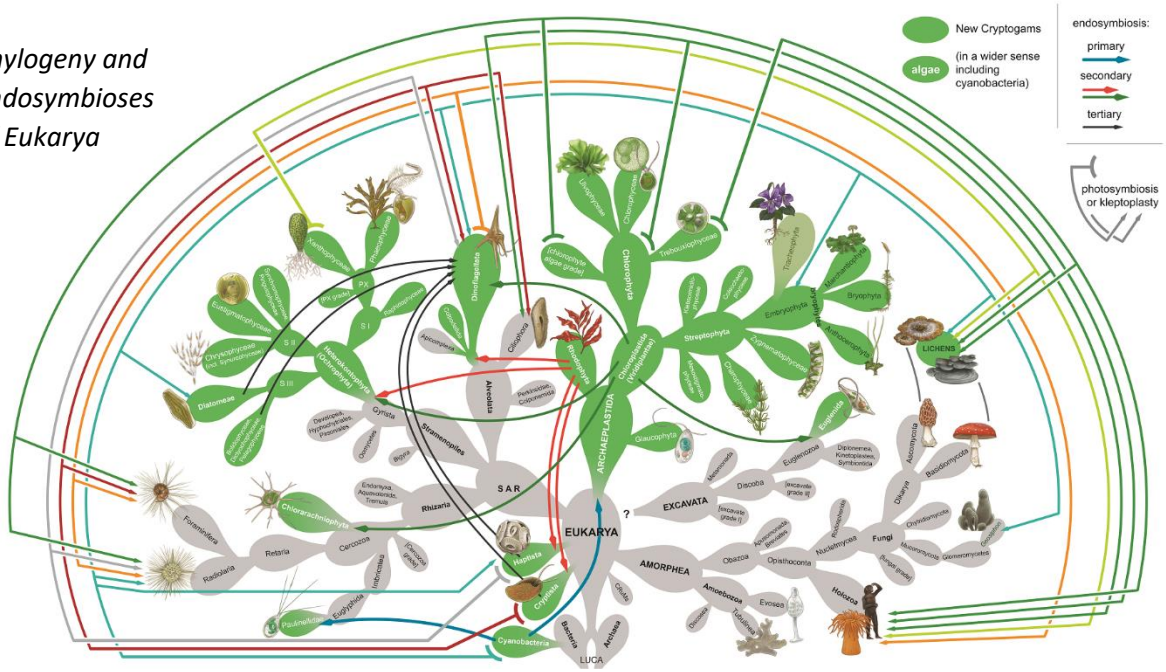
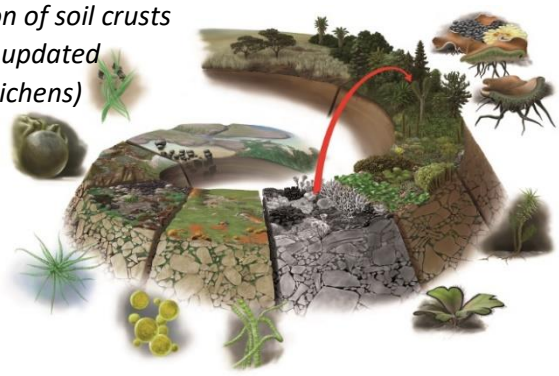
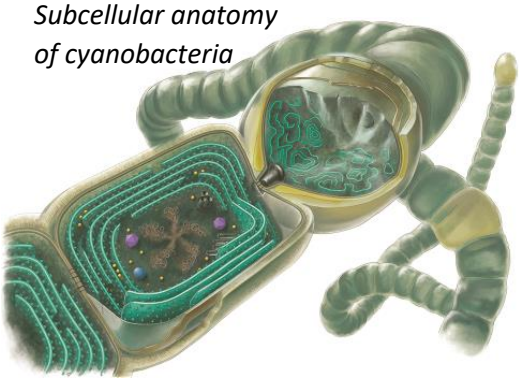
Phylogeny and endosymbioses of Eukarya



Evolution of soil crusts (arrow: updated FAD of lichens)



Subcellular anatomy of cyanobacteria



Büdel, B., Friedl, T. & Beyschlag, W. 2023. *Biology of Algae, Lichens and Bryophytes*. Berlin: Springer, 904 S.

