Dear Colleagues, Dear Friends, Dear Delegates:

We are delighted to welcome you at this year's annual meeting of the 'Paläontologische Gesellschaft', despite this very unusual format.

After last year's meeting had to be cancelled due to the Covid-19 pandemic and the corresponding restrictions on travelling and holding larger meetings, we all hoped to be able to meet again in person this year. Unfortunately, the pandemic still is ongoing and due to this year's imponderability of travelling and meeting in a larger crowd, we decided to host this meeting purely virtual. This is the first time in the history of the 'Paläontologische Gesellschaft' that we use a virtual platform to avoid cancelling the conference again. So, this is where we are in 2021, which is the 109th anniversary of this society, and we wonder whether virtual meetings will become more regular in the future. There certainly are advantages of online conferences that would comply with ecological and economic necessities. But this would prevent an essential aspect of our meetings, to exchange our ideas and thoughts in personal conversations or small groups, and we thus hope that we will return to personal meetings next year again.

Nevertheless, in times of such uncertainties, restrictions, and global unease, it is our pleasure that we were able to arrange this first virtual conference of the 'Paläontologische Gesellschaft' so that we all can connect and share our interest, enthusiasm, and new results covering all aspects of palaeontology. We shouldn't forget that we, as scientists, play a key role in understanding the interplay between organisms, environments, and climate over geological timescales. It is of utmost importance to communicate our knowledge to various stakeholders and decision makers to contribute to a better understanding of the mechanisms underlying possible current and future crises. Actively disseminating our contribution to society is all the more important as more and more palaeontological positions are not being replaced and whole departments are being closed. And what better platform could there be than a scientific conference from which new research approaches and directions as well as collaborations result? Therefore, it is all the more delighting that we are able to exchange our ideas and results this year, at least virtually. A total of 92 scientists from all palaeontological disciplines will present their exciting, novel, and perhaps ground-breaking insights. To facilitate the exchange between us we also created break-out rooms where discussions can continue in parallel to the scientific sessions. We also hope to meet many of you at our virtual icebreaker party on Sunday evening, where you will have the opportunity to mingle with your fellow colleagues to discuss personal and scientific matters in a relaxed environment.

We owe a great debt of gratitude to Prof. Dr. Mojib Latif from the GEOMAR Helmholtz Centre for Ocean Research Kiel and the University of Kiel, who will present a public lecture Tuesday evening entitled 'The challenge of climate change - can we still avoid a catastrophe?', a very topical and timely issue that concerns us all. Last but not least we also thank our sponsors *Verlag Dr. Friedrich Pfeil (Munich, Germany)* and *Transmitting Science (Barcelona, Spain)*.

Once again, we are pleased to welcome you to this first virtual conference of the 'Paläontologische Gesellschaft' and hope you will enjoy the talks and discussions.

Cathrin Pfaff, Vanessa Roden, Julia Türtscher, Julia Wukovits, Sebastian Stumpf, Patrick L. Jambura & Jürgen Kriwet

SUTURE MORPHOLOGY AND SKULL MECHANICS IN THE PERMIAN 'ANAPSID' *CAPTORHINUS AGUTI* AND THE ORIGIN OF AMNIOTE TEMPORAL FENESTRATION

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Ancestrally, the temporal region in the tetrapod skull was completely covered by dermal bone. This 'anapsid' condition was probably still present in the ancestral amniote; however, temporal openings like fenestrae or emarginations evolved independently at least twice in the subsequent early amniote radiations and have been retained, modified, and sometimes lost multiple times in the branches leading to mammals and reptiles. Yet, the functional backgrounds for the initial evolution of these openings are yet to be understood. They have been hypothesized to be bound to changes in jaw muscle attachment and responses to cranial forces. However, even in extant 'anapsids' such as sea turtles the completely covered temporal region is a result of secondary evolution derived from the ancestors with an emarginated cranium. Hence, they cannot be represented as a suitable analogue for the functional morphology in ancestral amniotes. Here, we use micro-computed tomography of a skull of the early Permian stem-reptile *Captorhinus aguti* as a model for an ancestral 'anapsid'. We describe in detail its skull sutures and discuss the cranial mechanics, as well as the likely arrangement of the jaw adductor musculature and how this would affect cranial force distribution and kinesis. We argue that *Captorhinus* possessed lesser-loaded regions at the jugal-squamosal-postorbital intersection, as well as the parietal-postorbital contact. This corresponds to the loci of temporal openings in other early amniotes, corroborating the hypothesis that temporal openings were evolutionarily formed in response to the reduction of lesser-loaded areas in the skull.

DIFFERING EFFECTS OF SIZE AND LIFESTYLE ON BONE STRUCTURE IN MAMMALS

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The skeleton is involved in most aspects of vertebrate life history. Previous macroevolutionary analyses have shown that structural, historical, and functional factors influence the gross morphology of bone. The inner structure of bone has, however, received comparatively little attention. Here we address this gap in our understanding of vertebrate evolution by quantifying bone structure in appendicular and axial elements (humerus and mid-lumbar vertebra) across therian mammals (placentals + marsupials). Both cross-sectional geometry and trabecular traits were acquired through µCT-scan data. Our sampling captures all transitions to aerial, fully aquatic, and subterranean lifestyles in extant mammal clades. We found that mammalian inner bone structure is highly disparate. We show that vertebral structure mostly correlates with body size, but not lifestyle, while the opposite is true for humeral structure. The latter also shows a high degree of convergence among the clades that have acquired specialised lifestyles. Our results suggest that radically different extrinsic constraints can apply to bone structure in different skeletal elements. Refining these broad trends will require including additional key fossils to the dataset. These will for instance comprise Oligocene talpids from Southern Germany.

IS ACCURATE PHYLOGENY RECONSTRUCTION POSSIBLE IN PALEONTOLOGY?

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An unprecedented amount of evidence now illuminates the phylogeny of living mammals and birds on the Tree of Life. We use this tree to measure phylogenetic value of data typically used in paleontology (bones and teeth) from six datasets derived from five published studies. We ask three interrelated questions: 1) Can these data adequately reconstruct known parts of the Tree of Life? 2) Is accuracy generally similar for studies using morphology, or do some morphological datasets perform better than others? 3) Does the loss of non-fossilizable data cause taxa to occur in misleadingly basal positions? Adding morphology to DNA datasets usually increases congruence of resulting topologies to the well-corroborated tree, but this varies among morphological datasets. Extant taxa with a high proportion of missing morphological characters can greatly reduce phylogenetic resolution when analysed together with fossils. Attempts to ameliorate this by deleting extant taxa missing morphology are prone to decreased accuracy due to long-branch artefacts. We find no evidence that fossilization causes extinct taxa to incorrectly appear at or near topologically basal branches. Morphology comprises the evidence held in common by living taxa and fossils, and phylogenetic analysis of fossils greatly benefits from inclusion of molecular and morphological data sampled for living taxa, whatever methods are used for phylogeny estimation.

FOSSIL ORGANISM SIZE AS A PALAEOCLIMATE PROXY FOR DEEP TIME – PROSPECT AND FIRST RESULTS

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Modelling of the climate of the past is crucial for understanding the geological history as well as aiding us in predicting future climate changes. A wide variety of proxies have been used to look into the climates of the past. Yet, it is important to remember that most of the proxies, such as oxygen isotopes, palaeomagnetism, palynological profiles, and lithology, are only efficient under certain conditions. That limits the amount of fossil deposits available for palaeoclimatological reconstructions. Fossil fauna shave been often used as climate proxies, albeit mostly in a qualitative way – by the relation of certain groups of animals to certain climatic conditions. One of the most widely used quantitative proxies in palaeoclimatology is a reconstruction of the temperatures in the Quaternary based on the profiles of subfossil remnants of Chironomidae (Diptera) in lake sediments. However, this method only works well because most of these Quaternary species still exist, and we can observe their temperature preferences directly today. We do not have such options for the faunas of the Triassic or, let's say, the Eocene. Therefore, another type of quantitative proxies is required. The size of animals is to a large degree regulated by environmental factors, in particular temperature. Numerous size-temperature relationships are known in animals, Bergmann's rule being one of the most famous. Numerous groups of insects, such as Chironomidae mentioned above, can be used to test viability of size as a temperature proxy in palaeontology, due to their high abundance in numerous fossil deposits. Our first analysis, based on over 4,000 extant and fossil specimens of Chironomidae, shows that these insects are getting larger with increasing temperature. Our results show that while size of Chironomidae can be used as a palaeclimate proxy, taphonomic biases in the size of the animals during preservation pose a significant challenge.

ELASMOBRANCH FISHES FROM THE CENOMANIAN (LATE CRETACEOUS) OF PATAGONIA, ARGENTINA DISPLAY AN IMPRESSIVE PALAEODIVERSITY IN HIGH LATITUDE DEPOSITS

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The Cretaceous was an important period in the evolution of vertebrates, both on land and in the oceans. This time coincides with the appearance of all modern elasmobranch clades (sharks, rays, skates) that also adapted to new environments (e.g., the open marine realm). Reconfiguration of landmasses resulting from the break-up of Gondwana during the Cretaceous opened new seaways enabling the establishment of new migration routes and also created wide, shallow epicontinental seas that are considered to shape diversity patterns of marine organisms positively. Here, we present an elasmobranch fauna from the Cenomanian Mata Amarilla Fm. in the Austral Basin of Argentine Patagonia (Santa Cruz Province) collected during an Argentine-German field project funded by the National Geographic Society and German Research Foundation (DFG). The Mata Amarilla Fm. is characterized by an alternating sequence of continental and marine strata that yielded different vertebrate assemblages. So far, at least ten different elasmobranch taxa including hitherto unknown species based isolated teeth from marine sediments have been identified. Isolated vertebral centra and dermal denticles of less taxonomic value additionally were recovered. This unique elasmobranch assemblage is the most diverse assemblage from Cretaceous deposits of South America up to now and contributes significantly to our still poor knowledge on elasmobranchs in early Late Cretaceous high latitudes and especially in South America. The strong taxonomic similarities of elasmobranch faunas between Patagonia, North America and Europe indicate migration patterns between the two hemispheres that most likely were enhanced by the opening of the Atlantic.

RAPTORIAL APPENDAGES IN MANTIS SHRIMPS – EVOLUTION OF A SPECIALIZED PREDATORY APPARATUS

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Mantis shrimps (Stomatopoda) are marine predatory crustaceans of the group Hoplocarida with an interesting, though incompletely known, evolutionary history. First appearing in the fossil record in the Carboniferous (about 300 million years ago), mantis shrimps were not the highly specialized predators that they are today. The group is mostly known for their major raptorial appendages, which separate extant adults into “spearers”, impaling their prey with spines on the distal elements of their major raptorial appendages, and “smashers” punching their prey with a massive club on the distal element of their major raptorial appendages (maxilliped 2). The following three appendage pairs (maxillipeds 3–5) are significantly smaller raptorial appendages, closely resembling each other. However, the raptorial apparatus did not always have this morphology. In early representatives of the group, the maxillipeds were not yet specialized or differentiated in size. Here, we outline the stepwise evolution of the raptorial apparatus and present the latest addition of characters: a unique arrangement of maxillipeds 2–5. In two newly described specimens of mantis shrimps from the Early Jurassic Limestones of Osteno, Italy, the maxilliped insertion areas are not yet highly condensed as they are in modern mantis shrimps and representatives from the Late Jurassic limestones of southern Germany. Additionally, we highlight the importance of different documentation methods on fossil specimens to make all present details visible.

IDEAS FOR A MORE OBJECTIVE ASSESSMENT OF A FOSSIL LOCALITY'S IMPORTANCE BASED ON AN EXEMPLARY NON-MARINE EARLY PERMIAN SITE AND ITS PEERS

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After Seilacher's introduction of the concept of Fossillagerstätten in 1970, palaeontologists have used the germanicism "lagerstätte" as a technical term for fossil localities and rock units whose fossil record is exceptional in its preservation quality and/or quantity. However, not all dense accumulations of fossils ("Konzentrat-lagerstätten") are of particular importance for the understanding of certain groups, ecosystems or evolutionary processes in the history of life, nor do all fossil localities with a high quality, fidelity or completeness of preservation ("Konservatlagerstätten") yield a fossil record, which is rich enough to make them exceptional in comparison to others. An additional dimension to the meaning of lagerstätten has been added in recent palaeodiversity studies, which consider a diversity peak due to exceptional fossil occurrences in a certain time slice as a "lagerstätte effect", which may obscure the actual diversity pattern of a group. As an alternative to the arbitrary use of the term "lagerstätte" for any fossil occurrence, which is perceived to be important in some way, and in loose agreement with Seilacher's definitions, we introduce the concept of a group- or problem-specific combined quality and quantity ranking for fossil localities and we use of a set of late Palaeozoic continental fossil sites as an exemplary sample – including the Bromacker site of the Thuringian Forest among contemporaneous fossil and ichnofossil localities. Apart from a clarification of the term "lagerstätte" and its meaning, our redefinition and classification approach may provide criteria for the choice of exceptional fossil occurrences that shall be subjected to enhanced study and protection efforts by public stakeholders.

PHANEROZOIC PARASITISM AND MARINE METAZOAN DIVERSITY – DILUTION VERSUS AMPLIFICATION

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Growing evidence suggests that biodiversity mediates parasite prevalence. We compiled the first global database on occurrences and prevalence of marine parasitism throughout the Phanerozoic and assess the relationship with biodiversity to test if there is support for amplification or dilution of parasitism at the macroevolutionary scale. Median prevalence values by Era are 5% for the Paleozoic, 4% for the Mesozoic, and a significant increase to 10% for the Cenozoic. We calculated Period-level shareholder quorum sub-sampled (SQS) estimates of mean sampled diversity, three-timer (3T) origination rates, and 3T extinction rates for the most abundant host clades in the Paleobiology Database to compare to both occurrences of parasitism and the more informative parasite prevalence values. Generalized linear models (GLM) of parasite occurrences and SQS diversity measures support both the amplification (all taxa pooled, crinoids and blastoids, and mollusks) and dilution hypotheses (arthropods, cnidarians, and bivalves). GLMs of prevalence and SQS diversity measures support the amplification hypothesis (all taxa pooled and mollusks). Though likely scale-dependent, parasitism has increased through the Phanerozoic and clear patterns primarily support the amplification of parasitism with biodiversity in the history of life.

COMPARATIVE MORPHOLOGY BETWEEN EXTINCT AND EXTANT FORMS PROVIDES EVIDENCE FOR EARLIER RADIATION IN ISTIOPHORID BILLFISHES (TELEOSTEI, ISTIOPHORIFORMES)

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Billfishes include some of the largest pelagic teleostean species, but several aspects about their morphology, paleobiology and evolution remains ambiguous. Their fossil record is very fragmentary and mostly represented by rostral and skull remains. Here, we present a comparative study of the caudal vertebral morphology of extant istiophorid species and we use this information to describe two fossil vertebrae from the Gatun and Chagres formations, both from the late Miocene of Panama. The caudal vertebra from the Gatun Fm. is characterized by the presence of a lateral apophysis and accordingly identified as *Makaira* sp., while the vertebra from the Río Indio Member of Chagres Fm. lacks this structure and its morphology indicates a different genus. The estimated total length of the *Makaira* sp. specimen from Gatun Fm. is about 5.18 m, the largest size calculated for a marlin, while the Rio Indio specimen was about 2.56 m long. The phylogenetic analysis conducted here demonstrates that crown istiophorids lack lateral apophyses on the caudal vertebrae. Loss of this feature most likely evolved in the Pliocene when crown istiophorids diverged from its closest relative. However, the fossil vertebra from Río Indio proves that the lateral apophysis already had been lost in some istiophorids during the late Miocene, ~8.3 – 7.1 Ma. Our results highlight that both *Makaira* ssp. and taxa lacking the lateral apophysis already occurred during the late Miocene, indicating that the radiation of crown istiophorids most likely occurred earlier.

PALYNOLOGICAL DEVELOPMENT OF THE MKHUZE SWAMPS, KWAZULU-NATAL, SOUTH AFRICA

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Palynological studies were carried out on cored late Holocene sediments from the Mkhuze Swamp at the northern shore of Lake St. Lucia located in the Indian Ocean Coastal Belt Biome of KwaZulu-Natal, eastern South Africa. The project is part of TRACES (Tracing Human and Climate Impacts in South Africa, coordinated by MARUM, University of Bremen, Germany). The aim is to reconstruct past environmental changes and infer past climate fluctuations during the late Holocene, as well as human disturbances. The record starts c. 2000 yrs BP with the palynological results showing a dominance of Poaceae (grasses, > 80 %) suggesting a predominance of grassland with some woodland and forest elements. The decline in fungal spores, cryptogams, wetland plants as well as *Podocarpus* (yellowwood tree) and other forest elements, with a corresponding increase in the bushveld tree S*pirostachys* (jumping bean tree/tamboti), between 1200 yrs BP and 450 yrs BP indicates a drop in water table and a change from a shallow lake system surrounded by a humid forested environment to a swamp with drier open savanna vegetation. The peak of microscopic charcoal around 900 yrs BP suggests an increase in wildfires that may have been caused by the drier climate and/or anthropogenic impact (Pre-European human disturbance like shifting cultivation i.e., by Iron Age farmers). The increase in microscopic charcoal, charred cuticles, *Persicaria* pollen, a peak of Amaranthaceae pollen and corresponding decrease in trees and grasses in the last 250 yrs suggest disturbances by the European settlers.

VEGETATION RECONSTRUCTION ON THE SOUTHERN SHORES OF THE TETHYS OCEAN DURING THE EARLY OLIGOCENE – INSIGHTS FROM CONTINENTAL PALYNOMORPHS, EGYPT

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This study documents continental palynomorphs recovered from the late Eocene to early Oligocene Dabaa Formation near the Qattara Depression. The recorded assemblages are well preserved and comprise diverse lineages of algae, spores and pollen belonging to 46 families encompassing chlorococcalean algae, lycopods, ferns, gymnosperms and angiosperms. The assemblages are mainly of tropical vegetation, including tropical deciduous forests, grassland and (semi-)arid tropical shrublands, in which angiosperms were among the main representatives; additionally, open, drier habitats might have existed in the hinterland. The current data have been combined with previous megafossils and palynological evidence to assess and refine vegetation changes during the early Oligocene time window in Egypt and across North Africa. The inferred vegetation was a mosaic of different plant belts that ran more or less parallel to the Tethys coastline under the variable geographical influence of streams and lagoons. Evidently, the belt of tropical forest along the coast of the Tethys Ocean narrowed during the Oligocene in tandem with climatic deterioration following the Eocene–Oligocene boundary, which may have also led to the fractionation of forest habitats.

