Paleo & Life

Abstracts of the 90th Annual Meeting of the Paläontologische Gesellschaft, Munich 2019

(Paleontological Society)

15 –18 September 2019

Paleo & Life

Munich PalGes 2019

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- Paläontologische Gesellschaft

ISBN 978-3-946705-07-9
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der
Deutschen Nationalbibliografie. Detaillierte bibliografische Angaben sind im Internet über
https://www.dnb.de/EN/nationalbibliografie abrufbar.

https://bspg.palmuc.org/

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ISBN 978-3-946705-07-9

Welcome to Paleo & Life 2019

Dear participants of the 2019 meeting of the Paläontologische Gesellschaft,

We are very pleased to see the lively interest in the 2019 annual meeting of the Paläontologische Gesellschaft in Munich and the many excellent contributions that have been submitted. The Paläontologische Gesellschaft, founded in 1912, is one of the oldest and largest paleontological associations worldwide. Paleontology communities are small in all countries, and hence international cooperation is mandatory to promote our field. Since its inception the Paläontologische Gesellschaft has therefore identified itself as an association with international orientation. The 2019 meeting of the Paläontologische Gesellschaft is in line with this ambition, having attracted colleagues from 15 different countries.

We are also delighted with the diversity of this meeting, not only with regard to the number of nations represented, but also because of a good gender balance and a large number of student attendees. One of the core functions of scientific meetings and conferences is to provide students and early-career researchers with a discussion forum for their scientific work, and allow them to network among peers – still essential in our increasingly digitized world.

Paleontology and neontology (biology) are highly interconnected in their desire to decipher the evolution of life on our planet, and we therefore decided to use Paleo & Life as the conference motto.

Munich has always figured prominently in German paleontology, and this year's gathering is in fact already the fifth annual meeting of the Paläontologische Gesellschaft in this city. We thank the numerous colleagues who have contributed to make this endeavor a success, in particular our staff and students, as well as our sponsors. We sincerely hope that you will enjoy the meeting and your visit to Bavaria's beautiful capital.

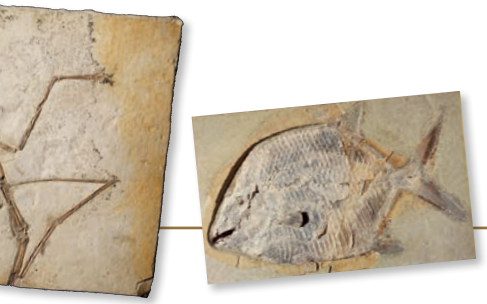
Sincerely,

Alexander Nützel

Bettina Reichenbacher

Michael Krings

Gert Wörheide



Abstracts

Abstracts of the 90th Annual Meeting of the Paläontologische Gesellschaft, Munich 2019

Compiled and edited by: Alexander Nützel, Bettina Reichenbacher & Michael Krings
Set and Layout: Martine Focke

Authors are solely responsible for the contents of their Abstract(s)

ID: 123

Evolution of the temporal region in the early amniote skull

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Evolving ecosystems, poster presentation

Amniota, the clade of tetrapods comprising reptiles, birds, and mammals with their closest relatives, first appeared during the Carboniferous, likely descending from reptiliomorph "amphibians". Even though a divergence of early amniotes in the two main lineages Synapsida (mammals and their ancestors) and Reptilia (reptiles and birds) is well-settled, there are still controversies regarding their early phylogeny. Traditionally, amniotes have been classified by the bone configuration of their temporal skull region, with a clade identified by one pair of temporal openings (Synapsida), a clade with two pairs of temporal openings (Diapsida), as well as amniotes lacking any temporal opening (Anapsida). While synapsids and diapsids are still considered to represent natural groups, anapsids are likely para- or even polyphyletic, with turtles as the only extant anapsid reptiles nested deeply within Diapsida in many recent analyses. It is due to these controversies, the unresolved phylogenetic position of several key taxa as well as the apparent high plasticity of the temporal region, that a reconstruction of the ancestral amniote skull has remained difficult. To add to the solution of these problems, we want to trace and reconstruct the macroevolution of the temporal region in the early amniote skull by using a large dataset comprising taxa near the origin of Amniota. Furthermore, we want to view these macroevolutionary changes within a paleobiogeographic and paleoecological context and analyze the influence of different ontogenetic strategies on the configuration of the temporal region. Our preliminary results highlight the problematic taxa in the dataset making a clear ancestral reconstruction difficult. These include early synapsids and parareptiles, which need a more detailed anatomical observation in the future.

ID: 168

GEOTRAC – INTERREG V-A Italy-Austria, 2014-2020 Project for The Transboundary Geopark of The Carnic Alps

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Open session, poster presentation

The project aims to create a partnership and the basis for a cross-border geopark in the Carnic Alps through the connection between the existing "Geopark Karnische Alpen" in Austria and the Italian side of the Carnic Alps, part of the "Geoparco della Carnia". The purpose is to highlight the geological heritage and elaborate strategies for sustainable development of the involved area in order to reinforce the awareness about the value of natural heritage, to promote the balance between growth and protection of the environment as well as scientific culture, and to increase the touristic attractiveness of the involved regions. For this purpose, the project entails the following actions: i) creation of a cross-border working group; ii) scientific research regarding the whole area involved in the project; the results will be used for travelling exhibitions as well as for scientific and educational publications; iii) creation of info-points, use of multimedia technologies; iv) creation or renewal of (cross-border) geologic itineraries; v) creation of educational paths and of a "guide for guides" in order to provide proper training of professional figures; vi) preparation of a program of educational activities and events in order to promote the geological knowledge and increase visits to the geopark; vii) drafting and managing of a communication and marketing plan for the promotion of the cross-border geopark; viii) production of publications and videos (documentaries); ix) creation of a GIS system supporting the territorial management of the geopark; x) study of organization models for the consolidation of the geopark.

ID: 234

What, if anything, is a placoderm? New discoveries and insights from the gnathostome stem group

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Plenary presentation

The extant gnathostome clades, Chondrichthyes (cartilaginous fishes) and Osteichthyes (bony fishes and tetrapods), have substantially contrasting morphological and histological character sets. It is impossible to polarize most of these character differences by outgroup comparison with cyclostoms (hagfishes and lampreys), so evidence from fossils becomes central to understanding the origin of jawed vertebrates and the chondrichthyan-osteichthyan divergence. Here I review how new fossil discoveries, and the application of phase contrast sychrotron microtomography (PPC-SRμCT) to fossil imaging at morphological and histological scales, are overturning established perceptions of the early fossil record of vertebrates. I will focus on the significance of the 'placoderms', jawed armoured fishes of the Silurian and Devonian periods. Traditionally these have been regarded as a clade, the sister group to osteichthyans + chondrichthyans. Like the osteichthyans they have a dermal skeleton consisting of large bony plates, but this similarity has been dismissed as the product of parallel evolution. Placoderms have also been held to lack true teeth. Consonant with these interpretations, the distinctive features of osteichthyans (including tooth-bearing marginal dermal jawbones) have been regarded as specialized relative to conditions in chondrichthyans. All of these positions are now being overturned: placoderms appear to be a 'grade taxon' paraphyletic to osteichthyans + chondrichthyans, their osteichthyan-like features are homologues not parallellisms, and the most phylogenetically basal forms show marginal tooth-bearing jawbones. Osteichthyans retain more of the primitive gnathostome character complement than chondrichthyans. The early evolution of jawed vertebrates is best understood as a "placoderm-osteichthyan continuum" of gradual change, with chondrichthyans representing a highly divergent branch.

ID: 110

When Bavaria was the Ancient Caribbean – Plattenkalk Fossil Treasures from Painten

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Evolving ecosystems, poster presentation

Fossils from around the Altmühl Valley in the Southern Franconian Jura are well-known for providing a detailed insight into the Late Jurassic ecosystem of the Northern Peri-Tethys reef platform. What collectors and scientists know as the "Solnhofen plattenkalk" in fact comprises numerous scattered localities. The Eastern Altmühl area has long been underestimated, now regarded with a new exhibition at the Dinosaur Museum in Denkendorf in the centre of Bavaria. Twenty years of scientific excavation – the most extensive ever carried out in Bavaria – revealed the outstanding fossils treasure from Painten. These are not only well preserved and nicely contrasted, but frequently represent important discoveries , such as the furry theropod *Sciurumimus*, or an unnamed transitional pterosaur that was preliminarily published. Newly discovered highlights include articulated sea urchins, a rich diversity of actinopterygian fish, a surprisingly high number of coelacanths, a large turtle with hook-shaped mandible, and new ichthyosaurs. A complete skeleton of the marine crocodile *Dakosaurus* measures 5.5 metres in length, representing the largest plattenkalk fossil ever discovered. A putative neonate of this genus measures 23 centimetres and yields the first evidence for live birth in archosaurs.

ID: 226

First record of a fossil predatory Haplochromini (Cichlidae) from the upper Miocene of Kenya

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Among the African cichlids (Pseudocrenilabrinae), the Lake Tanganyika Radiation is the most specious clade. Within this clade, the tribe Haplochromini comprises the greatest species diversity, but there is only limited knowledge on its evolutionary history. Two hypotheses about the divergence age of the Haplochromini have been raised: One favors the origination within Lake Tanganyika, presumably about 5–6 MYA ago. The other one postulates that Haplochromini lived prior to the formation of Lake Tanganyika and that their divergence age could have taken place about 23 MYA ago. Here we present a new very well-preserved fossil cichlid from the upper Miocene site Waril (9-10 MYA) in Central Kenya. A phylogenetic analysis based on integration of the data into a previously published character matrix confirms it belongs to the subfamily Pseudocrenilabrinae. Comparative morphology supported by Micro-CT imaging data reveals that the fossil is provided with a unique combination of characters concerning the dentition, the cranial bones, the caudal skeleton and meristic characters. Accordingly, it represents a new genus and new species. The scale morphology of the new taxon and a statistical analysis based on meristic data indicates that it is a member of the Haplochromini. Due to its fang-like dentition and non-fusiform body, the new fossil species might have possessed a sit-and-wait hunting strategy, which is a rare among the Pseudocrenilabrinae, and has not yet been proposed for a fossil cichlid. Moreover, its occurrence in a 9-10 million years old palaeolake in the Central Kenya Rift indicates that Haplochromini were widely distributed already in the late Miocene and does not support the theory of their divergence only 5-6 MYA ago.

Young Scientist Award

ID: 154

Quo vadis *Conocardium* ? – the archetype of Rostroconchia lost in the systematic jungle

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Open session, oral presentation

Our ongoing revision of the Rostroconchia, a group of pseudo-bivalved molluscs with a univalved protoconch, started in the late 1980s. After the erection of the class in 1972 some basic studies and analyses have successfully established the class, although biological systematics mostly still ignore the taxon. Many palaeobiological details have been discovered, and after the first attempt of a classification published by Pojeta & Runnegar in 1976, we presented a revised systematic arrangement of families and subfamilies in the 2000s. This was based on the assumed division of the class into the three orders Ribeirioida, Ischyrinioida and Conocardiida, the latter being the most diverse, advanced group in the middle and late Palaeozoic. Contrary to earlier views, the core group of the Conocardiida is the superfamily Hippocardioidea, whereas the "typical" representatives of the rostroconchs, the Conocardioidea, include the most advanced, "modern" taxa. Based on several analyses, we accepted and supported the "traditional" separation of the two superfamilies based on the presence or absence of the characteristic hood, a shell structure surrounding the posterior face of the conch. Following our study of the Hippocardioidea, we relaunched morphological studies on the type species of the genus *Conocardium*, the archetype of the Conocardioidea, *Conocardium aliforme* J. de C. Sowerby in order to revise and fix the definition of the genus, the family and the superfamily. Since the 1850s, hundreds of specimens were determined as *Conocardium aliforme*, comprising a wide range of phenotypes and, thus, suggesting a wide intraspecific variability. Unfortunately, our studies revealed that syntypes of *C. aliforme* also show indications for the presence of a – probably narrow – hood. If this feature is confirmed in further specimens close to the types, the distinguishing apomorphic, "modern" character for the taxon is obsolete and the whole group requires systematic re-arrangement.

ID: 176

Adding to the understanding of the so-called pholidophoriform fishes: News from the Jurassic of Nusplingen, Germany

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Since 1940 when Berg created the order Pholidophoriformes to include a few teleostean families, the group underwent significant enlargement due to it becoming a "waste basket" of superficially similar teleosteomorphs, e.g., their relatively small to moderate size, ganoid-type scales, and a few other primitive features. Consequently, Pholidophoriformes became a non-monophyletic group, and to note this condition, it is referred to as "Pholidophoriformes". Although considerable progress has been made for Triassic Euro-Asiatic pholidophorids (now with at least nine genera), the Jurassic "pholidophoriforms" are in need of major revision to clarify their taxonomic assignment and phylogenetic position. Among these are all species previously assigned to "*Pholidophorus*", which may be important in understanding the early evolutionary history of the total group Teleostei.

The extraordinarily well-preserved fishes of Nusplingen, Baden-Württemberg (Upper Jurassic) include *Eurycormus* — with amioid-type scales — and a variety of "pholidophoriforms" with ganoid-type scales that form two groups based on jaw configurations. One pattern corresponds to that of *Siemensichthys* (first described from the Jurassic of the Solnhofen limestones as *Pholidophorus*) with an elongate jaw and low coronoid process or no process, whereas the second pattern has a short jaw with a high coronoid process, plus a suite of characters from other cranial and postcranial elements that identify the group as new Jurassic taxa. Given their extraordinary preservation, new information on the structure of the braincase, vertebrae column and associated elements, and especially of the caudal endoskeleton including details on uroneurals and hypurals is available for the first time for Late Jurassic "pholidophoriforms".

ID: 177

Fishes in a temporal dimension: Origins, radiations, and extinctions

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Plenary presentation

Today, aquatic ecosystems worldwide are dominated by osteichthyans, which are characterized by a bony endoskeleton. Bony fishes comprise the largest clade of vertebrates, which includes the lobe-finned fish lineages: both the piscine and tetrapod (amphibians, reptiles, birds, and mammals) sarcopterygians. The main piscine osteichthyan lineages include actinopterygians (ray-finned fishes) and two sarcopterygians: actinistians (coelacanthiforms) and dipnoans (lungfishes). Piscine sarcopterygians were well-diversified in the past, between the Upper Silurian and end-Permian, but actinistians have only one living genus with two species and dipnoans just six living species among three families. In contrast to actinistians and dipnoans, actinopterygians had a very modest beginning in the Silurian (about 420 Ma) followed by important appearances and diversifications in the Paleozoic (e.g., palaeoniscimorphs, tarrasiiforms, guildayichthyiforms) and Mesozoic (e.g., chondrosteans, subholosteans, and neopterygians); though many forms are long extinct, teleosts are by far the most diverse living vertebrates. With a modest beginning in the Early-Middle Triassic, teleosts greatly diversified over the past 200 million years, and today teleosts dominate all aquatic environments across the globe with more than 30,000 species. During their long evolutionary history, osteichthyans have experienced several extinctions events, particularly at the K-Pg boundary, from which they recovered in various ways that will be discussed for some of the major taxa, including a comparison of morphological evolutionary rates. While sarcopterygians and primitive actinopterygians had their higher acquisition of synapomorphies in the Paleozoic, teleosts are unique in having at least two important moments, one during the Jurassic and another after the K-Pg boundary.

ID: 240

Cuticular analysis of a diverse Upper Permian Flora from Shanxi, China

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

The Cathaysia Flora is one of the four major late Palaeozoic floral provinces and includes plant fossil assemblages from present-day China and East Asia. Major constituents of the Cathaysia Flora are Noeggerathialeans, Gigantopterids, *Pteridosperms* and *Cycads*. However, the taxonomy of most assemblages is based on macromorphological critera, yielding limited information about natural affinities – especially if only single leaves or leaf-fragments are preserved. Cuticular analysis is a very helpful tool to identify and classify fossil plants based on unique epidermal characteristics. Furthermore, the epidermal anatomy allows a correlation of dispersed organs to reconstruct whole plants, and eventually provides important information on palaeoecology and palaeoclimate.

The Upper Shihhotse Formation (Guadalupian-Wuchiapingian) of the Palougou section in Shanxi (North China) was previously thought to contain few plant fossils. Our newly discovered assemblages reveal well-preserved and highly diverse floras with cuticular preservation of Noeggerathialeans, *Cycads*, *Pteridosperms* and conifers. Moreover, bulk samples include well-preserved arthropod cuticles.

Our results not only reveal a highly diverse flora, but also allow palaeoecologic and palaeoclimatic interpretations. *Cycads*, *Pteridosperms* and conifers have hypostomatic leaves, thick cuticles with papillae and sunken stomata that are protected by overarching papillae – xeromorphic features which are indicative for a seasonal or dry climate. By contrast, the co-occurring Noeggerathialeans have thin cuticles with well-exposed stomata – features indicative for a humid climate. Throughout the Upper Shihhotse Formation the climate became increasingly seasonal in Shanxi and it is unlikely that Noeggerathialeans – coal-forming plants in the Lower Shihhotse Formation – could grow in drier habitats. Consequently, Noeggerathialeans represent parautochthonous fossils in the assemblage which lived in the floodplains with permanent water supply, whereas *Cycads*, conifers and *Pteridosperms* were transported from hinterland areas where water supply was limited.

ID: 104

Brachiopod Shell Thickness links Environment and Evolution

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Physiology in Deep Time, oral presentation

Shells are fundamental elements of many metazoan body plans and provide protection and structural support for soft parts. But secreting a shell comes at a metabolic cost and shell thickness should always balance the needs for protection and structural support against the available metabolic budget. Within ecologically similar groups, variation in shell thickness should thus reflect on the fluctuation of environmental conditions. Here I present shell thickness data for 123 specimens of 57 Ordovician/Silurian and 9 Cenozoic genera and interpret them in the context of the Great Ordovician Biodiversification Event and the Late Ordovician Mass Extinction. As brachiopods have pronounced differences along the posterior margin due to shell articulation and lophophore support, shell thickness was measured as the area of the anterior half of the shell in a longitudinal cross section. The anterior half of the shell is considered as functionally homologous across brachiopods as it covers the filtration chamber. The results show a prominent difference in shell thickness at order level, with groups that dominated the Great Ordovician Biodiversification Event (particularly orthids and strophomenids) having significantly thicker shells than groups that co-existed in the Ordovician but only diversified in the Silurian (rhynchonellids and pentamerids). The data also show a trend of increasing shell thickness with water depth, which could be linked to slower growth rates in deeper waters. Shell thickness prominently decreases across the second phase of the Late Ordovician mass extinction and gradually recovers throughout the Early Silurian. Overall, the observed patterns in brachiopod shell thickness across the Ordovician and Silurian suggest an increasing importance of metabolically efficient shell secretion.

ID: 200

Fly palaeo-evo-devo: reconstructing ontogeny and growth of fossil window gnats (Diptera: Anisopodidae)

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Open session, oral presentation

Fossil immature stages of the holometabolous insects are often seen as obsolete paleontological record. This is caused by the implicit bias of contemporary paleoentomology towards alpha-diversity and new taxa description, most often done in insects based on the adult males. The larvae of flies (Diptera) are immensely important in performing quite a number of key ecosystem functions, ranging from carbon sequestering to stabilization of the lake bottom sediments and reducing water turbidity. Still, these larvae appear especially neglected. That leads to the misguided belief that fossil immatures of Diptera are rare in the fossil records. Despite that, our targeted search for dipteran larvae and pupae in several amber collections has yielded hundreds of specimens of larvae and pupae from various ingroups of Diptera.

Here we report first results of the examination of more than 50 larvae and 15 pupae of window gnats (*Mycetobia* sp, Anisopodidae, Diptera) from Baltic amber. We have strived to identify the number of larval stages and the growth rates of fossil window gnats. To do so we applied Dyar's rule to the dataset with morphometrics of the head capsules of the larvae. Dyar's rule is a description of growth Euarthropoda, when body length increases between the larval molt. It is characterised by a permanent factor (i.e. x3 increase after each molt). Applying Dyar's rule and calculating growth factor for the head capsule of larvae is within the range of 0.58-0.67. We also have identified that, like extant representatives of the Anisopodidae, fossil larvae of *Mycetobia* developed through four instars. This study shows, how attention to fossil immatures of insects can reveal exquisite details about lifestyle and ontogeny of animals from the deep time.

Young Scientist Award

ID: 106

Lower Oligocene fishes from the Dynów Marls (Paratethys, Poland) and their paleobiogeographic implications

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Reconstruction of fossil fish faunas can provide important information on palaeoenvironments and palaeogeography. The Dynów Marl Member of the Menilite Formation in Poland is one of the most significant lithostratigraphic units containing fauna of the Early Paratethys. The fish fauna from this member from the Early Oligocene of the Central Paratethys is presented and includes 3 elasmobranchs genera and 7 teleost genera.

The connection between Upper Rhine Graben and Central Paratethys during the calcareous nannoplankton zone NP23 (about 30-32 Ma ago) is consistent with the occurrence of the teleost *Anenchelum* and the shark *Keasius parvus*. The presence of the teleosts *Scopeloides glarisianus*, *Eovinciguerria obscura*, *Oligophus moravicus* confirms the connections between Eastern and Central Paratethys. This confirms the existence of a marine connection between Upper Rhine Graben, Central and Eastern Paratethys during the Early Oligocene. The fish assemblage contains high percentage of deep water fishes, living in the depth interval between 0 and 500 m. The presence of Gonostomatidae, Phosichthyidae and Myctophidae supports normal salinity in deep pelagic life zones. Based on the occurrence of *Eovinciguerria obscura, Oligophus moravicus* and *Scopeloides glarisianus*, the ichthyofauna supports correlation of the upper Pshekian stage of the Eastern Paratethys with the Dynów Marl Mbr of the Central Paratethys. The fish fauna shows distinctly Paratethyan affinities.

ID: 202

Reconstructing late Permian *Dicroidium* plants from the Dead Sea Region, Jordan

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

The Late Permian Umm Irna Formation occurs in a series of natural rock exposures along the shore of the Dead Sea, Jordan. In the past, this formation has yielded spectacularly well-preserved plant compression fossils of the otherwise typical Triassic seed fern *Dicroidium*. The depositional environment is characterized by a highly structured riverscape influenced by monsoonal climate and rapid lateral and vertical facies changes.

Four *Dicroidium* species and associated fertile structures are now known from the Umm Irna Formation. *Dicroidium irnense, D. jordanense* and *D. robustum*, which were previously only known from their type locality in Wadi Himara, have now been collected from several sites, some yielding complete, bifurcate fronds with pristinely preserved cuticles. Additionally, two new species of the pollen organ *Pteruchus* and one new species of the cupulate structure *Umkomasia* have been collected.

By means of cuticular analysis, the largest foliage species *Dicroidium robustum* can be correlated with both a pollen-organ species and a species of cupulate structure. The second species of pollen organ can be associated with fronds of *Dicroidium irnense* based on consistent co-occurrence. All known *Dicroidium* plants from Jordan are characterized by comparatively large fronds, and both known species of *Pteruchus* are characterized by strongly elongate, strap-shaped microsporophylls. This pattern of association is similar to those Umkomasiaceae of the Triassic growing under comparable seasonally dry conditions.

Dicroidium first appeared during the late Permian in the palaeotropical regions and survived the end-Permian biotic crisis, colonized large parts of Gondwana during the Triassic, and persisted in southern high-latitude refugia into the Jurassic–a pattern that has been reported from several seed plant groups by now. Likewise, the fossil record of the Umkomasiaceae provides further support for the hypothesis that plants in general were seemingly less affected by biotic crisis than coeval fauna.

ID: 205

Impact of Emsian/Eifelian (Devonian) global events on faunas and biofacies in the Moroccan Meseta

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Evolving ecosystems, oral presentation

The Devonian is famous for its 1st order mass extinctions at the Famennian base and top but a complex sequence of 2nd to 4th order global events occurred throughout this global greenhouse period. Similarities of smaller scale events and the main crises demand a holistic approach towards an advanced understanding of palaeoceanography, extinction, and re-radiation patterns. Most events reflect recurrent episodes of climatic heating, rapid eustatic fluctuations and eutrophication pulses causing the spread of hypoxia. Emsian/Eifelian events are well-known from Europe, especially Bohemia, and from the stable Gondwana craton (southern Morocco). The intermediate, poorly studied Moroccan Meseta represents a complex mosaic of blocks with individual biofacies developments and synsedimentary tectonics. The latter strongly overprinted global event signatures but enables to study event patterns in adjacent different facies and Eovariscan settings.

The basal Upper Emsian Daleje Event caused in the Oued Cherrat, Rabat-Tiflet Zone and Benahmed regions the gradual drowning and extinction of an extensive reefal carbonate platform, followed by the spread of hypoxic goniatite shales. In the Skoura region south of the High Atlas, Daleje Shale equivalents are especially thick and replace a nodular pelagic carbonate platform with a top-Lower Emsian *Mimagoniatites* marker limestone. The transgressive basal Eifelian Chotec Event is less distinctive in most regions but prevailing highstand condition on all blocks prevented the growth of new biostromes. A new major reworking event is recognized in the Skoura Middle Devonian. The top-Eifelian Kacak Events is well-developed as a sharp facies break, with conodont extinctions and black shale intercalation in the Oued Tiflet succession. One of the best outcrops on a global scale, with a thick interval of alternating black shales and turbiditic dacryoconarid coquinas above oxygenated cephalopod limestones, lies in the Tinejdad region at Oued Ferkla, in a Devonian block at the Southern Variscan Front.

ID: 132

Maximum resilience after the P/T event - the ammonoid diversity peak of the Anisian

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Evolving ecosystems, oral presentation

Life was drastically decimated during the Permian/Triassic extinction event. Particularly ammonoid diversity has been affected by the fundamental shift from Palaeozoic to Mesozoic faunas. Ammonoids are known to be a powerful tool for biostratigraphy and allow to rate the timing of diversity fluctuations. The high diversity of the early Mesozoic ammonoid fauna was preceded by a first prominent — but very brief — diversity peak of Ceratitida in the earliest Triassic, which was abruptly terminated by the end-Smithian event. Thereafter, ceratitid diversity swung onto a peak again in the Middle Triassic, but this time diversity remained on a generally high level until the end of the Triassic.

Generally, environmental change is regarded as one of the key driving factors for evolutionary change. In our study, we mainly focus on the Anisian stage in Nevada, USA, which was mainly deposited under "quiet" environmental conditions. The minor ecosystem perturbation during the Anisian is contradictory to its particularly high diversity. It is open to debate what caused this contradiction.

For this reason, our study examines the interrelation of Middle Triassic ammonoid biodiversity and environmental change with the focus on the famous Anisian faunas of Nevada, USA. One of the main challenges is the high intraspecific variability of the species in focus. In order to discriminate species, we analysed ontogenetic pathways using high precision cross sectioning. Thereby, we pursue the goal of gaining a better understanding of the species concept and diversity of ammonoids in the aftermath and the prelude of two of the most severe mass extinction in Earth history.

Young Scientist Award

ID: 161

Late Kimmeridgian fossil plants from the Lagerstätte Brunn in the Lower Solnhofen Archipelago (Bavaria, Germany)

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

The Upper Jurassic "Plattenkalk" is widely known as a source of well-preserved vertebrate fossils. Plattenkalk fossils are often misleadingly referred to the locality name "Solnhofen". However, the Plattenkalk facies comprises a geological time slice ranging from the Late Kimmeridgian to Early Tithonian, with several subfacies that are exposed in different basins of the former archipelago. The subfacies are distinguished primarily based on the fossil content. The Lagerstätte Brunn in the Southern Franconian Alb (Bavaria, Germany) is a rhythmic Plattenkalk assigned to the subeumela-Subzone of the U. Kimmeridgian, and represents the oldest segment of the Plattenkalk series. Brunn has yielded the richest flora of all Plattenkalk localities, due possibly to its location at the margin of the basin. Brunn belongs to the most productive sites for Late Kimmeridgian plant fossils in Eurasia. Plants represent approximately 30% of the fossils. The flora from Brunn currently comprises more than 1,000 specimens. Especially abundant are the Bennettitales (*Z. feneonis*, *F. pumilio*, *Z. moreaui*, *Ptilophyllum*, *Williamsonia*, 2 species *Weltrichia* and *Cycadolepis*) and Cycadales (*Pseudoctenis*, *Ctenis*, *Sphenozamites*, 2 species Cycadites, Cycadales cone and isolated Cycadales megasporophyll). Conifers with branch and female cones (e.g. *Araucarites*, *Athrotaxites*, *Frenelopsis*, *Palaeocyparis*, *Brachyphyllum*, *Hirmeriella*, *Pagiophyllum*, *Pseudotorellia*, *Podozamites*), ferns (*Sphenopteris*), and seed ferns (*Cycadopteris*, *Peltaspermum*) also occur regularly. We anticipate that our thorough documentation of the Brunn flora will not only be useful for a better understanding of the evolutionary history of the vegetation in this area during the Jurassic, but also for the precise reconstruction of the Plattenkalk paleoecosystems with their numerous famous inhabitants.

ID: 235

Life at Low Oxygen

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Evolving ecosystems, oral presentation, plenary presentation

Oxygen is abundant in the present atmosphere and oceans, fueling aerobic organisms that largely define the macroscopic life of the Earth. However, different organisms have different oxygen requirements, and these differing requirements may have influenced the history of life through the evolution of oxygen availability on the Earth. In this talk I will outline key aspects of the history of oxygen availability on Earth. From here, I will explore the oxygen requirements of various groups of organisms ranging from prokaryotes through algae and animals and discuss how the interface between these requirements and oxygen availability may have influenced the history of life.