According to an updated definition, cryptogams comprise photosynthetically active non-tracheophyte organisms, i.e. cyanobacteria, the wide and polyphyletic spectrum of algae, lichenised fungi, and bryophytes. Therefore, dealing with cryptogams requires a panoply of virtually the entire tree of life, with focus on "protists" and less popular multicellular groups. While our central diagram is clearly a tree model, the re-activated historical bubble-style resembles *Opuntia*, a famous cactus. This chart is part of a comprehensive treatise creating a context for major basic evolutionary steps, such as early eukaryote endobiosis or the evolution of reproductive cycles. From a paleontological point of view, cryptogams deserve a greater perception regarding their role in biological soil crusts, which gave rise to the evolution of soils, atmospheric composition, and cycles of matter. Linking the paleo-perspective to extant cryptogam research is a chance for an enhanced awareness of eco-factors, apart from the macroscopic and predominantly aquatic microscopic fossil record.

(S9) Science Communication, Geotourism and Public Relations (Organization: Silvia Kolomaznik, Sylvia Reyer-Rohde, Mauro Alivernini)

This session presents science communication aspects of paleontology. Concepts, presentations in popular science publications and exhibitions, involvement of citizen scientists or children, paleontology in geoparks and museums are all important for the acceptance of and the interest into our field of science.

Talk: UNESCO Global Geopark Thüringen Inselsberg-Drei Gleichen: Der Geopark stellt sich vor.

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Der UNESCO Global Geopark Thüringen Inselsberg-Drei Gleichen, im Herzen Deutschlands gelegen, repräsentiert ein Gebiet mit Geotopen von besonderer wissenschaftlicher Bedeutung, Seltenheit und Schönheit, die repräsentativ für die Thüringer Mittelgebirgslandschaft und deren geologische Entstehungsgeschichte sind. Im Laufe seines 21-jährigen Bestehens hat der Geopark ein breites geotouristisches Angebot für unterschiedliche Zielgruppen entwickelt, wobei sich die Angebote sowohl an Besucher als auch an die einheimische Bevölkerung richten. So stehen ein modernes GeoMuseum im Schloss Ehrenstein in Ohrdruf sowie mehrere lokale GeoInfozentren und -Infopunkte, Schauhöhlen und Besucherbergwerke für die Besucher zur Verfügung, welche interessante Einblicke in die Regionalgeologie der jeweiligen Standorte anbieten. Sie dienen außerdem als Ausgangspunkte für 18 lokale GeoRouten (Wander- und Radwege) zu verschiedenen Themenbereichen, wie z.B. Vulkanismus, Bodenkunde sowie zu den lokalen mineralogischen und petrographischen Geotopen am Wegesrand. Mit über 400 Schautafeln entlang der Routen wird das Geoparkgebiet geotouristisch in seiner Gesamtfläche erschlossen, da jede Geoparkgemeinde über eine GeoRoute verfügt oder deren Einrichtung zukünftig geplant ist. Besuchermagneten sind die beiden Premium-Wege „Saurierlebnispfad" zwischen Georgenthal und Tambach-Dietharz, welche die Ursaurierfunde vom Bromacker thematisiert, sowie der Geo&Genuss-Weg „Vom Bier zur Bratwurst" bei Haarhausen, der Bodenkunde mit kulinarischen Spezialitäten aus Thüringen verknüpft.
UNESCO Global Geoparke sind Modellregionen für nachhaltige Entwicklung. Effektive Managementstrategien müssen auf die lokalen Gegebenheiten im Geoparkgebiet zugeschnitten sein und eine enge Zusammenarbeit mit der Anwohnerschaft, lokalen Einrichtungen sowie den kommunalen Trägern umfassen, damit unterschiedliche Interessenslagen in der Geoparkarbeit