CONTROLS ON THE SKELETAL TAPHONOMY OF ANURANS FROM LACUSTRINE-HOSTED CENOZOIC LAGERSTÄTTEN

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The skeletal taphonomy of fossil vertebrates has enormous potential in understanding the origins of Lagerstätten as it informs on biological, chemical and physical characteristics of the depositional setting. Analysis of the skeletal taphonomy of a particular taxon in different fossil biotas can thus explain variations in preservation through space and time. Anurans are an ideal test case because their body plan has been conserved since the Mesozoic and they are abundant components of many Cenozoic lacustrine Konservat-Lagerstätten. Here we undertook a systematic analysis of the skeletal taphonomy of 180 anurans from Geiseltal (Eocene, Germany), focusing on completeness and articulation. We compared our results with published data on anurans from Libros (Miocene, Spain) and with new observations on the taphonomy of anurans from Enspel (Oligocene, Germany), Bechlejovice (Oligocene, Czech Republic) and Messel (Eocene, Germany). Our results reveal important shared taphonomic patterns. Anurans from all five biotas show a decrease in completeness from proximal limb elements (e.g. humerus) to distal limb elements (e.g. phalanges). Completeness is typically highest in the torso, excepting hip bones, which are often preferentially disarticulated or lost. These taphonomic trends are controlled by proximal factors that include the size and location of bones in the body, the 3D configuration of joints, stomach rupture and the decay resistance of connective tissue. These trends are superimposed by inter-biota variations in completeness and articulation, e.g., displacement and/or loss of entire limbs and larger body units, ultimately yielding a unique taphonomic signal for each biota. The primary controls on anuran skeletal taphonomy therefore reflect characteristics of the skeleton (bone size, configuration, location), soft tissue (decay rate, tissue recalcitrance) and depositional setting (water temperature, depth and bottom currents). These indices, and ultimately the broad palaeoclimatic setting and lake physiography, are the key taphonomic controls on the preservation of anurans in lacustrine-hosted Cenozoic settings.

BURNING EXPERIMENTS ON CALCAREOUS NANNOFOSSILS – CONTRIBUTION TO A BETTER UNDERSTANDING OF HISTORIC MORTAR PRODUCTION

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Calcareous nannofossils are calcitic fossil remains < 30 µm of single-celled marine photoautrophic algae. Since their appearance in the Late Triassic (about 209 Ma) these algae have been important primary producers in the oceans and are thus present in many marine sediments. These sediments are used as raw material for lime-based mortars. The limestones ($CaCO_3$) are heated approx. up to 900°C. The burning causes the thermal decomposition of $CaCO_3$ into CaO (=quicklime) and CO_2. The very reactive quicklime is slaked with water, producing $Ca(OH)_2$ (=lime). In a last step, lime reacts with CO_2 of the atmosphere, forming again solid $CaCO_3$.Unexpectedly, we have encountered remains of these algae in historic mortars and mortar-based materials. To gain a better understanding of the behaviour of calcareous nannofossils during the burning procedure, four samples were heated to nine temperature levels (100°C, 300°C, 500°C, 600°C, 700°C, 750°C, 800°C, 850°C, 900°C). Both, original and heated, samples were analysed with respect to their nannofossil content and preservation by using settling slides. Our results show a decrease of absolute numbers and preservation from 500°C onwards, nannofossils are preserved up to 900°C. Changes in the relative abundance of individual species show that some taxa are more heat resistant than others. This pattern is explained by different crystal sizes and forms. The abundance of calcareous nannofossil, their preservation and the presence / absence of different nannofossil taxa can therefore be used for estimating the burning temperature during the quicklime production. Our study helps to gain a better understanding of historic mortar production. It will also supply information for the preservation of monuments, because new mortars can be made with the same material and under the same conditions like those in the past.

A TAIL OF DEFENCE – ALMOST COMPLETE TAIL SKELETON OF *PLATEOSAURUS* (SAUROPODOMORPHA, LATE TRIASSIC) REVEALS POSSIBLE DEFENCE STRATEGIES

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A recently excavated partial skeleton of the Late Triassic dinosaur *Plateosaurus trossingensis* from Frick (Switzerland) shows an almost complete series of tail vertebrae including an articulated whip-like end. The preserved articulated tail allows a first look at the morphological implications on the behaviour of these dinosaurs. Using these bones, the tail lashing power of *Plateosaurus* was reconstructed, investigated, and compared with other fossil and extant long-tailed reptile taxa such as the extinct sauropod *Diplodocus*, the recent Asian water monitor (*Varanus salvator*), and the green iguana (*Iguana iguana*). These novel insights reveal constraints and possibilities of combining paleontological and behavioural sciences leading to a better understanding of this Late Triassic prosauropod species.

ENVIRONMENTAL CONTROLS ON THE RECOVERY FOLLOWING THE END-PERMIAN MASS EXTINCTION – NEW INSIGHTS FROM JAPAN

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The Hiraiso Formation of northeast Japan represents an important and underexplored archive of Early Triassic marine ecosystems following the end-Permian mass extinction. Here, I present a palaeoecological analysis of its benthic faunas in order to explore the temporal and spatial variations of diversity, ecological structure and taxonomic composition. The ichnofossils from the Hiraiso Formation show an onshore-offshore trend with high diversity and relatively large faunas in offshore transition settings, but a low diversity of small ichnofossils in basinal settings. The body fossils do not record either spatial or temporal changes, which is likely a consequence of the shell beds representing allochthonous communities due to wave reworking. The dominance of small burrow sizes, presence of key taxa, presence of complex trace fossils, and both erect and deep infaunal tiering organisms suggests that the benthic fauna from the Hiraiso Formation represents an advanced stage of recovery for the Early Triassic, but not full recovery. The ecological state suggests a similar level of recovery to other Spathian communities and that globally the Spathian marks an important recovery interval. The onshore-offshore gradient is also consistent with onshore-offshore ecological gradients known to be controlled by oxygen gradients in modern tropical and subtropical settings. The lack of observed full recovery is likely a consequence of persistently hot Early Triassic temperatures and the lack of a steep temperature/water-depth gradient in shallow marine settings.

PERAMORPHOSIS IN THE PTEROSAURIAN NECK VERTEBRAE – ELLIPTIC FOURIER ANALYSIS SHOWS DIFFERENT PATTERNS OF SHAPE CHANGE AMONG THE CERVICAL VERTEBRAE BETWEEN GROUPS

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Regionalization of the vertebral column and heterochrony are commonly studied in most ingroups of Vertebrata, Pterosauria being no exception. This study attempted to quantitatively resolve shape differences in the vertebrae of pterosaurians to detect possible patterns of shape change between cervical vertebrae. The material for this study comprises images of specimens from museum collections in Germany, recorded with cyan-red-fluorescence photography, and reconstructions from publications. Elliptic Fourier Analyses were performed to quantify the shape of the individual vertebrae using their outlines as shape proxies. When testing for differences within the spine of specimens, between species, and between ontogenetic stages of the same species, four distinct patterns were found: Pattern 0, found in *Preondactylus bufarini* and partially in an immature *Rhamphorhynchus muensteri*, shows the cervicals forming two shape groups, 1–4 and 5–7. Pattern 1, found in other early non-pterodactyloideans and some pteranodontoideans, shows a drastic change of vertebral shape from the early towards the middle cervical vertebrae largely based on elongation. Pattern 2, found in *Anurognathus ammoni*, immature archaeopterodactyloideans and some pteranodontoideans, shows a more gradual elongation with a clear peak around vertebra 5. Pattern 3, found in adult archaeopterodactyloideans and azhdarchoideans, shows a drastic shape change from vertebra 2 to 3 and a grouping of vertebrae 3–7 based on extreme elongation of the latter. In all groups, vertebrae of position 8 or further posterior are more similar in shape to anterior vertebrae. Thoracic vertebrae show comparably little differentiation. All immature specimens show a more plesiomorphic condition in their vertebral shape indicating heterochrony (peramorphosis). The distribution of pattern 2 and 3 throughout phylogeny is likely the result of convergent evolution. This combined with the shape recapitulation in immature specimens implies these patterns are likely the result of a morphological constraint based on the degree of proportional elongation in the cervical vertebrae.

THE ORIGIN OF THE BURMESE AMBER WILDLIFE – HOW THE FOSSIL RECORD OF ARACHNIDS SHEDS A LIGHT ON CRETACEOUS PALEOGEOGRAPHY

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Late Cretaceous Burmese amber, also referred to as burmite, is one of the richest known sources of fossil arachnids, such as spiders and scorpions. Arachnids generally have a very sparse fossil record in the Mesozoic, but Burmese amber has provided an anoxic milieu that preserved many species and fine details of morphology at an exceptional level. Indeed, the study of Burmese amber allows deep insights into patterns of arachnid evolution and diversity in the Cretaceous. Besides evolutionary patterns, the palaeogeography of the West Burma Terrane and hence the origin of the Cretaceous Burmese amber flora and fauna is still unclear. There presently are two main hypotheses on the palaeogeography of this terrane with one suggesting a Laurasian origin for the fossil flora and fauna of the Burmese amber and the other putting the origin of the preserved ecosystem on Gondwana. Here we address this knowledge gap by extensive morphological studies and taxonomic descriptions of fossil arachnids, namely pseudoscorpions and schizomids. The detailed description of 49 specimens, in total providing seven new genera and ten new species, shows that all newly described fossil pseudoscorpion and schizomid genera display a distinct similarity to related recent genera that today exclusively occur in areas that are considered former parts of Gondwana. Therefore, we suppose that the fossil wildlife documented in Burmese amber originated on Gondwana rather than Laurasia. Thus, our results contribute significantly to the ongoing research and shed a further light on the palaeogeographical history of the West Burma Terrane as well as on the palaeobiogeography of its well-preserved fossil content.

LATITUDINAL GRADIENT IN FUNCTIONAL DIVERSITY OF MARINE MOLLUSK ASSEMBLAGES FROM THE LOWER MIOCENE (~20 Ma) OF THE SOUTHEAST PACIFIC COAST OF CHILE

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Understanding latitudinal variations in diversity is central for biogeography. Along the coasts of the SE Pacific, several taxa show inverse latitudinal patterns of diversity, i.e., increasing species numbers from lower to higher latitudes. A plausible explanation for these patterns is that fjords, formed during the Pliocene-Pleistocene glaciations, generated niche opportunities that allow for higher diversity in high latitudes. Testing this hypothesis requires to analyze functional diversity (which is intimately related to niche use) and latitudinal patterns of biodiversity in the absence of fjords; that is, earlier than the formation of fjords. In this study, we propose to test if the fossil record earlier than the generation of fjords will show higher functional diversity at the lower latitudes than at higher ones (a “classical” diversity gradient). To test this prediction, we analyzed several components of functional diversity (functional richness, functional divergence, and functional evenness) for a fossil marine mollusk fauna from the lower Miocene (~23-16 million years ago) along the Chilean Southeast Pacific coast. We characterized the change in various elements of functional diversity of Miocene fossil gastropods and bivalves across four regions spanning more than 10 latitudinal degrees of the Chilean coast. With this work, we hope to enhance our mechanistic understanding of the spatiotemporal variation of diversity observed today.

HOW TO SURVIVE A CRISIS – BIOGEOGRAPHY AND MACROECOLOGY OF EARLY TRIASSIC CONODONTS

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Understanding the evolution of organisms in the context of biotic crises is of paramount importance in anticipating the consequences of the 6th mass extinction we are currently experiencing. The Permian/Triassic (PT) boundary crisis is of particular interest as it is the deadliest of the whole Phanerozoic Eon. Following this event, the Early Triassic was long considered a slow and delayed recovery interval. Over the past 15 years, geochemical, sedimentological and palaeontological studies have shown that several global events punctuated this period, such as the late Smithian crisis (Olenekian, Lower Triassic). To study the consequences of the environmental perturbations of the PT crisis and the Early Triassic Epoch on biodiversity, we use conodonts, small jawless marine vertebrates that are mostly studied through their oral elements, i.e. the conodont elements. We focus on patterns and processes responsible for the spatial distribution of Early Triassic conodonts. To do so, we built and analysed a database of global occurrences of Early Triassic conodont species. Through multivariate analyses (ordination, classification, network), biocores, i.e. regions with particular association of conodont species, were described for each Lower Triassic substage (Griesbachian, Dienerian, Smithian, Spathian). The processes related to the formation of these biocores were assessed *via* niche assembly *vs.* dispersal theories using PER-SIMPER and DNCI (Dispersion-Niche Continuum Index) methods, which decipher the biotic/abiotic nature of the processes responsible for conodont biogeography in the aftermath of the PT crisis.

THE EUROPEAN CENOZOIC LAND SNAIL FAUNAS – EXTINCTIONS AND TURNOVERS

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The evolution of the European Cenozoic terrestrial gastropod faunas is characterized by a complex pattern of diversification, turnover, extinction and immigration events. Based on a critical review of a literature-based dataset comprising 1640 species from 609 sites, we calculated net diversity through time (expressed as species, genus and family richness) and β-diversity (as species, genus and family turnover). Within these data, we recognize major disruptive phases, with turnover events at the Ypresian–Lutetian and the Eocene–Oligocene boundaries, as well as extinction events at the Oligocene–Miocene, Burdigalian–Langhian Pliocene–Pleistocene boundaries. Phases of diversification during the Lutetian, Burdigalian and Pliocene, in contrast, seem to be linked to phases of relative climate stability. At least five immigration events are reflected by the appearance of exotic elements in European faunas. Many of them correlate with the formation of terrestrial pathways and major migration events in mammals. The correlation of the observed patterns with global climatic events will be discussed.

THE FOSSIL RECORD OF CATERPILLARS – THE RISE OF A UNIQUE EATING MACHINE

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Caterpillars are the larval stages of moths and butterflies (Lepidoptera), certain wasps (Hymenoptera) and certain scorpion flies (Mecoptera). In the modern fauna, the biomass of caterpillars must represent a quite important share, at least in terrestrial ecosystems. While their adult forms often are important pollinators and hence beneficial for plants, the caterpillars can cause quite severe damage and can even have a negative economical impact. Therefore, it is of advantage that myriads of other organisms, including larger animals such as birds, will readily consume large amounts of caterpillars, making caterpillars quite central pieces in the modern-day food web. Looking back in time, the specific larva type 'caterpillar' must have evolved at a certain point in the different lineages. While there are some fossils with certain caterpillar-like characters in the late Palaeozoic and few individuals in the Mesozoic, it is only in the Cenozoic when caterpillars become a more common component. I will provide an overview of the still comparably scarce fossil record of caterpillars and discuss certain interactions with other faunal components. I will especially present different fossils preserved in amber, among them some rather recent findings from the Cretaceous, unique pieces from the Eocene, first quantitative data from the Miocene, but also an individual from copal. The rise of the caterpillar and the evolutionary lineages with such larvae seems to have been coupled to losses in diversity of other lineages, painting a picture of complex cases of ecological interactions and co-evolution.

THE FOSSIL SCUTTLE FLIES – PALAEODIVERSITY AND EVOLUTION FROM CRETACEOUS TO HOLOCENE

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The scuttle flies (Phoridae) are one the most species-rich, biologically diverse families of Diptera. They have an extensive fossil record in the world's amber and copal deposits, from their origin in the Cretaceous to the present. Amber is particularly favourable because morphological characters can be observed in it with exceptional detail in each of the geological ages between the Cretaceous and the Holocene periods. The major problem is the lack of palaeontological data in many amber and copal deposits specimens that have been found but have never been studied. Currently, all of gaps in the fossil record do not allow complete understanding of morphological evolution and adaptation the Phoridae may undergone over the last 110 million years. The selection of new phorid flies specimens will be studied from amber and copal deposits from different geological ages and geographical distributions to better understand the palaeodiversity and evolution of selected Phoridae from Cretaceous to Holocene. The aims are to determine: 1) if the high diversity of phorids were already present during the Cretaceous period; 2) how the family developed after the Cretaceous in the earlier geological periods covered by amber deposits; 3) if the diversity observable in the specimens preserved in amber and copal is a response to the evolutionary pressures (e.g., climatic and biological changes) during the different periods or a reflection of taphonomic bias of non-comparable data between the different amber deposits.

KILLIFISH PALAEODIVERSITY FROM A MIDDLE MIOCENE LAKE IN THE BUGOJNO BASIN, BOSNIA AND HERZEGOVINA

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Killifishes are known for their amazing diversity and ability to survive in difficult and extreme conditions. Fossil killifishes are known around Europe and, like their extant relatives, appear to present low interspecific variability, which makes correct identification of species difficult. This research aims to identify the killifish palaeodiversity in the middle Miocene alkaline paleolake of Gračanica in the Bugojno Basin, Bosnia and Herzegovina. The studied material comprises an exceptional high number of fossil killifish skeletons (177 specimens), often with otoliths preserved in situ. Morphometry of the fossil skeletons and the otoliths, meristic counts and osteological study was done along with statistical analyses to understand the composition of the sample. Cluster and multivariate analyses of the otoliths differentiated two groups. However, it was not possible to accurately separate the corresponding skeletal material into two species. We conclude that a single species is present that is characterized by high intraspecific variation of both skeleton and otolith traits. Based on both osteological and otolith characters, the material is preliminary identified as a new species of †*Aphanolebias* Reichenbacher & Gaudant, 2003. This would be the second known species of this genus that is based on skeletal material. The new species differs from the type species of †*Aphanolebias,* †*A. meyeri*, in meristic counts as well as body morphometry. It can be differentiated in otolith morphology from the three species that have been diagnosed solely based on otoliths (*A. konradi*, *A. gubleri*, *A. sarmaticus*). The new species expands the geographic distribution of *Aphanolebias* in the middle Miocene, allowing better knowledge on the genus palaeobiogeography. It also adds new information on the intraspecific variability of *Aphanolebias*. It can be concluded that the new species was adapted to extreme environmental conditions, as it is known from many recent species of killifishes.

SYNINCLUSIONS AND 'FROZEN BEHAVIOR' IN AMBER – WHAT THEY CAN TELL US ABOUT THE EVOLUTION OF INSECT LIFESTYLES

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Insects show an extremely wide range of different lifestyles and strategies today, concerning e.g. reproductive aspects, care of eggs and young, or predation and defence. Also, very different modes of intraspecific interaction occur today – from a solitary lifestyle, to sociality in different degrees, to eusociality. The evolution of these lifestyles is highly debated in the literature for some insect groups, such as eusocial bees, ants, or termites, but also several sub-social or aggregating representatives of species of e.g. earwigs, grasshoppers, cockroaches and others. The majority of studies regarding the evolution of sociality and different lifestyles are mainly based on species living today. Information about fossil representatives is rare, but can add important aspects to these reconstructions and can provide information about the minimum age of specific lifestyles in deep time. We present new examples of insect syninclusions in Miocene, Eocene and Cretaceous amber, some of these representing cases of so-called 'frozen behaviour'. Cases of 'frozen behaviour' are especially of high interest for the reconstruction of behavioural aspects of extinct organisms, as these fossils are preserved in a specific moment, such as mating, feeding, oviposition, or hatching. However, the interpretation of these cases demands for a comprehensive comparison with observations of organisms living today. We present also examples of syninclusions of several individuals up to a mass occurrence of conspecifics of insect groups, which are usually not considered to show social interactions. Owlflies, as an example, are usually described to show a highly aggressive behaviour against conspecifics, but perform a form of group defense in early developmental stages today. New findings indicate that this strategy might already have been present in the Cretaceous. We discuss possible conclusions and limitations of the interpretation, based on syninclusions from different time periods relating to the evolution of lifestyles within insect groups.