ID: 128

A tubeshoulder (Platytroctidae) from the early Oligocene of Czech Republic, and the fossil record of the Alepocephaliformes

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

The Alepocephaliformes is a small group of meso- and bathy-pelagic fishes that comprises less than 140 species arranged in three families, Alepocephalidae, Bathylaconidae and Platytroctidae. Although earlier hypotheses associated alepocephaliforms with clupeiforms, in the last decades these fishes have been included within the Euteleostei, and considered as closely related to the argentinoids. However, molecular data concur to indicate that alepocephaliforms must be included within the Otomorpha, representing the sister-group of the Ostariophysi. The sister-group relationships with the ostariophysans whose fossil record dates back to the Late Jurassic, necessarily implies that the earliest members of the alepocephaliform lineage were in existence at the end of the Jurassic. However, the fossil record of the alepocephaliforms is remarkably poor, solely represented by the alepocephalid *Carpathichthys polonicus* from the Oligocene deposits of the Polish Carpathians and a few alepocephalids otoliths from the Cenozoic of Europe. Therefore, there is no verifiable record so far known for the alepocephaliform families Bathylaconidae and Platytroctidae.

We report a well-preserved articulated skeleton belonging to the family Platytroctidae from the Lower Oligocene (NP23, Rupelian) Dynów Marlstones exposed in the vicinity of Kelč, Moravia, Czech Republic. Fishes of the family Platytroctidae, also known as tubeshoulders, are characterized by a unique synapomorphy, the so-called shoulder organ, which can secrete and discharge a bioluminescent substance, presumably for deterring predators. Although the shoulder organ is not directly preserved, its original presence is indicated by the "accessory bone" that supports the tubulus of the organ located posteriorly to the pectoral girdle. The fossil documented herein shares some characters with the extant genus *Holtbyrnia* and is unique within the platytroctids. The fossil fishes associated to the new tubeshoulder documented herein seem to indicate a mesopelagic environment.

ID: 109

A historical freshwater fish collection from the Neogene of the Peruvian Amazon

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Between 1912 and 1913, the two Swiss scientists of the University of Zurich Drs. Hans Bluntschli (1877–†1962) and Bernhard Peyer (1885–†1963), left for a scientific expedition to the Pampas region in Argentina, and the Amazon of Brazil and Peru, with the aim of collecting animals, plants and fossils, with focus on mammals, especially primates. During the expedition, important discoveries and a substantial amount of zoological, botanical, geological, palaeontological and anthropological specimens were collected. Most of the collections from the expedition in the Pampas and Amazonian regions were distributed among various institutions and museums in Europe, including Berlin, Frankfurt, Vienna, and Zurich. Here we study part of the classical, over a century old, Bluntschli/Peyer paleontological collection housed at PIMUZ (Zurich), which consists of a freshwater fish fauna from Neogene sediments in Iquitos, Peru. The fossil assemblage consists of several micro- and macrofossils, i.e., isolated elements (jaws, teeth, vertebrae, pectoral spines, dorsal spines, scales and squamules, among others) of at least 19 families of fishes, including stingrays (Myliobatiformes) and bony fishes (Characiformes, Cichliformes, Osteoglossiformes, Siluriformes, and Perciformes). Other fossil vertebrate remains associated to the fish fauna from Iquitos include caimanine and gavialid crocodylians, turtles, snakes, and coprolites. Peyer, who became later the first ordinarius of Palaeontology and Comparative Anatomy at the University of Zurich and director of the PIMUZ, collected the fossil specimens and provided a small geological profile in written form, but lacking the larger stratigraphic context. Using the locality of origin in Iquitos, as well as the historic information published about the expedition, we infer that the fossil assemblage belongs to the Miocene Pebas Formation. The fish fauna reported herein from the Peruvian Amazonia offers new insights on the origin and diversity of the scarcely known freshwater fish fauna in the western Amazonia "megawetland" system during Miocene time.

ID: 108

Neotropical freshwater fish fauna in "deep time": a perspective from the Caribbean basins of Colombia and Venezuela

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Shared species diversity between fish species inhabiting the cis-Andean (Eastern-slope) and trans-Andean (North and West of the Andes) rivers, is the result of different geological events and paleohydrographic connections that occurred in the region during the Miocene. The early-late Miocene fish record with Orinoquian-Amazonian affinities that have been reported for the region has sustained this. By late Miocene, major changes in large hydrographic systems in northern South America (linked with the northern Andes uplift) triggered loss of habitats, extinctions and faunal turnover, shaping the biogeography of modern, regional freshwater fish biodiversity. Fishes, due to their habitat specificity and physiological requirements, can be used as indicators for past environmental, ecological and biogeographic inferences. In this sense, northern South America hosts excellent Neogene freshwater sequences in Brazil, Colombia Peru and Venezuela necessary to address the issues above. Here we offer new data and analyses of the freshwater fish fauna diversity and its turnover in the most northern peripheral drainages before and after their isolation with the Orinoco/Amazonas basins. This is based on new Miocene and Pliocene findings from the Caribbean basins of Colombia (Upper Magdalena River and the Guajira Peninsula) and Venezuela (Urumaco sequence and eastern Falcón state). The new fossil findings include abundant cranial and postcranial remains of stingrays, dipnoids, bonytongues, catfishes, characins, cichlids, drums, eels, among others, of which some taxa are reported for the first time in the fossil record. We document extinction and extirpation of many taxa, where dipnoids, bonytongues, catfishes where the most affected. Among the new data the oldest record of several taxa that serve for calibrations and document the extreme hydrographic and environmental changes that have taken place in the region in the last 7 ma.

ID: 189

An actualistic case study on the caudal skeleton of three closely related killifish species from the Middle East

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

The genus *Aphanius* (Nardo, 1827) with 44 valid species is characterized by its high level of adaptability to diverse environments and its great speciation potential when populations become reproductively isolated by natural barriers. Such instances of population splitting have been proposed for *Aphanius dispar* (Rüppell, 1828), which is the most abundant species of *Aphanius* in the Middle East. According to the latest molecular phylogenies, *A. dispar* does not represent a single species, but rather a species group comprising six distinct species, which originated from four geographically restricted clades. In this study we focus on three of these species, namely (i) *Aphanius hormuzensis* Teimori, Esmaeili, Hamidan & Reichenbacher, 2018 from the Hormuzgan Basin in southern Iran, (ii) *Aphanius stoliczkanus* (Day, 1872) spread around the Persian Gulf, Gulf of Oman and surrounding inland areas, and (iii) *Aphanius kruppi* Freyhof, Weissenbacher & Geiger, 2017 from springs in northern Oman. Discrimination between the three species is difficult on the basis of morphological and meristic characters, on account of their relatively recent divergence. Nonetheless, the species have been identified based on molecular phylogeny. In the case of *A. hormuzensis* and *A. stoliczkanus*, otolith morphology has also confirmed their separate status. The objective of this study is to investigate the taxonomic value of their caudal skeleton. A total of 108 specimens were identified as *A. hormuzensis*, *A. stoliczkanus* and *A. kruppi* according to their distribution and molecular data. Based on X-raying and staining procedures, the data indicate that *A. hormuzensis* has a higher number of preural vertebrae involved in the support of the caudal fin when compared to *A. stoliczkanus* and *A. kruppi* (5 vs. 3-4). This characteristic suggests differences in the swimming and maneuvering abilities among the species and could provide insights on the evolutionary forces that acted after the initial separation of the species.

ID: 175

Tracing the evolution of the coral skeletome

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Molecular Geobiology and Paleobiology, oral presentation

Scleractinian corals (Cnidaria: Anthozoa) are among the model organisms used in biomineralization studies. As their skeletons play a pivotal role in the formation of coral reefs, several aspects of coral biomineralization have intensively been studied, also to understand how anthropogenic stressors can affect the future ability of corals to calcify. However, how calcification evolved within scleractinians remains largely unanswered. Of particular importance is the marked time difference observed for the divergence times of modern scleractinians – with its two major clades, Complexa and Robusta, splitting ~ 415 Ma ago according to molecular clocks - and the Triassic appearance of "modern" coral skeletons in the fossil record. The proposed Paleozoic origin of scleractinians is supported by the presence of Ordovician (450 Ma) 'scleractinianmorph' fossils. The apparent gap in the fossil record might have been caused by biomineralization being an ephemeral trait in early scleractinians, in conjunction with poor fossil preservation. Phylogenetic analyses retrieved the biomineralization-related protein galaxin distributed polyphyletically across scleractinian families (e.g. Pocilloporidae), suggesting multiple independent recruitments. As estimated divergence times for these taxa are posterior to the Triassic, corals might have acquired at least part of their machinery for calcification after their skeletons appeared in the fossil record. To further test this hypothesis we analysed the distribution and phylogenetic relationships of coral biomineralization-related proteins. We sensibly increased taxon sampling and combined our results with available molecular clock analyses. We show that scleractinian-specific events linked to biomineralization, such as acidification of skeletal proteins and recruitment of some taxonomically restricted genes (TRGs), preceded the Robusta-Complexa split. Such events might have therefore taken place in the scleractinian common ancestor. This suggests that putative Palaeozoic scleractinians may have possessed the same molecular machinery currently employed by modern representatives of the group, opening questions about the reason for the delayed appearance in the fossil record of these organisms.

Young Scientist Award

ID: 139

Quantifying population-specific carbon utilization in serpentinite-hosted microbial communities at the Mid-Atlantic ridge.

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Molecular Geobiology and Paleobiology, oral presentation

Serpentinite-hosted systems have been shown to be modern analogs for early Earth environments where life could have originated and evolved due to the presence of abiotic organic synthesis in the presence of strongly reducing and high pH alkaline fluids emanating from the serpentinization process of ultramafic rocks. One of the key features of these harsh environments is the presence of molecular hydrogen (H_2) due to the serpentinization and its potential as an energy source for H_2-oxidizing microorganisms. Here, we aimed to quantify the effect of H_2 on carbon utilization in specific populations in a serpentinite-hosted system via quantitative DNA stable isotope probing (qSIP) in incubations amended with ^{13}C-labeled bicarbonate, acetate and formate. Serpentinized rock samples were collected from the St. Paul's Archipelago, Mid Atlantic Ridge (Expedition AL 170602), which contained microinclusions exhibiting hydrogen and methane gas indicative of ongoing serpentinzation reactions capable of supporting microbial metabolism. After a 24-hour incubation of rock material with ^{13}C-sources and H2, the qSIP experiment showed that hydrogen stimulated carbon fixation and acetate utilization in many populations, but reduced formate utilization in all populations. Carbon utilization stimulated by hydrogen was found for several groups of uncultured microbes whose physiology remains poorly understood. For example, most populations of Thaumarchaeota exhibited an increased utilization of acetate and bicarbonate in the presence of hydrogen, and the uncultivated '*Candidatus* Atribacteria' showed an H_2-dependent carbon fixation activity. Future plans are to phylogenetically analyze ^{13}C-labeled hydrogenase encoding genes to better understand the ecophysiology and carbon metabolism of hydrogen-oxidizing microorganisms in marine serpentinite-hosted ecosystems.

Young Scientist Award

ID: 117

A new freshwater hybodont from the Upper Jurassic of Thailand

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Phu Noi, in Kalasin Province, northeastern Thailand, is currently the most productive site from the Phu Kradung Formation and has yielded remains of a diverse vertebrate assemblage, including bony fishes, turtles, crocodiles, pterosaurs and dinosaurs. Recently, remains of a hybodont shark including pieces of cartilages (possibly Meckel's cartilage and palatoquadrate) with teeth in connection as well as two patches of skin with preserved dermal denticles have been recovered. The dermal denticles are of the same type as the ones previously recorded from the conglomerate at the base of the fossiliferous series at Phu Noi. They display a quite unusual morphology and similar dermal denticles were so far only recorded in the Bathonian-Callovian Khlong Min Formation in the peninsular part of Thailand, confirming the Upper Jurassic age of Phu Noi. Their association with teeth in Phu Noi allows ascribing these unusual dermal denticles to a "*Hybodus*"-like animal. Although the teeth are superficially similar to those of *Hybodus*, they differ from the latter because the one to three pairs of cusplets are widely separated from the main cusp. Together with the morphology of the dermal denticles, this indicates that this hybodont belongs to a new genus and species. In addition, some of the cartilages recovered appear to display a globular appearance. The analysis of the stable oxygen isotope compositions measured incrementally along the growth axis of a dorsal finspine from the same site and likely belonging to the same taxon, has demonstrated that this animal spent its whole life in a freshwater environment, without any indication that it migrated in brackish or marine environment, strongly suggesting that it was truly restricted to freshwater environment. The Phu Noi fossil represents therefore the very first discovery of Jurassic hybodont remains found in connection in a freshwater environment.

ID: 214

The impact of the Pliensbachian-Toarcian crisis on belemnite distribution

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Physiology in Deep Time, oral presentation

The Pliensbachian-Toarcian transition has been considered a major bottleneck in the early evolution of belemnites probably related to major paleoenvironmental and paleogeographic changes during the Early Toarcian. Most of the previous research has been based on the study of belemnites from higher, temperate latitudes, while high-resolution studies on diversity and size of subtropical belemnite assemblages in the NW Tethys are comparatively rare. The lack of high-resolution (ammonoid subzone) data on diversity and size distributions of belemnite assemblages does not allow separating changes during the Pliensbachian-Toarcian boundary event (Pli-Toa) from those during the Toarcian anoxic event (TOAE).

Rarefied diversity analyses on new collected data from Iberian sections suggest the Pli-Toa corresponds to a slight decrease in diversity which also corresponds with an adult size decrease within particular lineages. Cluster and non-metric multidimensional scaling analyses, however, suggest that largest changes in diversity and paleogeographic distribution of belemnite assemblages occurred during the Toarcian Anoxic Oceanic Event (TOAE) rather than the Pliensbachian-Toarcian boundary. In southern basins like the Lusitanian Basin and Rif Mountains, belemnites even disappear entirely during the TOAE. The lack of widespread anoxia in southern basins of the NW-Tethys indicates that the deoxygenation on its own cannot fully explain this crisis. Direct impact of warming or increased pCO2 triggered by volcanism as well as the more indirect impact on nutrient availability and productivity might have played an important role during both crises.

ID: 222

Divergence time estimates of helminths: host constraints versus parasite fossils

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Molecular Geobiology and Paleobiology, oral presentation

The fossil record of parasitic helminths is often stated to be severely limited. Many studies have therefore used host constraints to calibrate molecular divergence time estimates of helminths. Here we compare molecular divergence time estimates based on host constraints with direct fossil evidence for these parasitic lineages and their closest free-living relatives. Our compilation shows that the fossil record of soft-bodied helminths is patchy, but more diverse than commonly assumed. The fossil record provides evidence that ectoparasitic helminths in various lineages have been around since the early Paleozoic, while endoparasitic helminths arose during, or at least before the late Paleozoic. Lineages parasitizing terrestrial plant and animal hosts have been in existence at least since the Devonian and Triassic, respectively. All major phyla had evolved endoparasitic lineages at least since the Mesozoic. Interestingly, although parasitism is considered derived within Metazoa, the oldest evidence for particular phyla often includes fossils of parasitic representatives. Furthermore, the oldest fossil evidence of parasitic lineages often falls within divergence time based on host co-evolution suggesting the fossil record of helminths themselves might be just as good or at least complementary (and less circular in justification) to calibration based on host associations. Data also provide evidence for obvious host switches or extinctions, which cautions against models of pure co-divergence where use of host calibrations to constrain divergence time estimates may be considered.

ID: 195

Secondary vascular growth in Paleozoic plants: some advances and future directions

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

More than 350 years after the first microscopic observation of fossil wood, the understanding of the processes underlying the evolution of secondary vascular tissues remains one of the major research areas in paleobotany. In this talk we will present recent and ongoing work that adresses two key questions:

(1) How many times did secondary vascular growth evolve? The fossil record indicates that during the Paleozoic secondary vascular tissues were produced in a wide array of plants, including some groups that are extinct or that do not have such secondary growth today. Recent investigations of Devonian-Carboniferous representatives of the Stenokoleales, progymnospems, seed plants, Cladoxylopsidales, and Sphenophyllales are providing new information on their anatomy that will ultimately allow to test the presence of shared mechanisms of secondary growth accross vascular plants.

(2) What were the functional properties of Paleozoic wood? While the wood of extant plants shows a trade-off between hydraulic capacities and mechanical strength, the first woody plants seem to have been more optimized for water transport than for support. By the Early Carboniferous, plants showed a diversity of wood anatomies that likely allowed them to cover a broad range of hydraulic properties. The development of hydraulic modelling at the cell and tissue levels is expected to improve our understanding of how these properties evolved, and of the environmental and functional constraints involved.

ID: 244

Revision of the type material of *Prestosuchus chiniquensis* (Archosauria, Pseudosuchia): implications for pseudosuchian phylogeny and diversity

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Open session, oral presentation

Being one of the first described "rauisuchians", *Prestosuchus chiniquensis* from the Ladinian-Carnian Santa Maria Supersequence of southern Brazil has played an important role in our understanding of basal pseudosuchian evolution, and is currently regarded as one of the best known taxa, as several specimens have been referred to this species. However, the original type material, consisting of cranial fragments and a partial postcranial skeleton has received little attention since its original description. A revision of this material showed that *P. chiniquensis* indeed represents a diagnosable taxon, and we tested the referral of additional material with the help of a specimen-based phylogenetic analysis. The results of our analysis show that *Prestosuchus* represents a distinct clade of basal pseudosuchians, the Prestosuchidae, which also includes the species *Stagonosuchus nyassicus*, *Saurosuchus galilei* and *Luperosuchus fractus*. The analysis consistently grouped the type or *Prestosuchus chiniquensis* with *Stagonosuchus nyassicus* and the specimens referred to *P. chiniquensis*, but without further resolution in this group. We therefore interpret this group to represent the genus *Prestosuchus*, so that *S. nyassicus* becomes *Prestosuchus nyassicus*. However, marked differences between the type of *P. chiniquensis*, *P. nyassicus* and one other referred specimen indicate that the genus includes at least three species. Thus, pseudosuchian diversity in the Santa Maria Supersequence was higher than previously recognized, with the genus *Prestosuchus* representing the top of the food chain. The phylogenetic analysis also showed that numerous distinct lineages of pseudosuchians coexisted in the Middle-Late Triassic, but with marked differences in abundance in different regions of Pangaea. Thus, whereas the Prestosuchidae seem to have been a predominantly southern Gondwanan lineage, poposauroids and rauisuchids were more abundant in the Northern Hemisphere. However, the rare occurrence of both of the latter lineages in South America underlines the wide distribution of distinct lineages over the supercontinent of Pangaea.

ID: 121

Late Paleozoic xeromorphic floral elements as upland, extrabasinal, and/or paleoclimatic indicators

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Plenary presentation

The late Paleozoic paleobotanical debate about upland drought-tolerant (DT) vs. basinal wetland (WL) floras is conceptually flawed. The Late Paleozoic Ice Age (LPIA) was a time of glacial-interglacial fluctuations, linked to sea-level and climatic changes, likely on orbital frequencies. In tropical Pangea (Euramerica, Cathaysia) vegetation tracked these periodic environmental fluctuations, marked by changing spatial distributions of WL and DT biomes. (1) These biomes coexisted during all of the LPIA, with permanent DT populations in Western Pangea and the Variscan Mountains. DT plants migrated into central Pangean "coal basins" during seasonal climate periods, accompanied by WL biome fragmentation; DT plants retreated during wetter periods as the WL biome expanded. (2) The WL biome was much more likely to be preserved then, and discovered today. The "coal age" tropics are misinterpreted as invariably "wet"; they were oscillatory wet-dry. (3) There is a massive taphonomic megabias against the Pennsylvanian DT flora (preservation is unlikely), and an analytic megabias (we are not looking for it, with vast wetland material available). (4) The Euramerican tropics became drier (on average) from Pennsylvanian into Permian, resulting in loss of areally extensive wetlands. (5) Largely fortuitous DT-plant preservation did not change in tempo or mode as wetland deposits declined, but the geologic apparency of the DT biome increases. Both biomes covered vast areas. Their interdigitation diminished through time as drying occurred; the WL biome became restricted to patches in seasonally dry landscapes. Clear understanding of LPIA spatial and temporal dynamics as well as taphonomic filters is crucial to reconstructing the ecological "stage" on which late Paleozoic plant evolution took place, in order to make meaningful contributions to evolutionary biology. Precocious appearances of major new phenotypic innovations appear to be concentrated in seasonally dry habitats, whereas wetlands were "museums" where lineages tended to remain conservative morphologically (low phenotypic innovation).

ID: 167

On mysterious creatures and their enigmatic habitats – exploring carbonate ecosystems with Ediacara-type organisms

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Evolving ecosystems, oral presentation

The Ediacaran Period (ca. 635–541 Ma) is characterized by the first global occurrence of complex soft-bodied macroscopic life forms ("Ediacara-type organisms"). The biological affinity of these organisms is still puzzling, but some forms might represent stem-group metazoans. A comprehensive appraisal of their diversity and ecology is commonly hampered as the fossils are usually preserved as imprints in siliciclastic or volcaniclastic facies, resulting in a significant loss of textural and biogeochemical information. Carbonate records potentially provide a more complete picture of these enigmatic ecosystems, but there are only two known settings known so far: The Shibantan Member (<551 Ma, South China) and the Khatyspyt Formation (c. 544 Ma, Arctic Siberia). In this talk we will explore biological communities and ecological interactions in these two fossil lagerstätten. In both cases, fossils of Ediacara-type organisms occur in bituminous, laminated limestones deposited in subtidal environments close to storm wave base. Detailed examination of these facies reveals an intricate relationship between microbial mat growth and event deposition. Furthermore, fossils of Ediacara-type organisms are typically associated with microbial mats, suggesting a close ecological relationship between these macroscopic creatures and microbes. Biogeochemical data (e.g., trace elements, δ^{13}Ccarb and δ^{13}Corg, sedimentary hydrocarbons) tied to sedimentary observations suggest that organisms inhabiting these environments were confronted with dynamically changing degrees of stratification, salinity and oxygenation. These varying and unstable environmental conditions may provoked evolutionary responses that were critical for the further diversification of complex macroscopic life on Earth. Our ongoing studies are exploiting these archives further to develop a more complete understanding of ecosystems with Ediacara-type organisms.

ID: 126

Community structure and ecosystem collapse across major extinction events

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Physiology in Deep Time, keynote presentation

In order to fully understand ecosystem collapse across mass extinction events, it is essential to consider extinction dynamics within a trophic community framework. As palaeobiologists, we often make the assumption that all taxa that went extinct at times of mass extinction did so in response to severe abiotic stress. However, ecological theory suggests that many victims of past extinction events did not become extinct as a direct effect of abiotic stress, but probably did so in response to cascading secondary effects brought about by the loss of prey resources and changing competition dynamics.

Here, I outline theoretical ideas and methods for reconstructing ecological community networks for ecosystems consisting of long extinct organisms. I then present a case study of using trophic network models to assess the impact of extinction cascades in response to the early Toarcian extinction event. Food webs were reconstructed for pre- and post-extinction ecosystems from the Cleveland Basin of NE England. Secondary extinction cascades were simulated across the extinction event in order to assess ecosystem robustness to informed and random primary extinction events. Model outputs were then compared to empirical post-extinction food webs to determine the likely abiotic driver of ecosystem collapse. Results show benthic organisms with high metabolic demands were selected against which fits well with an anoxia primary kill mechanism.

Young Scientist Award

ID: 228

Paleoenvironments and taphonomy of the fish-rich marls of the Cañadón Calcáreo Formation in Central Patagonia

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

The Cañadón Calcáreo Formation in Central Patagonia bears unique fossiliferous assemblages for the Upper Jurassic of Gondwana, including well preserved remains of plants, arthropods, gastropods, fish, and archosaurs. The characterization of the taphonomy and paleoenvironments of these assemblages is important to understand the evolution of different groups of organisms during the Upper Jurassic. This work focuses on a specific level of finely laminated (1 to 0.03 mm) lacustrine marls containing abundant fish skeletons, conchostracan and ostracod shells, that has long been used as a reference stratigraphic level due to its widespread lateral extension and consistently recognizable nature. Previous studies have only characterized the paleoenvironment of this approximately 6 m thick level along with the much wider (up to 200 m) lacustrine succession present in the unit. We consider the interpretation of both permanent and sporadic lake environments in a rift setting to be valid, especially considering the generalized normal microfaulting and the sporadic presence of apparently primary evaporitic minerals (gypsum, halite) and structures reminiscent of dessication (or shrinkage) cracks. Additionally, studying the unique lamination pattern of the reference level, we propose several shifts in the seasonality of the climate (from markedly seasonal to very variable) which may have caused long-term (at least 6000 years) stress conditions on the fauna, resulting in the low diversity, high abundance associations found for both fish and conchostracans. This would also explain the predominance of stress-related opisthotonous bending of the spine, especially in smaller fish specimens, as well as the consistent presence of said young specimens. Moreover, we identify that the calcareous component that characterizes much of this level is what allows the excellent preservation of these organisms, even yielding the first in-situ find of a large vertebrate (sauropod) in the lower lacustrine succession of the Cañadón Calcáreo Formation.

Young Scientist Award

ID: 146

Enlarging the Phylogeny of Pycnodontiformes - New genera from the Upper Jurassic and Cretaceous

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation,

Pycnodontiformes Berg, 1937 are an extinct order of ray-finned fishes from the Triassic (Norian) to Eocene (late Ypresium). With their deep, laterally compressed bodies and comparatively large fins, Pycnodontiformes were manoeuvrable reef fish. Nearly all Pycnodontiformes were highly specialized, with a characteristic durophagous dentition strongly suggesting a diet of predominantly hard-shelled prey; preserved shells and sea urchin spines in the gut contents of Pycnodontiformes clearly indicating their durophagous feeding habits. Pycnodontiformes have been proposed as sister group to Teleostei or Teleosteomorpha (Gardiner et al., 1996; Nursall, 2010), but recent phylogenies suggest that the Pycnodontiformes are the earliest diverging Neopterygians (Poyato-Ariza, 2015).

With the description of the new genera *Turboscinetes* Ebert, 2016 and *Piranhamesodon* Kölbl-Ebert et al., 2018 the authors provided a new phylogeny of Pycnodontiformes adding eleven taxa to a phylogeny for the first time. With this poster the authors include four additional Pycnodontiformes to a phylogeny for the first time: '*Proscinetes*' *wagneri* Thiollière, 1852 (from the Kimmeridgian of Cerin, France and Wattendorf, Germany); Mexico 1 (from the Cretaceous (Albian) of Tlayua, Mexico); *Acrorhynichthys* Taverne & Capasso, 2015 and *Libanopycnodus* Taverne & Capasso, 2018 (both from the Cretaceous of Haqel and Namoura, Lebanon). The new analysis shows *Acrorhynichthys* as basal Pycnodontidae and sister taxon to *Akromystax* Poyato-Ariza & Wenz, 2005, which still have some primitive features such as high number of dentary teeth and completely ossified anterior-dorsal scales; '*Proscinetes*' *wagneri* and Mexico 1 as members of the Proscinetinae and Libanopycnodus belonging to a group (*Tepexichthys* Applegate, 1992 + more advanced Pycnodontidae) which is mainly characterized by the presence of a dermocranial fenestra or a posteriorly largely exposed endocranium.

ID: 157

Jurassic decline in abiotic controls on marine ecological success

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Physiology in Deep Time, oral presentation

The role of environmental change versus biotic interactions in evolution has been debated since Darwin, but their relative importance over geological time remains largely unknown. We test the hypothesis that environmental factors exerted a greater control on the ecological success of marine calcifiers in the early Phanerozoic, whereas biotic controls became dominant later on.

Marine calcifiers build skeletons of calcite or aragonite, and abiotic precipitation of these calcium carbonate polymorphs is governed by the Mg:Ca ratio and temperature. We created a model of aragonite and calcite sea conditions by combining Phanerozoic seawater Mg:Ca estimates with δ18O temperature reconstructions. This environmental forcing model was used to predict the ecological success of fossil calcifiers relative to their aragonitic or calcitic shell composition. From the Ordovician to the Middle Jurassic, ecological success was significantly coupled to shell mineralogy and aragonite-calcite sea conditions. After the Middle Jurassic, the environmental forcing no longer correlates with the ecological success of marine calcifiers.

The timing of this shift coincides with the proliferation of coccolithophores and planktonic foraminifera: The large-scale deposition of their skeletons on the ocean floor buffers ocean carbonate-ion concentration. Consequently, marine calcifiers during the past 170 million years have been less responsive to changes in the abiotic environment than their Palaeozoic – early Mesozoic counterparts, indicating an evolutionary regime shift. A persistent diversity rise starting in the Jurassic supports this interpretation.

Young Scientist Award

ID: 170

Morphometric and $\delta^{13}C$ ranges of the Lopingian (late Permian) conifers of the Bletterbach flora (Dolomites, NE Italy)

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

The Bletterbach (NE Italy) flora is one of the most diverse and best documented late Permian (Lopingian) floras. It includes very well-preserved specimens that belong to several plant groups such as sphenophytes, seed ferns, putative cycadophytes, ginkgophytes and conifers. The latter are the most diversified and the dominant plant group of the flora. The analysis of their well-preserved cuticles allowed to determine at least eight species, belonging to five genera (i.e. *Ortiseia*, *Majonica*, *Dolomitia*, *Pseudovoltzia* and *Quadrocladus*). Morphometrical analyses on the 50 best-preserved conifer shoot fragments enabled to delimit and compare leaf dimentional ranges of each taxon, showing differences and similarities between taxa determined at specific and generic levels. Taxon-specific carbon stable isotopic analyses were carried out using cuticles and coalified tissues collected from the Bletterbach conifers. Significant differences of the isotopic composition among some taxa suggest that they were living under different environmental conditions. The combination of morphometric and taxon-specific geochemical analyses is here applied for the first time. Both morphometric and taxon-specific stable isotopic analyses highlighted intra-specific and/or intra-generic variability. The $\delta^{13}C$ values are generally uniform except for some taxa, reflecting a distinct taxon-specific fractionation or an adaptation to a specific ecological niche. Moreover, no significant isotopic differences were observed between photosynthetic and heterotrophic tissues. The combined use of morphometry and stable isotopie geochemistry showed great potential for taxonomical identification and ecological characterization of fossil plants.