abgebildet werden können. Ein wichtiges Ziel des Geoparks ist es, verantwortungsvoll mit den zur Verfügung stehenden natürlichen Ressourcen umzugehen und einen nachhaltigen, „sanften“ Tourismus zu fördern. Wichtig sind in diesem Kontext auch die vielfältigen Bildungsangebote des Geoparks, welche in den letzten beiden Jahren entwickelt wurden. 2023 wurde der Geopark vom ThILLM (Thüringer Institut für Lehrerfortbildung, Lehrplanentwicklung und Medien) als „außerschulischer Lernort" offiziell anerkannt. Gemeinsam mit der Geoparkstadt Ruhla wird das „Grüne Klassenzimmer“ am Naturerlebnisweg seit 2023 als Lernort für BNE-Angebote (Bildung für nachhaltige Entwicklung) genutzt.

Darüber hinaus unterstützt der Geopark nationale und internationale wissenschaftliche Forschungsprojekt in seinem Gebiet, wie das vom BMBF geförderte Projekt „BROMACKER“ sowie das IKYDA-geförderte Projekt "Cave ostracoda from Greece and Germany“. Neben der studentischen Ausbildung wurden dabei im Rahmen von Projektwochen auch Bildungsangebote für ortsansässige Schulen gemeinsam mit den Forschenden entwickelt und 2023 erstmals durchgeführt. Diese Angebote sollen verstetigt und zukünftig regelmäßig angeboten werden.

Nicht zuletzt befördert der intensive Austausch mit den anderen deutschen Geoparken im Netzwerk der „AdG- Arbeitsgemeinschaft der deutschen Geoparke“ und „Forum der UNESCO Global Geoparks in Deutschland“ die Entwicklung neuer Ideen und Projekte, welche vom Geopark aufgegriffen werden und in zukünftige Entwicklungsstrategien einfließen. Internationale Vernetzung erfolgt durch die intensive Zusammenarbeit mit unseren Partnergeoparken „Erz der Alpen“ im Pongau, Österreich und „Chelmos Vouraikos“ in Patras, Griechenland sowie durch die Mitarbeit in den Netzwerken der EGN (European Geoparks Network) und GGN (Global Geoparks Network). Diese Arbeit dient als Grundlage für fundierte Entscheidungsfindung, um die Erhaltung dieses bemerkenswerten Geoparks für zukünftige Generationen zu gewährleisten.

Talk: Dinosaurs in Comics – how subtle paleontological knowledge transfer can be fun!

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[2] Independent Researcher, Germany
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Next to movies, comics are probably the most influential medium to present dinosaurs to the public in a memorable way. The easily accessible visual format offers the possibility to transmit scientific results to a broad audience (although strips involving prehistoric creatures are aimed predominately at a young readership). Comics have the advantage of being able to take up and adapt new paleontological ideas in a very short time. Such a fast pace is not possible with films and books. At the same time, many comic strips base their prehistoric depictions on contemporary paleoart and, like it, minutely document the change in ideas on dinosaurs and other extinct animals over the 20th century up to the present day. This makes dinosaur comics ideal chroniclers of advances in paleontology.

