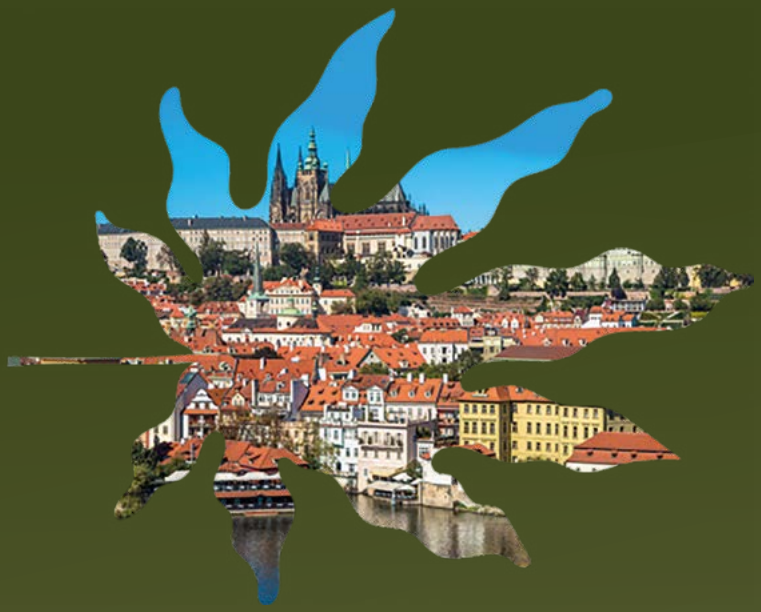
CONFERENCE
XV IPC - XI IOPC
PRAGUE 2024



XV International Palynological Congress XI International Organization of Palaeobotany Conference

27–31 May 2024, Prague
Czech Republic

Abstract Book

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XV International Palynological Congress

XI International Organization of Palaeobotany Conference

27–31 May 2024, Prague
Czech Republic

ABSTRACT BOOK

EDITED BY:

Jiří Bek
Jana Votočková Frojdová

Welcome Words

It is a pleasure for us to welcome the international communities of palynologists and palaeobotanists. Fossil spores, pollen and plants illustrate the evolution of life on earth. They also provide significant information and data on the ecology, taxonomy, systematics and palaeoclimate of the past. Palynologists and palaeobotanists have an excellent database of climatic changes that goes back for hundreds of millions of years. Floristic changes give evidence about ecology and climate of a region as well as in the global scope, often with a very high degree of precision. One of the main principles in palaeontology including palynology and palaeobotany is that present is the key to the past. In the case of climatic changes, we can only study the past in order to see what might happen in the future.

The main motto of the conference is 200 years of palaeobotany. This is dedicated to famous Czech palaeobotanist Caspar Maria von Sternberg, known also as a "Father of Palaeobotany". Scientific palaeobotany and binominal classification of plants is normally taken to have started in the 1820s when the first part of Sternberg's seminal work Versuch der Flora der Vorwelt was published.

We offer to 520 participants from 51 countries 48 symposia 2 workshops and one colloquium covering all aspects of palynology and palaeobotany and eight field-trips that will take participants to several interesting localities throughout the Czech Republic.

We are obliged to our parent organizations IFPS and IOP that showed great confidence in the technical and scientific competence of the Prague team. We are also much obliged to our conference partner company Czech-In and its highly professional conference management for vital and crucial help with organization. Last but not least a great thank for enthusiastical help to the organizing committee that worked hard not for four years as organizers of every IPC/IOPC but for more than eight years because the conference had to be postponed by four years from 2020 to 2024 due to global Covid pandemy.

We thank to our sponzors and all participants for their help and interest and for coming to Prague meeting.

It is our hope that the joint meeting of XVth IPC and XIth IOPC in Prague will stimulation cross fertilization between palynology and palaeobotany and encourage further integration of the two fields of research.

We wish you all a very successful, fruitful and productive conference and pleasant stay in Prague.

Organizing Committee

Oral Presentations

28/05/2024, 08:30–10:30, Room: Zenit+Nadir
Opening ceremony & Keynote Talks

O-001 - Neogene history of the Amazonian flora, insights from paleopalynological and phylogenetic data

Carina Hoorn[1], *Lúcia G. Lohmann*[2], *Lydian M. Boschman*[3], *Fabien L. Condamine*[4]

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2 Instituto de Biociências, Departamento de Botânica – Universidade de São Paulo, São Paulo, Brazil
3 Department of Earth Sciences, Utrecht University, Utrecht, Netherlands
4 Institut des Sciences de l'Evolution de Montpellier, CNRS – Université de Montpellier, Montpellier, France

The Amazon hosts one of the largest and richest rainforests in the world and has a history going back to the beginning of the Cenozoic (66 Ma). Species richness was mainly driven by climate and geological forces, in combination with other factors such as edaphic and biotic factors. Here we review the geo-climatic history of the Amazon by summarizing paleopalynological records and time-calibrated phylogenies to evaluate the response of plants to environmental change. The Neogene history is characterized by the following phases: 1) In the early Neogene (23–13.8 Ma), a large wetland developed with episodic estuarine conditions and vegetation ranging from mangroves to terra firme forest; 2) In the late Neogene (13.8–2.6 Ma), the Amazon changed into a fluvial landscape with a less diverse and more open forest, although the details of this transition remain to be resolved. These geo-climatic changes have left imprints on the modern Amazonian diversity that can be recovered with dated phylogenetic trees. Amazonian plant groups show distinct responses to environmental changes, suggesting that Amazonia is both a refuge and a cradle of biodiversity. Phylogenies of eight Amazonian plant clades paint a mixed picture, with the diversification of most groups best explained by constant speciation rates through time, while others indicate clade-specific increases or decreases correlated with climatic cooling or increasing Andean elevation. In summary, the Amazon rainforest represents a museum of diversity with a high potential for biological diversification through time. To fully understand how the Amazon got its modern biodiversity, further multidisciplinary studies conducted within a multimillion-year perspective are needed. For further information see: Hoorn et al. (2023), doi.org/10.1146/annurev-earth-081522-090454.

28/05/2024, 08:30–10:30, Room: Zenit+Nadir
Opening ceremony & Keynote Talks

O-002 - Fossil wood from the Cupressaceae from Late Cretaceous crater sediments of the Salpeterkop volcano, South Africa

Marion K. Bamford[1], *Mike de Wit*[2]

1 University of the Witwatersrand, Evolutionary Studies Institute, Johannesburg, South Africa
2 Stellenbosch University, Earth Sciences, Stellenbosch, South Africa

Five pieces of silicified wood were collected from the crater filled sediments of the Late Cretaceous Salpeterkop volcano, sectioned and identified as a new species of *Cupressinoxylon, C. widdringtonioides*. This is the first example of the form genus in South Africa. Only one member of the family Cupressaceae s.l. occurs in southern Africa today, *Widdringtonia*, with a restricted distribution. From the wide and indistinct growth rings in the fossil wood it can be deduced that the local climate was warm and humid with little or no seasonality, in support of global records of a warm Late Cretaceous. An overview of the history of the southern African conifer flora is included.

Cretaceous deposits are rare in southern Africa and limited to a few coastal deposits and inland kimberlite and volcano crater-lake sediments. Forming part of the ca 70 Ma Sutherland Suite of alkaline rocks, an igneous province composed of olivine melilitites, carbonatites, trachytes and ultramafic lamprophyres, the Salpeterkop volcano is a remnant of the summit tuff ring structure that surrounds a crater. It is almost 1 km in diameter and is filled with epiclastic sediments. Since remnants of the ejecta mantle remain outside the crater ring this is evidence that the intense land denudation during the post-Gondwana breakup through to the Cretaceous ended abruptly and was followed by much reduced erosion rates during the Cenozoic.

28/05/2024, 08:30–10:30, Room: Zenit+Nadir
Opening ceremony & Keynote Talks

O-003 - The fascinating development of palynological preparation techniques

James B. Riding[1]

1 British Geological Survey, n/a, Nottingham, United Kingdom

Palynology is a relatively recent branch of science; the term itself was introduced in 1944. Compare the history of ammonite research, which is over 200 years. One of the major breakthroughs in palynology was the use of inorganic acids to extract palynomorphs by dissolving the surrounding mineral matrix during the 19th century. The number of practitioners using of hydrochloric and hydrofluoric acids to extract organic microfossils at this time was very small. Later, the joined-up use of HCl and HF followed by oxidation, centrifugation, and sieving only developed during the 1950s. Since then, the literature on palynomorph preparation has burgeoned, and includes two textbooks and several major papers. Most palynological preparations are based around HCl and HF digestion. Following acid treatment, palynomorphs are concentrated before being mounted on microscope slides or SEM stubs. There is no such thing as the 'standard preparation technique', this is because each sample is different and most require individual treatment. Great care must be taken following acid digestion because damage to, and loss of, palynomorphs can be caused by injudicious acetolysis, bleaching, heating, oxidation, ultrasonic treatment etc. This individual attention, sample-by-sample, is one of the principal reasons that automation and mechanisation of laboratory preparation of palynomorphs has not developed. Most samples processed are clay-rich; other lithotypes such as coal require different techniques. Clearly, the use of mineral acids requires modern laboratory equipment and extreme care to avoid accidents. Because palynomorphs are so numerous and ubiquitous, all efforts should be made to avoid contamination right through from sample collection to slide mounting. Non-acid preparation offers a cheaper, less hazardous, and faster method of preparing palynomorphs for study. A recently documented technique used sodium hexametaphosphate as a clay deflocculant and this has proved a very effective alternative to acid digestion for most siliciclastic samples.

28/05/2024, 08:30–10:30, Room: Zenit+Nadir
Opening ceremony & Keynote Talks

O-004 - New advances in excavation and research of Permian Plant Lagerstätte-Vegetational Pompeii

Jun Wang[1], *Jiří Bek*[2], *Hermann W. Pfefferkorn*[3], *Mingli Wan*[1], *Weiming Zhou*[1], *Dandan Li*[1]

1 Nanjing Institute of Geology and Palaeontology – Chinese Academy of Sciences, Key Laboratory of Palaeobiology and Petroleum Stratigraphy – Department of Palaeobotany and Palynology, Nanjing, China
2 Institute of Geology of the Czech Academy of Sciences – v.v.i, Laboratory of Palaeobiology and Palaeoecology, Prague, Czech Republic
3 University of Pennsylvania, Department of Earth and Environmental Science, Pennsylvania, USA

A peat-forming forest was preserved *in situ* by a 298.34 ± 0.09 Ma volcanic ash bed in the Wuda Coalfield, Inner Mongolia, being called Wuda Tuff Flora. Concerning the geologic and taphonomic similarities to the world-famous Italian UNESCO World Heritage Site of the Roman city of Pompeii, this flora has been also called Chinese "**vegetational Pompeii**", well known as a plant lagerstätter, snapshotting a glimpse into the late Paleozoic peat-forming forest. Such a T^0 deposit provides an unrivaled chance to reconstruct the taxonomic diversity, vegetation structure and density, and synecological associations.

Through the past two decades years, the progress of the open-cast mining of the Wuda Coalfield offered opportunities for fossil collecting and in total certain areas of over 10, 000 square meters of quantitative investigation of forest ecology, which have yielded a larger collection of the material. The completeness and the exquisiteness of plant remains certainly facilitate a thorough systematic study of many taxa of this peat-forming forest. Nearly all the taxa of this peat-forming forest show both gross morphology and anatomy, and both vegetative and fertile parts, and thus likely to facilitate restoration as whole plants (hitherto about 10 species have been reconstructed) and natural species (hitherto about 12 species have been described), which is impossible in most other localities due to the often small number and the limited size of specimens. In addition, landscape heterogeneity (e.g. species-area curve), forest structure (e.g. density of individuals), and vegetational recovery are detectable. There is one site where noeggerathialeans, for the first time are found to be dominant.

Concerning the exceptionally high scientific significance, the fossil site has been proposed to be a candidate for the Second 100 Geoheritage of IUGS, given to be well enough protected to some extent, having the potential to build a museum and geopark.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-005 - Late Cretaceous mesofossils from Portugal

Else Marie Friis[1], *Peter Crane*[2], *Kaj Raunsgaard Pedersen*[3]

1 Univeristy of Aarhus, Department of Geoscience, Aarhus, Denmark
2 Oak Spring Garden Foundation, Oak Spring Garden Foundation, Upperville, USA
3 University of Aarhus, Department of Earth Science, Aarhus, Denmark

Two mesofossil floras, Esgueira and Mira, of Campanian-Maastrichtian age collected from the northern part of the Lusitanian Basin, Portugal, have yielded rich assemblages of small flowers, isolated stamens, fruits and seeds of angiosperms, some of which are already published including *Endressianthus foveolatus*, *Endressianthus miraensis*, *Esgueiria adenocarpa*, *Esgueiria miraensis*, *Miranthus elegans*, *Miranthus kvacekii* and *Normanthus miraensis*. Studies of new monocot and eudicot flowers from Mira and Esgueira using synchrotron X-ray microtomography and scanning electron microscopy will be presented and the environmental and palaeogeographic implications discussed. During the Late Cretaceous Portugal was part of the Northern Boreal Normapolles floral province, named for the characteristic triaperturate Normapolles type pollen that is widespread from eastern and southern North America through Europe to Siberia and parts of China. The Late Cretaceous angiosperm flowers from the Portuguese floras are similar in organisation and general phylogenetic diversity to other Late Cretaceous mesofossil floras known from North America and Europe. The floras are dominated by eudicot angiosperms with several Normapolles producing plants of fagalean affinity, a diversity of other rosids, as well as fossils related to the Ericales. However, there are clear regional differences and with very few exceptions the angiosperm component of the Portuguese floras is distinct from other mesofossil floras. For instance, the *Caryanthus/Plicapollis* complex of Normapolles flowers, which is common in Central and northern European floras, is unknown in Portugal, while *Endressianthus/Interporopollenites* Normapolles flowers are unique to Portugal. Similarly, flowers of the rosid *Esgueiria*, which are characteristic for the Esgueira and Mira floras, are unknown elsewhere in Europe and North America, but are recorded from Japan. The Portuguese floras also have a relatively diverse monocot component, which is not known from other Late Cretaceous mesofossil floras.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-006 - Phylogenetic evaluation of putative Cretaceous Magnoliales and their implications for character evolution and biogeography

James Doyle[1], *Peter Endress*[2]

1 University of California Davis, Evolution and Ecology, Davis CA, USA
2 University of Zurich, Department of Systematic and Evolutionary Botany, Zurich, Switzerland

We evaluated the phylogenetic position of presumed Cretaceous Magnoliales using a molecular scaffold approach, in which a morphological data set of extant and fossil taxa is analyzed with extant taxa constrained to arrangements based on molecular data. Four fossils are most securely nested in Magnoliales. *Archaeanthus* (late Albian, Kansas) is strongly linked with Magnoliaceae, but it is unresolved whether it is sister to or nested within the crown clade. In either case, it indicates that most of the distinctive apomorphies of the family had evolved by the late Albian, and it occurred in Laurasia by this time. The older fossils *Endressinia* and *Schenkeriphyllum*, from the Aptian of Brazil, form a clade sister to Magnoliaceae (including *Archaeanthus*). They indicate that inner staminodes were ancestral in Magnoliales, and the typical sheathing leaf base and dry fruit wall of extant Magnoliaceae evolved before loss of inner staminodes and elongation of the floral axis. Their occurrence in Brazil is consistent with the hypothesis that the magnoliaceous line originated in Gondwana, as inferred for other Magnoliales, while their small leaves and other indicators of aridity imply that some early Magnoliales were adapted to drier conditions than the modern representatives. *Futabanthus* (Coniacian, Japan) is nested within crown group Annonaceae, near the base of the family; it implies that one extinct annonaceous line entered Laurasia before any of the living Asian lines. By contrast, *Pecinovia* (Cenomanian, Czechia) appears to be unrelated to Magnoliales, whereas *Serialis*, *Riaselis*, *Cecilanthus*, and *Detrusandra* may belong in either Magnoliales or the basal ANA grade. *Cronquistiflora* (Turonian-Coniacian, New Jersey) is weakly associated with the Australian genus *Eupomatia*; this relationship would imply that the hypanthium and introrse anthers of *Eupomatia* evolved before its bizarre floral architecture, and that this line formerly occurred in Laurasia.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-007 - Evaluating angiosperm flowers in mid-Cretaceous amber from Myanmar using X-ray imaging techniques

Simon Beurel[1], *Julien B. Bachelier*[2], *Alexander Schmidt*[3], *Eva-Maria Sadowski*[1]

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2 Freie Universität Berlin, Institute of Biology: Plant Ecology and Systematics, Berlin, Germany
3 University of Göttingen, Department of Geobiology, Göttingen, Germany

Kachin amber from northern Myanmar currently represents the most important source of three-dimensionally preserved Cretaceous terrestrial organisms, with more than 2600 species found as inclusions. Although the number of seed plant taxa from Kachin amber has increased during the past couple of years, their obscured internal structures often remained unstudied, which hampered confident taxonomical assignment. We consider state-of-the-art X-ray imaging techniques essential to uncover the anatomy of seed plant inclusions. Using the presumed *Phylica* (Rhamnaceae) fossil as an example, we show that these techniques can enlighten relevant characters of amber-preserved reproductive organs and help achieving confident taxonomic assignments. This fossil possesses bisexual flowers with a spiral phyllotaxis comprising an undifferentiated perianth with a floral cup, many stamens with bilocular valvate anthers and a pair of basal filament appendages, inner staminodes, and a semi-inferior ovary. This mosaic of characters excludes any affiliation to Rhamnaceae and revealed typical features of several families within the Laurales. Our analysis rejected the previous notion that the fossil belongs to the extant genus *Phylica* which would have had dramatically pushed back the age estimations of angiosperms.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-008 - Late Cretaceous Angiosperm variation in Hokkaido, Japan: New permineralized flowers found by using an innovating method MULPIS

Tsubasa Ohmori[1], *Aya Kubota*[1], *Harufumi Nishida*[1], *Shin Ikegami*[2], *Yusuke Takeda*[2], *Yasuhiro Iba*[2]

1 Chuo University, Faculty of Science and Engineering, Tokyo, Japan
2 Hokkaido University, Facukty of Science, Sapporo, Japan

Fossil flowers, particularly, mesofossils, provide significant evidence for understanding the phylogenetic diversification of angiosperms. It has been known that the carbonate concretions from the Late Cretaceous Yezo Group preserve mesofossil-like flowers as permineralizations. However, their discovery depends predominantly on encounters by chance as found on rock surfaces or slab-sawed faces. Recently, IY established a new technique, “high-resolution multidimensional petrographic imaging system (MULPIS)” that can make fossil encounter almost non-incidental. The MULPIS machine automatically continues grinding and surface photographing of a concretion, allowing sequential image capture inside the entire rock. We preliminarily applied MULPIS for six carbonate concretions from the Yezo Group (mainly Turonian and Cenomanian) and successfully obtained 3D images of every fragment of plant debris inside the rock matrix. Here we report nearly ten fossil flowers found in two concretions so far. The most well-preservedone is a pentamerous and perigynous bisexual flower consisting of five perianths, ten stamens and one gynoecium. The gynoecium is composed of five carpels fused at the base and terminates in five elongated styles. Each locule contains two to three inverted ovules. The fossil can be morphologically attributable to the Saxifragales but further phylogenetic analysis is still ongoing. Other flowers represent a variety of morphologies showing high diversity of the Late Cretaceous Angiosperms in Hokkaido. The MULPIS certainly expands our understandings of the past floras and biodiversity, although certain problems remain to be discussed because of its totally destructive nature.

This research is supported by Chuo University Grant for Special Research 2022–2023 toHN.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-009 - Revision of the Late Cretaceous genus Walbeckia (Normapolles plants; Fagales) from Central Europe

Zuzana Heřmanová[1], Maria von Balthazar[2], Jiří Kvaček[1], Jürg Schönenberger[2]

1 Národní Muzeum, Paleontologické oddělení, Praha 10, Czech Republic
2 University of Vienna, Department of Botany and Biodiversity Research, Vienna, Austria

Our study shows that the genus *Walbeckia* Knobloch et Mai forms a rather heterogenous group that is in need of revisions. Originally, the genus contained ten species. Based on the new morphological analyses in the present study, two of these species, namely *Walbeckia aquisgranensis* and *W. fricii*, are reinterpreted and removed from the genus. *W. aquisgranensis* is transferred here to a newly established genus *Felianthus* gen. nov. The genus includes two species: *Felianthus aquisgranensis* (Knobloch et Mai) sp. nov. and *Felianthus aacheniensis* sp. nov. Flowers of *Felianthus* gen. nov. are structurally bisexual and epigynous. The perianth consists of two small tepals and the androecium consists of two stamens (only filament bases preserved). Pollen grains are triangular-oblate, triaperturate. The gynoecium is syncarpous, two-locular at the very base and unilocular above. The ovary surface is characterized by longitudinal ribs that run from the ovary base to the tepals. The fruits are one-seeded and the seeds are attached basally. Based on the triangular-oblate and triaperturate pollen grains of the Normapolles type, the genus *Felianthus* gen. nov. is here treated as part of the Normapolles complex.

In addition, specimens previously described as *Walbeckia fricii* Knobloch et Mai are here reinterpreted as *Zlivifructus fricii* (Knobloch et Mai) comb. n. based on the presence of a tetramerous perianth and tetramerous androecium, which is characteristic for the Normapolles genus *Zlivifructus* Heřmanová, Dašková, Ekrt et J. Kvaček.

Our study also shows that the remaining species and specimens of the genus *Walbeckia* Knobloch et Mai still form a rather heterogenous group in need of further revisions, which will have to await the discovery of additional and hopefully better-preserved specimens from the Late Cretaceous of Central Europe.

28/05/2024, 11:00–13:00, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-010 - Angiosperm flowers reached their highest morphological diversity early in their evolutionary history

Andrea M Lopez Martinez[1], Susana Magallon[1], Maria von Balthazar[2], Jürg Schönenberger[2], Herve Sauquet[3,4], Marion Chartier[2]

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2 University of Vienna, Department of Botany and Biodiversity Research, Vienna, Austria
3 Royal Botanic Gardens and Domain Trust, National Herbarium of New South Wales, Sydney, Australia
4 School of Biological – Earth and Environmental Sciences – University of New South Wales, Evolution and Ecology Research Centre, Sydney, Australia

Flowers are the complex and highly diverse reproductive structures of angiosperms. Because of their role in sexual reproduction, the evolution of flowers is tightly linked to angiosperm speciation and diversification. Accordingly, the quantification of floral morphological diversity (disparity) among angiosperm subgroups and through time may give important insights into the evolutionary history of angiosperms as a whole. Based on a comprehensive dataset focusing on 30 characters describing floral structure across angiosperms, we used 1201 extant and 121 fossil flowers to measure floral disparity and explore patterns of floral evolution through time and across lineages. We found that angiosperms reached their highest floral disparity in the Early Cretaceous. However, decreasing disparity toward the present likely has not precluded the innovation of other complex traits at other morphological levels, which likely played a key role in the outstanding angiosperm species richness. Angiosperms occupy specific regions of the theoretical morphospace, indicating that only a portion of the possible floral trait combinations is observed in nature. The ANA grade, the magnoliids, and the early-eudicot grade occupy large areas of the morphospace (higher disparity), whereas nested groups occupy narrower regions (lower disparity).

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-011 - Comparing pollen complexes of the Chernobyl type and of the Neanderthal time climatic extreme

Galina Levkovskaya, Natalia Shamal, Natalia Rudaya, Anastassia Bogolyubova, Gennady Baryshnikov, Vasiliy Lyubin, Belyaeva Elena

SEM studies of pollen samples obtained from the Chernobyl NPP exclusion zone on the second year after the accident, and from the sediments of the Neanderthal climatic extreme have documented “cemeteries” of numerous indeterminable pollen of different taxa.

The most severe climatic extreme was determined for the Neanderthal layer of Barakayevskaya cave (the Caucasian broadleaf forest belt). Based on palynological and palaeozoological data, the steppe and alpine belts contact, and the upper limits of all flowering plants were reconstructed. The complex resembles the “cemetery” of contours of sterile, thinned due to immaturity, and indeterminable dwarf (10 μm) pollen grains. The monstrous forms are almost absent, like in all natural complexes. Only Betulaceae grains from polyade were determined.

The Kryuki (16 km from the ChNPP). Maximum contamination with 137Cs (270000 Bq/kg). “Cemetery” with co-domination of three ecologically important abnormalities in each form: monstrosity (dominant feature) + underdevelopment + dwarfism. Only three dwarf forms were identified: Pinaceae, *Betula* and *Alnus*.

The Masany complex (12 km from the ChNPP) reflects the most severe conditions under the maximum contamination with 241Am (150 Bq/kg), 90Sr (14000 Bq/kg) and 239–240Pu (99 Bq/kg). It resembles the “cemetery” of indeterminable “empty” forms with white colloided exine. Each form bears three, more pronounced than in natural complexes, environmentally significant abnormalities: instead of immaturity – underdevelopment of many traits; the defective forms look monstrously; the dwarfism.

The Lesok complex (22 km from the ChNPP) is dominated by monstrous pollen forms, but there are more identifiable ones. This is due to protective effect of the nearby forest and a greater distance from the ChNPP.

The complex of the natural climatic extreme differs from the Chernobyl ones by the co-domination of two ecologically important abnormalities in each form: underdevelopment + dwarfism. In natural complexes the defective forms are rare, with their maximums in the distribution area margins.

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-012 - Image-based multispectral flow cytometry – A new approach for fast and efficient pollen analysis

Franziska Walther[1,2], Carolin Plos[3,4], Till J. Deilmann[5], Annalena K. Lenk[5,6], Christine Römermann[3], Elsa Friedrich[7], Annette Schroeder[7], Selina Campbell[8], Martina Janke[8], Demetra Rakosy[9,10], Stan Harpole[1,2], Martin Hofmann[11], Thomas Hornick[1,2], Susanne Dunker[1,2]

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5 Institute of Ecology and Evolution – Friedrich-Schiller-Universität Jena, Plant Biodiversity, Jena, Germany
6 Institute of Biology – Leipzig University, Systematic Botany and Functional Biodiversity, Leipzig, Germany
7 Universität Hohenheim, Landesanstalt für Bienenkunde, Hohenheim, Germany
8 Niedersächsisches Landesamt für Verbraucherschutz und Lebensmittelsicherheit LAVES, Institut für Bienenkunde, Celle, Germany
9 Helmholtz Centre for Environmental Research – UFZ, Community Ecology, Leipzig, Germany
10 German Centre for integrative Biodiversity Research iDiv Halle-Jena-Leipzig, Species Interaction Ecology, Leipzig, Germany
11 Institute of Applied Computer Science – Technische Universität Ilmenau, Data-intensive Systems and Visualization Group dAI.SY, Ilmenau, Germany

Manual microscopic analyses are traditionally the gold standard for various palynological applications. But the trend is towards automated, database-driven pollen analyses that are expected to be cheaper, less time-consuming and allow better reproducibility

than the traditional microscope-based methods. Such a new automated method is multispectral imaging flow cytometry linked with machine learning. It enables microscopic brightfield and fluorescence images and a variety of pollen traits (e.g. diameter, fluorescence or shape) of pollen to be recorded quickly. Based on this data, a convolutional neural network classifier can be trained, which then allows pollen identification based on pollen pictures. This method was tested for pollen identification in various (honey) bee-relevant matrices such as honey or pollen baskets. In addition, intraspecific pollen trait variation was studied to better understand the amount of variability needed to robustly identify pollen with this method. In this presentation, I would like to introduce this novel method with a focus on the identification of insect-pollinated plant pollen. Pollen analysis in honey and in pollen baskets are presented as application examples. Moreover, I will summarize a pollen trait variation study, in which we found significant spatial as well as temporal variation for at least one pollen trait of four plant species (*Achillea millefolium*, *Lamium album*, *Lathyrus vernus*, *Lotus corniculatus*). All in all, pollen analysis using image-based multispectral flow cytometry is a promising application for Palynology.

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-013 - Reconstructing Maunder Minimum and Satellite Era relative changes in surface UV-B flux in the Southern Hemisphere based on sporopollenin chemistry

Bert Verleijsdonk[1], *Timothy Anane*[1], *Katherine Holt*[1], *Barry H. Lomax*[2], *Phillip Jardine*[3], *Marcus Vandergoes*[4]

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2 University of Nothingham, School of Biosciences, Sutton Bonington, United Kingdom
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The quantity of UV-B radiation that reaches the Earth's surface varies through time. Currently our methods for reconstructing past UV-B levels are limited. Sporomorphs (pollen and spores) contain UV-B absorbing compounds (UACs) in the sporopollenin biomacromolecule forming their outer walls. Empirical and experimental studies show that UACs are ubiquitous in sporopollenin, and that the quantity increases with higher exposure of the parent plant to UV-B. Since sporomorphs are abundant in the fossil record and their UAC content is relatively stable over time, they offer an avenue for the reconstruction of surface UV-B. To date this method has been applied in some studies focused on Northern Hemisphere and equatorial locations, but not yet in New Zealand or the wider Southern Hemisphere.

We have used Fourier Transform infrared (FTIR) microspectroscopy to measure UACs within sporopollenin of *Prumnopitys taxifolia* and *Pinus* sp(p). pollen recovered from sediments of Lake Ohau (44°16.782'S, 169°55.480'E). We have targeted two periods: (1) 1954–2016 CE (approx.), representing the period for which we have satellite measurements of solar activity, and (2) the Maunder Minimum (MM; 1645–1710 CE). We compare the UAC-based record of relative UV-B variation against the satellite measurements to evaluate the strength of the correlation between solar radiation and UAC variation. The UAC datasets representing the satellite data acquisition era shows no correlation with incoming solar UV-B. There is a positive relationship between the *Pinus* sp(p). and *Prumnopitys taxifolia* UAC data, and Lauder UV-B surface data, indicating that these taxa are both responding in a similar fashion to their local/regional UV-B environment. Our preliminary data from the Maunder Minimum indicates variation in UAC levels at Ohau, suggesting that UV-B and solar activity during solar minima may be more dynamic than once thought.

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-014 - Chemotaxonomy on pollen: Unpacking past agricultural systems?

Faidra Katsi[1], *Matthew Kent*[2], *Alastair Wills*[1], *Matthew Jones*[1], *Wesley T. Fraser*[3], *Phillip Jardine*[4], *Warren Eastwood*[5], *Simon Connor*[6], *Janelle Stevenson*[6], *Victoria Miller*[6], *Antoni Romano*[7], *Anna Florin*[8], *Andrew Clarke*[2], *Collin Osborne*[9], *Stella Edwards*[2], *Michela Mariani*[1]

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Exploring past agricultural systems is a challenging, yet important step, toward understanding the adaptability of past societies to climatic or societal changes. Sedimentary archives offer numerous and widespread pollen records that can be used for reconstructing past plant management. In addition to the substantial evidence of domesticated cereal crops (Poaceae family) within pollen assemblages, the ethnographic records frequently contain information about lesser-known food plants, for example, *Microseris* species (Asteraceae, Cichoroideae subfamily) which use by Indigenous Australians declined after the British colonisation. However, both Poaceae and Cichoroideae pollen cannot usually be classified using traditional techniques below family or subfamily level due to morphological similarities among species leaving questions regarding the presence/absence of important subsistence crops in the past. Recent attempts to address this problem have suggested the use of chemical traits for the classification of cryptic pollen, which is commonly referred to as chemotaxonomy.

In this talk, the methodology of using the chemotaxonomy of modern pollen and its application to subfossil pollen records from a lake in Turkey and one in Australia will be presented. Chemotaxonomy of modern pollen yielded a classification success of 86% at species level for individual Poaceae grains and 87% for *Microseris* species. These promising results, along with the spectral similarities between modern and subfossil pollen, suggest that the classification of subfossil pollen using their spectra is feasible. Using the chemotaxonomic approach, we demonstrate the presence of cereal crops of the Poaceae family in the subfossil samples of Turkey, while for the first time we also recorded the presence of *Microseris* (Asteraceae) in Australian subfossil pollen records. Together these data highlight how a chemotaxonomic approach can enhance our understanding of cryptic pollen to further our understanding of past agricultural systems.

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-015 - New marker grains! – 'Palynospheres' as marker grains for microfossil analyses with improved performance

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Marker grain method is commonly used by palynologists to quantify absolute pollen concentration in sediments. DuPont NEM plastic microbeads and *Lycopodium* spore tablets are two of the most commonly used marker grains. However, the production of NEM has been discontinuous since more than a decade, and the production of the Lycopodium spore tablets is very sporadic. Here we propose a solution. Microspheres of black ceramic, coined 'Palynospheres' produced by Palynotech Co. Ltd. (http://www.palynotech.com/), can be used as marker grains for palynology. They are tolerant to all chemical and physical stresses during pollen extraction processes. The particles are matt black, spherical, available in a wide range of size clusters, have a density very close to that of fossil pollen grains (1.424 g/cm^3 vs. 1.494 g/cm^3 in average), and resist a long storages. The behaviour of ceramic spheres was closer to the pollen grains than the *Lycopodium* spores. In combination, these properties make the black ceramic spheres an even better solution for palynologists than DuPont NEM microbeads or *Lycopodium* spore tablets. The absolute pollen concentrations

estimated from ceramic spheres and those estimated from volume method were indistinguishable within errors. On the other hand, when the samples were relatively poor in fossil pollen grains, the concentrations calculated by *Lycopodium* method tended to be significantly overestimated. The 'Palynospheres' are available either as a dry powder in different size ranges, or as a mixture of two size ranges blended in a defined ratio and dispersed in a buoyancy-neutral liquid, ready to be added to sediment samples. Mixing two different size ranges in a known ratio serves to detect any laboratory failures that differentially favour recovery of larger or smaller pollen types.

Introduction movie of Palynospheres: https://www.youtube.com/watch?v=yKqUD32pV6c
Palynotech: http://www.palynotech.com/

28/05/2024, 11:00–13:00, Room: Leo
M07 Applied palynology: methodological innovations

O-016 - Conifer pollen: A reliable paleoaltimetry proxy for indicating uplifts of the northern Tibetan Plateau

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The reconstruction of the paleoelevation history of the Tibetan Plateau (TP) is vital for comprehending the tectonic movements, the genesis of the Asian monsoon, the alpine biodiversity formation as well as the global carbon cycle. End-member tectonic models predict different uplift histories for different parts of the TP, which contributes to elucidating certain geological events and issues on biological evolution. However, to this day, direct evidence of the paleoaltimetry of the TP remains predominantly confined to its southern and central regions, and, simultaneously, the results based on different proxies are full of contradictions. For instance, in the Lunpola basin of central TP, the fossil fish show a 1000 m asl, whereas the isotope data reveal a 4500 m asl during the late Eocene. In the northern TP, the records are still poorly investigated. Here, we firstly use pollen records of montane conifers (*Tsuga*, *Podocarpus*, *Abies* and *Picea*) as a new paleoaltimetry to construct two parallel mid-range paleoelevation sequences in the northern TP: at 1332±189 m and 433±189 m, respectively, during the Middle Miocene (~15 Ma). They increased rapidly to 3685±87 m in the Late Miocene (~11 Ma) in the east, and to 3589±62 m at ~7 Ma in the west. Our reconstructed rises in the east and west parts of the northern TP during 15–7 Ma, together with data from other regions of the plateau, indicate that during the Late Miocene the entire plateau may have reached a high enough elevation close to that of today, with consequent impacts on atmospheric precipitation and alpine biodiversity. In the future, we will try to form a systematic methodology aimed at enhancing the reliability of the method, continuously apply it to the entire Tibetan Plateau, and subsequent expansion to encompass the Alps, Iranian Plateau, and North American Plateau regions in the Northern Hemisphere.

28/05/2024, 14:30–16:30, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-017 - Comparative study on paleo-vegetation and paleo-climate on both sides of Ailao Mountain in Late Paleogene

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The formation and evolution of mountain ranges play a pivotal role in shaping regional climate and biodiversity. The Ailao Shan-Honghe fault, subjected to intense shear deformation due to the India-Eurasian plate collision during the Cenozoic, created a significant NW-SE strike-slip fault belt. This tectonic activity resulted in the uplift of Ailao Mountain, profoundly influencing climatic patterns and the modernization of vegetation in southwest China. This study focuses on the late Paleogene palynoflora of two coal-bearing basins, namely Meizi Coal Mine and Jianshui Coal Mine, situated on opposite sides of Ailao Mountain. Through optical microscopy and single pollen scanning electron microscopy, we identified and described the palynoflora in the two profiles, reconstructing vegetation and plant diversity on both sides of Ailao Mountain during the late Paleogene. Key findings include a prevalence of *Alnipollenites*, *Carpinipites*, *Caryapollenites*, *Juglanspollenites*, and *Pterocaryapollenites* in Meizi Coal Mine,

while Jianshui Coal Mine's lower section exhibits dominance by *Alnipollenites* and *Betulaceoipollenites*. *Taxodiaceaepollenites*, *Quercoidites*, *Caryapollenites*, and *Pterocaryapollenites* characterize the grey and white mudstones in Jianshui's middle and upper sections. Fern spores, including *Polypodiaceoisporites* and *Polypodiisporites*, are abundant in both basins. Analysis of the palynological assemblages reveals the presence of Betulaceae, Fagaceae, Juglaceae, and *Polypodiaceaesporites* in both coal mine basins. Utilizing quantitative pollen analysis, this research reconstructs paleo-vegetation, paleo-climate, and plant diversity based on fossil sites on either side of Ailao Mountain. The study provides insights into the climatic environment and ecosystem evolution of Ailao Mountain before and after uplifting, emphasizing the driving role of monsoon climate evolution on vegetation and plant diversity in Yunnan.