Young Scientist Award

ID: 171

The Kungurian (Cisuralian, early Permian) flora of Tregiovo (NE Italy) – palaeobotany, palaeoenvironment and organic geochemical proxies

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

Tregiovo is a small middle Kungurian (early Permian) sedimentary basin within the Athesian Volcanic Complex in the upper Val di Non (Trento Province, NE Italy). The sediments are intercalated between two volcanic formations respectively dated 274.1 ± 1.6 Ma and 276.5 ± 1.1 Ma. Since a long time, the Tregiovo locality has been known for its fossil content, such as conchostracans, invertebrate tracks, vertebrate footprints, palynomorphs and plant fossils. The Tregiovo Formation is characterized by three main lithofacies. The base and top are dominated by sandstones and conglomerates, the middle part consisting of laminated siltstones/claystones is divided in two different lithozones, a lower carbonate-free and an upper microbial carbonate-bearing one. Recently, two new sections have been discovered. In the "Le Fraine" section two different assemblages, respectively: assemblage A (lower one) and assemblage B (upper one) from the carbonate-free laminated lithozone yielded rich plant assemblages. Sphenophytes (*Annularia*), taeniopterids (*Taeniopteris*), seed ferns and ferns (*Sphenopteris*, *Peltaspermum*), ginkgophytes (*Sphenobaiera*) and conifers (*Hermitia*, *Feysia*, *Quadrocladus*, *Dolomitia*) were found in both assemblages. Conifers, the dominant group in both assemblages, decrease from over 80% in assemblage A to 60% in B. Vice versa, sphenopterids and seed ferns, poorly represented in the assemblage A, are common in B (30%). The "Tregiovo Village" section correlates with the upper part of the "Le Fraine" section, including the transition from the lower carbonate-free zone to the middle carbonate-bearing one. A geochemical study on the δ13C of bulk organic matter from the two sections shows a clear trend towards more negative δ13C values. The taxon-specific geochemical analysis on the common conifer taxa in the paleobotanical assemblages shows the same negative trend. Answering the question whether the isotopic shift reflects changes in the floral composition, local environmental changes or a global perturbation, will need additional work.

ID: 129

Trophic community structure of the Late Jurassic Kimmeridge Clay Formation

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Physiology in Deep Time, poster presentation

Food webs, the networks of feeding links between taxa, provide a tractable representation of biodiversity and species interactions which are central to our understanding of community structure and ecosystem function. Despite this, feeding interactions have been largely ignored in palaeobiology due to the uncertainty surrounding the life histories of long extinct organisms. Here, we present a trophic community reconstruction of the exceptionally preserved Late Jurassic marine ecosystem of the Kimmeridge Clay (SW UK) in order to determine whether Mesozoic marine ecosystems possessed a similar structure to modern marine ecosystems.

Food webs were built at the trophic guild and species level from species occurrence data derived from primary literature searches and museum collection visits. Interactions between species were defined by body size relationships, motility, tiering, and feeding mechanisms inferred from palaeoecological evidence and summarised within an inferential model framework. Community structural metrics were calculated for the Kimmeridge Clay food web and were compared to various well-defined modern marine communities.

Community structure metrics suggest that the Kimmeridge Clay ecosystem is largely comparable to modern marine ecosystems. This supports an earlier timing for the establishment of modern ecological structure in the oceans via a pre-Late Jurassic culmination of the Mesozoic Marine Revolution. However, the Kimmeridge Clay species-level food web is more densely connected than modern marine webs as fossil reconstructions using inferential methods are more likely to reproduce fundamental trophic niches rather than the realized trophic niches which are observable in modern marine ecosystems.

ID: 131

Bivalves from the Finis Shale (Virgilian) of North Central Texas – analysis of life habits and palaeoecology

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Evolving ecosystems, poster presentation

The uppermost Pennsylvanian succession of North Central Texas is united as Cisco Group, each of the six formations within represents an almost complete transgression – regression megacycle. The lowermost of these six cycles is known as the Graham Formation, with the Finis Shale, a complete second order cycle, near the base. The Finis Shale Cycle mainly consists of dark coloured mudstones and shales. The succession yields an exceptionally well-preserved and moderately highly diverse invertebrate fauna and plants.

The bivalve fauna, which rarely makes up more than 10 % of the complete fauna, is dominated by infaunal bivalves of several taxa of palaeotaxodonts. Pteriomorphs and heteroconchs are minor components of the fauna.

It is assumed that all occurring genera of the Palaeotaxodonta are deposit feeders and belong to the mobile endofauna, whereas all other taxa are suspension feeders. The Carditida (*Astartella*) and Trigoniida (*Schizodus*) are the only infaunal suspension feeders. In consequence, c. 80 % of the bivalve fauna consists of infaunal taxa. Except for semi-infaunal taxa, the rest of the bivalve fauna, which makes up only 6 %, consists of epifaunally attached taxa of different groups.

The presence of a high percentage of infaunal bivalves indicates aerobic conditions in the muddy substrate and the high number of deposit feeders shows that it was a vital biofacies with organic-rich, fine-grained substrate. The byssally attached epifaunal bivalves were probably related to rare objects for attachment, e.g., other organisms, such as bryozoan colonies, corals, crinoids or algae may have been suitable attachment objects.

The particularly high number of infaunal taxa is presumably a result of mutual food and space competition. A typical tiering was developed and the bivalves mostly settled the infaunal niches, where the competitive pressure was lower compared with the substrate surface dominated by brachiopods.

ID: 116

Palaeoecology of benthic faunas from three Middle Triassic carbonate platforms

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Evolving ecosystems, oral presentation

The recovery of marine benthic ecosystems after the end-Permian mass extinction was not completed before the Middle Triassic, the time interval when large carbonate platforms re-established. How did the resurgence of these large carbonate platforms affect the diversification of benthic macroinvertebrates? Which evolutionary changes were involved in the colonization of this new habitat type? To answer these questions, quantitative ecological analyses were performed on benthic communities from three Middle Triassic carbonate platforms: (1) The early Middle Anisian *Tubiphytes*-microbial buildup (North Dobrogea, Romania), (2) the late Anisian Latemar Limestone (Dolomites, Italy) and (3) the Late Ladinian – Early Carnian Schlernplateau beds (Dolomites, Italy). The *Tubiphytes*-microbial buildup is one of the oldest Triassic carbonate reefs and was formed on the upper slope of a distal platform in relatively deep water. The Latemar carbonate platform represents an atoll, with a well-stratified platform interior that contains the investigated fauna. The fauna from the Schlernplateau beds (Dolomites, Italy) represents a soft-bottom community from an open lagoon in a platform interior. The investigated faunas are compared with other Middle and Early Triassic benthic communities in terms of species richness and trophic composition. This comparison shows an increase in species richness during the Middle Triassic, coinciding with the main phase of recovery after the end-Permian mass extinction. During this recovery phase, bivalves that dominated Early Triassic benthic communities continued to diversify, but gastropods diversified quicker and outnumbered bivalves by the end of the Middle Triassic in carbonate platform settings. We hypothesise that co-evolution between carbonate producers and level-bottom faunas as well as the increased environmental heterogeneity in the context of carbonate platform resurgence were factors that contributed to this shift in taxonomic composition.

Young Scientist Award

ID: 178

Environment and biogeography of a Middle Triassic fish fauna near Davos (Canton Graubünden, Eastern Swiss Alps)

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

The Middle Triassic Prosanto Formation near Davos (Canton Graubünden, Eastern Swiss Alps) has been systematically excavated and studied since 1989. The sediments were deposited in a small, approximately 30 km wide restricted basin on a large shallow-water carbonate platform in the North-Western Tethys. To date, several hundred well preserved skeletons of 25 different actinopterygian fishes (Perleidiformes, Saurichthyiformes, Semionotiformes, Peltopleuriformes, Holostei, Halecomorphi and Halecostomi), two actinistian fishes and two aquatic sauropterygian reptiles have been discovered, alongside as much if not more fragmentary or disarticulated material. Other finds include a shark tooth, a few echinoderms, cephalopods, brachiopods, several crustaceans, bivalves, gastropods, siliceous sponges, benthic foraminifera and dasycladacean algae, all pointing to a marine environment. Rare insects and terrestrial reptiles, together with common plant remains indicate nearby islands or larger land areas.

The benthic organisms did not live on the seabed in the basin due to the overall stagnant, hypersaline bottom waters and depletion of oxygen by decaying organic matter. These fossils therefore represent life washed in with sediments disturbed by storm activity across the platform or slumping around the basin edge. Observed displacement of specific skeletal elements, but otherwise relatively high articulation and completeness, in the fish fossils can be linked to adherence to the substrate, most likely by microbial mats, in a process.

The ichthyofauna of the Prosanto Formation is comparable to that of the UNESCO world heritage site at Monte San Giorgio (Southern Switzerland/Northern Italy) and other Middle Triassic sites in Northern Italy, Slovenia and Austria. These were all deposited in similar intraplatform basins, separated by shallow carbonate platforms from the open ocean of the Western Tethys. Some genera are also known from the Germanic Muschelkalk Basin in Germany, the Netherlands and Spain, and others are related to the fauna from Southern China representing the Eastern Tethys.

ID: 164

Experimental fossilisation of fishes

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

There are many world class locations where fishes are near-perfectly preserved. However, there are hardly any experiments that simulate conservation conditions. Intuitively, pressure, salinity, pH, redox potentials (Eh), and the presence of bacterial mats are important parameters. We have designed autoclaves that allow to control these parameters to document with time series experiments the decay of fishes.

Pressure is a fundamental parameter to promote the sinking of fish carcasses to the bottom of a water body and their deposition at the water-sediment interface. We have calibrated in pressure-salinity space for marine conditions the minimum pressure required for fish carcasses to sink to the bottom. Deposition in deep water also promotes preservation by preventing fermentation gases inside fish carcasses to expand. Reducing conditions have no fundamental influence on the conservation and the decomposition rate of fishes. A low Eh is, however, important to keep scavengers at bay before the carcass is covered by sediment. A critical parameter for the conservation of fishes in marine environments is the salinity of the solution. Experiments varying salinities show that hypersaline waters delay decomposition and promote the preservation of soft tissue. At salinities three times seawater, applicable to a settings like the Jurassic Solnhofen basins, decay is stopped and soft tissues can remain virtually unchanged until the carcass is covered by sediment. High pH values also promote preservation. Alkaline pH conditions inhibit the decay similarly like high salinities. Highly alkaline conditions are applicable to fossils in tuff crater lakes like Messel where hydrolysis reactions of tuff with water may have imposed pH values as high as 9 to 10.

Our experiments outline the conditions most favorable for conservation. They also suggest that the transformation of a fish carcass to a well preserved fossil may be a matter of a few months.

ID: 246

Tracing the evolution of secondary metabolite evolution in sponges (Porifera)

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Molecular Geobiology and Paleobiology, oral presentation

Sponges (Porifera) constitute the oldest extant metazoan phylum. Their sessile, predominantly filter-feeding lifestyle makes them vulnerable for a wide range of predators and parasites, however their high regeneration potential and a particularly sophisticated chemical defence mechanism ensured their survival until present. This chemical defence mechanism consists of the production of highly bioactive secondary metabolites with deterrent, antibiotic, antifungal and other properties. So far, more than 15000 bioactive compounds are described from sponges, much more than for any other marine phylum. Nevertheless, the evolution of secondary metabolite production within this phylum is still unknown. As a first step to unravel patterns and processes of bioactive compound production throughout time, we analyze the current compound distribution in sponges and trace the biochemical character evolution with the current phylogenetic hypotheses of Porifera.

ID: 193

How to recognise a species – quantifying a case in horned dinosaurs

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Open session, oral presentation

For the past decade, palaeontologists studying dinosaurs have been heavily debating how many species of Dinosauria are valid. This was especially triggered by the suggestion that certain morphotypes originally described as separate species are in fact only different ontogenetic stages of the same species. One of the most prominent examples for such a re-interpretation can be seen among "horned-face dinosaurs" (Ceratopsia). Within Ceratopsia the validity of the species *Torosaurus latus* has been questioned, suggesting that it might represent nothing else than the true adult form of *Triceratops horridus*, while "normal" specimens would represent not fully grown individuals. Such interpretations have a significant influence on the species-level diversity of dinosaurs in the late Cretaceous. The view that both forms are a single species has been based especially on bone histological approaches. Yet, morphometric approaches have been used to support the contrary view, restoring *Torosaurus latus* as a separate species. Here we try to contribute to this issue by further exploring different types of morphometrics, comparing the skulls of ceratopsian dinosaurs suggested to represent *Triceratops horridus* (and *Torosaurus latus*) to shed further light on the true diversity in the late Cretaceous. To test whether multiple different described species of ceratopsian dinosaurs may actually represent different ontogenetic stages of a single species their skull shapes were quantified. Different methods were used such as Fourier transformation, semi-landmark analysis and relative length measurements, as well as a grid-based landmark approach. We also try to take the recent suggestion about a potentially anagenetic speciation between *Triceratops horridus* and *Triceratops prorsus* into account to increase the accuracy of detecting ontogenetic signals within this historically troublesome group. With this approach we aim at improving the estimation of species diversity in the late Cretaceous.

Young Scientist Award

ID: 241

Phylogenetic placement of fossil gobioids: a total-evidence approach

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Gobioidei are one of the most species-rich groups among vertebrates, comprising 320 genera and >2200 species. They can be found in fresh, brackish and marine habitats and show remarkable adaptations like the mudskippers with their amphibious life style or the waterfall-climbing gobies. In relation to their modern diversity, the fossil record of Gobioidei is rather scarce with about 100 fossil species, of which ~70% are known exclusively from otoliths (ear stones). Gobioid fossil systematics is a difficult endeavor because the classification of recent gobioids relies heavily on soft-tissue characters like the sensory papillae pattern. Comprehensive studies on a wide range of osteological characters containing a high number of species representing all eight families currently recognized have never been published, so a phylogenetic framework based on morphology remains to be established. Our work is addressing this issue by building a phylogenetic database that allows to place fossil gobioids in the context of extant species' relationships, leading to improved understanding of gobioid evolutionary history. We compiled a morphological matrix (342 characters) representing all gobioid families as well as nine fossil taxa and analyzed it in combination with published molecular sequence data from the extant species, resulting in the first total-evidence tree for Gobioidei. We recover not all extant families as monophyletic, but could place the fossils in positions that are largely congruent with their taxonomical classifications. This total-evidence approach will be the starting point for future studies to further enhance the understanding of gobioid phylogeny and evolution.

ID: 115

Revision of *Morone major* (Agassiz) from the Oligocene formations of Piatra Neamţ (Eastern Carpathians) - the first record of a Sea Bass (Perciformes, Moronidae) skeleton from the Oligocene of Romania

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

In the present-day fish fauna, the Moronidae (sea basses) consist of two genera (*Morone, Dicentrarchus*) with six species, which occur in the marine coastal areas of brackish and fresh waters from the North America (Atlantic Ocean and Gulf of Mexico), Europe (Atlantic coastal waters, Mediterreanean and Black Sea) and North Africa; some of the species are anadromous (e.g. *M. saxatilis*) while two of the North American species inhabit fresh waters.

The Moronidae have a diversified fossil record; based on otoliths and skeletons, fossil moronids were reported from the Cenozoic formations of Europe (Eocene: Italy, France, Germany, Czech Republic; Oligocene: Belgium, Romania, Czech Republic; Miocene: Germany, France, Austria, Hungary, Bulgaria, Republic of Moldova), but the whole group is in need of a detailed revision. In Romania, the first record of a moronid (*Morone major* (Agassiz)) was carried out on an incomplete and poorly preserved skeleton collected from the Oligocene deposits of Piatra Neamţ (Lower Dysdodilic Shales, Marginal Folds Nappe, Eastern Carpathians). Previously, *M. major* (Ag.) was described from the Middle Eocene of France.

Re-examination of *M. major* (Ag.) from the Oligocene of Piatra Neamţ area, is presented simultaneously with the description of a *Morone* sp. specimen recently identified in the Oligocene formations of the Vrancea area (Bituminous Marls Formation, Marginal Folds Nappe, Eastern Carpathians). The specimen determined as *M. major* (Ag.), from the Oligocene of Piatra Neamţ lacks any diagnostic characters which allow us to conclude that the formerly proposed assignment is inaccurate and the specimen does not belong to the Moronidae family. Accordingly, the specimen from the Vrancea area represents the only reliable record of a *Morone* skeleton from the Oligocene of Romania.

ID: 153

The pre-scientific history of *Lepidotes* Agassiz, 1832

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Teeth of *Lepidotes* Agassiz, 1832 have recently been identified amongst the gemstones decorating the 14th century crown of the King of Bohemia, Charles IV, prepared for his coronation as King of the Romans at Aachen in 1349. Contemporary belief was that these stones originated in the heads of old toads; they were cited thus by the greatest scholars of Antiquity (Dioscorides, Pliny the Elder) and the Middle Ages (Isidore of Seville, Alexander Nackham, Arnold of Saxony, Vincent de Beauvais, Conrad of Megenberg etc.), who referred to them as nusae, batrachites, bufonites, crapaudina, borax etc.. They were believed, by sympathetic magic, to have curative and prophylactic powers, especially in the detection and neutralisation of poisons. Toads were known to secrete poisons from dermal wart-like structures (especially parotoid glands). The dome-like teeth of *Lepidotes* probably evoked the morphology of such glands and led to their therapeutic use in the detection and elimination of poison. Set in rings, they were believed to sweat in the presence of poison. The specimens in the crown are the oldest tangible artefacts of this magical or curative interpretation.

The earliest 'scientific' images of *Lepidotes* teeth appear in Gesner's (1565) *De omni Rerum Fossilium* and Ulisse Aldrovandi's later (1648) *Musaeum Metallicum* who both stated that the stones came from the ground. In the 17th century, Christopher Merrett and Agostino Scilla first considered that the stones were teeth and compared them to Recent durophagous Wolf Fish or sparids. In the 18th century, French botanist Antoine de Jussieu (1723) and French scholar Pierre Barrere (1744) considered 'crapaudines' to be fossil teeth of the Brazilian coastal "grondeur" or the 'Orata' (*Sparus aurata*) and "*Sinagris*" of Rondelet. Louis Agassiz, the founder of palaeoichthyology, established the semionotiform genus *Lepidotes* in the 19th century.

ID: 162

Discovery of non-rigid eggs and hatchlings in two *Archaeopteryx* fossils

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Open session, oral presentation

The rediscovery of two iconic *Archaeopteryx* fossils as Jurassic still-lives of nests will be presented. An investigation into the disruptive hypothesis that the fossilized pose of the Berlin specimen corresponds to a nesting posture, rather than being the carcass of an animal that sunk into the bottom of a Jurassic lagoon, will be presented. The experimental approach and evidence gathered from macrophotography, with and without transillumination, stereomicroscopy and computerized tomography (CT) analysis, including 3D software analysis of CT data, collected from the original slabs of the Berlin and Teylers specimens of *Archaeopteryx* will be explained. Firstly, a reinterpretation of the relative position of the slabs of the Berlin specimen and the originality of the slab proper of its counterslab will be explained. Postural evidence of nesting, in addition to backbone and rib cage changes caused by an underlying egg mass will be shown in the Berlin specimen. Eggs from the Berlin and Teylers fossils measuring on average 1.3 cm will be shown, some containing fossilized fetuses. The case for the non-rigid nature of these eggs will be presented. In addition, six hatchlings in the Berlin specimen and two from the Teylers specimen, all with the same size and characteristics, including a beak and tail, in addition to the shoulder and wing finger anatomy of *Archaeopteryx*, will be presented. One of the Berlin hatchlings, located on the very front surface of the main slab of this fossil, has several of its tiny bones exposed whereas the others show surface morphology preservation. Remarkably, hatchlings will be shown that died while hatching and others in a clinging pose. The hypothesis that patches of land among Solnhofen marine lagoons were nesting sites for *Archaeopteryx* will be presented. The implications of these discoveries will be analyzed in their potential to transform our understanding of evolution.

ID: 236

A fresh look on the Fossil Record of Gobioid Fish Otoliths from the Vienna Basin

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Gobioid fishes are one of the most diverse groups within the bony fish (Teleostei) with an abundant fossil record of their species-specific sagittal otoliths (ear stones). However, family-, genus- and species identification of isolated fossil gobioid otoliths is a challenge and the ancient diversity of the group still remains to be explored.

Here we conduct a re-evaluation and revision of fossil gobioid otoliths from the middle Miocene of the Vienna Basin. The Vienna Basin is a well-studied area whose geological and palaeontological history was examined in great detail in previous works. It is part of the biogeographic province of the Central Paratethys Sea, an ancient sea north of the former Tethys. During the middle Miocene (i.e. the chronostratigraphic Central Paratethys stage Badenian), the Central Paratethys was well connected to the Mediterranean Sea. In contrast, a gateway to the Indo Pacific is under debate and appears to be unlikely according to the invertebrate fossil record. However, fishes are well known to be capable to use even very short-term seaways for dispersal. Examining whether such a short-term a seaway may have existed between the Central Paratethys and Indo Pacific is a further aspect that makes a reexamination of the middle Miocene fossil gobioid otoliths from the Vienna Basin interesting.

The material comprises a total of 419 and 230 gobioid otoliths, respectively, from historical collections of two previously described outcrops, Kienberg and Vöslau, both of ~14 Ma and located in the Vienna Basin. We conduct both qualitative approaches (digital microscopy and SEM) and quantitative techniques (Fourier shape analysis) to examine and test the significance of differences between our predetermined gobioid otolith "groups". We hope that the outcome of our study will contribute to the knowledge of ancient gobiod diversity and clarify whether a seaway to the Indo Pacific existed at that time.

ID: 107

Palaeolyngbya (Cyanobacteria, Oscillatoriales) from the Triassic of Antarctica

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Late Paleozoic and Mesozoic Plants and Floras, keynote presentation

Cyanobacteria are one of the most successful groups of prokaryotic organisms in Earth history that may have originated well before 3.0 Ga. Innumerable fossils ranging from simple cocci to complex filaments have been described throughout geologic history and directly compared with present-day forms. However, the vast majority of these fossils come from marine deposits; documented evidence from non-marine paleoenvironments is comparatively rare. The study herein presents a large filamentous cyanobacterium structurally preserved in Triassic peat from the central Transantarctic Mountains of Antarctica. The filaments are characterized by wide, unbranched trichomes with discoid cells several times wider than long, and prominent sheaths. High levels of morphological congruence exist between this fossil and the recently described *Palaeolyngbya kerpii* from the Lower Devonian Rhynie chert, several Proterozoic *Palaeolyngbya* species, as well as certain species in the modern genus *Lyngbya* C. Agardh ex Gomont sensu lato (Oscillatoriales, Oscillatoriaceae). What is perhaps most interesting is the fact that the Antarctic filaments consistently occur in association with fungi similar to *Endochaetophora antarctica*. Although no evidence has been found of interactions between the two organisms, this association provides insights into the necessary special taphonomic circumstances required to preserve cyanobacteria in permineralized peat. Moreover, the Triassic filaments support the long-standing hypothesis that cyanobacteria were important constituents of Antarctic paleoecosystems.

ID: 187

Immatures of silky lacewings through the ages - an attempt to be quantitative and holistic

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Open session, poster presentation

Lacewings, with the rather well known forms such as green lacewings and ant lions, are representatives of the group Neuroptera. Neuroptera is an ingroup of the super-diverse group Insecta, more precisely of its large ingroup Holometabola. Within Holometabola, Neuroptera is closely related to Coleoptera, beetles. The internal relationships within Neuroptera are still not reliably reconstructed, several conflicting reconstructions have been put forward. Yet, a stable ingroup is Myrmeleontiformia, represented by the ant-lion-like forms. Among these are silky lacewings, forming the group Psychopsidae. The group is relative species-poor with only 26 extant species. Furthermore, the group has a disjunct distribution with extant representatives in Australia, Asia and Africa. As in most other lacewings, their larvae are highly specialised predators. Silky lacewing larvae differ from those of other myrmeleontiformians by possessing a prominent, forward-projecting upper lip (labrum) and trumpet-shaped attachment structures (empodia) on their walking appendages. Additionally, many myrmeleontiformian larvae have prominent teeth on their venom-injecting mouthparts (stylets); these are absent in silky lacewing larvae. Larvae resembling extant silky lacewing larvae are known from several occurrences in Eocene Baltic amber (about 40-50 million years old) and Cretaceous Burmese amber (about 100 million years old). We review all known occurrences of extant and fossil larvae interpreted as silky lacewings. We furthermore report numerous new fossil larvae. We provide a comparison of the morphological diversity of these larvae through time, based on a morphometric approach.

ID: 186

Stiff lower lip - the shape of the seventh appendage of sword tails, sea scorpions and scorpions

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Open session, poster presentation

Euchelicerata is a large group including spiders, scorpions, mites and their relatives. Most "common" representatives of Euchelicerata are characterised by the posterior trunk region lacking appendages (spiders with their spinnerets being a notable exception). Ancestrally, the post-ocular segment 7 bore a true functional leg-like pair of appendages, used for walking, feeding, and swimming. Modern day sword tails, commonly called "horseshoe crabs", retain at least the proximal part of this appendage, closing the feeding apparatus from posteriorly. In sea scorpions, both appendages have become conjoined to form a rather immobile ("stiff") lower lip. In scorpions, the structure is no longer involved in feeding and forms a functional sternitic plate, the sternum. In other representatives of Euchelicerata no clear traces of these structures are apparent. We provide here a quantitative comparison of the shape of the appendages of post-ocular segment 7, including more than 200 representatives of Euchelicerata, including sword-tail-like forms, sea scorpions and scorpions. We used an outline approach based on elliptic Fourier transformation. All three major investigated groups separate well from each other. Only few sea scorpions show very similar shapes of their appendages of post-ocular segment 7 to those of scorpions. Some fossil scorpions as well as immatures of modern-day scorpion species appear to be more similar in shape in this structure to those of sea scorpions. This indicates that heterochrony, the evolutionary change of developmental timing, probably played a role in the evolution of this structure.

ID: 185

Getting a grasp on the concept of convergence - evolution of prehensile appendages in the group Euarthropoda

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Open session, oral presentation

Euarthropoda is an astonishingly diverse group. The basic bio-mechanics of most movements in the appendages of these forms is that of a simple hinge joint. This limits the possible variations of a single joint, yet is compensated by the combination of numerous of these joints. Given this rather simple bio-mechanics, it should not be astonishing that several evolutionary lineages of Euarthropoda evolved similar mechanic solution for similar functions independently. Therefore, such lineages are ideal "experimental set-ups" for studying the phenomenon of convergent evolution. One of the functions that euarthropodan appendages perform is grasping. Grasping or prehensile appendages are furthermore used in various different sub-functions. Some are used for holding a partner during mating, some allow a parasite to attach to a host. The probably most spectacular ones are appendages that are used for catching prey. I present several examples of different types of prey-catching appendages that evolved independently in various lineages of Euarthropoda. While already the modern fauna yields numerous examples of convergence, the fossil record reveals that certain types of raptorial grasping appendages evolved even more often. Convergence also reaches beyond the mechanics of a single appendage, but in some cases includes more complex raptorial apparatuses. Astonishing is especially that appendages of very different body segments can evolutionarily be combined to very similar types of apparatuses.

ID: 184

Diversity beyond taxonomy - what the fossil record of larvae can contribute

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Open session, oral presentation

Diversity has become an important concept, especially in recent years. Also within palaeontology the reconstruction of changes of diversity through time is a major field, gaining importance with he current political environment. Recognising and truly measuring diversity is more challenging in some groups of animals than in others. Insecta is today a super-diverse group by any means, be it species richness, biomass or individual richness. Yet, the possibilities to identify species are in many aspects largely restricted. Modern-day forms are best identified based on male adults. Females are in many groups not easily identifiable, immatures are often impossible to be identified to a narrow group. In fossil representatives of Insecta, also adults are in the centre of study when it comes to identify species as they are mostly based on wing characters. Also here immatures can often not be identified to a narrow ingroup. Yet, this situation is in fact rather unfortunate. Especially the various types of amber provide myriads of immature forms of Insecta, which can, given the current common approaches, either not or at least not easily be included into diversity analyses. I present some recent examples of exceptional fossil larval forms of Insecta that indicate a larger diversity of morphology and ecological roles in some lineages than we see in their modern forms. I will also try to outline quantitative approaches how such aspects preserved in the fossil record could be recognised by diversity measures.

ID: 225

Mesh size effects on diversity and palaeoecological estimations of Late Triassic marine invertebrate assemblages

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Evolving ecosystems, oral presentation

Sieve mesh size can have a strong effect on estimations of biodiversity and ecology in fossil and recent assemblages. Consequently, comparing samples processed with different mesh sizes may lead to biases in evaluating similarities or differences between these samples. Using different sampling methods to retrieve fossil samples, i.e., surface and bulk sampling, may also lead to a mesh size effect; during surface sampling, only fossils are collected that can be seen by the naked eye, whereas for bulk samples all preferred mesh sizes are available for sieving.

To study this influence on fossil samples, we use various data sets from the Late Triassic Cassian Formation (northern Italy, Dolomites), since these sediments are unconsolidated in most cases. From every locality, bulk (sieved down to 0.5 mm) and surface samples are available.

It has been shown that taxonomic composition and species abundances vary to a high degree between corresponding surface and bulk samples, because small-sized species are rare or completely absent in surface samples, whereas these species may be dominant in bulk samples. In addition, patterns of predation traces found on molluscan shells can be highly influenced by the applied sampling method. This results at least partly from the fact that some of the preferred prey species are too small to be detected during surface sampling. In addition, the Shannon and Simpson diversity indices point to a lower diversity in surface samples compared to bulk collections. Rank-abundance distributions also differ in shape and fit best to different models. In contrast, when applying rarefaction analyses, corresponding surface and bulk samples show a similar diversity.

These results indicate that rarefaction curves can be used for a rapid biodiversity estimation. However, when conducting more detailed diversity and palaeoecological analyses, sampling methods may have strong effects on the outcomes.