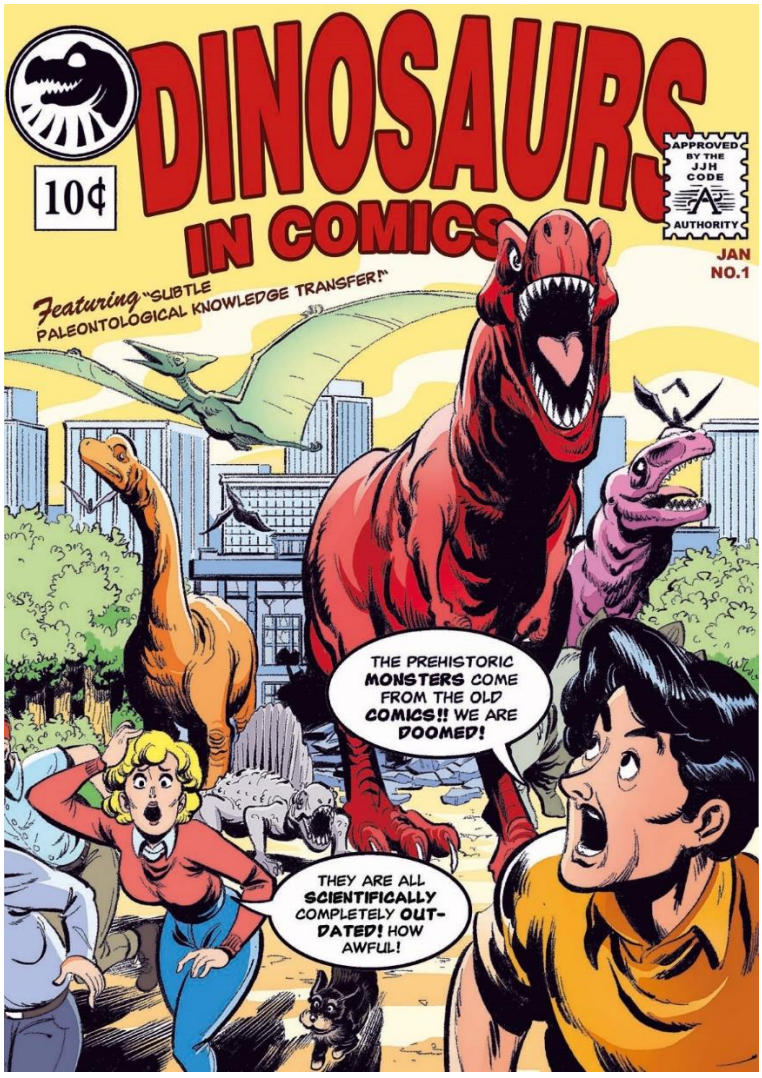
In the field of dinosaurs in comics, there are many pure entertainment and adventure stories. These represent the absolute majority for the past 130 years with thousands of strips handling tales from science fiction, fantasy, horror, mystery, western, or the superhero genres. These strips are essentially not dinosaur comics but comics with dinosaurs. Nowadays, however, there is a small but diverse niche that uses different approaches of a more documentary form of representation and narration (Wings et al. 2023) which portray the animals as real creatures according to modern concepts. This way,

additional background knowledge can subtly be conveyed without reducing the entertainment value. These are the real dinosaur comics. The first approach is to provide additional brief background information about prehistoric life to the reader of adventure stories in the form of few supplementary pages. The next approach creates pure dinosaur stories with a scientifically more robust background and naturalistic depictions of the animals and environments. The focus in these modern comics is on the needs and experiences, but also failures, of the dinosaur protagonists. Another approach is text-reduced visual storytelling, similar to a sophisticated storyboard. The paleontological background is not explained further. Instead, the reader is challenged to extract all information from the drawings. In addition, all language barriers are easily overcome here. Comic science books in turn convey paleontological information through a direct implementation of popular science book content in comic style. In this scenario, an adventurous story with (intrusive) human protagonists can mostly be abandoned in favor of imparting knowledge via panels with text boxes. The last approach is the individual mix of the previously mentioned comic styles to get a genre „potpourri“.

So dinosaur comics are not just for children, but can be an effective means of communicating scientific ideas for all ages: Colorful, exciting, entertaining and yet informative, proving that paleontology can also be fun!