28/05/2024, 14:30–16:30, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-018 - Vegetation change across the Eocene-Oligocene Transition in mid-latitudinal Europe – A review

Lutz Kunzmann[1], *Margaret Collinson*[2], *Peta Hayes*[3], *Vasilis Teodoridis*[4], *Agathe Toumoulin*[5], *Mengxiao Wu*[6]

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The Eocene-Oligocene-Transition (EOT) is known as a marked phase of accelerated palaeoclimatic change terminating the Eocene global greenhouse and leading to Oligocene coolhouse conditions. Current concepts refer to a duration of EOT of about 790 ka. The onset is related to a global temperature drop recorded in the oceans, including extinctions of marine microbiota. The end is marked by the first major Oligocene glaciation event, often recorded by a major sea level drop seen in relevant sedimentary series. Recognized in the oceanic realms, remarkable changes in terrestrial flora and fauna also occurred across the EOT. In particular, faunal change in fossil vertebrate assemblages in Eurasia at the end of EOT is known as Stehlin's Grand Coupure.

Here, we give an overview reviewing palaeovegetation changes across EOT in mid-latitudinal Europe mainly based on macrofloristic assemblages from central Germany, northern Czech Republic, and southern UK. It is clear that a major turnover took place after the Oligocene glaciation event, likely linked to availability of new migration routes after significant sea level fall, similar to the faunal Grand Coupure event. This floristic turnover is characterized by a pronounced appearance of temperate elements but there is also persistence of thermophilous taxa. In addition, in some regions, disappearance of typical Eocene subtropical elements is recorded prior to the EOT onset. Simultaneously, immigration of temperate elements had already started before the Eocene-Oligocene boundary, which could be interpreted as a response in the terrestrial realm to the latest Eocene oceanic temperature drop. However, gaps in the macrofossil plant records are noted affecting the completeness of the floristic history. Overall, data indicate that the floristic change across the EOT in mid-latitudinal Europe cannot be interpreted as a uniform one-step event.

O-019 - Temperate to tropical palaeoclimates on the northwest edge of Europe during the Oligocene – early Miocene (33.9–15.97 Ma)

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The Oligocene-Early Miocene (33.9–15.97 Ma) was an interval characterised with a warmer and wetter palaeoclimate than present, thus reconstruction of deep-time palaeoclimates allows for better understanding of climate dynamics with a developing Antarctic ice sheet with comparable to present and future pCO2 levels. Previous studies suggested North Atlantic Late Oligocene sea-surface temperatures, increased with declines in pCO2 (700–300 ppm). The Miocene was identified as an interval of interest in the recent IPCC AR6 report for use in better understanding 21st century anthropogenic climate change. The Oligocene-Early Miocene-age palaeoenvironmental record, from the British Isles, has been reconstructed, though no attempts to reconstruct the palaeoclimate have yet been made. We consider the British Isles, given its ability to provide a unique perspective on climate, as its terrestrial climate is controlled by heat outputs from the Atlantic Ocean and the North Sea. We present the British Isles' first Oligocene-Early Miocene-age palaeoclimate record through applying the Bayesian probability-density-function-based reconstruction model, Climate Reconstruction Software (crestr), on the nearest-living relatives of palynofloral taxa from secondary sources, and data from renewed palynological study of Lundy borehole 73/58. We present a new method of assigning Köppen-Geiger (K-G) signatures to reconstructions. We show Oligocene-Early Miocene palaeoclimates were mostly warmer, as reconstructed K-G classifications ranged from a subtropical warm summer signal with no overall dry season (Cfb) to a tropical rainforest climate (Af), which was paced by orbitally–forced long eccentricity (~400 kyr) pulses during the Chattian. Monsoonal K-G reconstructions were driven by precessional (26-kyr) forcing. Early Miocene-age reconstructions reconstructed no dry season with warm summers, providing the first K-G classification of Early Miocene-age sediment on Europe's northwest edge.

O-020 - Global climate proxies for the Miocene Climate Optimum – Do they sufficiently reflect regional climate in the Paratethys region?

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The Miocene Climate Optimum (MCO) is regarded a global greenhouse interval with increased temperature and precipitation lasting about 2 million years (~ 16.9–14.7 ma). Probably it is the most intensively studied Miocene time interval and it is regarded a potential future climate analog. Therefore the understanding of climate development not only on the global but also on the regional scale is essential. For large parts of Europe warm temperate mixed forests are predicted for this interval. The European floristic record is rich and often well dated. In fact, numerous fossil assemblages point towards warm and humid climatic conditions.

The Parschlug Basin and the Leoben Basin (Styria, Austria) are situated along the Norian depression, about 20 km apart from each other. They are well known for their rich plant assemblages which were deposited in lacustric sediments representing the drowning of the coal seams there. Recent revisions of both floras indicate distinct differences both in vegetation and climate. Based on the IPR vegetation analysis and CLAMP, for Parschlug subhumid sclerophyllous forests and seasonally dry climate are predicted whereas Leoben points towards mixed mesophytic forests and humid climate. The Similarity Approach predicts most likely modern vegetation proxies in SE and SW Europe for Parschlug whereas proxies for Leoben are broad-leaved deciduous, mixed mesophytic and

mountain forests in China and Japan. The further plant record from the Paratethys region, e.g., Mecsek Mts (Hungary) and Randeck Maar (Germany) and further palaeontological and geological records support the differentiation of biota and climate in Central Europe. This implies that the MCO was a climatically dynamic rather than a "stable" period in the Paraethys region.

The presentation will focus on aspects of global versus regional climate predictions and possible parameters contributing to climate variability.

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T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-021 - Documenting the leaf flora from a new fossiliferous locality of the Lesvos Petrified Forest

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2 University of the Aegean, Department of Geography, Mytilene/Lesvos, Greece
3 University of Patras, Department of Geology, Rio/Patras, Greece
4 Natural History Museum of the Lesvos Petrified Forest, Director, Sigri/Lesvos, Greece

This study presents the first results of the plant taxonomy from a new fossiliferous locality of the Akrocheiras hill range within the protected area of the Petrified Forest of Lesvos Island UNESCO Global Geopark (NE Aegean Sea, Greece). During the last ten years, the Natural History Museum of the Lesvos Petrified Forest has conducted major rescue excavations on the western part of the island along with the progress of new road cuttings. More than 15 fossil localities where mass-occurrences of leaf macro-remains as well as numerous petrified tree trunks have been unearthed from the pyroclastic rocks of the area, rendering the Petrified Forest among Europe's richest fossil floras. In particular, several leaf impressions from the Vrisaki fossiliferous outcrop have been found, the characteristic morphotypes of the respective plant assemblage have been described and the palaeoecological interpretations of the identified taxa have been evaluated. Around 180 fossiliferous blocks with more than 2400 leaf macro-remains were examined. Based on the studied material, the leaf assemblage is mainly dominated by dicotyledons with minor contributions of monocotyledons (*Smilax*, Arecales, Zingiberales) and pteridophytes (*Pronephrium stiriacum*, aff. *Rumohra recentior*). So far, the Lauraceae family predominates with *Daphnogene polymorpha* as the main floristic representative. Additionally, *Myrtophyllum* sp. is very abundant in the leaf assemblage, while *Pungiphyllum cruciatum*, *Rubus* sp., *Populus* sp., *Rosa* sp., *Apocynophyllum* sp. and Fagaceae foliage appear to be less common. Among the few reproductive organs found in the fossil assemblage stands a cone which probably belongs to *Alnus* cf. *kefersteinii*, suggesting the first occurrence of this taxon in the Lesvos fossil record. The ongoing systematic taxonomy focuses on the investigation of the material into several distinct leaf morphotypes which will provide valuable insights on the palaeovegetational evolution of this rare fossilized forest ecosystem.

28/05/2024, 14:30–16:30, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-022 - Palynological characteristics of Neogene deposits from Bełchatów Lignite Mine (Central Poland)

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The Bełchatów Lignite Mine (BLM) in central Poland, recognized as one of Europe's largest Neogene lignite deposits, plays a pivotal economic role and offers crucial insights into the evolution of palaeoflora. Located within the Kleszczów Graben, the BLM is characterized by four distinct lithological units: subcoal, coal, clayey-coal, and clayey-sandy units.

The study presents the palynological investigation of Neogene deposits across the entire BLM profile. Palynological analyses were conducted on thirty-three samples from the BLM profile, comprising samples from all lithological unites. A total of 49 sporomorph taxa were identified, including 7 taxa of plant spores, 10 taxa of gymnosperm pollen, and 32 taxa of angiosperm pollen. Pollen grains from angiosperms and gymnosperms were consistently observed in all samples, while plant spores were relatively scarce.

Palynological results delineate three zones characterized by distinct taxonomic compositions. Zone 1 exhibits rich riparian and swamp forests, dominated by *Ulmus*, *Pterocarya*, *Carya*, and *Taxodium*. Zone 2 witnesses a transition to mixed mesophilous forests

with *Ulmus*,*Quercus*, *Ilex*, *Carpinus*, *Corylus*, *Betula*, *Fagus*, *Tricolporopollenites pseudocingulum*, *Tilia*, and conifers dominance. Zone 3 indicates swamp forests with *Taxodium* prevalence.

Palaeoclimate interpretations indicate warm-temperate conditions in Zone 1, transitioning to a slightly cooler environment in Zone 2, marked by the presence of arctotertiary elements. Zone 3 indicates warm-temperate, moderately wet conditions. The study aligns with the chronostratigraphic evolution, supporting a late Early to Late Miocene age for the BLM.

28/05/2024, 11:00–13:00, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-023 - Investigations of late Paleozoic plant fossil concretions, casts, and permineralizations using computed tomography

Michael D'antonio[1], *Carol Hotton*[2], *Peter Crane*[3], *Fabiany Herrera*[1]

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There is little overlap in the information provided to paleobotanists between typical concretion, cast, and permineralization fossils. Casts and concretions provide a sense of size and shape of an organ and its external surface features, but little of the internal anatomy is preserved. On the other hand, permineralizations preserve in high fidelity the internal anatomy of an organ but extracting surface morphology is incredibly difficult and understanding the organ size and shape is a time-intensive process. Here, we present results from investigations of late Paleozoic plant fossils from a diversity of preservational modes including concretions, casts, and permineralizations using X-ray micro-computed tomography (μCT). Scans of siderite concretions from the Pennsylvanian Mazon Creek flora yield 3D morphological reconstructions that can sometimes be combined with preserved anatomy and in-situ spores to yield a composite view of a tissue or organ. Scans of siltstone casts of arborescent lycopsid stigmarian rooting axes reveal traces of the entire vascular system, including both the central vascular cylinder and the network of rootlet traces radiating off of the central cylinder and linking up to individual rootlet scars. Scans of coal ball calcium carbonate concretions reveal remarkably detailed 3D reconstructions of anatomical tissues, such as the parichnos in the bark of the arborescent lycopsid *Sigillaria*, and organs, including a clump of stigmarian rootlets, an ovule, and a medullosan branching axis – all with minimal sample destruction. This important finding shows unrecognized potential of cast and concretion fossils for inferring internal structure as well as the utility of μCT for nondestructively reconstructing 3D plant morphology from coal balls, at a time when coal balls have become a limited resource.

28/05/2024, 11:00–13:00, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-024 - U-Pb age constraining of first Glossopteris Flora occurrences in southeastern Brazil: Phytostratigraphic implications

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In recent years, outcropping sections from the top of the Itararé Group and the Rio Bonito Formation have been radiometrically dated using high-resolution U–Pb zircon CA-TIMS methods and provide absolute age constraints for the strata bearing the first *Glossopteris* Flora occurrences in the southern Paraná Basin (Rio Grande do Sul state). These lower plant assemblages are characterized by the dominance of *Phyllotheca*-type sphenophytes and *Gangamopteris* leaves, presence of *Botrychiopsis* fronds, low diversity of *Glossopteris* leaves and absence of true ferns (pecopterids and sphenopterids) and sphenophyllaleans, and correspond to the *Phyllotheca–Gangamopteris* (P–G) Flora Stage. Based on the new ages obtained, sections and plant fossil-containing outcrops were stratigraphically repositioned, which enabled a more straightforward correlation between the phytofossiliferous horizons.

Therefore, a new phytozone (Bp-Ss) is proposed, using well-dated fossiliferous sections and layers as type- sections and horizons. *Botrychiopsis plantiana* and *Stephanophyllites sanpaulensis* are considered guide-species of this new phytozone, as they are exclusive to the P–G Flora. *Coricladus quiterensis*, *Arberia minasica*, *Giridia quiterensis*, *Cheirophyllum speculare* and *Lycopodites riograndensis* are among the guide-taxa indicated as secondary. Stratigraphically, Bp-Ss zone extends from the uppermost portion of the Itararé Group to the base of the Rio Bonito Formation. Temporally, it is positioned in the ?latest Gzhelian–early Asselian interval. Climatically, Bp-Ss zone represents the vegetation that colonized the lowlands immediately after the end of the major glacial phase in the Paraná Basin. In terms of floristic succession, it depicts the transition between typical Carboniferous and Permian floras, recording new groups, such as the first glossopterids, but also shows the occurrence of relict elements from the Carboniferous, i.e. *Botrychiopsis*. The Bp-Ss zone can be considered chrono-correlated to floras recorded in the northern Paraná Basin (Paraná and São Paulo states), but also in the Paganzo Basin (*Gangamopteris* Flora), in Argentina. [CNPq-PQ313946/2021–3]

28/05/2024, 11:00–13:00, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-026 - Pleuromeia–Sinoglossa flora: A key link of spatiotemporal evolution in Phanerozoic

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The Earth experienced a mass extinction and recovery from Late Permian to Middle Triassic. It is a key transmit period for Phanerozoic lives. Recently, a large number of the Glossopterid specimens were discovered form the Middle Triassic Linjia flora of Benxi, North China. In these fossils, two specimens show sterile organs attached by fertile organs, named *Sinoglossa sunii* Zhang et al., 2022. *Ottokaria buriadica* of the Early Permian South Africa, *Denkania indica* of the Late Permian Indian, and *Sinoglossa sunii* of the Middle Triassic China indicate that the Glossopterids experienced a series of spatiotemporal evolution in their morphologies. Their midveins in each scale leaf changed from absent, to wider and unclear, and eventually to marked and strong; while their seeds in each scale leaf from small and numerous, to larger and more, and eventually to larger and few. The Linjia flora is composed of not only Paleozoic elements from four phytogeoprovinces, such as *Paracalamitina*, *Dryophyllites* (Gigantopterids–like plants with axial bud), *Pecopteris candolleana*, and *Sinoglossa*, but also Mesozoic elements from three floristic regions, such as *Scytophyllum*, *Pleuromeia* and *Yabeiella.* The Linjia flora probably resulted from three factors: 1) Pangaea present from Permian to Triassic, made it possible for plants to migrate in the whole Pangaea land; 2) Dramatic change in global climate, resulted in the Paleozoic flora replaced by the Mesozoic one; 3) Convergence of warm and cold ocean currents at the high latitude under the background of Global warming, caused the "Boreal tropical" climate formed in some special area, making it possible for the Late Paleozoic plants to find a refuge. The Linjia flora with an assemblage of *Pleuromeia–Sinoglossa* from Benxi, Northeast China, gives a key–link evidence to show how the plants experienced spatiotemporal evolutions from Paleozoic to Mesozoic.

28/05/2024, 11:00–13:00, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-027 - New analytical tools to improve the taxonomy and ecophysiology of early Permian medullosans of the Chemnitz Fossil Forest, Germany

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The plant fossil record usually biases the recognition of natural taxa in various ways. This statement applies well to the genus "Medullosa" Cotta 1832, a group of Pteridospermopsida composed of nine species described from the late Carboniferous and six from the early Permian of Euramerica. Medullosans have eustelic stems with a wide central parenchymatous pith and a variable number of vascular strands. One or several peripheral vascular segments are surrounding the pith. They produce leaf traces and abundant secondary xylem. Classification of "Medullosa" taxa is based on anatomical characteristics of tissue types, including

their structural features and proportions in stem sections. With increasing knowledge of stem ontogenetic development and organ connections, it was recently found that the taxonomy of several medullosans needs to be reassessed to enhance our understanding of their diversity, evolutionary pathways, and phylogenetic relations.

Our study applies modern taxonomic analyses, including morphometric and statistical approaches, to test their potential in classifying medullosan taxa based on stem-anatomical features. We measured diverse variables describing the dimensions and shape of the anatomical elements in 158 transverse sections. We also extended the dataset with qualitative and quantitative data on cellular details (e.g., tracheid dimensions and pitting). We applied Principal Component Analyses to reveal the relationships across the main traits structuring anatomical and morphological variation in Medullosans and illustrated them with bivariate plots.

The preliminary results reveal that morphometric and statistical analyses are valuable tools for highlighting taxonomically important features usually described qualitatively. The methods provide the chance to produce more accurate and reproducible data regarding taxonomy. The analyses show that at least one more medullosan taxon among the existing ones requires a separate description. The quantitative data set will also be used for ecophysiological modelling approaches, encompassing the vulnerability of conducting tissues to embolism spread and the stem water flow potential.

28/05/2024, 11:00–13:00, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-028 - This was the fate of a complicated plant: Mississippian seismicity is responsible for the 3d preservation of a new tree architecture

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Mississippian continental rocks in North America are rare, and Lower (Tournaisian) and Middle (Viséan) deposits comprise between 0.06% and 0.03% of the surface-and-subsurface record, respectively. Of these, the majority represent alluvial, fluvial, and deltaic coastal depositional environments (EOD). Fossil assemblages consist mainly of small, fragmentary axes and stems, leaves, and reproductive structures in these depositional settings whereas rare palynological assemblages commonly are from nearshore to offshore facies. Hence, it is highly unusual to encounter a fully continental environment of deposition in which there are plant fossils, let alone one in which entire trees with apical crowns are preserved. Such is the case in a Tournaisian rift lake located in New Brunswick, Canada.At least five specimens of *Sanfordiacaulis*, all of which are preserved in close spatial proximity, originate from the Hiram Brook Member of the Albert Formation. The biostratinomic process responsible for their transfer to the lake bottom was local seismic activity of at least a 4.3 Mw magnitude. Trees are >0.75 m in length around which a dense spiral of leaves is conserved. Tree architecture consists of a monopodial, non-woody trunk, up to 16 cm in diameter, with compound leaves arranged in spirals of ~13 and compressed into ~14 cm of vertical trunk length. Compound leaves measure >1.75 m in length and preserve alternately arranged secondary laterals beginning at 0.5 m from the trunk. The compact leaf organization and length created a crown volume of 30 m^3, in a growth strategy that maximized light interception and reduced resource competition from groundcover.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-029 - The role of structural fingerprints in recognizing gene-mediated developmental pathways that underlie plant evolution

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Paleontological studies that employ plant development to illuminate plant evolution have a long history that extends back nearly 100 years. Early studies focused on transformational series of morphologies and tissue compositions through time (i.e., chronoclines) to infer evolutionary pathways. More recently, the rise of molecular biology has dramatically extended such work to the realm of developmental genetics through the recognition that specific genes and developmental regulatory pathways produce diagnostic structural features. Such features are termed "structural fingerprints" of plant development that can be recognized in both living and fossil plants. The first structural fingerprint to be recognized consists of swirly patterns of tracheary elements in regions where branch traces interrupted the basipetal flow of polar auxin during wood development, but our growing understanding of the genetic control of development provides the opportunity to link a vast array of such features to specific genes and genetic regulatory mechanisms. More recent studies reveal that developmental regulation is both modular and hierarchical, and that developmental modules preserved in the fossil record can be used to infer their role in the evolutionary modifications that have produced the diverse structural variations that characterize modern plants. Examples from the fossil record illustrate how predicting the makeup of gene regulatory networks from fossils establishes an interactive agenda for reciprocal investigations of paleontological chronoclines and experimental studies of plant development to reveal the regulatory underpinnings of plant evolution.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-030 - A paleo-evo-devo perspective on the origin and evolution of apical growth in land plants

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Plant development results from the activity of specialised self-renewing populations of cells termed meristems. When located at the apex of axes, such as the root or shoot, these meristems enable directional growth known as apical growth, also associated with production of new iterative organs. Apical growth is the primary cause at the origin of the tremendous breadth of plant morphological diversity that populates the known fossil record and exists in living floras. Characterising the evolution of apical growth and its underpinning genetic toolkit has been a primary focus of evo-devo studies in living plants for the last few decades. These studies have provided a significant framework of data and hypotheses for the evolution of apical growth and the genes regulating meristems in disparate species. However, these studies alone can only take us so far when piecing together the evolution of this key trait through geological time. To fully characterise the origin and evolution of apical growth requires the integration of fossils and we see the study of apical growth as an area that is ripe for exploring in a paleo-evo-devo perspective.

Here we aim to synthesise the current evidence provided by the fossil record for the evolution of apical growth and identify key questions to focus on for the future. These include predictions about the meristems enabling apical growth of both the sporophyte and gametophyte phase of vascular plants, the steps involved in the delineation of shoots, leaves and roots and more speculatively meristems present in the common ancestor of total, and crown group, land plants. By combining studies of living plants, fossils and genetic networks we hope to demonstrate how a holistic evo-devo approach, i.e., one including information from fossils, can lead to advances that no one discipline would have achieved alone.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-031 - Origins of vascular plant key structures exemplified by phloem and leaf development

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The successful evolution and rise to dominance of vascular plants was underpinned by the origin of the efficient vascular tissues, xylem and phloem, and novel organs such as leaves. However, there is still much to be elucidated about the origins of these structures. Two of the pending questions are whether the genetic toolkit of phloem conducting cells are conserved in vascular plants, and if all fern leaves share common development.

To address the first question, we investigated the expression pattern of homologs of the MYB transcription factor *ALTERED PHLOEM DEVELOPMENT*, which is demonstrated as the main regulator of phloem development in angiosperms, although homologs of this gene are present in all groups of land plants. Using the lycophyte *Selaginella moellendorffii* as a model, we demonstrate that one of the homologs is expressed in developing vascular cells, indicating that an ancestral copy of this gene was likely involved in vascular development in the ancestor of vascular plants.

Regarding leaf development in ferns, we are currently trying to establish when fern leaves that develop from an apical meristem with distinctive apical cell and fiddleheads evolved. To do this we are taking a broad analysis of living and fossil plants to shed light on fern leaf development.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-032 - Hunting for leaf precursors in the early euphyllophyte jungles

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Leaves originated independently in lycophytes and several euphyllophyte lineages: in each of the latter, leaf-bearing members are younger stratigraphically (middle Devonian or younger) and more derived that those lacking stem-leaf differentiation. Despite such unequivocal evidence for independent leaf evolution, the processes and changes underpinning each independent leaf origin remain unresolved. Physiological and developmental-structural constraints on leaf evolution – maximizing photosynthesis and developing as lateral appendages from meristems that maintain indeterminacy – have led to convergence toward the same defining features: vascularization, bilateral symmetry and dorsiventral polarity, regular arrangement, determinate growth. Consequently, an approach to investigating leaf evolution is by deconstructing leaves into their defining structural features that can be traced separately through the fossil record. In euphyllophytes, the traditional view that leaves evolved from lateral branching systems has supported hypotheses of partial homology. However, the simple morphology of early euphyllophytes makes it difficult to recognize the level of organization at which these lateral branching systems were partially homologous. Detailed evaluation of the lateral branching systems of Early to Middle Devonian euphyllophytes (some of which were documented recently) reveals a breadth of structural diversity that belies their apparent simplicity and morphological similarity, supports multiple leaf origins, and offers clues on tempo and mode of leaf evolution in different lineages. These show that by the end of the Early Devonian, at least two euphyllophyte lineages had evolved appendages with regular arrangement, some of which also exhibited bilateral symmetry. Major progress in reconstructing the evolutionary tempo of each leaf-defining feature in different lineages will come from improved resolution of phylogenetic relationships between Early Devonian euphyllophytes and younger Devonian plants with *bona fide* leaves. Significant advances in understanding the mechanisms of parallel evolution of leaves will also come from sustained molecular regulatory studies in extant seed-free lineages where such information is currently minimal.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-033 - Independent evolution of medullated steles among early euphyllophytes

Ellie Frazier[1], *Alexandru Tomescu*[1]

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The euphyllophyte clade underwent a first major diversification toward the end of the Early Devonian. By the late Emsian, broad taxonomic diversity in the group was paralleled by equally broad structural diversity, including stelar architectures that varied from haplosteles to actinosteles of varying complexity, to intricate actinostelic-plectostelic organization. While this broad euphyllophyte diversity (much of it recently discovered) cannot be parsed yet into well-resolved phylogenetic relationships, structural features of the plants allow for recognizing some taxonomic boundaries and distinguish at least two groups. Thus, in Early Devonian strata we recognize plants of cladoxylopsid affinities, of which *Adelocladoxis praecox* and two other plants that await formal publication are the oldest representatives of the group with preserved anatomy. These cladoxylopsids share tracheids with modern-looking bordered pits that distinguish them from all other coeval and older euphyllophytes, which have tracheids with *Psilophyton*-type pitting. The latter group comprises diverse plants that range from morphologically simple (e.g., *Psilophyton*) to different levels of structural complexity (e.g., *Kenrickia*, *Wilhowia*, *Gothanophyton*), some of which are part of the plexus that gave rise to the lignophytes. One of these plants, *Leptocentroxyla*, has at the center of its axes paedomorphic metaxlem that probably represents an intermediate stage in the evolution of central parenchyma (pith) by delayed and shortened differentiation of protoxylem. Among the earliest cladoxylopsids, we find unequivocal evidence of pith and possibly of amphiphloic organization in a new plant that is coeval with *Leptocentroxyla* and is closely related to *Adelocladoxis*. In this plant, the center of the actinostele is occupied by large parenchyma cells and small phloem-like cells mark the contact between the central parenchyma and the xylem, consistent with amphiphloic organization. Together, *Leptocentroxyla* and the new cladoxylopsid support the conclusion that pith evolved independently and at different tempos in at least two distinct euphyllophyte lineages.

28/05/2024, 11:00–13:00, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-034 - Periderm evolution: Integrating perspectives from fossil and living plants

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Periderm is a structural feature with roles in protection of inner plant tissues and wound healing. Knowledge of periderm occurrences in living lineages and in the fossil record, outside the seed plants, is limited and the origins and early evolution of periderm remain poorly explored. We review the known taxonomic distribution of canonical periderm (developed as a typical ontogenetic stage) and wound periderm (self-repair mechanism). To this sparse body of knowledge we add new data from observations and experiments on living plants and new fossil occurrences. One of the latter, documented in a new early euphyllophyte (*Nebuloxyla*), joins the oldest known periderms (Early Devonian), which allow us to construct a model for the development of wound-response periderm in early tracheophytes. Using a new system of quantifying periderm organization, we show that periderm represents a continuum of structural configurations that are predicated by the same basic process – repeated periclinal divisions – but fall anywhere between very loosely organized types (diffuse periclinal growth) and very tightly coordinated types (organized periclinal growth). Overall, our data show that wound and canonical periderm of seed plants has higher degrees of organization than those of seed-free plants, possibly due to co-option in the former of the programs that organize their vascular cambial growth. Considered within the framework of their level of structural organization, the taxonomic and stratigraphic spread of canonical and wound periderm suggest that wound periderm may have had a single origin in euphyllophytes and canonical periderm may have originated separately in different lineages by co-option of the basic toolkit regulating the development of wound periderm. In one evolutionary scenario, wound periderm regulators activated initially by tearing due to the tensional stresses elicited by woody growth, underwent heterochronic change that switched their activation trigger from tissue tearing to the tensional stresses that precede it.

28/05/2024, 11:00–13:00, Room: Zenit
A01 Late Precambrian to early Paleozoic OWM (Organic-Walled Microfossils) and SCF (Small Carbonaceous Fossils)

O-035 - Chains of the Silurian chitinozoan Margachitina margaritana preserved on a bedding plane of the Much Wenlock Limestone, Wales, UK

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The question of biological affinity of chitinozoans has been discussed over 90 years, since the first description of the group by Eisenack in the early 30´s of the last century. In the last decades, the discussion has centred around two hypotheses: 1) chitinozoans represent independent organisms, or cysts of independent organisms, such as protists; 2) chitinozoans represent eggs or egg capsules of yet unknown metazoans. As the direct evidence to prove either the first or the second hypothesis is missing, indirect evidence must be analysed. Here we analyse specimens of *Margachitina margaritana* arranged in a chain preserved on a bedding plate of the calcareous mudrock of the Much Wenlock Limestone Formation, Wenlock, Silurian, UK. Based on a detailed morphological analysis of the fossil and sedimentology of the sample, we argue that such a chain-like structure must have been deposited intentionally by an egg laying animal. Thus the hypothesis that chitinozoans represent eggs or egg capsules of unknown metazoans fully agrees with our finding. Morphology of peculiar species *M. margaritana* is further discussed in terms of chitinozoan clusters, i.e. homoclusters and anticlusters sensu Vodička et al. (2022). The vesicle morphology of *M. margaritana* excludes the formation of clusters and requires a different type of egg laying. Therefore, the herein described specimens support the interpretation that this chitinozoan species has been laid directly on the sea bottom in the form of chains.

Vodička, J., Muir, L.A., Botting, J.P., Špillar, V. and Fatka, O., 2022. Palaeobiological significance of chitinozoan clusters with parallel vesicles. Marine Micropaleontology, 172, p.102109.

28/05/2024, 11:00–13:00, Room: Zenit
A01 Late Precambrian to early Paleozoic OWM (Organic-Walled Microfossils) and SCF (Small Carbonaceous Fossils)

O-036 - Organic-walled microfossils from the Skryje-Týřovice Basin (Cambrian, Teplá-Barrandian area, Czech Republic)

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Cambrian deposits of the Buchava Formation (Skryje-Týřovice Basin) represent one of the classical regions of palaeontological research since the 19th century with numerous world-famous localities with exquisitely preserved trilobites, echinoderms and other skeletal fauna. However, organic-walled microfossils have been generally understudied with only handful of reports, generally representing small-scale studies from individual localities (Konzalová 1974, Vavrdová 1982, Chlupáč et al. 1998). These earlier researches uncovered the presence of multiple stratigraphically important taxa like *Timofeevia lancarae* (Cramer and Diéz 1972), *Eliasum llaniscum* Fombella 1978, and *Cristallinium cambriense* (Slavíková 1968) documenting a Miaolingian age of the Buchava Formation in agreement with macrofossils.

Recently, the authors have focused on a more complex analysis of microfossil assemblages of the Buchava Formation. We processed over 60 samples from 13 outcrops representing various levels of the Buchava Formation via standard and/or "low-manipulation" processing methods. Herein, we bring preliminary results of this research.

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28/05/2024, 11:00–13:00, Room: Zenit
A01 Late Precambrian to early Paleozoic OWM (Organic-Walled Microfossils) and SCF (Small Carbonaceous Fossils)

O-037 - Miaolingian (Cambrian)–Early Ordovician acritarchs of the Baishan area, Jilin Province, China: Palaeogeographical and palaeoecological significance

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Two classic sections in the Baishan area (Jilin Province, China), the Xiaoyangqiao and Muxiantougou sections, spanning the Miaolingian (Cambrian) to Tremadocian (Ordovician), were sampled systematically for acritarchs and associated organisms.

A total of 188 samples from the two sections have been processed. 38 species of 22 acritarch genera are recognized, of which 12 species are first reported from the Baishan area. The assemblages of the Xiaoyangqiao section are dominated by *Leiosphaeridia*, *Polygonium*, *Pterospermopsis*, *Timofeevia*, *Synsphaeridium* and *Priscogalea*, whereas in the Muxiantougou section the genera *Leiosphaeridia*, *Polygonium*, *Timofeevia*, *Synsphaeridium*, *Priscogalea*, *Pterospermopsis*, and *Baltisphaeridium* are the most abundant.

The palaeoecological analysis of these Cambrian to Ordovician acritarchs is conducted in order to understand the temporal-spatial dispersal pattern during this significant period of thePhanerozoic. Based on this study, together with comparisons with assemblages from the three palaeoplates in China, including taxa from some 60 sections in total, a selection of 40 dominant taxa is used for the analysis. The results show preliminarily an ecologically expanding pattern of the dominant taxa in the Cambrian and Ordovician periods. Overall, the morphological diversity and ecospace of the dominant acritarchs taxa increased progressively from Cambrian to the Early Ordovician. In the early Cambrian, the assemblages of acritarchs were mainly of simple morphologies and the occurrences are limited to nearshore environments. Subsequently, in middle to late Cambrian, the diversity of acritarchs gradually increased, and the taxa with complex morphologies became more common. During the latest Cambrian to Early Ordovician, the acritarchs experienced a significant ecological and geographical expansion, by spreading to almost all the available marine habitats.

28/05/2024, 11:00–13:00, Room: Zenit
A01 Late Precambrian to early Paleozoic OWM (Organic-Walled Microfossils) and SCF (Small Carbonaceous Fossils)

O-038 - New research progress in Late Ordovician-early Silurian non-marine palynology of China

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Early Paleozoic non-marine palynology has greatly advanced the understandings of the origin, biological affinities, spatial and temporal distributions of early land plants. In research of early land plants, palynomorph records tend, to be biased towards Avalonia, Laurentia and Gondwana, as fossil records outside of these palaeocontinents are relatively restricted. Early Paleozoic

non-marine palynomorphs of China have rarely been studied, with only several sporadic reports. Here, we report palynomorphs from the Kalpintag Formation (Llandovery) from the north-western margin of Tarim Basin, Xinjiang, China. Here studied palynomorphs include cryptospores, ?trilete spores, cuticle-like sheets, tubes, acritarchs and scolecodonts, corresponding to an assemblage of marine origin but with a noticeable terrestrial input. Newly discovered cryptospores belong to eight genera and twelve species, including *Cheilotetras caledonica* Wellman and Richardson, 1993, *Dyadospora murusdensa* Strother and Traverse, 1979, *D. murusattenuata* Strother and Traverse 1979, *Laevolancis chibrikovae* Steemans and al. 2000, *Pseudodyadospora laevigata* Johnson 1985, *P. petasus* Wellman and Richardson 1993, *Segestrespora laevigata* Burgess 1991, *S.* cf. *rugosa* (Johnson) Burgess, 1991, *Sphaerasaccus glabellus* Steemans et al. 2000, *Tetrahedraletes grayae* Strother 1991, *T. medinensis* Strother and Traverse emend. Wellman and Richardson 1993, *Velatitetras laevigata* Burgess 1991. Based on taxonomic comparisons and quantitative analyses, the Kalpintag sporomorph assemblage is considered to be most similar to those of the northern Chad, northeastern Libya, and central Saudi Arabia in the western Gondwana. This indicates that Tarim was in close proximity to the western Gondwana in the Llandovery, during which the geographical zonation of sporomorph probably appeared. The early Silurian cryptospore producers in Tarim basically inherited from their Ordovician predecessors and evolved on this independent continent being influenced by local climatic variation.

28/05/2024, 11:00–13:00, Room: Zenit
A01 Late Precambrian to early Paleozoic OWM (Organic-Walled Microfossils) and SCF (Small Carbonaceous Fossils)

O-039 - New techniques for studying the morphology of chitinozoan plugs

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All chitinozoan chambers were sealed by a plug at the aperture side. The plugs are named operculum or prosome, which are of decisive significance in both chitinozoan systematics and exploring their biological affinity. According to the current chitinozoan classification put forward in 1999, an operculum is a disk-like plug sealing the aperture at the test lacking a neck and a prosome is an internal plug situated within the neck. Morphologically, the prosome could be as simple as a disk-like feature similar to the operculum, or as complex as a tubular structure with several horizontal septa. Both the operculum and the prosome could have a membrane expansion flaring anti-apertural ward. Hitherto, the descriptions of the morphology of the plugs inside an opaque chitinozoan test are based on optical microscopy (OP) with high light density, near-infrared microscopy (NIR), or scanning electron microscopy (SEM) of broken tests. However, neither OP nor NIR could provide high-resolution imaging, and SEM could not present enough data. We applied NIR, Micro-CT, and focused ion beam scanning electron microscopy (FIB-SEM) to determine the plugs' morphology and ultrastructure. NIR is involved in the first step to detect specimens with plugs preserved intact. Micro-CT is then used to reveal the morphology of the inner plugs without destroying the specimens. FIB-SEM is applied to cut the selected specimens at critical places and obtain high-resolution images of the ultrastructure of the plugs. With new data accumulating by these techniques, novel findings are expected to better understand the plugs' functional morphology and the biological affinity of chitinozoans.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-040 - Rise of angiosperms in the Late Cretaceous palaeoenvironments of Central Europe

Jiří Kvaček[1], *Marcela Svobodová*[2], *Jana Čepičková*[3], *Veronika Veselá*[3], *Petra Zahajská*[4]

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3 Charles University in Prague, Institute of Geology and Palaeontology, Praha 2, Czech Republic
4 University of Bern, Institute of Geography and Oeschger Center for Climate Change Research, Bern, Switzerland

Angiosperms dominate most terrestrial palaeoenvironments in the Late Cretaceous strata of Central Europe. They grew particularly on alluvial plains; during the Cenomanian, lauroid and platinoid angiosperms prevailed in these environments; in the Coniacian-Santonian, this vegetation was enriched by angiosperms of Normapolles complex. Comparisons of palaeoenvironments of the Late Cretaceous basins in Central Europe with the palaeoenvironment of the Portuguese Early Cretaceous Lusitanian Basin show remarkable and interesting differences. Late Cretaceous palaeoenvironments show dominance of angiosperms in the vegetation of alluvial plains, while in the Early Cretaceous, angiosperms are usually subordinate elements of the vegetation, occupying only disturbed

habitats. In terms of plant strategies, angiosperms abandoned their original ruderal (disturbed) strategy employed during the Early Cretaceous in favor of a competitive strategy in the Late Cretaceous. Conifers grew in alluvial plains during the Early Cretaceous, while they dominate saltmarshes and wetlands in the Late Cretaceous. In a similar manner to angiosperms, they exchanged their original competitive strategy employed in the Early Cretaceous for a stress-tolerant strategy in the Late Cretaceous.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-041 - New palaeobotanical insights into understanding the Edmontosaurus ecosystem: Inferences from the Maastrichtian of Wyoming

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Samples retrieved from the Senckenberg Excavation of an *Edmontosaurus* bone-bed and adjacent profiles from the Lance Formation, Wyoming, USA, yielded a well-preserved and diverse palynofloral assemblage. The composition is dominated by spores of water ferns (Salviniales; mainly *Azolla*) and other cryptogams, including bryophytes, with minor amounts of gymnosperm and angiosperm pollen. The latter show great diversity and include characteristic phytogeographic elements as well as biostratigraphically informative taxa such as *Wodehouseia spinata*, *Tricolpites microreticulatus*, *Leptopecopites pocockii*, *Liliacidites complexus*, and *Aquilapollenites* spp. The assemblage is assigned to the Maastrichtian-age *Wodehouseia spinata* Assemblage Zone typical of the Northern boreal *Aquilapollenites* province. The systematic composition of the assemblage indicates a diverse mosaic of plant communities, including (a) a prominent component of freshwater algae and aquatic ferns; (b) herbaceous understorey of hygrophilous mosses, ferns and angiosperms; and (c) sub-canopy- and canopy-forming gymnosperms dominated by cycadophytes and cupressaceous conifers.