Young Scientist Award

ID: 233

Middle Viséan (Mississippian) monospecific biostromes from eastern Belgium – corals at their limits

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Evolving ecosystems, poster presentation

During the mid-Viséan extended monospecific biostromes of the fasciculate rugose coral *Siphonodendron martini* occur in Belgium and northern France as isochronous levels within the strongly cylic middle Lives Formation. They are mostly restricted to the lowermost Awirs Member. Lithostratigraphy and facies were studied in the Corphalie section E of Huy. For regional variability samples from Lives Rock east of Namur and from two additional sections in between were inspected. Corphalie constitutes an about 4.85 m thick shallowing upwards cycle subdivided into three minor cycles. The lowermost minor cycle is without corals. The second minor cycle starts with cross-bedded peloidal-bioclastic, foraminifer-rich grainstone. Above, almost suddenly *Siphonodendron martini* enters and forms the 0.84 m thick *S. martini* biostrome. Corallites are embedded parallel to bedding planes and enriched in layers, with decreasing abundances upwards. Corallite-rich layers are separated by peloidal-bioclastic packstone. Internal erosional surfaces occur. Besides, broken *Syringopora* corallites, crinoid ossicles, brachiopod shells, calcispheres, calcareous algae, rare gastropods and bivalves, burrows and micritic intraclasts occur. In the upper part of the cycle, *S. martini* disappears below an oolitic grainstone. In the third minor cycle, corals are missing except for a basal *Siphonodendron*-microbe boundstone. Lithoclastic-peloidal-bioclastic grainstone to packstone and a green algal *Issinella* packstone is overlain by a loferite/stromatolitic bindstone. Accordingly, the biostrome grew in shallow inner platform settings engirding the London-Brabant massif. In height, it might have been restricted to single colonies. Storms repeatedly destroyed the biostromal thickets. Seawards of the biostrome girdle lagoonal algal meadows, mostly composed of *Issinella* developed. Landward, it was bordered by high-energetic oolitic foreshore sand bars and microbial tidal flats. Rapid and repeated sea level changes strongly hindered the establishment of flourishing and diverse coral growth. Regional comparison shows increasing proximality from southwest to northeast, i.e. shallower environments closer to the coast, as expressed by increasing corallite diameters and a more diverse microfacies.

ID: 238

Morphological diversity of myrmeleontiformian larvae through time

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Open session, oral presentation

Ant lions (Neuroptera: Myrmeleontidae) represent one of the few cases in which the larval stage is better known by non-expert people than the corresponding adult stage. In spite of this, the taxonomic knowledge of the adults is currently more complete. Myrmeleontidae has over 1700 described species, but only from about 70 of these species the larvae are known. The same applies for the fossil record of this group: while the larvae are considered infrequent, the adults are prevalent.

Myrmeleontidae is a rather species-rich ingroup of Neuroptera (lacewings), and it is specially prevalent in xeric environments, where many of the larvae build traps. This may partly explain the scarcity of well preserved fossil larvae; having a soft cuticle, the preservation of these organisms is mostly as amber inclusions.

An autapomorphy of Neuroptera is the modification of the larval mouthparts, which are piercing-sucking stylets as a result of the combination (juxtaposition) of the mandibles and the maxillae. A well-characterised larger ingroup known as Myrmeleontiformia includes, besides Myrmeleontidae, also the groups Psychopsidae, Nemopteridae, Nymphidae, and Ascalaphidae. Myrmeleontiformia is characterized by larvae having a sturdy head capsule, powerful mouthparts and other adaptations to hunt massive prey items.

Although there is a consensus about the monophyly of Myrmeleontidae, its morphology is still not well understood in an evolutionary context. Often the fossils found have clear similarities with Ascalaphidae and Myrmeleontidae, but a more precise association is normally not possible. In the current study, a morphology-oriented approach by the use of morphometrics is applied. Ten dimensions were measured in extant and fossil myrmeleontiformian larvae. Differences in morphology can be perceived and can be correlated to specific geological periods, enabling us to detect changes of larval morphology through time.

Young Scientist Award

ID: 223

Description of a *Machairodus* (Mammalia, Carnivora, Felidae) skull from Rhodos (Greece) with some palaeoecological notes on the *M. aphanistus–giganteus* transition

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Open session, oral presentation

A cranium, mandibula and several teeth of an individual belonging to the genus *Machairodus* were excavated in 1970 on Rhodos. The specimens are preserved remarkably well, with only slight lateral deformation and compression. The associated fauna suggests a Turolian age. The specimens are described and compared with other specimens of this genus. Additionally, the transition between *M. aphanistus* and *M. giganteus* is explored from a palaeoecological perspective. A careful assessment of all species characteristics shows that the Rhodos specimen exhibits intermediate characteristic between *M. aphanistus* and *M. giganteus*, whereas *M. kurteni* represents a junior synonym of *M. giganteus*. A decrease in humidity at the MN11/MN12 boundary may have caused a decrease in forestation. This decrease in forestation would have made *Machairodus* more dependent on hunting larger prey, such as bovidae and Giraffidae, instead of the previously important Cervidae, Suidae and Tragulidae. This may have necessitated further development of derived sabertooth features, resulting in the evolution of *M. aphanistus* into *M. giganteus*.

ID: 218

Environmental effects on clam shrimp size and shape: Implications for palaeontological studies

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Physiology in Deep Time, oral presentation

Lake environments witnessed major re-organizations during the Late Cretaceous to Paleogene, exemplified by a dramatic decline of spinicaudatan presence in the fossil record. In order to understand that decline, we study environmental effects on carapace growth in Spinicaudata. Morphogroups in fossil Spinicaudata often correlate with distinct lithologies, which can be variously interpreted as evolution or ecophenotypic variability (after having considered other sources of size and shape variation). To evaluate these two contrasting interpretations, we design rearing experiments following hypotheses based on palaeontological observations. For example, carapace growth of various Middle Jurassic to Early Cretaceous species from eastern Asia seems to have responded to population density. To examine whether that observation reflects a true relationship, we set up rearing experiments involving two extant species of two different families: *Eulimnadia texana* and *Eocyzicus argillaquus*. The resultant growth model corroborates our observation: the response of carapace length to population density follows a natural log relationship, with lower densities triggering faster growth. Also, 40% of the density-dependent shape variation in hermaphrodites of *E. texana* can be described by relative umbo height, which we interpret as a measure of egg clutch size. In addition, we identified strong temperature effects on both size and shape. Hermaphrodite shapes reared under temperatures of 20°C and 29°C were significantly different, while intermediate temperatures yielded intermediate shapes. Our results of strong temperature and, perhaps less intuitive, population density effects on carapace growth in extant species imply a considerable amount of ecophenotypic variability in Spinicaudata and impact our understanding of fossil taxonomy and palaeoecology.

ID: 183

Palynology of the Lopingian (late Permian) Bletterbach Gorge succession (N-Italy)

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

The Gröden/Val Gardena Formation (Wuchiapingian) comprises mainly terrestrial near-coastal/floodplain sediments, and is the most important fossiliferous succession in the famous Bletterbach Gorge (Dolomites, N Italy). The local fossil record includes a diverse tetrapod fauna represented by abundant footprints, as well as a rich and diverse assemblage of plant macro- and micro-remains. Most of the plant fossils come from strata above and below the so-called "Cephalopod Bank", a marine horizon representing a sea level highstand. The final stage of the transgression below and the initial phase of the regression above provide exceptional conditions for the preservation of fossils. These strata were sampled for palynology, and a qualitative and quantitative study of the organic content was carried out. The samples yielded a varying but generally high content of organic material mainly derived from terrestrial sources, but marine elements such as acritarchs and algal cysts are also present. An increase in marine elements coincides with the "Cephalopod Bank". Sporomorphs are dominated by various types of pollen grains with an occasional increase in the number of spores. This dominance of pollen grains parallels previously described sporomorphs from the Gröden/Val Gardena Formation. Most taxa previously described from this formation are confirmed, with some being recorded from the Bletterbach for the first time. Both sporomorph assemblages and macro-remains collected from the same layers suggest that hygrophytic elements were rare in the local flora. On the other hand, ginkgophytes, which are locally abundant in macrofloras, are potentially represented only by rare pollen grains or are missing from the palynological record, whereas fern spores are present in the palynological assemblages, but have so far not been evidenced as macrofossils. It is therefore sensible to integrate both datasets in order to provide a more complete depiction of the vegetation that covered the studied area some 260 million years ago.

Young Scientist Award

ID: 239

The Jurassic Osmundales of Curio Bay, New Zealand – an overview of diversity and systematics

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

Osmundales (the order of royal ferns) has a diverse fossil record with a nearly global distribution. Their permineralized trunks and rhizomes are of special importance for systematic analysis. Bomfleur et al. (2017) have shown a comprehensive overview on osmundalean systematics and provided a tool-kit to identify and classify fossil royal fern rhizomes and axis using a morphological character matrix and creating a standard framework for description and classification of osmundalean rhizomes on species level.

In this study we analyzed 15 osmundalean rhizomes from the Middle Jurassic of Curio Bay (near Waikawa), New Zealand using an updated version of the character matrix of Bomfleur et al. (2017). The use of single specimens as basic operational units – in contrast to Bomfleur et al. (2017) – gives new insights into the natural variability of royal fern species.

We identified at least three different species of remaining *Millerocaulis*, a very diverse taxon of royal ferns. We recognised the occurrence of major differences in size, growth habit, leaf trace and stipe base evolution within these species, proving that some Osmundales show a high natural variability. Hence, these fossils provide additional information on osmundalean diversity in the Jurassic of New Zealand. Furthermore, this study adds crucial data on osmundalean systematics and is the first attempt to analyze the natural variability of at least one group of fossil royal fern rhizomes based solely on specimens.

ID: 159

The evolution of raptorial morphological adaptations within dictyopteran insects

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Evolving ecosystems, oral presentation

The group Dictyoptera, ingroup of Insecta, includes the groups Mantodea (praying mantises), Blattodea (cockroaches) and Isoptera (termites, as ingroup of Blattodea). Modern day representatives of Dictyoptera exhibit a wide range of lifestyles, including different types of sociality within cockroaches and termites, whereas all representatives of Mantodea are obligate predators with an almost always solitary lifestyle.

Dictyoptera has a long fossil record. Its representatives were already abundant more than 315 million years ago in the Carboniferous forests. These Palaeozoic forms possessed a cockroach-like morphotype with many similarities to modern representatives of Blattodea in general habitus. First clear morphological indications of a raptorial lifestyle within this group can be found in the Cretaceous. In this time period, also first clear evidences of the presence of representatives of Mantodea occur, yet, the origin of the group in deep time is still debated.

In contrast to representatives of Dictyoptera today, a raptorial lifestyle seems to not to have been restricted to the group Mantodea. There are also indications of raptorial behaviour in Cretaceous cockroaches and other dictyopteran groups exclusively known from fossils. Based on morphological indications, also different strategies for capturing prey seem to have been present in comparison to what we can observe in species living today.

Investigations in respect to the first presence of raptorial behaviour, as well as different kinds of raptorial strategies within Dictyoptera can help to gain a better understanding of the evolution of the group in deep time. The role of these animals in past ecosystems and food-webs is only very fragmentarily known; insights about raptorial adaptations might also be a chance to add some pieces for a reconstruction of these complex systems.

ID: 165

The microfauna (Foraminifera, Ostracoda) of the Eggenburgian (Lower Miocene) stratotype section and its associated deposits

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Open session, Micropaleontology, poster presentation

Correlations of sedimentary records within the Paratethys realm are still very challenging, predominantly caused by poorly described sections. For instance the fossil content of the Mold Formation and the Loibersdorf Formation in Lower Austria is only described on a macroscopic scale. Especially for the latter it is of absolute importance, as these sediments are hosting the stratotype section of the Eggenburgian regional stage. This study presents for the first time the microfauna of these deposits.

The Eggenburgian (~20.5 – 18.2 Ma) documents a continuous transgression throughout the Paratethys, accompanied by the uprising of a typical Pectinid fauna. In the Horn Basin of Lower Austria the initial transgressive phase is documented in the sedimentary record by the Mold Formation (silt, clay), overlain by the Loibersdorf Formation (fine sand, coralline algae limestone, sandy silt). This record shows the interfingering and finally replacement of a typical brackish mollusk fauna, comprising *Mesohalina*, *Ostrea* and *Mytilus* by a marine assemblage with the species *Laevicardium kuebecki*, *Oopecten gigas*, as well as the genera *Turritella* and *Glycimeris*.

The microfauna examined in this study validates these observed environmental changes in the Horn Basin. The material for micropalaeontology was collected during the mapping campaign of the Austrian Geological Survey on the 1:50000 sheet 21 Horn. In the Mold Formation opportunistic benthic foraminifera of the genus *Ammonia* are dominant, accompanied with an ostracod fauna mainly comprising the limnic genus *Ilyocypris*. In contrast the assemblages in the Loibersdorf Formation are very diverse, showing shallow marine individuals of the genus *Elphidium*, as well as the genera *Nonion*, *Cibicidoides*, *Bolivina*, *Stilostomella*, and *Ammonia*. For the first time, these results provide comparative material for stratigraphic issues in the Paratethys. Furthermore, a detailed facies analysis of the Horn Basin is now possible, integrating macro- and microfossil assemblages.

ID: 147

Using the Paleobiology Database and MorphoBank to facilitate collaborative research and data archival

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Workshop open data, oral presentation

The internet has made it possible to share and store large quantities of data, and as a result, there is an increasing imperative to make data easily accessible and results reproducible. This has been facilitated by the proliferation of online tools available for archiving and sharing data. In this talk I will describe two databases that are structured in different ways but provide useful platforms for collaboration, reproducibility, and data archival. The first is the Paleobiology Database (PBDB), which is a public resource for paleontological data in support of global, collection-based occurrence and taxonomic data for organisms of all geologic ages. I will give a brief history of the PBDB; describe how data is contributed; describe data services for browsing data, downloading data, and the independent development of analytical and visualization tools; and describe how to make research based on data from the PBDB replicable. The second is MorphoBank, which is a project-based platform for organizing and archiving morphological data and images affiliated with that data, and whose primary use has been for building morphological matrices for use in phylogenetic and disparity analyses. I will give a brief history of MorphoBank; describe tools for data creation, editing, and export; and describe how the platform is best used for replicability and data archival during the review process and after publication. Finally, I will discuss the future of both databases, focusing particularly on initiatives for connecting each with other databases and with the R Project for Statistical Computing, as well as educational resources and funding.

ID: 145

New approaches to peer review in the age of online, open-access publishing

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Workshop open data, oral presentation

"Electronic publishing" can mean a variety of things, but for the dissemination of scientific results, there are two major categories: 1) materials that have not gone through peer-review, such as community-database entries, presentations from conferences, and manuscripts posted on preprint servers; and 2) materials that have gone through peer-review and are subsequently posted online. In the latter case, the process of peer-review is usually managed by a body of editors associated with a journal. If a manuscript is published by such a journal, the reader can be assured that it went through the peer-review process successfully. In the last decade or so, journals have started to abandon printed issues of peer-reviewed articles and are now publishing exclusively online; there have also been a proliferation of new online-only journals. Concurrently, there has been a shift towards open-access publishing, which, while making scientific studies more broadly available, has also transferred the financial burden from the reader or subscriber to the authors and funding agencies. Lastly, there has been a shift in how manuscripts on preprint servers are viewed, and it is increasingly common in many scientific fields for authors to post a finalized manuscript to a preprint server prior to submission to a journal. This talk will describe the "Peer Community In" (PCI) Project, which is a non-profit organization that was established in response to these major shifts in scientific publishing. The PCI Project is comprised of communities of researchers working in different fields (including paleontology), who peer review and recommend research articles publicly available on preprint servers. The goal is to promote rigorous scientific study by providing an alternative to traditional avenues for peer-reviewed publishing.

ID: 242

A probabilistic model of correlated discrete morphological character evolution for phylogenetic inference

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Molecular Geobiology and Paleobiology, oral presentation

Despite the importance of morphology and the fossil record for understanding macroevolutionary patterns and processes and the history of life, statistical models of morphological evolution for use in Bayesian frameworks to infer phylogenetic trees remain relatively simple and restricted. Here, we present a new discrete Markov model for modelling correlation between morphological characters. Under this Mc (Markov correlated) model, correlated clusters of character evolve under latent processes from which observed character states are emitted probabilistically. Character clustering is determined using a Dirichlet process mixture model. We use the Mc model, as implemented in the popular Bayesian phylogenetic inference program MrBayes, to infer a phylogeny of mammals using a large binary dataset. We further perform divergence time estimation and compare the results under our model with previous tree topologies and dates in the literature.

Young Scientist Award

ID: 138

Reproducible data analysis of data archived in PANGAEA with pangaeapy and Jupyter notebooks

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Workshop open data, oral presentation

Data are the basis of the empirical sciences, especially in life and earth sciences. Thanks to the systematic collection and archiving of research data in trustworthy long-term archives, researchers today can access large amounts of such data in order to evaluate them in a multidisciplinary and transparent manner for their own questions.

PANGAEA is one of the world's largest archives of this kind offering essential data services such as data curation, long-term data archiving and data publication. PANGAEA hosts about 385,000 datasets comprising around 15 billion individual measurements and observations that have been collected within the framework of more than 240 international research projects. The system is open to any project, institution or individual scientist using, archiving or publishing research data.

PANGAEA also supports the processing and analysis of research data using Big Data and Data Science methods. Since the programming languages Python and R have become increasingly important for scientific data analysis in recent years, we have developed 'pangaeapy' (https://github.com/pangaea-data-publisher/pangaeapy), a new, custom Python module that considerably simplifies typical data science tasks. Given a DOI, pangaeapy uses PANGAEA's web services to automatically load PANGAEA metadata into a dedicated python object and tabular data into a Python Data Analysis Library (pandas) DataFrame with a mere call of a specialized function. This makes it possible to integrate PANGAEA data with data from a large number of sources and formats (Excel, NetCDF, etc.) and to carry out data analyses within a suitable computational environment such as Jupyter notebooks in a uniform manner.

In this talk, we present PANGAEA, its geoscientific database and its international role. We introduce the use of 'pangaeapy' using Jupyter Notebooks and show a number of data science application examples, such as Bayesian statistics, time series analysis or paleotemperature reconstructions using modern analog techniques (MAT).

ID: 207

Save the conodonts! Archiving museum collections of Swedish Silurian conodonts in the Paleobiology Database

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Workshop open data, oral presentation

The conodont research programme initiated by the late Lennart Jeppsson during half a decade of his work at Lund University has transformed not only the understanding of the multielement taxonomy and function of these animals, but, above all, the vision of early Palaeozoic ecosystems. His seminal models postulating multiple ecological crises affecting marine fauna, coupled with changes in oceanic circulation and manifested in carbon isotope excursions, have inspired generations of scientists and research projects. Lennar Jeppsson was famous for refining the procedure of conodont extraction and for processing extraordinarily large samples. This decades-long sampling effort resulted in an unrivaled record of conodont communities from the Silurian of southern Sweden, hosted now at Swedish Museum of Natural History. However, observations scattered across tens of articles combined with taxonomy changing over the years have made it very difficult to exploit this dataset for quantitative ecological analyses. Here we present the preliminary results of archiving the content of over thousand samples in the publicly available Paleobiology Database. This archive offers countless opportunities for research in conodont community ecology and evolutionary dynamics. We argue that this Open Data approach to archiving museum collections may give them a second life, enhance their use, and foster on-site, specimen-level use.

ID: 114

The life history traits of five common pleurotomariid (Gastropoda) taxa from the Pennsylvanian of Texas

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Evolving ecosystems, oral presentation

The order Pleurotomariida is one of the most diverse gastropod groups of Late Paleozoic seas. The diversity of pleurotomariids had its acme in the Carboniferous and decreased continuously afterwards. Understanding the life history traits might help to better understand the intrinsic factors that might have played a role in their extinction. We analysed exceptionally well-preserved specimens from bulk and surface samples from the Pennsylvanian Finis Shale of Texas from two localities. Shell breakages in specimens smaller than 1 mm show that the specimens were exposed to durophagous predation starting from the very early period of their life after benthic larval settlement (metamorphosis). The number of juveniles and the ratio of juveniles to adult specimens are much higher in the members of two eotomariid genera *Trepospira* and *Glabrocingulum* compared to the members of two phymatopleurid genera *Phymatopleura* and *Worthenia*. This suggests that *Trepospira* and *Glabrocingulum* had higher reproductive rates (i.e., number of juveniles per adults) and lower survival rates. Comparison of protoconch size between the eotomariid and the phymatopleurid taxa (~100 µm vs ~200 µm) suggests an evolutionary trade-off between the number and size of the offspring. We find a negative (but not significant) correlation between the reproduction rate and the shell repair frequencies of the taxa that have been previously reported. Shell repair frequency (total number of repaired injuries divided by total number of specimens) depends among other factors on the lifespan and is expected to be lower in organisms with shorter lifespan. The differences in shell breakage frequencies observed in the pleurotomariid taxa have been explained with morphological traits in previous studies; however, an evolutionary trade-off between the reproduction rate and the lifespan might be an alternative explanation for this observation.

Young Scientist Award

ID: 160

Diversity and palaeoecology of the bivalve fauna from the Pliensbachian (Lower Jurassic) of Buttenheim, Franconia

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Evolving ecosystems, poster presentation

The dark clays of the Amaltheenton Formation (Pliensbachian, Spinatum Zone) of Franconia (N Bavaria) yield a diverse and well-preserved macrofauna. Together with gastropods, bivalves form the most abundant and diverse benthic group. The last taxonomic study on the Pliensbachian bivalves from Franconia was done by Kuhn in the 1930ies. We studied, from a taxonomic point of view, new rich bivalve collections (ca. 7,000 specimens) from a clay pit near Buttenheim. The bivalve fauna comprises 57 species belonging to 40 genera and represents the most diverse benthic faunal group at Buttenheim and one of the most diverse Early Jurassic bivalve faunas in European epicontinental seas. Infaunal bivalves (e.g., *Ryderia doris*) are more diverse and abundant (55%) than semi-infaunal (e.g., *Myoconcha francojurensis*) and epifaunal (e.g., *Pseudopecten equivalvis*) bivalves. The most abundant species (24%) is *Harpax spinosus*, which cemented itself to a hard substrate (mostly other shells) when juvenile and became a free recliner on soft substrates during the adult stage. Although not abundant (2%), five species with a chemosymbiotic mode of life are present. Among them, many shells of the infaunal "*Thyasira*" *antiqua* exhibit drill holes (78% of the articulated specimens). Drilling predation is quite rare in the Jurassic, and such a high drilling frequency suggests that the predator was highly specialized with respect to its prey. Two species, belonging to a new genus, are probably the oldest members of the microcarnivorous family Cuspidariidae. Two endemic *Nicaniella* species show morphological dimorphism (i.e., presence/absence of crenulations along their shell margin). The change through ontogeny from smooth to crenulated shell margins suggests that these species were protandrous hermaphrodites (changing their sex from male to female). Generally, the studied bivalves are small-sized, probably due to the soft substrate and oxygen fluctuations. Many of the taxa became extinct at the end-Pliensbachian/Early Toarcian extinction event.

ID: 227

A late Permian mesoflora from Trebnitz near Gera (Thuringia, Germany)

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

Fossil plants from the German Zechstein are known in different types of preservation. The classical Zechstein flora from the former copper mining regions, in Saxony, Lower Saxony and Hesse, consists of adpressions without organic material, occurring in marine copper slates. The information of the epidermal anatomy of Zechstein plants is primarily based on cuticles that have been isolated from compression specimens. Another, less well studied, type of flora consists of usually dispersed, strongly fragmented plant debris deposited in a terrestrial to marginally marine environment. This type of association received little attention so far. The region around Gera is long since known for well-preserved Zechstein fossils. In the 1990s Zechstein marls and limestones were exposed in a temporary outcrop in a highway construction site at Trebnitz near Gera, Thuringia. The sediments were deposited in a lagoonal environment and bedding planes are often completely covered with fine commutated plant debris. Cuticles are excellently preserved and bulk macerations appeared to contain 10 taxa, including two genera, *Ortiseia* and *Majonica* that were originally described from the Southern Alps, northern Italy, but had not been recorded from localities elsewhere, and a new species of *Quadrocladus*. The association is strongly dominated by conifer remains (9 taxa) with the peltaspermalean seed fern *Germaropteris martinsii* as a minor constituent of the flora.

ID: 113

Diversity of Middle Permian gastropods in Central Thailand

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Evolving ecosystems, oral presentation

Mainland Southeast Asia was formed by the collision of two main terranes, the Indochina terrane in the East and the Sibumasu terrane in the West, during latest Paleozoic to early Mezosoic times. Two Middle Permian gastropod assemblages from two localities in Central Thailand, which were collected from the Tak Fa Limestone of the Indochina terrane and the Ratburi Limestone of the Sibumasu terrane, were investigated regarding their diversity. These two assemblages derive from shallow water carbonate platforms yielding abundant invertebrate fossils, especially gastropods. The Tak Fa Limestone yielded ca. 1,000 silicified gastropod specimens representing 40 species and the Ratburi Limestone yielded ca. 400 specimens representing 34 species. Rarefaction analysis suggests that the gastropod fauna from the Tak Fa Limestone is more diverse than that of the Ratburi Limestone. Diversity indices indicate moderate diversity for both assemblages. Although both gastropod assemblages have approximately the same age (Middle Permian), their taxonomic composition differs strongly. The gastropod fauna from the Tak Fa Limestone is strongly dominated by the vetigastropod *Anomphalus* sp. followed by *Warthia* cf. *brevisinuata* and *Glabrocingulum magnum* in abundance. The gastropods *Warthia* cf. *saundersi*, *Protostylus* sp. and *Stegocoelia*? sp. being the most abundant species of the Ratburi Limestone. Both assemblages share only a single nominate species *Retispira lyelli*. Both gastropod assemblages from Thailand are compared with other faunas from Asia (Malaysia, Timor and Japan). Rarefaction analyses and diversity indices suggest that gastropod diversities from Thailand are less diverse than the others Permian gastropod faunas from Asia. However, Late Palaeozoic cosmopolitan genera are present throughout these faunas. On the species level, a high Beta diversity can be recognized i.e. few species are shared. This suggests that the tropical eastern Tethys was hotspot of gastropod diversity during the Middle Permian.

Young Scientist Award

ID: 143

Microbial-, fusulinid limestones with large gastropods - an unusual facies from the Middle Permian of Central Thailand (Khao Khad Formation, Saraburi Group)

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Open session, poster presentation

The Middle Permian of Central Thailand has long been part of intensive research focusing on stratigraphy, sedimentology and tectonic evolution. It is characterised by complex reef-bearing carbonate platform and basin development (Pennsylvanian to Guadalupian) prior to the Indosinian orogeny (Lower-Middle Triassic) resulting in complex tectonic patterns with several fold-and-thrust belts. The well exposed carbonates of the Khao Khwang platform in the Saraburi region are situated in the Khao Khwang fold belt along the western edge of the Indochina terrane on the eastern side of the Chao Phraya central plain and the western margin of the Khorat Plateau. The sediments belong to the Saraburi group with three main carbonate sequences (Phu Phe, Khao Khad, Khao Khwang formations) interbedded with mixed siliciclastic-carbonate basinal sequences (Sap Pon, Pang Asok, Nong Pong formations).

The Khao Khad formation generally developed through the late Kungurian to Capitanian (Midian) on a marine shelf with a broad range of environments ranging from peritidal, low-energy lagoonal, high-energy middle platform to backreef, algal reef to outer shelf foreslope settings. Herein we describe a new unusual coarse grained rudstone/bindstone facies from Khao Wong Hill, Phra Phutthabat district, Saraburi province, characterized by large gastropods, fusulinids, large dasyclads, solenoporaceans, intraclasts and thick microbial-cyanobacterial coatings and reticulate microbial patches as well as thick inter- and intragranular radial fibrous cement crusts. Preliminary data suggest a shallow water high energy perireefal deposit. The fusulinids from Khao Wong Hill can be attributed to the latest Kungurian. Large gastropods contribute significantly to the rock volume and this is unusual for Permian carbonate rocks. This sheds light on the impact of the end-Permian mass extinction on gastropod size, i.e., the widely discussed Lilliput Effect.

ID: 203

Evidence for a new extinct group of African cichlid fish

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

One of the most iconic examples of diversification is the remarkable variety of cichlid fishes in the modern East African Rift Lakes, with hundreds of endemic species inhabiting each of the biggest lakes (Victoria, Tanganyika, Malawi). The past ichthyodiversity of this region still remains to be fully explored, although several sites have long been known to yield well-preserved fish fossils. In this study, articulated fossil fish specimens from the Ngorora Fish Lagerstaette of the Tugen Hills, Kenya, dating to the middle-to-upper Miocene, are presented for the first time (sites Yatianin and Terenin) or reappraised (Rebekka, Poi). Unlike many fossil fishes, some of the newly studied fossils revealed a high X-ray attenuation, permitting the application of microCT technology. The micro-CT scans revealed anatomical details to an unprecedented degree for fossil cichlids. At least four new species were identified from the sites Yatianin and Terenin. The unique combination of morphological traits such as tricuspid or unicuspid oral dentition, a preopercle with six lateral line foramina, a slender urohyal lacking or with a very reduced anterodorsal projection and cycloid scales, indicates the presence of a new extinct group of African cichlids. The high degree of silicification of the fossil-bearing sediments of three of the four localities is evidence for the alkalinity of the respective paleolakes. This may indicate that this new group of cichlids may have been adapted to survive such harsh environments. These discoveries open several new windows for research, including questions on the geographic distribution, the diversity and the ecology, as well as the timing, the places and causes of the emergence and extinction of this group.

Young Scientist Award

ID: 148

Do reefs evolve?

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Plenary presentation

Coral reefs, as we know them today from tropical, shallow-water coasts, are just one of several realizations of a basic principle: an enhanced production and fixation of calcium carbonate relative to the surrounding sea floor. Dominant calcifying taxa, diversity, and various additional attributes of reefs changed profoundly over geological time. Multivariate analyses of these attributes have been used to define Reef Evolutionary Units (REUs). Identifying discrete units in reef patterns does not automatically imply that reefs evolve in a Darwinian sense, that is, through heritable variation and natural selection. However, there are increasing hints that reefs actually evolve.