THE TEMPORAL RESOLUTION OF THE STRATIGRAPHIC RECORD AND ITS ENVIRONMENTAL GRADIENTS

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Sedimentary particles, such as biogenic or volcanoclastic grains, are the building blocks of the depositional record. These allow the reconstruction of past life, climate, and environmental conditions. However, between their introduction to the sediment and before becoming immobilized in the stratigraphic record, biological and physical processes close to the sediment surface may mix sedimentary particles. As a result, particles of the same age can be found at different burial depths. For the same reasons, the ages of particle at a given burial depth can display offsets of more than a thousand years (time-averaging). This offset in age and burial depth is well documented for biogenic grains (fossils) from recent environments. However, the redistribution of particles is unappreciated in its impact of common geochemical analyses and the stratigraphic time series constructed from them. We use the interquartile range of particle ages at a specific stratigraphic position as measure for the temporal resolution of the stratigraphic record. It quantifies how many years are recorded by the grains contained in an individual sample, e.g. a cm-thick layer. Combining a global compilation of empirical sedimentation rates, mixing intensities, and bioturbation depths with a model of particle movement in surface sediments, we predict the temporal resolution of the stratigraphic records and identify its environmental gradients in marine environments. The results show that (1) due to empirical constraints on the model parameters, sedimentation rate exerts the strongest control over the temporal resolution of the stratigraphic record and (2) the temporal resolution drops below tens of millennia in slope and deep sea settings. The results provide an assessment of the maximum temporal resolution that can be achieved when deriving information from marine sedimentary stratigraphic records, which directly translates into the time series and age models derived from them.

THE WORLD'S LARGEST AMMONITE *PARAPUZOSIA* (*P.*) *SEPPENRADENSIS* (LANDOIS, 1895): ONTOGENY, EVOLUTION AND PALAEOGEOGRAPHIC DISTRIBUTION

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The world's largest ammonite, *Parapuzosia* (*P.*) *seppenradensis* (Landois, 1895), fascinated the world ever since the discovery, in 1895, of a specimen of 1.74 metres (m) diameter near Seppenrade in Westfalia, Germany. Subsequent findings of the taxon have been rare, and its systematic position has remained enigmatic. We have revised the historical specimens and document abundant new material from England and Mexico, mostly with stratigraphic information. The 160 specimens from Europe and North America were analysed regarding morphometry, growth stages and stratigraphic occurrence wherever possible. High-resolution integrated stratigraphy allows for precise cross-Atlantic correlation of the occurrences. Our analysis provides insight into the ontogeny of *Parapuzosia* (*P.*) *seppenradensis* and into the evolution of this species from its potential ancestor.

UNCERTAIN PHYLOGENETIC RELATIONSHIPS AS A SOURCE OF ERROR IN THE TRACKWAY-DATA-BASED RECONSTRUCTION OF LOCOMOTION EVOLUTION WITHIN AMNIOTE ANCESTORS

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Some of the variability among Carboniferous to early Permian tetrapod tracks can be attributed to evolutionary changes in trackmaker anatomy and locomotion style close to the origin of amniotes. We have suggested an ancestral state reconstruction approach as a method to utilize trackway data to infer steps of evolutionary change: Based on measurements of trackways referred to common late Paleozoic ichnotaxa, correlation of these ichnotaxa with certain groups of amniote and related non-amniote trackmakers according to imprint morphology, and known skeletal-morphology-based phylogenies of the supposed trackmakers, we inferred ancestral states for functionally controlled trackway measures in a maximum likelihood approach. However, apart from uncertainties in the trackmaker assignment of Carboniferous track types, the controversial phylogenetic relationships among crucial tetrapod groups poses a serious challenge to the reconstruction of locomotion evolution, most notably (1) the relative position of seymouriamorphs and lepospondyls within the stem-group of amniotes, (2) the position of diadectomorphs – as the sistergroup to all amniotes or as a monophyletic or paraphyletic group on the synapsid branch of amniotes, (3) the placement of varanopids within synapsids or eureptiles. Thus, we have reconstructed ancestral states of trackway measures for several alternative phylogenetic hypotheses, including those named above, to derive robust hypotheses of evolutionary change that are in agreement with each of the assumed phylogenies. Accordingly, our earlier assumption of a body-size-increase-related locomotion change within the ancestors of amniotes (but also the suitability of *Orobates* as a model taxon for the last common ancestor of amniotes) relies quite much on the placement of diadectomorphs. A small-bodied, crawling salamander- to lizard-like last common ancestor to all amniotes remains a plausible alternative according to some scenarios and cannot yet be ruled out with certainty.

TO THE STUDY OF OSTRACOD OF THE QUATERNARY DEPOSITS IN THE SOUTH CASPIAN OFFSHORE PART OF THE BASIN

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Studies on fauna and stratigraphy of the Quaternary deposits in the South Caspian basin and surrounding area are essential for understanding the Quaternary history of the Caspian Sea. Data collected from numerous offshore boreholes drilled in the South Caspian basin have provided useful information on the ostracod fauna, stratigraphy, and lithofacies characteristics of the Quaternary deposits in this basin. 685 core samples from 71 exploration and shallow engineering boreholes over 45 offshore structures have been studied. The analysis included 20 exploration and engineering drilling wells from the Turkmenia shelf, 25 from Apsheron archipelago, 23 from the Baku archipelago (Azerbaijan sector of the Caspian Sea) 3 from Iranian shelf. Limited core materials were taken from the 33 boreholes, which allowed us to determine the stratigraphic boundary between Apsheronian and Akchagylian deposits. Multiple boreholes sections and their micro and macrofauna content allowed identify 126 species of ostracods from the 685 offshore core samples of the South Caspian basin. Biostratigraphy study included complex analysis of the offshore drilled borehole's litho stratigraphy sections, logs, seismic and outcrops data. The resulting study enabled us to propose a detailed stratigraphic chart for the Quaternary deposits of the entire South Caspian basin. The Quaternary deposits of the South Caspian divided into five supra horizons and ten horizons by using seven index ostracod species. The index species were identified according to their successive range within zonal complexes (biozones). All the subdivisions mentioned above play regional roles. Analysis of the lithofacies, thickness of the deposits, and fauna distribution revealed that in the Quaternary period, the South Caspian region was characterized by dynamic paleogeography. Furthermore, considerable changes in the sea bottom topography, salinity, temperature, and sea level in the South Caspian basin occurred in the Quaternary period.

EVOLUTION AND DEVELOPMENT OF CHONDRICHTHYAN SKELETAL MINERALIZATION

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Among the vertebrates, the group Chondrichthyes (Elasmobranchii [sharks, rays] and Holocephali) is distinguished by a predominantly cartilaginous endoskeleton, overlain by a mineralized layer of calcified tiles known as tesserae. The tesserae of rays are particularly well-developed, polygonal in shape with distinct upper and lower cellular zones and connected via a series of distinct spokes which leave open spaces between the tesserae; the development of these tesserae is also well understood, including some of the genes involved. However, it is becoming clear that the tesserae in the rays are not necessarily characteristic for the chondrichthyans, nor even the elasmobranchs. In the holocephalans (chimaeroids), mineralization in extant taxa comprise more irregularly-shaped units. In *Chimaera* (Chimaeridae), these show a reduced number of spokes and some fusion, while in *Callorhinchus* (Callorhinchidae), the spokes have become completely lost, the units themselves are very small, and substantial fusion occurs. Nevertheless, there are some similarities during development to the elasmobranchs. For example, in *Callorhinchus*, cartilage-producing cells become surrounded by the developing mineralization, but compared to the cellular ray tesserae, these are lost, rather than retained with the tessera. In the holocephalan fossil record (Symmorida, *Helodus*, Iniopterygiformes) skeletal mineralization includes larger, more polygonal tesserae, connected by small spokes, demonstrating that the tesseral morphology in extant forms is the result of reduced mineralization. In fossil rays (e.g., *Sclerorhynchus*), tesserae are polygonal, but appear closely appressed to one another suggesting that spokes are absent. Thus it appears that there may be different evolutionary trends between the main groups of chondrichthyans, with respect to skeletal mineralization.

THE EXTINCTION AND RECOVERY OF PLEUROTOMARIIDA (GASTROPODA) ACROSS THE PERMIAN–TRIASSIC – HOW TAXONOMIC AND ECOLOGICAL STUDIES IMPROVE OUR KNOWLEDGE

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Pleurotomariida (slit-band gastropods) have the longest fossil record among living gastropods and represents one of the most diverse and abundant gastropod groups in the Middle and Late Palaeozoic. Gastropods including Pleurotomariida declined at the end-Permian mass extinction event. Previous diversity studies of gastropods were hampered by outdated and wrong generic assignments. We studied globally distributed important Late Palaeozoic genera (e.g., *Worthenia*, *Glabrocingulum*) from the Upper Carboniferous of the USA and revised all Pleurotomariida from the Carnian (Upper Triassic) St. Cassian Formation (Italy). We documented the early shell characters and ontogenetic development of several taxa for the first time. These new shell characters are found informative in inferring evolutionary relationships. Apart from few Lazarus taxa, the Triassic Pleurotomariida studied so far do not belong to the Palaeozoic genera as assumed by previous studies. The species and generic diversity of Pleurotomariida ranging through the Permian–Triassic interval was calculated by using the Permian data from the Paleobiology database and a global Triassic gastropod database consisting 2177 nominate species. The species and generic diversity of Pleurotomariida increased especially in the Anisian and peaked in the Carnian. However, they failed to recover fully, also in comparison to other gastropod groups, especially caeonogastropods. Although many new pleurotomariida genera first appeared in the Carnian, few of those genera crossed the Carnian-Norian boundary. This suggests an interruption of recovery within the Carnian, likely during the Carnian Pluvial Episode. Pleurotomariida is the most abundant gastropod group in surface collections from the Virgilian (uppermost Carboniferous) Finis Shale (Texas, USA) but their abundance is lower when bulk samples are investigated. Their abundance in post-Carnian assemblages is much lower than in Middle Triassic and Late Paleozoic assemblages.

GROWTH ALLOMETRY IN UPPER TRIASSIC CONODONTS SUPPORTS MOLAR-LIKE ELEMENT FUNCTION

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Conodont dental elements are distinguished by their high disparity and rapid morphological evolution. P_1 elements located in the pharynx are the most rapidly evolving, but their function in the animal has been only investigated in a handful of taxa and proposed to be analogous to mammal molars. This hypothesis predicts that their surface area should show positive ontogenetic allometry with respect to element length, as has been previously identified in 2D projections in two Carboniferous taxa. Here we apply the same method to test this hypothesis in 3D models of platform-bearing P_1 elements of two common Late Triassic taxa, *Metapolygnathus communisti* and *Epigondolella rigoi*. We further hypothesise that these commonly co-occurring taxa differed in their growth allometry, reflecting their different trophic niches. Platform length grew isometrically with respect to element length, whereas log-transformed platform area showed positive allometry with respect to element length, with slopes equal 3.86 in *M. communisti* and 4.16 in *E. rigoi*, supporting a function of the platform analogous to molars and trophic differentiation. Previous studies applying morphological and ultrastructural proxies for the dietary position of conodonts addressed mostly stratigraphically older conodont taxa, but our results indicate that Late Triassic species occupied the predator/scavenger niche in spite of the high diversity of gnathostomes in this niche.

SAPORTAEA SALISBURIOIDES FONTAINE ET WHITE – AN ENIGMATIC, LONG-RANGING, WIDELY DISTRIBUTED BUT RARE TYPE OF LATE PALEOZOIC FOLIAGE

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New material of the enigmatic plant *Saportaea salisburioides* is reported from the late Permian Umm Irna Formation, Dead Sea region, Jordan. The preservation and the sedimentology indicate that remains were transported over a very short distance. The specimens from one locality apparently belonged to a single monospecific stand, or maybe even a single plant. Another locality yielded a large leaf portion showing the leaf architecture. In a third locality *Saportaea* foliage was found in close association with *Nystroemia* sp., may suggest that this fructification belongs to *Saportaea*. *Saportaea* is a long-ranging but very rare genus with four species with a wide geographical distribution. It first appeared in the Westphalian D (Moscovian, Pennsylvanian) and its last appearance is in the Carnian (Late Triassic). In the late Paleozoic it evidently grew in drier, stress-prone, well-drained habitats where the preservation potential was low, which may explain the rareness of this taxon. The oldest Pennsylvanian and Permian representatives are known from low palaeolatitudes, whereas the youngest grew at higher latitudes in the Southern Hemisphere. An origin at low palaeolatitudes followed by a colonization of more temperate regions seems to confirm the trend also seen in several other late Paleozoic gymnosperm groups. *Saportaea salisburioides*, an easily recognizable species that cannot be overlooked, is so far only known from the uppermost Carboniferous of North America. It apparently had a very long range, spanning some 50–60 Ma. *Saportaea salisburioides* must have been out somewhere for many millions of years. It has never having been recognized or reported again in the over 140 years after its first discovery. On one hand, this demonstrates the imperfectness of the fossil record, and on the other hand it shows that the overall late Paleozoic flora must have been much more diverse than commonly believed.

A COMPLETE PLANT OF THE LATE PALEOZOIC LYGINOPTERID, *SPHENOPTERIDIUM GERMANICUM* (WEISS) KERP ET DIMICHELE NOV. COMB., AND A TAXONOMIC REVISION OF THE SPECIES

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A whole-plant specimen of the lyginopterid pteridosperm *Sphenopteridium germanicum* (Weiss) Kerp et DiMichele nov. comb. was discovered at the Late Pennsylvanian (Missourian) Kinney Quarry, New Mexico, complete from roots to a crown of attached leaves. Taxonomic review, based on vegetative and associated reproductive organs, supports Mamay's assignment to *Sphenopteridium* Schimper. Mamay described a new species, *S. manzanitanum* Mamay, vegetatively identical to *Sphenopteris germanica* Weiss, originally described from the lower Permian of Poland. A critical review reveals that *Sphenopteris germanica* should be assigned to *Sphenopteridium* and *S. manzanitanum* is later homonym. The complete specimen has a growth habit consisting of a short, subterranean or surficial, mound-like stem bearing a tuft of ascendant leaves and a vertically disposed taproot, a low-growing, upright form. It is of sufficient size to suggest that this is the mature growth configuration, but it does not represent the maximal size the species could attain, based on excavated leaves much larger than those found in attachment. Based on sedimentary context, the specimen was likely growing along a river or estuary bank, and incorporated whole as the bank eroded and collapsed, resulting in transport of the plant into the embayment in which the Kinney flora and fauna were preserved. *Sphenopteridium germanicum* plants were, thus, relatively small, and low growing; there is no evidence of laterally initiated stems or plantlets that might indicate a clonal growth form. The growth habit reported here is new, enlarging the range of growth architectures known in late Paleozoic plants, and thus spotlights the morphological richness that had evolved by that time, despite significantly lower diversity than that of the modern world. A small plant with roots and three leaves, originally described as *Arnophyton kuesii*, is a juvenile individual of the same species. The latest occurrence of this lyginopterid is the upper Permian of Jordan.

HOLOCENE MARINE MICROGASTROPODS FROM BANGKOK CLAY OF SAMUT SAKORN PROVINCE, CENTRAL THAILAND

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Marine gastropod remains have been investigated from Bangkok Clay, where a whale's skeleton (3,380± 30 years old) was found, about 12 kilometres inland from the current coastline in Amphaeng Sub-district, Ban Phaeo District, Samut Sakorn Province, Central Thailand. The specimens were collected from Holocene sedimentary layer, where the Bryde's whale remains were deposited, representing 18 families, 23 genera and 25 species. These gastropod species belong to the cosmopolitan family, such as Turritellidae, Naticidae, Muricidae, Nassariidae and Architectonicidae, including some microgastropod family. The microgastropod assemblage is highly dominated by pyramidellids. These marine gastropods are first recorded from Bangkok Clay and many of the gastropod families are also the first record in Thailand. Therefore, this discovery has proven that the Amphaeng area was once part of the sea. This contribution facilitates a better understanding of the biodiversity of molluscs in Thailand.

PHYLOGENETIC RELATIONSHIPS OF FOSSIL HERRING-LIKE FISHES (CLUPEIFORMES, TELEOSTEI)

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Fishes of the Order Clupeiformes (herrings, shads, anchovies and allies) comprise more than 400 modern distinct species, are economically important and play a crucial ecological role. Clupeiformes have left a rich fossil record, with more than 100 species described so far. However, little is known about the evolutionary history of this order, largely due to the fact that the systematics of most of these fossils remain uncertain. Here we examine the phylogenetic affinities of about a fifth of all described fossil species, from the earliest putative representatives, dating to the Cretaceous, to species from the Pleistocene. The studied fossils come from different parts of the world, but most of the material originates from the Circum-Mediterranean realm, where such fossils are common. We constructed a phylogenetic matrix comprising more than 200 morphological characters for 70 modern species, based on X-ray images, µCT scans and cleared and stained specimens, as well as literature data. Preliminary results indicate that the first identifiable representatives or close relatives of several modern genera date back to the Oligocene and Miocene. Our results are also relevant to discussions concerning faunal turnovers in the Mediterranean and corroborate the idea that during the Neogene, the (Circum-) Mediterranean was inhabited by taxa which today are regarded as tropical or invading species.

“CAMOUFLAGE” IN IMMATURE BARK LICE IN 100 MILLION-YEAR-OLD AMBER

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Deception or false communication among animals involves three entities: a primary signal generator (i.e. the species or background with which is deceived), a secondary signal generator (i.e. the deceiver) and a signal receiver (i.e. the deceived). Mimicry is the most common example of one species deceiving another. This deception happens for multiple reasons, e.g. warn colouration to signal toxicity and thus avoiding predation. Camouflage is another example of deception, though less studied, wherein the deceiver blends into their background to avoid detection or recognition. There are different modalities in which one can camouflage oneself, mostly studied within visual camouflage. Specific colour patterns that allow the deceiver to blend into their background, or disruptive colouration that masks or blurs the deceiver’s body outline to hamper detection are widespread examples of visual camouflage. Other strategies that do not involve camouflaging colour patterns, but more behaviourally influenced mechanisms are e.g. masking or debris-carrying behaviour. Therein the animal accumulates debris either actively or passively on the back to blend into the background and adheres the debris with special morphological structures. Within Insecta there are a few in-groups that exhibit this behaviour, immatures of mostly Reduviidae (Hemiptera), lacewings (Neuroptera), caddisflies (Trichoptera) and bark lice (Psocodea). Bark lice are paraneopteran insects with relatively few species that are rather small and live mostly on plants or in/on soil. Many extant bark lice are bark-dwelling (hence the name!) and most are well camouflaged against this background, not only as immatures, but also as adults. Adult bark lice mostly employ colour pattern camouflage, whereas immature bark lice seem to exhibit multiple camouflaging strategies, like debris-carrying, plant-part masquerade or even mimicry. Here we describe four bark lice immatures from Myanmar amber that probably exhibited debris-carrying behaviour as their dorsal sides are covered in fine sand granules and organic material.

TRILOBITE DIVERSITY IN BALTOSCANDIAN ERRATIC BOULDERS

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The term „erratic" is derived from the Latin verb „errare", which means „to wander". According to Quaternary geology, erratic boulders are those rocks that are transported from original provenance areas by glaciers or ice sheets. Erratics are often embedded in glacial sediments and are found far away from their regions of origin. They differ in size, shape and type from native rocks. Erratics range in size from small pebbles to huge, metre-sized boulders. Erratics found in Poland originate from Scandinavia and other Baltic countries (for example Estonia), but also from the Baltic Basin itself. For palaeontological research, the most important constituents are sedimentary rock types. It is possible to find many types of these, a number of which will be presented in this presentation. It is focused on Cambrian, Ordovician and Silurian erratics, which contain numerous trilobite species. The most common are asaphids, phacopids, and encrinurids. Mostly, there are only some parts of their body, for example pygidium, but recognition of genera (sometimes even species) is possible. Some of them are very characteristic for specific rock types, for instance *Agnostus pisiformis* in *Agnostus*-limestone or *Toxochasmops macrourus* in *Macroura*-limestone. The aim of this work is to show trilobite diversity in erratic boulders and ways of their recognition.