Of special interest is the presence of coalified plant mesofossils in these (and similar-aged) samples. Preliminary analyses reveal a diversity of angiosperm fossils including more-or-less intact small flowers, flower fragments, fruits, dispersed anthers, and pollen clumps as well as a possible taxodioid seed-cone fragment, abundant *Azolla* megaspores along with megaspores of *Molaspora*. Our ongoing study of these new finds promises to allow a first detailed reconstruction of the botanical affinities of the peculiar, still poorly understood index taxa of the *Aquilapollenites* province.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-042 - Large fruits in a Late Cretaceous tropical forest show earlier expansion of angiosperm dispersal strategies

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Diaspore (dispersal unit) size is an important ecological trait relating to several aspects of reproductive strategies, including number of offspring, dispersal mechanisms, and seedling survival. Results from previous diaspore studies suggest that Cretaceous angiosperms had small diaspores and were commonly dispersed abiotically. Following the Cretaceous-Paleogene transition (K-Pg), angiosperm diaspore size seemed to increase rapidly, both in average and range, and their morphology became more diverse. The general pattern contributed to the view of Cretaceous angiosperms being weedy, small-statured, and occupying open and disturbed habitats, and that their disperser ecologies only began expanding after the K-Pg. Several hypotheses attributed this change around the K-Pg to be associated with global ecosystem transitions, such as the spread of multistratal, close-canopied tropical forests,

an expansion of angiosperm growth forms into large trees, and the radiation of modern frugivorous tetrapod groups, including birds, rodents, and primates. Here, we present new data from the late Campanian Jose Creek Formation (74.7 Mya) from south-central New Mexico, USA. The specimens come from a 1.2km-long bed of recrystalized volcanic ash that preserves a hyperdiverse tropical *in situ* forest, with angiosperms being the most diverse and dominant group across the landscape. Nearly seventy distinct diaspore morphotypes are identified, and the preserved morphologies suggest that ~30% were fleshy and presumably animal-dispersed and ~6% were winged and dispersed by wind. Importantly, the average, maximum, and range of diaspore sizes in this flora was significantly larger than other Cretaceous carpofloras, and are comparable to most Cenozoic records. Our results demonstrate that angiosperms deployed much more diverse reproductive and dispersal strategies than previously known, at least in wet megathermal regions. These new findings support an increasing body of work suggesting that angiosperms achieved much more diverse ecologies and ecological dominance in regions with more tropical climates before the end of the Cretaceous.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-043 - Bisexual Climbers of Araceae In Deep Time: A Reexamination of Arthmiocarpus hesperus from the Late Cretaceous of South Dakota

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The study and re-evaluation of Cretaceous fossil plants offers insights to the early evolution of angiosperms prior to the establishment of modern ecosystems. Araceae display significant eco-morphological diversity (e.g., geophytes, climbers, epiphytes, helophytes, and free-floating aquatics), with their fossil record dating back to the Early Cretaceous (110 to 120 Ma). However, confidently assigned aroid fossils before the Cretaceous-Paleogene (K-Pg) mass extinction are limited to early divergent lineages (Orontioideae and Lemnoideae), hindering our understanding of the historical evolution of aroid subfamilies over deep time. This study focuses on *Arthmiocarpus hesperus* (Wieland) Delevoryas, a permineralized fossil from the Late Cretaceous Fox Hills Sandstone of South Dakota. Previously classified as a drupe from the fig family (Moraceae), it exhibits features consistent with Araceae. Through thin-sectioning and X-ray micro-computed tomography (μCT), we conducted a detailed examination resulting in 3D reconstructions of the seed and characterizing structures in multiple planes of section. Furthermore, we created a *de novo* character database by analyzing 300 species of fruits with μCT for fruit, seed and embryo morphology. This process resolved conflicting interpretations of fruit-seed morphology and anatomy, allowing us to identify additional characters useful for refining taxonomic affinities.The helically arranged sessile berries on a central spadix confirm affinities to Araceae, and features of the fruits and seeds such as berries with fibrous pericarp and stylar region, thick stylar region, a smooth seed coat, and a monocotyledonous L-shaped embryo suggest it is most closely related to members within the subfamily Monsteroideae. However, *Arthmiocarpus* presents a unique set of characters that differentiates it from extant and extinct members of Araceae. This investigation exemplifies how the subfamilies of extant angiosperms were integral components of Cretaceous ecosystems prior to the K-Pg mass extinction, contributing to the establishment of modern ecosystems.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-044 - A permineralized Jenkinsella-like follicle with central laminar placentation from the Kashima Formation (Santonian – Coniacian) of Hokkaido, Japan

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Here we introduce an angiosperm fruit structurally preserved in a calcareous concretion collected from the Late Cretaceous Kashima Formation of Mikasa City, Hokkaido, Japan. External morphology was preliminarily observed with X-ray CT that provided preferable orientation for making serial sections. Anatomical images from serial peel sections were rendered to obtain a 3D image using Amira software. The reconstructed morphology is an ovoid follicle of 14 mm long x 9.2 mm wide with a dorsal longitudinal

slit reminiscent of fossil Cercidiphylloid genera *Jenkinsella* or *Nissidium* often found in the Cenophytic flora of the Northern Hemisphere. The follicle contained 44 thin winged seeds which are vertically piled in the locule. The follicle has three major veins comparable to those in a typical conduplicate carpel. However, the seeds are not marginal but are attached alternately to the main dorsal bundle. If the reconstructed anatomy represents those of some *Jenkinsella*-like follicles, the laminar placentation of the present fossil throws question for attributing it to the cercidiphylloids. The laminar placentation is rather rare in angiosperms and widely occurs in nymphaeoid plants. The presence of a thin woody stipe at the base of the fossil follicle suggests its attachment to a certain woody axis of plant with terrestrial habitat instead of aquatic one. The fossil can add evidence showing broad anatomical variation in early follicles or a uni-carpellate fruits during the Cretaceous, which are important to pursuit origin and early evolution of the carpel.

This research is supported by Chuo University Grant for Special Research 2022–2023 to HN.

28/05/2024, 14:30–16:30, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-045 - The oldest record of reproductive structure of Nothofagaceae and Proteaceae, Upper Cretaceous, Antarctica

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Proteaceae (Proteales) and Nothofagaceae (Fagales) are angiosperm families that are widely distributed in the Southern Hemisphere. These families are well represented in the Cretaceous and Paleogene of the Antarctic Peninsula based on wood, leaf, and pollen records. Reproductive structures, however, are almost unknown in this region. The marine deposits of the Campanian age Santa Marta Formation (James Ross Basin) contain an assemblage of angiosperm fruits permineralized within carbonate concretions. These fossils are studied based on the acetate peel technique and X-ray microtomography. One of the fruit types is assigned to the Nothofagaceae Family, which is represented by both, two and three fused carpels with three clearly differentiated fruit layers: an outermost sclereid layer with vascular bundles, a middle zone with interlocking fibrous cells, and a thin inner layer with glabrous lining. A second reproductive structure corresponds to a seed type assignable to Proteaceae, with four differentiated layers: an exotesta with columnar and isodiametric cells that contain sclerenchyma cells, a mesotesta consisting of four thin-walled isodiametric cells in thickness, a palisade endotesta, and a tegmen with elongated, uniform and thick-walled cells. The two fossils studied here represent the oldest reproductive structure records for both families. The case of Nothofagaceae, is contemporary with the most ancient pollen record, and our findings support that the three flowered cupules (with a middle dimerous flower) evolved early in the evolutionary history of the family. The arrangement of wall layers in the Proteaceae seed resembles those of Grevilleoidea subfamily. The new records provide important anatomical and morphological characters that allow an increase in the deep knowledge of the evolution and biogeographical history of these Gondwanic families.

28/05/2024, 14:30–16:10, Room: Leo
M07 Applied palynology: methodological innovations

O-046 - The ancient manuscripts as palaeo-archives: Attempt of palaeoecological and molecular analysis of the palm-leaf manuscripts of different geographical origin

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Question of the manuscript provenance (including its origin and production) has become important in the studies of material codicology in two recent decades. Manuscript archives play central role in understanding material culture including written artefacts, and the public institutions such as museums, libraries and manuscript collections keep accurate records of the provenance of their artworks, but there are often large gaps in these. The colophons are often missing, the manuscripts change their owners through the history and the initial information on the manuscript origin – if it was available at all – is getting lost. This makes it difficult, dubious or even impossible to track the origin of the manuscripts. These doubts are very often the case in the palm-leaf manuscripts studies.

Together with that, ancient palm-leaf manuscripts themselves may often serve as archives: manuscripts manufacturing that is/was different from country to country and involves a large number of other plants and substances, handling of the manuscripts, storing and conservation measures are the actions that leave material traces on the manuscripts' surface. Our project attempts to reconstruct the recipes of the manuscript preparation (modern ones, those are still being applied, as well as the ancient ones, available only from the literature nowadays) and to track the possible geographical origin of the manuscripts using plant DNA studies and the classical methods of palaeoecology (e.g. studies leaf tissues and material accumulated or developed on top of the manuscript surface, such as phytoliths, algae cells and cysts, fungi hyphae and spores), multivariate data analysis, and Geographic Information Systems (GIS). In our presentation we will discuss the possible use of the ancient palm-leaf manuscripts from South India, Sri-Lanka, Nepal, Thailand, Laos, Burma and Indonesia as the palaeoecological archives and potential advantages, challenges and ethical issues of that approach.

28/05/2024, 14:30–16:10, Room: Leo
M07 Applied palynology: methodological innovations

O-047 - High-throughput assessment of pollen traits and variability using multispectral imaging cytometry

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Pollen functional traits allow for exploring developmental, evolutionary or community assembly processes in plants. In contrast to commonly assessed vegetative traits, however, the availability of pollen traits depicting also generative processes is relatively limited because of labor and time consuming methodological constraints. These data gaps can be addressed by multispectral imaging flow cytometry (MIFC), which allows for high-throughput assessment of morphological traits (e.g. pollen grain size) and physiological traits (e.g. fluorescence) across temporal and spatial scales. Thus, we analyzed >500,000 single pollen images of >500 individual plants including >100 species that were sampled across 5 years. To validate our method we compared size estimates of pollen with literature values, which are usually based on not more than fifty measured pollen ($R^2_{adj} > 0.86$). However, by measuring several hundreds to thousands of pollen per sample, we are able to derive a robust statistical measure of trait values, inter- and intraspecific trait variability and even within-individual trait variability relating to ecological functions such as dispersal in air. Thus, we were able to describe the pollen dispersal potential of >100 common anemophilous plant species based on estimates of their pollen size, that can help to better assess and model pollen dispersal. Hence, our approach allows, not preventing by sampling effort, to address broad ecological questions across temporal and spatial scales.

28/05/2024, 14:30–16:10, Room: Leo
M07 Applied palynology: methodological innovations

O-049 - Comparing pollen data from moss and archeological samples in urban environments: The case-study of Reggio Emilia (Northern Italy)

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Moss cushions are often used as modern analogues for palynological studies, to compare between past sediment deposition and modern pollen assemblages. Usually, this is done in areas that are considered natural, where anthropic influence can be present but not so important to completely shape the local plant cover. In urban areas, instead, human presence strongly influences what plant species are present, and archeological sites can be helpful to reconstruct past flora in the town/city. To better understand how urban green areas evolved, we conducted a palynological study in Reggio Emilia (Emilia Romagna, Northern Italy) comparing pollen from archeological and moss samples. Archaeological samples, dating back to the city founding (I-II century BC), were taken from two sites in the city centre (Vittoria Park and San Prospero square), under the supervision of Dott. A. Capurso (Soprintendenza Archeologia Belle Arti e Paesaggio per la città metropolitana di Bologna e le province di Modena, Reggio Emilia e Ferrara; Sabap-BO), that the authors thanks. Moss samples were taken from parks and green areas. Pollen results show mostly similar taxa, but moss samples have higher arboreal pollen percentages (mean 69% in moss, 14% in archaeological samples). Therefore, plants were strongly modified by human presence and activities, and kept as such, changing mostly due to water availability and city expansion, with the recent introduction of new trees (such as *Platanus)* or taxa expansion (like *Juniperus* type) only in modern times. Data obtained from the archaeological samples also allowed to track changes in allergenic pollen, allowing a first reconstruction of the history of taxa that are currently monitored by aeropalynological stations. This study on urban green areas allows a better understanding of how the local populations shaped the flora/green inside city walls, alongside how plants known for their allergenic pollen changed during the historical period.

28/05/2024, 11:00–13:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-050 - Upper Paleocene–Lower Eocene tropical rainforests in West Africa: Systematics, diversity and composition of pollen and spore assemblages from southeastern Nigeria

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Tropical rainforests are the most structurally complex and diverse land ecosystems on Earth, and fossil pollen and spores are a vital source of information on the geological history of these unique ecosystems. However, such information relies on a sound underpinning taxonomic framework, which is challenging to achieve in the tropics because of the large number of pollen and spore morphotypes that are encountered in low latitude sediment samples. Fossil pollen and spores from tropical West Africa are in particular need of taxonomic work as there are numerous species that have not been described, and because of the widespread use of illegitimate names in this region. In this presentation we outline recent descriptive systematic work on pollen and spores from the Upper Palaeocene–Lower Eocene of south-eastern Nigeria and analyses of diversity and composition. The palynoflora we have described consists of 29 spores, two gymnosperm pollen grains, and 138 angiosperm pollen grains. Sample richness ranges from 29 to 76 taxa, and rarefaction analysis indicates diversification of rainforests from the Paleocene to the Eocene in tropical West Africa.

O-051 - Early Paleocene occurrence of Trochodendraceae in Northeast Japan

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Trochodendraceae, a family with two monotypic genera, *Trochodendron* Siebold & Zucccarini and *Tetracentron* Oliver, is now distributed in restricted areas of eastern Asia. While recent studies on North American materials have shed light on the diversity and history of the family in the region since the mid or late Paleocene, fossil records from eastern Asia remain limited, and the history of the family in this area is not yet comprehensive.

Fossils of Trochodendraceae have been identified in the early Paleocene (63.4 ±0.9 ma) Minato Formation. The wood exhibits distinctive features, including inconspicuous vessels with scalariform-reticulate perforation plates, tracheids with bordered pits, uniseriate and multiseriate rays (up to 10 cells wide), and the absence of unique tracheids found in *Tetracentron*. These wood structures closely resemble those of extant *Trochodendron*.

Additional evidence from the Minato Formation includes very small tricolpate, spheroid to subprolate pollen, and simple ovate leaves with actinodromous venation and regular teeth. The pollen exhibits a somewhat twisted regulate network of strand-like and parallel striate margo areas, while the leaves have fine veins running from the sinus to near the teeth apex. Both pollen and leaves closely resemble those of extant *Tetracentron.*

The relationship among wood, pollen and leaves from the Minato Formation is not clear. This occurrence of Trochodendraceae in the Minato Formation represents one of the oldest records of the family in the Cenozoic. A recent genome study revealed that the divergence of *Trochodendron* and *Tetracentron* occurred between 44 and 30 ma. The presence of fossils resembling both genera in the early Paleocene provides valuable information for discussions on the evolutionary history of Trochodendraceae.

O-052 - Challenges in reconstructing the vegetation inhabited by a population of late Eocene mammals

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Since 1987 Collinson and Hooker have aimed to elucidate mammal-plant interactions during the Paleogene in the UK. Using taphonomic evidence of damage patterns (fragmentation, etching and puncture marks) on fossil mammal teeth and bones, Vasileiadou, Hooker and Collinson 2022, in Palaeontologia Electronica, 25(2):a16, reconstructed an ancient food web from a lake margin setting (bed TB33 within the How Ledge Limestone). This food web included mammalian predators and prey (ground dwelling, scansorial and arboreal; insectivores, frugivores, herbivores and carnivores) as well as two inferred owls. Unfortunately, the extensive bulk sediment sampling and sieving used to obtain the vertebrate fauna had not yielded any plant fossils other than charophyte gyrogonites. Subsequent work has focused on plant mesofossils and palynofacies in the uppermost horizons of the vertebrate-rich bed aiming to reconstruct the vegetation that hosted the mammals. Other than possible cysts of Zygnemataceae, phytoplankton are absent. The free-floating aquatic plants *Azolla* and *Salvinia* are represented by megaspores and microspore massulae. The presence of seed plants is indicated by at least three types of small seed cuticles. These may represent lake margin plants: one is similar to *Typha*, consistent with presence of rare *Sparganiaceaepollenites* pollen. Resin rodlets and globules are extremely abundant in palynofacies slides but (other than extremely rare bisaccate grains) pollen of possible resin-producing plants have not been recognised. The palynomorphs are dominated by *Azolla* microspore massulae fragments and two morphologies of trilete fern spores. These data indicate a lake with abundant floating *Azolla* and rarer *Salvinia* with a margin vegetation dominated by ferns. They support our previous inferences that the arboreal mammals are likely to have been brought to the site from some distance away by predators or came to the lake to drink. However, the challenge to fully reconstruct the mammalian habitats remains.

28/05/2024, 11:00–13:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-053 - Productivity and leaf ecophysiology of arctic broad-leaved deciduous forests under environmental conditions of the Eocene

Wilfried Konrad[1,2], *Anita Roth-Nebelsick*[3], *Christopher Traiser*[1]

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Greenhouse conditions of the Eocene allowed for lush Arctic forests to thrive under elevated CO2, a temperate climate and high precipitation. We studied ecophysiology and primary productivity of deciduous broad-leaved trees for Eocene climate conditions and annually extremely different daylengths which represent a quite spectacular no-analogue habitat of Earth's greenhouse past. We present results from a study whose aim was to 1. model photosynthesis and transpiration for deciduous broad leaves in Arctic forests under Eocene climate and CO2 conditions, 2. calculate whole-tree primary productivity, 3. evaluate the impact of leaf size. For this study, a model of annual photosynthesis was derived – including upscaling to the canopy level – and run for Eocene palaeoclimate conditions, including annual day lengths (derived by celestial mechanics) and different light regimes (indicating different cloud cover situations) for two fossil Eocene sites, Svalbard and Ellesmere Island. In addition, a mid-latitude comparison site was studied to identify the effects of CO2, site-specific day length and climate. The results indicate that productivity was enhanced at both high latitude sites by elevated CO2, temperature of the growing season and high maximum daylength (24 hr) during late spring and early summer. With productivity values about 30%–60% higher as for a mid-latitude continental European forest, the results indicate a potential for high productivity at the Eocene polar sites which is in the range of extant tropical forests. In contrast to speculations, no evidence for a selective advantage of large leaf size – as shown by various fossil leaves from high latitude sites – could be found.

28/05/2024, 11:00–13:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-054 - Detection of chlorophyll degradation products and flavonoid pigments in Eocene leaves by targeted mass spectrometry

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4 University of Bonn, Institute of Geosciences, Bonn, Germany

Cenozoic leaf compressions typically appear brown to gray in color. However, some fossil floras, such as the Eocene Geiseltal flora in eastern Germany, have yielded leaves with a distinct green hue when freshly excavated. This exceptional color preservation is a phenomenon that has only been observed at very few localities worldwide. Chemical studies from 1970 and earlier, which used the limited spectroscopic methods available at that time, suggested the presence of chlorophyll derivatives in green leaves from Geiseltal. However, until now, no studies utilizing state-of-the-art analytical chemical techniques have been carried out on these fossil leaves.

Here we chemically analyze leaf compressions from the middle Eocene Geiseltal lignites for the preservation of original biological pigments using high-performance liquid chromatography coupled with mass spectrometry. In order to extract as little as possible from the valuable fossil material, we developed a highly sensitive and selective targeted mass spectrometry method for the identification of individual metabolites. Extracts of the Geiseltal leaves were screened for more than 50 common plant pigments and degradation products, including polyphenolic pigments, carotenoids, and chlorophyll derivatives. Indeed, our results indicated the presence of two flavonoid pigments and several chlorophyll degradation products in the Eocene leaves. We are now continuing the search for ancient leaf pigments and related metabolites in other fossil floras with exceptionally well-preserved leaves, such as the Miocene Clarkia flora in Idaho. Such chemical screening will provide new information on the diversity of ancient plant metabolites.

28/05/2024, 11:00–13:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-055 - The secret behind pale leaves from the Cenozoic: A peculiar type of organic preservation

Mahdieh Malekhosseini[1], *Hans-Jürgen Ensikat*[2], *Lukas Schreiber*[3], *Viktoria V. Zeisler-Diehl*[3], *Victoria E. McCoy*[4], *Dieter Uhl*[5], *Torsten Wappler*[6], *Jes Rust*[7], *Lutz Kunzmann*[8]

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5 *Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Frankfurt am Main, Germany*
6 *Hessisches Landesmuseum Darmstadt, Hessisches Landesmuseum Darmstadt, Darmstadt, Germany*
7 *Paleontology Section – Institute of Geosciences – Rheinische Friedrich-Wilhelms-Universität Bonn, Paleontology Section – Institute of Geosciences, Bonn, Germany*
8 *Senckenberg, Senckenberg Naturhistorische Sammlungen Dresden, Dresden, Germany*

Observation of a pale layer on fossil leaves from various Cenozoic localities aroused the curiosity of paleobotanists. This layer has been attributed to the presence of quartz or diatoms, but until now there is no detailed study on this matter. The similarity of this coating to the white cuticular layer, composed primarily of waxes, in many extant leaves led us to test for the presence of wax. 7 samples of fossil leaves, in addition to 3 genera of extant leaves (the closest living relatives to the fossil genera) were examined. Initial tests for occurrence of the wax, such as dissolving at wax-melting temperatures, boiling in chloroform and observing 3-D wax topography were performed on isolated whitish coatings and the sediment (coal) around it. All examinations identified wax in both whitish layer and the nearby sediment. Gas chromatography showed that all fossil leaves contained the typical aliphatic wax components such as primary alcohols, fatty acids and alkanes. The morphology and chemical composition of the wax on the adaxial and abaxial sides of the extant leaves were examined. wax components in neither the abaxial nor the adaxial side showed a specific trend. The percentages of wax compounds were higher in the whitish coating on fossil leaves than in the sediments.

This study demonstrated presence of wax in the pale layer which explain well preservation of organic biomarkers in million years ago. The occurrence of the whitish layer on leaves and not on sediments could be explained with various theories, although more research is needed to determine which theory is best supported: special phylogenic character of those species, since a similar whitish wax layer in also present in close extant relative; the resistance of chemical compounds during fossilization; or movement of wax molecules to the surface due to exposure to the air.

28/05/2024, 14:30–15:30, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-056 - Leaf cuticular analysis of the upper Pennsylvanian and lower Cisuralian (Carboniferous – Permian) species of Cordaites UNGER from the Bohemian Massif, Czech Republic

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Until now, poorly known cordaitalean leaves from the Stephanian and Permian of the Bohemian Massif have been studied through cuticular analysis that helped classify the known species and establish new species. Stomata arrangement patterns have enabled the cuticles to be classified into three principal groups: 1) Stomata dispersed more or less regularly over the cuticle [*Cordaites rudnicensis, C. sudeticus* and *C. sudeticus* (Krušovice loc.)]; 2) Stomata arranged in simple or double stomatal rows (*Cordaites malesicensis, C. radvanicensis, C. risutensis, C. roprachticensis* sp. nov., *C. setlikii*, sp. nov. and *C. pastuchovicensis* sp. nov.); 3) Stomata arranged in stomatiferous bands consisting of several stomatal rows (*Cordaites barthelii, C. melnicensis* and *C.* cf. *melnicensis*). This new study brings new information on the spatial distribution of *Cordaites* species. The material studied came from coal mines, outcrops, and boreholes. The *Cordaites* leaves from boreholes are fragmentary, and cuticles help with their determination. The *Cordaites* came from different habitats: peat-forming swamps (samples from coal mines and some boreholes) and

deltaic and lake deposits (mainly from outcrops). Cordaitaleans growing in peat-forming swamps indeed represent hygrophilous plants; the fragments found in the deltaic environment can be characterised as remains of mesophilous plants with less demand for water. The plants found in lake deposits could be either hygrophilous (nearly autochthonous that grew in coastal vegetation) or mesophilous (allochthonous, originally growing upstream, more or less far from the river that transported material to the lake). Specimens of xerophilous cordaitaleans are usually preserved only as imprints in red deposits and therefore their cuticles cannot be studied. Grant GACG 22-116661K.

28/05/2024, 14:30–15:30, Room: Taurus
A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

O-057 - The upper Silurian land plant with circinately coiled fertile tips from the Prague Basin, Czech Republic

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Circinate vernation is a morphological feature occurring in lycophytes (Gensel and Berry, 2001), ferns (Vasco et al., 2013) and seed plants as cycads (Brenner et al., 2003) and some angiosperms (Fleischmann et al., 2018). It is characterised by the typical spiral coiling of young leaves or fronds that develop as they mature. Despite its prevalence, several questions about circinate vernation remain unanswered, such as its origin and whether it independently occurred multiple times. Aside from leaves, circinate vernation is also found in axes of the basal lycophytes – zosterophylls. It is possible that this feature evolved in the earliest terrestrial plants, but the fossil record shows no clear evidence.

In this study, we focus on the upper Silurian plant from the Prague Basin, the Czech Republic. This plant exhibits leafless dichotomously branched axes with terminal "trefoil"-like structures. Our investigation explored the nature and origin of these structures, considering the possibility of circinate vernation. We also delve into discussing the taxonomic affinities of the specimen.

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30/05/2024, 14:30–16:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-058 - Taxonomy and biostratigraphy of late Permian to Early Triassic megaspores from Yunnan and Guizhou provinces, Southwest China

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The first detailed investigation of megaspores using scanning electron microscopy (SEM) and transmission electron microscopy (TEM) is presented from upper Permian to Lower Triassic strata of the eastern Yunnan and western Guizhou region, Southwest China. Thirty-three megaspore taxa belonging to three stratigraphically constrained assemblages, representing the Xuanwei Formation,

Kayitou Formation and Feixianguan Formation, respectively. According to the distinctive representation of taxa, these megaspore suites are assigned to the *Paxillitriletes permicus–Henrisporites yunnanensis*, the *Biharisporites* sp., and the *Otynisporites* sp. assemblage zones in ascending order. Megaspores in the Xuanwei Formation (Lopingian) are abundant and diverse (18 taxa). Diversity sharply decreases across the Permian–Triassic boundary (PTB), with only one taxon remaining. A subsequent recovery of lycopsid diversity followed, recorded by an increase in richness to nine taxa in the Feixianguan Formation. Comparison with previously known *in situ*megaspores and details of the morphological features and wall ultrastructure of dispersed megaspore species, it is evident that the parent plants of the studied megaspores were a mix of Isoetales and Selaginellales suggesting their herbaceous parent plants occupied moist environments. The disappearance of arborescent lycopsids (represented by *Sublagenicula nuda*) and some isoetalean-like herbs (represented by having membraneous zona that generally dispersed in water to achieve reproduction) across the PTB, suggests a shift drier conditions in the earliest Triassic. This is supported by lithological changes from coal-forming environments in the late Permian to sandstone-dominated fluvial-estuarine facies in the earliest Triassic. This also provides new insights into the diversity and evolutionary history of lycopsids in the Cathaysian floral realm during the biotic crisis of end-Permian mass extinction.

28/05/2024, 14:30–15:50, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-059 - Reinvestigating the rooting system of a Lower Carboniferous lycopsid, Oxroadia, through 3D reconstruction

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Whilst the scientific consensus is that roots evolved separately in the plant clades euphyllophytes and lycophytes, the evolution and origin of rooting systems in lycophytes remains a point of lively scientific discussion. Various hypotheses have been proposed to explain the evolution of rooting systems in lycophytes including origins from shoots or leaves, while others claim that they arose as de novo organs. This study seeks to contribute to this debate by creating 3D reconstructions of the rooting system of *Oxroadia* a genus of Early Carboniferous low-lying lycopsids found from the famous Oxroad Bay locality in Scotland. *Oxroadia* has long been considered a "taxonomic football," but it is currently placed as an early-diverging member of Isoetales which also contains the famous arborescent lycopsids. All Isoetaleans have a rhizomorph; a rooting meristem from which rootlets develop in a regular pattern. This rhizotaxy (pattern of rootlet attachment) in Isoetaleans is a highly conserved trait across the entire clade, however it is unclear when it evolved. By modelling *Oxroadia*'s rooting system, we will be able to determine if the species developed rootlets in a regular rhizotaxy and compare it to other members of the Isoetaleans. The analysis is based on a reinvestigation of two *Oxroadia* specimens described previously by Long in 1986 and then Bateman in 1992 using the cellular acetate peel method. Here, using the digital reconstruction software SPIERS, these peels will be digitised, aligned, and turned into a tomographic dataset which will then be brought into the free 3D modelling software Blender. Visualising the rhizotaxy will allow us to generate new data about the evolution of rooting in Isoetaleans and lycopsids more broadly.

28/05/2024, 14:30–15:50, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-060 - Identity conversion during root growth in Lycopodium and its implication for body plans shared in lycophytes

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Early Devonian lycophytes of the Drepanophycales did not possess true roots. Instead, they had subterranean structures known as rooting axes. A rooting axis branched anisodichotomously from another subterranean organ called a root-bearing axis, which

emerged at a dichotomy of the creeping aerial axis. This fundamental body plan is also present in the Selaginellaceae, one of the three extant lycopsid families. In Selaginellaceae, the rooting axis evolved into a true root with the acquisition of a root cap, while the root-bearing axis transformed into a rhizophore. Traditionally, it was believed that the Lycopodiaceae, another extant lycopsid family, had lost the root-bearing axis since it developed roots endogenously from the stem near the shoot apex. However, we recently proposed a hypothesis suggesting that roots in Lycopodiaceae could have evolved from the root-bearing axis, implying a loss of true roots in this family. In this study, we explored the homology of Lycopodiaceae roots based on two key observations in *Lycopodium clavatum*. Firstly, we measured chlorophyll fluorescence in shoot-borne roots, revealing the presence of chloroplasts and photosynthetic activity in these roots. Secondly, we visualized cell divisions in the root meristematic tissue using EdU staining. The patterns of cell division were found to be similar among shoot-borne roots, young roots experiencing a few branchings, and the stem. In contrast, the frequency of cell divisions in the root tips decreased as the number of branchings increased, accompanied by a transition from an open to a closed type of root apical meristem. These findings suggest that shoot-borne roots and those with relatively few branchings can be compared to the root-bearing axes of Drepanophycales, while root identity becomes more distinct as roots mature.

28/05/2024, 14:30–15:50, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-061 - From integument to micropyle in Paleozoic seed plants: A new look into the fossil record and developmental genetics

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Seed plants underwent essential morphological and anatomical changes during the Devonian and Carboniferous periods. During the Late Devonian, early seed plants showed their first radiation, with an increase in diversity, and they are generally characterized by cupulate ovules with lobed integuments as female reproductive organs, mostly being documented as hydrasperman type. Recently, abundant types of early seed plants have been reported from Europe, North America and South China, exhibiting extensive variation in integument morphology. Compared to the dominant ovule structures observed from the Carboniferous upwards and in extant plants, the hydrasperman seed plants show distinct structural differences, lacking a true micropyle and their integuments remaining unclosed throughout development, and these plants became extinct in the Carboniferous. The integument of many modern plants seldom displays characteristics of lobes during development or at maturity. It has been traditionally hypothesized that morphological changes from lobed integuments to micropyle occurred gradually over time, but this view receives insufficient evidence from fossils and developmental mechanisms. Recent molecular biology studies have provided new insights into addressing this issue by examining ovule development regulatory genes such as *KANs* and *UCN*, which are extensively studied in angiosperms but also found to possess similar functions in gymnosperms. The interaction between these genes has been shown to play a significant role in specifying the abaxial identity of leaves and integuments and the planar identity of the outer integument. We propose here that how to integrate these regulatory genes during development is a key for the evolution of the observed diversity in early seed plants and for the later appearance of micropyles.

Keywords: Devonian, seed plants, micropyle, *KANADI*, *UCNICORN*, plant evo-devo

28/05/2024, 14:30–15:50, Room: Virgo
C01 Paleo-evo-devo: the fossil record and evolutionary developmental biology

O-062 - Long lasting water to ice phase transition-imposed drought during Cryogenian as a singular trigger of plant terrestrialization

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Currently accepted scenarios of the initiation of plant terrestrialization suppose that warm related continental drought and muds of the bank littorals of freshwater lakes and rivers were environments where charophytic streptophytes started their evolutionary journey to dry land. However, along with the challenge to explain the initiation of the evolution of land plants (embryophytes), it is unavoidable to explain the evolution of their sister line/clade – zygnematophytes. This constrains possible hypotheses on the origin of plant terrestrialization. Recent consensus is that zygnematophytes are secondarily reduced (including loss of flagella) from multicellular organization of common ancestor with land plants (anydrophytes) back to single-cell or filamentous state. Based on the possible timing of anydrophytes evolution and the fact that some basal zygnematophytes are psychrophilic organisms we have proposed a hypothesis on the Cryogenian era extensive glaciations as a trigger of plant terrestrialization. Adapting to freezing Cryogenian continents some multicellular charophytes evolved into anydrophytes and split into two lineages. Zygnematophytes adapted to the freezing conditions of glacial and periglacial oligotrophic areas by evolutionary reduction to unicellularity, loss of flagella and sex by conjugation (as co-evolving zygomycetous fungi did in a convergent manner), while multicellular stem-(pre-) embryphytes adapted to less cold but dry conditions of mesotrophic substrates (cryoconite or paleosols). During the warm periods of Ediacaran and following Palaeozoic eras, originally psychrophilic pre-embryophytes had to adapt and invade warm continental areas/spaces from polar regions so that still Silurian flora was more diverse in colder climate latitudes as compared to tropics. – Žárský, J., Žárský, V., Hanáček, M., & Žárský, V. (2022). Cryogenian Glacial Habitats as a Plant Terrestrialisation Cradle – The Origin of the Anydrophytes and Zygnematophyceae Split. Frontiers in plant science, 12, 735020. https://doi.org/10.3389/fpls.2021.735020

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-063 - The Umm Irna flora, a latest Paleozoic melting pot from the Dead Sea Region, Jordan

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2 Field Museum, Earth Sciences – Negaunee Integrative Research Center, Chicago, USA
3 Stephenson Geoscience Consulting Ltd & British Geological Survey, Biostratigraphy, Nottingham, United Kingdom

With some 60 species of fossil plants, the Umm Irna flora from the Dead Sea region in Jordan ranks among the most diverse late Permian floras known worldwide. During the latest Permian the present-day Dead Sea region was situated at a paleolatitude of c. 15°S at the western end of the Paleotethys in a monsoonal floodplain setting with meandering rivers, abandoned channels, ephemeral lakes and backswamps of various size. The Umm Irna Formation, exposed on the eastern side of the Dead Sea, is characterized by rapid vertical and lateral facies changes. About a dozen localities have yielded an altogether very diverse collection of different plant-fossil assemblages reflecting particular depositional settings. The high diversity, excellent preservation (particularly the cuticles), and the overall composition make this flora unique. The Umm Irna flora comprises elements of at least three of the four major floral provinces, namely of Euramerica, Cathaysia and Gondwana. Not only the mixed phytogeographic aspect of this flora is of interest, but also the earliest appearances of extinct plant groups traditionally regarded as typically Mesozoic, i.e., corystosperms and bennettitaleans, and the still existing podocarpacean conifers, which became major, some even dominant constituents of earlier Mesozoic floras. Moreover, the Umm Irna flora also records the last appearances of long-ranging Paleozoic groups, including noeggerathialean progymnosperms, lepidodendrids, as well as lyginopteridalean, callistophytalean and gigantopteridalean pteridosperms,

glossopterids, and walchian conifers. Altogether, the Umm Irna flora contributes to a better understanding of evolution, distribution, extinction and survival patterns in a crucial period in life history, shortly before the largest mass extinction on Earth.

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-064 - Protocupressinoxylon baii sp. nov., a gymnospermous fossil trunk from the Upper Shihhotse Formation (Permian) of Yangquan City, Shanxi Province, North China

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A new permineralized gymnospermous fossil trunk, *Protocupressinoxylon baii* sp. nov., is described from the Upper Shihhotse Formation (Permian) in Yangquan City, Shanxi Province, North China. The pith, primary xylem, and bark are not preserved. The wood is pycnoxylic, composed of tracheids, rays, and axial parenchyma. True growth rings are absent. However, growth interruptions are well-developed. In cross section, tracheids in the growth interruption vary gradually in diameter from thin-walled, larger cells to thick-walled, smaller cells, and change at an opposite direction, forming a symmetrical boundary. Radial tracheidal pitting is uni- to biseriate. When uniseriate, pits are contiguous or separated arrayed. When biseriate, pits are mostly alternately arranged. Rims of Sanio and tangential pits are absent. The percentage of abietinean pitting of current fossil wood is 23.6%, and the araucarian pitting is 76.4%. Axial parenchymatous cells are irregularly distributed among the xylem tracheids with opaque contents. Rays are homogeneous, commonly uniseriate, and are 1–24 cells high. The cross-field pitting is mainly of the cupressoid type, and there are commonly 1–2, rarely 3–4 pits in each cross-field unit. The fossil trunk represents the first record of *Protocupressinoxylon* Eckhold from the Permian of the Cathaysia. Fungal hyphae present in tracheids and rays, demonstrating the association between the current trunk and fungi. The absence of true growth rings, and the presence of growth interruptions indicate a suitable climatic condition with episodic drought for the flourishing of plants during the time when the Upper Shihhotse Formation get deposited in the Permian.