First, reefs show distinct assembly rules with limited membership at a variety of time scales. For example, Pleistocene coral reef communities exhibit constancy in composition in spite of dramatic changes in sea level and temperature, and middle Triassic sponge-microbial reef systems are similarly structured as the Late Permian counterparts, despite the end-Permian mass extinction. Second, selection of community types may occur through differential expansion. For example, the variance of biotic reef types has declined during the Ordovician radiation and in other intervals.

Broadening evolutionary concepts to the extended phenotype (sensu Dawkins) of all reef organisms and their symbionts may help to place reef paleobiology into the emerging integrated theory of evolution.

ID: 142

Brackish water algal reefs - facies development in the Miocene deposits in Mainz-Weisenau

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Evolving ecosystems, oral presentation

The Cenozoic Mainz Basin (mid-west Germany) is a well-studied area in terms of palaeontology. Though, some questions about the depositional system are still open. The outcrops in the renaturated quarry of Mainz-Weisenau offer the possibility to study the environmental conditions during the Rüssingen Formation (Aquitanium, Miocene). In this study the open questions about changes in salinity and water depth, as well as the thereby caused response of the depositional system, are tackled. Furthermore, the facies development and reef growth in brackish carbonates are documented, which are far less studied than marine or limnic carbonates. A detailed description and a profile of the section were made, and samples were taken for thin section analysis. The deposits can be described as allochthonous limestones which surround a big autochthonous reef complex and several small reefs. The allochthonous facies consists mainly of gastropods of the genus *Hydrobia*, the reef facies of the green algae *Cladophorites* which is overgrown by bacterially precipitated cloudy structures followed by laminated chemical precipitations. Occasionally quiver-shaped structures of protective cases of Trichoptera occur. The depositional setting during the Rüssingen Formation was a low depth, low energy, brackish and carbonatic (super-) saturated environment. A predicted general trend of reducing salinity during the Rüssingen Formation cannot be confirmed. But the set-up, the distribution of the reef facies, and reef debris indicate short-time variations of temperature, salinity and water depth. These variations are due to the position of the sedimentation space at the southwestern edge of an algal reef barrier separating the Mainz Basin from the Rhine Graben.

Young Scientist Award

ID: 144

Reef Fish Beware! Aggressive Mimicry in a Pycnodontid?

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Pycnodontiformes are an extinct order of Actinopterygian fishes, present from the Late Triassic (Norian) to the Eocene. Their mostly deep, laterally compressed bodies and comparatively large fins indicate that these fishes were mostly highly manoeuvrable reef fish. With their characteristic durophagous dentition, columnar to incisiform anterior teeth (on premaxilla and dentary) and the posterior crushing teeth of the prearticular and vomer, the whole group was highly specialized as predators on hard-shelled organisms.

In 2016, however, a new pycnodontid was found in the quarry of Ettling (Markt Pförring, Bavaria; Late Jurassic) by the excavation team of the Jura-Museum Eichstätt. The most striking feature of this new pycnodontid, *Piranhamesodon pinnatomus* Kölbl-Ebert et al., 2018 (JME-ETT4103), is its unusual dentition: It has long, pointed teeth at the front (on premaxilla and dentary), dagger-shaped teeth with a sharp, posterior cutting edge along the exterior-most tooth row of the vomer, and triangular teeth with serrations on their anterior margin along the exterior-most tooth row of the prearticulars. As revealed by CT-scanning, the inner teeth of prearticular and vomer are limpet-shaped cones on a columnar tooth base.

The "fangs" along the exterior-most tooth row of the prearticulars and vomer of *Piranhamesodon pinnatomus* interact like scissors; a comparison of their functional morphology with other actinopterygians stress the exceptional high bite-force (a legacy of their pycnodont ancestry), which is comparable to modern piranhas, suggesting a completely unusual mode of predation compared to all other known pycnodontids.

We propose this species to have exploited aggressive mimicry: Seemingly harmless and inconspicuous through the typical pycnodontid shape and possibly aided by corresponding colouring, it may have approached and then attacked unsuspecting other fish in the reef, biting and tearing a mouthful of flesh or fin from their unwary prey. Alternatively, it may also have acted at least occasionally as scavenger.

ID: 119

Biogeography of Mammutidae (Proboscidea) or What's your name again? *Mammut*?

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Open session, oral presentation

Mammutids are an extinct family of proboscideans which are known from Africa, Eurasia and North America. During the late early Miocene (MN3b, about 17.5Ma) the mammutid genus *Zygolophodon* immigrated from Africa to Eurasia, almost synchronous with some other proboscidean taxa, the deinotheres and gomphotheres. Mammutids stood extremely conservative in their tooth morphology in the course of time, and their fossil remains are rarely found, therefore a reconstruction of their evolution is difficult. According to the traditional view, in Eurasia *Zygolophodon turicensis* evolved during the Pliocene into "*Mammut*" *borsoni*. In a somewhat eurocentristic view, the genus *Mammut*, with its short symphysis and small or reduced lower tusks, evolved in Eurasia and reached North America via Bering-Land-Bridge during the Pliocene; where it persisted as *Mammut americanum* until the end of the Pleistocene.

The fossil record, however, proves that *Zygolophodon* occurred in North America already during the Late Hemingfordian NALMA (15.5Ma early middle Miocene). American authors generally accepted a continuous evolution from *Zygolophodon* to *Mammut americanum* in North America.

Based on so far unpublished materials from Kaltensundheim (Germany) and Unity (Oregon, USA) a strikingly similar evolution of the mammutids occurs in both, Eurasia and North America. Does this similarity result from a multiple faunal exchange? Did both groups evolve independently but parallel the same characters on both sides of the Pacific?

No indication is available that Mammutidae participated in any later faunal exchange than that in the Hemingfordian. The new material strengthens the plausibility of a continuous evolution in North America. Therefore, a parallel evolution on both sides of the Pacific has to be postulated. The genus *Mammut*, however, cannot have originated on different continents at different times. The genus name *Mammut* is tied to *M. americanum* and therefore the Eurasian species *borsoni* cannot be assigned to the North American genus *Mammut*.

ID: 194

Permian and Triassic scanilepiforms (Actinopterygii) of Eastern Europe and Northern Asia and their polypterid affinity

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

The polypteriforms, unique among living ray-fins by their three-layered (Palaeozoic-type) ganoid scales, several dorsal finlets developing from one long-based fin, four gill arches, a functional lung, etc., occupy a basal position in most current phylogenies, branching off the actinopterygian tree before or immediately after the Devonian *Cheirolepis*. Their fossil record, however, does not extend beyond the Cretaceous. A contrasting hypothesis considering the Scanilepiformes, an essentially Triassic group of freshwater actinopterygians, as ancestral to Polypteriformes, based mainly on a re-interpretation of cranial and branchial morphology, is supported by our ongoing investigation of new and rediscovered material of *Toyemia* Minich, 1990, *Evenkia* Berg, 1941 and *Oshia* Sytchevskaya, 1999.

Evenkia, resolved in some analyses as the fossil sister group of recent polypterids, comes from the Early Triassic Bugarikta Formation of the Lower Tunguska river basin in Siberia, whose age and palaeoenvironmental setting is constrained by a diverse non-marine fauna. *Evenkia* is conspicuous by the presence of a long-based dorsal fin with > 70 lepidotrichia, a hemi-heterocercal tail and pectoral fins with a fleshy scaly lobe.

Oshia is a comparatively large actinopterygian from the mid-Triassic lacustrine fossil lagerstaette of Madygen, Kyrgyzstan. Recently obtained CT data shed light on its endocranial morphology. Similarities to *Evenkia* in the structure of fins, skull bones and squamation justify the placement of this insufficiently known fish within the Scanilepiformes.

Toyemia, hitherto known only by incomplete and very fragmentary remains, is an important taxon for the Middle and Late Permian biostratigraphy of European Russia. The appearance of *Toyemia* coincides with a turnover in the regional fauna, interpreted in the context of palaeogeographic changes towards more restricted freshwater basins. A redescription of *Toyemia* on the basis of previously unpublished specimens reveals polypterid-like traits in the morphology of skull, scales and fins and allows tracing the scanilepiform/polypteriform lineage back into Middle Permian.

ID: 166

Success and demise of pycnodont fishes (Neopterygii, †Pycnodontiformes)

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

The rise of neopterygian fishes in the Late Triassic was associated with the emergence of modifications to the skull that enabled fishes to crush heavily armoured prey items such as crustaceans, echinoderms and molluscs. Three lineages of durophagous fishes were prevalent throughout the Mesozoic: Ginglymodi, †Dapediiformes and †Pycnodontiformes. Of these, pycnodontiforms were taxonomically much more diverse and seemingly very successful during most of the Mesozoic with a fossil record spanning 175 million years. While dapediiforms vanished during the middle Jurassic, pycnodontiforms prevailed but finally went extinct in the middle-late Eocene. The only group still present are the ginglymodians although very reduced in taxonomic diversity and restricted to freshwaters today. Nevertheless, all three groups occupied the same marine ecosystems during the Mesozoic but the role that competitive exclusion and niche partitioning played in their ability to survive alongside each other and the success of one group relative to the others remain unknown. We established diversity patterns and performed geometric morphometric analyses using the lower jaw as constraint for feeding adaptations and the body shape as constraint for habitat occupation to better understand competition and its consequences but also why pycnodonts seemingly were more successful but still died out. According to our results, pycnodonts were more successful than the others in terms of taxonomic diversity. Moreover, competition between dapediiforms and ginglymodians occurred, while pycnodontiforms were performing a different role in the ecosystem. Competition reduction between pycnodontiforms and the other two durophagous clades resulted in niche partitioning. While dapediiforms were outcompeted, ginglymodians evaded competition with pycnodontiforms by adapting exclusively to freshwater habitats in the Late Cretaceous. Competition within pycnodontiforms was reduced by developing different feeding strategies. Extinction of pycnodontiforms in the Palaeogene probably did not result from competition with emerging modern coral fishes, but other reasons might have been more important.

ID: 124

Did the Czekanowskiales already exist in the late Permian?

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

The Permian is a period of important innovations and radiations among the gymnosperms, including the peltaspermalean and glossopteridalean seed ferns, cycadophytes, ginkgophytes, Vojnovskiales and conifers. The modern aspect of the flora has been increased lately due to the appearance of "typical late Permian" taxa such as voltzian conifers in early Permian successions and of "typical Mesozoic"plant taxa such as *Dioonitocarpidium*, *Swedenborgia*, *Dicroidium*, Bennettitales, Araucariaceae and Podocarpales in Permian sediments. The possibility to discover such "abnormal" taxa in the flora is increased by exceptional preservation, high abundance in collected material and exceptional preservation potential of the sedimentary succession. The Bletterbach gorge (NE-Italy) is one of those areas worldwide, that yielded exceptional Wuchiapingian (late Permian) floras including the well preserved cuticles of the "cuticle horizon" and a diverse and articulated flora with plant-animal interactions in the "megafossil horizon". Thus, it is not surprising that the Bletterbach plant assemblage includes also some scales and strap-like leaves that resemble representatives of the order Czekanowskiales. The isolated capsule-like reproductive organs were recently described as a new genus, *Brinkia* Kustatscher et al., 2019. Two species have been distinguished, i.e., *Brinkia kerpiana* Kustatscher et al., 2019 and *B. cortianensis* Kustatscher et al., 2019, respectively from the middle and late Wuchiapingian of the Southern Alps. *Brinkia* capsules resemble in gross morphology single valves of the *Leptostrobus*-type, Mesozoic reproductive organs belonging to the Czekanowskiales. A czekanowskialean affinity is reinforced by the fact that the *Brinkia* remains are found associated with strap-like leaves resembling those of *Czekanowskia*. This expands the record of the Czekanowskiales to the Wuchiapingian (early Lopingian) and suggests that during the arid late Permian climate representatives of the order could occupy the more humid habitats within the deltaic floodplain formed during a sea-level rise.

ID: 125

First record of a complete *Pterigophycos* from the Eocene of Bolca (Veneto, N-Italy)

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Open session, poster presentation

"Monte Bolca" in northern Italy is most widely known today for exceptionally well-presserved Eocene fish fossils, but the Fossil-Lagerstätte has in fact yielded a diverse flora and fauna, both marine and terrestrial in origin. Fossils mostly come from laminated micritic limestones of the "Pesciara", in which exceptional preservation is common, but also occur in other deposits throughout the Bolca area. The carbonate mudstones were probably deposited in a moderately depressed coastal tropical setting strongly influenced by the open sea. Plant remains are generally rare in the collections, and mostly consist of small fragments or isolated leaves or seeds, due primarily to the transport from the terrestrial ecosystems and/or shallow marine growth environments to the deeper marine, often anoxic, depositional environments. The only exception are the impressive palm fronds that were mostly deposited in the coal horizons of the swampy, proximal environments of Monte Postale. In this poster, we present a rare fossil of a complete plant of a large marine alga. The general scarcity of large plant fossils makes this specimen noteworthy. The fossil is characterized by four large (up to 32 cm long and 10 cm wide) and several small, deeply incised blades, basally fused in a central nodular holdfast-like structure from which extend several narrow root-like appendices. The blades are quite variable in shape and dimension. Isolated blades similar to those seen in our specimen have previously been described by Massalongo (1859) and assigned to different taxa, including *Laminarites*, *Delesserites* and *Pterigophycos*. The new specimen presented here demonstrates that Massalongo's specimens all belong to a single species. Similar features can be observed also in some extant algae such as for example *Egregia menziesii* (Laminariales).

ID: 141

High resolution record of a sea-level shift during the Wuchiapingian (late Permian) in the tropics and its effects on floral composition and fossil preservation

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Evolving ecosystems, oral presentation

The Wuchiapingian is characterised by aridisation and substantial sea-level changes, which affected strongly the local composition of ecosystems and the preservation potential for terrestrial biota. The well-known succession exposed in the Bletterbach Gorge (Dolomites, N-Italy) yielded one of the best-preserved and most diverse vertebrate ichnoassociations and plant assemblages of the Wuchiapingian worldwide. These features, as well as the rare co-occurrence of plant fossils, tetrapod footprints and plant-animal interactions make the Bletterbach Gorge a crucial site for the understanding of late Permian terrestrial ecosystems in Euramerica. Most plant remains and tetrapod footprints come from the Gröden/Val Gardena Sandstone, a succession dominated by mainly coarse- to medium-grained sandstones, mostly red in colour. Particularly fossil-rich levels are located about 70 metres from the base of the formation, close to the so-called 'Cephalopod Bank' which corresponds to the maximum flooding surface of a marine incursion. High -resolution sedimentological, palaeobotanical and palynological analyses around the 'Cephalopod Bank' enable to reconstruct the environmental changes during the late transgression, highstand and initial phase of regression in a primarily near-coastal floodplain setting. Litho- and palynofacies provide information about continuous changes in the general landscape. Par-autochthonous plant fossils document quantitative and qualitative changes in the local composition of the ecosystem. Quantitative and qualitative changes in the composition of the palynological assemblages reflect variations in the biological content of the ecosystem changes at a regional scale in relation to the rise and fall of sea-levels.

ID: 201

Carnassial crown curvature as a possible indicator for functional reduction in dentitions of carnivorous mammals

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Open session, oral presentation

Molar crown curvature of the lower carnassials (m1) of carnivorous mammals was measured as the total Dirichlet Normal Energy (DNE) of the enamel cap. Comparatively high values occur in the mesocarnivorous morphotype, which reflects the ancestral condition for the Carnivora, with a carnassial blade besides a well-developed talonid basin. A diminution of curvature characterized the carnassials of hypercarnivorous Carnivora with a vestigial talonid and is lowest in Feliformia with a fully reduced talonid. The same pattern can be observed in carnivorous marsupials (Dasyuromorphia) and the extinct Hyaenodonta. Like in the Carnivora, the ancestral condition with a well-developed carnassial blade and talonid shows high curvature values, while low values occur in the specialized hypercarnivorous taxa with a reduced talonid. Low total crown curvature values in all three groups are linked to an increased degree of carnassialization and the reduction of the talonid-protocone functional complex. Further, a second trend of decreasing curvature can be observed in some hypocarnivorous Carnivora. Low curvature values, clearly outside the spectrum of mesocarnivores, occur in the mainly herbivorous cave bear and the frugivorous binturong (*Arctictis binturong*) and are correlated with a reduction of the carnassial blade. Thus, different phyletic lines of hypercarnivores convergently loose the crushing function of the carnassials by reduction of the talonid basin, while hypocarnivorous Carnivora loose the cutting function by reduction of the trigonid blade. The resulting functional constraints are reflected by total DNE values of the respective carnassial crowns. Overall, low curvature values seem to indicate a reduction of multifunctionality. This project is funded by the German Academic Scholarship Foundation.

Young Scientist Award

ID: 156

Widespread functional diversity in morphologically convergent sabre-tooth vertebrates

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Open session, poster presentation

The acquisition of elongated, sabre-like canines in at least seven different clades of synapsid vertebrates during the last 265 million years represents a remarkable example for convergent evolution. Sabre-tooth morphologies have evolved independently in Permian mammal-like gorgonopsians, in the marsupial sabre-tooth *Thylacosmilus*, and in five different lineages of carnivorous mammals. Due to the striking similarities in the cranial skeleton, the same or similar skull and jaw functions have been inferred for sabre-toothed species and interpreted as an adaptation to the hunting and killing of large-bodied prey. Although sabre-tooth felids have been divided into separate ecomorphologies – dirk-toothed and scimitar-toothed taxa – the functional diversity within and between groups and the evolutionary trajectories leading to these specialisations is unknown. Using digital visualisation, biomechanical analyses and evolutionary modeling, functional performance measures (absolute/effective jaw gape, bite force, mandibular stability) were compared across seven groups of sabre-toothed vertebrates. The results demonstrate that these performance measures varied considerably between different groups and between different species. Functional diversity was widespread among sabre-toothed species and cranial function and prey killing strategies progressed along a continuum but are largely obscured by superficial morphological similarity. Opposing biomechanical trends in sabre-tooth felids further suggest that this functional diversity was at least partially driven by niche-partitioning to avoid intra- and interclade competition.

Best practices and approaches for open data sharing and publication

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Open Data and Analysis workshop - presentation, oral presentation

Technological advances, such as digital visualisation and computational analyses, have considerably transformed the study of living and fossil organisms in palaeontological and biological research over the last two decades. The widespread application of computed tomography, laser and structured light scanning, and photogrammetry has revolutionised the study of morphology, while geometric morphometrics and biomechanical analyses provide new tools to quantitatively and rigorously test functional and evolutionary hypotheses. As a result, three-dimensional digital morphological data are commonly generated and employed by palaeontologists and biologists in research and represent an unprecedented pool of information.

However, the initial promise that the widespread application of such methods would facilitate access to and dissemination of the underlying digital data has not been fully achieved. The datasets for many published studies are not readily or freely available, introducing a barrier to verification and reproducibility, and the reuse of data. Currently, there is no general agreement or policy on the amount and type of data that should be made available alongside studies that use or are reliant on digital morphology. Here, a set of recommendations for data sharing standards and additional best practice for three-dimensional digital data publications (e.g. 3D PDFs) is presented and possible issues around data storage, management and accessibility are discussed.

These practices have the potential to erode barriers to data sharing and access to specimens because data exist as digital files that can be easily copied and readily distributed, allowing simultaneous analysis by multiple researchers. These attributes should also enhance the verifiability and reproducibility of studies, facilitating the reuse of data and metadata, more in-depth interrogation of any given dataset, and broader-scale comparative analyses through the assembly of large datasets of multiple specimens or taxa.

Young Scientist Award

ID: 180

Food preferences of mustelids from Göriach (Early-Middle Miocene) (Styria, Austria)

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Open session, poster presentation

Mustelids have a high diversity in food preferences and locomotion. They range from carnivorous members, like *Mustela*, to more omnivorous badgers and mollusk-crushing otters.

The aim of this work is to differentiate the modern European Mustelidae on the base of their food preference. To classify the feeding types a more detailed database of extant European Mustelidae was created. We combine traditional tooth measurements (taken after Friscia et al. 2007), which we correlate with a newly developed dental mesowear analysis, based on the carnassial dentition. For the mesowear study, landmark analysis of the carnassials was executed. Principal component analysis was performed for the interpretation of the results. We further use these results to determine the dietary preferences of the Early to Middle Miocene mustelid fossil remains from Göriach near Turnau (Styria, Austria). The following fossil taxa were included in our analysis: *Potamotherium miocenicum*, *Lartetictis dubia*, *Trocharion albanense*, *Trochictis depereti* and *Taxodon* sp. described by Toula (1884) and Thenius (1949).

To clarify the result, outgroups were taken for each feeding type. Felids (*Panthera leo*, *Lynx lynx*, *Felis silvestris* and the fossil *Megantereon cultridens*) are typically known to be hypercarnivores. The crushing feeding type is represented by the sea otter (*Enhydra lutris*) and the omnivorous type by the badger (*Meles meles*).

The smaller *Mustela*, as well as the bigger *Gulo* are a carnivore group. On the contrary the group of *Martes* are more omnivore, closer to the badgers. The European otter plots more to the sea otter.

Based on the results of this study it is possible to differentiate the three feeding types (carnivorous, omnivorous and crushing/hard object feeding) between the European mustelids. The Miocene mustelids from Göriach plot clearly in the omnivorous to crushing niche, close to the otters, badgers and the martins.

ID: 229

Filling gaps: Devonian echinoids, holothurians, and cyclocystoids (Echinodermata) from China

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Open session, poster presentation

Articulated echinoids from Palaeozoic strata are notably rare worldwide, even in China. Previously, only a handful of specimens and species were reported from the Carboniferous of southern China. However, the extensive Devonian marine deposits of southern China yielded diverse invertebrate faunas, including echinoderms. The Late Devonian Heyuanzhai Formation (late Givetian to Frasnian) of western Yunnan has delivered so far diverse and abundant crinoid faunas as well as one blastoid species. New collections and combined macro- and micropalaeontological methods result in the recognition of articulated and/or disarticulated echinoid, holothurian and cyclocystoid material, which increases the known echinoderm diversity from China.

Besides isolated ambulacral/interambulacral plates and spines, we are reporting one complete echinoid specimen of a new genus and species (Echinocystitidae), which is characterised by distinct imbricate plating of the test, very large pedicellariae, a conspicuous madreporite and Aristotle's lantern. We are also newly reporting radial/interradial calcareous ring elements of stem group apodid sea cucumbers. Additionally, a broken cyclocystoid marginal ossicle have also been found.

Those echinoderms collected from a coral biostrome unit of the upper Heyuanzhai Formation at Shidian sections have been found in association with rugose corals, stromatoporoids and bryozoans, suggesting a shallow-water depositional environment. Further microfossil findings provide evidence for the presence of ostracods, tentaculites, machaeridians, and asterozoan echinoderms. Based on conodonts, the upper part of the Heyuanzhai Formation in western Yunnan is Frasnian (~380 myr) in age.

Finally, this is the first record of Chinese Devonian echinoids and the first report of holothurian calcareous ring elements and cyclocystoid ossicles from China. These occurrences greatly expand the distribution of echinoid, holothurian and cyclocystoid echinoderm fossils from Laurussia to Gondwana.

ID: 237

A new Eocene batoid fish (Elasmobranchii, Myliobatiformes) from Monte Bolca (Italy) reveals an extinct body plan for stingrays

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

In the last few years, the detailed taxonomic and systematic revision of the Eocene cartilaginous fishes (Chondrichthyes) from the Bolca Lagerstätte (Italy), one of the most famous paleontological sites of the world, has provided new insights into the fish biodiversity of the western Tethys. The morphological analysis of two previously undescribed complete and articulated batoid specimens from the Pesciara deposit of Bolca revealed the existence of a new stingray genus which is unique among the myliobatiform batoids in having the following unique combination of characters: low number of vertebrae posterior to the pelvic girdle (65-68); thoracolumbar synarcual extending backward beyond the pelvic girdle; tail extremely short not protruding from the posterior edge of the pectoral disc; pectoral radials proximally fused to each other; pelvic girdle extremely small and strongly arched; dorsal and caudal fins absent; tail stings and cartilaginous tail rod absent; and teeth of dasyatoid morphology with smooth enameloid surface. The phylogenetic analysis suggests that the new taxon is deeply nested within the benthic stingrays (Dasyatoidea) representing the sister to all dasyatids and potamotrygonids. Its unique anatomy reveals the existence of a new hitherto unknown body plan experimented by the stingrays, whose evolution can be possibly linked to the adaptive fish radiation in the aftermath of the end-Cretaceous extinction.

Young Scientist Award

ID: 111

Revision of the pachycormiform fishes from the Upper Jurassic of Nusplingen (Baden-Württemberg, Germany)

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Known since the mid-1800s, the Upper Jurassic (late Kimmeridgian) Nusplingen lithographic limestone of Baden-Württemberg has yielded hundreds of exceptionally preserved vertebrate fossils, most of them of small- to medium size. Larger taxa are extremely rare, but have the potential to broaden our understanding of the trophic complexity of the ecosystem. We review the pachycormiform fishes of Nusplingen, and discuss their significance for variability and diversity of the clade.

Two skulls from Nusplingen have previously been referred to '*Hypsocormus*' *macrodon* and subsequently to *Pseudoasthenocormus retrodorsalis*. Re-evaluation indicates that the smaller specimen (1) is too fragmentary to be referred to genus, whereas the larger (2) shares similarities with *Orthocormus*. Two additional undescribed specimens are known: (3) a recently excavated skull and pectoral fin consistent with '*Hypsocormus*' *macrodon*, and (4) an articulated skeleton potentially referable to *Orthocormus* but differing from all known species in median fin position and squamation, as well as from specimen (2) in mandibular morphology. Specimens (2) and (3) are both large fishes, estimated at over 1000 mm standard length (SL), whereas specimen (4) is smaller (690 mm SL). Specimen (4) contributes additional palaeobiological information, with gastric contents preserved, and ribs showing signs of callus formation.

Pachycormiform diversity at the Nusplingen locality consisted of at least three taxa, but due to their extreme rarity, they were likely only occasional visitors to the region. Difficulties in referring the Nusplingen pachycormiforms to existing genera highlights gaps in our knowledge of the group: most notably, a lack of robust diagnostic characters pertaining to the skull. Large, pelagic fishes are expected to show broad geographic and stratigraphic ranges; however, our revision suggests a large amount of morphological variation between the pachycormiforms from Nusplingen and those from slightly older and younger localities. The underlying cause of this variation may be taxonomic, but requires further investigation.

ID: 179

Fauna and flora in the Alps before the Last Glacial Maximum evidenced by the Nesseltalgraben fossil record

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Open session, poster presentation

The Nesseltalgraben site in southeastern Germany provides a unique sediment record of the last glacial period for the Northern Calcareous Alps. The 21 m-long, radiocarbon-dated profile contains floral and faunal remains from the period 29.6-59 cal ka BP (based on extrapolation beyond 50 cal ka BP). It represents one of the very few Middle Würmian Alpine records covering the entire Marine Isotope Stage 3 (MIS 3). This period is characterized by extreme climate variability known as Dansgaard-Oeschger cycles. The effects of repeated cooling and warming on the vegetation are evidenced by the successive depletion of woody taxa in the pollen record. Almost all identified wood fragments belong to *Pinus*. Moss assemblages are dominated by fen taxa, with additional contributions of terrestrial and spring taxa at times. Charophyte layers, shells of freshwater gastropods and bivalves (*Pisidium* sp.), ostracod valves, and chironomid head capsules demonstrate the repeated presence of permanent bodies of standing water especially in the lower part of the section. Bone remains of bovids and mammoth indicate the presence of large mammals in the inner-Alpine valleys during MIS 3. Beetle remains belong to several families, including Chrysomelidae, Carabidae, and Curculionidae. Overall, the Nesseltalgraben site offers the unique opportunity to reconstruct Alpine habitats until the area was covered with c. 600 meters of ice during the glacier advance of the Last Glacial Maximum.

ID: 163

Unusual structure of the upper jaw of Jurassic and Cretaceous ammonites

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Physiology in Deep Time, oral presentation

Ammonoids, extinct cephalopods, inhabited seas for more than 300 million years, until their extinction at the end of Cretaceous. Their shells are iconic fossils which are very popular amongst fossil enthusiasts and are very useful tools for biostratigraphy. Jurassic and Cretaceous ammonoids of the suborders Ammonitina and Ancyloceratina (usually called “ammonites”) are of particular interest due to their abundance, diversity and rapid evolution. Their role in the Mesozoic marine ecosystems was extremely important. However, the study of their feeding strategies and position in the food chain is complicated since knowledge about their jaw apparatus is incomplete.

Ammonoid jaws are the oldest unquestionable cephalopod jaws, known to date. These jaws evolved throughout the Paleozoic and Mesozoic and researchers have identified up to 6 of different types. The most unusual and mysterious among them is the aptychus type, which is peculiar to most of Jurassic and Cretaceous ammonites. The lower jaws of this type consist of two symmetric valves (“aptychi”) which are often found disarticulated. The outer surface of these valves is often covered with calcite.

Lower jaws of the aptychus type are relatively well-studied. Nevertheless, the structure of the upper jaw still remains poorly known. In general, cephalopod upper jaws consist of two plates: inner and outer. The outer plate (“hood”) is responsible for biting. However, according to several observations, upper jaws of ammonites had no hood. Such a structure would have prevented hunting for large prey.

The study of ammonite jaw apparatuses from the Jurassic of Central Russia made it possible to delve further into the morphology of the upper jaw which is in fact much more complex than previously thought, and these jaws have a hood and could have been used for hunting large prey.