PALAEOBATHYMETRICAL AND PALAEOECOLOGICAL DEVELOPMENT IN THE VIENNA BASIN (AUSTRIA) DURING THE EARLY AND MIDDLE MIOCENE

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The Vienna Basin (VB) originated during the early Miocene and represents one of the largest onshore oil and gas field in Europe. The VB is composed of several horst and graben structures forming different subbasins, each with its own geodynamic evolution and deviating palaeobathymetric and palaeoenvironmental developments during the Miocene. We present an analysis of water depth evolution including changing palaeoecological trends along a NE-SW transect based on analyses of benthic and planktonic foraminifers of hundreds of samples derived of 52 drillings. We document dramatic changes in the depth profile through time, which coincide with shifts of prevailing tectonic regimes. Bathyal conditions were established during the early Miocene piggy-back stage and the early middle Miocene extensional phase. A clear shallowing trend from upper bathyal to inner neritic conditions occurred during the middle Miocene extensional tectonic phase. Further, our analyses comprise reconstructions of sea surface temperature (SST), bottom water temperature (BWT), salinity, trophic levels, stress indicators, mode of life, feeding preferences and diversity indices (Fisher α, dominance and equitability). Bottom water temperatures indicate a cooling during the early and middle Badenian (Langhian), which seemingly contradicts the global warming of the Middle Miocene Climatic Optimum (MMCO) and a subsequent warming, which contrasts the expected trend following the cooling of the Middle Miocene Climatic Transition. Both trends are discussed as result from bathymetric evolution of the VB and intense upwelling during the early and middle Badenian. All lowstand systems of relative sea level in the VB coincide with global Mi-events. The observed maxima of the relative sea level in the VB are vaguely in phase with the global record from the Ottnangian (late early Miocene) to the middle Badenian (middle Miocene) but exceed the range of global sea level rise by three to four times, suggesting a strong tectonic amplification.

THE PERMO–TRIASSIC TRANSITION AND ITS EFFECT ON PLANT DIVERSITY AND DISTRIBUTION

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The Permian and Triassic periods were important for the evolution of terrestrial ecosystems. Not only was this the time of the end-Permian mass extinction event (EPME) and subsequent recovery, there was a change from icehouse to hothouse climatic conditions that caused aridification in the palaeotropics. This shaped the landscape, changed the local and regional environmental conditions, and influenced plant palaeodiversity. Hundreds of papers, popular books and TV documentaries discuss the mass extinction, mostly from a marine and terrestrial animal perspective. The scale and pattern of species loss, the environmental and climatic changes during that time, as well as dynamics and pattern of the biotic recovery of the plant communities are still matters of an ongoing discussion and have become a hot topic in the last few years, since the scientific community accepted that not all groups of organism followed the same dynamics within the extinction interval. Due to scarce and impoverished fossil megafloras from the latest Permian and earliest Triassic, the common perception has been that land plants suffered a mass extinction like the terrestrial and marine animals. Early Triassic macroplant assemblages are indeed often markedly impoverished and dominated by opportunistic taxa such as the iconic lycophyte *Pleuromeia*, although some megafloras were more diverse and gymnosperm-dominated. There are very few regions worldwide where macrofloras provide a detailled and unbiased fossil record from the early Permian up to the Middle-Late Triassic. A strong taphonomic bias, along with the fact that the macrofossil record is considerably undersampled for the Early Triassic, gives the impression of an increased gymnosperm extinction during the latest Permian. Recent discoveries of nearly all major post-extinction plant groups, including bona fides Corystospermales, Cycadales, Bennettitales, Czekanowskiales, Podocarpales, and Araucariaceae in the middle to late Permian and the presence of “mixed” floras indicates that these groups did not evolve in response to the EPME, but rather that the mass extinction and correlated changes in climate and environmental conditions gave origin to their major radiation afterwards. The palynological record, not as deeply affected by the taphonomic bias due to the higher preservation potential of spores and pollen, reflects a series of ecological disturbances and climatic changes around the Permian–Triassic boundary and during the Early Triassic. The exceptional preservation of delicate plant tissues such as exceptionally preserved cuticles from the Permian, Middle Triassic seedlings from France, and in situ spores and pollen from the Permian and Triassic give unprecedented insights into the biology, evolution, as well as stratigraphic and paleogeographic distribution of the various plant groups. This affects not only our understanding of the plant evolution through time but also of their ability to react to present and future climatic crises.

BOTANICAL AFFINITIES OF SPORES AND POLLEN FROM THE TRIASSIC OF THE SOUTHERN ALPS

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Spores and pollen are produced in large numbers by plants and distributed by wind, water or animals up to thousands of kilometers away from the source area. Due to their high number and high preservation potential, they are particularly suitable to reconstruct past environments and climate. This works very well in relatively young sediments containing spores/pollen of still living plants or pollen of angiosperms. However, the older the rocks, the higher the percentage of spores and pollen originating from extinct plants, and therefore with unknown biological affinity. In order to reconstruct the botanical affinity, it is necessary to identify the original plant, and in particular the corresponding reproductive organs. In the Dolomites and the Southern Alps in general, there are a number of fossiliferous localities (Kühwiesenkopf/Monte Prá della Vacca, Piz da Peres, Rifugio Dibona, Dogna, Recorao) with fossil plants from the Triassic in an exceptionally well-preserved state of conservation. Dozens of different species of horsetails, lycophytes, ferns, seed ferns, cycads and conifers were found, always containing vegetative organs (stems, branches, leaves) but often also with the presence of male and female reproductive organs. Micro- and megaspores have been found in situ in sporangia of the sphenophyte *Equisetites mougeotii*, as well as the lycophytes *Selaginellites* and *Isoetites*. Several fertile fronds of possibly osmundaceous ferns (*Gordonopteris lorigae*, *Scolopendrites grauvogelii*, *S. scolopendrioides* and *Anomopteris mougeotii*) have yielded isospores. Cones attached to a well-preserved conifer shoot assignable to *Voltzia recubariensis* yielded bisaccate pollen. The detailed study of these reproductive organs permits to identify the palaeobotanical affinity of a considerable number of spores and pollen types previously known only dispersed in the sediment.

PLANT-ARTHROPOD INTERACTIONS FROM THE PIESBERG QUARRY NEAR OSNABRÜCK, GERMANY (MIDDLE PENNSYLVANIAN)

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In the last years, the Piesberg quarry became one of the most important fossil Lagerstätten of Middle Pennsylvanian insects. Nevertheless, bearing in mind the vast material provided here, little is known about relations between arthropods and plants. Intensive collecting revealed a range of plant-arthropod interactions. As a result, at least 14 damage types (DT´s) belonging to five Functional Feeding Groups (FFG´s) were distinguished. We recognised margin and surface feeding (DT12, DT30), oviposition damage (DT72, DT101? and six new DT´s), seed/stem boring, galling (two DT´s) and leaf-mining (two DT´s). The diversity and abundance of oviposition damage were significant and quite comparable to extant organisms. We recognised three oviposition types on seed-fern fronds (*Macroneuropteris scheuchzeri, Sphenopteris* cf. *crepini*) and four types associated with calamitalean stems. Further possible oviposition damage occurred on a fern axis. For comparison, longitudinal borings in the pith of calamitaleans were studied. Coprolite evidence in the boring casts of another specimen from the Late Pennsylvanian of the Saale Basin revealed that small millipedes likely produced the tunnels, which were visited by oribatid mites. Moreover, we found circular borings in *Trigonocarpus* – medullosan seeds. The record of plant-arthropod interactions comprises the first galling evidence from the Piesberg: Small, ca. 2 mm long, lenticular galls and one single, ca. 20 mm long, ovoidal gall were recognised on a sphenophyte axis. The existence of leaf mines before the Permo-Triassic extinction event is debated. Remarkably, we found the earliest evidence of leaf mines on *Neuropteris* seed-fern pinnules from the Variscan Foreland Basin. The mines resemble digitate or star mines of modern Diptera and Lepidoptera lineages and have implications on current evolutionary concepts. Furthermore, putative undulating leaf mines were recognised. Our findings reveal that the ecosystem of the Piesberg was more complex than previously thought and offer potential for further palaeoecological studies on Carboniferous wetland environments.

ELONGATE DINOSAUR TRACKS EXPLAINED AS DEEP PENETRATION OF THE FOOT, NOT PLANTIGRADE LOCOMOTION

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Dinosaur tracks with elongated metatarsal marks constitute a long-standing conundrum. Such tracks are produced by a variety of dinosaurian trackmakers small to large, and are known from numerous examples around the world. Due to their superficially human-like appearance, examples from the Paluxy River of Texas have infamously been claimed to be “man tracks” by creationists. The horizontal orientation of the metatarsal marks is widely believed to be evidence for a facultative plantigrade, or “flat-footed”, mode of locomotion in otherwise digitigrade trackmakers. This hypothesis, however, is at odds with the consistently low anatomical fidelity of such tracks and their long stride lengths that indicate regular locomotion speeds. The long stride lengths have been explained by assuming a highly crouched limb posture, which is incompatible with scaling relationships that predict more columnar limbs at large body sizes. We instead propose that the trackmakers walked in their regular digitigrade fashion with the metatarsus held at an angle to the substrate. In this model, the feet penetrated deeply into soft sediment, with sediment collapsing above the descending foot, leaving a shallow surface track that includes a horizontal metatarsal mark. The length of the metatarsal mark is determined by multiple factors and is not necessarily correlated with the length of the metatarsus.

EARTH SYSTEM MODEL CONTRIBUTIONS TO INVESTIGATING MESOZOIC ECOLOGICAL TRENDS AND EXTINCTIONS

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Elucidating past ecosystem dynamics and extinction events frequently demands information about local and global climate conditions as well as the mechanisms and timescales of climatic changes. As this can be difficult to extract from empirical records alone, climate models can provide valuable context. Here, we want to provide insights recent and ongoing work on modeling Mesozoic (~252 – 66 Ma) climate states and dynamics. This includes the long-term climate evolution, as well as effects of orbital cycles and rapid perturbations by e.g. volcanism or asteroid impacts, all of which can represent environmental drivers of ecological shifts and even mass extinction events. The CLIMBER-3α and CLIMBER-X global Earth System Models are employed for these investigations. Besides physical processes in the atmosphere, ocean and sea and land ice, the models are also able to simulate aspects of vegetation dynamics and marine and terrestrial biogeochemical cycles. With these tools, e.g. climatic cooling and warming sequences by pulsed sulfur and carbon emissions from Large Igneous Province volcanism involved in the end-Triassic extinction have been simulated. We show a few examples tentatively evaluating such model results against spatial distributions and assumed thermal niches of some Mesozoic forms of life (e.g. scleractinian corals). Related work has also been focusing on the Cretaceous – Paleogene boundary, modeling e.g. global cooling and ocean fertilization caused by the Chicxulub impact. We would like to further contribute Earth System modeling expertise and data to research on extinction events and deep time ecosystem dynamics and would like to use the opportunity for exchange with the paleontological community.

AN AFRICAN WORLD IN THE SHADOW OF GIANTS – MAMMALS AND OTHER MICROVERTEBRATES FROM THE JURASSIC–CRETACEOUS TRANSITION OF KSAR METLILI, MOROCCO

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The Jurassic–Cretaceous transition is a pivotal period: it is marked by the Pangea break-up, and witnessed the emergence or first diversification of most of the modern continental vertebrate groups. However, little is known about this time interval in the continental environments from Gondwana, especially in Africa. At the Ksar Metlili site (Tithonian–Berriasian, eastern Morocco), we identified about 40,000 vertebrate microremains, belonging to at least 53 species. It includes chondrichtyans, actinopterygians, non-tetrapod sarcopterygians, lissamphibians, chelonians, lepidosaurs, choristoderes, crocodyliforms, pterosaurs, dinosaurs, non-mammaliaform cynodonts and mammals. Thus, Ksar Metili delivered one of the richest and most diverse continental microvertebrate assemblages from the Jurassic–Cretaceous transition of Gondwana, and stands as an unrivalled window on the African continental ecosystems of this time. 'Dryolestoids' are the most abundant mammals from Ksar Metlili, but only one species, *Donodon perscriptoris*, was described on the basis of three specimens and referred to the monotypic Donodontidae. Our review of the mammalian remains from Ksar Metlili led to the discovery of 46 additional 'dryolestoidean' isolated teeth, referred to *D. perscriptoris* and to three new genera and four new species. Our morphological and phylogenetic analyses suggest that these five species form a clade, supported by ten synapomorphies, and can be grouped within Donodontidae, leading us to propose an emended diagnosis for donodontids. They appear to be more derived than meridiolestidans, a South American 'dryolestoidean' group that was previously thought to take its origin into donodontids. Our work also strongly suggests that donodontids are closer to Zatheria than to any other 'dryolestoideans'. This proximity renews the question of the origin of zatherians and opens up the possibility of an African or Gondwanan origin, instead of the Laurasian one currently widely accepted. It could have important implications for the understanding of the evolutionary and palaeobiogeographical history of modern mammals (Theria).

AN EXAMPLE OF DIVERSITY OF IMMATURE LACEWINGS – A QUANTITATIVE COMPARISON OF APHID LIONS OVER GEOLOGICAL TIME

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Lacewings (Neuroptera) are holometabolan insects with prominent larvae. Best known are the predatory antlions, but also the other lineages of Neuroptera possess larvae with similar feeding habits. Aphid lions, the larvae of Chrysopidae (green lacewings) or Hemerobiidae (brown lacewings) received their name due to their ecological function as predators on aphids. Accordingly, they play a role in biological pest control. Like most lacewing larvae, aphid lions have mouthparts formed as stylets. These are shaped like pliers and form venom-injecting and sucking tubes, which are used for sucking the liquids of the prey. Fossils that have been interpreted as aphid lions are preserved in amber of various ages including Cretaceous, Eocene, and Miocene. We here report 58 new aphid lion specimens from 100 million-year-old amber. To investigate possible changes in morphological diversity of these larvae over geological time, the shapes of the heads and the stylets were compared quantitatively between the different time periods. Together with the new fossils and the specimens accessible from the literature, a total of 361 specimens could be included into the analysis. The results indicate an increase in the diversity of the shape of head and stylets in Hemerobiidae, while the diversity of the shape of head and stylets in Chrysopidae remains more or less the same over time. In other ingroups of Neuroptera, a distinct decrease in diversity of the shape of head and stylets over time could be observed. This demonstrates that the diversity of lacewings did not simply decrease over time, as generally assumed; at least some lineages diversified since the Cretaceous.

MICROFAUNA AND MICROFACIES FROM THE INITIAL REEF STADIUM OF BINOLEN IN THE HÖNNE VALLEY (SAUERLAND, MIDDLE DEVONIAN)

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The Middle Devonian was a phase of extensive reef systems on a global scale. In this context, one of the best-known examples is the Givetian-Frasnian Hönne Valley Reef Complex in the northern Rhenish Massif, Germany. While there are several studies on the reefal faunal composition and stratigraphy, there is a great lack of knowledge concerning microfaunal compositions of reef limestones including their potential use as a biofacies proxy. The initial stadium of Rhenish reefs is largely unexplored in terms of its microfossil content. Therefore, a section at Binolen is examined, which exposes the lower part of the Hagen-Balve Formation (“Massenkalk”) concerning its marine microfauna. A total of 4097 representatives of the Foraminifera, Porifera, Scolecodonta, Echinodermata, and other, partly problematic, microfossils were analysed quantitatively to visualize distribution patterns through the stratigraphic column and to reconstruct possible changes of the paleo-habitat. Furthermore, the taxonomical classification revealed an unexpected broad diversity spectrum within the initial reef. The quantitative microfossil analysis was able to distinguish 6 different biofacies types, namely the Porifera-Scolecodonta-biofacies, Porifera-Echinodermata-biofacies, Foraminifera-biofacies, Scolecodonta-biofacies, Chitinozoa-biofacies, and Ostracoda-biofacies. A correlation between reef microfacies analysis and the fluctuating microfossil assemblages is only partly comprehensible.

ASSESSING THE SUITABILITY OF THE BONE ANALYSIS PLUG-IN OF ORS DRAGONFLY FOR BONE MICROSTRUCTURE ANALYSIS

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Bone constitutes a suitable research object due to compatibility with computer tomography (CT) based methods. By creating virtual representations of a specimen, scientific oriented imaging software offers the possibility to process and further investigate them. The Python-based imaging software ORS Dragonfly developed a bone analysis plug-in, suitable for both recent and fossil bone material. Through segmentation and the subsequent calculation of different bone parameters, the plug-in makes an internal examination of bone structures possible. During the analysis of intraspecific variations in the humeri of the European red squirrel (*Sciurus vulgaris fuscoater*), the suitability of the Dragonfly bone analysis plug-in for this type of research was tested and evaluated. The starting point of the study were image stacks, acquired and reconstructed from raw projection data scanned with the CoreTOM (microCT). Subsequently the image stacks were read into Dragonfly with a voxel size of 0.026 mm and analysed according to the defined steps of the plug-in. Problems encountered during analysis occurred mostly in the segmentation step and definition of the Regions of Interests (ROIs). Due to the organic residues in the bone, positioning of the bone during scanning as well as growth stage dependent variation, segmentation was often insufficient and had to be corrected manually, in a very time-consuming manner. A macro was programmed to minimize the problems, although manual correction was still necessary to an extent. In conclusion, Dragonfly poses as a very competent software for analysing internal bone structure. More focus, however, could be put into the recognition of the heterogeneous morphology of bones and compatibility with high numbers of samples. Furthermore, the programme might be well suited for the investigation of fossil bone material, but it cannot be excluded that similar segmentation problems might arise due to the condition of the fossilized bone as well as inorganic residue.

UPPER TRIASSIC PALAEOBIOTA FROM A MARINE KONSERVAT-LAGERSTÄTTE DEPOSITED DURING THE CARNIAN PLUVIAL EPISODE IN AUSTRIA

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Palaeobiota of fossiliferous sites known as Konservat-Lagerstätte are precious sources of palaeobiological information providing unique insights into palaeocommunities, food chains and dietary habits of marine ecosystems. A rich assemblage of various marine taxa from the lower Carnian Polzberg Konservat-Lagerstätte near Lunz am See (Northern Calcareous Alps, Lower Austria) is described for the first time in detail. The fossiliferous layers were deposited during the Julian 2 Ib (*Austrotrachyceras austriacum* Zone, *Austrotrachyceras minor* biohorizon). The fine-laminated Reingraben Shales comprise abundant and well-preserved members of the marine Carnian food chain. Invertebrates with the bivalve *Halobia*, the ammonite *Austrotrachyceras* and the coleoid *Phragmoteuthis* dominate over vertebrate actinopterygian fishes. Fragile groups such as polychaetes and isopods are entirely preserved as soft body fossils. The diverse assemblage comprises ammonites (*Austrotrachyceras*, *Carnites*, *Sageceras*, *Simonyceras*), coleoids (*Phragmoteuthis*, *Lunzoteuthis*), bivalves (*Halobia*), gastropods (caenogastropods/heterobranchs), one echinoid, thylacocephalan arthropods (*Austriocaris*), crustaceans (the decapod *Platychela* and isopods such as *Obtusotelson*, *Discosalaputium*), polychaetes (*Palaeoaphrodite* sp., eunicid polychaete), acytinopterygians (*Saurichthys*, *Polzbergia, Peltopleurus, Habroichthys*), cartilaginous fishes (*Acrodus*), coelacanth fish (*"Coelacanthus"*), a lungfish (*Tellerodus*), and a conodont cluster (*Mosherella*). Regurgitalites produced by large durophagous fish and coprolites produced by piscivorous actinopterygians accompany the Polzberg palaeobiota along with rare plant remains (*Voltzia*). The entire fauna of Polzberg and the excellent preservation of the specimens present a window into the Upper Triassic assemblage and palaeoenvironment during the so-called Carnian Pluvial Episode (CPE) in the early Mesozoic. The occurrence of the freshwater lungfish *Tellerodus* and the branchiopod *Eustheria,* a member of brackish to freshwater environments, points to the influence of occasional freshwater pulses or sediment transport events on the marine environment. The Polzberg palaeobiota was deposited during the global CPE, triggering the environmental conditions of the Polzberg Basin and resulting in the formation of the Reingraben Shales with the Polzberg Konservat-Lagerstätte.