Keywords: Fossil wood; Anatomy; Mixed radial pitting; Palaeoecology; Cathaysia Flora

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-065 - Anatomy of Neuropteris pseudovata Gothan et Sze from the Pennsylvanian-lower Permian in Yangquan City, North China

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Permineralized neuropterid pinnae with pinnules and rachides have been discovered from the upper Pennsylvanian-lower Permian Taiyuan Formation in Yangquan City, North China. Pinnae morphology is described based on materials preserved on surfaces of the specimen. Morphologically they are attributed to *Neuropteris pseudovata* Gothan et Sze 1933. Pinnules are ovate and 9–12 mm long by 4.3–6.6 mm wide. They have a rounded apex and auriculate constricted base. Marked midvein extends more than half the length of pinnules. Lateral veins are thin and closely spaced, dichotomizing three to five times before reaching the pinnule margin. Anatomically, in cross section, pinnules are 0.3–0.7 mm thick. Adaxial and abaxial hypodermis of pinnules are thin and only one to two layers rounded cells. The midvein is composed of vascular bundle and sclerenchyma. The sclerenchyma on abaxial side is thicker than adaxial side. Lateral veins contain vascular bundles, parenchyma sheaths and extended bundle sheaths. Ultimate rachides are 0.75–1.5 mm in diameter, with one -six vascular bundles. The hypodermis of rachides are composed of small

but compactly arranged parenchyma. Internal of rachides contain loosely placed rounded parenchyma with secretory canals. Sclerenchyma surround the vascular bundles and present in abaxial side of rachides. The putative penultimate rachis is 6–7.7 mm in diameter. It is elongated in cross section with a flat or slightly concave side. Sclerenchyma clusters form a ring area at the periphery of the rachis. Internal of the sclerenchyma zones contain parenchymatous ground tissue and numerous scattered vascular bundles. There are three differences between *N. pseudovata* and *N. ovata*, including (1) size of rachides, (2) the number and arrangement of vascular bundles, (3) secretory canals in the rachides of *N. pseudovata*. Our anatomical evidence supports to differentiate *N. pseudovata* in Cathaysia from *N. ovata* in Euramerica, although they are sharing a great similarity in morphology.

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-066 - The Asselian flora of the Lodève Basin, France: Diversity and significance of a classical early Permian assemblage

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The late Pennsylvanian-Permian was a period of major environmental transition. In the paleotropics of the supercontinent Pangea a stepwise aridification led to a decline of the wetland vegetation and the diversification of several major groups of seed plants including the peltasperms, cycads, ginkgos, and conifers. In this context, the well-preserved early Permian compression floras of the Lodève Basin in southern France have attracted the attention of numerous palaeobotanists since the 19th century, including Brongniart, Zeiller, Florin, Doubinger, and more recently Broutin and Galtier. In this study, we present a synthesis of the highly diversified macroflora of the Usclas-St Privat Formation ("grey Autunian", Asselian) based on the study of more than 1200 specimens from the collections of the University of Montpellier and of the Muséum National d'Histoire Naturelle in Paris.

Coniferales dominate by far the assemblage (78% of the specimens and 10 morphospecies) with an abundance of shoots belonging to *Walchia piniformis*, *Otovicia hypnoides,* and *Culmitzchia frondosa*. Other seed plants include pteridosperms, which are largely represented by peltasperms foliage formerly assigned to the genus *Callipteris* (13% of the specimens). *Autunia conferta* is dominant in this group, followed by *Lodevia nicklesi*. Other seed plants, such as cycadophytes (with the genus *Taeniopteris*) and ginkgophytes (e.g., *Ginkgophyllum, Trichopitys*), are relatively rare (1–2%) but significant from an evolutionary point of view. Although the changing climate favoured new groups, the assemblage still contains a small number of taxa characteristic of coal swamp floras (less than 1%) such as lycophytes (*Syringodendron*), sphenophytes (*Calamites*) and pteridophytes (*Pecopteris*). We compare this typical "Autunian" flora to several coeval assemblages from North America and Europea and highlight its importance for future paleoenvironmental and evolutionary studies of the early Permian tropical vegetation.

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-067 - Limited change in silicate weathering intensity during the Permian–Triassic transition indicates ineffective climate regulation by weathering feedbacks

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The Permian-Triassic transition marked a profoundly dramatic climate warming event that not only contributed greatly in the largest biotic crisis on the surface of the Earth during the Phanerozoic, but also led to a lethally hot world persisting for millions of years into

the Early Triassic, delaying the recovery of life. How the climate remained exceptionally hot for such a long time was enigmatic. Silicate weathering, considered a major geological thermostat, has long been postulated to have increased dramatically during that time. However, evidences of such remains inconclusive.

Understanding how the silicate weathering conditions have evolved during the Permian-Triassic transition holds immense importance in unravelling this enigma. In this study, we have compiled the Chemical Index of Alteration (CIA) data from 37 terrestrial and marine Permian-Triassic sections that are relatively well-studied with well-defined time framework and constrained provenances. After careful screening and evaluation of the suitability of the data as a weathering index, a prevailing pattern has emerged showing no discernable increase in CIA across the Permian-Triassic transition. In fact, most of the sections examined exhibit a decreasing trend in CIA, indicating decreased chemical weathering intensity. In addition, our investigation of clay mineral assemblages from several sections reveals the increase of illite and chlorite at the expense of kaolinite, further supporting the notion of decreased chemical weathering intensity.

These results stand in stark contrast to previous expectations. Considering the results from the most recent modeling studies on seawater Li and Sr isotope evolution showing limited increase in the chemical weathering influxes, our results highlight the possibility of the inefficacy of silicate weathering as a climate regulator at that critical time. Our finding provides an ancient reference for understanding the role of continental silicate weathering in the regulation of climate, especially amid rapid global warming that modern humanity is currently experiencing.

28/05/2024, 14:30–16:30, Room: Zenit
A03 Permian plant succession and the global climate changes

O-068 - In situ fossil coniferopsid forest from the Wuchiapingian (upper Permian) of southern Bogda Mountains, northwestern China

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A Wuchiapingian (late Permian) coniferopsid forest is reported from the lower part of Wutonggou Low-order Cycle in South Tarlong section, Turpan City, Xinjiang Uygur Autonomous Region, northwestern China. Thirteen tree stumps are preserved in growth position with attached rooting systems penetrating down into underlying layers along a 50 m strike. No ground cover was observed, nor were foliage or reproductive organs attributable to the dominant plants found. Anatomical features demonstrate that they all belong to *Protophyllocladoxylon dolianitii* Mussa. Basal stump measurements range from 40 to 85 cm, indicating that this species were mostly large trees. Allometric estimates of tree height suggests that the largest trees were up to approximately 36.44 m tall. Sedimentological analysis reveals that these gymnospermous fossil trees grew in the floodplain environment adjacent to the river and got entombed by crevasse-splay deposits. Growth patterns of the stumps, occurrence of tylosis in tracheids of the secondary xylem, and palaeopedological evidence indicate that the growth of the forest in the floodplain of high water availability, likely in a humid climate with erratic wet–dry seasonality. The newfound fossil forest provides the first example of unequivocal tall coniferopsid trees in growth position in the floodplain setting of NE Pangaea, and sheds important light on community tree density, composition and structure in the subangara floral region during the late Permian.

Keywords: Fossil forest; *Protophyllocladoxylon dolianitii* Mussa; Permian; NE Pangaea; Palaeoecology

28/05/2024, 15:50–16:30, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-069 - Deep learning approaches to the classification and phylogenetic placement of fossil pollen

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The palynological record encompasses hundreds of millions of years of land plant evolution. It is the most extensive and complete paleobotanical record. However, researchers have been able to only utilize and interpret a fraction of the available fossil data. Advances in computer vision offer deep learning methods for increasing the throughput, precision, and reproducibility of pollen identifications. This includes the discovery of morphological features that inform the phylogenetic placement of unnamed fossil specimens. Using a series of neural networks, we developed an explicitly phylogenetic toolkit for analyzing the overall shape, internal structure, and texture of a pollen grain captured by superresolution microscopy. Features of novel specimens produced by a trio of convolutional neural networks are passed to a multi-layer perceptron network trained to transform these features into predicted phylogenetic distances from known taxa. We use these predicted distances to place specimens within a phylogeny using Bayesian inference. Our models are most effective when trained using robust phylogenies independently developed using molecular data or total evidence approaches and where the morphological diversity within a clade is fully captured by our training images. We demonstrate the potential of this deep learning approach in the placement of fossil *Podocarpidites* specimens within a published *Podocarpus* phylogeny. Our results demonstrate that the phylogenetic history encoded in pollen morphology can be recognized by neural networks and that deep-learned features can be used in phylogenetic placement of extinct taxa.

28/05/2024, 15:50–16:30, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-070 - Assessing the spatial expansion of plants in an Earth System model

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The emergence of land plants and their expansion across the Earth's surface has helped shape the climate of the Phanerozoic. Land plants are a major contributor to global photosynthetic biomass which in turn influences atmospheric CO2 and O2 levels. They also amplify continental weathering processes, which are a critical component of many global biogeochemical cycles. The inclusion of spatially-resolved vegetation within climate-biogeochemical models that predict paleo-CO2 and O2 levels can create a more accurate picture of the paleo-Earth [Gurung et al., in revision], however these applications have been limited by the availability of climate model simulations at high time resolution, which makes continuous spatial modelling difficult. Here, we use a new machine learning approach [Zheng et al., in revision] to build a 1-Myr climate emulator for the SCION climate-biogeochemcial model, and couple this to a deep-time vegetation model [FLORA; Gurung et al., 2022]. This allows us to re-run the plant colonisation of the land over the Paleozoic in detail and to view the global impact of changes in land occupation and productivity between early and more complex plants. By integrating simplified evolutionary and competition dynamics into the model, we can compare the effects on weathering, carbon burial and climate to help us better understand the dynamics that influence the expansion of plants and the resulting long-term Earth system changes.

Gurung et al., Climate windows of opportunity for plant expansion during the Phanerozoic *Nat Comms* 13 (2022)

O-072 - Early angiosperms: New insights from pre-Aptian pollen floras of Portugal

Julia Gravendyck[1,2], *François-Nicolas Krencker*[2], *Rute Coimbra*[3], *Ulrich Heimhofer*[2]

1 University of Bonn, Biology, Bonn, Germany
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The timing of the origin of angiosperms is a long-standing topic of debate in plant evolution. Different disciplines and approaches provide highly variable age estimates. It is generally accepted, that early macro- and mesofossils showing unequivocal angiosperm features occur in lower Aptian deposits. Workers employing palynology, i.e., the extremely durable, abundant, and widespread pollen record, have suggested much earlier, but highly disputed ages. To date, it remains questionable how far back pollen with unequivocally angiospermous features can push back the age for the origin of (early) angiosperms.

Here we present new 'early records' from pre-Aptian coastal marine strata from the Lusitanian Basin of Portugal that are known for their rich and unique fossil assemblages and excellent pollen preservation. Based on strontium isotope stratigraphy, we provide a refined high-resolution stratigraphic framework for existing and newly studied sections to better constrain the age assignment of our new palynological findings of subsequent palynological findings.

Employing a new fluorescence-based screening method paired with the standard light-microscope approach, we try to find the needle in the haystack. We document challenges and solutions to finding the extremely rare angiosperm pollen and illustrate new finds of early angiosperms with super-resolution microscopy (Airy Scan). The rare but exciting finds of four triaperturate pollen grains from the Early Barremian (124.63–126.24 Ma, GTS2020) of Portugal indicate the presence of eudicot angiosperms in pre-Aptian strata and provide a new, well-dated calibration point for phylogenetic approaches.

O-073 - Lower Cretaceous Araripe basin (NE Brazil) a possible cradle for Aquifoliaceae (basal Campanulidae, Asteridae): Evidence from pollen

Christa-Ch. Hofmann[1], *Leyla Seyfullah*[1], *Ulrich Heimhofer*[2], *Mario Coiro*[1]

1 University of Vienna, Palaeontology, Vienna, Austria
2 University of Hannover, Geology, Hannover, Germany

Aptian age *Gemmatricolpites* pollen from several horizons of the Cascata sedimentary rock section (Araripe basin) were investigated in detail with SEM for the first time, because the minute sizes of these grains (>13 µm) makes it difficult to recognize the structure of the exine using LM only. However, using SEM magnification the genuinely unique exine structure composed of heterogeneously sized and shaped conspicuous clavae and baculae is clearly visible and is similar to the exine of monotypic tricolporate Aquifoliaceae (precisely *Ilex* L.). The Aquifoliaceae are a family of Aquifoliales (an order also including also four other morphological divergent families Cardiopteridaceae, Helwingiaceae, Phyllonomaceae and Stemonuraceae) that are considered to be an early divergent lineage of the campanulids within the large asterid clade. However, *Ilex* and its closest relatives *Helwingia* and *Phyllonoma* are separated by a very large genetic distance making the rooting of the Aquifoliales order difficult. Previously, the unique exine structure of *Ilex* facilitated the recognition of fossil medium-sized pollen with various apertural conditions (tricolpate, tricolporoidate, tricolporate) affiliated with "*Ilex*", "Aquifoliaceae" or "*Ilexpollenites*" from Upper Cretaceous sedimentary rocks in Antarctica, Australia, Africa and the Americas, and later also from Eurasia, but not from earlier strata. This stand in contrast to the phylogenetic dating of asterids, which revealed an early Cretaceous diversification of asterids with stem node ages for Aquifoliales of 99.7 to 121 my (113 my for crown node ages). Here, the question arises whether pollen grain size and the tricolporate aperture weighs more than the uniqueness of the exine sculpture and ornamentation as witnessed by the Araripe basin *Gemmatricolpites* pollen.

28/05/2024, 17:00–18:20, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-074 - Palynological and palaeoecological evaluation of Cenomanian locality Hloubětín-Hutě, Prague

Veronika Veselá[1], *Jiří Kvaček*[2], *Svobodová Marcela*[3]

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2 National Museum, Department of Palaeontology, Praha 1, Czech Republic
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Geological profile in Praha – Hloubětín locality provides a sequence of terrestrial palaeoenvironments of the Peruc-Korycany Formation. Alternation of clay, silty and sandy rocks with coaly mudstones together with diverse fossil plant remains indicates presence of fluvial to shallow-marine facies.

Examined material from drill core PV2 was macerated by standard HCl-HF-HCl treatment together with use of $ZnCl_2$ in a form of heavy liquid. Processed samples were observed in open slides (preparation for single-grain method) and sealed slides with use of the immersion oil. Obtained palynofacies consist of yellow, brown, and black amorphous matter with fragments size range between finely particulate debris up to 40 µm large organic fragments. Palynomorph content consists of 49 % spores, 33 % gymnosperm pollen and 18 % angiosperm pollen.

Based on thorough palaeobotanical and palynological analyses, presence of four terrestrial palaeoenvironments was confirmed:
1) Saltmarshes
   Environment highly influenced by presence of brackish and sea water, represented by halophytic *Frenelopsis alata* and its pollen *Classopollis classoides*.
2) Coastal wetlands
   Estuarine environment with influence of freshwater streams and coastal swamp represented by *Cunninghamites* sp., *Elactocladus* sp. and *Quasisequoia* sp. and pollen genera *Taxodiaceaepollenites* sp., *Cycadopites* sp., and fern spores *Gleicheniidites* sp.
3) Alluvial plains of braided rivers
   Environment with streams and rivers of various diameters, with regular flooding, represented by angiosperm species *Mauldinia bohemica*, *Eucalyptolaurus* sp., gymnosperm pollen *Inaperturopollenites* sp. and angiosperm pollen *Retitricolpites minutus* and *Liliacitides* sp.
4) Vegetation of slopes and drier upland areas
   Slopes of hard Ordovician quartz were overgrown by a mesophytic vegetation represented by spores *Cicatricosisporites* sp., *Gleicheniidites* sp., conifer pollen *Araucariacites* sp., and angiosperm pollen *Bohemiperiporis* sp., *Eucommiidites* sp. and *Clavatipollenites* sp.

28/05/2024, 17:00–18:20, Room: Aquarius
C05 Recent advances in the study of Cretaceous angiosperms

O-075 - Triprojectacites in China and Canada: Classification and comparison

Yixiao Wu[1], *Jianguo Li*[2]

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2 Nanjing Institute of Geology and Palaeontology – Chinese Academy of Sciences, Department of Paleobotany and Palynology, Nanjing – Jiangsu Province, China

Triprojectacites Mtchedlishvili, 1961 emend. Stanley 1970 is an important angiosperms pollen group in the stratigraphic division and correlation of the terrestrial Upper Cretaceous, for its high diversity, limited geographical distribution and rapid evolution. It is characterized by three (occasionally four or five) projections at the equatorial zone of the body with colpate apertures and endexinous thickenings. Triprojectacites fossils from the Songliao Basin in China and the Western Interior Basin in Canada are studied using a combined observation technique with both optical microscopy and scanning or transmission electron microscopy on single pollen grain. Based on morphological features, a new generic classification system is proposed including nine genera with necessary revisions. Accordingly, Triprojectacites species in China and Canada are identified and classified, and a comparative analysis is conducted to elucidate the similarities and difference. Both palynofloras exhibit distinct domestic lineages comprising local taxa, while the majority of taxa demonstrate commonalities and comparability. Being located further south of the circumpolar

distributed Triprojectacites palynoflora, China yielded this pollen group with lower abundance and diversity compared to Canada. According to the geological distribution of each species, the evolution of Triprojectacites can be divided into five development phases in the Songliao Basin and nine in the Western Interior Basin. Two communication events of the two palynofloras can be recognized. During the latest Campanian, some taxa that have long been present in Canada occurred for the first time in China. This incongruent is potentially attributed to the migration between palynofloras resulting from Maastrichtian regression, or a southward shift in distribution boundary of Triprojectacites caused by climate cooling. Conversely, the other event was observed in Canada during the late Maastrichtian, possibly influenced by another marine regression. This comprehensive investigation of Triprojectacites will facilitate its application in stratigraphy and palynofloristic provinciality.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-076 - Aerobiology and phenology of late-flowering grasses and local peculiarities

Lukas Dirr[1], *Katharina Bastl*[2], *Maximilian Bastl*[2], *Markus Berger*[3], *Thomas Zechmeister*[4], *Uwe Berger*[5], *Fridgeir Grimsson*[1]

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5 University of Innsbruck, Department of Botany, Innsbruck, Austria

With approximately 12,000 species, the Poaceae are one of the most species rich plant families worldwide. However, their typical but highly variable habitus does not extend to their pollen morphology. In light microscope (LM) investigation, it is not feasible to classify Poaceae pollen to species level. This uniformity poses a challenge for aerobiologists, who primarily use LM to assess pollen concentrations in the ambient air with the goal to inform pollen allergy sufferers about the potential burden they may experience.

Despite sharing morphological similarities, grass species exhibit different allergenicity, causing individual reaction patterns in the sensitized population (up to 30% in Europe).

Hence, phenological fieldwork is a valuable addition to the aerobiological routine for getting detailed insights into which species are responsible for the current pollen concentrations. Various studies revealed that the grass pollen season can be divided into multiple phases dominated by different species. Nevertheless, local peculiarities such as ornamental, biomass or other late flowering grasses also need to be considered, as ambient air measurements easily miss them, even though they eventually still cause an extended period of burden period for pollen allergy sufferers.

Allergic diseases still show an increasing prevalence, and since grasses play an essential role in natural habitats and agriculture, the avoidance of their pollen is not entirely possible. Therefore, phenological observations are of importance on a local scale to provide detailed information for pollen allergy sufferers affected to overcome the season with the least possible burden.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-077 - Pollen diversity in honey from a Central European metropolis

Karen Koelzer[1], *Alexandra Ribarits*[2], *Josef Mayr*[2], *Karin Weyermair*[3], *Johannes Martin Bouchal*[1], *Martina Weber*[1]

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2 Austrian Agency for Health and Food Safety, Food Security, Vienna, Austria
3 Austrian Agency for Health and Food Safety, Data – Statistics and Risk Assessment, Vienna, Austria

Urban beekeeping has become a popular trend in many cities worldwide. Green spaces such as parks, private gardens, and road verges provide pollinators with diverse floral resources. Pollen analysis with light microscopy is a valuable tool to identify foraging plants of honeybees and determine honey's botanical and geographical origin. However, urban areas, with their high diversity of ornamental, non-native plants, pose a specific challenge in authenticity checks. Because they are also exceedingly affected by climate warming, many municipalities have started using adapted planting regimes to adapt to heat and drought.

To characterise the "urban", pollen in honey from eighteen apiaries across Vienna, Austria was microscopically analysed over three consecutive years. Pollen grains were counted out to 500 per sample to determine the relative abundances of each pollen type. Differences in the pollen spectra were qualitatively and quantitatively examined according to year, extraction time and extent of urban built-up area within honeybees' typical 3 km flight radius.

A total of 202 plant taxa could be identified, of which 48 % to genus level and 25 % to species level. The median number of pollen types per sample was 46. Overall, out of 71 identified ornamental plant taxa, 41 were non-native. Woody species were major contributors of pollen and nectar for urban honeybees, including the invasive *Ailanthus altissima*, the predominant pollen type in 15 out of 50 samples. Other non-native trees important for mass foraging included *Gleditsia triacanthos*, *Sophora japonica*, *Koelreuteria paniculata* and *Liriodendron tulipifera*.

This research evaluates bee-friendly municipal and private planting regimes in urban areas. The results suggest potential synergies between climate-adaptive taxa, pollinator ecology, and food security in cities.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-078 - Ultrastructural variability and chemical composition of Orchidaceae pollen

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2 Austrian Academy of Sciences OeAW, Department of Historical Archaeology, Vienna, Austria

The Orchidaceae show an enormous diversity in flower morphology, which is also reflected in the orchid specific pollen dispersal units, the so called pollinia and pollinaria. Packaging of pollen by elastoviscin, an orchid characteristic sticky material, results in a huge variety of this morphological and structural complex pollen units. Despite the fact that orchids are one of the most diverse families among angiosperms, available palynological data are still meagre and contradicting. This study provides new insights into pollen morphology and ultrastructure of 11 selected orchid species belonging to subfamilies Epidendroideae and Orchidoideae, studied with combined light microscopy (LM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). The main aims were to compare the morphology and ultrastructure of pollen dispersal units, and to clarify the controversial chemical nature of the pollen wall layers and of elastoviscin. The combined LM and SEM study exhibited the presence of all known tetrad types even within a single pollinium, which is unique for the orchids. The application of different TEM staining methods confirmed the assumed lipidic nature of elastoviscin and the differences in contrast and ultrastructure assume a mixture of sticky materials with dissimilar chemical compositions. Chemical detection reactions conducted on extracted elastoviscin also indicate the presence of aldehydes and neutral polysaccharides. The study affirmed that sporopollenin is limited predominantly to outer pollen grains of peripheral tetrads in compact and sectile pollinia, whereas inner tetrads exhibit highly reduced non-sporopollenin pollen walls.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-079 - On the trail of a pollen artwork – A long-term study from the MoMA in New York

Martina Weber[1]

1 University Vienna, Department of Botany and Biodiversity Research, Vienna, Austria

Dust is an excellent source of pollen for forensic investigations. Pollen grains are particularly well preserved in indoor samples and can remain intact for many years or decades. A long-term experiment launched in August 2015 at the Museum of Modern Art (MoMA) in New York demonstrates this preservation ability of pollen in an artful way. From January to March 2013, the MoMA presented the fascinating installation "Pollen from Hazelnut" by Wolfgang Laib, an artist with a preference for using natural materials such as rice, marble, milk, beeswax, and pollen. For his installation he collected hazel pollen manually for many years in southern Germany. The artwork was presented in the "Marron Atrium" and consisted of a 30 square meter installation of bright yellow pollen, that was sieved by the artist directly onto the floor. Since August 2015, dust samples taken from unfrequented areas in the Marron Atrium have been analysed. The results showed that *Corylus* (hazel) pollen was still present in strikingly high numbers (up to 16%) in the dust samples. The amount of hazel pollen in the samples has remained more or less constant over the first

three years. The wind pollinated species is generally rarely planted as an urban tree in New York and is not growing in the vicinity of the museum. This eliminates the possibility of pollen entering the building from outside and from visitors' footwear. A significant change was first observed in 2018 due to the replacement of the floor in the Marron Atrium.While the number of hazel pollen found in the dust samples of recent years was as expected, a remarkably high percentage of *Quercus* pollen in all samples raised a legitimate question: Was the source material for the artwork "Pollen from Hazelnut" pure hazel pollen? Pollen tells the whole story.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-080 - Selected pollen types and their parent plants around the Lake Ranwu in SE Tibet, China: An aid to Quaternary pollen analysis

Qinran Gu[1,2], *Limi Mao*[1], *Wei Chen*[1]

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2 University of Chinese Academy of Sciences, Nanjing College, Nanjing, China

The accurate and consistent identification of fossil pollen is essential to allow robust inferences to be drawn with regard to past vegetation and climate change (Gosling et al., 2013). However, there is a big gap between published pollen floras and the highly diverse plants in China (>29, 200 species of seed plants from >3,200 genera, 270 families). Therefore, more work on pollen morphological investigation is still expected to be carried out. Due to the fast development of digital imaging and information technology, it is now possible to produce high resolution pollen images from reference collections and make them accessible globally. In this study, we present the selected pollen grains in light microscope (LM) and/or scanning electron microscope (SEM) images from 62 species in 40 genera and 23 families, representing different vegetation types from around the Lake Ranwu in SE Tibet, China. These pollen types occur commonly in Quaternary sedimentary archives in our study area. Beyond pollen types, information on plant life form, habitat, pollination, and ecology are also briefly presented, which are useful to interpret fossil pollen spectrum in Paleoecological study. This study will serve as useful guide for Quaternary pollen analysis, supporting comprehensive reconstruction of vegetation history, climate and environment changes, as well as human impacts on landscape changes in SE Tibet, China.

28/05/2024, 17:00–19:00, Room: Leo
M08 Open symposium on basic (LM, SEM, TEM) and applied palynology

O-081 - The exine ornamentation of Rubus taxa correlates with their geographical origin

Olga Gavrilova

It is known that molecular markers of many taxa correspond with geographical distribution. But in *Rubus* taxa we found pollen characters correlated to species origin. The genus *Rubus* (Rosaceae) has medium, mainly tricolporate grains with striate, perforate, reticulate, rugulate, verrucate, echinate or complex exine. Pollen measurements often vary in one species and even specimens, and the colpi number may differ in some specimens up to having 48 percent of one-, two-, four- or six-colporate grains. The species, sections and subgenera delimitation by pollen data are difficult or impracticable. Striate or striate-perforate ornamentation with thin, long striae are found in more than 80 percent of studied *Rubus* species and in many Rosaceae members. The subgenus *Rubus* is uniform in exine pattern. Typical striate *Rubus* pollen appear throughout the world; and only this sculpture pattern occurs in Europe. Variations of non-typical striate and non-striate pollen revealed mainly in Southeast Asia and Oceania, a few variation have been shown for the Arctic and the Americas. Taxonomists denoted three centers of *Rubus* species richness around the world: eastern North America, central and northern Europe and Southeast Asia. Pollen data indicate a geographical center of species diversity is in Southeast Asia. The origin and evolution of the genus are discussed.

28/05/2024, 17:00–18:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-082 - The possible role of a few plant taxa in the late Neogene vegetation of NW Italy

Edoardo Martinetto[1], *MIchela Bornancin*[1], *Piero Damarco*[2], *Cinzia Ragni*[1], *Giovanni Repetto*[3]

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3 Museo Civico Eusebio, Scienze Naturali, Alba, Italy

The abundance of late Neogene plant fossil sites in NW Italy (6.0 to 2.6 Ma), provides good conditions for a general survey of the macrofossil record, that can permit the reconstruction of the environmental preferences and vegetational role of particular plant taxa, based on the analysis of the geological and palaeontological contexts of their fossil occurrences. This is particularly true because the plant-bearing sites are comprised in a not too-broad area, possibly influenced by rather homogeneous palaeoclimatic conditions, with a consequently restricted floristic spectrum. The completion of recent works on Neogene plant-bearing sites pointed out an uneven distribution and abundance of meaningful, isolated remains of different plant taxa. Identification of isolated plant remains may pose serious challenges to palaeobotanists, in particular in those assemblages which are rich in extinct or extirpated plant taxa, as it is the case for the Neogene of NW Italy. Here, as elsewhere in Italy, the 19th century literature reported a large number of questionable occurrences of genera or species, which were often not confirmed by subsequent studies. A general survey of all the plant-bearing localities of this area permitted a better interpretation of those plant remains which were fragmentary or rare at certain sites, whereas occurred abundantly in others. Co-occurrence of leaves, fruits and seeds, threw light on the correct taxonomy of less diagnostic parts, thus confirming uncertain determinations. Isolated plant parts where conceptually assembled in a list of hypothetic "Whole-Plant" taxa, that grew in the studied area in the Messinian to Gelasian time interval. The relevant information is resumed in a planned series of plates, each one dedicated to a "Whole-Plant" fossil-taxon (e.g., *Alnus, Fagus, Trigonobalanopsis*, etc.). The distribution and abundance of fossils referred to these taxa will be discussed in relation to the Neogene vegetation history of NW Italy.

28/05/2024, 17:00–18:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-083 - Paleoenvironmental analysis of the Suriname coastal area, northeastern South America

Kathleen Gersie[1,2,3], *Eva Visser*[1], *Roel Verreussel*[4], *Elton Dantas*[5], *Roberto Ventura Santos*[5], *Salomon Kroonenberg*[2], *Carina Hoorn*[1]

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5 Universidade de Brasilia, Institute of Geosciences, Brasilia, Brazil

The coastal environments and geomorphology of the Guyana coast (i.e. French Guiana, Suriname and Guyana) are strongly influenced by the Amazon River that feeds the characteristic nearshore mud flats. The age of the Amazon River is debated, with its onset reportedly starting in the late Miocene (c. 10 Ma), with vast increase and deep channel incision during the Quaternary (<2.5 Ma). Here we question when the Amazon first deposited Andes-derived mudstones along the Guyana coastline and how this changed the coastal environments and morphology. To address this question we obtained samples from two nearshore, cored sections (270 m and 810 m depth, respectively) that include the Onverdacht, Saramacca, Alliance, Coesewijne and the Zanderij formations. We performed palynological and geochemical analyses on selected samples. Our initial results suggest that most of the sediments in these cores are rich in mangrove pollen (i.e. *Zonocostites*) pollen and a high diversity of forest taxa; these sediments were sourced in the nearby Guiana Shield (i.e. Amazon Craton) and of Paleogene and Early Neogene age. A hiatus separates these sediments from presumed Plio-Pleistocene sediments that suggest a different (Andean?) source and include pollen of Asteraceae, Poaceae, *Borreria, Hedyosmum, Podocarpus* Our initial results suggest that the geomorphology and mudflats of the Guyana coast initiated, at the earliest, in the Pliocene.

28/05/2024, 17:00–18:00, Room: Nadir
T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

O-084 - The Pliocene Kon Tum flora from central Vietnam – Ancient analog of Mainland Southeast Asia's endangered tropical seasonal forests

Tengxiang Wang[1], *Jia Liu*[2], *Peter Wilf*[1], *Jian Huang*[3], *Shi-Tao Zhang*[4], *Van Do Truong*[5], *Hung Ba Nguyen*[3,5,6], *Tao Su*[2]

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3 Xishuangbanna Tropical Botanical Garden, Key Laboratory of Tropical Forest Ecology, Mengla, China
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5 Vietnam Academy of Science and Technology, Vietnam National Museum of Nature, Hanoi, Viet Nam
6 University of Chinese Academy of Sciences, University of Chinese Academy of Sciences, Beijing, China

Mainland Southeast Asia (MSEA) is one of the world's biodiversity hotspots, hosting high endemism of plants under a tropical seasonal climate. Unfortunately, it suffers from high extinction risks due to increasing anthropogenic pressure. Effective conservation requires a better understanding of the regional vegetation's evolutionary history to clarify its origin, information that most reliably comes from the fossil record. However, paleobotanical studies in MSEA are currently limited and restricted to the northern part of the region, leaving much unknown in southern MSEA, which today has extensive tropical forests. Here, we report a new Pliocene flora discovered by our international team in 2019 from the Kon Tum Formation in the Kon Tum Province, Central Highlands region of Vietnam. The flora was found in a lenticular claystone deposit, preliminarily interpreted as an overbank floodplain fill. The Kon Tum flora is comprises 572 specimens entirely of angiosperms, mostly leaves with well-preserved venation or cuticles. The assemblage predominantly has entire-margined leaves (only one morphotype toothed) with relatively small leaf size (90% microphylls and notophylls). We recognize ca. 40 morphotypes including species of *Ficus*, *Syzygium*, Dipterocarpaceae, Fabaceae, and Lauraceae. The associated palynoflora is highly diverse, with more than 200 palynomorphs providing a clear signal for tropical forest. The recognition of *Loranthus*, *Casuarina*, *Alangium*, *Dacrydium*, and multiple Poaceae pollen types infers an age of Pliocene-early Pleistocene for the Kon Tum flora. The total assemblage indicates the presence of a tropical seasonal broadleaved forest in central Vietnam since at least the Pliocene, with an apparently similar floristic composition to present-day forests in the area. This new flora is the first macrofossil evidence of Neogene paleovegetation in southern MSEA and indicates the antiquity of the biodiverse yet endangered Vietnamese tropical forests.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-085 - Pollen based land-cover reconstructions as a tool to disentangle the drivers of environmental change during the Holocene

Anneli Poska[1], *Vivika Väli*[2], *Jüri Vassiljev*[1], *Tiiu Alliksaar*[1]

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Lessons from the past can offer a key to understanding the drivers and form a basis for predictions of future changes in the composition of terrestrial vegetation. The hemiboreal zone of Northern Europe, which forms the northern boundary of major a agrarian production area is situated in a sensitivity hotspot for climate driven land-cover change.

We have used the centennial resolution pollen data from five sites to study the dynamics of vegetation composition, anthropogenic deforestation, species-specific responses to climate cycles, and fire history during the Holocene. The Landscape Reconstruction Algorithm (LRA) was used to reconstruct the vegetation composition at extra-local, local and regional scales. The major land-cover changes are in good accordance with the climate-based formal tripartite subdivision of the Holocene. The changes include a succession through the tundra, boreal, and nemoral biomes. Several episodes of compositional turnover ranging from a century (e.g., the transition from a wet to a dry tundra) to several millennia (e.g. the replacement of the temperate deciduous forests with the boreal mixed forests) were identified. Most of the late successional tree taxa show high frequency (ca 200–400 year) cyclicity, possibly reflecting the community rejuvenation processes or as a response to DeVries cycles. Furthermore, some late successional tree taxa show a response to ca 1500-year Bond events and 2500-year Bray solar forcing cycle.

The anthropogenic deforestation initiated by introduction of slash-and-burn agriculture caused forest composition changes by promoting early successional tree species, already prior establishment of permanent agriculture, and opening of the landscape. The only late successional tree species favored by early long-rotation time slash-and-burn cultivation was spruce. However, the application of more intensive and permanent cultivation strategies reduced its representation considerably.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-086 - Landscape changes during periods with monumental burial mounds – A quantitative vegetation reconstruction based on pollen records from the island of Karmøy in south-west Norway

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The northern part of Karmøy in south-west Norway was a prehistoric centre which is shown by monumental burial mounds with rich grave finds from the Bronze Age to the Iron Age. This centre was most likely developed because of its proximity to the Karmsund Strait, which is a strategic maritime passage. The monumental burial mounds in northern Karmøy were built during three time-intervals: Bronze Age Period II/III–VI (1300 BCE–500 BCE), the Roman Period (1–400 CE) and the Merovingian Period (c. 600–800 CE). In this study, the land-use history in Northern Karmøy is explored between 5500 BCE and present, with focus on the agricultural development. The landscape is reconstructed both at regional scale using the REVEALS model (based on pollen records from three sediment cores), and at local scale (within 1000 m radius) using the LOVE model based on the pollen record from Lake Bøvatn. A compilation of archaeological remains in the area are used for comparison with the land-use reconstructions on the northern part of Karmøy. In addition, the environmental evidence from the burial mound Storhaug are analysed in more detail, based on a recent archaeological excavation, to provide evidence for how it was constructed and analyse its environmental context.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-087 - Evaluation of relative pollen productivities in temperate China for reliable pollen-based quantitative reconstructions of Holocene plant cover

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The Landscape Reconstruction Algorithm (LRA) is regarded as the soundest approach for quantifying taxon-specific plant cover from pollen data. The reliability of relative pollen productivity (RPP) estimates is fundamental in the accuracy of quantitative vegetation reconstruction using the LRA approach. Therefore, it is crucial that the RPP estimates are evaluated before being applied for quantitative vegetation reconstruction. We have tested two alternative approaches, namely, a leave-one-out cross-validation (LOO) method and a splitting-by-subregion strategy, using surface pollen assemblages and the REVEALS model – the first step in the LRA – to evaluate the reliability of RPPs estimates of 10 target taxa obtained in the cultural landscape of Shandong. We compared the REVEALS estimates (RVs) with observations of regional vegetation abundance (OBVs) and pollen proportions (PPs). The RVs of all taxa are generally closer to OBVs than PPs, and the degree of similarity depends strongly on the abundance of individual taxa in plant and pollen. The comparison of RVs with OBVs collected from different spatial extents shows that the RVs of all herb taxa are more similar to OBVs collected from shorter distances, whereas the RVs of all tree taxa are more similar to OBVs collected from longer distances. Furthermore, our findings highlight the importance of testing different sizes of area for vegetation surveys for evaluation of the RVs given that the appropriate size of vegetation survey may vary between low pollen producers (mainly herbs)

and high pollen producers (mainly trees). We consider that the LOO strategy is the best approach in this case study for evaluating the RPP estimates from surface moss polsters. The evaluation confirms the reliability of the obtained RPP estimates for their potential application in quantitative reconstruction of vegetation abundance in temperate China.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-088 - Quantitative reconstruction of climate and plant diversity of the Altai Mountains during the Holocene: A palaeobotanical approach

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The objects of this study are lake sediment cores sampled in different parts of the Altai and adjacent areas. In total, twelve lakes were sampled and 14 sediment cores were analysed with a maximum temporal coverage of 14 thousand years and time resolution of 10 to 100 years. Lake sediment cores were studied using a complex of methods that allowed us to obtain age-depth models, qualitative and quantitative reconstruction of vegetation, reconstruction of plant alpha and beta diversity, and reconstruction of climate based on the pollen data.