ID:

The lithological dependence of *Hydrobia* (gastropod) preservation in monospecific deposits of the Miocene Mainz Basin

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Open session, oral presentation

The genesis of limestone-marl alternations (LMA) is lively debated in carbonate sedimentology. Regardless of the rhythmicity's origin, limestones were lithified early by $CaCO_3$-cement derived from dissolution in adjacent marls. It is debated, however, whether pressure dissolution of calcite, or selective aragonite dissolution (differential diagenesis) is the major process. This question is difficult to answer because aragonite is usually not preserved, and thus its dissolution hard to prove. The Miocene brackish-water deposits (Rüssingen Formation) from the Mainz-Weisenau (Germany) offer an opportunity to fill this gap. These carbonates developed as alternating horizontal beds of moderately to poorly lithified monospecific sands of aragonitic *Hydrobia* snails, which resemble classical LMA. These monospecific deposits reflect times of little to no changes in sediment input and allow to study the preservation of *Hydrobia* in both lithologies, and thus to gauge the diagenetic process forming LMA and its influence on aragonite loss.

XRD and RFA analyses revealed high $CaCO_3$ contents (92% Æ) without clear differences between lithified (limestone) and unlithified (marl) beds. Analyses of the carbonate phases, however, revealed a high amount of aragonite and a low amount of calcite in marls, and the opposite in limestones, where calcite is the main carbonate phase. These differences in aragonite to calcite ratio (A/C ratio) fit the model of differential diagenesis. According to this model, aragonite is dissolved, transported along geochemical gradients, and re-precipitated as calcite cement lithifying the later-on limestone beds. The different preservation of *Hydrobia* is documented by observations of stained thin sections. Despite significant loss of aragonite in marls, the relative amount of aragonite is higher than in limestones because the dissolved aragonite precipitated here as calcite cement, shifting the A/C ratio. Although the investigated succession is no classical (micritic) LMA, it obviously experienced differential diagenesis, introducing a differential preservation potential for aragonitic fossils.

Young Scientist Award

ID: 211

Palaeogeographical distribution of terrestrial floras from the Lopingian to the Middle Triassic and implications for biodiversity

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

It is certain that terrestrial floras underwent important changes in the Lopingian (late Permian) to Middle Triassic interval, but there are open questions about the specifics, such as the timeline in relation to the end-Permian mass extinction among marine invertebrates and possible differences between palaeogeographic regions. We therefore analysed the available occurrence data of land plant macrofossils and sporomorphs from the Lopingian to Middle Triassic for differences between regions and respective changes across stages. One main problem is unequal sampling between regions. In terms of data abundance, Europe and South China have the best documented land plant fossil records. These two regions are also the only ones with well-dated records concerning both macro- and microfossils from all six stages here considered, albeit with varying coverage. The macrofloras – but not sporomorphs in the current dataset – of North China also cover all six stages. Well-dated Early Triassic macrofloras are documented from considerably fewer locations and represent fewer palaeogeographical regions in total compared to the late Permian and Middle Triassic. By contrast, sporomorph assemblages from the late Permian have a more limited palaeogeographical distribution than those from the Triassic. These differences can in part explain the disparate trends in the taxonomic diversities of land plant macrofossils and sporomorphs for this stratigraphical interval. In general, the gaps and other limitations in regional sampling limit the reliability of biodiversity calculations and palaeobiogeographical assessments.

Young Scientist Award

ID: 127

Gastropods as parasites and carnivorous grazers – a major guild in marine ecosystems

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Evolving ecosystems, oral presentation

Parasitism and similar life styles such as carnivorous grazing without killing the prey are important in marine gastropods. Some of the most diverse living gastropod families have this feeding behavior. Taxonomic uniformitarism is the most important tool to infer parasitism in fossil gastropods. The extant family groups in question, Eulimidae, Epitoniidae, Coralliophilinae, Pyramidellidae, Arcitectonicidae, Coralliophilinae, Cerithiopsidae and Triphoridae originate mostly in the Late Cretaceous (Cerithiopsidae in the Middle Jurassic) and Paleocene. They are performing an ongoing adaptive radiation and some of the mentioned families belong to the most diverse gastropod groups forming a considerable part of marine ecosystems regarding species richness and relative abundance. At the same time, origination and radiation of the carnivorous, commonly predatory Neogastropoda took place. This points to a trophic revolution in Gastropoda that forms an important aspect of the Mesozoic Marine Revolution. Most modern parasitic gastropods are small, high-spired, show high diversity and low disparity within families and belong to Apogastropda. By analogy, some extinct gastropod families which show the same properties might have lived parasitic too (e.g., Pseudozygopleuridae, Zygopleuridae, Meekospiridae, Donaldinidae). However, this remains largely speculative. Direct evidence for parasitism is exceptional, with the Palaeozoic platyceratid/crinoid interaction one of the best-studied examples. Functional shell morphology may help to identify parasitism in the fossil record but this field is scarcely studied.

ID: 130

The oldest cowrie – an early African immigrant to Italy?

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Open session, poster presentation

Cowries (Cypraeidae) comprise approximately 400 living species and subspecies, and have a rich Cenozoic and scanty Cretaceous fossil record. Today, we often associate their glossy, colourful shells with the tropical Indo-Pacific, where most of their modern diversity is located. However, the oldest Cypraeidae are known from Europe, from the island of Sicily (Italy). During a visit to the Museo di Geologia 'G. G. Gemmellaro' in Palermo, we 're-discovered' the type material of *Cypraea tithonica*, which had been considered lost. The species was established by Giovanni Di Stefano in 1882, together with a second species, *Cypraea gemmellaroi*, the type of which is still missing. The specimens come from an isolated limestone outcrop at Termini Imerese, which is Early Tithonian in age, and part of a series of structural domains formerly located on the African continental margin, which were obducted onto the European part of Sicily. With a wink, the coffee-bean-shaped *Cypraea tithonica* could thus be considered an early African immigrant to Italy. Cowries are conspicuous in having a convolute shell, with the last whorl overgrowing all previous whorls, and a narrowly elongate, slit-like aperture. The type material of *Cypraea tithonica* has never been re-studied since its initial description in the late 19th century. The shells generally have the typical morphology of modern cypraeids, but differ sufficiently from younger taxa to represent a new genus (to be described). The new Cypraeidae genus and the genus *Columbellaria* from the Late Jurassic of Central Europe are the oldest gastropods that share a slit-like aperture. This feature has been interpreted as a – probably convergent – anti-predatory adaptation, which evolved in the course of the Mesozoic Marine Revolution.

ID: 217

A rare find: protoconch in Cretaceous nerineid "gastropod dinosaurs"

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Open session, poster presentation

Nerineoidea is a very diverse fossil group of mostly high-spired gastropods, some of them quite large and with complex folds and protrusions in the aperture respectively whorls. The family ranges from the Jurassic to the end-Cretaceous mass extinction event so that the group can be referred to as "gastropod dinosaurs". There are several hundred to a few thousand named species. Despite this high diversity, only very few protoconchs have been reported because nerineoids occur mostly in shallow water mixed siliciclastic/calcareous sediments that are prone to strong diagenetic alteration and are thus not favourable for the preservation of tiny, delicate gastropod protoconchs. We found well-preserved protoconchs in the nerineids *Aptyxiella granulata* Münster and *A. flexuosa* (Sowerby) from Cretaceous deposits of the Gosau Group at the Pletzach Alm in Austria. It is a smooth heterostrophic larval shell. The high-spired taxa in question is also well-documented in terms of external shell ornaments and the fold pattern within whorls. The latter are documented by internal moulds as well a micro-ct scans. The new find sheds new light on the discussions of the phylogenetic position of Nerineoidea either close to Tubiferidae ("opisthobranchs") or Pyramidellidae. The systematic position of nerinid gastropods (Tubiferidae) is supported by the position of the exhalant opening at the posterior end of the aperture as a consequence of the shifting of the pallial cavity to the right side. Furthermore, the parietal and the palatal plaits which obviously had no function in muscle attachment delimit a posterior space proceeding from early ontogenetic whorls to the penultimate whorl. It is opening to the anterior part of the whorl in a narrow slit and is considered as equivalent to the pallial caecum of the Heterobranchia. Besides this morphological distinction, a comparabale diet of these generally large gastropods to that of modern Pyramidellidae seems unlikely.

ID: 169

The Pennsylvanian flora of the Italian Carnic Alps

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Late Paleozoic and Mesozoic Plants and Floras, poster presentation

The Carnic Alps, located along the Italian–Austrian border, provide excellent outcrops of Pennsylvanian deposits often very rich in fossils. Besides the diverse fauna preserved in marine carbonates and siliciclastics, the successions yielded exceptional macrofossil plant assemblages. It is therefore not surprising that these well-exposed fossiliferous successions have attracted attention of earlier geologists and palaeontologists since the middle of the 19th century. After WWI and the division of the Carnic Alps between Austria and Italy, the studies of the Carboniferous plant fossils of the Carnic Alps continued almost exclusively on the Austrian side. Today more than 30 fossiliferous sites and more than 90 taxa are distinguished. On the other hand, the plant assemblages collected from the Italian side, today mostly stored at the Museo Friulano di Storia Naturale (about 2,500 specimens), have so far never studied in detail. A revision of the plant assemblages permitted to distinguish 14 different fossiliferous sites on the Italian side of the Carnic Alps. All major plant groups are preserved. The lycophytes are represented by vegetative organs (*Sigillaria*, *Syringodendron*) and reproductive organs (*Lepidostrobophyllum*, *Sigillariostrobus*). Sphenophytes are represented by the genera *Calamites*, *Annularia*, *Asterophyllites*, *Calamostachys* and *Sphenophyllum*. Zygopteridales are quite rare and restricted to the two genera *Nemejcopteris* and *Schizostachys*. Ferns are very abundant and diverse and include, among others the genera *Cyathocarpus*, *Lobatopteris*, *Acitheca*, *Pecopteris*, *Diplazites*, *Scolecopteris*, *Senftenbergia* and *Oligocarpia*. Quite common are also the Callistophytales (*Dicksoniites*, *Eusphenopteris*), Medullosales (e.g., *Alethopteris*, *Neuropteris*, *Odontopteris*, *Callipteridium*) whereas taeniopterids (*Taeniopteris*) and Cordaitanthales (*Artisia*, *Cordaites*) are subordinate. The Plant assemblages from all the 14 localities are of Late Pennsylvanian age.

ID: 245

Fish fossils and the reconstruction of continental paleoenvironments

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Fossil fishes in the context of evolution, environments and biogeography, keynote presentation

In the current context of global change and biological extinction, paleontology provide original information on the biodiversity response to environmental change. With that aim, one crucial information is the reconstruction of past environments and their change through time, which is peculiarly complex in the case of the continental contexts that are much less continuous and homogenous than marine ones. Since environmental conditions and their change along geological times mold each organism, the study of the fossils themselves appears nonetheless relevant but necessary to document environments and their change at various time scales.

In that frame, I will show the interest of freshwater fossil fish to reconstruct past environments on landmasses where they will inform us on the aquatic systems, their connectivity, extant and permanence and on other features such as resource, temperature and climate. Evolutive processes link each species with tectonics and climate, and phylogenies allow redrawing the watershed fragmentation over long timescales. At an instant geological time, the ecological assembly in each site tells the nature of the aquatic system that prevailed, and the growth of the fish and the record of isotopic markers in skeletal elements along its life inform on climatic features. Alongside the development and use of these tools to provide paleoenvironmental data, the interpolation of these data is critical to built robust reconstructions. Finally, I will conclude with the thorny and still open question of relating paleoenvironmental information with paleodiversity change on landmasses.

ID: 151

Investigating the role of Southern Ocean phytoplankton in the end-Eocene climatic events

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Evolving ecosystems, poster presentation

Marine planktonic diatoms are today's main carbon exporter to the deep-sea. Although they are known since the Cretaceous, they only diversified and became an ecologically important group in the plankton for the first time in the late Eocene. At the same time, the Southern Ocean as we know it today formed due to the opening of the Drake and Tasman Passages, allowing the formation of the Circumantarctic Current, and thus the establishment of the Antarctic planktonic biome. The latest Eocene is also marked by the glaciation of East Antarctica, and a known drop in global temperature and atmospheric pCO2. In our new project, funded by the DAAD's "Make Out Planet Great Again" initiative, using an integrative approach combining diatom paleobiology, radiolarian biogeography, foraminifera-based geochemistry and ocean-climate modelling, we intend to test the hypothesis according to which tectonically-driven changes in the ocean circulation, together with an increase in weathering rates, increased the polar ocean areal extent and ocean nutrients, and impacted polar diatoms diversity, abundance and thus productivity, which in returns affected global climate through a drawdown of pCO2. Also of interest, this project will allow us to study the evolutionary impact of climate change on diatoms and radiolarians.

ID: 196

Stable isotopes sclerochronology on freshwater gastropods of the Steinheim basin

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Evolving ecosystems, oral presentation

The Steinheim Basin (Baden-Württemberg, south Germany) is an epicontinental sedimentary basin set in place by a meteoritic impact in the Langhian stage (middle Miocene, 14.6 Ma). Early in the lake history, a small pioneer species, the planorbid gastropod, *Gyraulus kleini* Gottschick & Wenz, 1916, colonized the lake and underwent a remarkable endemic evolution. This site is one of the most famous and well known in the history of palaeontology thanks to the work of Hilgendorf (1867) and has been the object of several successive researches. However, a clear environmental characterization of the lake and the evolutionary pressures that triggered the evolution of so many different forms and their ecological specialization are still poorly understood. In this work, we try to understand processes and environmental changes that might have played a role in the ecological evolution of one of the clades that evolved from *Gyraulus kleini*, the so-called main branch, characterized by bigger species and high intra- and inter- specific variabilities. To do so, we serially sampled the shells for the analysis of stable isotopes of carbon and oxygen. This method allows to study environmental variations that occurred during the lifetime of the animals. In addition, the method can be used to estimate the lifespan of the specimens. Preliminary results from the specimens analysed so far show isotope ratios that are in accord with past research, with δO values relatively high (from 1.00 to 3.50‰) and $\delta^{13}C$ ranging from -3.00‰ and -1.00‰. The specimens were likely living for longer than a year, growing the most during their first year. With the next results we hope to be able to characterize the Steinheim lake environment, its seasonal changes in water parameters and to describe the ecological strategies of some species of the Main-branch.

Young Scientist Award

ID: 190

A pygocephalomorphan crustacean from the Piesberg quarry highlights the resemblance of European and North American Coal Measures faunas

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Open session, poster presentation

It was during the Paleozoic that many of the lineages of crustaceans living today first appeared. Fossils of Eumalacostraca, a very diverse group within eucrustaceans, are common in all Upper Carboniferous deposits referred to as Coal Measures in Europe and North America. In Germany, the Piesberg quarry near Osnabrück in Lower Saxony yields a great diversity of fossils. This Pennsylvanian deposit (Moscovian or Westphalian D) is famous for plant remains. Also the diversity of Euarthropoda is impressive. There are fossils of Euchelicerata such as scorpions and xiphosuridans, wings and other remains of different species of Insecta, diplostracan and ostracodan crustaceans, and also now eumalacostracans. Five new specimens of the latter group are presented: one almost complete specimen with delicate structures, including mouth parts and thoracic appendages, an isolated pleon and three isolated shields. The shields are smooth on the dorsal side. The anterior margin is drawn out into a prominent rostrum and bears one pair of antero-lateral spines, the lateral margins have six lateral spines. The first pair of thoracic appendages is specialized as maxillipeds, with an elongated endopod that reaches the mouth. The remaining seven pairs of thoracopods have slender and locomotory endopods and short, setose natatory exopods. No remains of pleopods are visible. The telson and broad uropods form a tail-fan, a plesiomorphic character within Eumalacostraca. The characters presented by the fossil are similar to *Anthracaris gracilis*, a pygocephalomorphan from the Mazon Creek Lagerstätte of North America. Also other fossils from both localities share striking external morphological similarities, providing a basis for comparing and reconstructing the faunas of the coal measures.

ID: 188

Advances on reconstructing the evolutionary history of peracaridan crustaceans

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Open session, oral presentation

Eumalacostraca is one of the most diverse and successful lineages of mostly aquatic animals living today. Also, the group has an impressive fossil record, from very unspecialized species in the late Paleozoic to highly specialized species from the Mesozoic around the world. This fact has led to the belief that most of the major modern groups of Eumalacostraca were already differentiated during the Paleozoic, like for example Peracarida. From the nine major ingroups of Peracarida, only Isopoda, Tanaidacea, Cumacea and now Amphipoda have fossil species from the late Paleozoic. All, but the last, come from the Carboniferous Konservat-Lagerstätte Mazon Creek. From the remaining ingroups, Mictacea has no fossil record at all, and Spelaeogriphacea is known from Mesozoic fossils, while the lineage towards Mysida, Stygiomysida and Lophogastrida may have early representatives within the Paleozoic group Pygocephalomorpha. This potentially non-monophyletic association of species comprises shrimp- to lobster-like crustaceans recorded from near-marine to brackish deposits of Laurasia and Gondwana. Many of the 26 species described as pygocephalomorphans exhibit only plesiomorphic characters which place them certainly within Caridoida, such as a strong tail-fan possibly capable of an escape reaction. However, some pygocephalomorphan females possess oostegites, specialized thoracic structures that form a brood pouch. Oostegites are one of the autapomorphies of Peracarida. One of the characters used to group these fossils is the shape of the shield. Yet, this character is challenging. Apparently, we see convergent evolution of characters of the shield in various lineages of Eumalacostraca. We used a morphometric approach for quantifying aspects of this similarity among pygocephalomorphans and other eumalacostracans.

Young Scientist Award

ID: 191

Evaluating the phylogenetic potential of cichlid scales

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Cichlids are tropical freshwater fishes and exhibit an exceptional diversity of species. Their generally conservative 'bauplan' and the occurence of great similarities even between distantly related species often cause difficulties in species identification. Since cichlid scales vary in size, shape, ornamentation and arrangement on different parts of the fish, scale characteristics have been repeatedly included in taxonomic studies of extant and fossil cichlids. The first comprehensive survey on scales and patterns of squamation for extant African cichlids (Pseudocrenilabrinae) was provided by Lippitsch (1989–1998). Her matrix comprised about 100 characters concerning 26 distinct regions of the fish. She used this dataset as a basis for phylogenetic investigations with a focus on the tribe Haplochromini, which accounts for a major part of the ichthyodiversity in the Great Lakes of the East African Rift System. However, in the last decade the Haplochromini as well as other cichlid tribes have undergone considerable taxonomic and systematic change, and also new tribes have been described. Lippitsch's systematic concept is thus not congruent with the current understanding of the present-day tribes of African cichlids, and some tribes are not included. The aim of this study is to review and re-evaluate the taxonomic and phylogenetic usefulness of scales of Pseudocrenilabrinae. This will be achieved by creating a new matrix of scale characteristics that includes all known 27 extant tribes of the Pseudocrenilabrinae and approximately 70 selected genera. The characters compiled by Lippitsch will be re-evaluated and new characters (e.g. scale width-to-length ratios, relative scale sizes), which have turned out to be useful in the taxonomic classification of recently described fossils, will be added. We hope that future determinations of fossil cichlid specimens will greatly benefit from this new data matrix, which will thus contribute to the understanding of fossil cichlid diversity.

ID: 232

Preliminary work on the evolutionary history of *Sweetognathus* through morphometrics

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Micropaleontology, poster presentation

The *Sweetognathus* conodont genus is a shallow-water taxon that has a global distribution, displays high degrees of morphologic variability, and has an uncertain evolutionary history. This study will quantitatively test how biotic and abiotic stresses impacted the evolution of this lineage and to consider whether *Sw. asymmetrica* is an example of convergent evolution with *Sw. whitei*. The type specimens of *Sw. whitei* were first described in the Mayoworth area of Wyoming in 1963 and are correlated to be Asselian (296 Myr) in age. The homeomorph, *Sw.* aff. *whitei* (now *Sw. asymmetrica*), originated in the Ural Mountains of Russia and are correlated to be early Artinskian in age (290.1 Myr).

This project investigated the Mayoworth section in Wyoming in order to collect a representative conodont population. Conodont samples were collected from the Nowood Member of the Tensleep Formation, a pelletiferous, bioclastic, dolostone interbedded with red, fine-grained sand to siltstone deposits. The Nowood Member displays cyclic patterns of marine and non-marine deposits, which likely correspond to short eccentricity cycles of 100-kyr that can be correlated to cyclothems in Kansas.

Of the samples analyzed, conodonts important for biostratigraphic correlations and examining the *Sweetognathus* lineage included *Sw. merrilli*, *Sw. whitei*, *Sw.* sp. A, *Streptognathodus constrictus*, and *St. fusus*. A single bed of the Nowood Member had both the highest diversity and abundance of conodont fauna, and based on the occurrence of *St. constrictus*, *St. fusus*, and *Sw. whitei* is latest Asselian in age.

The next stage in this project will involve constructing 3D models using a GE Phoenix V | tome | xs240 μCT scanner of adult P1/P2 elements and using geometric morphometric and Fourier-based analyses to quantify inter- and intra-specific morphological variation of the Mayoworth material as well as representative material from Nevada, arctic Canada and the Ural Mountains of Russia.

ID: 134

Insights *Mesiteia emiliae* GORJANOVIĆ-KRAMBERGER, 1884

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

On the eastern edge of the Mediterranean Sea, in the mountains of Lebanon, fossils have been discovered and excavated in small limestone quarries for centuries, at least since Herodotus (5th century BC). A huge amount of incredibly well preserved upper Cretaceous plants and animals of a tropical shallow water sea has been collected by local families. Finds from the fossil deposits of Hakel (Haqil) and Hajula (Hgula) (lower Cenomanian), of En Nammoura (middle Cenomanian) and Sahel Alma (upper Santonian) are among the best preserved fossils in the world. Like fossils of the Jurassic limestones of Bavaria, they can be found in all museums around the world, but unfortunately many groups, despite their fame, have so far been poorly scientifically researched.

Mesiteia emiliae Gorjanović-Kramberger, 1884 is one of the most enigmatic and rarest species of fossil sharks. For more than hundred years after it's first description in 1884 it was thought that the only known specimen was found in the Eocene limestones of Monte Bolca in Italy. In 1980 Cappetta corrected this error and described *Mesiteia* as belonging to the family Hemiscylliidae, together with *Acanthoscyllium* and *Almascyllium*, all three from the upper Cretaceous limestones of Lebanon.

At the Mineral Show 2011 an excellently preserved specimen of *Mesiteia emiliae* could be purchased for the Bavarian State Collection of Palaeontology and Geology. During the past seven years the author had the chance to collect and study some more specimens of *Mesiteia*. New finds of specimens combined with some excellent preparations and an overview on all 24 known specimens provides astonishing insights and allows anatomical descriptions of many parts of the skeleton and also of the teeth. Many unique anatomical and odontological characters separate *Mesiteia* from the family Hemiscylliidae and led to the question if *Mesiteia* can remain within the family Hemiscylliidae.

ID: 243

First fossil teeth of the etmopterid deepwater lanternshark genus *Miroscyllium* (Squaliformes), new taxonomic classification of teeth erraneously attributed to *Miroscyllium* and new genera attributed to Etmopteridae

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Ledoux (1970) presented drawings and described in detail teeth of modern Squalidae. In 1972 he added a Miocene squaloid shark assemblage from Southern France, including two teeth of a *Centroscyllium* sp. from Bonpas.

A few years later Dolganov (1986) described a new modern species of *Centroscyllium*, *C. sheikoi*, which had a strange lower jaw dentition with labiolingually compressed teeth and all cusps strongly bent distally. Shirai & Nakaya (1990) raised *Centroscyllium sheikoi* to the new generic rank *Miroscyllium*.

Siverson (1993) noted that Ledoux's *Centroscyllium* sp. could belong to *Miroscyllium* and later Adnet, Cappetta & Nakaya (2006) assigned Ledoux´s teeth to *Miroscyllium*.

The author presents here pictures of a new specimen of *Miroscyllium sheikoi* and rejects the former attribution of Ledoux's *Centroscyllium* sp. to *Miroscyllium*. Instead he shows pictures of the so far only fossil record of *Miroscyllium* from Mitterdorf near Passau (Lower Ottnangian). The striking difference to Ledou's teeth is the inclination of the main cusp of the crown. Ledoux's *Centroscyllium* sp. and also aff. *Miroscyllium* sp. from latest Burdigalian of Slovakia (Underwood & Schloegl, 2013) belong to another new genus of Etmopteridae.

In Lower Eggenburgian sediments of Wallern, Upper Austria the author found (1980-1985) teeth of a new genus of Etmopteridae, with lower jaw teeth similar to Ledoux's species but without lateral denticles and with needle-shaped upper jaw teeth.

There are more new Etmopteridae from Paleocene to Miocene localities of New Zealand belonging to this same “group”.

Welton (2016) correctly re-arranged *Orthechinorhinus* Adnet (2006) with *O. pfeili* from Eocene of SW France and also St. Pankraz near Salzburg, and *O. davidae* from Oligocene of Oregon. He shifted *Orthechinorhinus* from Echinorhinidae to Etmopteridae.

Only the presence of some characters of the lower jaw teeth supports the attribution of these new fossil genera to Etmopteridae and so this remains dubious.

ID: 221

A microfossil study of a Late Glacial and Holocene section of the Siebleber Senke (Gotha, Thuringia)

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Micropaleontology, poster presentation

The Siebleber Senke (Depression of Siebleben) close to Gotha in Thuringia, Central Germany belongs to a number of natural saline inland water (athalassic) sites in the Thuringian Basin which are in contact with evaporate bearing sediments of Triassic or Permian age. The ascendance of brines is facilitated by NW-SE trending faults running through the study area. We test several methods of ostracod-based palaeoenvironmental reconstruction using the indicator species approach, mutual ecological/climatic range methods, transfer functions, modern analogue technique and morphological variation within *Cyprideis torosa* in reconstructing the site evolution of this late Quaternary small lake basin. Sediment sections containing a diverse ostracod fauna were studied and compared with those from modern water bodies of Thuringia. Palynological investigations were executed to reconstruct the environmental conditions in the catchment area and for an obtaining a biostratigraphical framework. The brackish water ostracod *Cyprideis torosa* as well as the foraminifer *Haplophragmoides* indicate phases of saline groundwater influence, fed by salt bearing sediments of the Triassic basement. The accompanying freshwater ostracod fauna, however, reflects only low variations of water temperature and climate. However, the abrupt and distinct occurrences of saline ostracods with plants, indicate wet meadows, suggest mobilisation of salts in the underground during wetter climate periods.

ID: 122

Pairwise clustering of Devonian oncocerids (Cephalopoda) suggests semelparity

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Open session, oral presentation

Reproductive strategies of fossil groups are often difficult or even impossible to reconstruct, especially when the organisms in question have no close relatives today. In rare cases, however, some clues can be gathered from the distribution patterns of individuals on a bedding plane. For instance, conspicuous occurrences of closely associated pairs of specimens of the same species have previously been interpreted as indications for reproduction.

Here, we present a case of late Givetian (Middle Devonian) oncocerids (Cephalopoda) from the Tafilalt of Morocco that frequently occur in closely associated pairs in one locality. We statistically analysed the distribution of 73 oncocerid specimens in an area of 80 m^2 on one bedding plane. We used spatial point pattern analyses with Monte Carlo simulations and several models of point pattern processes. The analyses show that the pattern strongly deviates from models of spatial randomness. By contrast, the specimens fit a clustering model well, with an average cluster size of two. We furthermore analysed the spatial distribution of ammonoids and orthocerids on the same bedding plane but found no evidence of a similar clustering pattern. This indicates that the oncocerid pattern was caused by a biological process rather than post-mortem transport. The latter also cannot explain the high prevalence of pairs.

Because of the absence of any indications for a "death trap" that might have surprised mating partners, we suggest that these oncocerids were semelparous, which is further supported by the absence of juveniles on this bedding plane. Similar reproductive strategies are common in modern coleoids. By contrast, the presumably more closely related extant *Nautilus* is iteroparous.

Young Scientist Award

ID: 247

Growing preservability in the early evolution of animals

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Molecular Geobiology and Paleobiology, poster presentation

The seemingly abrupt appearance of fossils of recognisable members of animal phyla in the Early Cambrian remains as one of the biggest mysteries in Paleontology. Many scenarios that attempt to explain the exceptional nature of this event have been posed, with different authors listing possible causes, both intrinsic, related to the biology of early animals, extrinsic, i.e.: taphonomical, or a mix of both. A popular interpretation considers that this sudden appearance may be a consequence of the acquisition of jaw elements, thick cuticles and mineral skeletons in a brief period during the diversification of bilaterian phyla. However, this perception probably derives from our clearer understanding of bilaterian morphology and evolution, in contrast to the non-bilaterian lineages, sponges, ctenophores, placozoans, and cnidarians, some of which also possess hard parts. A similar pattern of sudden appearance is also observed in the record of sponges; despite the lack of convincing Ediacaran spicules, Early Cambrian microfossil assemblages contain diverse spicule assortments, including some types that are diagnostic of extant orders. Here we explore the sequence of character acquisition across Metazoa in an attempt to explain the conflict between molecular clocks and the scant record of early animals by looking at the correlation between the evolution of taphonomically preservable characters in the stem lineages and their appearance in the record. We argue in favour of a taphonomic limit imposed by the simplicity of early animal bodyplans. Our results are consistent with the traditional view that most of the apomorphies accrued along the main stem of the animal lineage are predominantly characters with extremely low preservation potential. Finding unambigous members of total group phyla may be very unlikely for certain groups of both bilaterians and non-bilaterian animals. Furthermore, this study could provide novel search images for researchers working on lagerstätten that may contain early metazoans.