3D RECONSTRUCTION OF LATE TRIASSIC COLEOID CRANIAL CARTILAGE FROM THE POLZBERG KONSERVAT-LAGERSTÄTTE (NORTHERN CALCAREOUS ALPS)

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Hyaline cartilage is widely distributed in various invertebrate groups such as sabellid polychaetes, molluscs (cephalopods, gastropods) and the chelicerate arthropod group of the horseshoe crabs. It can be seen as convergent trait in animal evolution and thus it does not seem to be a vertebrate invention. Due to the poor fossil record of cartilaginous structures, occurrences of mineralized fossil cartilages are of vast importance for evolutionary biology and palaeontology. Although the biochemical composition of recent cephalopod cartilage differs from vertebrate cartilage, histologically, the cartilages of these animal groups resemble remarkably. The examined material derives from the late Triassic Polzberg Konservat-Lagerstätte near Lunz am See (Lower Austria, Northern Calcareous Alps), which has been known for nearly 150 years. Besides the preservation of a rich Carnian vertebrate and invertebrate carbonized and phosphatized fauna, a morphogroup (often associated with coleoid remnants) of black, amorphous appearing fossils still remained undetermined. In this study, the conspicuous micro- and ultrastructure of these fossils was examined by thin sectioning and Scanning Electron Microscopy (SEM). The geochemical composition analysed by Microprobe and Energy Dispersive X-ray Spectroscopy (SEM-EDX) revealed carbonisation as taphonomic pathway for this fossil group. High-resolution serial sectioning by micro-tomography (m-CT) of 14 specimens and their 3D reconstruction allows detailed insights to the interior of these unique Mesozoic fossils. Preliminary results point to a characteristic branched channel system as well as to exterior attachment grooves for a coleoid muscular system. Measurements of internal structures of the preserved elements and landmarking on the exterior surface facilitated the identification of the different elements and their assignment to their equivalences in recent coleoid cartilage. The findings provide new knowledge on the early coleoid evolution and in particular the morphology and function of cephalopod cartilage. Finally, the morphology and internal structure of cranial cartilage can also hint evidence for evolutionary relationships.

IDENTIFICATION OF CALCIUM OXALATE BIOMINERAL TRACES IN FOSSIL PLANT LEAVES OF THE OLIGOCENE AND EOCENE

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Calcium oxalate crystals and druses occur in different parts of many plant species, particularly in the leaves. In fossil plants, calcium oxalate crystals (CaOx) have not yet been identified. In this study for the first time we identify traces of CaOx druses and crystals in fossil leaves from the Rott fossil site (late Oligocene) and Indian amber (Eocene). Granular structures with various shapes, sizes, and distributions in fossil leaves and fresh leaves were investigated by Light microscopy (LM) and scanning electron microscopy (SEM) including energy-dispersive X-ray (EDX) element analyses. The patterns of granular structures in the parenchyma cells and vascular system of the fossil leaves bear a strong resemblance to the distribution of CaOx crystals in fresh leaves. Comparison of those granular structures in fossil leaves convenience us that they most probably originated from CaOx druses and crystals in plant leaves. Obviously, composition and size of the original CaOx crystals would be altered during fossilization by environmental factors. Our results showed they being filled with organic materials and minerals containing Ca, Si, Al, S, and Fe. The identification of CaOx remains will provide us better understanding of the role of CaOx in plant ecology through geologic time and a broader conception of the fossilization processes that can preserve plant biominerals. Key words: Calcium oxalate crystals (CaOx), fossilization, plant leaves, Oligocene, Eocene.

BIVALVES FROM THE INNVIERTEL GROUP OF ALLERDING IN THE NORTH ALPINE FORELAND BASIN (LOWER MIOCENE, UPPER AUSTRIA)

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During the Ottnangian (early Miocene), the North Alpine Foreland Basin (NAFB) operated as a sea-way connecting the Central Paratethys Sea with the Rhône Basin in the Western Mediterranean. Within this short time window, an intensive faunal exchange between the two palaeobiogeographic units occurred, which is reflected in macrofossil assemblages. The extraordinarily rich fossil record of the study site, Allerding, located in the westernmost Central Paratethys, provides valuable insights into the composition and origins of the bivalve fauna colonizing the marine gateway. The site documents the early Ottnangian marine transgression over deeply weathered crystalline basement, grading from fossil bearing shallow water clay and sand into the open marine "Schlier" facies of the Ottnang Formation. Despite considerable taphonomic overprint, a total of 46 species is recorded. The dominance of suspension feeders, and the presence of several deposit feeders and chemosymbiotic taxa point to well diversified inshore settings, including low intertidal mudflats, as well as seagrass meadows. An abundance of primary and secondary hardgrounds is reflected in the high number of cementing and byssate species, as well as in the occurrence of species drilling actively into hard substrate. Finally, the dominance of active burrowers suggests a patchwork of habitats, where sandy and muddy soft bottoms occur interspersed. Biostratigraphic analysis constrains the deposits to the early-middle Ottnangian, based on the presence of the index species *Flexopecten davidi* and the concurrence of several taxa, which have their last or first occurrences within this interval. These are predominantly taxa persisting into the Badenian, therefore allowing for a straightforward differentiation between Eggenburgian and Ottnangian assemblages. While a few Central Paratethys endemics reflect a continued semi-isolated position of the area, the majority of the newly arriving species are shared with the Mediterranean and NE Atlantic, documenting the establishment of a faunal migration route via the NAFB.

NEW MAMMALS FROM THE EARLY CRETACEOUS OF BALVE-BECKUM (NORTH RHINE-WESTPHALIA, GERMANY) AND THEIR PALAEOBIOGEOGRAPHIC IMPLICATIONS

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Three new trechnotherian and cladotherian mammals are reported from the Early Cretaceous (Barremian–Aptian) karstic fissure fillings of the Balve-Beckum locality in northwestern Germany. The locality so far yielded isolated vertebrate remains of hybodontiform sharks and other fishes, amphibians, turtles, lizards, crocodyliforms, pterosaurs, sauropod, theropod and ornithopod dinosaurs, and multituberculate mammals. The new spalacotheriid "symmetrodontan" genus and species, represented by one lower and two upper molars, is the first record of spalacotheriids in Central Europe. The new spalacotheriid is similar to *Spalacotherium,* but differs by a smaller stylocone and a larger parastyle on the upper molars, and a labially interrupted cingulid on the lower molar. A new small dryolestid genus and species is erected based on one lower and two upper molars. Phylogenetic analysis revealed the new taxon as the most primitive member of a clade comprising *Laolestes, Krebsotherium, Dryolestes,* and *Guimarotodus*. A dryolestid mandible with unevenly rooted molars and extremely worn teeth cannot be attributed to the small taxon. With unevenly rooted molars and extremely worn teeth twice as large in size as the small dryolestid, it is assigned to a separate new genus and species. The mandible has the dental formula 3i, 1c, 4p, 8m and a fully reduced Meckel´s groove. It lacks any trace of a coronoid or splenial. In the phylogenetic analysis, the new taxon appears as the most primitive member of a clade comprising *Achyrodon, Phascolestes, Crusafontia,* and *Hercynodon*. The new mammals are stratigraphically the youngest European representatives of their clades. The late survival and endemic evolution of the dryolestids is possibly the result of isolated evolution in an Early Cretaceous island environment. This finding of new spalacotheriid and dryolestid mammals from Central Europe adds to an emerging palaeobiogeographic pattern that Europe is distinct from Asia in the constituents of mammalian faunas during Barremian–Aptian.

RECONSTRUCTING OLIGO-MIOCENE PALAEOENVIRONMENTS AND THE INFLUENCE OF SEA LEVEL FLUCTUATIONS ON THE SOUTH-WESTERN COAST OF SOUTH AFRICA

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The Cape Floristic Region (CFR) houses a diverse range of plant species that are characteristic of a Mediterranean-type winter-rain climate that was established in the Neogene. Palynomorphs recovered from early Neogene sediments of Core BH2 are identified to reconstruct the palaeoenvironment at Langebaanweg, ~120 km north of Cape Town in order to reveal the evolutionary history of fynbos vegetation. A preliminary study of Core BH2 was conducted by Sciscio *et al*. (2013), but many pollen grains were concealed by debris, the sample resolution was low and dinoflagellates were provisionally assigned to one genus. For the current study, 76 microscope slides were analysed with a light microscope and 104 palynomorph types including pollen, spores and dinoflagellates were recorded. Palynological and statistical results confirm a subtropical-tropical forest dominated by Podocarpaceae, palms, vines and ferns, indicative of annual rainfall with more summer rainfall than today. Wetlands comprising Sparganiaceae, Restionaceae, Cyperaceae and Poaceae were abundant, pointing to a high water table. Mangrove tree pollen were rarely recorded, possibly implying little input of brackish water conditions at the bottom of the section. Patches of proto-fynbos probably provided an understorey component and co-fluctuated with the forest elements. A considerable marine influence was imposed on the terrestrial environment, inferred by three marine transgressions in the Late Chattian *Apteodinium spiridoides* zone and a fourth and final one in the Middle to Late Aquitanian *Operculodinium centrocarpum* zone, which are probably linked to global Late Oligocene to Early Miocene sea level changes. Savanna woodlands with *Psilatricolporites quenua* (*Alchornea*), Combretaceae and *Peregrinipollis nigericus* (*Brachystegia*) gradually replaced subtropical forests, possibly due to drier conditions and enhanced seasonality. A Late Oligocene (Early Chattian) to Early Miocene (Early Burdigalian) age is inferred for Elandsfontyn Formation at Langebaanweg based on the presence of *Mutisiapollis viteauensis* (Asteraceae) and dinoflagellates *Apteodinium spiridoides*, *Chiropteridium lobospinosum* and *Cordosphaeridium minimum*.

INTEGRATED LEAF TRAIT ANALYSIS – A NEW TOOL FOR ANALYZING EUROPEAN PALEOGENE ECOSYSTEMS

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Fossil leaf assemblages are excellent archives of environmental evolution of the earth´s history. Leaves as primary photosynthetic organs are directly exposed to their environment and their traits thus reflect adaptions or responses to habitat conditions through time. Functional leaf traits are keys to shifts in plant economics; insect damage types on fossil leaves, as evidence of plant-insect interaction, are the key to the complex and intricate trophic network in terrestrial ecosystems. As a new approach, the integrated leaf trait analysis combines these features of fossil leaf assemblages to characterize palaeoecosystem functioning. Exemplary on two lower Oligocene volcanic floras, namely Seifhennersdorf (Saxony, Germany) and Suletice-Berand (Northern Bohemia, Czech Republic), the concept of the integrated leaf trait analysis will be introduced. Further, methodological issues concerning applied methods, such as the Trait Combination Type (TCT) analysis, the image-based reconstruction of fossil leaves to obtain leaf size and leaf mass per area (LM_A), as well as the acquisition of insect herbivory parameter will be discussed. In the Seifhennersdorf flora insect herbivore traces are mainly evident on leaves of deciduous fossil species characterized by low LM_A, like *Betula alboides*, *Carpinus grandis* or *Carya fragiliformis*. In contrast to that, a higher diversity and abundance of herbivory traces on fossil species like *Engelhardia orsbergensis*, *Sloanea artocarpites* and *Daphnogene cinnamomifolia* indicate increased interaction with evergreen hosts in Suletice-Berand. Generally, evergreen species with long-living leaves are characterized by showing an opposite pattern of low insect herbivory caused by their traits (e.g., high LM_A through increased robustness/ toughness, high amount of plant secondary metabolites as defensive compounds). In both fossil floras, the host plants showing simple toothed leaves with craspedodromous venation (TCT F) are preferred by herbivores, as well as rareness or absence of leaf mining and galling.

PROVENANCE ANALYSIS OF HISTORIC MORTARS AND MORTAR BASED MATERIALS – A MICROPALAEONTOLOGICAL APPROACH

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Mortar has been the essential construction agent of buildings for more than 9000 years, with lime as the most widely used mortar-binder in historic buildings. For producing lime mortars, naturally occurring limestone is heated to > 800°C, causing a thermal decomposition into quicklime (CaO). Post-Triassic limestones often contain calcareous nannofossils. These calcitic, single-celled, marine photoautotrophic algae (< 30 µm) are significant components of the Earth's biogeochemical cycle since the Jurassic and are as such well studied in the fields of oceanography, marine biology, micropalaeontology and geology. Here we focus on the neglected application of these algae in archaeology and related fields. We analysed 28 mortar samples from six, archaeologically well-dated medieval churches (800 – 1510 AD) from the Münsterland Basin (northern Germany) for their calcareous nannofossil content. Notwithstanding substantial heating most samples yielded low diversity assemblages which provided in some cases reliable biostratigraphic ages of the limestone mined. In all examples locally outcropping limestones were used; in one case the lime was transported over a distance of 20 km. The medieval builders preferred limestones over marly limestones, even if the later are exposed nearer to the former building site. In the case of the Paderborn Cathedral different limestone resources have been used over the 500 years of construction, suggesting that socioeconomic factors (e.g., ownership of land) partly controlled the source area of the mined material. The general lesson of the current study is that calcareous nannofossils are i) present in mortar and mortar-based materials (render, colour version) of historic buildings; ii) a good tool for the provenance analysis of mortars (even a few nannofossil findings can suffice).

EXTINCTION AT THE FIFTH AND SIXTH MASS EXTINCTION – A FRESHWATER PERSPECTIVE

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Earth's biodiversity faces a massive decline today. Because of the magnitude of the already observed and future predicted change, many scientists consider the current biodiversity crisis an incipient "sixth mass extinction". The current crisis resembles the previous, fifth mass extinction event at the Cretaceous–Paleogene (K–Pg) boundary 66 million years ago in terms of the rapidity of the change – an asteroid impact paired with extreme weather conditions in the successive months/years vs. anthropogenic impact and climate change. The fifth mass extinction is well understood for terrestrial and marine biota, but little data are available on freshwater biota. Freshwater vertebrate faunas seem to experience a much lesser decline of 10–22% (compared to the global average of 76%). However, vertebrates make up only a minor proportion of freshwater biota, and no comprehensive data are available for invertebrates. We estimated speciation and extinction rates for a large dataset spanning the fossil record of freshwater gastropods of Europe, with 3,122 species from 24,759 fossil occurrences from Jurassic to Pleistocene deposits. To compare the impact of the sixth versus the fifth mass extinction, we predicted future extinction rates and species loss based on conservation statuses of the extant European freshwater gastropod fauna. The results were alarming. While our reconstructions show that already the fifth mass extinction has been dramatically underestimated – 92.5% of the gastropod species go extinct and the extinction rate is an order of magnitude higher than the background rate – the predictions for the future are much worse. Our estimates suggest that a third of the modern European gastropod fauna may be lost within 100 years. The estimated extinction rate is approximately a thousand times higher than for the fifth mass extinction event. Our results once more highlight the devasting prospects for Earth's biota and the need for immediate action.

FOSSIL CEMENTUM OFFERS A WINDOW ONTO PHYSIOLOGICAL EVOLUTION AMONGST MAMMALIAFORMS AND EARLY MAMMALS

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A wealth of new fossil discoveries has revolutionised our knowledge of the phylogenetic and ecomorphological evolution of mammaliaforms and early mammals during their diversification from the Late Triassic through Mid-Late Jurassic. However, until recently, understanding of their physiological evolution has been limited by a lack of robust metrics to pinpoint their metabolic properties relative to living taxa. We have recently employed synchrotron radiation-based computed-tomographic (SRCT) imaging to study the fossilized cementum of the teeth of Earliest Jurassic mammaliaforms *Morganucodon* and *Kuehneotherium*, and count their circum-annual growth increments to estimate their maximum wild lifespan. The finding of significant negative relationships between maximum wild lifespan and mass-specific standardised/basal metabolic rates (SMR/BMR) amongst living terrestrial mammals and non-avian reptiles using phylogenetically corrected least squares regression, and significant separation of regressions for both clades, allowed us to use our mammaliaform maximum lifespans to estimate their SMR/BMR. unexpectedly long maximum lifespans for both fossils (nine years for Kuehneotherium and 14 years for *Morganucodon*) in-turn provided significantly lower estimates of SMR/BMR than extant terrestrial mammals of similar size, instead correlating with small-bodied reptiles. This suggests that, contradictory to several earlier hypotheses, the elevated endothermic BMRs of extant mammals had yet to be developed amongst the earliest mammaliaforms. We have since applied SRCT imaging to study cementum in a wide range of mammaliaform and mammal taxa from two important Jurassic faunas: the Mid-Jurassic (Bathonian) Kirtlington assemblage (UK) and the Late Jurassic (Kimmeridgian) Guimarota assemblage. This has let us study both macro-evolutionary and ecological changes in lifespan and BMR amongst and between major mammaliaform/mammal groups, and test previous hypotheses relating physiological evolution to the adaptive radiation of crown mammals in the Mid-Late Jurassic. Cementum thus offers a unique opportunity to track major patterns in mammalian physiological evolution through the Mesozoic and provide context to both documented and hypothesised macro-evolutionary patterns through this period.

PREDATION ON MIOCENE MARINE MOLLUSKS ALONG A LATITUDINAL GRADIENT IN THE SOUTHEASTERN PACIFIC

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Predation traces in the fossil record have been the subject of several studies over the years because they are evidence of predator-prey interactions in the past. Through the analysis of drillings and repair scars in mollusk shells, information can be obtained to infer the macroevolutionary impact of predators on the structure of communities, and evaluate the effect of latitude on these interactions, considering that globally there is a gradient of increasing species diversity from high to low latitudes. Today, Chile has an inverse latitudinal gradient of species diversity (which increases from low latitudes to high latitudes). This gradient originated during the Quaternary, while before this period the latitudinal gradient was conventional (with increasing diversity from high to low latitudes), which would influence a higher frequency of predation interactions at low latitudes. We analyzed 15,627 gastropod, bivalve and scaphopod shells from the Navidad Formation, Ranquil Formation, Lacui Formation and Ipún beds. Our study shows that a latitudinal gradient exists in predator-prey interactions in the lower Miocene of Chile as inferred from the frequency of predation traces (drillings and repair scars). This increase in predation frequency from higher towards lower latitudes, which is influenced by latitudinal factors and species richness, is evidence that predator-prey interactions are important for the configuration of these populations of marine mollusks.