Reference:

Wings, O., Fischer, J., Knüppe, J., Ahlers, H., Körnig, S. & Perl, A.-M. 2023. Paleontology-themed comics and graphic novels, their potential for scientific outreach, and the bilingual graphic novel EUROPASAURUS – Life on Jurassic Islands. *Geoscience Communication* 6, 45–74. https://doi.org/10.5194/gc-6-45-2023



Talk: Visions Of The Apocalypse – an International Paleoart Project on the Dinosaurs Darkest Day

Westphal, J. *[1]
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Ever since the Alvares hypothesis arose, artists tried to process and cope with the incredible event in stunning and breathtaking artworks of varying plausibility. And even though the final works are mere approximations of what the world looked like 66 million years ago, they do communicate scientific findings of their time and they spark excitement and joy in young and old. We all have seen depictions of the event: documentaries on the Mesozoic, books on dinosaurs, and even most collections of modern paleoart feature artworks of the great extinction event. Yet there are thousands of facets and aspects still invisible: From the peaceful moments before impact, over the hard-to-grasp event itself, to the earth-changing aftermath that followed. From the depths of the sea, over the living ecosystem that were massive sauropods, to the small worlds of insects: Incredible artworks attempt an approximation of our world and its inhabitants in these (post-)apocalyptic times.

The *Visions of the Apocalypse* project curates a collection of diverse international paleoart by artists from all around the globe. The artists interpret scenes in a variety of styles and with refreshing and previously unseen focal points. Designed with love and effort, this collection is an excellent addition to any art collection, for popular scientific exhibitions, museum shops all over the world and is a real eye-catcher on every coffee-table!

So far, almost 40 artists from over 20 countries have submitted their works. More than 40 more are interested and have fantastic works to show or are willing to create pictures especially for the collection. This includes celebrities of the paleoart community such as: Mark Witton, Doug Henderson, Brian Engh, Joschua Knüppe, RJ Palmer, Midiaou Diallo, Natalia Jagielska, and many others!

Current movies, games, books, and toys prove it: the public interest in dinosaurs experiences a renaissance, comparable to the peak dinosaur-era of the late 80's and 90's. This is a great timing to publish an exciting book in an edutaining manner to reach serious dinosaur enthusiasts as much as the broad public. And then, ultimately, there is yet another aspect to the whole topic that makes an engagement with earths *fifth* great mass extinction event even more contemporary:

Right now, extant dinosaurs face a global extinction event even more devastating than the famous asteroid impact that wiped out their non-avian cousins 66 million years ago.

The sixth great mass extinction of our planet has already begun. Experts on biodiversity agree: The current loss of species exceeds the level of the usual background extinction by 1,000 to 10,000 times. One particular group of animals that suffers terribly under these conditions are birds, the last surviving family members of the group known as dinosaurs.

Talk: Paleoart and visual communication

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Science communication is on the rise and the need for scientific visualization increases. Although the result of a paleoart project depends primarily on the skills of the artist and the funding of the institution, the applied forms of communication and style determine the impact that the project will have on its viewers.

Engaging with these issues helps to develop a clearer vision of a project in the making and thereby actively improves the communication with creatives.

In this lecture, various communication strategies and visual languages are briefly introduced by using international examples.

Talk: Paläontologische Bodendenkmalpflege im Rheinland - Quo Vadis?