ID: 137

Articulated fossils of the deep-sea smelt (Bathylagidae) from the Oligo–Miocene of the Czech Republic

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

The family Bathylagidae (deep-sea smelts) is a small group of argentiniform fish with 22 contemporary species arranged to eight genera. The unambiguous fossil record of this group is rather poor; skeletal remains have been recognized in the Miocene deposits of California (*Bathylagus angelensis* and *Quaesitia quisquilia*), Japan (*Bathylagus sancta*, *B. obesa*, *B. toyohamaensis*, and *B.* sp.), and Russia (*Leuroglossus kobylianskyi* and several bathylagid taxa in open nomenclature), while otoliths are known from the Pleistocene of Europe only (genus *Bathylagus*). The remains of the family Bathylagidae has been newly recognized also in the Oligocene–lower Miocene marlstones (Egerian) of the Krumvíř locality (Moravia, Czech Republic). The attribution of these fossils to the family Bathylagidae is supported by the presence of two branchiostegal rays, numerous uniform teeth presented at the dentary, toothless premaxilla, large orbit, rounded profile of the head and overall appearance. Although the remains are incomplete and partly disarticulated, the presence of the orbitosphenoid, reduced basisphenoid and general morphology of the neurocranium in lateral view suggests affinity of the remains to the genus *Dolicholagus*. The specimens from Krumvíř locality such represent the oldest verifiable record of this group and document distribution of the Bathylagidae within Paratethys during Oligo–Miocene.

ID: 219

ImageJ and 3D Slicer: Open Source 2/3D Morphometric Software

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Workshop Open Data, oral presentation

In a world where an increasing number of resources are hidden behind paywalls and monthly subscriptions, it is becoming crucial for the scientific community to invest energy into freely available, community-maintained systems. Open-source software projects offer a solution, with freely available code which users can utilise and modify, under an open source licence. In addition to software accessibility and methodological repeatability, this also enables and encourages the development of new tools.

As palaeontology moves towards data driven methodologies, it is becoming more important to acquire and provide high quality data through reproducible systematic procedures. Within the field of morphometrics, it is vital to adopt digital methods that help mitigate human bias from data collection. In addition, mathematically founded approaches can reduce subjective decisions which plague classical data. This can be further developed through automation, which increases the efficiency of data collection and analysis.

With these concepts in mind, we introduce two open-source shape analysis software, that arose from projects within the medical imaging field. These are ImageJ, an image processing program with batch processing features, and 3DSlicer which focuses on 3D informatics and visualisation. They are easily extensible using common programming languages, with 3DSlicer containing an internal python interactor, and ImageJ allowing the incorporation of several programming languages within its interface alongside its own simplified macro language. Additional features created by other users are readily available, on GitHub or through the software itself.

In the examples presented, an ImageJ plugin "FossilJ" has been developed which provides semi-automated morphometric bivalve data collection. 3DSlicer is used with the extension SPHARM-PDM, applied to synchrotron scans of coniform conodonts for comparative morphometrics, for which small assistant tools have been created.

Young Scientist Award

ID: 206

Die Evolution der Schnecken im Steinheimer Becken (Mittelmiozän, SW-Deutschland): Prädation als Steuerungsfaktor?

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Evolving ecosystems, oral presentation

Das Steinheimer Becken auf der Schwäbischen Alb (Baden-Württemberg) entstand wahrscheinlich zeitgleich mit dem Nördlinger Ries vor rund 15 Ma und gehört zu den wichtigsten Fossillagerstätten des Miozäns. Dies einerseits wegen seiner Säugetierfauna und der Typuslokalität der Säugerzone MN7, andererseits wegen der einzigartigen endemischen Evolution von Süßwasserschnecken in einem fossilen Langzeitsee. Die Gehäuse der Gattung *Gyraulus* aus der Familie der Tellerschnecken zeigen eine ungewöhnliche Entwicklung von dünnen, kleinen fragilen Schalen hin zu großen trochospiralen Formen mit dicker Schale. Diese Entwicklungsreihe ist wissenschaftlich schon lange bekannt und führte im Jahr 1866 zur historisch ältesten Rekonstruktion eines Stammbaum von Fossilien. Die Interpretationen der Ursachen für diese Entwicklungsreihe mit rezent nicht bekannten Gehäuseformen, reichten vom Einfluss thermaler Quellen bis hin zur Adaptation an Kleinsthabitate sowie nicht-adaptiver Evolution, bis hin zur Interaktion mit Parasiten. Vor wenigen Jahren fanden sich in rund 5% der Gehäuse der dicksten und größten Form, *Gyraulus trochiformis*, kleine Löcher mit Durchmessern von rund 0,8 mm. Eine REM-Analyse zeigte, dass diese Löcher nicht durch rein taphonomische Prozesse entstanden sein konnten, sondern Spuren von Prädation darstellen müssen. In Anbetracht der in Steinheim vorkommenden potentiellen Prädatoren, und nach der Beobachtung des Fressverhaltens durophager Fische in Aquarien, konnte die Schleie *Tinca micropygoptera* als „Täter“ identifiziert werden. Die Löcher entstanden durch die spitzen Kanten an den Schlundzähnen dieser Fische und zeigen, dass die Schalen von diesen nicht geknackt werden konnten. Diese Funde legen die Hypothese nahe, dass die endemische Evolution mit unterschiedlichen Gehäuseformen von einem Jäger-Beute-Verhältnis geprägt war und der Anpassung an schalenknackende Prädatoren diente.

ID: 215

Formation, transport and deposition of rhodoliths on reefless insular shelves of the Azores volcanic Archipelago

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Evolving ecosystems, poster presentation

The Azores Archipelago constitutes a group of high-energetic reefless volcanic islands with fossil (Santa Maria Island) and Recent (Pico Island) rhodoliths (i.e., coralline algal nodules). This study deals with the question how rhodoliths cope with the environmental pressure on these high-energetic, steep shelves. All fossil rhodoliths are multi-specific (*Lithophyllum prototypum*, *Lithophyllum* sp., *Spongites* sp., *Hydrolithon* sp., *Phymatolithon calcareum*, cf. *Phymatolithon* sp.), with robust and lumpy growth-forms. The nuclei consist of bioclasts or volcanics. Taphonomic analyses reveal several destructive events during growth, suggesting life in a highly dynamic system, with transport and final deposition being storm-associated. Present-day shallow (-2 to -4 m) rhodoliths are composed of *Phymatolithon calcareum* reveal dominantly spheroidal shapes. In deeper-water settings (-60 to -80 m), they show outer layers with *Lithophyllum incrustans*, encrusted by *P. calcareum* with mainly ellipsoidal shapes, which appears to be influenced by local hydrodynamics. Volcanic rock nuclei indicate the availability of volcaniclasts in a large depth-range, or that rhodoliths were transported offshore from shallower waters. The Pliocene rhodoliths feature assemblages with small thalli that are highly spheroidal and basalt nuclei. The fossil deposits rest on former basalt rocky shores that supplied the nuclei in nearshore environments. The absence of fossil and living rhodoliths on the north side of the islands suggests these are probably too energetic for them to form. Offshore transport of the deeper rhodoliths is supported by the commonly mixture of shapes (ellipsoidal dominant) and the fact that *P. calcareum* is encrusted by *L. incrustans*. Likewise, ellipsoidal rhodoliths are rare or absent in fossil deposits studied on Santa Maria Island, which are thought to have formed in shallower settings. Transport by storms appears to be an important factor in the formation of some deep-water rhodoliths around volcanic oceanic islands subjected to high-wave energy.

ID: 158

From short-term experiments to ancient hyperthermal events: marine clade sensitivities to climate change conform across time scales

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Physiology in Deep Time, oral presentation

Anthropogenic increases in atmospheric CO2 levels are raising seawater temperatures, lowering seawater oxygen concentrations and pH ('climate-related stressors', CRS), among other changes. Under such change, ecological experiments suggest some marine clades to be more vulnerable than others. However, whether these vulnerabilities directly scale up to extinction risk, or are somehow compensated e.g. by rapid range shifts, is unclear because few modern, global extinctions are unequivocally caused by CRS. The fossil record, meanwhile, documents myriad extinctions, often with strong clade selectivity, that amount to mass proportions under hyperthermal conditions. We attempt a quantitative cross-scale evaluation of the role of CRS as extinction triggers, comparing individual responses to CRS in laboratory experiments and the range shift responses to global warming over recent decades, to extinction selectivity at ancient hyperthermal events and across the sum of metazoan evolutionary history (the Phanerozoic aeon). Clades with strong negative responses to experimental CRS are most likely to go extinct at hyperthermal events, their genera also having the shortest geological durations. Among CRS, the experimental combination of seawater warming and hypoxia has the most severe impact on marine organism performance. Response details suggest chiefly metabolic constraints in setting organism performance responses to CRS, which appear to scale up to extinction probabilities of past (and potentially future?) hyperthermal events.

Young Scientist Award

ID: 224

New insights into early evolution of modern myriotrochid holothurians (Echinodermata)

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Open session, poster presentation

Myriotrochids are small, infaunal apodid sea cucumbers that occur in bathyal, abyssal and hadal depths of modern seas but have been also found in artic and sub-arctic shallow waters. The presence of myriotrochids, stem-group myriotrochids and apodid relatives in the fossil record is mostly indicated by isolated distinctive body-wall ossicles and calcareous ring elements since the Silurian. However, their record is sporadic and the evolutionary information is largely based on isolated ossicles only. Fortunately, in a handful of cases articulated/partly articulated calcareous ring material or whole body fossils were found recently in several Palaeozoic strata and fossil lagerstätten, facilitating much more significant insights in the evolution and phylogeny of this class.

The Late Triassic Cassian Fm. of Italy (~235 myr) is regarded as one of the most important strata of early Mesozoic invertebrates worldwide, including all groups of extant echinoderms (Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea) as well as the youngest representatives of the extinct ('Palaeozoic') ophiocistioids. Here we present well-preserved holothurian calcareous ring material from a fossil assemblage sampled near Misurina, Dolomites, Italy, yielding apparently a new member of 'modern' myriotrochids (Apodida). Based on several partly articulated calcareous rings, which are showing the typical morphology concerning the anterior processes and arrangement for the passages of nerves in dorsolateral and ventral radial elements, we can assume a crown group member of the Myriotrochidae, as all Palaeozoic representatives have a clearly different entire calcareous ring structure.

Our new record from the Late Triassic Cassian Fm. has novel implications for understanding the evolution of apodids and the timing of distinction between stem and crown group myriotrochids in the course of the Mesozoic Marine Revolution.

ID: 149

Precambrian–Cambrian phosphorites & cherts – novel windows into early sponge evolution

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Evolving ecosystems, oral presentation

The early evolution of sponges is still enigmatic. A number of Ediacaran sponge-like fossils have been described, but all these reports are questionable. The earliest sponge spicules date back to ca. 535 Ma. Here we report three-dimensionally preserved articulated sponges in phosphorite and chert deposits of South China and Central Spain, both older than Cambrian Age 2 (Luo & Reitner 2019). Thin section observations and 3D-reconstructions on materials from both localities confirmed the presence of rather intact sponge fossils. Phosphorites and cherts of the Niutitang Formation from South China were dominantly formed through authigenic mineral precipitation. Spicules of these specimens are completely embedded in phosphate and often overgrown by isopachous phosphate cements. The sponge fossils can be separated into two groups: (i) Sponges characterized by hexactines in three distinct size-hierarchies and (ii) sponges dominated by diactines plus few perpendicularly arranged hexactines. Both groups are interpreted as stem group Hexactinellida, which is well in line with reports of hexactinellid spicules in cherts of the Terreneuvian Yanjiahe Formation (Chang et al 2017). The Niutitang Formation also contains disarticulated demosponge spicules that are randomly scattered in the mineral matrix. Sponge fossils in phosphorites of the Terreneuvian Pusa Formation (Fontanarejo, Spain) are preserved within phosphatic pebbles. The preservation mode of sponge fossils is strikingly similar to the Niutitang Formation (Reitner et al. 2012), but the paleocommunity appears to be quite different. Particularly noticeable are specimens that exhibit a *Saetaspongia*-like skeletal frame or consist of fused hexactines. Taken together, our results stress that lower Cambrian phosphorites and cherts represent novel taphonomic windows into early sponge evolution. We are going to assess the taxonomic diversity of sponges in these deposits in much greater detail and to elucidate the impact of microbial processes on the paleoecosystems – a crucial prerequisite to understand the earliest evolution of sponges better.

ID: 112

Drivers of beta diversity in Triassic reefs and reef basins

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Evolving ecosystems, oral presentation

Reef assemblages are highly heterogeneous habitats providing complex structures with strong environmental gradients, yielding extremely diverse faunal assemblages. Environmental factors in adjacent level-bottom habitats are thought to be more uniform. However, some studies have shown large variations in faunal composition in uniform habitats, such as soft-sediment macrobenthic communities from the Norwegian continental shelf. This may be due to stochastic processes related to drift and dispersal as well as regional-historical processes.

Here we provide a case study from the Triassic Cassian Formation (Dolomites, northern Italy) to assess the faunal turnover within and between reef and reef basin assemblages. The Cassian Formation comprises deposits with considerable differences in depth, from back-reef and lagoonal settings as well as from the shallow and deeper reef basin. We use pairwise dissimilarity measures of washed bulk samples of > 0.5 mm sieve size, focusing on the 10 most abundant species in each sample.

Preliminary findings show very high variation in community composition among samples that is not related to geographic or temporal distance. There are large differences in faunal composition between shallow and deep water communities. Mean dissimilarity in proximal, shallow water settings is higher than in the deeper reef basin. In addition to water depth, however, regional diversity and stochastic processes may also contribute to beta diversity.

Young Scientist Award

ID: 248

Linking microbial diversity to carbon cycling in subseafloor sediments from Namibian Continental Shelf through Quantitative Stable isotope probing (qSIP)

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Molecular Geobiology and Paleobiology, poster presentation

The Benguela Upwelling System (BUS) is one of the most productive ecosystems in the world (0.37 Gt carbon/year). This oceanographic feature exhibits a wind-driven, seasonal primary production that peaks during the austral winter when cold, nutrient-rich waters are injected into the photic zone. The increased primary productivity leads to a high export rate of organic carbon to the marine seafloor, where remineralization occurs, mainly driven by microbial metabolic processes such as sulfate reduction, denitrification, methanogenesis, methanotrophy and fermentation. Thus, carbon turnover in Namibian marine sediments plays a key role in large-scale nutrient losses and gains, oceanic N:P ratio dynamics and production of greenhouse gases such as CH4, NO2 and H2S. Here, a novel experimental approach known as quantitative Stable Isotope Probing (qSIP) was used to quantify 13C incorporation into bacterial and archaeal 16S rDNA from subseafloor sediments of the Namibian Continental Shelf. Incubations from 28 cm depth carbonate-rich, sulfidic sediments were set up for ten days under anoxic conditions with [13C] labeled bicarbonate and [13C] labeled diatomaceous extracellular polymeric substances (dEPS). Experimental data shows DIC assimilation by a total of 1676 microbial operational taxonomic units (OTUs) primarily affiliated to Gamma and Deltaproteobacteria, Chloroflexi, Planctomycetes, Latescibacteria and Acidobacteria. Archaeal OTUs belonging to the Bathyarchaeota, Euryarchaeota and Asgardaeota accounted for 52% of the [13C] bicarbonate labeled populations. Lower levels for [13C] dESP incorporation were measured, with a total of 329 enriched microbial OTUs mainly from the same taxonomic groups found enriched in the autotrophic incubation, likely indicating a bias towards consumption and cycling of organic matter produced in dark carbon fixation. This study gives insights into the ecological features of several uncultured groups and their metabolic activity. Furthermore, it sheds light on the taxonomic identity of key microbial populations performing biochemical processes linked to carbon turnover in Namibian Continental Shelf anoxic sediments.

ID: 213

Paleoecology of the Late Triassic Marine Biota from the Cassian Formation

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Evolving ecosystems, oral presentation

The late Triassic Cassian Formation (South Tyrol, N-Italy) is well known for its exceptional preservation and has produced a large number of marine invertebrate species. However, quantitative paleodiversity and paleoecology analyses of the fossil assemblages from the Cassian Formation are still scarce. For this study, bulk samples from 7 spots at Misurina were obtained in stratigraphic order. The sediments were washed and sieved at a mesh size of 0.5 mm. The picked fossils comprise a size range from 0.5-5 mm; only very few shells are bigger than 5 mm. The bulk samples from Misurina yielded ca.1,300 individuals that are assigned to 46 species, excluding fragmentary or disarticulated material representing mostly echinoderms and calcareous algae. The paleocommunities consist of mollusks (gastropods, bivalves, and scaphopods), echinoderms, corals, ostracods, foraminifera, and calcareous algae. Species composition and rank abundances of the samples differ strongly from each other indicating a high degree of beta diversity. Despite of this dissimilarity, mollusks are the dominant group in each of the samples (more than 80%). Gastropods are especially abundant and diverse. Most gastropods, some of the bivalves, echinoids, holothurians, and ophiuroids lived on the substrate. Other bivalves, some gastropods and the scaphopods lived infaunal or semi-infaunal. Calcareous algae indicating photic zone conditions are present in two of the samples. The moderately diverse fauna present in the studied samples suggests soft-bottom conditions with sufficient oxygen supply. The differences in faunal composition in the studied samples indicate fluctuating environmental constraints.

Young Scientist Award

ID: 172

Dental development and complexity in stem-Chondrichthyes

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Hypotheses on the development of teeth have long been based on conditions in extant Chondrichthyes, which generally possess simple, conical teeth with few cusps and regulated replacement. Using this model of organized and patterned tooth addition and replacement to interpret dental development in Osteichthyes has met with limited success. Evidence from stem-Chondrichthyes, like ischnacanthid acanthodians with jawbones comprising distinct marginal tooth rows, might help to elucidate ancestral conditions.

Using Synchrotron Radiation X-ray Tomographic Microscopy (SRXTM) the growth of the dentition is reconstructed. Surface complexity of teeth is analyzed using orientation patch count rotated (OPCr) and changes in the number of cusps during dental development are measured. The marginal dentition of the studied ischnacanthid acanthodians was statodont, comprised of multicuspidate teeth that were added sequentially in up to three rows that diverge from a proximally-located 'pioneer' tooth, supplemented by replacement teeth that developed superpositionally in worn proximal locations without resorption. Tooth morphology, the number of cusps and dental complexity vary along the rows and during growth. Associated tooth whorls are comparable in development and structure to the fused toothwhorls of Palaeozoic Chondrichthyes and the tooth rows of living sharks, but also to the fused symphyseal toothwhorls of Palaeozoic stem- and crown-Osteichthyes.

Variation of dental complexity in stem-Chondrichthyes might indicate different developmental modes in the dentition and ecological diversity. Differences in tooth replacement in Chondrichthyes and Osteichthyes might reflect the loss and independent evolution of modules that occur only together in early jawed vertebrates.

ID: 120

Within a dinosaur's head - Braincase morphology in spinosaurid theropods (Dinosauria: Theropoda)

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Open session, oral presentation

Representatives of Spinosauridae (members of the mainly predatory theropods) were repeatedly associated with a semiaquatic lifestyle and piscivory. The holotype of *Irritator challengeri* Martill et al., 1996, a nearly complete skull, from the late Early Cretaceous Santana Formation of northeastern Brazil comprises one of the very few preserved spinosaurid braincases. To generate digital models of the cavities within the braincase, it was analyzed with a medical CT scanner in the Deutsches Herzzentrum in Munich and a micro CT scanner in a subsidiary of Zeiss in Aalen. It was possible to reconstruct the impressions of the olfactory tracts and bulbs in the prefrontals and frontals, as well as the cavities that housed the brain, cranial nerves, the inner ear, blood vessels and pneumatic spaces. Furthermore, the cast of a braincase assigned to *Suchomimus tenerensis* Sereno et al., 1998, the original holotype of *Baryonyx walkeri* Charig & Milner, 1986 and two recently excavated braincases, supposedly of the same genus, were examined for comparison. The digital models are described herein, as well as the outer morphology of the braincases of *I. challengeri*, *S. tenerensis* and *B. walkeri*.

Young Scientist Award

ID: 173

Emausaurus ernsti - the volatile history of a small thyreophoran dinosaur from the Early Jurassic of eastern North Germany

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Open session, poster presentation

Emausaurus ernsti is an ornithischian dinosaur and was placed at the base of the Thyreophora that also include stegosaurs and ankylosaurs. The holotype of *E. ernsti* consists of teeth, cranial and post-cranial bones that, after several preparation steps in the last 56 years, got recently scanned with a micro CT scanner. Future examination of this Early Jurassic material will focus on an overview of what is left of it as well as tooth replacement and tooth wear patterns.

ID: 210

How to dispose a systematic waste basket – Revision of the fossil isopod form genus "*Palaega*"

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Open session, oral presentation

In groups in which fossils do not show phylogenetically important characters, or morphology in general does not reflect well the relationship between the studied species, often the use of form genera come into play. To avoid putting up generic names for every new species of uncertain systematic position and to express the similarity to other species, some generic names factually become 'waste baskets' for more or less closely related species. No doubt exists about the non-monophyletic nature of such groups.

Many fossil remains of isopods (pill bugs, woodlice and their relatives) are only known from their dorsal sclerites. Thus, often even the rough systematic position remains uncertain. Because of this reason, the generic name "*Palaega*" has evolved into a name tag for isopod remains with a certain morphology of the most posterior dorsal sclerite (pleotelson). This comes with two problems: 1) The holotype of "*Palaega*", *Palaega carteri* Woodward, 1870 is likely a representative of the group *Bathynomus* with several extant species ('giant isopods'). 2) Although the shape of the pleotelson in species of the group *Bathynomus* is very characteristic and can be interpreted as autapomorphic for *Bathynomus*, only a fraction of the fossils attributed to "*Palaega*" shares this morphology.

Some of the "*Palaega*" species need to be formally re-described as representatives of *Bathynomus*, others need to be revised regarding their systematic affinity. In many cases, a narrow attribution will not be possible. Here, the approximat systematic position (including the uncertainty that comes with it) needs to be carefully evaluated. First attempts in this direction are presented here.

Young Scientist Award

ID: 212

Schaßbach - A new locality for abundant and well preserved fossil insects from the Miocene of Carinthia (Austria)

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Evolving ecosystems, poster presentation

Insects make up a large amount of the biomass in terrestrial ecosystems and play key roles in almost every food chain. Fossil insects can thus be a powerful tool to understand past ecosystems. However, insect carcasses (and exuviae) are fragile and very prone to physical destruction. Undisturbed conditions during the burial of insects in the sediment are hence crucial for their preservation of insect fossils. Yet, if the taphonomic conditions favour the preservation of insects, fossils of them can come in large numbers.

For various reasons, it is often not possible to collect every single fossil from a locality. However, when faunal compositions of different sites should be compared, selective sampling often limits the conclusions that can be drawn from comparative studies as the abundance of specimens is arbitrarily biased towards conspicuous or rare species. Here, we present a new unbiased collection of fossil insects and compare its faunal composition to those of other unbiased collections.

The Schaßbach quarry near Wolfsberg in Carinthia (Austria) lies within the Lavanttal Basin. The sediments exposed in the quarry are part of the Mühldorf Formation and are of Early Badenian age (Early Langhian, Middle Miocene, ca. 15 million years). The site is well known for the abundance of fish fossils (‘fish-shale’). Prior to this study, only a few (less than 10) insect remains from the site have been discovered and stored in museum collections. With over 370 identified insect remains collected via unbiased sampling, we are able to provide a much more detailed insight into the insect fauna of this promising locality.

ID: 182

What was first: knob or facet on the Carpale 4 of *Prosantorhinus germanicus* from Sandelzhausen?

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Open session, oral presentation

Sandelzhausen is a fossillagerstätte in Bavaria (Germany), around 70 km north of Munich, with exposed sediments of Miocene age (around 16 Ma). The locality was discovered in 1959 and is famous for its fossil mammal assemblage. One of the first finds was a lower jaw of a juvenile rhino. Rhinoceros remains are the most abundant vertebrate remains from Sandelzhausen. During the Miocene, three sympatric species lived in the area of Sandelzhausen. *Prosantorhinus germanicus* was the smallest and most abundant rhino species. This animal has short legs and a barrel-like body. Because of its hippo-like appearance, a semi-aquatic mode of life was proposed for this rhino. *Plesiaceratherium fahlbuschi*, a medium sized rhino, was nearly as abundant as *P. germanicus*. *Lartetotherium sansaniense* was the largest and rarest rhino species from Sandelzhausen.

Prosantorhinus germanicus shows a high variability in its carpal bones. Some specimens of the carpal bones Intermedium and Carpale 4 show additional articulation facets on their palmar processes. Both bones are situated in different rows of carpal bones. With these additional facets in contact, the possible flexion in the mid-carpal joint of the wrist was restricted, leading to a stiffening of the wrist. This could be an adaptation to the semi-aquatic mode of life. Such a wrist stiffening may prevent injuries while walking on muddy or slippery grounds. In case of the Carpale 4, the specimens without the additional articulation facet to the Intermedium show knob-like structures. The question arises if these knobs are precursory structures of the facets, or leftovers of a reduction of the facets? Such knob-like structures can be built by ossification of tendons and ligaments.

This work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under grant number: SCHE 1882/1-1.

ID: 174

A vendobiont from the Lower Devonian of Germany?

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Open session, oral presentation

The Vendobionta represent a variety of enigmatic fossils about which an intense debate is ongoing for decades (e.g., systematic position, uni- vs. multicellular, mode of life, environment, mode of preservation). Specimens of the group typically occur in Neoproterozoic strata; in a very few cases, however, some representatives have also been found in Palaeozoic rocks. A single specimen from the Lower Devonian of Alken (Mosel area, Rheinisches Schiefergebirge) would be the first record for the Devonian of Europe. It has been discovered in a fine-grained sandstone sequence of the uppermost part of the lower Emsian Nellenköpfchen Formation. The fossil probably represents the genus *Protonympha* which is hitherto only known from two Upper Devonian (Givetian and Frasnian, respectively) localities in the Appalachian Mountains of New York State (USA). The discovery at Alken is spectacular, especially when taking into account that the Nellenköpfchen Formation was deposited in a very shallow to even coastal high-energy environment, not at all favourable for the preservation of delicate structures (mouldic soft-body preservation). Because of the poor preservation, no further details on the conditions responsible for the preservation of the fossil can be studied. However, the occurrence in fine-grained sandstone, most probably representing a near-shore environment, is in common with the examples from the Devonian of the Appalachians.

ID: 199

Origination and dispersal dynamics of Cenozoic marine plankton

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Evolving ecosystems, oral presentation

Several ecological and evolutionary hypotheses have been proposed to explain the latitudinal diversity gradient. The “out of the tropics” hypothesis posits the tropics as a cradle of biodiversity, with most clades originating in the tropics and then expanding their ranges towards temperate regions through dispersal. This study analyses the diversity gradient of planktonic microfossil groups (foraminifera, coccolithophores, diatoms and radiolaria) over the Cenozoic. The aim is to investigate if origination and dispersal events are more prominent in and to tropical or extratropical regions using fossil data compiled in the Neptune database. Two definitions of the tropical region are considered: (i) an arbitrary cut off at latitudes 30° north and south, and (ii) a climatic definition whereby the tropical sea surface temperatures are within the range 25-30 °C. Log odds ratio comparing origination in the tropics vs extratropics as well as proportions exported to and from each region were calculated. Our findings showed that plankton exhibited a slight predilection for origination in the extratropics during the Cenozoic. Overall, the extratropical region was more notable for exported diversity, although proportions exported varied among the different groups.

Young Scientist Award

ID: 135

Where the *Diceras* dwells… : The hippuritid fauna of the 'Kelheimer *Diceras*-Kalk'

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Open session, poster presentation

The Late Kimmeridgian 'Kelheimer *Diceras*-Kalk' (now Kelheim Member, Frankenalb Formation) preserves one of the richest Late Jurassic invertebrate faunas of Europe that was monographed by Munich palaeontologists in the late 19th century. New fossil collections from a quarry at Saal an der Donau include numerous epidiceratid and a few diceratid rudists – but not a single *Diceras*, which, as it turns out, erroneously lent its name to the stratum. Instead, another small diceratid species, *Valletia auris*, occurs together with three species of Epidiceratidae and the requieniid *Hypelasma salevensis*. Epidiceratidae comprise the two 'classic' species *Epidiceras carinatum* (previously described as *Diceras bavaricum*) and *Plesiodiceras muensteri*, and one new genus and species, which is so far only known from Saal. The large *Epidiceras* and the moderately-sized *Plesiodiceras* are widespread and common in Late Jurassic reefal-lagoonal carbonates, and well-known from numerous Tethyan localities. The small *Valletia* and *Hypelasma*, however, were probably often overlooked or considered as juvenile diceratids/epidiceratids. At species level, it is astonishing that *Epidiceras carinatum*, which was first described from the early Tithonian of Sicily, makes its only other reported appearance in the Kelheim area in Bavaria. The most unexpected result, however, is the occurrence of a new genus of Epidiceratidae with a rather peculiar morphology: the commissure is lunate in outline; two strong, highly elevated, crest-like carinae rise from the ends of the crescent, and due to its regular curl, the attached valve attains a woodscrew-like shape, while the shorter free valve displays only a slight backward twist. The hippuritids occur within a highly diverse community dominated by corals, brachiopods, bivalves and gastropods, and the new genus, as well as the two species newly recorded for the area, once more attest to the important role of Late Jurassic reefal environments as a cradle of speciation.

ID: 136

The Pleistocene Bivalvia of Rhodes

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Open session, poster presentation

The island of Rhodes (Dodecanese Islands, Greece) preserves a remarkably fossiliferous succession of Pleistocene strata, which has attracted scientists and collectors for nearly 200 years. The account of the predominantly marine bivalve fauna, which we are giving here, is largely the result of 'only' 30 years of collection and study on Rhodes by the second author. Nevertheless, it is the most comprehensive compilation so far, with the total diversity of Bivalvia ranging in the order of 140 species (work in progress). Much of this diversity is preserved in parautochthonous shell accumulations in shallow to medium shallow water fine-grained siliciclastic deposits, but Rhodes has more to offer. The Pleistocene succession conserves a variety of palaeoenvironments, including fluvial channels, brackish-water mud- and sand-flats, high-energy foreshores, low-energy shallow-water settings and different deep-water environments, including cold-water coral reefs. Naturally, all these environments were inhabited by bivalves, whose shells are generally well preserved, and thus are key to decoding the palaeoecology of the respective habitats. Interestingly, what reads like a lateral transect from the coast into the deep is also a vertical transect, reflecting one large-scale transgressive-regressive sea-level cycle, with three smaller-scale cycles superimposed. While our scientific endeavours focus on a monographic documentation of the bivalve fauna, we also exploit its palaeoecological potential, to improve our understanding of Pleistocene life on and around Rhodes, and its development through time. Our samples are probably biased towards larger taxa, since screen washing was not consistently applied, and certainly, shallow water carbonate environments are underrepresented due to the difficulty to extract fossils from limestone. Nevertheless, the uncovered environmental framework is complex and comprehensive, and emphasizes the importance of Rhodes for the study of the Pleistocene faunal development of the Mediterranean Sea.