The early Holocene was relatively dry in all parts of the Altai Mountains, and the area was under North Atlantic influence. Afforestation begins around 10.8 ka BP, coinciding with the general pattern of Holocene trends in northern Asia; a sharp increase in precipitation does not occur in the Altai until around 8 ka BP. The LIA in the Altai consisted of two phases: relatively dry between 1400–1500 and relatively humid between 1500–1700.

Indicators of phytodiversity obtained for lakes in intermountain basins and for high altitude lakes in arid areas show the same patterns: as forest area increases, plant diversity increases. In the arid highlands, plant diversity responds positively not only to afforestation but also to increases in the area of different types of non-steppe highland formations. Phytodiversity calculated for lakes in mountain belts characterised by high afforestation increases with the increase in open areas occupied by steppe or tundra communities. During the Holocene, no abrupt changes in the level of plant diversity are observed in the Altai. The maximum restructuring of the taxonomic composition of plant communities in the Altai occurred only at the Holocene-Pleistocene boundary.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-089 - Changing fuel loads in the face of Indigenous population expansion in southeast Australia

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Wildfires in the world's forests have increased due to climate change and are projected to become more frequent and intense. In regions such as southeast Australia and North America, recent literature has demonstrated that fire suppression and forest management have led to more severe fires. However, others argue that climate change is the sole cause of recent devastating wildfires.

We challenge this argument by quantifying fuel loads at various levels of human occupation, including times prior to Indigenous settlement, in fire-prone forests of south-eastern Australia.

In Australia, this debate was provoked by the large amount of forest burnt during the recent unprecedented wildfires of 2019–2020. Ethnohistorical evidence suggests that for tens of millennia, Indigenous peoples of Australia practiced cultural burning, which limited understorey woody growth, resulting in less intense wildfires. However, empirical evidence is still scattered and time limited. We use a regional compilation of multiple proxies combining 2,833 records for vegetation cover, past climate, fire activity and human population. We used the REVEALS model on multiple pollen records (n=39) to estimate past regional vegetation cover whilst correcting for productivity and dispersal biases.

Human population expansion and cultural fire use is associated with a 50% reduction in shrub biomass in forests. Modelling suggests that humans deliberately pushed ecological trajectories towards low shrub cover, while retaining canopy trees and understorey grasses. Since British colonisation, levels of shrub cover increased to the highest recorded (~35%) in this region, setting the stage for the current fire crisis. While we acknowledge the significant impact of climate change in triggering recent fires, we demonstrate that land management by First Nations people historically played an important role in modulating fuel abundance.

28/05/2024, 17:00–19:00, Room: Taurus
H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

O-090 - Palynology never alone: The integration with historical data reveals the complex dynamics of Lake Volvi region in Macedonia (Greece) among natural and anthropogenic factors

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The potential of palaeoenvironmental reconstructions during historical time scales is well known but at the same time incredibly underestimated. However, studies at high resolution of sedimentary sequence combined with historical primary sources are extremely rare. Here we present a case study of perfect integration of those two archives with the purpose to reconstruct the paleoenvironment of the last two millennia in the Lake Volvi region (Macedonia, northern Greece). The lake region is a biodiversity hotspot, located in the communication corridor linking the eastern and western parts of the Balkans. The studied pollen sequence has a mean temporal resolution of ca. 50 years documenting, with good resolution, environmental changes dating back to the Roman rule. Data highlights shifts in wetland habitats, mixed deciduous oak, thermophilous-mesophilous forests, as well as patterns of cereal cultivation, grazing, and arboriculture, showcasing varying intensities over time. Geochemical data complement the reconstruction of the past environmental changes. Following the consilience concept, the palaeoecological evidence is interpreted together with archaeological data, available for the 1st millennium CE, and historical data, based on Byzantine and Ottoman documents and registers from the 13th century CE onward. Both historical and palaeoecological records converge on identifying the 16th century as a period marked by the most significant population pressure on the landscape surrounding Lake Volvi. Nonetheless, discrepancies between the proxies for other periods suggest the need for a nuanced understanding of the socio-ecological dynamics in the study region. Through our research approach, we demonstrate that these contradictions can be reconciled with a more intricate comprehension of the interplay between social and ecological factors shaping the history of Lake Volvi and its region.

28/05/2024, 17:00–18:40, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-091 - Multispectral imaging flow cytometry & Deep learning for analyses of paleopalynological sediment core samples

Susanne Dunker[1], *Andrei A. Andreev*[2], *Kathleen Stoof-Leichsenring*[2], *Philippe Krajsic*[3], *Thomas Hornick*[1], *Bogdan Franczyk*[3], *Patrick Mäder*[4], *Ulrike Herzschuh*[2]

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Paleopalynological studies of pollen are traditionally performed with manual light microscopy of specialized taxonomic experts. The high time investment required severely limits the sample throughput, which is, however, necessary for a more comprehensive understanding of past climatic changes. For different microscopic particles it could be demonstrated, that multispectral imaging flow cytometry (MIFC) is a promising tool, which overcomes sample throughput limitations (Dunker et al. 2018, Dunker et al. 2021, Dunker et al. 2022). The instrument used has the capability of collecting images of up to 2000 particles/ s and with 12 images/ particle (brightfield, multispectral fluorescence and scatter images). In the project SedimentAI we tested the applicability of this method for paleopalynological samples of different sediment core origin. One challenge in comparison to automated identification of recent pollen is that for paleopalynological applications the amount of annotated ground truth reference data is limited. The number of underrepresented classes cannot easily be increased to be sufficient for a ML-based classification. We therefore first tested the general applicability of the method to recognize pollen, algae and Lycopodium spores, and as a second step also tried to apply semi-supervised learning tools to limit the number of images required for training.

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Dunker, S., Boho, D., Wäldchen, J., & Mäder, P. (2018). Combining high-throughput imaging flow cytometry and deep learning for efficient species and life-cycle stage identification of phytoplankton. BMC ecology, 18(1), 51.
Dunker, S., Boyd, M., Durka, W., Erler, S., Harpole, W. S., Henning, S., ... & Wilhelm, C. (2022). The potential of multispectral imaging flow cytometry for environmental monitoring. Cytometry Part A, 101(9), 782–799.

28/05/2024, 17:00–18:40, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-092 - PROTO Database: Establishing a link between pollen and flora in the digital era

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Palaeopalynological analyses may require the use of pollen types and pollen groups, i.e. categories collecting species whose pollen grains have similar morphotypes, regardless of taxonomy. Therefore, due to their nature, pollen types/groups do not always provide on their own the information needed to study plant biodiversity of the past at species level.

A higher level of species-wise precision can be achieved in the study of past flora of a locality by coupling the information in pollen types/groups with current local floras, linking microscopic and macroscopic plant biodiversity. PROTO Database hosts the first attempts at this approach, and was created as a digital archive showing matches between pollen florula and flora. This is a useful and quick-to-use tool to support palynologysts in enhancing biodiversity features in their studies. This contribution presents an example of application of PROTO Database, linking pollen florula from archaeological and moss samples to present flora composition of selected Italian sites.

Three pollen florulas (two from archaeological samples, one from modern analogue) from two different locations (Terramara di Montale and Palù di Livenza, N Italy) were digitised and linked to actual plant species. Next, each of the resulting floras was linked to local floras from the relevant sites, excluding neophytes in ancient pollen florulas, and locally extinct species in modern

pollen florulas. Each local flora obtained this way was then uploaded to PROTO Database, which allows for searching plants by location, by chronology, by pollen type/group and by species.

28/05/2024, 17:00–18:40, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-093 - Exploring human-plant interactions in central Italy over the centuries: Compiling and comparing published and unpublished archaeobotanical records

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The gradual implementation of archaeobotany in archaeological excavations in the Italian territory in last decades has greatly helped to gain knowledge about past human-plant interactions. Information is now available, among others, about diet, selection of natural resources, introduced taxa, and ritual uses of plants. However, archaeobotanical studies continue to be published in different types of sources, such as scientific articles and archaeological reports, the latter of which are often complex to retrieve. Furthermore, data often concern single contexts or sites, making it hard to piece the puzzle together.

A noteworthy step to obtain an overall picture of human plant interactions in Italy is represented, since 2015, by BRAIN (Botanical Record of Archaeobotany Italian Network), a cooperative network and database listing all the sites, their locations, chronology, cultures, archaeological contexts, and various types of archaeobotanical studies conducted, along with their bibliographic references. The database is periodically updated with new publications.

In this study, produced within the PNRR PE5 CHANGES Spoke 8 and CN5 NBFC Spoke 3, we present a georeferenced tool to compare data about plant macro-remains extracted from publications present in BRAIN and deriving from unpublished studies, homogenizing them, and sorting them by periods. The project now covers central Italy and will gradually be implemented to include the rest of the country. Through the implementation of the developed protocol, the reconstruction of dietary preferences and the introduction of new plants from the Neolithic to the modern-day will be more accessible and straightforward. It will thus be possible, for example, to better trace the arrival and spread of archaeophytes and neophytes in the Italian Peninsula.

28/05/2024, 17:00–18:40, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-094 - Using convolutional neural networks to predict the phylogenetic and ecological affinities of fossil moss spores

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Mosses play a critical role in key biomes such as boglands, tundra, and temperate rainforests. However, their sparse fossil record limits our understanding of their role in past ecosystems. Additionally, mosses occupy an essential phylogenetic position, yet there are few fossils to provide useful minimum age nodes for phylogenetic analyses. Fossil spores offer the potential to address these limitations given their significantly greater chance of being preserved in the fossil record. Except for *Sphagnum*, few moss spores are recorded in deep time, likely because of their frequently smaller size and lack of easily visible diagnostic features typically used in spore identification. Here, we have developed Convolutional Neural Networks (CNNs) for the first time in mosses using SEM images of extant moss spores to predict the phylogenetic and/or ecological affinities of fossil moss spores. CNNs learn features directly from image data for classification tasks, without requiring manual feature selection. To develop this CNN, we sampled over 200 moss species covering the breadth of the moss phylogeny. Lycophytes and ferns were also sampled to use as outgroups. SEM imaging allows for the surface perine sculpturing of mosses to be considered in the neural network, in contrast to light microscopy, where these features are not easily visible. While CNNs have previously been used on 3D scans of pollen, this is the first application

of CNNs to spores. In addition to developing a neural network, we have produced an extensive SEM image database of moss spores that will be publicly available through the Cornell University Plant Anatomy Collection (CUPAC). This novel work will greatly assist in identifying moss spores in the fossil record, allowing for particular clades to be recognized and providing ecological information.

28/05/2024, 17:00–18:40, Room: Virgo
Z04 Palynology and palaeobotany in the digital era

O-095 - Digital Palynology

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The study of pollen and spores started more than a century ago and provides the fundamental basis to understand vegetation changes through time, date sedimentary rocks through biostratigraphy, and model plant evolution among many other applications. Since its origin, palynology has relied on the manual count of pollen and spores using a microscope. This is a process that requires a long time, years of training, and produces data that is not fully reproducible. The advent of new robotic tools that can digitize complete microscope slides and the fast development of neural network algorithms have provided the timing for Palynology to enter a new era in data generation and analysis. We are developing a training set of neotropical pollen to be used in a neural network that will assist pollen counts and identification. The developments produced here could be applied to multiple research questions where pollen can be used from paleoecology and paleoclimate to pollination biology and honey production.

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-096 - The habit and ecology of Lopingian gigantopterids from South China

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Gigantopterids, one Permian enigmatic plant group but most important group for Lopingian South China before the Permian–Triassic mass extinction. This group is famous for leaves with meshed venation pattern. And they were always recorded by isolated leaves. It is still not clear for its morphology of whole plant and its ecology. Here we found abundant gigantopterid leaves, especially *Gigantonoclea* connected with adhesive roots, hooks or grapnels, in South China. New materials gave more evidence for reconstructing the morphology of whole gigantopterids. And there are also some prehensile branches preserved around the support *Pecopteris* branches, which indicate both active climbing and passive climbing mechanisms for *Gigantonoclea*. And its support plant is proved to be *Pecopteris* here.

Keywords: Permian, gigantopterids, ecology, habit

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-097 - Permian-Triassic fossil woods from the northern Xinjiang, northwestern China

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Starting from the end of the Pennsylvanian epoch, the Paleo-Asian Ocean in northern China began to close, resulting in the formation of several inland basins in northwest China. During the Permian-Triassic period, these basins thrived as habitats for vegetation. These plants include not only typical Angara flora plants but also a mixture of elements from the Cathay flora. Interestingly, a remarkable abundance of petrified wood, including silicified, calcified, and carbonized wood (charcoal), has been exceptionally preserved within the Permian-Triassic strata of the Junggar Basin and Tuha Basin in northern Xinjiang. The discovered fossil woods include Equisetales, Cordaitales, and Conifers. These wood fossils consist of scattered stem and root fossils, as well as in-situ tree stump fossils. Extensive research has been conducted using these wood fossils, leading to significant advancements in plant classification and the reconstruction of paleoclimate and paleoenvironment. Recent collections of petrified wood materials have provided valuable insights into the characteristics of Permian forests in northern Xinjiang, allowing us to evaluate the effectiveness of the pith structure as a reliable identification feature. Furthermore, these wood fossils illuminate the intricate relationship between environmental changes and tectonic movements in northern Xinjiang during the Permian-Triassic period.

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-098 - The evolution of the Kungurian (Cisuralian) flora in the paleotropics (Southern Alps, Northern Italy)

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The end of the Late Paleozoic Ice Age is associated with a distinct vegetation turnover that gradually replaced wetland forests with a vegetation dominated by drought tolerant plants. The Kungurian plant fossil and sporomorph assemblages of the Southern Alps are among the most rich, diverse and well-dated from the Cisuralian paleotropics. The integration of plant macrofossil and sporomorph assemblages from the Athesian Volcanic District provide a comprehensive and well-dated paleobotanical dataset of the Cisuralian in the Southern Alps. This allows to trace almost continuously the evolution of the flora throughout the Kungurian. This permits to identify: i) the so far oldest co-occurrences of walchian and voltzian conifers during the early Kungurian; ii) the presence of putative endemic taxa of gymnosperm groups, iii) an increase in diversity and abundance of voltzian conifers and sphenopterids throughout the Kungurian; iv) the establishment of a stable, rich and diverse gymnosperm-dominated flora from the middle Kungurian onwards, which, despite occasional wildfires, prospered until the late Kungurian; v) the presences of more stable and putatively more humid environmental conditions during the late Kungurian. In addition, combined palynofacies and lithofacies analyses reconstruct a complex depositional environment composed of lacustrine and alluvial settings.

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-099 - How did the Permian-Triassic hot house climate shape the vegetation landscape and how did the land plant fight back?

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During the Permian-Triassic Mass Extinction (PTME) ~252Ma, diverse lowland forests were replaced by pioneer herbaceous lycopod communities that proceeded to dominate the Early and Middle Triassic landscape. The flourishing of Early-Middle Triassic herbaceous lycopods was coincident with the lethally warm surface temperatures (>40 ºC) occurred across large regions of the planet. To explore how these plants were able to thrive during this interval of enhanced climatic stress, we collected data from over 400 fossil plant specimens from South China, supplemented by additional data from literature reviews from other regions and geological ages. Our studies on their morphology indicate that among all Phanerozoic lycopods the transitional Permian-Triassic *Tomiostrobus* (=*Annalepis*) has the closest morphological relationship with the recent lycopod *Isoetes.*

Extant *Isoetes* are renowned for their flexibility with regard to the photosynthetic pathway they use and their capacity to absorb CO_2 through their roots. We undertook carbon isotope and sedimentary facies analysis including plant taphonomy to test for the presence of the Crassulacean Acid Metabolism (CAM) photosynthetic pathway in the Triassic lycopods. Plants capable of CAM pathway growing in stressful environment typically have heavier isotopic signatures while show typical C3 plant signatures in hospitable environment. Our carbon isotope data shows that Permian Triassic Transition to Middle Triassic herbaceous lycopods isotopic signature is on average 2‰ to 1.07‰ less negative when compared to contemporary non lycophyte vegetation, while Late Permian *Lepidodendron* exhibits a similar $\delta^{13}C$ value with other contemporary plants. These findings suggest that CAM photosynthesis may have played a role in the dominance of the Triassic herbaceous lycopods. The dominance of CAM plants following the PTME has implications from an Earth Systems standpoint due to their diminished productivity and a lower capacity for biotic weathering, features that likely suppressed negative feedback loops important in driving climate stabilization during the ~5Ma PTME recovery phase.

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-100 - Architectural model of Arnhardtia scheibei (Gothan) Haubold et Kerp reveals the paleoecological role of callipterid peltasperms in seasonally-dry landscapes of the early Permian

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The “callipterids” (Peltaspermales) represent a group of pteridosperms that arose in the Pennsylvanian. Their radiation in the early Permian of Euramerica was presumably linked to major global change favoring the extension of dry habitats. Due to the taphonomic megabias mainly affecting dry floral communities, our knowledge on these plants is restricted to several foliage taxa and mostly disarticulated reproductive structures.

Here, we report on the callipterid peltasperm *Arnhardtia scheibei* (Gothan) Haubold et Kerp which is mainly known from Asselian–Artinskian strata of central European post-variscan, intramontane basins. The fossil remains were found in lacustrine and alluvial-plain deposits, the latter revealing nearly monospecific assemblages with articulated fronds, pollen organs, and foliated stems. The fossils indicate that *A. scheibei* was a self-supported, shrub-like plant with insignificant stem secondary thickening.

Active fronds were <1 m long and sub-vertically originating from the apex, whereas defoliated (inactive) fronds were still attached to the medial and basal stem. The 3D-morphology of the eusphenopterid-like foliage reveals reduced leaf surface area and distinctly increased leaf thickness, a feature commonly observed in modern leaf succulents. Moreover, *A. scheibei* possessed densely arranged spines covering the frond rachises and outer stem surface. The pollen organs are reconstructed as separate fertile fronds with a dozen of cup-shaped synangia attached to several bifurcating secondary rachises.

So far, *Arnhardtia scheibei* is the only callipterid of which the habitus and growth strategy can be reconstructed in great detail. It reveals that callipterids were forming ground vegetation assemblages of exceptionally low diversity, with Walchian conifers as the only evidenced accompanying floral element. These assemblages were most likely growing at (seasonally) dry and exposed localities with high evapotranspiration potential. The plants were presumably pioneer settlers on occasionally flooded alluvial plains, forming open vegetated habitats in rather unfavorable environments and, therefore, developed mechanical defense strategies against various herbivores.

28/05/2024, 17:00–19:00, Room: Zenit
A03 Permian plant succession and the global climate changes

O-101 - How Nature freezes Life cell-scale: New ways to date and reconstruct plant silicification

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Fossils that provide three-dimensional anatomical detail are among the most spectacular and significant archives of past life. The spatial preservation of cellular structures opens windows into the microanatomy of the former organisms, allowing valuable conclusions about their biology. However, since the first microscopes illuminated the submillimeter worlds of anatomical preservations more than three centuries ago, we have been struggling to understand their formation. Here we present a novel approach combining palaeontology, petrology and geochronology to reconstruct the deep-time 3D mineralisation of plant tissues. Methods applied include fossil-wood histology, sediment petrography, cathodoluminescence and Raman spectroscopy of mineralising agents, fluid-inclusion analyses in quartz and U-Pb radioisotopic dating of preserved wood structure and authigenic quartz. For this study, we investigated Upper Pennsylvanian petrified woods of the Kyffhäuser (Siebigerode Formation, central Germany) – a model example of silicified woody debris from fluvial red beds poorly influenced by synsedimentary volcanism. The results reveal a three-stage petrifaction extending over 150 myr. Initial, eogenetic silicification, dated to 304±10 Ma, affected the wood incompletely along fiber-like domains that run axially through the wood. Lepisphere ghost structures indicate primary opalisation, later crystallised to form the present-day quartz. An early-mesogenetic, second silicification is dated to the late Permian (260±5 Ma) and comprises epitaxial quartz blades that grew from the initially mineralised fibers into the wood. A late-mesogenetic, third silicification related to basinal brines occurred at 160–240 °C and 5 km depth in the Late Jurassic–Early Cretaceous, based on fluid inclusions and the regional subsidence history. Following some silica remobilisation and subsequent precipitation in fractures, the fossil woods faced final exhumation in the Cenozoic. The outcomes open up new ways of reconstructing deep-time silicification with absolute data and highlight the need to include sediment diagenesis into fossilisation studies.

O-102 - Ecological trade-off strategy of the Early Eocene angiosperms in Lingbao, central China and their indication of paleoclimate

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Plant functional traits are a series of biological characteristics that are closely related to plant colonization, survival, and adaptation, which not only reflect the response of plants to the environment, but also can be linked to ecosystem function, as an important ecological indicator for assessing the plant's fitness to survive. Under the certain ecological constraints, plants need to optimize the allocation among functional traits in the most economic way (i.e., maximizing the use of limited resources and obtaining the optimal ratio of functional traits), in order to meet survival and reproduction needs. It is known as the ecological trade-off strategy of plants.

The Eocene is recognized as one of the warmest part of the Cenozoic, while the Eocene climate of East Asia, especially the central China, is complex due to the influence of many factors such as atmospheric circulation, geomorphic patterns, and tectonic events. In recent years, a new flora is discovered from the Lower Eocene of Lingbao, Henan Province in central China, which is expected for providing new clues to the Eocene climate restoration of the controversial zones in central China.

Based on the leaf morphometric analysis and integrated plant records, the results demonstrate that under the warm and humid temperate monsoon climate, the Early Eocene flora of Lingbao, central China was dominated by "fast-return" species, but there were also a considerable proportion of "slow-return" species. These ecological strategies may have contributed to the rapid return of the flora, while at the same time improving its ability to cope with extreme conditions. The favorable hydrothermal conditions and optimized vegetation ecological trade-offs in the Early Eocene of central China were important conditions for the rapid north-south migration and dispersal of plants, as well as for the eventual formation and diversification of the modern distribution pattern of the East Asian flora.

O-103 - Latitudinal vegetation changes in the Japanese islands during the mid-Pliocene warm period

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The mid-Pliocene is the warm episode that is considered a potential model for future climate change under anthropogenic warming. It is also an important time for the formation of the Ryukyu Islands, a continental archipelago between Japan and Taiwan, due to the rifting of the Okinawa Trough, which partially served as a biogeographic corridor between the Eurasian continent and the Japanese islands, leading to the formation of modern native forests in both regions. Recently, we discovered a mid-Pliocene (ca. 3.5 Ma) macrofossil site on Aguni-jima Island in the central Ryukyus (E127.21°, N12.58°) and realized that the flora represents the first subtropical forest vegetation, with some endemic species in Ryukyus, such as *Cinnamomum doederleinii* and *Quercus miyagii*, mixed with those typical of the Eurasian continent or Taiwan: *Cunninghamia*, *Liquidambar*, and so on. In order to understand the climatic conditions during the Mid-Pliocene Warm Period (mPWP: 3.6–3.0 Ma) and their impact on the formation of the modern forest vegetation, we quantitatively analyzed the Aguni flora and three contemporaneous assemblages distributed over a latitudinal range of about 2,000 km using a CLAMP technique: Shigehira (N31.70°), Kabutoiwa (N36.20°), and Sanzugawa (N38.94°) floras. The results show more or less similar temperature and precipitation conditions to the modern climate in Aguni-jima and two fossil sites in Honshu (Kabutoiwa and Sanzugawa), while Shigehira in Kyushu indicates a slightly warmer condition than the present. The Shigehira flora contains some species in common with the Aguni flora, such as *Q. miyagii*, which no longer exists in Kyushu. These warm elements may have expanded their distribution during this warm episode. The mPWP did not have a major impact on the climate pattern of the Japanese islands; however, the area of subtropical conditions may have expanded at that time, leading to the intrusion of warm elements toward northern areas.

28/05/2024, 18:20–19:00, Room: Aquarius
C06 Early Cretaceous and Jurassic floras of Asia

O-105 - Middle Jurassic Flora from the East Gobi Desert (Mongolia). Preliminary results on systematics and palaeoecology

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The Middle Jurassic terrestrial deposits of the East Gobi Basin are mined for coal and explored for potential hydrocarbons. Due to their economic significance, these deposits are of interest and in the focus of comprehensive biostratigraphic investigation. The Khamarkhoovor Formation, a key geological unit within this context is traditionally considered Lower- Middle Jurassic in age. The studied material comes from the middle coal-bearing sequence of the Khamarkhoovor Formation, which is Middle Jurassic in age.

The studied fossil plants come from seven wells and the open cast quarry Dovtsogkhudag, all in the Mandah Area, Mongolia. Thirty-five specimens come from wells; fifty-three specimens come from the quarry. Over 100 floral remains, including leaves, roots and reproductive structures were examined. Systematically, the analysed flora comprises the following plant groups: liverworts, horsetails (*Equisetites lateralis*), ferns (*Coniopteris heminophylloides, C. burejensis*), cycadophytes (*Doratophyllum* sp.), ginkgoaleans (*Ginkgo* sp.), czekanowskiales (*Czekanowskia baikalica, Phenicopsis angustifolia)*, and conifers *Podozamites* sp.). This study lays an emphasis on understanding the palaeoecology of plants by incorporating sedimentological data.

The studied fossiliferous strata were compared to potentially coeval terrestrial strata from Mongolia and adjacent countries. Based on plant phytostratigraphy, we propose an Aalenian age for the studied strata. The observed sedimentology structures and occurrence of coal argue for a humid climate and low drainage, resulting in a fluvial-swamp environment. Notably, frequent leaf finds attached to brachyblasts (such as *Czekanowskia* and *Phoenicopsis*) suggest seasonality or temperature fluctuations. Additionally, a moderately high occurrence of cycadophytes, in comparison to more northern basins, and a number of characters of cuticle, like its thickness, occurrences of stomata and papillae argue for a warm temperate climate in the studied region. Nevertheless, the flora includes diverse boreal elements (*Coniopteris*ferns, czekanowskiales etc.) and lacks thermophilous elements like *Dictyophyllum* or *Clathropteris* demonstrate that the studied area related to Siberian palaeofloristic region (or its southmost margin).

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O-106 - Fossil woods from the Early Cretaceous Huolinhe Formation of northeastern China

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Silicification represents a type of plant fossils in which internal cells and tissue systems are all exceptionally well preserved in the chert. It provides an opportunity for understanding anatomical details of reproductive and vegetative structures of extinct ancient plants. The silicified peat recently discovered from the Early Cretaceous Huolinhe Formation at the Zhahanaoer open-cast coal mine in Jaurd Banner, eastern Inner Mongolia, northeastern China yields exceptionally well preserved and diverse plant fossils, among which silicified woods are especially abundant. Most of our fossil woods from the Zhahanaoer locality have distinct growth rings and exceptionally well preserved pith. So far six types of fossil woods have been recognized and five of them are conifers including *Protopodocarpoxylon* and *Cupressinoxylon*. The secondary xylem of our samples preserves extensive evidence of fungal attack including hyphae, fungal reproductive structures and fungal damage. There are also diverse perforations in the secondary xylem resulted from activities of arthropods. The excavate galleries are either empty or contain frass. The nurse logs were also found in the fossil woods. These records of fungal and arthropods activities provide new insights into the ecological relationships in the conifer dominant Early Cretaceous peat swamp forest in northeastern China.

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C06 Early Cretaceous and Jurassic floras of Asia

O-107 - A new silicified peat from the Early Cretaceous of northeastern China

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The recent discovery of an Early Cretaceous silicified peat at the Zhahanaoer open-cast coal mine in Jaurd Banner, eastern Inner Mongolia, northeastern China, provides new insights into the structures and relationships of diverse range of extinct Mesozoic plants. The chert occurs toward the bottom of the 'lower coal-bearing member' of the Huolinhe Formation above a thin layer of ash that may have been the source of the silica responsible for the silicification of the plants. U-Pb zircon dating using SIMS method constrains the age of the ash layer to 125.6 ± 1.0 Ma, corresponding to a middle Barremian age. This age assignment is consistent with analysis of the palynological assemblage associated with the chert. The silicified fossil assemblage from the Zhahanaoer locality includes diverse fungi and a variety of land plants including vegetative axes and leaves of lycopsids and rachides of osmundaceous and gleicheniaceous ferns. Remains of seed plants include simple narrow multi-veined leaves that are probably attributable to *Pseudotorellia*, seed-bearing structures of doyleoid corystosperms, and seeds of possible gnetalean and cycadalean affinity. Also present are distinctive short shoots and several different kinds of gymnosperm woods. Conifers are important in the flora and are represented by woods, leaves, seed cones and isolated seeds of cupressaceous and pinaceous conifers. Remains of angiosperms have not so far been encountered in the silicified peat. The Zhahanaoer fossil assemblage is distinctive from coeval floras in southern China, which are dominated by *Cladophlebis*, Bennettitales and cheirolepidiaceous conifers. However, it is generally similar in floristic composition to other Early Cretaceous floras from northeastern China that are based on compression fossils.

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C06 Early Cretaceous and Jurassic floras of Asia

O-108–3D-preserved fossil plants, including angiosperm, from the Lower Cretaceous Miyako Group – Potential for innovative research using a large synchrotron radiation facility

Hideo Takimoto[1], *Tamiko Ohana*[2], *Hisayasu Nakajima*[3], *Takafumi Mochizuki*[4], *Julien Legrand*[5], *Kentaro Uesugi*[6], *Masato Hoshino*[6], *Taichi Kato*[1], *Kosuke Yoshikawa*[1]

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This study first reports on plant megafossils from the Lower Cretaceous Miyako Group. About 140 plant fossils were provided by a local fossil collector for our study. They were obtained at Tanohata Village, Iwate Prefecture, Northeast Japan, during road construction along the coast over 30 years ago. We found out last summer that they came from the calcareous nodules in the lower part of the Aketo Formation, Miyako Group, estimated to be Aptian–Albian in age from its ammonoid content.

Fossil plants consist of impression leaves and compression cones or other parts. The impression leaf fossils are represented by *Matonidium, Acrostycopteris, Cladophlebis, Sagenopteris, Ptilophllum, Nilssonia, Brachyphyllum, Cupressinocladus,* and others. Most of them are characteristic elements of the Ryoseki type Flora, which flourished in East Asia from the Late Jurassic to Early Cretaceous.

Most of studies on compression plant fossils in Japan were made on specimens prepared using the peel method, as satisfying CT images could not be obtained. However, present fossils are 3D-preserved and have densities different than the base rocks; recent

improvements in the performance of CT equipment also made it possible to obtain high-resolution images. Recently, we tried to use a high energy synchrotron radiation X-ray microtomography at SPring-8 BL28B2 in Japan. The X-ray energy is enough high (200 keV) to see the internal structures of several centimeters-sized rock. Furthermore, the X-rays are highly coherent enough to capture small differences of linear absorption coefficients in rocks, which is ideal for observing fossil specimens. The results of this study are expected to provide essential insights into the study of plant evolution during the critical period of angiosperm.

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C06 Early Cretaceous and Jurassic floras of Asia

O-109 - Early Cretaceous palynofloras from the Dadianzi Formation in the Luanping Basin, northern Hebei Province, China, and their paleoenvironmental significances

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The Dadianzi Formation of the Hebei Province, a key stratum yields world-renowned Jehol Biota, is of great value in studying Cretaceous stratigraphic division and correlation as well as evolutionary phases of the Jehol Biota. Nevertheless, the geological age of the formation is still controversy. The earliest Cretaceous age of which determined by previously preliminary palynostratigraphic research is obviously older than radiometric and paleomagnetic ages obtained recently. In addition, the related regional vegetation and climate are unrevealed during the sedimentary period of the Dadianzi Formation. Our new materials, collected from the First Member of the Dadianzi Formation of the Xiaying section in Luanping county of northern Hebei, recognize a late Valanginian (Early Cretaceous) Bisaccate assemblage and a *Aequitriradites-Hekousporites* assemblage of early Hauterivian age for the first time. The vegetation represented by the former is mainly consist of cool-adapted and mesophytic conifers, which is replaced by warm- and wet-adapted ferns and bryophytes during the sedimentary period of the latter. The vegetation shift suggests an increase in both temperature and humidity, and a corresponding change in climate from semi-humid to semi-arid and cool during the late Valanginian to generally semi-humid and warm to hot with occasionally climatic fluctuation during early Hauterivian, which most likely causes by the end of the global cooling Weissert Event. This paleoclimate change, favored by previous research on terrestrial weathering of the Dadianzi Formation, shows accordance with the shift in the Jehol Biota to a developed phase.

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C06 Early Cretaceous and Jurassic floras of Asia

O-110 - Diversity of Taxaceae in Northeastern China during Middle-Late Jurassic

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Taxaceae (the yew family) are a small family of conifers comprising about 25 extant species in five genera, including *Taxus*, *Amentotaxus*, *Torreya*, *Pseudotaxus*, and *Austrotaxus*.Their axillary ovulate structures are characterized by bearing a single terminal seed with a fleshy aril, which makes the family very different from other extant conifers. Taxaceae have a long fossil history with the earliest occurrences from the earliest Jurassic (Hettangian, 201–197 Ma) of southern Sweden. Recently, we discovered well-preserved, diverse Taxaceae fossils from the Middle– Late Jurassic Daohugou Biota (~165–158 Ma) in eastern Inner Mongolia, northeastern China. These include a least four species that could be assigned to *Amentotaxus*, *Taxus*, *Torreya* and probably an extinct genus different from all extant genera of Taxaceae. Among the new fossils, *Amentotaxus ningchengensis* sp. nov. and *Taxus daohugouensis*

sp. nov. are based on leafy shoots with attached seed-bearing structures, and they resemble those of extant *Amentotaxus* and *Taxus* respectively in vegetative as well as ovulate features. *Torreya daohugouensis* sp. nov. is based on leafy shoots with well-preserved cuticles. It is also comparable to extant *Torreya* in morphology of leaves as well as detailed cuticle structures. The new fossils from the Dahugou Biota show that the yew family had been diverse in Northeastern China since the Middle-Late Jurassic and this pattern of diversification is also seen in early Cretaceous floras of Mongolia. *Amentotaxus*, *Taxus* and probably *Torreya* appeared early in the evolutionary history of the family. The Asian fossils also indicate that *Amentotaxus* and *Taxus* may have undergone little morphological change since the Middle-Late Jurassic.

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C06 Early Cretaceous and Jurassic floras of Asia

O-111 - The Middle Jurassic flora of Central Iran: Palaeofloristic and palaeographical implications

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Iranian Jurassic flora is known as one of the most important flora, in terms of diversity and preservation, in the world. The Shemshak Group bears this rich and astonishing flora in Alborz, central Iran, and Kerman basin ranges from the Late Triassic (Norian) to the Early Middle Jurassic (Early Bajocian). Plant macrofossils from the Middle Jurassic coal-bearing Hojedk Formation in the Tabas (central Iran) are discussed herein. The flora includes 30 taxa (20 genera) belonging to horsetails, ferns (Eusporangiate and Leptosporangiate), caytoniales, cycads, bennettitaleans and conifers. Ferns are the most frequent group in the flora, with 14 species of Marattiaceae, Osmundaceae, Matoniaceae, Dipteridaceae, Schizaeaceae, and Dicksoniaceae. Among the gymnosperms, the Cycadales (ranking second in frequency) are considered by a high species diversity of the genus *Nilssonia* (7 species). The flora of Central Iran located at the southern margin of Eurasia during the Middle Jurassic. European and Mid-Asian flora assemblages (129 genera) were reordered in a wide variety of environments and different palaeogeographic positions, which is reflected in a wide variety of taxa. The comparison between the coeval Middle Jurassic floras reveals different degrees of dissimilarity and similarity between those in these two regions of the Eurosinian Region, in contrast with previous studies dealing with Middle Jurassic floras of the Region. Using the Sørensen–Dice index (IS) a conspicuous similarity between Iran and Afghanistan floras is given, which also confirms the uniformity theory of these two areas during the Middle Jurassic.

Keywords: Middle Jurassic, Central Iran, Eurasia, palaebiogeography, IS

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C06 Early Cretaceous and Jurassic floras of Asia

O-112 - Diversity of Middle to Late Jurassic fossil wood in China and its palaeoclimate implications

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Western Liaoning is a unique region in China that bears diverse types of Jurassic plants, including leaves, fern rhizomes, and wood, providing significant proxy for vegetation and palaeoenvironment reconstruction of the well-known Yanliao Flora in East Asia. In particular, the silicified wood is very abundant in the fossil Lagerstätte of the Jurassic Tiaojishan Formation in Beipiao, western Liaoning. Previous and recent systematic investigations documented a high diversity of the Jurassic wood assemblages. These assemblages are dominated by conifers, followed by cycads and ginkgoaleans. In total, about 30 species belonging to 21 genera of fossil wood have been recorded so far, which are represented by Cycadopsida, Ginkgopsida, Coniferopsida, and Gymnospermae incertae sedis. In this study we calculated CSDM curves of 20 species fossil wood in Tiaojishan Formation. Some of the speices are evergreen trees and some species are deciduous trees, which provide more information of Jurassic palaeoclimate in North China Craton.