IN SITU FERN SPORES FROM THE TRIASSIC IN EUROPE

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We studied the *in situ* spores of ferns from exceptionally well-preserved palaeofloras of the Triassic in Europe with a focus on intraspecific and interspecific morphological variability. The material mainly comes from the Kühwiesenkopf/Monte Prà della Vacca flora (Dont Formation, Anisian) of Italy, the Lettenkeuper (Erfurt Formation, Ladinian) of Germany, and the Lunz flora (Lunz Formation, Carnian) of Austria. The studied specimens belong to the Marattiales (*Asterotheca merianii*, *Mertensides bullatus*, *Danaeopsis* spp.), Osmundales (*Todites* spp.), possible Osmundales (*Anomopteris mougeotii*, *Gordonopteris lorigae, Scolopendrites* spp.), and Gleicheniales (*Dictyophyllum serratum*, *Clathropteris* cf. *reticulata*). Our analysis is aimed at distinguishing characters that can serve to identify specific taxa from those that fall into the normal range of variability, differentiating developmental stages, and determining the frequency of malformed or abortive grains, which may provide evidence for environmental disturbances affecting plant reproduction. We found considerable variability in spore size and surface ornamentation both between individual plant specimens of a particular species and within single sporangia. Both can be attributed in part to different stages in the sporogenesis, as the spores are not equally mature. Even spores from different parts of a frond show significant differences in their average and maximum sizes, which suggests diachronous maturation. Differences in the size of spores between individuals may also be related to ploidy levels (genome size), which can vary even within populations. Variations in the surface ornamentation are mostly based on the presence or absence of certain sculpture elements. Spore grains with or without these elements correspond to different dispersed taxa. Abortive grains are generally rare but appear with increased frequency in some specimens. The cause may be environmental stress or disease, as well as natural hybridization.

THE LAZARUS METAPHOR IN PALAEONTOLOGY AND THE SCIENTIFIC VALUE OF THIS AND OTHER METAPHORS

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The Lazarus effect in Palaeontology means an outage of the fossil record of a taxon or an evolutionary lineage, especially after mass extinctions. It is based on the biblical story (John 11:1–45) in which Jesus brought Lazarus back to life. The Lazarus metaphor (Lazarus effect or phenomenon) is also used in other sciences e.g., in physics, biology, medicine, and also in arts. However, a google search revealed that most references in natural sciences are in palaeontological context. The Lazarus metaphor is somewhat crooked because the biblical story is meant unironic: Lazarus was really dead for four days and was awakened by Jesus. However, the extinction of an evolutionary lineage is irreversible. Thus from the beginning, the Lazarus metaphor meant only an apparent temporary extinction. The outage of a taxon reflects decreased population sizes, survival in refugia, an incomplete sedimentary record or other possible causes. Analysis of a database of Triassic gastropod species revealed that the lower the standing species diversity is, the greater is the number of Lazarus genera indicating that both reflect the same underlying reasons. The Lazarus metaphor is known to most palaeobiologists. Its use is justified because it elegantly circumscribes the cumbersome phenomenon of an incomplete fossil record. Fancy metaphors were coined or used for phenomena connected with major mass extinctions, especially with the end-Permian one: Elvis-taxa, Dead clade walking, and Lilliput effect. Research on great mass extinctions is one of the most important palaeontological contributions to earth and life sciences. Therefore, it attracts most ambitious scientists who want to produce high-impact research and coin the wording to enhance the impact even more. However, caution is needed when introducing and using such metaphors. They may detract from the solution of scientific problems and compromise the seriousness of our work.

ARCHAEOBOTANICAL EVIDENCE OF THE EMERGENCE OF PASTORALISM AND FARMING IN SOUTHERN AFRICA

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There are contrasting models citing migration and/or diffusion for the emergence and spread of pastoralism and farming in southern Africa during the first millennium AD. These models, which are often based on archaeological signatures such as pottery, pits and bins, grindstones, iron slags, and iron objects, remain equivocal and controversial. This calls for a synthesis of reliable, independent proxies (e.g., palynology, phytoliths, anthracology) to ascertain a narrative of pastoralism and farming that is consistent with existing archaeobotanical and archaeological data and provide new insights for identifying anthropogenic impacts and cultivars in the palaeorecords. Harnessing archaeobotanical evidence is potentially viable for tracing the spread of pastoralism and farming in the first millennium AD because of the associated anthropogenic practices, the impact of which likely resulted in distinct patterns of vegetation changes. We assess this impact through the synthesis of published archaeobotanical evidence of pastoralism and farming, as well as vegetation changes from southern Africa in the first millennium AD. In addition, we present the palynological results of three Iron Age cow dung samples from northern South Africa emphasizing the role of Tribulus (puncture vine) as an indicator for cattle farming. We also highlight gaps in the current knowledge of pastoralism and farming and potential areas for further research. It is commonly argued that the decline of forests during the first millennium AD relates to climatic changes alone. This argument often precludes anthropogenic effects on vegetation. A reassessment of the relationship between vegetation, climate, and human activities in southern Africa revealed clear evidence of human occupation during the same period. We hypothesize that the pattern exhibited by forest tree pollen decline, coupled with the increase of open-land indicators, pioneer trees as well as the spores of coprophilous fungi are reflective of, and consistent with anthropogenic activities of pastoralists and farmers.

A NEW LATE TOARCIAN (EARLY JURASSIC) ICHTHYOSAUR FROM SCHANDELAH (LOWER SAXONY) IN 3D-PRESERVATION

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Ichthyosaurs are some of the most iconic extinct marine vertebrates, representing an important faunal element in marine ecosystems from the Early Triassic to the beginning of the Late Cretaceous. Early Jurassic ichthyosaurs are generally well known thanks to a series of Lagerstätten deposits in Europe, notably the early Toarcian Posidonienschiefer. However, the diversity and structuration of ichthyosaur assemblages during the late Toarcian is poorly known. Herein, we present a new 3D-preserved ichthyosaur skull from the late Toarcian of the Posidonienschiefer Formation at the Geopunkt Jurameer Schandelah, Lower Saxony, Germany. The locality is situated near Braunschweig and appears characteristic for 3D-preservation in contrast to the classical 2D-preservation of Swabian ichthyosaurs. The specimen is referable to a new species within the genus *Wahlisaurus* and is notably characterised by a small adult size and a distinct overbite. This specimen shows a series of leptonectid traits, such as small and slender conical teeth, which lack enamel ornamentation, a slender snout, a quadratojugal placed posterolaterally, a small supratemporal fenestra, and a large orbit. A high-resolution CT-scan from the University Hospital Münster uncovered additional skull elements hidden by sediment. This new species represents one of only a few small-bodied post-Triassic ichthyosaurs. *Wahlisaurus* sp. nov. is together with other specimens from Schandelah and the adjacent excavation at Hondelage, one of the northernmost ichthyosaurs from Germany. In terms of taphonomy, most of the disarticulation within the dorsolaterally exposed skull can be attributed to diagenetic compression. However, the dislocation of both premaxillae might have been caused by an anterior crash into the substrate, entombing the skull while leaving the postcranium exposed, explaining the lack of the latter.

EXAMINING ECOMORPHOLOGY USING 3D GEOMETRIC MORPHOMETRIC ANALYSIS ON THE POSTCRANIA OF THE MESOZOIC MAMMALIAFORM *BOREALESTES*

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Early mammal groups underwent diversification in the Middle Jurassic, including the stem-mammalian clade, Docodonta. Recent discoveries in China indicate docodontans exhibited ecomorphological diversity similar to extant small-bodied mammals, but our understanding of the emergence of this ecological diversity is hindered by: 1) a lack of Middle Jurassic fossils from other parts of the world; 2) the difficulties in detecting ecomorphological signals in small-bodied animals; 3) limitations in quantitative comparison between early-diverging, extinct Mesozoic taxa, with that of highly derived extant mammals. In this study, we examined two extremely rare partial postcranial skeletons of *Borealestes serendipitus* and *Borealestes cuillinensis*. These docodontan mammaliaform specimens come from the Kilmaluag Formation, Scotland, and are currently the most complete Mesozoic mammaliaform skeletons described from the UK, and among the best preserved in Europe. *Borealestes* is considered an early diverging member of Docodonta, and so provides key information for understanding the clade's anatomical evolution, and the emergence of ecomorphological diversity in mammaliaforms as a whole. Using digital reconstructions of the skeletal elements (from micro-CT and synchrotron scan data), we carry out principal components analyses using 3D landmarks on these fossils and a comparative dataset of 42 extant mammal taxa. *Borealestes* is morphologically intermediate between the robust morphology of fossorial and semi-fossorial/semi-aquatic *Haldanodon* and *Docofossor*, and the gracile morphology for scansorial *Agilodocodon* and *Microdocodon*. Our results indicate *Borealestes* lacked specialisations for derived locomotor behavior, although we detect some similarity in the humerus between *Borealestes* and *Ornithorhynchus*. We suggest ecological diversity in Docodonta may arise from an unspecialised basal bauplan, of which *Borealestes* may be representative.

NEW INSIGHTS INTO THE WORLD OF MESOZOIC ECHINODERMS – EXCEPTIONALLY PRESERVED FOSSILS FROM THE ORNATENTON FORMATION OF THE WIEHEN HILLS (CALLOVIAN, MIDDLE JURASSIC)

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Despite having a fairly extensive fossil record in the Middle Jurassic, articulated fossils of echinoderms from this epoch are rather rare. Much of our knowledge of some of the earliest representatives of important post-Palaezoic groups is based on isolated ossicles, often making inferences on morphology and systematics difficult. Taphonomic biases add to this problem: in particular, most of the typical Callovian siltstone and mudstone deposits throughout Europe only include poorly preserved, isolated and overall rare remains of echinoderms, which has led to the believe that they did not constitute an important part of Callovian marine ecosystems. A newly discovered well-preserved echinoderm fauna from the Ornatenton Formation of Wallücke in the Wiehen Hills includes a total of 14 species belonging to the Crinoidea, Asteroidea, Ophiuroidea and Echinoidea. Some of the fossils belong to previously unknown species and will be described in a publication that is currently in preparation. Unusual morphological features include echinoid-like spines in a solasterid asteroid, unique spine morphologies in a polycidarid echinoid and the overall very small size and delicate build of many of the different species. Preservation of the fossils is often exceptionally good and includes fully articulated crinoids and asterozoans as well as echinoids with attached spines, intact lanterns and complete apical discs. The fossils are interpreted to belong to several obrution deposits where distal storm events resulted in sudden burial of the animals with fine-grained sediment. The new fauna shows that the perceived rarity of echinoderms in Callovian fine-grained successions is at least in part due to taphonomic circumstances and that the actual diversity and abundance might have been much higher than expected.

THE BROMACKER LAGERSTÄTTE IN THE THURINGIAN FOREST – A UNIQUE WINDOW INTO THE CONTINENTAL LOWER PERMIAN WORLD

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The Lower Permian of Central Europe is mainly recorded by continental, intramountain sediments, since it was positioned in the centre of the supercontinent Pangaea. Sand- and siltstones of several fossil sites in the Tambach Formation contain a characteristic fauna and flora, indicating extreme environments caused by a continental near-equatorial climate. Early tetrapod vertebrates of the lower Permian are increasingly adapted to terrestrial conditions; invertebrates, including conchostracans, hydromedusae, insects, diplopods and others suggest a semiarid environment and perennial water bodies. Typical ichnofossils characterise temporary ponds and their remnants as well. Climate marks such as raindrop imprints, water level- and possible ice marks indicate strong seasonal climatic variability and regular flooding events. Since the late 19th century, the quarries of the Bromacker site close to Tambach-Dietharz in the Thuringian Forest, central Germany, are well known for their fossils, especially for trace fossils. In the 1970s, a regular systematic exploration of the fossil bearing layers started. Since 1993 the Fossillagerstätte Bromacker became better known as a result of its unique and exceptionally preserved lower Permian tetrapod fauna recorded by both skeletons and tracks. After a gap of ten years (2010-2020), 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, restarted research on the Lagerstätte with focus on geological and paleobiological research as well as modern science communication techniques that involve the general public in the research progress. Participating institutions include the Museum für Naturkunde Berlin – Leibniz-Institute for Evolution and Biodiversity Research, the Stiftung Schloss Friedenstein Gotha, the Friedrich-Schiller-Universität Jena and the recently declared UNESCO Global GeoPark Thüringen Inselsberg-Drei Gleichen, with several additional national and international partners. The goal of the project is to comprehensively reconstruct this unique continental Early Permian ecosystem with interdisciplinary and actualistic methods.

STUDY OF THE DENTITION OF THE PARTICULAR PLACODONT HENODUS CHELYOPS – TOOTH REPLACEMENT AND FEEDING BEHAVIOUR

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Placodontia is a Triassic sauropterygian reptile group characterized by flat and enlarged crushing teeth adapted to a durophagous diet. The enigmatic placodont *Henodus chelyops* has numerous autapomorphic character states, including extreme tooth count reduction to only a single pair of palatine and dentary crushing teeth. This renders the species unusual among placodonts and challenges the interpretation of its particular dentition. The skulls of two *H. chelyops* specimens were visualized with synchrotron tomography to investigate the complete anatomy of their functional and replacement crushing dentition in 3D. All teeth of both specimens were segmented, measured, and statistically compared to reveal that *H. chelyops* teeth are much smaller than the posterior palatine teeth of other cyamodontoid placodonts except for *Parahenodus atancensis* from the Iberian Peninsula. The replacement teeth of this species are quite similar in size and morphology to the functional teeth. As other placodonts, *H. chelyops* exhibits vertical tooth replacement. This suggests that vertical tooth replacement arose relatively early in placodont phylogeny. Analysis of dental morphology in *H. chelyops* revealed a concave shape of the occlusal surface and the notable absence of a central cusp. This dental morphology could have reduced dental wear and protected against failure. Hence, the concave teeth of *H. chelyops* appear to be adapted to process small invertebrate items, such as branchiopod crustaceans. These crushing palatine teeth are combined with a cutting edge with denticles and baleen-like grooves, which could respectively be used to scrape the plants of the substratum and filter the plankton from the water.

DIVERSITY OF OWLFLY LARVAE – A QUANTIFIABLE MORPHOLOGICAL ANALYSIS ACROSS THE FOSSIL RECORD AND EXTANT REPRESENTATIVES

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Ascalaphidae, the group of owlflies, is an ingroup of Neuroptera, the group of lacewings. Owlflies are closely related to the well-known antlions (Myrmeleontidae). Owlflies are widely distributed in all non-polar continents, thriving in tropical as well as temperate climates. Adult owlflies are known as generalist aerial predators with certain similarities to dragonflies and butterflies. Owlfly larvae are voracious ambush hunters, often covered in debris to conceal their presence, and equipped with large mandibles often presenting three major teeth. We reconstructed 38 fossil specimens resembling modern day owlfly larvae and used these together with about 200 modern representatives of Ascalaphidae and Myrmeleontidae in a quantitative analysis. The shapes of the head and mandibles of these individuals were outlined from a dorsal or ventral point of view (depending on the specimen). The morphological analysis was conducted on this data using an elliptic Fourier transformation and principal component analysis. With this, we can compare the morphological diversity of the larvae in the Cretaceous, the Eocene, the Miocene, and the modern fauna.

ROLLING AROUND ROCKY SHELFS – FOSSIL AND EXTANT RHODOLITHS ON NORTH ATLANTIC ISLANDS

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Rhodoliths can be regarded as the response of coralline red algae to a lack of hard substratum. They form unattached nodular aggregates that are mainly composed of coralline algae. Since they are not attached to any substratum, their composition, growth from and size are controlled by the physical conditions of the depositional/living environment. These control composition, growth form and size of the heavily calcified nodules. As a consequence, deeper-water rhodoliths usually show a different taxonomic composition compared to shallow-water equivalents, and high-energetic nodules have other growth forms than low-energetic ones. Therefore, rhodoliths are valuable proxies for the analysis of fossil environments. The analysis of rhodoliths for the reconstruction of fossil environments requires a profound knowledge of their extant equivalents. This presentation shows three examples for such an approach, dealing with the Macaronesian islands in the Northern Atlantic, which include the Azores in the north, and the Cape Verde islands in the tropical belt in the south. They are comparably young volcanic islands and reveal Late Pliocene to Recent rhodoliths. The topographic changes of the islands over time are well known and have been studied in detail, including the relative sea-level changes. This makes them a perfect natural laboratory for the study of extant rhodoliths and their implications for the fossil record. We are currently studying them in cooperation with biologists, paleontologists, and volcanologists from the Universities of the Azores and Lisbon.

THERMAL EXTINCTION SELECTIVITY PATTERNS DURING GLOBAL WARMING EVENTS

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Anthropogenic global warming is expected to raise regional extinction risk following the stress responses of warm-water organisms, especially coral reefs, while cold-water organisms may also suffer from decreases in sea ice. Empirical data on widespread extinctions can only really be sourced from the fossil record, with interpretations of hypothesis support complicated by sampling heterogeneity and timescale mismatches. Previous studies of regional extinction selectivity have used the occurrence paleolatitude of marine genera but trends under global warming events have been inconsistent, potentially because latitude is a complicated proxy for seawater temperature and other abiotic variables. Here we assess marine extinction selectivity of marine animals based directly on regional temperatures sourced from climate models. We assess whether thermal selectivity trends deviate under hyperthermal conditions and how patterns associate with environmental and sampling parameters. Sampling patterns have an important influence on observed extinction selectivity but could not account for some of the trends observed at hyperthermal events, including raised extinction risk cold-water genera. The modern spread of organism thermal preferences makes these findings particularly important.

NEGLECTED MICROFOSSILS – EARLY JURASSIC ECHINODERM LARVAL SKELETONS FROM GERMANY AND FRANCE

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Larvae of brittle stars, sea urchins, and allies are common, ecologically important members of marine ecosystems in all oceans today. It has been recognized that all modern echinoderm representatives, with the exception of Crinoidea, have feeding (planktotrophic) larvae, whereas benthic, free-living feeding larvae are missing. Lecithotrophic (non-feeding) larvae with benthic or planktonic habits have been reported in all modern echinoderms. All of these types of echinoderm larvae have unique morphologies, and, with the exception of the bipinnaria of Asteroidea, a calcitic skeleton. In contrast to modern representatives, the fossil record of echinoderm larvae is essentially non-existent and biased due to missing studies or lack of awareness of such small and fragile microfossils. However, modified micropalaeontological techniques and detailed study of sieve residues below 0.1 millimetre have the promise to provide microscopic larval skeletons as shown recently by Reich (2021). Our study reports a few hundreds of ophiopluteus and echinopluteus skeletons from Sinemurian, Pliensbachian and Toarcian strata of Germany (Lower Saxony, Saxony-Anhalt) and France (Ardennes). Most of the specimens found (>95%) belong to ophiuroids, only a few correspond well to echinoid larval skeletons. All plutei skeletons found are of compound type including unique characteristics, revealing evolutionary changes between Mesozoic and Cenozoic forms. Our new findings provide a window into the poorly known fossil record of echinoderm larvae, showing a hidden diversity of such fragile microfossils and the possibility of direct geological recording.