ID: 192

Cretaceous cold start: the Jurassic–Cretaceous transition in the Rollrock Section, Sverdrup Basin, Canadian Arctic Archipelago

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Open session, oral presentation

The Rollrock Section on Ellesmere Island, exposing >500 m of fine-grained sediments, is one of the most complete rock archives of the Jurassic-Cretaceous transition in the Arctic, and provides a unique opportunity to study the stratigraphy and palaeoclimate of this interval in detail. The lower half of the succession (Ringnes Formation) is dominated by mudstones, with fine-grained sandstones and siltstones forming the top of the unit. A rapid transition to mudstone deposition and the sudden occurrence of abundant dropstones mark the onset of the Deer Bay Formation, which grades into the sand-dominated Isachsen Formation at the top. The succession likely was deposited on the outer shelf of the Sverdrup Basin. Dropstones occurring throughout the Deer Bay Formation are evidence of either coastal ice rafts formed during winter, or proper icebergs. Glendonites from ten horizons in the upper half of the unit also document cold, Arctic conditions during the deposition of the Deer Bay Formation. We sampled the Rollrock Section at 1.5 m intervals for microfossil, palynomorph and geochemical analysis. Additionally, macrofossils were collected from sideritic concretion horizons in the upper 350 m of the succession. Ammonites, bivalves and belemnites collectively document early Tithonian to Valanginian ages: the early Tithonian *Buchia rugosa* Zone; the mid Tithonian *Dorsoplanites maximus* Zone; the *Buchia terebratuloides* Zone marking the Jurassic-Cretaceous boundary interval; the early Berriasian *Chetaites sibiricus* and *Hectoroceras kochi* zones; and a Valanginian succession above 410 m. Dinoflagellate cyst assemblages suggest an Oxfordian age for the basal part of the section and broadly confirm the macrofossil ages from higher-up. They further document significant environmental perturbations during the Cretaceous interval. These data improve the biostratigraphy of the Sverdrup Basin succession as a whole, and pave the way for establishing the presence of Arctic cold snaps and ice caps over the Jurassic-Cretaceous transition.

ID: 105

How do fish otoliths and ancillary hearing structures move in a sound field? – Insights from synchrotron radiation-based imaging

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

We still lack knowledge of how otolith morphology and the presence of ancillary hearing structures such as a swimbladder-ear connection (otophysic connection) affect otolith motion in the fish ear. Recently, we visualized sound-induced otolith motion in situ using hard X-ray phase contrast imaging. Based on this approach, we developed two improved setups that should enable 1) a separation of sound pressure and sound-induced particle motion using radiography (3D imaging) and 2) to characterize sound-induced motion patterns in a three-dimensional aspect (4D imaging). We aimed to study the effects of different types of otolith shapes and otophysic connections on otolith motion when animals were subjected to a 50, 100 or 200 Hz pure tone stimulus. The 3D imaging-setup consisted of a 2L horizontal standing wave tube-like tank equipped with an inertial shaker at each end. Driving the shakers in-phase resulted in "maximum" sound pressure whereas driving the shakers out-of-phase led to "maximum" particle motion in the center of the tank. For the 4D imaging-setup, we used one inertial shaker at the base of a 20mL upright tube. We studied two different types of otophysic connections, i.e., anterior swimbladder extensions contacting the ears in the cichlid *Etroplus canarensis* (3D) and the Weberian apparatus in goldfish (3D) and zebrafish (4D). The motion of the saccular otolith (goldfish, *E. canarensis*) and the Weberian ossicles (goldfish) was more pronounced when the swimbladder walls oscillated due to sound pressure fluctuations (in-phase condition). The tomography provided further details on the motion pattern of the Weberian apparatus in zebrafish. We were able to provide 1) a detailed characterization of the interplay between otoliths and ancillary hearing structures and 2) first experimental evidence on the effects of different types of otophysic connections on otolith motion. These insights may pave the way for interpreting fossil otoliths in a physiological context.

ID: 103

The rise to dominance of lanternfishes (Myctophidae; Teleostei): a paleontological perspective.

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Lanternfishes (Myctophidae) are among the dominant fishes of the deep open oceans, the largest habitat of the world, and together with bristlemouths (*Cyclothone* spp.) represent the largest biomass of any vertebrate group. In the fossil record their remains (mostly otoliths) are considerably abundant in pelagic sediments since the Neogene.

A review of their fossil otolith and skeletal record reveals that the myctophiform lineage dates back to the Late Cretaceous. Fossil otoliths unquestionably pertaining to the Myctophidae are known since Late Paleocene. Paleogene records are primarily represented by extinct basal taxa such as *Eomyctophum* and *Oligophus*, both known with otoliths in situ on articulated skeletal remains. During the Eocene, lanternfishes have been found in outer shelf to upper slope sediments. Apparently, they were not then adapted to an oceanic habitat.

This changed with the establishment of the modern thermohaline oceanic circulation at the Eocene-Oligocene transition. It seems that the myctophids invaded bathyal habitats around that time. Unusually large myctophid otoliths are known from bathyal sediments of Early Oligocene age and most modern genera appeared by the Early Miocene. However, small-sized lanternfishes prevailed during most of the Oligocene to Middle Miocene, and particularly during the Miocene Climate Optimum.

Myctophid diversification accelerated after the Middle Miocene Climate Transition and especially during the Biogenic Bloom (Late Miocene and Early Pliocene). Notably *Diaphus* experimented a remarkable proliferation of species since Late Miocene coupled with an increase of size in some species. These trends are coincident with the speciation and development of gigantism in whales. We postulate that the maximal sizes of myctophid otoliths can be used as proxy for primary ocean productivity.

The accelerated speciation rates and wide distribution makes myctophid otoliths a useful tool for the Late Neogene supra-regional biostratigraphy. Recent studies show promising results, but a myctophid otolith stratigraphy is still in its infancy.

ID: 150

The Late Paleozoic Ice Age (LPIA) – Turnover rates during a phase of major climatic changes

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Open session, oral presentation

The Late Paleozoic Ice Age (LPIA), a phase of major climatic changes, is commonly considered a phase of sluggish turnover rates. Using a large compilation of occurrence data, we re-assess turnover rates and diversity patterns of marine benthic taxa during the LPIA. We compare dynamics in the Paleozoic (here: brachiopods) and the modern evolutionary fauna (here: bivalves, gastropods) using occurrence data from the Paleobiology Database (PBDB) and investigate the roles of environmental factors in determining their diversity dynamics.

During the early phase of the LPIA, taxa show similar diversity trends. However, brachiopods demonstrate a distinct diversification during the Permian, which is less pronounced for the modern fauna. During the earliest Carboniferous, origination rates of all taxa were elevated, whereas extinction rates were especially high in the Viséan and from the Wordian onward. Towards the end-Permian mass extinction, brachiopods had markedly higher turnover rates compared to bivalves and gastropods. Nonetheless, rates of all taxa are similar throughout the main phase of the LPIA, indicating that clade membership was a less important determinant of temporal turnover than climatic and/or environmental circumstances in this interval.

Considering environmental factors, taxa preferred siliciclastic and carbonate deposits similarly, with bivalves showing more affinity to siliciclastic, and gastropods and brachiopods to carbonate lithologies. Grain size is less important for gastropods, bivalves, and brachiopods, while there is an affinity towards shallow marine and non-reefal settings.

Our study confirms that overall turnover rates were reduced during the LPIA, but that there were greater dynamics within clades than previously assumed.

ID: 197

Upper Frasnian tornoceratids (Goniatitida) from the Sand Formation of the Bergisch Gladbach-Paffrath Syncline (Rhenish Massif, Germany)

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Open session, oral presentation

The Bergisch Gladbach-Paffrath Syncline is one of the classical areas for Devonian palaeontology. During construction works (2003/2012) in the Sand district, outcrops of the Upper Frasnian Sand Formation were exposed, that yielded partly beautifully preserved haematitic tornoceratids. This goniatite fauna has never been investigated in detail. This study therefore explores a unique fauna containing several new taxa. Specimens of *Archoceras* indicate an uppermost Frasnian age corresponding to the Lower to Upper Kellwasser interval (UD I-K/L).

There are representatives of four/five tornoceratid genera. The *Aulatornoceras eifliense* Group comprises a new species with strong ventrolateral double furrows from middle stages on. Two forms are close to *A. auris* and *A. constrictum*. *Aulatornoceras* n. sp. 1 and n. sp. 2 possess wide lateral and low ventral saddles; the second resembles "*Phoenixites*" *keyserlingi* but displays a ventral band. ?*Aulatornoceras* n. sp. 3 lacks clear furrows and resembles in its falcate ornament the Lower Famennian *A. lepiferum*. *Crassotornoceras* is represented by *C. belgicum*. *Tornoceras* n. sp. is characterized by broadly rounded, subsymmetrical A-lobes; it is associated with *Tornoceras* cf. *typum*. Specimens with narrow A-lobe are close to *Linguatornoceras linguum*, specimens with rounded, slightly asymmetric A-Lobe close to *L. clausum*. *Linguatornoceras* n. sp. displays asymmetrically curved A-lobes similar to the Lower Famennian *L. haugi*. gen. aff. *Linguatornoceras* n. sp. differ from typical linguatornoceratids by a V-shaped A-lobe and clearly developed ventral band.

The investigation of this previously unknown sand fauna is significant for our general knowledge of tornoceratid taxonomy and diversity in the Kellwasser Crisis Interval. There are some similarities with contemporaneous goniatite shale faunas, including Büdesheim (Eifel) or Waterside Cove (South Devon).

Young Scientist Award

ID: 102

Live Birth in a Jurassic Marine Crocodile

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Open session, oral presentation

Secondary aquatic lifestyle in reptiles has led to viviparous habits in several lineages, most prominently in ichthyosaurs, mosasaurs, plesiosaurs. This strategy allows for maximum pelagic adaptation, as terrestrial locomotion during oviposition is no longer required. Although marine crocodiles of the Jurassic and Cretaceous show similar modifications of certain pelagic reptiles, there is an ongoing debate whether crocodiles are capable of vivipary at all. Recent investigations conclude for vivipary in metriorhynchid crocodiles, regarding e.g. their paddle-shaped limbs and loose pelvic structures. However, there are strong arguments against this possibility, such as the dependence of archosaur embryos on the calcareous reservoir in eggshells, or environmental sex determination as a common trait in extant crocodiles. Proving live birth in fossil reptiles requires finds of pregnant females, while interpretations of young juveniles are usually less indicative. A new fossil from the Late Jurassic of Bavaria provides the first evidence for live birth in Metriorhynchidae, being the first case for Archosauria in general. It contains a complete skeleton of a tiny neonate with fully developed dentition. The anterior extremity is reduced to few tiny elements, making a forelimb functionally inexistent. This demonstrates that the reduced anterior paddle in adult metriorhynchids was not gained by allometric growth from a limb-like juvenile condition, but was even less developed in neonates. In the hind leg, the metatarsus is longer than the tibia. As no functional limb with walking abilities exists, terrestrial hatching and a subsequent walk to the sea can be precluded for metriorhynchids. For comparison, hatching sea turtles with quick quadrupedal locomotion across the shore still suffer from immense predation pressure. The morphology of the new neonate metriorhynchid strongly implies a fully aquatic lifestyle, probably performing ovovivipary.

ID: 118

Teeth of actinopterygians from the Permo-Carboniferous of the Bohemian Massif have an important taxonomic value

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Fossil fishes in the context of evolution, environments and biogeography, poster presentation

Actinopterygians form a significant component of the vertebrates in the Permo-Carboniferous basins of the Bohemian Massif. 21 species of actinopterygians are described from the Upper Carboniferous and Lower Permian. A wide variation in the form, size, arrangement, attachment and number of marginal teeth and other teeth on the bones of the jaw apparatus and palate can be recognized in this small sample of species. These range from the tiny fish *Pyritocephalus sculptus* (Frič, 1875) with an absence of teeth, to the large carnivorous *Progyrolepis speciosus* (Frič, 1876). Similar dentition is demonstrated in *Elonichthys krejcii* (Fritsch, 1895). The Permían genus *Letovichthys* Štamberg, 2007 is also characterised by the teeth being in two rows, large sharply pointed teeth in an inner row and numerous small teeth in an outer row, but their number and arrangement differ considerably between the species *L. tuberculatus* Štamberg, 2007 and *L. multidentatus* Štamberg, 2007.

Numerous sharp pointed teeth covering the whole occlusal borders of the jaws including the palatal bones occur in the small Carboniferous fish *Sphaerolepis kounoviensis* Frič, 1876. Well-developed teeth of one size arranged in one row characterize another small Carboniferous species *Sceletophorus biserialis* Fritsch, 1894. Teeth of equal size and shape but with a relatively wide base occur in the small Permian fish *Igornichthys bohemicus* Štamberg, 2016. The largest groups of actinopterygians occurring in the Permian of the Bohemian Massif are Amblypteridae and Aeduellidae, and they are characterized by brush arranged tubular teeth which consist of a long tubule with a small acrodin tooth-cusp distally.

The wide range of different types of dentition presented in this set of actinopterygians from the Permo-Carboniferous of the Bohemian Massif demonstrate not only the wide variety of food items taken, but indicates the possibility for using dentition for taxonomic classification.

ID: 140

Of teeth and spines: The riddle of *Strophodus*' (Hybodontiformes, Chondrichthyes) validity

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Extinct shark-like chondrichthyans of the order Hybodontiformes, which encompass numerous described species of Palaeozoic to Mesozoic age, are characterized *inter alia* by rather robust bodies with two dorsal fins supported by convex spines. The hybodontiform fossil record is by far dominated by their teeth and spines, which commonly display morphological characters that are either ambiguous or broadly distributed among these chondrichthyans, rendering the interpretation of hybodontiform taxonomy and systematics difficult.

The genus *Asteracanthus* apparently was one of the most common Mesozoic hybodontiforms, as teeth and spines traditionally referred to this taxon have been reported almost worldwide from Middle Triassic to Late Cretaceous strata so far. *Asteracanthus* was erected by Louis Agassiz during the first half of the 19th century based on isolated dorsal fin spines characterized by prominent star-like tubercles from the English Middle and Late Jurassic. Later, Arthur Smith Woodward synonymized *Strophodus*, a genus originally introduced by Agassiz for prominent durophagous crushing teeth of Triassic to Jurassic age, with *Asteracanthus* based on associated teeth and spines he described from the Middle Jurassic of England. This taxonomic scheme has generally been accepted for more than 100 years until now, although articulated material has never been found.

We present a new hybodontiform skeleton with dentition from the Late Jurassic (Tithonian) of Germany exhibiting an unexpected combination of characters: tuberculate dorsal fin spines reminiscent of *Asteracanthus ornatissimus* (type species) and multicuspid grasping teeth similar to those traditionally referred to *Hybodus obtusus*. In an attempt to evaluate the significance of this enigmatic specimen for better understanding Mesozoic hybodontiform taxonomy and systematics, we compared its dorsal fin spines to the type material of *Asteracanthus ornatissimus* and those described by Woodward using qualitative and quantitative approaches, providing evidence that Agassiz's *Strophodus* in fact represents a valid taxon.

ID: 181

Stomach Contents of the Early Jurassic Fish †*Lepidotes* AGASSIZ, 1832 (Actinopterygii, Lepisosteiformes)

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Fossil fishes in the context of evolution, environments and biogeography, oral presentation

Two specimens of the actinopterygian fish †*Lepidotes* (Ginglymodi, Lepisosteiformes) from the Lower Jurassic (early Toarcian) of Germany show gastric contents consisting of compact masses of small crustacean cuticle fragments. These fragments belong to one or more unidentifiable shrimp-like taxa. The dentition of †*Lepidotes* with grasping teeth on the jaw margins and crushing teeth within the oral cavity is well adapted to such a diet. Dental morphology and compact body shape suggest that besides shrimp-like crustaceans, other potential food items of †*Lepidotes* may have included moderately elusive, relatively soft-shelled or unprotected, free-living invertebrates, such as small gastropods and bivalves, nudibranchs, annelids, actinias and soft sponges. Due to the similar dental morphology, a similar spectrum of food sources is assumed for the coeval dapediiform actinopterygians †*Dapedium* and †*Tetragonolepis*.

In recent marine ecosystems, small crustaceans, gastropods, bivalves, nudibranchs, annelids, actinias and soft sponges form abundant or even major faunal components of macroalgae forests. Based on this probable dietary spectrum, we hypothesise that coastal macroalgae forests represented the preferred habitat of those three fishes, even though clear evidence for such forests has not been reported from the German early Toarcian so far. Fin position and a deep-bodied shape, as seen in particular in †*Dapedium* and †*Tetragonolepis*, indicate highly manoeuvrable swimmers well adapted to a structurally complex environment such as macroalgae forests. Drifting masses of seaweed and colonies of pseudoplanktic crinoids could have also served to some degree as habitats for †*Lepidotes*, †*Dapedium* and †*Tetragonolepis*.

ID: 155

Deciphering the formation of a unique fossil window into early Permian microworlds at the birthplace of palaeobotany

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

For 300 years, fossil plants from fluvial deposits of the Manebach Formation (Asselian, central Germany) have kept both collectors and scientists in their spell, and their investigation is considered to represent the onset of palaeobotany. Compressions and casts of various plant organs, many of them preserved in striking detail, provided insights into the morphology and synecology of fossil taxa and shed light on both vegetation structure and palaeobiogeography in early Permian tropical Pangaea.

Despite occurring at a classical locality of palaeobotanical research, anatomically preserved plant fossils from Manebach deserved comparably less scientific attention. Due to high carbon contents, anatomical detail of the permineralisations is largely obscured impeding further research since their first mention in 1808. During the past 10 years, HF-etching revealed a fossil archive unlocking a previously unknown dimension of Permian continental micro-ecosystems. Accordingly, the permineralisations represent up to 0.5 m large stems of gymnosperms, and psaroniaceous tree ferns assigned to the fossil species *Psaronius gimmii* Barthel et al. 2010. In the outer root mantle of the latter, epiphytic ferns and gymnosperms, as well as microscale networks of fungal organisms, were discovered elucidating diverse interactions between plants, animals and microorganisms.

However, assessing the ecological significance of these co-occurrences requires a profound understanding of their stratigraphic position and geological circumstances favouring their fossilisation. In order to reconstruct the depositional environment, the talk summarises first results of two field campaigns and cathodoluminescence analyses. The data support quick flooding of a wetland plant-community and its in-situ encrustation by freshwater stromatolites at littoral depths recorded at the base of the Manebach Lake Horizon prior to silicification. Hence, the Manebach permineralisations not only reveal taphonomic pathways in fluvial environments but also prove seminal discoveries to be unearthed even at localities being subjected to collecting and study over centuries.

ID: 204

GANOVEX XIII: New plant-fossil sites in the Permian to Jurassic Victoria Group (Beacon Supergroup) in Victoria Land, Antarctica

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Late Paleozoic and Mesozoic Plants and Floras, oral presentation

The Devonian to Jurassic Beacon Supergroup of the Transantarctic Mountains has yielded exceptionally well-preserved plant fossils. Extensive fossil collections especially from South Victoria Land have contributed greatly to the stratigraphy and palaeoenvironmental interpretation of these deposits. The geology and palaeontology of the Beacon Supergroup in North Victoria Land, however, is still poorly known; many outcrop areas have only rarely been visited, and stratigraphic relationships are in many cases unclear. During the 13th German Antarctic North Victoria Land Expedition (GANOVEX XIII, 2018/2019), we visited old and new locations and collected late Palaeozoic and Mesozoic plant fossils in three major study areas: (1) In North Victoria Land within helicopter range of the Gondwana Station, namely the Eisenhower, Deep Freeze and Mesa ranges; (2) in the Helliwell Hills, central Rennick Glacier; and (3) in the southern Prince Albert Mountains in South Victoria Land, via helicopter reconnaissance and a satellite camp. During 26 days of field work, we visited 39 different locations and collected 450 kg of micro- and macrofossils. High-resolution palynological samples were taken across a potential Permian-Triassic boundary section in the Helliwell Hills (central Rennick Glacier) and at Triassic-Jurassic transition outcrops in the Eisenhower Range. Several outcrops of uncertain stratigraphic assignment in the southern Prince Albert Mountains were sampled for a first palynological age assessment. In addition, we found several new plant-fossil deposits with petrified wood, plant foliage, and silicified peat. This presentation gives an overview about newly collected plant fossils from Victoria Land, including diverse Permian and Triassic seed ferns (Glossopteridales, Umkomasiales) and Triassic horsetails (Equisetales). We anticipate that detailed analyses of these newly collected plant macro- and microfossil assemblages will enable better correlation of the regional stratigraphic schemes of northern and southern Victoria Land and enhance our understanding of these now extinct high latitudinal polar forest ecosystems.

ID: 152

Fossils, molecules, development and morphology suggest that comb jellies (Ctenophora) are coelenterate diploblasts

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Plenary presentation

The phylogenetic placement of comb jellies has been a debated subject for the last decade or more. A great number of molecular phylogenetic studies recover ctenophores as the sister group to all other metazoans with great implications for hypotheses of body plan evolution and the complexity of the ancestral metazoan. The discovery that a number of Cambrian weird wonders—the tulip animal, *Siphusauctum*, and *Dinomischus* preserve a suite of characters that are intermediate between polypoid cnidarians and comb jellies present an alternative line of evidence suggesting that comb jellies are the sister group of cnidarians in the classic clade of Coelenterata. In this talk I will present the fossil evidence for this hypothesis and review molecular and morphological evidence that all corroborate this hypothesis. With comb jellies resolved in their traditional phylogenetic position, it is possible to constrain early metazoan character evolution with more certainty.

ID: 230

A unique tetrapod fauna from the late Paleozoic Saar-Nahe Basin, SW Germany

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Evolving ecosystems, poster presentation

Fossils from the late Paleozoic continental Saar-Nahe Basin, SW Germany, have been known for more than 250 years. Despite the abundance and diversity of continental biota of Carboniferous-Permian age, there is still a significant lack of non-aquatic vertebrates from the basin. Recent discoveries in nearly 300 Ma (Gzhelian-Asselian) old fluvio-lacustrine deposits of the Remigiusberg Formation of the Remigiusberg-Rammelskopf quarry near Kusel in the centre of the Saar-Nahe-Basin, however, fill this gap of knowledge piece by piece. Within the last few years, a highly diverse tetrapod assemblage has been unveiled, making the Remigiusberg-Rammelskopf quarry to one of the most productive localities of early tetrapods in Europe regarding abundance, diversity and quality of the tetrapod fossils.

The currently known tetrapod assemblage of the quarry includes: (1) A variety of not yet specified lepospondyls (lysorophids, 'microsaurs', urocordylids); (2) a trimerorhachid-like dvinosaur (*Trypanognathus remigiusbergensis*); (3) remains of at least three large eryopids; (4) two one-meter-sized skeletons of tseajaiid diadectomorphs; (5) remains of four individuals of edaphosaurid 'pelycosaurs' (*Remigiomontanus robustus*); and (6) a jaw fragment of a sphenacodontid 'pelycosaur' (*Cryptovenator hirschbergeri*). Remains of a small supposed diapsid skeleton, an essentially complete, about 1.4 meter long 'pelycosaurian' skeleton as well as numerous isolated and unidentified bones still awaiting preparation.

Altogether, the tetrapod fauna contains fully aquatic, semiaquatic and terrestrial animals. Litho- and biofacies pattern indicating a marginal lacustrine paleoenvironment. Here, the accumulation of tetrapod remains seems mainly be the result of mudflow events after ancient heavy rain falls. Special significance of the Remigiusberg-Rammelskopf locality is further obtained through the occurrence of the distinct 'pelycosaurian' remains representing the oldest known amniotes from Germany and the second oldest ones from Europe as well as the striking similarities of the tetrapod assemblage with early Permian tetrapod fossils from central the German Bromacker and North America.

ID: 133

Metabolic potential and gene expression of the deep biosphere in oxic and anoxic abyssal clays from the North Atlantic Ocean.

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Molecular Geobiology and Paleobiology, poster presentation

The deep biosphere is an essential component of marine ecosystems extensively populating the sediments and regulating key nutrient cycling. Its global distribution and density in the oceans mainly derives from primary organic matter production, while sedimentation rates control the depth of oxygen penetration in the subseafloor. We focus on organic-poor oxic and anoxic sediments from the Northern Atlantic abyssal plain.

We targeted both environmental DNA and RNA using quantitative PCR and high-throughput sequencing of 16S rRNA genes, metagenomes, and metatranscriptomes. At the oxic site, 16S rRNA gene copies decreased from 10×7 at the surface to 10×3 at 16 m below seafloor, with a taxonomic diversity dominated by benthic groups of ammonia oxidizing Thaumarchaeota (AOA). The metabolism of AOA is characterized by ammonia oxidation, mixotrophic utilization of organic nitrogen via deamination, and the chemolithoautotrophic hydroxypropionate/ hydroxybutyrate carbon fixation cycle, which shows that these AOA have the potential to couple deamination with ammonia oxidation for additional energy to fuel carbon fixation. At the anoxic site, 16S rRNA gene copies were 10×6 at the sediment surface and down to 5 m depth, further decreasing to 10×4 at the core bottom. A single Atribacteria JS1 taxon dominated the microbial community throughout the core. The candidate Atribacteria JS1 has metabolic potential for mixotrophic utilization of sugars and peptides through glycolysis, the acetyl-CoA pathway and partial tricarboxylic acid cycle. Transcriptomes showed that energy production is sustained via the fermentation of aldoses, ketoses, alcohols and volatile fatty acids, which is made possible by the presence of a microcompartment in the cell that recycles aldehydes, ketones and ethanolamines. These new insights into metabolisms of the deep biosphere show that cellular survival underlying these extremely energy limited conditions is mostly based on the turnover of bacterial necromass and designed to reduce energy loss.

ID: 208

Scorpions in "space" – morphometric approach to the diversity of scorpion shape

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Open session, oral presentation

Scorpions are predatory representatives of Euchelicerata with about 2,300 extant species and various fossil occurrences, the oldest ones dating back to the Silurian (about 430 mya). Scorpions are known from terrestrial habitats all over the world, their sizes ranging from about 1 cm (*Typhlochactas mitchelli*) to over 20 cm body length (*Pandinus imperator*). However, morphological diversity is not only represented by size differences, but also by differences of body organization. Scorpions, like all arthropods, possess a segmented body, with several segments being organized into functional units, termed tagmata. These tagmata are specialized in their morphology to perform different functional tasks, such as walking or food uptake. In Euchelicerata, especially the transition area between the anterior and the next tagma shows a high morphological variability. Segments may have undergone compression, functional integration into one tagma while usually interpreted to be part of the other one, but also appendage differentiation. In scorpions, this transition area shows a combination of all three processes leading to a highly compressed area with obscured segment borders. For a better understanding of this transition area and its evolution a morphospace-based approach was used. Morphospaces are multidimensional spaces representing the shape of organisms, or mostly different structures of an organism in detail, based on measurements of these structures. These measurements include different lengths and widths of the specimen, e.g. the maximum width of the prosomal shield or the length of the trunk. After size correction these measurements can be plotted as a morphospace which yields information about the body organization and tagmatization. Including specimens from different geological periods, as well as different ontogenetic stages, provides information about changes of morphological diversity through evolutionary history and individual development. We present first results and discuss in how far this approach is improving our understanding of scorpion evolution.

Young Scientist Award

ID: 216

Microbialites from the Sylvana Limestone (Middle Miocene, SW Germany): precipitation patterns and actualistic comparisons

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Open session, poster presentation

During the Middle Miocene, an extensive lake district existed along the southern margin of today's Swabian Alb. Sediments include marls to carbonates of lacustrine and palustrine origin, being part of the Obere Süßwassermolasse. The limestones are known as Sylvana Limestone. They comprise a wide range of microbialites of presumably cyanobacterial origin. Macroscopically, they show a distinctive layering with alternation of whitish and tan-colored layers. Thin sections and SEM studies reveal a micro-structure comprising an unbranched filament zone formed by erect and parallel calcified filaments, as well as a zone of false-branching filaments forming tufts or shrubs of *Dichothrix*-morphotype. This two-fold zoning is reminiscent of the modern filamentous and heteropolar cyanobacteria *Rivularia periodica*. Thalli of *R. periodica* show a third type of zone formed by a horizontal arrangement of basal heterocysts. Similarities between the studied microbialite and the zonation of the recent *R. periodica* allow for a comparison on the level of morpho-types. Differences exist with respect to the mineralization. The studied fossil zoned microbialite shows a microbially-influenced and microbially-induced mineralization ("organomineralizaton"). A specific feature of the studied microbialite are dark micritic accumulations of carbonate at the presumed location of basal heterocysts in petrograpic thin sections and dense carbonate nodules in SEM samples. The specific docking of heterotrophic bacteria to cyanobacterial heterocysts is known from recent procaryots and described in scientific literature. The carbonate accumulations at the presumed location of basal heterocysts can be explained by establishing a model based on microbially-induced mineralization. Consumption of the available O_2 by aerobic respiration of procaryotes promotes an anerobic microenvironment surrounding the basal heterocysts. In this microenvironment depleted of O_2 anerobic heterotrophs such as sulfate reducers are metabolically active resulting in an increase in alkalinity which in turn could induce mineral precipitation around heterocysts forming the observable accumualtions of carbonate.