29/05/2024, 08:30–09:50, Room: Leo
M04 Fire as an ecological and evolutional driver

O-113 - What burned where and when in the Carboniferous coal swamps? Tales from a 300-Myr-old, 23-Myr-long fossil record

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The Carboniferous (359–299 Myr ago) was a time when the presence of vast amounts of standing plant biomass was still relatively new to our planet and rapidly expanding. Major plant groups developed tree habits and built up terrestrial fuel supplies. Simultaneously, the atmosphere is thought to have been hyperoxic. Consequently, it seems plausible that during such times wildfire grew into a major ecological and evolutionary force. Thus, with heightened selective pressures, Carboniferous wildfire records may hold clues about the evolution of emerging fire adaptations, be it *de novo*, or via co-optation of exaptations. An exceptional opportunity to investigate this was found in a recently (re-)digitized dataset, the Phillips Coal Ball Collection, in which tissues of the plants that made up the iconic coal swamp forests have been permineralized and preserved at a cellular level. Many hundreds of thousands of tissue subsamples have been identified, both taxonomically and as to what plant organ they represent. Additionally, it has been noted whether or not the tissues were charcoalified. Here we explore if we can extract information on fire ecology and fire adaptations from data which have been strongly filtered by other ecological and taphonomic factors that acted during peat formation.

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M04 Fire as an ecological and evolutional driver

O-114 - Carboniferous wildfire revisited: Wildfire, post-fire erosion and deposition in a Mississippian crater lake

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Fires have been shown to have been common in many Carboniferous ecosystems worldwide yet we still have little understanding of the detail of what, where and how such fires occur or indeed their effects both on the local ecosystem as well as on the Earth System as a whole. The Kingswood limestone, of late Viséan (Mississipian age) found near Pettycur in Fife, Scotland, is interpreted as being deposited within a crater lake. The limestone contains a range of volcanic clasts together with charcoalified and uncharred plants. Two distinctive communities existed. One dominated by the herbaceous lycopsid *Oxroadia* that is permineralized and one dominated by a range of pteridosperms and other gymnosperms preserved as charcoal. Fires surrounding a crater lake charred the plants that were then washed into the lake by post-fire erosion. All plant organs are found as charcoal including woody axes, leaves, pollen organs and ovules. *Oxroadia* that was living close to the lake was not affected by fire. Rising lake and sea levels allowed saline water to be introduced to the lake and connection to the sea was established. Many new charcoalified plants have still to be formally described.

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M04 Fire as an ecological and evolutional driver

O-115 - Fossil charcoal from the Upper Triassic of western Junggar Basin, Xinjiang, and its palaeoecological significance

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Charcoal is a primary product of wildfires. Fossil charcoal has been found from a variety of sedimentary rocks deposited in terrestrial or marine environments and has been considered as direct evidence of palaeo-wildfire that had occurred in the geological history. Here we report abundant macro- and meso-fossil charcoals that were discovered from the Upper Triassic of Shendigou section, northwestern Junggar Basin, Xinjiang Uygur Autonomous Region, China. Based on sedimentary and lithological analyses, charcoal remains are preserved in alluvial fan facies. They are attributed to three types of coniferous woods based on radial tracheidal pitting, cross-field pitting, and rays. All three types are characterized by the dominantly uniseriate abietinean radial tracheidal pitting and parenchymatous and uniseriate rays. The first type of fossil charcoal of the current study has window-like cross-field pitting, with one to two simple, large, and oval pits in each field. The pit occupies nearly the entire cross-field. It is comparable with the species of *Phyllocladoxylon* Gothan. The second type is comparable with the species of *Cupressinoxylon* Göppert, which is featured by the occurrence of one to two cupressoid pits in each cross-field. The third type is typified by the taxodioid cross-field pitting. There are two to five pits in each field. It is similar to the species of *Podocarpoxylon* Gothan. The new-finding fossil charcoals with anatomical features demonstrate that conifers were important elements of Late Triassic terrestrial communities in Junggar Basin and had a higher diversity in northern China than previously thought. It proves that wildfires were an integral part of the Late Triassic ecosystems in the mid-latitudes of northeastern Pangaea. Atmospheric oxygen concentration during that time would have been above 18.5%.

Keywords: Fossil charcoal; wildfires; Upper Triassic; Wood; Palaeoecology

29/05/2024, 08:30–09:50, Room: Leo
M04 Fire as an ecological and evolutional driver

O-116 - Late Triassic and Early Jurassic wildfires confirmed by the presence of charcoals and polycyclic aromatic compounds (PACs)

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Some Late Triassic and Early Jurassic localities in Poland show evidence of fire events, mainly by the occurrence of charcoals that originated from burnt wood, leafy shoots and fern crosiers. The study regards three localities from Poland: Poręba and Zawiercie (Upper Silesia, Norian) and Sołtyków (Holy Cross Mts., Hettangian). Poręba and Zawiercie are outcrops with conifers, mainly *Brachyphyllum* shoots and trunks. From Zawiercie equisetaleans and brachyphyllous conifers were found as macroremains. Sołtyków is known from its diverse flora dominated by *Hirmeriella* and a fern assemblage including tree ferns and more frequent herbaceous ferns. Some seed ferns, cycadophtyes and ginkgophytes also occur. All localities represent terrestrial riverside areas with moderately diverse topography typical of such areas.

The structure of charcoal from Poręba and Zawiercie was investigated. In microscopic view, the cell walls are homogeneous and without cracks, indicating relatively high fire temperatures (above 300 °C). To verify this, fusinite reflectance of charcoal samples from Zawiercie (8 samples) and Poręba (15 samples) was measured in reflected light and immersion oil with an Axio Imager A2m microscope. The results indicate average temperatures ranging from 325 to 790 °C, with higher temperatures recorded for the Poręba samples. The measured temperatures correspond to surface fires (lower temperature), occasionally extending to crown fires (higher temperature; three charcoal samples). PACs characteristic for pyrolytic processes, including anthracene, 4H-cycopenta[*def*]phenanthrene, benz[*a*]anthracene, benzo[*b*]naphthofurans and benzo[*a*]pyrene were found in all samples. However, the distribution of PACs differs in low- and high-temperature samples. Based on measurements of fusinites from the source rock and herbaceous fern fragments from the Sołtyków, the wildfires were lower-temperature, not exceeding 420 °C. The differences in wildfire temperatures confirm the diverse stratigraphic position of the charcoals from different localities and/or may be explained by various ecological conditions.

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29/05/2024, 08:30–09:50, Room: Nadir
T02 Cenozoic continental climate and vegetation patterns on both sides of the North Pacific-an open NECLIME symposium

O-117 - Leaf trait data of two Miocene floras from eastern China and its palaeoclimate implications

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The study of Neogene palaeoclimate enhances our understanding of effects and consequences of current climate changes. However, numerous aspects and details concering Miocene climate development remain unclear. Fossil leaves serve as a valuable and rich source of palaeoclimate proxy data. Two Miocene floras from eastern China, the Toupi flora (17–14 Ma) and the Shengxian flora (~10.5 Ma), were studied in terms of palaeoclimate and leaf economics. Leaf mass per area (LM_A) is a fundamental leaf trait closely associated with leaf lifespan and could be calculated from the fossil leaves. LM_A data indicated evergreen vegetation at both the Toupi and the Shengxian floras, consistent with the fossil vegetation and previous palaeoclimate estimates. Regarding palaeoclimate, CLAMP results suggest a warm and humid climate with MAT values ranging between 13 and 17 °C in both the Toupi and Shengxian regions during the Miocene. Furthermore, the Shengxian flora exhibited lower temperatures in the cool season. This

observation may indicate heightened temperature seasonality due to a slight climate cooling and the intensification of the East Asian monsoon from the middle to late Miocene.

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29/05/2024, 08:30–09:50, Room: Nadir
T02 Cenozoic continental climate and vegetation patterns on both sides of the North Pacific-an open NECLIME symposium

O-118 - Evaluating the Paleogene successions of Garo Hills, Meghalaya, India – An Integrated palynology and geochemistry study

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This study includes the reconstruction of palaeoecological history based palynology and geochemical studies. Palynofossils taken from outcrops samples will allow us to identify the different environmental elements. The samples recovered a mixed kerogen types including pollen, spores and algae of both terrestrial and marine origin. The recovered palynofacies are indicative of terrestrial environment conditions and is further supported by the presence of *Hammenisporis* spp. which suggests the tropical and subtropical climate conditions during the Tura sedimentation. The Siju marls mainly consists of amorphous organic matter, black debris/charcoal, spore/pollen grains, dinoflagellate cysts and foraminiferal linings and restricted to tropical and subtropical, warm humid climate condition under a shallow coastal sea. The late Palaeogene of the Rewak Formation contains terrestrial organic matter with spores/pollen grains that indicates terrestrial deposition. Carbon isotopes ($\delta^{13}C$) values of Tura shales range from -23.62 to -31.15‰, Siju ranges from -3.45 to -25.49 ‰, and the Rewak ranges from -24.453 to -26.33‰. The Tura and Rewak shales belong to terrestrial C3 plants and suggest arid environment. The Siju marls are composed of C4 plants and indicative higher aridity and or a dramatic decrease in atmospheric CO_2 level. Biomarker signature of selected sample suggests suboxic to oxic and suboxic depositional environment respectively. Rock-Eval data of Tura and Rewak samples indicate immature, type III kerogen. Kerogen types III, immature and poor are indicative of the Siju Formation. Geochemical data (Ba/Sc, Ba/Co, Th/Sc, Th/Co, Th/Cr, Cr/Th, Cr/Zr, Th/U, U/Th, V/Cr and Ni/Co) shows felsic source rock in comparison with PAAS and UCC ranges.

29/05/2024, 08:30–09:50, Room: Nadir
T02 Cenozoic continental climate and vegetation patterns on both sides of the North Pacific-an open NECLIME symposium

O-119 - Plant community and climatic response to Miocene climatic changes in the U.S. Pacific Northwest within a refined chronological framework

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The US Pacific Northwest (PNW), including the states of Washington, Oregon, and Idaho, hosts a suite of well-preserved Oligocene–Miocene fossil plant sites representing temperate forests with notable floristic similarity to modern eastern Asia and North America. Importantly, these sites span Earth's most recent period of sustained global warmth, the Miocene Climatic Optimum (MCO; ca. 17–14 Ma), and the Middle Miocene Climatic Transition (MMCT; ca. 14–12 Ma), which is generally associated with global cooling, decreases in climate equability, and increased aridity. An understanding of how these global events manifested

in PNW terrestrial climates and ecosystems is currently limited by conflicting evidence from varying fossil plant types, a reliance on outdated methods, and a lack of precise age control in prior work. Here we address these limitations by integrating new and historic macrofossil, palynomorph, and phytolith records in a multi-proxy approach to reconstruct plant community ecology and climate across 14 PNW fossil sites spanning the MCO and MMCT. A chronological framework was first established with U-Pb of zircons using CA-ID-TIMS, resulting in highly precise dates (± 10^3–10^4 years) that revise those previously constrained by K-Ar and plant biostratigraphy. Within this framework, we will present preliminary results for patterns in vegetation structure, the composition and diversity of floras in terms of function and (para)taxonomy, and paleoclimate reconstructions using leaf physiognomy and nearest living relative based proxies. Taken together, this study adds to a growing collection of evidence disclosing the complexity of regional responses to global climatic change, with important implications for anthropogenic climate change.

29/05/2024, 08:30–09:50, Room: Taurus
H02 Forward to the past-research development on quantifying land cover change and its implication for the biosphere

O-120 - Data-model biome comparisons over the last 21,000 years

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With a standard biomization approach we translated pollen data from LegacyPollen 2.0 – a global taxonomically and temporally standardized fossil pollen dataset of 3728 palynological records – into biomes for 43 time-slices throughout the last 21,000 years with a temporal resolution of 500 years. These biomes have been adapted to the categories used to biomized Earth System Model results so that reconstructed biome estimates can be directly compared to simulations. The accuracy of the new global biomization scheme was determined to be 80.1% by comparing the reconstructed biome distribution with the modern potential natural vegetation pattern derived from observations. Then, the distributions of pollen-based biomes were compared against an ensemble of model simulations for the last deglaciation using the Earth mover's distance. The overall global biome trend in the reconstruction is in line with the simulations, even if differences are visible at the continental scale. We are now able to identify regions and times with the greatest disparity between Earth System models and reconstructions, and to discuss better possible reasons for model-data mismatches based on regional characteristics.

29/05/2024, 08:30–09:50, Room: Taurus
H02 Forward to the past-research development on quantifying land cover change and its implication for the biosphere

O-121 - Testing REVEALS-based vegetation reconstruction with absolute pollen productivity estimates around Lake Biwa, western Japan

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Lake Biwa pollen records and the REVEALS model provide a new insight into the dynamic shifts in the past Japanese vegetation. Instead of relying solely on pollen percentages we employed the REVEALS model with absolute pollen productivity estimates (aPPEs) derived from flower counting approaches (Hayashi et al. 2022). This methodology, coupled with a Lagrangian stochastic dispersal model (LSM), yielded results dramatically closer to the modern vegetation survey data within 100 km of the lake. For instance *Cryptomeria* pollen over-represents the true landscape composition greatly (63.8% pollen vs. 17.5% tree cover); however, the REVEALS-LSM estimate landed at a much more accurate 24.7%, mirroring the vegetation data far more faithfully. Importantly the Gaussian Plume model within REVEALS proved ineffective for the Lake Biwa pollen record, particularly for plants that produce heavy pollen, such as *Abies*. Unlike relative pollen productivity estimates obtained and applied in Europe, China and elsewhere,

flower-counting-derived aPPEs combined with the LSM appear optimal for REVEALS-based reconstruction in Japan. This opens exciting avenues for exploring forest dynamics and human impacts throughout the 20th century and the Holocene in Japan and potentially beyond.

29/05/2024, 08:30–09:50, Room: Taurus
H02 Forward to the past-research development on quantifying land cover change and its implication for the biosphere

O-122 - Quantitative reconstruction of the vegetation of western coast of Bohai Sea, North China, during late Holocene

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Coastal wetlands, as a transitional ecosystem between land and sea, are sensitive to changes in climate and sea level; hence, it is important for reconstructing past climate and sea-level changes and for predicting future changes. In this study,we used pollen analysis and the Landscape Reconstruction Algorithm (LRA) based on relative pollen productivity, combined with AMS ^{14}C dating, to quantitatively reconstruct the vegetation response to climate and sea level change on the western coast of Bohai Sea. The main conclusions are as follows: (1) The coverage of the main plant taxa reconstructed using estimates of relative pollen productivity was closer to the actual vegetation conditions than that based on pollen percentages. (2) The study area was occupied by temperate deciduous broadleaved forest, dominated by *Quercus*, with a smaller proportion of *Pinus* forest. The regional vegetation types did not change significantly, but the forest cover decreased gradually from ~60% in the Middle Warm Period (MWP, 1250–1310 A.D.) to ~40% in the LIA (1310–1610 A.D.), due to the combined influences of climate and human activities. (3) The composition of herbaceous plants changed substantially during the LIA. In the early LIA (1310–1450 A.D.), the climate became cold and dry and the sea level began to fall, resulting in a substantial increase in the proportion of Poaceae (~10%). In the middle of the LIA (1450–1610 A.D.), the climate became colder and drier, the sea level fell further, and the lagoon shrank. In response, there was an increase in drought and salt-tolerant Chenopodiaceae (~10%) and *Artemisia* (~5%), a substantial increase in *Selaginella sinensis* supplied by fluvial processes.

29/05/2024, 08:30–09:50, Room: Taurus
H02 Forward to the past-research development on quantifying land cover change and its implication for the biosphere

O-123 - Holocene radiative forcing from land cover change in North America: Patterns and processes

Andria Dawson[1], *John W. Williams*[2], *Marie-José Gaillard*[3], *Simon Goring*[2], *Behnaz Pirzamanbein*[4], *Johan Lindstrom*[5], *R. Scott Anderson*[6], *Andrea Brunelle*[7], *David Foster*[8], *Konrad Gajewski*[9], *Daniel G. Gavin*[10], *Terri Lacourse*[11], *Thomas A Minckley*[12], *Wyatt Oswald*[13], *Bryan Shuman*[12], *Cathy Whitlock*[14]

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Land cover governs biogeophysical and biogeochemical feedbacks between the land surface and atmosphere. Holocene vegetation-atmosphere interactions are of particular interest, both to understand the climate effects of intensifying human land use

and as a possible explanation for the Holocene Conundrum, a widely studied mismatch between simulated and reconstructed temperatures. Progress addressing the Conundrum has been limited by a lack of data-constrained, quantified, and consistent reconstructions of Holocene land cover change. Following protocols from PAGES LandCover6k, a network of 1445 sedimentary pollen records from the Neotoma Paleoecology Database, and the REVEALS pollen-vegetation model coupled with a Bayesian spatial model, we developed land cover reconstructions with uncertainty for North America for 25 time intervals spanning the Holocene. We use these spatially comprehensive land cover maps to determine the pattern and magnitude of land cover changes at continental to regional scales and discuss underlying ecological, climatic, and anthropogenic drivers. Finally, we infer Holocene radiative forcing from these land cover shifts.

Land cover trends vary within and across regions due to individualistic taxon-level responses to environmental change. Major species-level events, such as the mid-Holocene decline of eastern hemlock, may have altered regional climates. The substantial land-cover changes reconstructed here underscore the importance of biogeophysical vegetation feedbacks to Holocene climate dynamics. Continental-scale radiative forcing inferred from land cover change indicates early and late pre-industrial Holocene warming interrupted by a mid-Holocene period of cooling and followed by cooling in the recent millenia. These forcings from natural vegetation change are of the same order of magnitude as global forcings resulting from changes in atmospheric greenhouse gas concentrations from 1750 to 2019.

29/05/2024, 08:30–10:30, Room: Virgo
Z05 Plant insect interaction and their co-evolution during deep time

O-124 - Response of plant-arthropod interactions through the Permian Shihhotse formations (Shansi Province, N China)

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Plants and arthropods (mainly insects) represent two major groups of organisms in terrestrial ecosystems. In recent years, the biological history of plant-insect relationships has gained interest; however, evidence of these interactions in complete floras is scarce, especially during the Permian. This communication shows the preliminary results on plant-insect interactions from the Lower Shihhotse and Upper Shihhotse formations of Shanxi Province (N China).

The Permian floras from Shanxi are some of the best sampled Permian floras in the world, offering a continuous stratigraphic plant succession from the Asselian to the Kungurian (sensu Shen et al., 2022) or even to the Wuchiapingian (e.g., Ma et al., 2011; Yang et al., 2020). During this time interval, deep climatic and environmental changes took place, including several cooling and warming events. In this context, changes in assemblages containing plant-insect interactions during this period should improve understanding of the ecological responses to these climatic and environmental changes.

Results show the presence of all FFGs in this flora, except for Mining, and a high diversity of Damage Types. One of the more relevant FFGs from this flora was Seed Predation, represented by several early endophytic examples of oviposition in different fossil seeds, including at least four damage (morpho)types of this FFG in *Cornucarpus*, *Samaropsis*, *Rhabdocarpus*, *Cordaicarpus*, *Trigonocarpus,* and *Acanthocarpus*. The most common interactions were Margin Feeding and Hole Feeding, followed by Galling and Oviposition. Several examples of Piercing and Sucking, Pathogenic damage, and Surface Feeding were also found in the Shansi Flora. This abundance and diversity of FFGs and DTs on various host plants evidence a well-established web of plant-arthropod interactions in the Permian of China along with a diverse entomofauna that found egg repositories and food in the Permian plant communities dominated by pteridophytes, pteridosperms, and other gymnosperms in the region.

29/05/2024, 08:30–10:30, Room: Virgo
Z05 Plant insect interaction and their co-evolution during deep time

O-127 - Early to Middle Triassic plant-arthropod interactions in Gondwana: Evidence of absence, or absence of evidence?

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Plants and arthropods are primary drivers of terrestrial ecosystem function. In the absence of a rich arthropod body fossil record, trace fossils of plant-arthropod interactions (PAIs) are a key method for assessing terrestrial ecosystem health through geological time and evaluating changes in herbivorous arthropod feeding guilds in the wake of global biotic crises. The end-Permian event (EPE; c. 252 Ma) was the most severe ecological crisis of the Phanerozoic. On land, this event resulted in the loss of keystone plant species from humid tropical and high-latitude ecosystems and the extinction of several major insect groups. The subsequent Early to Middle Triassic evinced diminished terrestrial productivity, punctuated by a series of second order biotic crises that hindered recovery. We reviewed records of Gondwanan lower Mesozoic leaf fossil assemblages for reports of PAIs as an indication of ecosystem recovery following the EPE. We compiled a dataset of leaf taxa and PAIs, noting a gradual increase in floral diversity throughout the Early to Middle Triassic. We identified a lack of PAIs reported from many localities with abundant fossil leaves, which may have been partly a consequence of a post-EPE delay in the recovery of arthropod feeding guilds compared to the flora. However, our results also partly attribute the absence of PAIs to the relative paucity of palaeobotanical and palaeoichnological studies for this interval in Gondwana. We also present a novel leaf damage investigation of a well-described Australian flora that demonstrates the underreporting of PAIs in the Triassic. To this end, our review highlights several Lower and Middle Triassic Gondwanan fossil-rich successions that require further investigation. We predict that even modest advancements in these areas will greatly elucidate the relationships between rapidly changing environments during the Early and Middle Triassic and their effects on the plant and arthropod communities in the Southern Hemisphere.

29/05/2024, 08:30–10:30, Room: Virgo
Z05 Plant insect interaction and their co-evolution during deep time

O-128 - Towards an improved understanding of palaeoecological signals in two Middle Miocene plant assemblages from the South German Molasse Basin

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Numerous sand and gravel pits provide insight into the Middle Miocene vegetation history of the Upper Freshwater Molasse, which was deposited by dynamic Braided River systems. Two almost contemporaneous floras from the end of the Middle Miocene Climatic Optimum (MMCO) reveal different site conditions with regard to groundwater availability, which may also be due to climatic fluctuations. Accordingly, both are characterized by different alluvial forest communities. In Unterwohlbach, *Populus balsamoides* and *Daphnogene polymorpha* dominate, with *Ulmus pyramidalis, Platanus leucophylla* and *Ginkgo* to a lesser extent. Entrischenbrunn, on the other hand, is characterised by *Populus mutabilis*, which is apparently adapted to drier and more open conditions, and the distinctly narrow-leaved sunleaves of *D. polymorpha*. Other characteristic elements are reminiscent of the somewhat older Randeck Maar site in the Swabian Alb, which is characterised by seasonal dryness, such as *Berchemia parvifolia, Quercus drymeja* and small-leaved elms. However, large-leaved specimens of *P. leucophylla* and *P. balsamoides*, which were concentrated in a certain layer, prove the simultaneous presence of adjacent wet sites. The question of the intensity of hygric seasonality in the alluvial forests of the Molasse is therefore not only difficult due to the influence of groundwater, which possibly overlaps the quantities of water supplied by local precipitation. There may also have been a mixing of signals due to plant remains from different locations. The studies that have just begun on the interaction of plants with their environment – via insect tracks and pathogen infestation on leaves – will hopefully allow further conclusions to be drawn about the respective ecological conditions, e.g. degree of moisture. A statistical evaluation is still pending, but some observations and in part previously unrecorded phenomena can already be presented here, which may serve to expand the knowledge about damage typification.

29/05/2024, 08:30–10:30, Room: Virgo
Z05 Plant insect interaction and their co-evolution during deep time

O-129 - Herbivory provides insights into the evolution of nyctinasty

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Plants move in diverse ways in response to external stimuli. These mechanisms include responses to environmental stimuli, such as tropic responses to light or gravity and nastic responses to humidity or contact. Nyctinasty, the movements involving circadian rhythmic folding at night and opening at daytime of plant leaves or leaflets, has intrigued scientists and the public for centuries. Charles Darwin published pioneering work on the diverse range of movements in plants in his book entitled 'The Power of Movement in Plants'. His systematic examination of plants showing 'sleep [folding] movements of leaves', led him to conclude that the legume family (Fabaceae) includes many more nyctinastic species than all other families combined. Darwin also found that a specialized motor organ, the pulvinus, is responsible for most sleep movements of plant leaves. However, the origin, evolutionary history, and functional benefits of foliar sleep movements remain ambiguous owing to the lack of fossil evidence for this process. Here, we document the first fossil evidence of foliar nyctinasty based on a distinctive symmetrical style of insect feeding damage (*Folifenestra symmetrica*) in gigantopterid seed-plant leaves from the upper Permian (~259–252 Ma) of China. The pattern of insect damage indicates that the host leaves were attacked when mature but folded. Our finding reveals that foliar nyctinasty extends back to the late Paleozoic and evolved independently among various plant lineages. Surveys of published angiosperm fossils suggest that several other extinct plants, especially legumes, adopted foliar nyctinasty well before the Neogene. We highlight insect damage as potentially useful for detecting a range of other plant behaviours and mutualistic strategies that are otherwise difficult to detect in the fossil record.

29/05/2024, 08:30–09:10, Room: Zenit
M02 Recent advances in modern dinoflagellate cysts

O-130 - Modern distribution of Dinoflagellate cysts from the Northern Bering Sea in relation to hydrographic conditions and primary productivity

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Dinoflagellate cysts were analyzed from 26 surface sediment samples in the northern Bering Sea. This area is one of the most biologically productive marine ecosystems in the world with a range of oceanographic conditions. Known ocean environmental gradients such as sea-surface temperature and salinity, duration of the sea-ice cover and primary productivity, along with the measured sedimentary geochemical proxies were used to examine the influence of upper water masses on the cyst assemblages. All samples were collected with a Van Veen grab during the 2019 Distributed Biological Observatory-Northern Chukchi Integrated Survey cruise and processed using a standardized palynological preparation technique. Total concentrations of the organic-walled dinoflagellate cysts vary spatially and range from 726 to 11,673 cysts g^{-1}, with an average of 4,535 cysts g^{-1}. The highest cyst concentrations were observed in the area south of St. Lawerence Island that is influenced by the relatively warm, nutrient-rich Alaska Coastal Current and terrestrial runoff. Well-preserved cysts were recovered in all the samples, with a total of 35 taxa. Cysts of autotrophic *Operculodinium centrocarpum* sensu Wall and Dale (1966), and heterotrophic *Islandinium minutum* were the most abundant in the dinoflagellate cyst assemblages. Fragile cysts of harmful algal bloom causing *Alexandrium* spp., mostly *A. catenella*, were found in all samples, with the highest abundances recorded in samples close to the Bering Strait contributing ~22.9 % to the cyst assemblage. Other common dinoflagellate cysts taxa were *Spiniferites* spp., *Spiniferites elongatus* and *Brigantedinium* spp. Multivariate statistical analyses based on the cyst assemblages identified five environmental regions in the study area.

29/05/2024, 08:30–09:10, Room: Zenit
M02 Recent advances in modern dinoflagellate cysts

O-131 - Changes in sea-surface conditions in northwestern Baffin Bay over the last 400 years inferred from organic-walled dinoflagellate cyst assemblages

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The North Water (NOW) polynya is an ecologically important area of recurrent open water surrounded by sea ice in northern Baffin Bay. These open waters form due to ocean currents, strong northerly winds, and ice bridges that consolidate to the north in Nares Strait. However, climate warming causes changes in the formation factors of the NOW, particularly the stability of the Nares Strait ice bridges. Failure of the Nares Strait ice bridges cause more freshwater (solid and liquid) to be exported from the Arctic to lower latitudes, while also impacting the open water conditions in the NOW region along this export route.

The objective of this project is to compare recent changes in the NOW sea-surface conditions with the long-term natural variability of the system. We focus on the western portion of the NOW, located along two freshwater export routes (Nares Strait and Jones Sound) from the Arctic Ocean through northern Baffin Bay. We infer changes in sea-surface conditions using dinoflagellate cysts from two cores collected in northwest Baffin Bay, covering the last ~400 years (AMD19-2.7BC and AMD19-2.5BC). The northernmost core (AMD19-2.5BC) shows an overall decrease in cold water indicators such as *Islandinium minutum* and *Echinidinium karaense* towards the present, complemented by an increase of autotrophic taxa, such as *Operculodinium centrocarpum* and the cyst of *Pentapharsodinium dalei*, indicating a change to fresher and seasonally less persistent sea ice conditions. The southernmost core (AMD19-2.7BC) shows a similar trend with generally higher total dinoflagellate cyst fluxes. Our preliminary data indicate a switch from cold and high sea ice concentrations conditions to fresher and less persistent sea ice in the NOW in the last ca. 60 years, which could be attributed to the recent failures of the Nares Strait ice bridges and subsequent freshwater inflow into the region.

29/05/2024, 09:10–10:30, Room: Zenit
A02 Advances in Devonian Paleobotany

O-132 - Revisiting the Silurian–Devonian plant biostratigraphy: Palaeographical implications

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The currently accepted phytozonation scheme for the Silurian–Devonian time interval, in which eleven interval zones are distinguished, has been revised based on a quantitative analysis of the macrofossil record. Special attention has been paid to the impact of palaeogeography on the recognition of the zones. Data from a recent comprehensive compilation of early plant genera were analysed using a set of multivariate procedures (clustering and ordination methods). To determine global patterns, a first analysis was run considering only well-defined taxa recorded from more than one locality/region. Subsequent analyzes were then run considering different phytogeographical regions (endemic taxa included), such as Laurussia, Siberia, Kazakhstania, NE, NW and S Gondwana. From this, we identified eight interval zones defined by particular stratigraphical levels (biohorizons) where there are identifiable changes in the macrofloras (extinctions and/or appearances) reflecting the dynamics of the original vegetation. These included five major biohorizons (I = Homerian/Gordstian, II = lower/middle Pragian, III = Pragian/Emsian, IV = lower/upper Eifelian and V = Frasnian/Famennian), and two additional ones at the Silurian/Devonian and the Middle/Upper Devonian boundaries. These groupings were supported by a highly significant ANOSIM value ($p < 0.001$). Some of these divisions agree with the previous phytozonations by Banks and Edward et al. Importantly, however, the results show major differences between the phytogeographical units. For instance, while we can see several regional biohorizons in the Emsian, a single interval zone was identified in this stage in Laurussia, suggesting differences in vegetation dynamics and floral composition at the end of the Early Devonian. This is evidence that geographical disparities will strongly impact on the recognition of a global macrofloral biostratigraphy, especially when a high degree of provincialism is detected. Finally, constraints on the use of plant macrofossils for biostratigraphy is also discussed, which is challenging compared with palynological dating schemes.

O-133 - Reconstructing the Devonian Rhynie Chert plants using a new high-resolution imaging technique, MULPIS

Nao Kawagoe[1], *Harufumi Nishida*[1], *Aya Kubota*[1], *Alexander J Hetherington*[2], *Yusuke Takeda*[3], *Oguz Derin Mehmet*[1], *Yasuhiro Iba*[3]

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The 3D image inside the Rhynie Chert is obtained using a new method 'Hyper-resolution **Mul**ti-dimensional **P**etrographic **I**maging **S**ystem (MULPIS)' designed by IY. The MULPIS machine automatically grinds the chert at extremely thin intervals and photographs each surface at high resolution. The serial image data are rendered to reconstruct complete internal structure of the material, including the rock matrix and embedded organic/inorganic bodies.

Two blocks (1 and 2) of the Rhynie Chert were used for preliminary study. The rock was ground down at 2 to 0.5 μm intervals in each case. Each surface was photographed with digital cameras. The entire virtual space was 3-dimentionally rendered from obtained image data using rendering software. The ground area of the block 1 is ca. 5 x 3 cm square and 3 cm thick. Based on success with block 1 we carried out the same procedure for block 2. The tissues of plants and associated fungi are well-preserved with high anatomical resolution. Other organisms such as arthropods are not found yet but are expected to encounter in future.

More than 140 plant fragments are recognized manually within the rendered space of block 1. The majority of plant fragments in block 1 are the protracheophyte, *Aglaophyton*. Our continued analysis of block 2 reveals a more diverse flora, including *Rhynia,* and *Horneophyton* as well as the gametophyte of *Aglaophyton, Lyonophyton* with antheridia. Several types of sporangia are found, some are 3D reconstructed including printed models.

Using MULPIS we can obtain unprecedented 3D digital renderings of Rhynie plants which have previously only been reconstructed based on serial sections. It also provides a new approach for understanding key aspects of life in the Rhynie ecosystem.

This research is supported by Grant-in-Aid for Scientific Research [Kakenhi] (B), 23H02544 and Chuo University Grant for Special Research 2022–2023 to HN.

O-134 - Investigating the origin of phloem through the application of high-resolution microscopy techniques to the plants of the Rhynie chert

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Phloem – the sugar-conducting tissue of vascular plants – facilitates the highly-efficient movement of sugars around the plant, from where they are produced in photosynthesis to where they are needed in respiration. This function of phloem enabled the increase in size and tissue complexity seen in vascular plants, therefore phloem can be considered a key innovation in plant evolution. The specialised sugar-conducting cells of phloem, the sieve cells, are defining anatomically by the occurrence of sieve pores, small holes in cell walls with a role in the movement of sugars. Sieve pores can be used to identify phloem tissue in the fossil record, and the first known record of sieve pores is from a Late Devonian progymnosperm (Wight & Beck, 1984). This finding demonstrates true phloem was present in woody species in the Late Devonian, but alone does not shed light on the origin and very early evolution of phloem. Therefore, to elucidate when phloem and its characteristic sieve pores first appeared, earlier and exceptionally-preserved fossils must be studied. The plant fossils of the Rhynie chert represent just such an opportunity. The Rhynie chert preserves Early Devonian land plants with exceptional preservation. All species exhibit a 'phloem-like' tissue, but with no previous record of sieve pores. However, owing to the very small size of sieve pores in extant relatives of some Rhynie chert species, (lycopsids, ~0.2μm), high-resolution imaging methods must be employed to determine if sieve pores were present in the plants of the Rhynie chert. I have used a combination of Airyscan Confocal Laser Scanning Microscopy (CLSM) and Scanning Electron Microscopy (SEM) to search

the ‘phloem-like’ tissue of the Rhynie chert for sieve pores, the results of which will enable me to conclude when sieve pores, and therefore phloem, first appeared in the plant fossil record.

29/05/2024, 09:10–10:30, Room: Zenit
A02 Advances in Devonian Paleobotany

O-135 - Fungi associated with the charophyte alga Palaeonitella cranii from the Lower Devonian Rhynie chert of Scotland

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Charophytes today are known to host a variety of epiphytic and endophytic fungi; however, fungal associations of fossil charophytes are largely unknown. *Palaeonitella cranii*, a structurally preserved charophyte from the Lower Devonian Rhynie chert, consists of a main axis of alternating cylindrical internodes and disc-like nodes giving rise to whorls of furcating branchlets. The below-ground parts include rhizoids with multicellular nodes, and spherical to ovoid rhizoid bulbils. Three fungal colonizers and probable parasites of main axes and branchlets of *P. cranii* were described some 30 years ago, and two of them were shown to have caused hypertrophy in their host. Four additional fungi were recently discovered as colonizers of bulbils of *P. cranii*. Two of them are chytrid-like and characterized by epibiotic sporangia and endobiotic apophysate rhizoidal systems, while the third resembles certain present-day Mucoromycota and consists of a slender stalk terminating in a pinhead-like inflation, and a club-shaped endobiotic axis giving off rhizoids distally. The fourth occurs in the form of hypha-like elements extending from the bulbil surface. Three-dimensional meshworks of intertwined colonizer rhizoids in densely populated bulbils indicate that colonization occurred while the bulbils were crammed with starch grains. Because the grains were obviously impenetrable, all rhizoids in the bulbil lumen had to grow through the narrow interstices between the individual grains, and over time developed into a contiguous structure comprised of the rhizoidal systems of all colonizers. Bulbils were probably a good source of nutrition. The starch either could have been broken down and digested by the colonizers themselves, or metabolites from starch degradation by other microorganisms were absorbed. Although main axes, branchlets, rhizoids, and bulbils of *P. cranii* commonly co-occur in the chert, the new fungi have been found exclusively on bulbils, which suggests organ-specific host colonization.

29/05/2024, 09:50–10:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-136 - Wood recorded beetles’ early life: Formation, host response, and distribution of larval tunnels

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Even more than plant and animal fossils, the evidence of their life and interactions teaches us about the existence, complexity and development of ecological relationships in ancient habitats. As essential components of food chains that decompose plant matter into organic remains and interact with saprophytic microbiota, animal-plant interactions reach far back into the Earth’s history. Due to their higher potential to be preserved, fossil woods are virtually predestined to record feeding tubes and animal remains. Abrasion-resistant silicifications can not only be found at their places of growth but also resist longer transport. *Pectichnus multicylindricus* feeding traces are known from Late Paleozoic conifers and were caused by the larvae of early beetles, as documented for Carboniferous–Permian sedimentary basins in central and southeast Europe up to northwest China. As a result, we can trace their first occurrence to the late Carboniferous (Stephanian). The results underscore the ecological importance of insects even in very distant terrestrial habitats. Since conifers and beetles first appeared in the late Carboniferous and the feeding track seems to be restricted to conifers, the late Carboniferous is probably close to the highest age of their appearance. Furthermore, new finds extend the palaeogeographic distribution from western and central Germany, northern Bohemia, southern Poland, and eastern Ukraine to China. The recognition value of the typical feeding track gives reason to hope for further evidence in petrified wood collections of other geological periods and regions. The conifers living during the formation of the tunnels show multiple reactions, such

as the formation of callus tissue from the vascular cambium or from the medullary rays, which can lead to the partial or complete closure of the individual tunnels. Furthermore, the tracheids adjacent to the borer ducts show intense swelling and lumen reductions, which indicate fungal infestation leading to selective delignification of the wood's tracheids.