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“Zeugnisse pflanzlichen und tierischen Lebens aus erdgeschichtlicher Zeit“ wurden erstmalig 1914 im Preußischen Ausgrabungsgesetz, neben Kulturgütern, als schützenwert anerkannt. In gleicher Form wurde der Begriff 1980 in das Denkmalschutzgesetz von Nordrhein-Westfalen – Denkmalrecht fällt in die Verantwortung der Länder – übernommen und findet sich heute in ähnlicher oder leicht abgewandelter Form in den Denkmalgesetzen von fünf weiteren Bundesländern. Die rechtliche Verankerung von Fossilien innerhalb des Gesetzes ermöglicht die Unterschutzstellung bekannter Fossillagerstätten als ortsfestes Bodendenkmal und gewährleistet so die Sicherung der Verfügbarkeit für zukünftige wissenschaftliche Untersuchungen und Generationen. Im Zuge von geplanten Überbauungen oder Erdeingriffen können des Weiteren Verdachtsflächen anhand geologischer Karten, Bohrdaten und Publikationen als vermutetes Bodendenkmal eingestuft werden. Dies ermöglicht – äquivalent zur Archäologie – eine bauvorgreifende oder, weitaus häufiger, eine baubegleitende fachwissenschaftliche Untersuchung, Bergung und Dokumentation der betroffenen Abfolgen und Funde. In aller Regel kommt dabei das sogenannte Verursacherprinzip, welches Anfang der 1990er Jahre eingeführt wurde, zum Tragen. Dabei sind alle anfallenden Kosten der baubegleitenden Tätigkeiten im Bereich des (vermuteten) Bodendenkmals und die damit verknüpften Personal- und Sachmittel durch den Verursacher der Bautätigkeit zu tragen, solange diese im Bereich des Zumutbaren liegen. In der Archäologie hat das Verursacherprinzip in NRW zur Bildung eines diversen Ökosystems privatwirtschaftlicher archäologischer Fachbüros mit teils unterschiedlichen wissenschaftlichen Spezialausrichtungen geführt. Eine ähnliche Entwicklung blieb in der Paläontologie, bis auf wenige, meist freiberuflich Tätige, bisher leider aus. Trotz eines nach wie vor hohen Auftragsaufkommens im Bausektor und teils umfangreicher Projekte mit entsprechenden Bodeneingriffen, fristen paläontologische Begleitungen ein Nischendasein. Ein Faktor ist hier sicherlich die dünne Personaldecke im paläontologischen Sektor innerhalb der entsprechenden Fachämter. Es fehlt allerdings auch an freiberuflichem Personal für die Durchführung solcher Projekte, die teils über mehrere Jahre angelegt sein können. Manches kann und wird in diesem Fall durch ehrenamtlich Tätige, zumeist interessierte Laien, abgedeckt und aufgefangen. Vieles muss jedoch zwangsläufig auf der Strecke bleiben. Aus Sicht der Paläontologie ist dies in mehrerlei Hinsicht bedauerlich. Die Sichtbarkeit der Paläontologie innerhalb der Bodendenkmalpflege bleibt dadurch häufig deutlich hinter ihren Möglichkeiten zurück. Potentiale und Chancen, auch für die interdisziplinäre Verknüpfung der Archäologie mit der Geologie/Paläontologie, werden nicht erkannt oder genutzt. Da viele klassische Fundstellen heute nicht mehr zugänglich, überbaut oder zerfallen sind, stellen baustellenbedingte Bodeneingriffe ein wichtiges, wenn auch zeitlich eng begrenztes Fenster in die erdgeschichtliche Vergangenheit dar. Die Funde der letzten Jahrzehnte im Kontext der paläontologischen Bodendenkmalpflege im Rheinland zeichnen hier ein klares Bild des innewohnenden Potentials, auch in Bezug auf mögliche Kooperationen mit der universitären Forschung.

Die paläontologische Bodendenkmalpflege sollte daher als Chance für die Paläontologie in Deutschland verstanden werden und als gleichberechtigte Aufgabe des Denkmalschutzes einen stärkeren Fokus erhalten.

Poster: Citizens, science and industry save several thousand fossils from the Remigiusberg lagerstaette (Pennsylvanian-Permian boundary, Saar-Nahe Basin, SW Germany)