WESTERN GONDWANA ARTHROPOD-PLANT INTERACTION – A PERSPECTIVE FROM A HIGH PRODUCTIVITY EARLY PERMIAN ASSEMBLAGE OF BRAZIL

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The Cisuralian Rio Bonito Formation (Paraná Basin, Brazil) is known for its mineable coal seams, which originate during transgressions/regressions related to climate ameliorations after the finish of Late Palaeozoic Ice Age (LPIA) and the transition into the Early Permian Greenhouse in Western Gondwana. Its uppermost unit, the Siderópolis Member, contains the Barro Branco coal seam. Above this coal seam follow 0.5 m of fossil-rich mudstones in which the Early Permian Artinskian Itanema II outcrop is situated (Urussanga Municipality, Santa Catarina State). The outcrop is famous for well-preserved kerogenized plant remains. The plant assemblage consists of several glossopteridalean elements, but also cordaitalean leaves, pecopteridean fronds, sphenophylalean and phyllothecacean leaf whorls and is inferred as transitional from the wet Glossopteris flora to the impoverished semi-arid Glossopteris flora. The analysis of the common Glossopteris spp. leaves, larger than 1 cm², yielded an almost 30% arthropod-plant interaction rate and 24 different damage types. A larger variability, with 36 damage types, is only known for the Cisuralian La Golondrina Formation (Argentina), however, with only 14.8% interaction rate on Glossopteris spp. The analysis of the Carboniferous/Permian Rio Genoa Formation flora brings a 27% interaction rate, though, with 12 damage types. Despite those high rates, other Western Gondwana assemblages of similar age demonstrate generally a 5.8% to 9.8% rate and 3 to 14 damage types only. Larger rates and a higher diversity of damage types are more often found in palaeoequatorial belt plant assemblages. The high rates and diversities at the Itanema II site are directly related to the shift of elevated bioproductivity to higher palaeolatitudes with the end of LPIA. However, its unusual numbers may also denote singularities of the transitional flora.

UNRAVELLING THE BIOLOGY OF THE NODOSAURID DINOSAUR *STRUTHIOSAURUS AUSTRIACUS* FROM THE LATE CRETACEOUS OF AUSTRIA

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Nodosaurids are thyreophoran dinosaurs displaying extensive body armor composed of closely arranged bony osteoderms, which are partly modified into prominent spikes around their neck and shoulders. *Struthiosaurus* is a European Late Cretaceous representative of this spiky group of herbivorous quadrupeds. Numerous cranial and postcranial remains were unearthed in the 19th century and later assigned to different individuals of *Struthiosaurus austriacus*; with a comparatively small body size of approximately three meters in maximum length. The material comes from early Campanian continental beds of Austria, now housed in the Department of Palaeontology of the University of Vienna. Although subject to extensive research in the past, some aspects of the biology of this enigmatic thyreophoran dinosaur still remain unknown. In this talk, we are aiming to help answer unresolved questions and overcome limitations of previous studies by providing a closer look at the available material of *Struthiosaurus austriacus*.

CLOSE RELATIVES OF EXTANT PARASITIC FORMS OF CRUSTACEANS FROM THE MESOZOIC OF EUROPE

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Isopoda is a species-rich group of crustaceans living in various habitats and pursuing different ecological strategies, ranging from detritus-feeding terrestrial woodlice to large deep sea scavengers and parasites of fishes and other crustaceans. The fossil record of the group is overall relatively sparse compared to that of other crustaceans, such as crabs (Brachyura) or seed shrimps (Ostracoda). Nevertheless, fossils of the group occur in many field sites, and also fossils of presumed parasites have been recorded. Fossils that have been associated with the name Urda Münster, 1840 are known from a few Jurassic and Cretaceous field sites throughout the world and have also been discussed as possible parasites presumably closely related to extant parasitic forms. However, only some of the Urda fossils, and so far only those from Europe, can safely be identified as being closely related to each other as well as to an extant group of fish parasites, Gnathiidae Leach, 1814. The close relationship to Gnathiidae is attested by a number of apomorphic features shared between the fossil specimens and extant representatives of Gnathiidae. However, there seems to be no unambiguous autapomorphy for a group Urda. This results in a still to be resolved, maybe complex, relationship between the fossils and their extant counterparts, making the fossil specimens a valuable source of information that could help to elucidate the, also still to be resolved, relationship between Gnathiidae and other extant lineages of Isopoda.

MOLAR OCCLUSION WITH AN ANTERIORLY DIRECTED COMPONENT IN THE POWER STROKE IS UNIQUE TO THERIAN MAMMALS AND MAY HAVE INFLUENCED EARLY THERIAN DIETARY DIVERSIFICATION

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Unlike most vertebrates, mammals have a precise dental occlusion, a lower jaw composed of one bone, and middle ear ossicles derived from ancestral jaw bones. Non-mammalian synapsids and early mammals underwent complex evolutionary changes in both feeding and hearing adaptations, which were crucial for the radiation of extant mammals. To investigate functional transitions in the chewing mechanisms of synapsids, we compiled jaw movement directions during postcanine occlusion based on primary literature for a sample of 133 synapsid genera. Occlusal complexity generally increases in more recently evolved synapsid clades, but occlusal movements among non-therian synapsids are limited to orthal-dominated shearing processes with some taxa that developed posteriorly directed (i.e., palinal) chewing movements. Therian mammals in comparison are the only synapsids that include lineages which exhibit transverse occlusal movements with a significant anterior component. An anterior directed jaw movement during occlusion necessitates anteriorly directed muscle force vectors. We posit that such a change in direction of muscle force vectors is preserved in the mammalian fossil record by the appearance of the cladotherian (i.e., therians and close relatives) angular process that shifts the orientation of superficial masseter and medial pterygoid muscles. The evolutionary change in jaw morphology was followed by the development of the lower molar talonid basin, which facilitates additional occlusal contacts during extended transverse movements. In earlier synapsids anterior movement might have been absent because of the middle ear elements were still attached to the lower jaw, prohibiting a more posterior insertion of jaw musculature. Thus, a complex shift in the entire masticatory apparatus of early cladotherians, involving transformations of the jaw corpus and muscles, molar shape, and detachment of the middle ear elements permitted the evolution of novel masticatory movements. This evolutionary transition starting with the earliest cladotherians may have been a critical prerequisite for the dietary diversification of therians.

THE WEBERIAN APPARATUS IN ACTION – HOW DO THE AUDITORY STRUCTURES OF OTOPHYSAN FISHES INTERACT DURING SOUND EXPOSURE?

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The otophysans are a speciose group of modern bony fishes (10,350 species), which possess improved auditory abilities. Improved hearing in these fishes is correlated to a unique type of connection between the swimbladder and the inner ears, namely the Weberian apparatus. The Weberian apparatus consists of soft tissue elements such as the sinus impar and the interossicular ligaments as well as the Weberian ossicles; the latter can also be preserved in fossil specimens. Until now, it remains widely elusive, which selective pressure(s) may have driven the evolution of this complex structure. Approaching questions on how the Weberian apparatus has evolved are tightly linked to a profound understanding of how the auditory structures in extant otophysans work together and what factors may affect their function. Despite the well-investigated morphological diversity of the auditory structures in otophysans, hypotheses on the function of the Weberian apparatus formulated decades ago still await experimental testing. To tackle this issue, we are currently developing a 4D tomography approach at the TOMCAT beamline of the Swiss Light Source. The synchrotron radiation-based tomography using high spatio-temporal resolution allows quantifying the motion patterns of the auditory structures in 3D. So far, we have subjected individuals of the glass catfish *Kryptopterus vitreolus* in a miniature standing wave tube-like setup to 350 and 450 Hz pure tone stimuli. First results indicate that we are able to successfully visualize and quantify the *in-situ* motion patterns from the swimbladder through the Weberian ossicles to the otoliths of the inner ears. In a next step, we will compare the motion patterns in cypriniform and silurifom species differing in the morphology of the swimbladder and the number of the Weberian ossicles. In a long run, our results should provide the basis for modeling the motion of Weberian apparatus-like structures in well-preserved fossil specimens.

AMPHIBIANS FROM THE HIGH LATITUDE EARLY CRETACEOUS TEETE LOCALITY, YAKUTIA, RUSSIA

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The Early Cretaceous (Berriasian–Barremian) Teete locality in Yakutia, Eastern Siberia, Russia was formed close to Mesozoic polar latitudes (62–66.5° N) and has become known for its polar dinosaurs, as well as other vertebrates, including amphibians. The amphibian faunal components of Teete include two salamander taxa: the relic stem salamander *Kulgeriherpeton ultimum* (described on the basis of an isolated atlas) and an undescribed crown-group salamander. New material of *Kulgeriherpeton* shows significant similarities to the stem salamander *Marmorerpeton* from the Middle Jurassic (Bathonian) of Great Britain which may indicate close phylogenetic relationships. The histological structure of the femora of *Kulgeriherpeton* is similar to that of other stem salamanders in having a thick periosteal nearly avascular cortex and calcified cartilage in the small medullary cavity, but differs in the presence of well pronounced growth marks. The observed growth marks suggest that there were periods of strong seasonality in the local climate of Teete. The crown salamander is characterized by a gracile dentary with spaced pedicellate teeth and specific (thin parallel longitudinal grooves) sculpture on the lateral surface. The dentaries of the Teete crown salamander resemble the long-lived Jurassic-Cretaceous crown salamander *Kiyatriton*. The high-latitude vertebrate fauna of Teete is similar in composition to that of the Early Cretaceous mid-latitude Shestakovo locality in Western Siberia, Russia, including taxa with Jurassic affinities (e.g. stem salamanders) that survived as relics into the Early Cretaceous of present-day Siberia. The similarity in faunal composition between the high-latitude fauna of Teete and the mid-latitude vertebrate fauna of Shestakovo (including the amphibian component) suggests that the refugium (= “Great Siberian refugium”) for Jurassic vertebrate relics covered the vast northeastern part of the Asiatic continent.

EXCEPTIONALLY HIGH DIVERSITY IN THE FRASNIAN (UPPER DEVONIAN) TORNOCERATIDAE (AMMONOIDEA) FROM BÜDESHEIM (RHENISH MASSIF, GERMANY)

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The famous Büdesheim Formation in the Eifel region (Germany, North Rhine-Westphalia) is known to be an extraordinary place to study upper Frasnian ammonoids. While previous studies focused mainly on the Gephuroceratidae, we take a closer look on the equally significant Tornoceratidae. A total of over 1400 well preserved tornoceratid ammonoids from Büdesheim are investigated in terms of morphometry and taxonomy and reveal a highly diverse fauna with 24 tornoceratid taxa including a new genus for involute aulatornoceratids and five new species. Additionally, a new Büdesheim collection from slightly younger strata than typical ("*Archoceras*" Genozone, UD I-K, Intra-Kellwasser level) confirms slight changes of species composition but, overall, no measurable decline in tornoceratid species richness and biodiversity during the Lower Kellwasser Event. This indicates that during the extended Kellwasser Crisis (Late Devonian mass extinction) the younger Upper Kellwasser Event at the Frasnian-Famennian boundary was the significant extinction event for ammonoids leading to the complete extinction of the Gephuroceratidae and most Tornoceratidae.

EXTINCT STINGLESS BEES DISCOVERED IN DEFAUNATION RESIN AND HOLOCENE COPAL FROM AFRICA

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Specimens in fossil to Recent resins are remarkable for their fidelity of preservation. Amber is well known and studied, contrary to younger resins as Pleistocene copal (2.58-0.0117 Ma) and Holocene copal (0.0117 Ma—1760 AD), or Defaunation resin, which is resin produced after 1760 AD. The scientific relevance of these younger resins preserving arthropods that lived in pre-Anthropocene time is often underestimated. Copal and Defaunation resin can document losses of local biodiversity resulting, e.g., from deforestation. Here, we present specimens of stingless bees included in copal and Defaunation resin from Tanzania and Madagascar, ranging in age from almost 3,000 BP years to only 80 +/- 30 BP years. Stingless bees take essential ecological and economic roles. They are, e.g., pollinators and producers of honey or cerumen. In the present study, three known species and two new species have been discovered from the thirty-six studied specimens. The coastal forest in the East Africa region is now highly fragmented, so that we can expect that the new species are already extinct. The study of inclusions in copal and Defaunation resin can bring proof of this potential anthropic defaunation.

THE DISCOVERY OF *IRATINIA AUSTRALIS* – THE OLDEST KNOWN ANATOMICALLY PRESERVED AXIS BEARING AFFINITIES WITH CYCADALES

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Recently, we proposed the new genus and species *Iratinia australis* Spiekermann, Jasper, Siegloch, Guerra-Sommer & Uhl. The taxon is based on a monoxylic, anatomically preserved axis from the Irati Formation, Kungurian of the Paraná Basin, Brazil. This specimen was interpreted as a lycopsid in a preliminary study published in the 1980s, but a detailed re-examination of its morpho-anatomical characteristics revealed that it has systematic affinity with Cycadales. *Iratinia australis* is the oldest known anatomically preserved vegetative axis bearing affinities with this particular botanical order. It provides evidence that the overall anatomy of cycad monoxylic axes, as well as the armour of leaf bases and the girdling leaf traces which are characteristic for Cycadales, were already established in the Kungurian. The fossil is the first record of an anatomically preserved cycad axis from the Permian of Gondwana, and together with some foliage adpressions from Cathaysia, suggests that during the Cisularian Cycadales or their direct ancestors were already widely/worldwide distributed.

RESPIRATORY ADAPTATION TO CLIMATE IN THE UPPER PALAEOLITHIC

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As our human ancestors migrated into Eurasia they faced a considerably harsher climate, but the extent to which human cranial morphology has adapted to this climate is still debated. It remains unclear when such facial adaptations arose in human populations. Here, we explore climate-associated features of face shape in a worldwide modern human sample using 3D geometric morphometrics and a novel application of reduced rank regression. Based on these data, we assess climate adaptations in two crucial Upper Palaeolithic human fossils, Sungir and Mladeč, associated with a boreal-to-temperate climate. We found several aspects of facial shape, especially the relative dimensions of the external nose, internal nose and maxillary sinuses, that are strongly associated with temperature and humidity, even after accounting for autocorrelation due to geographical proximity of populations. For these features, both fossils revealed adaptations to a dry environment, with Sungir being strongly associated with cold temperatures and Mladeč with warm-to-hot temperatures. These results suggest relatively quick adaptive rates of facial morphology in Upper Palaeolithic Europe.

LIVING ON THE EDGE – DIVERSITY PATTERNS OF HYBODONTIFORM SHARK-LIKE CHONDRICHTHYANS PRIOR TO THE BIOTIC TURNOVER AT THE JURASSIC–CRETACEOUS TRANSITION

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The Late Jurassic marks a crucial time interval in the history of life leading to dramatic episodes of global environmental perturbation at the Jurassic–Cretaceous boundary, which significantly changed the faunal composition of many vertebrate communities in both the terrestrial and marine realms. Among marine vertebrates, hybodontiform shark-like chondrichthyans, which form a supposed sister group to the elasmobranch crown (i.e., modern sharks, skates and rays), witnessed a diversity decline in marine ecosystems from the Early Cretaceous onwards before they predominately occurred in continental environments, where they flourished and adapted to a wide range of ecological niches until they finally went extinct at the end of the Cretaceous. However, the controlling factors underlying post-Jurassic hybodontiform diversity dynamics remain unresolved. Hybodontiforms, whose fossil record is dominated by isolated teeth, have been reported from various European Late Jurassic localities so far. Our knowledge of hybodontiforms, however, still is very insufficient so that their diversity, ecology and distribution prior to the Jurassic–Cretaceous transition remain poorly understood. Nevertheless, this is of utmost importance for unravelling the response of these iconic shark-like chondrichthyans to the biotic turnover at the Jurassic–Cretaceous boundary. We provide a synopsis of the European Late Jurassic fossil record of hybodontiforms including a historically collected tooth assemblage from the Kimmeridgian of Poland and well-preserved but largely unstudied skeletal material from the Kimmeridgian of Normandy, the Kimmeridge Clay Formation of England and the Solnhofen Archipelago of Germany, and discuss their significance for better understanding Mesozoic chondrichthyan life prior to the Jurassic–Cretaceous boundary. Late Jurassic hybodontiform communities are dominated by large-bodied taxa of higher trophic position, indicating quite uniform distributional patterns characterized by epipelagic forms that were able to cross deeper marine areas. Although less well understood, small-bodied hybodontiforms appear to have been more diverse taxonomically and ecologically and even more widely distributed than previously thought.

GEOMETRIC MORPHOMETRICS – A NEW TOOL TO CLASSIFY SOUTH AMERICAN QUATERNARY GOMPHOTHERE (PROBOSCIDEA: MAMMALIA) MOLAR REMAINS?

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Fossil proboscideans are amongst the most abundant fossil megafauna in the Quaternary of South America. Problematically, this group has few diagnostic characteristics to taxonomically determine fossils, as only skulls and tusks can currently be used to differentiate between species. Such remains are found only scarcely, while most fossil material consists of molars, which were so far not usable for species determination. As a result, the majority of South American proboscidean remains cannot be determined on the species level, complicating species-niche discrimination and hampering palaeoecological analyses. Here, we try to compensate for this shortcoming by employing geometric morphometric analyses to differentiate between two monospecific genera of South American Quaternary gomphotheres (i.e. *Notiomastodon* and *Cuvieronius*) using left and right third lower molars (lM_3, rM_3). We chose 29 third lower molars (M_3) belonging to *Cuvieronius hyodon* and *Notiomastodon platensis* specimens from North, Central, and South America. Occlusal pictures were obtained both from published papers and museum collection material. Only M_3 associated with diagnostic remains (i.e. skulls or tusks) were used, so that the degree of correct classification using only molars could be assessed independently. Landmarks and semi-landmarks were extracted using ImageJ v. 1.8.0_172, generating a total of 1740 landmark coordinates. Data were analysed with MorphoJ v. 1.07a, using canonical variates analysis with 1000 permutations to differentiate between species. Based on the rM_3 data, *C. hyodon* and *N. platensis* differ significantly in tooth morphology at $p = 0.038$. These results look promising and may allow to differentiate between *C. hyodon* and *N. platensis* (and potentially other fossil proboscidean species and genera) based on molar morphology, using well calibrated databases. If successful, this will allow more complete studies of American Quaternary Gomphothere palaeobiology, as it would allow to use fossil material that has been unusable so far for lack of known species attribution.

PTEROSAUR TRACKS (*PTERAICHNUS* STOKES, 1957) FROM THE LATE JURASSIC OF THE WIEHENGEBIRGE, NORTHWESTERN GERMANY

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The Wiehengebirge is an east-west-trending hill range situated at the border of Northrine-Westfalia and Lower Saxony in northwestern Germany. It consists of sedimentary rock units, which were deposited north of the Rhenish massif during the Middle and Late Jurassic. Sea-level regressions during the Kimmeridgian resulted in terrestrial conditions becoming established in the area periodically. Consequently, tracks of dinosaurs were preserved and are frequently found at several sites throughout the hill range. One of these is the Störmer quarry north of the village Bergkirchen. In late 2019, a sandstone slab from the Störmer quarry, preserving potential pterosaur tracks, was reported to the LWL-Museum of Natural History in Münster. This triggered further explorations of the site, which yielded additional, similar ichnofossils. Nine tracks are referrable to the pterosaur ichnogenus *Pteraichnus* Stokes, 1957. This diagnosis is based on the presence of distinctly shaped manus and pes impressions. The manus tracks are asymmetrical, tridactyl and digitigrade imprints in which all three digits point in strongly different directions. The imprints of the pedes possess triangular outlines, often combined with a deep, V-shaped heel impression. In cases in which they are preserved, four slender pes digits with equally narrow claw traces are present. Most tracks are isolated specimens, but at least one manus-pes-set is among the material. The pes imprint is positioned anterior to the manus imprint, which is common in pterosaur ichnotaxa such as *Pteraichnus*. A short potential pterosaur trackway segment, consisting of two to three manus imprints and two pes imprints, was also recovered. However, it is not assigned to a particular ichnotaxon due to its bad preservation. The tracks vary between 25 and 90 mm in anteroposterior length, which covers a large portion of the size range known for *Pteraichnus*. Previously, only a single pterosaur manus hypichnium (*Purbeckopus* cf. *pentadactylus)* was known from Germany. In addition, this is the first German record of *Pteraichnus*.