29/05/2024, 09:50–10:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-137 - Infection of blue-stain fungus on an 160-million-year-old conifer wood from China

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Blue-stain fungus is a term for a peculiar wood colonizing fungal group which does not have the ability to decompose wood lignocellulose components, but can cause considerable discoloration of wood, especially the sapwood. It is generally believed that the infection of blue stain fungi does not cause the direct death of their host plant, but often hastens the death of trees attacked by wood-inhabiting insects. Taxonomically, the blue-stain fungi are a polyphyletic group consisting of several genera within the Sordariomycetes of Ascomycota. Calibrated molecular phylogenetic evidence suggests that Sordariomycetes should be an ancient fungal group, whose divergence from other Ascomycota can be dated back the Late Paleozoic to early Mesozoic. Though some fossils have been referred to Sordariomycetes, hardly anything is known for the geological occurrences of blue-stain fungi. The only credible fossil record of blue-stain fungi was reported from the Late Cretaceous South Africa represented by fungal hyphae preserved within an anatomically preserved petrified wood. Herein, we describe a fossil fungus colonizing the wood of an extinct conifer *Xenoxylon phyllocladoides* Gothan from the Middle-Upper Jurassic Tiaojishan Formation of western Liaoning Province, Northeast China. Morphological resemblances between the present fungal hyphae and the extant blue stain fungi enable us to conclude that this fossil fungus from China represents an unequivocal Jurassic blue stain fungus, which pushed the earliest fossil record of blue-stain fungi forward by about 80 million years. The new finding not only provides key fossil evidence for revealing the origin and evolution of blue-stain fungi, but also provides important clues for exploring the plant-fungus-insect interaction in the Jurassic terrestiral ecosystem.

29/05/2024, 09:50–10:30, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-138 - How the High Arctic Large Igneous Province affected polar forests

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Terrestrial vegetation is an integral part of the global carbon cycle, but the influence of drivers of major biotic change, such as large-scale magmatism, on terrestrial ecosystems is not well understood. The Hauterivian–Aptian Isachsen Formation was deposited in the Sverdrup Basin, Arctic Canada, contemporaneous with the onset of emplacement of the High Arctic Large Igneous Province (HALIP). The HALIP created protracted environmental disturbance and contributed to global warming associated with Ocean Anoxic Event (OAE) 1a. This contribution explores how both the HALIP and OAE 1a may have affected land plants using a quantitative palynological approach. Results show that an interval of climate warming occurred during the Hauterivian and promoted expansion of a hinterland community dominated by members of the Pinaceae. By the middle Barremian, this community was replaced by mixed heathland and mire, represented by up to 70% fern spores in the uppermost Paterson Island Member, in response to environmental disturbance associated with first volcanic flows of the HALIP. The Barremian age of the fern spike is consistent, using the ICS time scale, with the start of the first main magmatic pulse of the HALIP at ca. 124–120 Ma determined by U-Pb zircon geochronology from intrusive rocks. Above the fern spore spike, dinoflagellate cyst assemblages indicate an early Aptian age and a marine setting for mudstones of the Rondon Member in which OAE 1a is recorded. An interval of floral instability is recorded

in the overlying Aptian Walker Island Member, characterized by fluctuations in Pinaceae and Cupressaceae pollen and fern spores, possibly a result of post-OAE 1a temperature variability combined with continued landscape disturbance associated emplacement of the HALIP. This quantitative palynological analysis of the Isachsen Formation refines understanding of drivers and consequences of Mesozoic climate change. Results are compared to floral signatures during major events in Earth history.

29/05/2024, 09:50–10:30, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-139 - Paleoclimate and floristics of the late Paleocene Blindman River fossil site from south-central Alberta, Canada

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The late Paleocene (ca. 59–56 Ma) was characterized by an increase in global temperatures and elevated CO_2 levels, culminating in the Paleocene-Eocene transition and the hothouse world of the early Eocene. The early Eocene is often compared to a "worst-case scenario" of contemporaneous climate change, and has therefore seen extensive study. Further study of adjacent periods is needed for a more robust understanding of climate system dynamics and related biotic and evolutionary changes. The Blindman River fossil site near Blackfalds in south-central Alberta, Canada, preserves a diverse late Paleocene (late Tiffanian) fossil assemblage (e.g., plants, early mammals, other vertebrates, and insects) from the Paskapoo Formation. Blindman River is particularly rich in plant fossils and has yielded thousands of leaves, seeds, flowers, and various other plant parts, many of which remain undocumented and undescribed. Presented here is a preliminary floral survey and quantitative paleoclimate reconstruction using multiple independent paleoclimate plant proxies. Initial results indicate that the flora was relatively rich with several types of ferns (e.g., *Osmunda, Onoclea, Speirsopteris*), gymnosperms (e.g., *Metasequoia*, *Glyptostrobus*, *Ginkgo*), monocots (e.g., *Bognerospadix*, *Orontiophyllum*, *Zingiberopsis*), and approximately 36 types of broad leaf 'dicot' leaves (e.g., *Beringiaphyllum*, *Browniea*, *Ulmites*, *Macginitiea*, *Trochodendroides*), many of which remain unidentified. Numerous seeds, fruits, and other reproductive structures are also present in the Blindman River deposits. Initial paleoclimatic estimates indicate the regional climate was humid warm-temperate (MAT 11.2–13.9 °C, MAP 131 cm/yr), with mild winters (CMMT ~4 °C). These estimates are in line with the increasing temperatures characteristic of the late Paleocene and provide important new climate and floristic data for western Canada.

29/05/2024, 09:50–10:30, Room: Taurus
H05 Changing Island Ecosystems

O-140 - First pollen evidence of past vegetation dynamics in Southern Sardinia from Bronze Age to Roman Imperial period: A new record from the ancient city of Nora

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Large islands represented crossroads for many populations in the conquest of the Mediterranean and since the rise of agriculturally based societies in the Neolithic they underwent a progressive depletion of biotic and abiotic resources. Owing to their defined size and isolation, they may represent effective laboratories to disentangle the influence of natural versus human pressures on past ecological dynamics.

We present the results of pollen analysis carried out on sedimentary cores collected close to the ancient coastal city of Nora, near Pula in Sardinia. For the first time, the vegetation dynamics of Southern Sardinia could be traced from the Bronze Age to the Roman Imperial period thanks to a new high-resolution pollen record that was supported by a chronology with fifteen AMS

dates. The results depict a semi-open landscape with a saltmarsh dominated by Amaranthaceae, still present today around the archaeological site. The sparse local woodland, characterized by thermophilous evergreen taxa, such as *Quercus ilex/coccifera*, *Olea*, and *Pistacia,* underwent considerable floristic changes over time. Anthropogenic indicators are recorded throughout the sequence pointing to continuous human activities. Cereals were mainly cultivated from Nuragic to Punic phases, while *Olea* and *Vitis* cultivation prevailed in Roman times. Interestingly, farming activity does not intensify during the Phoenician use of the site as port of trade, because Phoenicians likely imported food and other goods through maritime trades. No clear deforestation can be ascribed to known rapid climate changes, as documented in other coastal sites of south-central Mediterranean regions sensitive to drought. This might be partly explained by the resistant and resilient vegetation, well adapted to the semi-arid conditions of the South Sardinian climate.

29/05/2024, 09:50–10:30, Room: Taurus
H05 Changing Island Ecosystems

O-141 - A record of natural and human disturbances in Caribbean ecosystems using pollen analysis: A case of study from Baie des Baradères, Haiti

Cesar Arturo Vera Florez[1], *Matthew Peros*[2], *Frédéric Bouchard*[3], *Émilie Saulnier-Talbot*[1], *Sydney Moser*[4], *Simon Pendleton*[5], *Jeffrey Donnelly*[6], *André Viau*[4], *Andrea Hawkes*[7], *Chad Lane*[7], *Pete Van Hengstum*[8]

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Much of the landscape of Haiti has been cleared of vegetation, increasing its vulnerability to erosion and floods. Despite this, there is limited long-term environmental data from the country to understand how ecosystems reacted to both natural and human disturbances through time. To address this, pollen analysis was undertaken from a sediment core collected at Baie des Baradères, a shallow bay adjacent to the delta of the Baradères river, to trace vegetation change over the last 8500 years.

A total of 63 levels of the core were analyzed, resulting in over 170 different pollen-types identified, including over 30 different trilete and 20 monolete spores. The results from 7000 to 2000 cal yr BP, represent changes in vegetation assemblages that possibly reflect sea-level rise and the onset of a drier climate in the late Holocene. Abrupt increases in silicates occur in at least five portions of the core, beginning at ~ 1600 cal yr BP, and may represent an influx of terrestrially derived sediments into the bay from the nearby Baradères river. The pollen assemblages from those sections are characterized by high levels of herbs and fern spores, as well as by an increase in palynological diversity, possibly reflecting disturbances from hurricanes or human arrival. Finally, the upper sediments are associated with spores and herb pollen such as Asteraceae, Poaceae, and *Borreria*, reflecting historic human impacts.

Future work elsewhere in the Caribbean will focus on understanding the impact of human arrival on coastal ecosystems, particularly during prehistoric times. A key site is the Rio Cauto delta, in eastern Cuba, which has a rich archaeological record and numerous depositional environments which should be sensitive to human impacts. This work will combine palynology with charcoal and geochemical analyses, to test hypotheses concerning human impacts on biodiversity in neotropical insular environments.

O-142 - Two species of basal angiosperms and their paleoecological implications in the Peruc-Korycany Formation: New Perspectives from the Cenomanian Flora

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The Cenomanian flora of the Peruc-Korycany Formation is one of the best-preserved fossil floras in the Czech Republic. The aim of this study was to describe two species from there, *Ascarinophyllum pecinovense* Čepičková et Kvaček and *Papillaephyllum labutae* Čepičková et Kvaček, and examine their paleoecological signals in the context of the whole Peruc flora. The material comes from the Pecínov quarry, units 1–3.

Based on the macrofossil observations, the leaf fossils were subjected to a micromorphological investigation. The main methods used in this research were cuticle analysis and the venation visualisation method for vein analysis.

The information obtained from cuticle analysis, along with previously published data, allowed the plant fossils to be divided between mesophytes to xerophytes. These are characterised by thick cuticles, with stomata sunken into stomatal pits, which may be surrounded by wrinkles or papillae. Additionally, the surface of the epidermis may be wrinkled or papillae-covered.

The venation visualisation technique revealed venation types – festooned-semicraspedodromous and semicraspedodromous – also found in members of the recent Chloranthaceae. Also variability of stomata indicates the early angiosperms of ANA or Chloranthaceae.

Based on micromorphology the fossils were categorised as growing into two types of terrestrial paleoenvironments: *Ascarinophyllum pecinovense* to slope and *Papillaephyllum labutae* to drier upland, based on the unit of discovery and its sedimentological, geochemical and palynological record. This classification is supported by the macro- and micromorphology of the leaf fossils. The uncommon presence of meso- to xerophytic angiosperms in the fossil record of the Peruc Member suggests a seasonal climate in the Bohemian Massif during the Cenomanian.

The research was supported by the Czech Science Foundation (GAČR) 20-06134S.

O-143 - Cuticular analysis of Triassic plant compressions from the Leigh Creek Coal Measures, Telford Basin, South Australia

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The Leigh Creek Coal Measures, South Australia, accumulated in a series of small intracratonic basins that were covered by minimal overburden since their time of deposition during the Late Triassic. The coals and dispersed organic matter are, therefore, of unusually low rank (lignite A to sub-bituminous coal C) given their age, offering a rare opportunity for extensive bulk processing for plant cuticles and mesofossils. We analysed material of weakly solidified fossiliferous mudstone from 22 sample sites representing 14 stratigraphic levels throughout the section exposed in the Telford Basin. Samples yielded mainly leaves and reproductive organs in cuticular preservation, but lignitic and – more rarely – cellulosic tissue remains occur along with charred plant debris. Collectively, the plant-fossil assemblages are overwhelmingly dominated by Umkomasiaceae, which is represented by at least seven species of *Dicroidium* foliage along with associated ovuliferous organs (*Umkomasia*, *Fanerotheca*) and pollen organs (*Pteruchus*). Individual beds also contain other gymnosperm taxa, such as ginkgophytes (e.g., *Sphenobaiera* and *Ginkgo* foliage)

and Petriellales (*Rochipteris* leaves, *Kannaskoppia* cupules and *Kannaskoppianthus* pollen organs), together with sideritized wood. On-going screening of the sample residues, however, continues to yield additional seed-plant remains, which include a new species of the poorly understood gymnosperm leaf *Kurtziana* and other, still more enigmatic leaves and reproductive organs. SEM and fluorescence microscopy yield fine micromorphological and anatomical details (including resin bodies) of the plants, together with a diverse array of herbivory damage. The richness, diversity and exceptional preservation of these plant-fossil assemblages highlight the Leigh Creek Coal Measures as a unique window into the Triassic vegetation of Gondwana.

29/05/2024, 11:00–12:40, Room: Aquarius
C04 Mesozoic plant cuticles: implications for evolution and palaeoenvironment

O-144 - Preliminary data on the spectrochemistry, biomechanics, and physiology of Pseudofrenelopsis dinisii (Cheirolepidiaceae) from the Lower Cretaceous of Portugal

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This contribution summarizes the preliminary results on the relationship between chemical composition (structural groups) and biomechanical/physiological aspects of the conifer *Pseudofrenelopsis dinisii* (Cheirolepidiaceae) from the westernmost sector of the Iberian Peninsula (Lower Cretaceous, Santa Susana Formation). The material comprises nine foliar compressions with well-preserved cuticles housed in the palaeobotanical collections of the Geological Museum of Lisbon, Portugal. The chemical composition of *P. dinisii* cuticles, previously determined using attenuated total reflectance (ATR)-Fourier transform infrared (FTIR) spectroscopy, is characterized by relatively high contents of aliphatic and carbonyl groups with low aromatic carbon contributions. Herein, four biomechanical properties have been analyzed: density, tensile strength (resistance to fracture), tensile modulus of elasticity (stiffness), and leaf mass per area (metabolic cost of tissue construction). They were calculated employing a 3D-multivariate statistical model based on ATR FTIR-derived data and plant-functional relationships linking density and remaining properties. Results comprise the following mean values: density = 0.92 g/cm^3, resistance to fracture = 4.46 MPa, stiffness = 1479.07 MPa, and metabolic construction costs = 1.09 g/cm^2. These values indicate that once-living plants bearing *P. dinisii* leaves may have invested considerably high amounts of resources to construct the aromatic, high-density, biomechanically resistant, lignified, metabolically expensive, and relatively long-lived tissues. This finding agrees with the xeromorphic features reported for *P. dinisii* including well-developed trichomes, deeply sunken papillate stomatal apparatuses, and moderately thick cuticles. Furthermore, cutinization and lignification of cell walls would imply the presence of variable amounts of organics related to free phenolic compounds, phenylpropanoids, lignins, tannins, and resins. Parent plants of *P. dinisii* probably developed combined strategies that would have optimized the biomechanical stability and physiological activities to respond to stressful environmental conditions. Highlighting the effectiveness of FTIR spectroscopy, this study exemplifies its utility in conducting realistic and detailed analyses of extinct plants' biomechanics, physiology, and autecology. *Grants: ANPCyT/PICT/2020-2271, 2021-158, CONICET/PIP/2021-016, UIDB/04292/2020, UIDP/04292/2020, LA/P/0069/2020.

29/05/2024, 11:00–12:40, Room: Aquarius
C04 Mesozoic plant cuticles: implications for evolution and palaeoenvironment

O-145 - The puzzles of reticulate-veined leaves through time

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Venation architectures and cuticular micromorphology of leaf fossils play important roles in higher-level taxonomic segregation, as these characters are broadly fixed within major plant clades. Three common fossil plant taxa are characterized by similar-shaped leaves or leaflets and anastomosing venation to such an extent that examples have commonly been assigned to the wrong taxon in past studies where fragmentary or ill-preserved material is available. We use standardized descriptions of vein cross-connection

types and stomatal features to compare and contrast the venation patterns and stomatal architectures of these genera. Our reanalysis of the macro- and micromorphology of *Glossopteris*, *Sagenopteris* and *Anthrophyopsis* leaves reveals important differences that help segregate these taxa even on the basis of incomplete specimens. *Anthrophyopsis* has distinctive alignments of vein cross-connections in the outer lamina and paracytic stomata consistent with those of Bennettitales. *Glossopteris* has perigenous and monocyclic – normally stephanocytic to actinocytic – stomata commonly protected in pits or by overarching papillae. *Sagenopteris* has more consistently evanescent midribs and surficial anomocytic or stephanocytic stomata with weakly modified subsidiary cells. Considering the putatively close relationship of glossopterids (*Glossopteris*), Caytoniales (*Sagenopteris*) and Bennettitales (here encompassing *Anthrophyopsis*) resolved as members of the 'glossophyte' clade in some past phylogenetic studies, cuticular features suggest that these groups are not closely related. In addition, anastomosing venation, superficially similar to that of *Glossopteris*, *Sagenopteris* and *Anthrophyopsis* appears to have arisen independently in numerous other plant groups suggesting that this character has ecological or physiological benefits and is strongly prone to homoplasy.

29/05/2024, 11:00–12:40, Room: Aquarius
C04 Mesozoic plant cuticles: implications for evolution and palaeoenvironment

O-146 - Neotropical Floras from the Early Cretaceous of northwestern Gondwana (Colombia, Ecuador)

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The Early Cretaceous is a critical period in Earth's history, characterized by the concluding of Pangea's fragmentation and heralding a significant floral change with the emergence and diversifications of angiosperms, substantially impacting terrestrial biodiversity. Despite advancements in understanding the early radiation of angiosperms, critical palaeobotanical gaps still persist, particularly in tropical regions of northwestern Gondwana. Early Cretaceous (Aptian-Albian) palynological evidence from Colombia and Ecuador suggest the presence of moderately diverse floras, composed of gymnosperms, gnetales, fern as well as angiosperms. Four macrofossil floras from the same region, two previously acknowledged (Abejorral, Paja) and two newly discovered (Hollin, Une), offer untapped potential for new insights into the vegetation of north-western Gondwana during the Early Cretaceous. So far, the examined floras have yielded a well-preserved, rich and varied flora consisting of conifers (Taxaceae, Cheirolepidiaceae, Araucariaceae), cycads and Bennettitales (e.g. *Zamites*, *Otozamites*), ferns (e.g. *Cladophlebis*, *Gleichenites*), and diverse angiosperms (leaves and flowers with *in situ* pollen), as well as concurrent biotic interactions such as fungi and arthropod damage. We are confident that tapping into these undocumented floras promise to fill critical gaps in macro-paleobotanical knowledge of Early Cretaceous neotropical floras, but also on the early radiation of angiosperms.

29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-147 - Evergreen or deciduous? Quantitative evidence from the growth-ring series of coniferous woods from the Late Jurassic Morrison Formation, USA

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The Late Jurassic ecosystem of the Morrison Formation, USA, consists of a diverse biota dominated by conifer forests and dinosaurs. Silicified conifer, or conifer-like, woods have been discovered at more than 22 localities across the Western Interior of North America. Many of the Morrison woods have been described taxonomically and anatomically, however, little is known about other biological aspects of the trees. For example, one basic trait, whether a species was evergreen or deciduous, is not well understood, although it is a habit that is reflected in the growth rings of living trees. Here we apply a mathematical model based on living trees to Late Jurassic woods from the Morrison Formation found preserved with a good series of true growth rings to determine if they

were likely to have been evergreen or deciduous. The fossil woods were recovered from sites at different latitudes in what is today Montana and Utah, and were identified as *Circoporoxylon* and *Xenoxylon*, respectively, two now-extinct genera of tracheid-dominated Mesozoic woods. Growth rings were studied in cross section in thin section, and a continuous series of at least 12 growth rings in each wood was analyzed using light microscopy. Data on cell diameter across each growth ring and on the percentage of latewood were collected, which were used to plot two curves superimposed on one another for each growth ring, one of which was the cumulative algebraic sum of each cell's deviation from the mean (CSDM curve). The direction of skew between the center of the CSDM curve and the zenith of the CSDM curve formed the basis of our interpretation on whether *Circoporoxylon* and *Xenoxylon* were evergreen or deciduous. The implications of this biological trait in these genera for the Late Jurassic Morrison forests will be discussed.

29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-148 - Palaeoclimatic signal captured in growth rings of fossil wood from the Albian to Danian of Antarctica

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Nowadays there is no known analogous of a polar forest from the Late Cretaceous and Paleogene era. Those ecosystems offer a unique opportunity to comprehend the extreme conditions prevalent in the region and the specific adaptations of organisms for these conditions. The extensive palaeobotanical record from Antarctica indicates that, during a greenhouse climate, the area supported dense vegetation. However, these plants had to adapt to a distinct solar regime marked by half-year mild polar nights (Herman, 2004; Poole et al., 2005; Beerling, 2007).

The fossil material from this study comes from the uppermost Lower Cretaceous to Paleocene (Albian – Danian) strata at James Ross and Seymour Islands, located in the Antarctic Peninsula. For a detailed analysis of the growth rings, 36 samples were selected from several stratigraphical levels (Whisky Bay Formation, Santa Marta Formation, Lopez de Bertodano Formation, Sobal Formation). These samples belong to the two most frequently encountered taxa of gymnosperms in the collections: *Agathoxylon* and *Podocarpoxylon*. Based on Mean Sensitivity Index and Mean Ring Width values, a climatic trend for the period mentioned was created and it corresponds to the existing climatic trends of this region. This study affirms that the growth rings of fossilized wood can be used as indicators for reconstructing paleoclimate.

29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-149 - Progress on Cretaceous plant trunks and rhizomes in Heilongjiang, northeast China

Fengxiang Liu[1], *Xi Wang*[1], *Xiaoyun Chen*[1], *Kai Tan*[1], *Dongwei Wang*[1], *Yeming Cheng*[1]

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Heilongjiang Province, northeast China is one of the areas with the high diversity of Cretaceous plant stem fossils in China and even East Asia. It is also a rare area with Cretaceous plant stem fossils in the Northern Hemisphere. Plant stem fossils reported from Heilongjiang in the past were mainly gymnosperms. In recent years, plant stem fossils with rich taxa, including ferns, gymnosperms and angiosperms, have been discovered in new fossil locations in northern and eastern Heilongjiang. There are 3 families and 5 genera of ferns, including *Heilongjiangcaulis keshanensis* Cheng et Yang, *Cyathocaulis* (Cyatheaceae), *Tempskya zhangii* Yang et al. (Tempskyaceae), *Osmundacaulis asiatica* Cheng et al., *Osmundacaulis sinica* Cheng et al., and *Plenasium xiei* Cheng et al. (Osmundaceae). There are 6 families and 12 genera of gymnosperms, including *Cycadeoidea* (Cycadeoidaceae), *Cupressinoxylon*, *Sequoioxylon zhangii* Tian et al., *Taxodioxylon* (Cupressaceae), *Ginkgoxylon* (Ginkgoaceae), *Cedroxylon*, *Keteleerioxylon*, *Piceoxylon* (Pinaceae), *Protocircoporoxylon*, *Phyllocladoxylon* (Podocarpaceae), *Taxaceoxylon* (Taxaceae), and *Xenoxylon*. There are 1 family and 1 genus of angiosperms, including *Platanoxylon* (Platanaceae). Fossil wood of *Xenoxylon* from eastern Heilongjiang contain arthropod borings and decay holes, as well as abundant fungal hyphae and spores. These fossils provide important evidence for understanding the development and evolution history of ferns, gymnosperms and angiosperms, as well as the paleoclimate, paleoenvironment and interactions between organisms in the ecosystem at that time.

Keywords: fern, gymnosperm, angiosperm, anatomy, diversity, evolution.

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29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-150 - Coniferous and angiosperm woods from the Maastrichtian of Colorado, U.S.A.

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Fossil woods are preserved in the Upper Cretaceous Vermejo Formation of the Raton Basin in southern Colorado, U.S.A. Most are conifers, but angiosperm woods are also present. The conifers are generally consistent in anatomical characters typical of Cupressaceae *sensu lato,* including predominantly uniseriate, circular intertracheary pits on the radial walls, cupressoid to taxodioid cross-field pitting, mostly uniseriate rays of medium height, and no intercellular canals. They also typically have growth interruptions indicating variable conditions.

There are multiple diffuse-porous specimens with character combinations similar to the widespread fossil genus *Paraphyllanthoxylon*. This is supported by the lack of distinct growth rings, vessels solitary and in short radial multiples, simple perforation plates, alternate intervessel pits averaging medium in diameter, vessel-ray pits with reduced borders, septate fibers, little axial parenchyma, and heterocellular rays often 1–2(–4) cells wide.

Two different angiosperm taxa, each represented by a single specimen, have diffuse porosity and scalariform perforation plates. One specimen has rays of two distinct size classes, with the larger rays being heterocellular, very wide (commonly >10-seriate), and very high (>1 mm). This combination of characters is unusual and occurs in few extant families, including Dilleniaceae. The other specimen with scalariform perforation plates has very thick-walled fibers, rays mostly 1–3 cells wide (occasionally wider) and <1 mm high, and traumatic canals.

Most of the limited records of Late Cretaceous woods in the Western Interior, U.S.A. come from New Mexico, Texas, and south into Mexico. Fossil woods from the Vermejo Formation (ca. 67–66 Ma) in the Raton Basin provide information about the structure and diversity of Laramidian forests further north in Colorado that grew near the margin of the retreating Western Interior Seaway. Angiosperm woods from Cretaceous deposits are relatively rare, so new localities provide opportunities to expand our knowledge of Cretaceous plant communities.

29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-151 - Wood you include phloem? Investigating undocumented Wyoming Eocene wood from collections of citizen scientists

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Hay's Ranch in the Eden Valley Basin, east of Farson, Wyoming, has been a popular fossil wood collecting site for amateurs since the 1950s. The site is in the Laney Member of the Green River Formation, deposited in or around the ancient Lake Gosiute in the Early Middle Eocene. To date, the only described fossil wood with a cambial variant from Wyoming is *Forchhammerioxylon*

scleroticum Kruse (Capparaceae) with successive cambia. Here, we describe previously unreported petrified wood specimens with a different cambial variant structure, interxylary phloem (included phloem). These specimens have diameters ranging from 0.7–16 cm. We prepared slides of transverse, tangential, and radial sections using standard grinding techniques. Excellent wood anatomical preservation reveals the combination of vessels commonly in radial multiples of 3–8, rarely more or less, occasionally in clusters, round in outline, mean tangential diameter 20 µm, range from 14–25 µm; mean vessel element length 138 µm, range from 76–164 µm; simple perforation plates, alternate intervessel pits. Vessel ray pits similar to intervessel pits. Dark deposits are often found at the end of vessel elements or fill some vessel lumina; very thick–walled fibers. Heterocellular rays 1–5 cells wide, predominantly tri–seriate. Rays, fusiform axial parenchyma, and fibers are strongly storied; septate axial parenchyma present, diffused interxylary phloem. Using InsideWood Database and relevant literature, there are at least 15 extant families with diffused included phloem. We will continue to investigate systematic affinities, ecological associations, and climatic implications of these specimens. Research by citizen scientists, collaborating with paleobotanists, on specimens from their collections with documented localities will enhance our understanding of interxylary phloem in the fossil record. This partnership will also augment our knowledge of the diversity of woody vegetation during the time of the Gosiute Lake.

29/05/2024, 11:00–13:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-152 - Eocene Woods from Oregon, western USA – Diversity and Paleoenvironmental Inferences

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Central Oregon is home to a sequence of middle Eocene to early Oligocene terrestrial sediments that contain abundant and diverse fossil woods, fruits and seeds, and vertebrates. We have been studying silicified woods from three late Eocene localities (ca 36.2 Ma) near the village of Post in the Crooked River Basin of central Oregon, USA. The woods vary in the extent to which they can be related to extant taxa: 1) similar to a single extant genus, e.g., *Acer* (Sapindaceae), *Prunus* (Rosaceae), *Ulmus* (Ulmaceae); 2) referable to a single family, but not to an individual genus, because the combination of features occurs in more than one extant genus, e.g., *Lithocarpoxylon* (Fagaceae), *Plerandreoxylon* (Araliaceae), *Pterocaryoxylon* (Juglandaceae), 3) referable to a single family, but whose combination of features is not found in any present-day genus and is likely extinct, e.g., *Wataria* (Malvaceae), *Platanoxylon* (Platanaceae); 4) referable to an order because features occur in more than one family, e.g., *Urticaleoxylon* with features found in the Cannabaceae and Moraceae; 5) affinities unknown. The geographic relationships of the Post woods are primarily with warm temperate east Asia and eastern North America. Among the Post assemblages are the oldest known *Pistacia* wood and the first report of *Keteleeria* wood in North America. Unexpectedly, although the three Post wood localities are near each other, there are relatively few genera in common: *Fagus, Hamamelidoxylon, Platanoxylon*, and *Ulmus*. These four genera persisted into the middle Miocene of the region and occur in the Vantage Fossil Forests of central Washington, USA. Generally, the wood anatomical traits (growth ring boundaries and porosity) of the Post wood assemblages differ from the older middle Eocene Nut Beds assemblage and the younger Oligocene Gray Ranch assemblage (Crooked River Basin), as would be expected with the cooling and increased seasonality of that time interval.

29/05/2024, 11:00–13:00, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-153 - The palynological record through a super-monsoon lake at the Devonian Carboniferous Boundary

John Marshall[1], *Henning Blom*[2], *Grzegorz Niedźwiedzki*[2], *Martin Qvarnström*[2], *Robert Gess*[3], *Jessica Whiteside*[4], *Per Ahlberg*[2]

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The terrestrial Devonian-Carboniferous in East Greenland is coincident with a wide, deep and long-lived lake that represents a considerable shift of the monsoon system into an arid continental interior. As such it represents the extreme warming that terminated the latest Devonian glaciation. Plant spores from a proximal section of the lake are malformed and clear evidence for elevated UV-B.

In 2022 we revisited Celsius Bjerg on an ERC funded expedition to collect the latest Devonian tetrapods in their palaeoenvironmental context. The lake sediments were continuously sampled using a backpack drill and large orientated blocks. These samples have been separated into sub-centimetric splits and analysed for palynology, TOC%, calcite% and $\delta^{13}C_{TOC}$ together with selected BSEM imagery.

The basal third of the lake is not atypical for a Devonian lake showing a TOC of about 1% and the presence of *Retusotriletes* spp, *Verrucosisporites nitidu*s and *Grandispora echinata* but without grapnel tipped spores, *Diducites* and *Retispora lepidophyta*. As TOC rises to peak at 10%, spores effectively disappear with the assemblage becoming AOM dominated. However, this AOM can be separated into at least 3 distinct 'microbial groups' based on $\delta^{13}C_{TOC}$. This includes a distinct interval that contains fish remains with shoals of an early bony fish and predators including a shark suggesting a connection to the sea at this time. There are numerous and diversified coprolites indicating the existence of a cryptic vertebrate fauna that has not yet been recovered as body fossils.

Above this level, TOC% drops to a stable 2% with the palynofacies now dominated by mats of the alga *Botryococcus* with a distinctive $\delta^{13}C_{TOC}$ isotope signature. The waters are now more oxygenated. At and above this level, spores reappear in abundance but are dominated by *Retusotriletes* and *Vallatisporites* and are clearly from the VI palynological assemblage of earliest Carboniferous age.

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B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-154 - Contemporaneous peat formation and glaciation in eastern Australia during the Late Palaeozoic Ice Age: Multiproxy records from the Aramac Coal Measures (Galilee Basin)

Alexander Wheeler[1], *Ulrich Heimhofer*[1], *Linda Burnaz*[2], *Joan Sharon Esterle*[3], *Ralf Littke*[2]

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Four phases of glaciation have been identified in the Permian-aged strata of Australia representing the end of the Late Palaeozoic Ice Age (LPIA). The P2 glaciation is thought to mark the final period of widespread continental glaciation in Gondwana. The early Permian also corresponds to the initial evolution and spread of the *Glossopteris*-flora across Gondwana and the development of significant coal deposits, which may act as climatic archives of this period. Based on the radiometric-age-calibrated Australian palynostratigraphic scheme, the early Permian Aramac Coal Measures in the Galilee Basin are contemporaneous with the P2 glaciation. This work aims to examine the palynology, coal petrology and biomarker record of these coals, which were apparently deposited at the same time as a regime of significant continental glaciation.

Palynological records show a flora consisting of a mix of pollen derived from glossopterids, cordaitaleans and conifers as well as spores derived from ferns, horsetails and lycopsids. This points to a more diverse forest bog flora than one would expect in a polar

tundra biome. Biomarker data shows a high proportion of aromatic compounds produced during the burning of organic matter suggesting wildfires were a significant source of the high proportions of inertinite in the coals, though the presence of funginite also indicates some degree of oxidation of organic matter by bacteria and fungi. The coal characteristics and palynofloral assemblages of the Aramac Coal Measures are not significantly different to those of the J/K seams, which formed several million years later during the P2/P3 interglacial period. This suggests that either the P2 glaciation did not significantly affect an area as far north as the Galilee Basin, or the coals formed during a period of glacial retreat within an intra-glacial cycle.

29/05/2024, 11:00–13:00, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-155 - Gauging continental carbon sink function and ecosystem health with organic microfossils

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Proxies of past biological productivity offer ways to indirectly measure the functioning of Earth's deep-time ecosystems and carbon cycles. Plants have been major contributors to the terrestrial carbon cycle for hundreds of millions of years and their fossil abundances in the rock record can indicate changes in carbon sequestration deep in Earth's past. Moreover, plants are particularly sensitive to rapid climatic changes; hence, measuring palaeoproductivity with plant microfossils can provide a gauge of ecosystem health in response to these changes, especially those linked to major extinction and evolutionary events.

Firstly, we reviewed proxies of prehistoric land primary productivity, from which we: 1, identified the factors that influence the preservation of land-derived organic carbon in the fossil record; 2, adapted and applied a framework of modern ecosystem productivity to prehistoric settings by incorporating post-burial impacts; and 3, explored the conditions under which terrestrial organic microfossil concentrations may provide valid estimates of relative changes in palaeoproductivity.

Secondly, we developed a new method for precise concentrations of organic microfossils and applied it to the end-Permian event (EPE; c. 252 Ma) records of eastern Australia. This 'field-of-view subsampling' method applies ecological quadrat sampling principles to palynological samples spiked with *Lycopodium* marker spores. This improved method can be readily applied to any palynological assemblages and, in our datasets and simulations (depending on microfossil density and homogeneity), it more than doubled the precision of microfossil concentrations for the same amount of data collection effort (=time).

Lastly, we produced a roadmap towards refined estimates of deep-time terrestrial productivity, which should facilitate more precise land carbon cycle modelling since the emergence of large land plants >360 million years ago.

29/05/2024, 11:00–13:00, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-156 - Testing elevated UV-B radiation as a driver of lycophyte spore malformations during the end-Permian mass extinction

Jeffrey Benca[1], *Ivo Duijnstee*[2], *Renske Kirchholtes*[3], *Cynthia Looy*[4], *Teuntje Hollaar*[5], *Matthew Kent*[6], *Barry H. Lomax*[6], *Bas van de Schootbrugge*[7], *Thijs Vandenbroucke*[8]

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Widespread, fossilized lycophyte spore malformations from the end-Permian mass extinction have been proposed as a signal of elevated UV-B radiation stress associated with massive magmatism. To test this hypothesis, we analyze spore development in a living relative to end-Permian lycophytes under elevated UV-B regimes. Megaspore and microspore malformation production increases significantly with increasing UV-B dosage in modern *Isoëtes howellii*. Irradiated lycophytes produce similar spore abnormalities to those in the end-Permian fossil record. Surprisingly, *Isoëtes* specimens amplify their megaspore production with increasing UV-B radiation dosage. Our experimental results indicate volcanic destruction of Earth's stratospheric ozone layer is a plausible driver for widespread lycophyte spore malformations associated with the mass extinction.

29/05/2024, 11:00–13:00, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-157 - A lost world of land plant life escaping the devastating end Permian mass extinction

Feng Liu[1]

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In the event of a hypothetical sixth mass extinction, the identification of land refugia becomes crucial for human survival. However, previous studies have been unable to provide fossil evidence of intact land ecosystems during the largest Phanerozoic extinction event. Here we conducted a comprehensive investigation of palynomorphs, macro-plant, and tetrapod fossils in the Permian to Triassic South Taodonggou section (STD section) in Xinjiang, China. Our high-precision Bayesian age model, calibrated using five radiometric dates below and above the Permian-Triassic boundary, reveals the existence of thriving fern fields and coniferous forests while marine organisms declined. These resilient terrestrial vegetation communities played a crucial role in the rapid recovery of indigenous animal species and the re-establishment of a diverse terrestrial ecosystem within approximately 75,000 years after the marine end Permian mass extinction (EPME). The palynological assemblages recovered from the STD section show continuity throughout the EPME and does not indicate any extinction events caused by severe drought or excessive rainfall associated with the rebalance of the hydrological cycle during a global hyperthermal event. Instead, it seems to be mainly influenced by moderate regional hydrological fluctuations. This stable hydrological condition may have served as a refugium for the iconic Mesophytic flora that had already emerged in the Late Permian. It facilitated the gradual disappearance of specific plant groups and the colonization of unoccupied resource spaces by pre-existing ones that had already been established before the EPME. This contrasts the belief of a sudden and catastrophic extinction event, followed by the establishment of ecosystems with completely new Mesophytic plant groups after the EPME. The intricate nature of terrestrial ecosystems recovered from the STD section necessitates a reevaluation of the significance of refugia in the evolutionary processes of terrestrial ecosystems. These refugia may have existed but were underappreciated due to unfavorable conditions for fossil preservation.