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The Remigiusberg lagerstaette is an outstanding fossil site with abundant and diverse aquatic and terrestrial biota from the base of the Rotliegend in the Saar-Nahe Basin, SW Germany (Voigt et al 2014). It refers to an about 50 m thick succession of fluvio-lacustrine sediments of the Remigiusberg Formation (Gzhelian-Asselian, Pennsylvanian-Permian boundary) that is exposed by an active quarry of the Basalt AG at Rammelsbach near Kusel, Rhineland-Palatinate. The Rammelsbach quarry mines subvolcanic andesitic rocks of early Permian age in order to produce road and railroad gravel. For several years, the Urweltmuseum GEOSKOP has been investigating the litho- and biofacies as well as the fossil record of the sediments of the Remigiusberg Formation in the Rammelsbach quarry on behalf of the Rhineland-Palatinate Department of Geological Heritage (Generaldirektion Kulturelles Erbe Rheinland-Pfalz) and with the support of the Basalt AG (Voigt et al. 2019). In 2023, an emergency dig was carried out for the first time, which is almost unprecedented in Germany in its dimension and with regard to the cooperation of citizens, paleontology and industry. Within 60 days, about 1,000 tons of fossil-bearing rocks of a paleotropical river channel were systematically sampled by volunteers under scientific guidance. Once announced, the project attracted 137 people between 7 and 83 years in age and from an area of more than 300 km around the site to assist in the field. The work has generated considerable public attention in the daily press, on television and in social media. In nearly 4,600 hours of field work, an estimated 3,500 fossils of scientific importance were recovered. Preliminary results of the 2023 excavation prove the Remigiusberg Formation in the Rammelsbach quarry to be one of the world's most important sites for Paleozoic millipedes, lungfishes and terrestrially adapted amphibians. In addition, about 30 other groups of fossils ranging from root traces to edaphosaurid tooth and bone material were recovered. Excellent results, the unexpectedly high interest over the entire excavation period as well as the enthusiasm of all volunteers even in the aftermath strongly argue for the involvement of non-professionals in such activities. Similar projects seem to be suitable not only for promoting the popularity of paleontological research, but also to awake understanding for the generally conflicting interests of monument preservation and industry and thus ultimately paving the way for a constructive-cooperative relationship between the two.

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Poster: Geologisch-Paläontologische Sammlungen im Naturkundemuseum Mauritianum Altenburg, Thüringen

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Im Jahr 1817 gründete sich in Altenburg die Naturforschende Gesellschaft des Osterlandes (NfGO). Ihr Ziel war insbesondere die Vermittlung naturwissenschaftlicher Erkenntnisse in der Heimatregion. Erste geologischen Objekte, z.B. Bernstein aus Pöppschen oder ein Bruchstück des Pohlitzer Meteoriten, stammten daher zunächst aus der Umgebung der Stadt. Durch Erwerb oder Schenkungen von Privatpersonen, Wissenschaftlern oder Mitgliedern der Naturforschenden Gesellschaft vergrößerten sich die Sammlungen stetig. Längst stammten die Objekte aus aller Welt. 1908 wurde ein eigens konzipierter Museumsneubau im Altenburger Schlossgarten eingeweiht, der als reiner Präsentationsraum genutzt wurde. Etwa 100 Jahre später mussten die Sammlungen infolge einer Komplett-Sanierung des Gebäudes umziehen. Die geologische Sammlung fristete ein Dasein in Archivkartons, sie war für wissenschaftliche Bearbeitungen nur schwer zugänglich. Ihr endgültiges Domizil fand sie 2020 im sog. "Kunstturm", einem 1844 errichteten Wasserturm, im Zentrum Altenburgs. Durch das Förderprogramm LEADER wurden die Voraussetzungen für eine Entwicklung des Gebäudes als "Haus der Geowissenschaften" geschaffen. Es vereint nun erstmals alle mineralogischen, petrologischen und paläontologischen Sammlungen, ein kleines Labor für die Gesteinspräparation sowie verschiedene Räume zur Archivierung und Digitalisierung der Sammlungsobjekte. Gleichzeitig bietet es Raum für wissenschaftliche Forschung und praktische Arbeiten im Bereich des Natur- und Umweltschutzes, welche eng mit geowissenschaftlichen und hydrologischen Themen verbunden sind. Es fungiert als Treffpunkt für interessierte Schüler, Studenten, Wissenschaftler sowie geowissenschaftlich interessierte Laien.