FOSSILIFEROUS CONCENTRATIONS – UNIQUE BIO-EVENTS IN A SECOND ORDER LOWSTAND WEDGE OF THE LOWER CRETACEOUS (NEUQUÉN BASIN, ARGENTINA).

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The Neuquén Basin (west-central Argentina) encompasses a nearly continuous Upper Triassic–lower Paleogene sedimentary record including marine and continental siliciclastics, carbonates and evaporites. Here, an early Valanginian marine succession representing a second order lowstand wedge (Mulichinco Formation) is studied at Cerro La Parva locality, in which several exceptional study cases are registered. The most remarkable of these can be found within the third order TST; it consists of 13-m-thick, laterally extensive oyster mass occurrences (OMOs) of the genus Ceratostreon. They are up to 2,5 km wide and represent the maximum expression of OMOs recorded basinwide in equivalent stratigraphic levels, in localities up to 50 km apart from each other. These were interpreted as composite biogenic concentrations of intercalated bioherms and autobiostromes. The extraordinary proliferation of oysters represents a population burst bio-event, which according to geochemical analyses, was triggered by lowered salinity and high primary productivity. Below the OMOs, 20 m above the base of the third order LST, a lenticular monospecific nerineoid assemblage is recorded, representing a mixed-origin concentration (within-habitat wave-reworking of locally abundant shells). Up-section, above the OMOs in the third order HST several individuals of the glypheidean lobster species Atherfieldastacus rapax are preserved in incomplete reworked calcareous nodules in shales and shell beds. The abundance of lobsters in these two beds was interpreted as event-concentrations caused by storm reworking. Further up-section, soft-bottom dwelling serpulids are found encrusted by smaller serpulids and Ceratostreon. Oysters eventually covered the serpulids, forming masses that coalesced laterally to constitute at least three simple biogenic concentrations up to 30 cm-thick. Each of these fossil concentrations represent unique bio-events, most of which are not recorded elsewhere in the basin, reflecting particular conditions that are currently under research. Their integral study will allow us to understand the development of benthic communities along the second order LST.

DEAD BUT STILL INTERACTIVE – FOSSIL WOODY DEBRIS AS ARCHIVE FOR DEEP-TIME INTERACTIONS IN CONTINENTAL ENVIRONMENTS

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Since the Middle Devonian woody debris has formed a significant component in vegetated continental ecosystems and depositional settings. Compared to other plant tissues, lignified matter has greater mechanical stability and chemical resistance, thanks to its composition and structure. As a result, wood can attain high retention times in depositional systems, allowing for numerous environmental interactions. Although relations among deadwood and organisms are well reflected in modern ecosystems, they remain poorly understood in deep-time environments. This talk scrutinises the significance, diversity, and abundance of interactions that deadwood had with other organisms and depositional processes in past continental settings. We provide fossil evidence of woody debris associated with microbes, plants, animals, and sediments, based on case studies from late Palaeozoic lacustrine, fluvial, alluvial and volcanic strata of both hemispheres. One example concerns permineralised conifer stems from the early Permian Manebach locality/Germany. At this site, the fossil wood occurs within microbialites at the base of the lacustrine Manebach Lake Unit. The preservation of the stems and the microstructure of their host rocks reveal that woody debris provided an important colonisation substrate for the stromatolite formation in littoral environments. By contrast, silicified stems from Winnweiler, Kyffhäuser (both Germany), the northern Czech Republic and north-central Brazil document the abundance of woody debris in Late Pennsylvanian–early Permian alluvial settings. Based on three-dimensional analyses of the log-bearing sediment architectures, the examples elucidate the role of woody debris in alluvial-fan deposition and fluvial bar formation. Finally, early Permian petrified deadwood from Chemnitz/Germany indicates that woody debris served as a shelter for animals during volcanic eruptions, making such accumulations excellent fossil traps. Our selection proves the potentials of fossil-wood research in understanding biosphere-geosphere dynamics on ancient Earth and supports evolution as a significant driver of landscape formation and biodiversity.

INDICATION OF PARASITISM AND ONTOGENETIC DEVELOPMENT IN THE FOSSIL RECORD – AN ISOPODAN CRUSTACEAN FROM THE LATE EOCENE AS EXAMPLE

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The group Isopoda does not only include woodlice or scavenging representatives, but also a large number of parasites. Isopodan parasites are not only known from extant examples, but have also been described in the fossil record. A collection of exceptionally well-preserved fossil specimens, representing an ingroup of Isopoda, is presented here. Excavated from the late Eocene from freshwater sediments of the Trupelník hill field site near Kučlín, Czech Republic, the specimens are approximately 40 million years old. These fossils are preserved with many details of the appendages being accessible, allowing for some ecological interpretations and comparisons to related extant groups. The morphological characteristics of the fossils were documented using macro-photography with polarised light, as well as stereo imaging. Overall body characteristics, including the trunk appendage morphology, body shape and size, were compared to those of related extant groups. All of the fossils examined were found to be conspecific, representing a single species. The shape and morphology of the trunk appendages suggests that these fossil specimens are ectoparasites, most likely of freshwater or anadromous fish species that were present at that time. Reconstructive illustrations were made of the fossil specimens. The body shapes of these and those of some related extant groups were included in a morphometric analysis for further interpretation of ontogenetic stages available in the material. Our analyses supported an interpretation of two, possibly three preserved ontogenetic stages of the species, including immatures.

THE DWARFING OF HIPPOPOTAMI ON CYPRUS

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Islands provide startling examples of evolution and have inspired both Charles Darwin and Alfred Russel Wallace. A notable example is hippopotami (or hippos). Many hippo fossils have been found on the Mediterranean islands, Madagascar, and Java. Body size of these insular hippos decreased after colonisation of the island, so that they were dwarfed compared to their mainland ancestors. The Cypriot dwarfed hippo (*Phanourios minor*) is the smallest dwarfed hippo ever to have roamed the earth. Its growth and life history have never been studied, however. Through histologic analyses of the long bones, it is demonstrated that the growth trajectory of the Cypriot dwarfed hippo was unlike that of any other mammal. In utero, growth was extremely slow, whereas initial postpartum growth displays the normal mammalian pattern. Then, there is a sudden decrease in growth rate, including the formation of up to 21 yearly lines of arrested growth. As natural resources were scarce on Cyprus during the Pleistocene, we propose that, post-weaning, dwarfed Cypriot hippos were straining to gather enough sustenance. This affected not only juvenile and sub-adult growth rates, but also foetal growth, as the foetus is dependent on its mother for nutrition. Infant growth rate of Cypriot dwarfed hippos follows the normal mammalian pattern. Modern hippo calves often suckle with multiple females. We postulate that Cypriot dwarfed hippo calves behaved similarly, but would have had to suckle with more females than modern hippos do, because the physical condition of Cypriot dwarfed hippos would not have allowed for much milk production per individual female. Reduced foetal growth rate has not been described in any other mammal and demonstrates a previously unknown flexibility with which the mammalian body is able to respond to extreme environmental conditions.

FIRST DATA ON PLIOCENE CONTINENTAL FOSSIL RECORD OF ARMENIA, SOUTHERN CAUCASUS

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Southern Caucasus with its geographic position at the crossroad of three continents is an important region in understanding past faunistic dispersals. In the few existing earlier works, this already partially was demonstrated by its continental fossil record. However, despite the availability of Cenozoic continental deposits in Southern Caucasus, their potential for systematic studies of Cenozoic vertebrates and palaeoenvironmental and palaeoclimatic studies has hardly been used. Here, we present our results of an interdisciplinary study on the Pliocene succession from Jradzor (Central Armenia, Lesser Caucasus). The 54 m thick continental succession comprises at least 15 horizons of vertebrate fossil faunas. The $^{40}Ar/^{39}Ar$ dating of abundant volcanic ashes along with an extensive palaeomagnetic sampling dated the section between 4.3 and 3.1 Ma. Six sedimentological units can be identified in the section: Unit 1 (distal lacustrine setting) with a white thinly-laminated diatomite succession; Unit 2 (palaeosol and downslope deposits) with brown mottled mudstones; Unit 3-4 (distal tail of pyroclastic flows) with mudstones containing extensive erosive sheet-like coarsening-upwards packages of scoria and pumice; Unit 5 (palaeosols and downslope deposition) with brown mottled mudstones; Unit 6 (alternating volcanoclastic and palaeosol environments). The lacustrine unit 1 provides both aquatic (mainly fishes) and rare terrestrial forms. The fossiliferous horizons of units 3, 4, 6 contain vertebrate faunas including amphibians, reptiles, birds and mammals. Here, horizons JZ-3 and JZ-13 are the richest ones with dominance of small sized vertebrates. Further, the horizon JZ-7 is remarkable with its rich large mammalian assemblage, including rare arvicolids and toads. All vertebrate groups suggest warm, rather dry and open habitats with very rare, forested regions. Based on a complex dating approach (biostratigraphy, $^{40}Ar/^{39}Ar$, and palaeomagnetic data) the age of the units is estimated as early Pliocene (unit 1-4), early/late Pliocene (unit 5) and late Pliocene (Unit 6).

PALAEOCOLOUR AND THE EVOLUTION OF DISPLAY AND CAMOUFLAGE IN DINOSAURS AND BIRDS

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The discovery of melanin in fossil feathers and integument has opened up for studying novel aspects of ancient life—their ecology and appearance. Melanin preserves as chemical residues and as melanosome organelles that reveal aspects of both melanin based colouration and even structural colour. Birds employ a wide variety of colour patterns for display and camouflage, and with preserved melanosomes it has been possible to eludicate how dinosaurs utilised their skin and plumage for such a purpose. In this talk I will summarise work on fossil pigments in dinosaurs and especially how countershading gradients reveal aspects of the habitats that dinosaurs lived in and ancient predator-prey dynamics. Derived theropods evolved colourful display evidenced by melanosomes generating iridescent structural colouration. Was this an adaptation due to their more complex feathers or a consequence of their new life style?

FINAL MEAL OF A FOSSIL FLY – EVIDENCE OF POLLEN CONSUMPTION AND INFERENCE OF PRESENT-DAY BIOLOGY

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The interaction between flowering plants and insects is believed to date back to the Early Cretaceous and be fundamental to the parallel diversifications in angiosperms and flower-visiting insects. The course of this evolution is shrouded by the lack of fossils providing direct evidence for flower-insect interactions. This study presents a unique fossil fly, from the early Cenozoic of Europe, with the contents of its digestive system still preserved. The fossil was collected in the middle Eocene Messel pit in Germany and was described as *Hirmoneura messelense* Wedmann, Hörnschemeyer, Engel, Zetter & Grímsson, 2021. The fly shows a conspicuously swollen crop inside its abdomen, which is filled with pollen. It was possible to sample pollen grains from the crop and to identify pollen from at least four different plant families. We used this information to interpret its foraging behaviour, to reconstruct its preferred habitat, and to conclude about its pollination role and importance in paratropical environments. This fossil represents the first record of pollen-feeding in nemestrinid flies, both fossil and extant. The research presented crosses disciplinary boundaries by combining paleontological research with present-day ecological research. The palynological methods employed are the same as in extant palynology yet involving pollen from the Eocene. Our study clearly shows that it is possible to deduce detailed and far-reaching insights from fossils by combining information from different disciplines and different methods of investigation; even so far as to provide predictive inferences on the biology and behaviour that have yet to be discovered of extant relatives.

THE EVOLUTIONARY–PHYLOGENETIC PATHWAY OF *AEGOCRIOCERAS* SPP. – REVISITING A CRETACEOUS AMMONOID

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The Cretaceous ammonite genus *Aegocrioceras* from the Boreal of northern Europe is an enigmatic ammonite taxon. Both, the systematic validity of its species as well as the origin of the genus are still a matter of debate. Here, we use an assemblage consisting of *Aegocrioceras* species from the clay pit Resse (NW Germany) to evaluate the genus' systematics, origins, and evolution. A total of 320 specimens have been analysed for their conch morphology using univariate measurements, and their ontogenetic growth trajectories have been predicted, to evaluate the genus' phylogenetic relationship. We observe a clear systematic distinction of *A. raricostatum*, *A. spathi*, and the *A. bicarinatum*/*semicinctum*/*quadratum* complex. A phenetic analysis puts all *Aegocrioceras*-species firmly within one clade, suggesting their monophyletic origin. The *Aegocrioceras bicarinatum*/*semicinctum* complex would be the phylogenetically oldest, with *A. spathi* being the youngest species and potentially a sister taxon to the boreal *Crioceratites seeleyi*. This is supported by the stratigraphic range observed in the Speeton clay (UK) as well as in the clay pit Resse. A derivation of *Aegocrioceras* from both the Boreal *Juddiceras* and the Tethyan *Crioceratites* leads to nearly identical phylogenies, coherent with the observed stratigraphic distribution of the species, so that a decision for either one of the derivation hypotheses cannot be made based on our data. We hypothesize, though, that at least some of the later (i.e. Hauterivian) *Crioceratites* in the Boreal may indeed be descendants of local *Aegocrioceras*-species, instead of newly invading Tethyan forms. *Aegocrioceras* seems to have been competitive against incumbent Boreal ammonoids mainly through abiotic forcing (Court Jester processes), while evolution within the *Aegocrioceras* clade seems to be dominated by biotic competition processes (Red Queen model).

THE RECENT DISTRIBUTION OF BENTHIC SHALLOW-WATER FORAMINIFERA IN CORFU ISLAND (GREECE, IONIAN SEA) – A BIODIVERSITY HOTSPOT BETWEEN THE EASTERN AND WESTERN MEDITERRANEAN

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The Island of Corfu (Greece) is situated in the northern Ionian Sea, which forms a transition zone between the Eastern and Western Mediterranean basins. This suggests the potential for a high biodiversity in marine organisms such as shallow-water foraminifera. We analyzed the foraminiferal assemblages of 51 samples from 25 unique locations around the island. They covered a depth range of 0.5 to 40 m and a variety of habitats (sandy sites, rocky shores and seagrass meadows). We calculated diversity indices and performed several analyses (e.g., Cluster and PCA) to study the community structures of local foraminiferal assemblages. With 200 benthic foraminiferal species we found a high species richness, which is comparable to neighboring areas of southern Albania but significantly higher than other locations in Greece or Italy. Diversity indices such as Fisher α and Shannon index were comparable or higher to other locations. We found that the main ecological drivers for assemblage composition were water depth (<2 m, 2–5m and >5 m) and habitat distribution, leading to 3 main Cluster-assemblages around the Island: 1) sandy or rocky, shallow-water areas from the South and West, 2) deeper areas from the West and 3) rocky, vegetated areas of variable depths from the North and West. We also found that the recent tropical invader *Amphistegina lobifera* is well established in Corfu. Our results show that the biodiversity of shallow-water foraminifera around Corfu Island is indeed high, which is most likely attributed to its unique location in the Mediterranean transition zone. It is also likely that Corfu Island is currently benefitting from ongoing range expansions of warm-adapted foraminiferal taxa due to ocean warming, as currently represented by the presence and establishment of *A. lobifera*.

INTRASPECIFIC VARIATION IN THE BONE MICROSTRUCTURE OF *SCIURUS VULGARIS FUSCOATER* HUMERI

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As small and arboreal mammals, red squirrels (*Sciurus vulgaris*) are interesting representatives of rodents for ecological research. Their lifestyle, which includes living and moving on trees and preserving food for winter instead of hibernating, brings specific challenges regarding locomotion and metabolism, which could be reflected in bone microstructure. Researching intraspecific variation in squirrels can provide information regarding this species and help paleontological studies, where sample sizes are often small, and it is important to have an idea of intraspecific variation in extant relatives to assess whether observed interspecific variation might be due to coincidence. This study focuses on humeri of *S. v. fuscoater* from Germany to uncover intraspecific variation such as laterality, seasonal variation, growth stage, and sexual dimorphism. The proximal and distal epiphyses were analyzed separately. The analyses were conducted using the software ORS Dragonfly, which allows visualization and segmentation of bones and calculates various parameters, which for this study, include cortical area, cortical thickness, periosteal surface, and endosteal surface. Preliminary results of the statistical analyses do not show significant differences in laterality, whereas several parameters do so between seasons. These include both trabecular and cortical parameters and the bone-volume fraction. Bone mass may be fluctuating with the availability of nutrients, specifically Calcium, between seasons. Comparing sexes also did not show significant sexual dimorphism except in cortical area, which on average seems to be larger in females. Additionally, results indicate significant differences in the trabecular parameters of the distal and proximal epiphyses, which are expected to evolve differently given differing loads of mechanical stress generally applied to the opposing ends of the humerus. The findings of this study suggest that appreciable intraspecific variation in bone microstructure exists in *S. v. fuscoater*. If this extrapolates to other species, this might have consequences for the interpretation of microstructure in fossils.

SCLEROCHRONOLOGY OF HERMATYPIC SCLERACTINIAN CORALS FROM THE MESOAMERICAN BARRIER REEF SYSTEM IN BELIZE, CENTRAL AMERICA

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Sclerochronologic methods are used to shed light on the skeletal growth of reef-forming (hermatypic) corals. Within the extinct Paleozoic corals, limitations are given by uncertainties in the time-related skeletal formation of their internal (tabulae) and external (epitheca) banding types, which are accompanied by further constrains of their phylogenetic and paleoecologic relationships with scleractinian corals. Therefore, a main advantage of living scleractinian corals is the development of taxon-specific age models for their formation of skeletons. Based on this, our research focusses on actualistic approaches on modern-day hermatypic corals to evaluate their skeletal formation. Analysed skeletal growth patterns include (1) annual extension rates [cm/yr] by investigating X-ray images, (2) measurements of skeletal density [g/cm^3] using the analytical approach of gamma(g)-densitometry, and, based on those (3) reconstructed calcification rates [g/cm^2*yr]. For quantifying skeletal density, we perform a grid scanning of the sample with a well-defined, mostly monochromatic gamma ray beam emitted by radioactive decay of a source of ^{241}Am-isotopes and measured by a single photon counting detector. With this approach, we obtain a particularly high control on statistical and systematical uncertainties. A spatial resolution of 0.5x0.5 mm per grid point, offers high-resolution density measurements by selecting isolated grid rows perpendicular to the growth direction. This approach enables the intraannual examination of high- and low-density bandings (HDBs/LDBs). Drill cores of the massive scleractinian coral *Orbicella faveolata* (formerly known as *Montastraea faveolata*) are herein used, representing a widespread hermatypic coral from the Mesoamerican Barrier Reef System (MBRS) in Belize, Central America. Time series analysis of a colony spanning >186 years of skeletal growth, showed long-term periodicities with cycle lengths corresponding to the Atlantic Multidecadal Oscillation (AMO). Overall, our data suggests a complex interplay of coral growth and environmental settings, which underlines the necessity of greater datasets to evaluate coral growth within wider reef areas.