Ausgewählte paläontologische Sammlungen des Mauritianums fokussieren sich auf folgende Objekte

- Silurische und devonische Graptolithenschiefer Ost-Thüringens (Ronneburg und Umgebung), Sammlungen von Ernst Kirste, Elfried Manck und Robert Eisele, ca. 1.000 Objekte
- Mit dem Versteinerten Wald von Chemnitz assoziiertes fossiles permisches Holz aus der Umgebung Altenburgs, Sammlungen von Peter Baum und Peter Rudolph, >2.700 Objekte
- Paläobotanische Sammlung Dr. Dietmar Storch, >650 Objekte
- Paläozoologische und paläobotanische Sammlung aus dem Tertiär der Leipziger Tieflandsbucht, Sammlung Prof. Dr. Arnold Müller, >3.600 Objekte aus dem Zeitraum 1974-1983
- Inklusen in Bitterfelder Bernstein (Sächsischer Bernstein), Sammlung Walter Ludwig, >10.000 Objekte
- Bernstein-Arten des Bitterfelder Bernsteins, Sammlung Dr. Roland Fuhrmann
- Mollusken und Ostracoden aus zahlreichen Quartär-Profilen des mitteldeutschen Raumes, Sammlung Dr. Roland Fuhrmann

In den 1990 Jahren übernahm das Museum das Kernmaterial von acht, zum Teil über 1.000 m tiefer Bohrungen der Wismut GmbH. Das Mauritianum sicherte so ein unwiederbringliches Zeugnis der erdgeschichtlichen Entwicklung im Ronneburger Revier seit dem Ordovizium.

Die Museumssammlungen stehen ausgewiesenen Spezialisten für wissenschaftliche Untersuchungen zur Verfügung.

Preview: 95th Annual Meeting of the Paläontologische Gesellschaft 2024 (Warsaw)

"More than extinct species: the importance of fossils for ecology, evolution and conservation across borders?" Announcing Joint Meeting of the Polish Paleobiologists and the 95th Annual Meeting of the Paläontologische Gesellschaft (Palges), Warsaw, September 16-21, 2024

Organizing Committee: De Baets, K. [1] (chairman), López-Torres, S. [1], Skawina, A. *[1], Tałanda, M. [1], Vanadzina, K. [1], Zapalski, M. [2], Łaska, W. [1], Mermer, J. [1]

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Fig 1. Logo of 95th Palges 2024 in Warsaw

The Organizing Committee is proud to announce the Joint Meeting of the Polish Paleobiologists and the "95th Annual Meeting of the Paläontologische Gesellschaft (Palges)", which is to be held for the first time in history in Warsaw, Poland, on September 16-21, 2024 (Fig. 1). The official language of the conference is English.

The Palges conference meetings have a long tradition, which dates back to the beginning of the 20th century (its first edition was held in 1912) - today it is a prestigious scientific event gathering researchers from all over the world and it is a platform for exchanging experiences and observing trends in paleobiology research world. The meeting in Warsaw, the main theme of which is "*More than extinct species: the importance of fossils for ecology, evolution and conservation across borders?*" will emphasize both the interdisciplinary direction that paleobiological sciences are taking today, as well as the key role of information from the geological past for the issues of ecology, evolution or biodiversity protection that concern us today.

We propose that the conference will consist of four basic modules:

- Sessions of scientific symposia
- Poster sessions
- Stationary workshops and the possibility of participating in additional (independent) field workshops
- Popular science session in Polish and/or German and/or English, open to a wider audience

We propose scientific symposia sessions on the topics as follows: novel methods in paleobiology; integrated and evolution paleontology; evolving ecosystems (session on environmental and conservation paleontology); advances in paleontology; and open session(s). We cordially invite you to submit your own proposals of topics for thematic sessions and workshops to the Organizing Committee (until the end of 2023): palgeswarsaw2024@uw.edu.pl. The applicant of the proposal is responsible for the organization of the thematic session or workshop.

We look forward to welcoming you in Warsaw in the following year and hearing your presentations at Joint Meeting of the Polish Paleobiologists and the 95th Annual Meeting of the Paläontologische Gesellschaft (Palges).