29/05/2024, 11:00–13:00, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-158 - Prolonged recovery of high-latitude forest ecosystems after the end-Permian event and the role of the Smithian–Spathian event

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The end-Permian event (EPE, *c.* 252 Ma) led to the collapse of continental ecosystems and to the extinction of the peat-forming Glossopteridales across southern Gondwana. The Sydney Basin in southeastern Australia (then at 60–65 °S) hosts a rich Permian to Triassic continental plant record, providing a clear window into this collapse and subsequent recovery. Here, we present the first high-resolution palynological analysis from the high southern latitudes through the entire Early Triassic. Sedimentological data were utilised for lithostratigraphic correlations and inferring local palaeoenvironmental conditions. Bulk organic matter carbon isotopes ($\delta^{13}C_{org}$) facilitated correlation of these complex changes to global perturbations in the carbon cycle and the geologic time scale. Moreover, the chemical index of alteration served as a proxy for continental palaeotemperature and precipitation patterns. Following the EPE, the microfossil record reveals a surge in trilete spores, especially the zonate *Densoisporites*, during the Late Smithian Thermal Maximum hyperthermal event. These represent shrubby cosmopolitan isoëtaleans, such as *Pleuromeia*, whose emergence was globally diachronous. This was followed by a cooling phase known as the Smithian-Spathian Event (SSE; *c.* 249.2 Ma), shown elsewhere to have led to the appearance of long-lasting gymnospermous forests. As expected, gymnosperm pollen gradually became the most common type of miospore but, for reasons unknown, the basin did not hold vegetation dense enough for coal deposits to form. Additionally, this pollen-dominated assemblage was disrupted after the SSE, which saw the emergence of various species of the distinctive monolete pleuromeian spore *Aratrisporites*. It was only after cooling concurrent with the Early–Middle Triassic boundary, approximately five million years after the EPE, that gymnosperm pollen became the consistently dominant group in the palynofloral assemblage. Future work will test for correlations between palaeotemperatures and floristic changes, and whether the seemingly extreme floristic changes were caused by amplified climatic fluctuations at high latitudes.

29/05/2024, 11:00–11:40, Room: Taurus
H05 Changing Island Ecosystems

O-159 - Using palaeoecology to fill in biodiversity knowledge gaps on the remote oceanic island of Corvo, Azores

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Many remote islands harbour unique endemic species and ecosystems. At the same time, they are some of the world's most human-impacted systems. To best conserve island biota in the context of global change, it is essential to understand how these species and ecosystems behaved prior to major anthropogenic disruption. This presentation discusses the Holocene palaeoecological and palaeoenvironmental record from Corvo Island in the Azores Archipelago. By comparing the fossil record to present-day biodiversity checklists, it is possible to pinpoint several native species that have been regarded as introduced until now. Pollen and macrofossils also indicate that Corvo has lost at least eight plant species to extinction since human arrival on the island and

the island's ecosystems have shifted dramatically from their pre-colonisation baseline. This information is critical for restoring habitats and building resilience on islands where ecosystems were heavily modified prior to formal scientific description.

29/05/2024, 11:00–11:40, Room: Taurus
H05 Changing Island Ecosystems

O-160 - Crossing the Green Sea: Early human colonization and palaeoecological change on Diego Garcia, Chagos Archipelago, remote Indian Ocean islands

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Most of about eighty habitable islands in the tropical Indian Ocean have no record of prehistoric human occupation despite archaeological, ethnological, biological, and linguistic evidence of direct contact between East Africa and Southeast Asia in antiquity, especially by Austronesian-speaking Asians who colonised Madagascar about the fifth century AD. In the remote atoll of Diego Garcia, Chagos Archipelaego, lying in a direct navigable line between Southeast Asia and East Africa, palaeoecological records of vegetation change reveal the timing and impact of early human colonisation on the biodiversity of the island as early as 1250 AD, some 550 years earlier than European occupation of the island. Regional palaeoclimate records of higher sea surface temperatures, greater monsoon activity and the formation of high coral rubble dunes between 700–1250 AD also point to a dynamic and potentially stormy central Indian Ocean climate that may have restricted human colonisation of the archipelago until after 700 BP, when conditions for maritime expansion of fishing populations from the Maldives were favorable for extending their activities into the Chagos Archipelago region. $d^{15}N$ isotope records point to the presence of sea bird rookeries on the island after 1100 AD, which may have provided added food resources for maritime visitors to the archipelago after this time. Archaeological surveys reveal material evidence for the significant phase of colonial expansion into the Indian Ocean from the early 1800s to the present, but are silent on earlier prehistoric occupation. The results show that while these islands may have experienced occasional human colonization as early as 1250 AD, the nature and pace of anthropogenic ecological transformation has been rapid and has led to significant transformation of island biodiversity over the last 700 year of human interaction with the environment in one of the most remote region of the globe.

29/05/2024, 11:00–12:20, Room: Virgo
A04 Glimpses of the evolution of Fungi

O-161 - The ecological diversification of lichen-forming fungi in terrestrial ecosystems

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Here we traced the underlying pathways by which symbiotic and phenotypic diversification occurred in one of the most iconic symbioses – lichens – while evaluating their ecological and macroevolutionary consequences. By inferring a time-scaled phylogeny of over 3300 species of lichen-forming fungi, we identified occasional instances of symbiotic instability that increased both the magnitude and diversity of lichen contributions to ecosystem processes from the Mesozoic through the Cenozoic. Symbiont switches broadly coincided with shifting environmental conditions, and the convergent evolution of phylogenetically or functionally similar associations in diverse lineages. We then inferred when LFF invaded arboreal habitats, and place them in a broader and more comparative framework by highlighting their paleoecological implications, and discussing them in the context of climate, vegetation, and the evolution of other epiphytic or arboreal lineages.

29/05/2024, 11:00–12:20, Room: Virgo
A04 Glimpses of the evolution of Fungi

O-162 - Fungi from plant exudates, past and present

Alexander Schmidt[1], *Christina Beimforde*[1], *Jouko Rikkinen*[2,3]

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Distantly related fungi inhabit plant exudates of various chemical composition. Representatives of the ascomycete order Mycocaliciales are probably among the most widespread and best recognizable fungi from exudates of woody gymnosperms and angiosperms, as their characteristic ascomata are persistent and often abundant. Ascomata and adjacent mycelia of these fungi are likely to become entombed by successive exudate flows. However, because gums and other water-soluble exudates hardly persist in the fossil record, resins that potentially form amber are currently the only source of fossil fungi from plant exudates. Resinicolous Mycocaliciales have a good fossil record in European Palaeogene ambers which derive from temperate ecosystems (especially Baltic and Bitterfeld ambers) but were never found from ambers that originate from tropical lowland forests. This is consistent with their modern distribution and abundance. Hyphae of extant resinicolous fungi commonly grow in semisolid resin. Remarkably, although inward growth of fungal hyphae is preserved in numerous other worldwide amber specimens since the early Palaeogene, no evidence of a similar capability has yet been reported from Mesozoic ambers. Cretaceous amber pieces from several different deposits may contain abundant filaments that grew from the resin surface into liquid resin, but all of these have been identified as filamentous prokaryotes (genera *Leptotrichites* and *Paleocolteronema*), and not as fungal hyphae. This suggests that this special niche was occupied by prokaryotes in the Mesozoic and that fungi probably did not yet exploit resin substrates at that time.

29/05/2024, 11:00–12:20, Room: Virgo
A04 Glimpses of the evolution of Fungi

O-163 - Diverse lichen-associated microfungi from European Palaeogene ambers

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Lichens are a classic example of symbiosis and in addition to the fungal host and algal and/or cyanobacterial partners, many types of microfungi and bacteria are known to associate with lichen thalli. While some lichenicolous fungi are bound to have a long history of evolution with their partners, fossil evidence of such interactions is restricted to Palaeogene ambers. Fossils of dematiaceous hyphomycetes growing on lichen thalli have been found preserved in Oligocene Bitterfeld and Eocene Baltic amber. Non-destructive imaging using light microscopy has allowed detailed comparison with extant analogues. The fossil fungi are filamentous ascomycetes and represent several different morphologies. Some of them are very similar to some extant species of *Sporidesmium*, *Taeniolella* and *Taeniolina*. Extant lichen-associated taxa in these hyphomycete genera are saprotrophic or weakly parasitic. Several specimens of *Lichenostigma* found growing on crustose lichens of the genus *Ochrolechia* add true mycoparasites to these fossil associations. Our findings demonstrate that diverse filamentous ascomycetes grew on lichens in the Palaeogene. As the fossils are essentially identical to their modern analogues, the evolutionary associations between lichen-associated microfungi and their substrate must extend back much further, most probably to the Mesozoic.

29/05/2024, 11:00–12:20, Room: Virgo
A04 Glimpses of the evolution of Fungi

O-164 - Using new tools for the study of the early diversification of fungi and oomycetes

Christine Strullu-Derrien[1,2], *Alan RT Spencer*[3], *Raymond Wightman*[4], *Paul Kenrick*[1], *Sebastian Schornack*[5], *Andrew H. Knoll*[6]

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Cherts formed around hot springs and in volcanogenic settings preserve a remarkable record of early life on land. In particular, the Devonian Rhynie chert (Scotland, UK) preserves a uniquely informative record of early terrestrial ecosystems. Also, the Carboniferous Esnost and Grand'Croix cherts (Massif Central, France), of volcanic origin, provide insights into early forests. At these geological sites, fossil plants are preserved down to the cellular level together with associated fungi and oomycetes (fungus-like microorganisms). These deposits all offer a record of the earliest interactions between plants and microorganisms and how they adapted to the changing face of terrestrial habitats.

This fossil record of microorganisms has typically been studied using traditional brightfield microscopy. The development of fluorescence-based methods offers alternative approaches for improving image quality, modelling minute structures in three dimensions, and discriminating among different organic fabrics. We will show how Confocal Laser Scanning Microscopy (CLSM) can be used on fossils preserved in cherts to improve image clarity and to enable their digital reconstruction in three-dimensions. We will also introduce Fluorescence Lifetime Imaging (FLIM), which is allowing us to discriminate plants from fungi. These approaches enable us to document the interactions among organisms with unprecedented precision, and they offer a promising way to decipher the biological affinities of the microorganisms themselves (i.e., fungus versus plant versus oomycete).

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-165 - Additional Information on the anatomy and morphology of a basal euphyllophyte from the Early Devonian of Gaspe – New interpretations possible?

Patricia Gensel[1]

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An assemblage of vegetative and fertile axis fragments from an Early Devonian sandstone bed from the north shore of Gaspé Bay, Quebec includes axes varying in length, width, and branching. Branched or unbranched axes range from wide (4–10 mm) very ribbed axes to narrow (2–3mm) smooth to ribbed ones. Some broader axes divide anisotomously to produce narrow laterals in the 2–3 mm range, supporting the possibility that these represent parts of one taxon. Axes with dichotomizing laterals terminating in paired fusiform sporangia occur. Morphologically, most of these appear similar to *Psilophyton*.

Short lengths of axis are preserved by pyrite. Smaller axes exhibit endarch haplosteles and lateral trace departure typical of *Psilophyton*. Medium-wide axes exhibit haplosteles with primary and secondary xylem. Both exhibit a thick-walled outer cortex reflecting ribbing. One sequence of sections shows two steles within a single pyrite nodule, a medium-sized haplostele with secondary xylem that clearly had separated from a larger-diameter stele with abundant secondary xylem), the larger axis being equivalent in size to the wide, ribbed forms.

The morphologically and anatomically variable axes may represent parts of a plant referable to *Psilophyton,* another taxon, or more than one *Psilophyton*-grade euphyllophyte. While smaller axes, comparable to narrow laterals of some wide axes, resemble the anatomy of *Psilophyton,* larger ones appear more similar to other Early Devonian woody taxa. Whether or not these represent one taxon or more, these specimens provide another example of variability in euphyllophyte anatomical diversification, comparing well with some examples of evolution of cambial activity in early plants, suggested by Gensel (2018) as stepwise and explored

more extensively by Tomescu and Groover (2019) as being a mosaic. It also raises the possibility that many plant remains referred to *Psilophyton* may represent distal regions of larger, as yet unrecognized taxa or parts of several taxa.

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-166 - Steps toward improved understanding of early land plant evolution: Additional resolution of zosterophyll phylogenetic relationships

Pénélope Claisse[1], *Alexandru Tomescu*[2], *Eliott Capel*[1], *Borja Cascales-Miñana*[3]

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Zosterophylls are a Silurian-Devonian group characterized by simple branching axes with exarch xylem and laterally attached bivalvate sporangia with distal dehiscence. Because of their abundance in the fossil record, zosterophylls are considered the main component of Eophytic floras. Thus, several studies were aimed at understanding their history among vascular plants. The group was initially defined by Banks (1968) based on six taxa, as Subdivision Zosterophyllophytina, but today it includes >40 genera. This has led to an increasing disjunction between the original definition of the group and its current morphological diversity, which requires renewed assessment of phylogenetic relationships of the group and within it. However, the diversity of zosterophylls, coupled with the small number of characters available due to their simple morphology, has led to conflicting hypotheses of relationships supported by different phylogenies and an overall lack of resolution, which maintain taxonomic uncertainty. We attempt to alleviate these problems with the broadest phylogenetic analysis to date on zosterophylls. This analysis, coupled with ancestral character state reconstruction and time calibration, allows for reconstructing morphological evolution in the group. Results show that despite their broad morphological diversity, zosterophylls are part of a clade that excludes euphyllophytes and includes the lycopsids. These results add support to those of a previous analysis by Kenrick and Crane (1997), which resolved a close relationship between zosterophylls and lycopsids with well-supported groups, such as the Sawdoniales, within the former. Lycopsida is, then, considered the crown-group while the remaining taxa (zosterophylls) are stem-groups that became extinct during the Devonian. Results further lend support to a palaeogeographic distinction between two main zosterophyll clades, which explains previous contradictory results found in the literature. Eliminating some of the previous phylogenetic instability, our results provide an updated framework for studies of zosterophyll diversity and paleogeography.

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-167 - Characterizing and distinguishing the earliest woody euphyllophytes based on secondary xylem anatomy: Method development and applications

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The oldest vascular cambial growth (woody growth), traditionally known from Middle and Late Devonian lineages, has been recognized more recently in several Early Devonian (ca. 410–395 Ma old) euphyllophytes. Because these fossils preserve little aside from their secondary xylem, comparisons and taxonomic decisions about these plants are limited to comparisons of their wood anatomy. However, such comparisons can be inconclusive due to a lack of quantitative characters that capture the anatomical intricacies of wood anatomy (especially for early-developed secondary xylem) and variations in tracheid size as a function of distance from the primary xylem. We developed multiple metrics for quantifying tracheid size as a function of rank in the secondary xylem (i.e., position in a radial tracheid file) and tested them against a dataset of extant gymnosperm (conifer, gnetalean, *Ginkgo*) wood. This proof-of-concept phase allowed us to identify those metrics that show consistent trends in tracheid size vs position within, and distinguish between, taxa: tangential size of each tracheid in a file relative to that of the first (innermost) tracheid and relative to that of the preceding tracheid; average increase in tangential size per tracheid along a file; tangential tracheid size relative to its absolute distance from the origin of the file. While none of these metrics individually leads to conclusive comparisons among taxa,

when combined, they allow for distinguishing each taxon. Applied to Early Devonian fossils, these metrics separate unequivocally previously described woody taxa – *Armoricaphyton*, *Franhueberia* and *Gmujij* – from each other and from specimens with radially aligned xylem assigned to *Psilophyton*. Application of these new secondary xylem metrics to new, previously undescribed Early Devonian specimens from the Battery Point Formation (Quebec, Canada) that represent some of the oldest woody plants allows for more confident taxonomic placement, demonstrating their utility for future studies of early woody plants.

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-168 - New materials of Cladoxylopsida from the Middle Devonian of Yunnan Province, Southwest China

Jiajia Shen[1,2], *Pu Huang*[3], *Jinzhuang Xue*[2,4], *Zhuo Feng*[1,2]

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The Cladoxylopsida, a group of basal euphyllophytes spanning the Middle Devonian to Early Carboniferous, has been considered central to forming modern sphenopsids and ferns. New Cladoxylopsida specimens have been collected from the Middle Devonian Haikou Formation, Qujing City, Yunnan Province, Southwest China. The main axis of the specimens is upright and 8–15 mm wide. The lateral branches are helically located on the primary axis. The stem surface is marked with fine longitudinal striations. The decurrent bases are the widest, about 5–7 mm, and then flattened and tapered, with longitudinal fine stripes on the surface. Spines are present at the edge of the lateral branches. The base of the spines is about 0.6–1 mm wide and 1.5–1.8 mm long. The main axes have a highly dissected primary xylem column. The primary xylem in the main axes consists of numerous primary xylem segments; most segments radially elongate, some connected toward the center to form V, Y, W, or more complex-shaped groups. One protoxylem strand occurs near each of the two ends of individual xylem segments or segment groups. Circular bordered pits exhibit on the radial walls of the metaxylem tracheids. The new specimens can be classified into the Class Cladoxylopsida Pichi-Sermolli 1959 due to the above characteristics. Compared with other species, especially the occurrence of spines on the lateral branches, the new specimens probably represent a new taxon. This study enriches the diversity in the Haikou Formation of Middle Devonian in Southwest China, and provides new information for further understanding the anatomical structure and phylogeny of Cladoxylopsida.

Keywords: Cladoxylopsida, Middle Devonian, Haikou Formation, China

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-169 - Devonian flora evolution from West Junggar, Xinjiang, China

Bingcai Liu[1,2], *Kai Wang*[1,2], *Ruiwen Zong*[3], *Jiao Bai*[1,2], *Yao Wang*[4], *Ning Yang*[1], *Yi Wang*[1], *Honghe Xu*[1]

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The Devonian Period witnesses the great radiation of terrestrial vascular plants, which had profoundly affected and changed the Earth's ecosystem. The Middle to Upper Devonian of West Junggar, Xinjiang, China are well developed and yield abundant plant fossils, allowing a thorough understanding to their fossil floras. The Middle Devonian Hujiersite flora is dominated by herbaceous lycopsids, whilst the early Late Devonian Zhulumute flora consists of forest-forming plants. Here, a new late Late Devonian flora from the Hongguleleng Formation of West Yangzhuang and Kekesayi sections in West Junggar is recognized and is dated as the latest Famennian age based on palynology. The Hongguleleng flora contains *Frenguellia eximia*, *Helicophyton* sp. and unnamed lycopsids, and is comparable with those in Gondwana and South China paleoblocks. There were at least two floral

turnovers occurring in West Junggar during the Devonian. The first one occurred at the end of the Givetian age and saw the transformation of the Hujiersite flora that was dominated by herbaceous lycopsids into the Zhulumute flora of typical arborescent plants. The second turnover might be near the Frasnian- Famennian boundary and saw the forest of Zhulumute flora into the Hongguleleng flora that contains widely-distributed members.

29/05/2024, 11:00–13:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-170 - Measuring land plant diversity in deep time: Lessons drawn from the Devonian fossil record

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Quantification of plant diversity throughout geological time is notoriously biased by numerous factors. Some are almost universal in the fossil record (e.g., sampling and geological heterogeneity) and were recently highlighted to distort trajectories of early land plant diversity. Another problem which has been scarcely addressed in quantitative paleontology however, is the effect of time discretization on diversity patterns (i.e., where taxa co-occurring in the same time bin but in different areas actually coexisted). For the first time, the 'uniform time bin' approach was applied to counteract this effect, using a new comprehensive dataset recording both genus and species plant diversity, from the late Silurian to the earliest Carboniferous period. Overall, few differences were observed with total diversity, except in the longer stages of the Late Devonian, showing that it is not a deeply biasing agent. Nevertheless, other biases more specific to fossil plants (e.g., differential preservation of different structural parts) have thus far never been tested quantitatively. Analyses using preservation data and a newly-developed completeness metric allowed to disentangle their impact. Although species-level diversity does not seem to be less appropriate than the genus-level to describe diversity trends, both these ranks are gradually becoming increasingly based on fragmented parts throughout the Devonian, as plants increased in complexity and size. This makes plant diversity, originally based on near whole-plant concepts, difficult to compare with fossil-taxa diversity from the earliest Carboniferous period. Preservation biases are also prevalent in explaining this shift since anatomical features became progressively sufficiently diagnosable for identification and naming of fossils. Indeed, plants are rarely found permineralized in their earliest history, when they become common towards the end-Devonian. Although these biases may be in large part unique to this period, a careful analysis of these elements can be useful for quantification of plant diversity in succeeding geological time periods.

29/05/2024, 11:40–12:40, Room: Taurus
H08 Success and Adaptation Strategies of Ancient Populations to Climate Changes

O-172 - Agricultural practices during the middle and late Yangshao periods (6000–4500 BP) in the Guanzhong Basin, North China

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The middle and late Yangshao periods (6000–4500 BP) were pivotal for the emergence of early social complexity in prehistoric China. To date, the strategies employed by ancient people to overcome challenges posed by environmental changes and human society remain unclear. In this study, we employ flotation and plant stable isotope analysis at the Chakou site in Guanzhong Basin, situated on the southern margin of the Loess Plateau, to elucidate human adaptation strategies during this early period. Our findings demonstrate that common millet dominated early agriculture from 5700–4900 BP, with manuring practices implemented to address increasing population pressure. During the late Yangshao period (4900–4500 BP), foxtail millet became the predominant crop in the region. Despite a northward shift in archaeological centers, similar levels of manuring intensity were maintained. Charred millet samples revealed widespread utilization of manuring between 6000–4500 BP in northern China, with particularly high levels observed in Guanzhong Basin as indicated by stable nitrogen isotope values (δ15N). Synthesizing data from 37 site studies, our analysis demonstrates that after 5000 BP, foxtail millet accounted for a higher proportion than common millet among archaeological sites in northern China; however, prior to this timeframe, common millet was more prevalent. These adjustments in agricultural strategies suggest an endeavor by middle-late Yangshao communities to ensure sustainable development of agriculture and lay

foundations for early civilizations and social complexity across northern China. Furthermore, our study results may contribute valuable insights towards addressing contemporary challenges posed by unprecedented climatic and social transformations.

29/05/2024, 11:40–12:40, Room: Taurus
H08 Success and Adaptation Strategies of Ancient Populations to Climate Changes

O-173 - Holocene climate change in the Altai Mountains and its implication for human activities

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Genetic and archaeological evidence shows that an increased human population and long-distance socioeconomic exchanges in the Altai-Sayan region of Central Asia occurred in the early Bronze Age, some five thousand years ago. However, the local/regional environmental and climatic drivers behind the enhanced cultural exchanges between east and west are poorly understood. We obtained a multiproxy-based Holocene climate history from the sediments of Kanas Lake and neighboring Tiewaike Lake, in the southern Altai Mountains, with the objective of determining the role of climate change in human migration and cultural exchanges. Records of the silicon isotope composition of diatom silica ($\delta^{30}Si_{diatom}$) and the biogenic silica (BSi) content indicate an exceptionally warm climate during ~6.5–3.6 kyr BP. During 4.7–4.3 kyr BP, especially, a peak in $\delta^{30}Si_{diatom}$ reflects enhanced lake thermal stratification and periodic nutrient limitation as indicated by concomitant decreasing BSi content. Supported by the widely-recorded humid climate of the middle to late Holocene in arid Central Asia, our geochemical results indicate a significantly warm and wet climate in the Altai Mountain region during 6.5–3.6 kyr, which promotes an increased prehistoric human population of pastoralist early Bronze Age Afanasievo Culture (~5.1–4.5 kyr) that migrated from the Yamnaya Culture (~5.5–4.5 kyr). Intriguingly, this unusually warm climatic interval (4.8–3.6 kyr) is simultaneous with the appearance of the thermophilic algal species *Pediastrum simplex* in Bosten Lake in southern Xinjiang. The climate cooled during 4.2–4.1 kyr and 3.6–3.5 kyr, as indicated by the decrease or absence of *Pediastrum simplex*. These cold events may have triggered the southward human migration out of the Altai region, resulting in the widespread distribution of archaeological sites at lower latitudes, in the Tienshan Mountains, and in the desert-oasis areas of the Tarim Basin in southern Xinjiang.

29/05/2024, 12:20–13:00, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-174 - Whole plant reconstruction of Tingia unita Wang from the Earliest Permian peat-forming flora, Wuda Coalfield, Inner Mongolia

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Tingia Halle 1925 is one of the typical genus in the Cathaysia Flora, whereas its affinity, along with the whole order Noeggerathiales Nemejc 1931, has long been uncertain. *T. unita* was established based on a tree crown illustrating the organic connection of the once compound leaf and pseudostrobilus, and it is among the very few species of Noeggerathiales that have both known fertile and sterile parts for certainty. A large collection of *T. unita* since its discovery has been accumulated, including various parts of the whole plant from the Asselian peat-forming flora in the Wuda Coalfield of Inner Mongolia (Chinese "vegetational Pompeii"), and therefore, a fully on-depth investigation appears feasible and would certainly promote our understanding of the systematic position of the enigmatic group Noeggerathiales, of which *Paratingia wuhaia* Wang et al. has been evidenced to be progymnosperm. Here we present a full documentation of the whole plant reconstruction of *T. unita*, which may represent the best-known taxon in the genus *Tingia*, and the second best known taxon in Noeggerathiales, next to *P. wuhaia* Wang et al. 2021. The gross morphology, heterospory and in-situ spore morphology, homology of leaf and strobilus, anatomy of leaf rachis and strobilus axis and the major stem and, sporophyll arrangement are all basically known, and conform its affinity to progymnosperms, like *P. wuhaia*. It is an understory tree in the coal swampy forest, approaching the height of tree ferns, with *Sigillaria* Brongniart forming the upper storey, contributing considerably to the biomass of the coal swampy vegetation.

29/05/2024, 12:40–13:00, Room: Aquarius
C03 Palaeobotanical Studies from Southern Afrrica

O-176 - Elucidating Oligo-Miocene palaeoenvironmental reconstructions along the southwestern coast of South Africa and their correlation with variations in sea level

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The Elandsfontyn Formation at Langebaanweg (LBW), located on the southwest coast of South Africa provides a record of Oligocene-Miocene vegetation history leading to the development of the Fynbos Biome of the Cape Floristic Region during the Plio-Pleistocene. The exact timing of biome evolution and drivers of vegetation change – possibly sea level fluctuations, oligotrophic soils, palaeoclimatic change and the associated development of the Benguela Upwelling System (BUS) – remain contentious. We aim to delineate the evolution of the Fynbos Biome during the late Palaeogene and early Neogene of southern Africa by re-assessing Core BH2 from the Elandsfontyn Formation. Standard palynological processing was applied to macerate palynomorphs, followed by light microscopy. Palynomorph fluctuations were recorded and statistically analysed with Detrended Correspondence Analysis (DCA). Palynological and DCA results indicate the existence of a (sub)tropical forest dominated by Podocarpaceae, palms, vines and ferns, alluding to wet conditions during summer rainfall. Patches of proto-fynbos with Ericaceae and Proteaceae presumably formed an understorey component of the (sub)tropical forest and co-fluctuated with forest elements. As the forest retreated, wetlands comprising Sparganiaceae, Restionaceae, Cyperaceae and Poaceae became common. Marine fluctuations, with possible links to global late Oligo-Miocene sea level changes are indicated by three marine transgressions in the *Apteodinium spiridoides* zone (18.96–18.24 m) and a final transgression in the *Operculodinium centrocarpum* zone (16.865–13.4 m). These transgressions correspond with major transgression events that occurred 24 Mya (late Oligocene) and 21 Mya (early Miocene). Increasing marine fluctuations and aridity at the Oligo-Miocene boundary (23 Ma) reduced the forest even further, replacing it with a proto-savanna woodland consisting of Combretaceae and *Brachystegia* (*Peregrinipollis nigericus*), together with persistent proto-fynbos. This study affirms that sea level fluctuations and other palaeoenvironmental factors were instrumental in altering the (sub)tropical forest with a proto-fynbos to the current fynbos ecotone at LBW.

29/05/2024, 14:30–15:30, Room: Aquarius
C03 Palaeobotanical Studies from Southern Afrrica

O-177 - Vegetation dynamics in southeastern Africa over a span of 16,000 years: Insights from a marine core extracted from Delagoa Bight, Mozambique

Frank H. Neumann[1], *Annette Hahn*[2], *Charlotte Miller*[2], *Louis Scott*[3], *Enno Schefuss*[2], *Lydie Dupont*[2], *Jemma Finch*[4], *Hayley Cawthra*[5], *Francois Engelbrecht*[6], *Andrew Green*[7], *Matthias Zabel*[2]

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A marine pollen record (GeoB20615-2) from Delagoa Bight, offshore of Mozambique, unveils fluctuations in vegetation over the past approximately 16 thousand years (ka), shedding light on a period that has generally lacked published records in southeastern Africa. The chronology relies on 12 radiocarbon dates derived from planktonic foraminifera, terrestrial organic remnants such as seeds, and gastropod shells. Prior to approximately 15 ka, there was a prevalence of high percentages of fynbos elements, particularly Ericaceae, indicating low temperatures, while forest or woodland taxa were minimal or absent. From around 13 ka BP onwards, there was a gradual increase in savanna taxa like *Spirostachys* and *Burkea*, suggesting climatic warming. The early Holocene period

around 11.5 ka BP and 8.5 ka BP is marked by heightened levels of *Spirostachys* pollen, a woodland tree thriving in dry, warm regions with poorly drained soils along water courses. A decline in *Spirostachys* pollen after 8.5 ka BP corresponds with a rise in *Podocarpus* pollen, indicating a potential expansion in coastal and/or montane forests, possibly reflecting increased moisture availability. From approximately 3.5 ka BP, *Podocarpus* values decline, likely due to slightly more arid conditions, as indicated by the increase in Amaranthaceae, Asteraceae, and *Spirostachys* pollen. The rise in sea surface temperatures in the Mozambique Channel from around 7 to 4 ka BP may have caused these precipitation shifts. The youngest section of the profile from around 0.25 ka BP onwards reveals the impact of European colonialists, with the appearance of pollen from pines, a typical neophyte, and an increase in indigenous *Alchornea*, a disturbance indicator.

29/05/2024, 14:30–15:30, Room: Aquarius
C03 Palaeobotanical Studies from Southern Afrrica

O-178 - Fieldwork though heat, fire and torrential rain in search for Jurassic successions and lemurs, or … The Jurassic paleobotany and palynology of Madagascar

Vivi Vajda[1], *Claudine Norovelo*[2], *Nicolas Rakotosolofo*[3], *Hery Lisy Ranarijaona*[3], *Sylvain Razafimandimbison*[4]

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4 Swedish Museum of Natural History, Botany, Stockholm, Sweden

The geological history of Madagascar is crucial for understanding the origins of its plant and animal life. The island split from continental Africa some 165 million years ago during the Jurassic. This separation resulted in Madagascar and its unique flora and fauna developing independently from other landmasses. There is a limited number of paleobotanical investigations, with the majority conducted in the 1960s and 1970s by Otto Appert. Appert's Mesozoic research focused on describing assemblages from Upper Jurassic (Oxfordian) strata of the Manamana Massif in southern Madagascar. The dominant components of these fossil plant assemblages include ferns from the Dipteridaceae family, conifers from the genera *Brachyphyllum*, *Elatocladus*, *Cupressinocladus*, *Cyparissidium*, and *Araucarites*, together with smaller quantities of "seed ferns".

The palynological findings from two exposed sections in the Mahajanga Basin indicate the presence of well-preserved spore-pollen assemblages that are exclusively of terrestrial origin. The older assemblage is composed mostly of spores from ferns and lycophytes, such as *Cyathidites*, *Baculatisporites*, *Dictyophyllidites*, *Ceratosporites*, and *Retitriletes*. In contrast, the younger assemblage consists mainly of gymnosperm pollen, which makes up around 70% of the assemblage. The pollen genera *Classopollis*, *Araucariacites*, *Perinopollenites*, and *Callialasporites* are the most common within the gymnosperms. The assemblage belongs to the *Corollina torosa* Zone of Helby *et al*. (1987), which corresponds to the Early Jurassic, possibly Pliensbachian–early Toarcian. The floras of the time, such as those found in Sweden and Australia, show a remarkable similarity, indicating a globally consistent vegetation pattern that persisted for millions of years in a stable environment. This similarity is also observed in the Late Jurassic, as described by Otto Appert.

29/05/2024, 14:30–15:30, Room: Aquarius
C03 Palaeobotanical Studies from Southern Afrrica

O-179 - Last Interglacial climate variability on the Cape south coast of South Africa through the integration of phytolith and leaf-wax data

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The South Cape region of South Africa holds significance for investigating ecosystems and the dynamics of human evolution. This area belongs to the Mediterranean-type ecosystem with mild wet winters and warm dry summers, featuring crucial archaeological sites characterized by well-dated, extensive depositional sequences and excellent material preservation. This research focuses on three such sites – Pinnacle Point 13B, Pinnacle Point 5–6, and Knysna Eastern Heads 1. Utilizing phytoliths and leaf wax n-alkanes, we examine human behavioral adaptations from a botanical perspective and explore their relationship with the surrounding environment from Marine Isotope Stage (MIS) 6 to the middle Holocene. Our approach involves analyzing, synthesizing, and harmonizing the connections between these techniques, creating a coordinated sampling strategy. Through this, we aim to offer an improved understanding of plant recognition, enhancing our ability to infer past climates and environments. This, in turn, helps us comprehend preservation conditions, plant resource availability, and the utilization of plants by ancient hunter-gatherer populations.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-180 - New findings on Eocene paleobotanical record of Panama

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Uncovering the paleobotanical record of the Paleogene of Central America is important to understand the composition of the earliest forests in the region. The Azuero peninsula in Panama shows paleobotanical richness, where we can find abundant petrified wood, well preserved permineralized seeds, and a few localities with leaf impressions. Most of the studied areas compile fossils from localities mapped as Oligocene to Miocene (30–23 Ma) as part of the Santiago Formation, but areas exposing Eocene plants are less common and have been scarcely investigated. For example, the Bucaro beach, where the late Eocene-early Miocene Tonosi Formation is exposed, has only been studied by Herrera and collaborators to date. They reported permineralized endocarps collected from the upper member of this formation of families such as Arecaceae, Vitaceae, Humiriaceae, Anacardiaceae, and Lamiales. Two of the discovered fossil taxa, *Dracontomelon* and cf. *Leea*, occur today only in lowland rainforests of the Old World. We have conducted two projects from 2017 to 2022, aiming to update the geological map of the Azuero Peninsula, through the addition of new geochronological, biostratigraphic, and palynological data and to reconstruct the paleofloristic composition of the forests, based on petrified wood specimens from different geological epochs in the Peninsula. We included a collection of Eocene wood samples for the first time in Panama, which we first attempted to identify using standard petrographic sections. Preliminary results show the occurrence of Moraceae, Leguminosae and Arecaceae. However, the preservation did not allow a finer identification of the samples, therefore, we are adding Scanning Electronic Microscope imaging which supported the suggested affinities. The evidence represented in the permineralized endocarps and preliminary identities based on woods suggest a rainforest environment in Panama during the Eocene. Our project contributes significant novel information on the early rainforests of Panama and its geological and paleobiological scenario.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-181 - The Eocene flora of the Paris Basin: Contribution of fossil wood from Cuise-La-Motte (Oise)

Anaïs Boura[1], *Marin Gangneux*[2], *Nicolas Gentis*[2], *Régnier Camille*[2], *Gabriela Lo Bue*[2], *Nyniane Steinkampf–Pellecuer*[2], *Dario De Franceschi*[2], *Cédric Del Rio*[2]

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Eocene macroflora from Paris Basin is known thanks to several deposits that have been partially studied mainly for taxonomical studies (e.g.,Icacinaceae, Menispermaceae): Le Quesnoy (MP7), Passy (MP8–9), Grès de Belleu (MP10) and Prémontré (MP10). For the moment, more attention has been paid to fruit and seed, although these deposits sometimes contain large quantities of fossil wood (i.e. Le Quesnoy). Other sites containing only fossil wood have been generally overlooked. This is the case of the historical stratotype of Cuisien (Upper Ypresian) at Cuise-La-Motte (Oise). This locality is particularly noteworthy for its great diversity of marine, brackish and freshwater molluscs. But the site also contains a large quantity of fossil wood, which has so far only been very partially studied. The Cuise-La-Motte site was first studied by P-H Fritel (1867–1927) in the 20th century. He highlighted the excellent state of preservation of the fossil wood and described four taxa belonging to *Quercinium*, *Cupressinoxylon*, *Pitioxylon* and *Piceoxylon*. Later, Koeniguer described two new specimens that he attributed to *Taxodioxylon* and *Palmoxylon*. The work of the AESSFG (Association for the Study and Protection of Fossil and Geological Sites) has revived the paleobotanical interest in the Cuise-La-Motte site. For several years now, members of this association have been collecting dozens of fragments of fossil wood. This new collection complements the collections already held at the MNHN in Paris (e.g., Fritel and Braillon collections). A study of all the samples from Cuise-La-Motte, from the historical collections and the new collection, revealed a much greater diversity than previously thought. Of the 70 specimens studied, 20 morphotaxons were identified. Half were conifers belonging to the Pinaceae, Cupressaceae and Podocarpaceae, while the others were broadleaved trees belonging in particular to the Combretaceae and Symplocaceae. This study adds to our understanding of the evolution of flora during the Ypresian.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-182 - New fossil woods from the Milá stratovolcano (upper Oligocene): First evidence of Pinaceae and Fagaceae in the fossil wood record of the České Středohoří Mts. (Czech Republic)

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The youngest palaeobotanical record of the České středohoří Mts. (Bohemian Massif, Czech Republic) was recently described from the upper Oligocene of the Milá stratovolcano. Two conifers: *Taxodioxylon gypsaceum* (Cupresaceae s.l.) and *Pinuxylon parryoides* (Pinaceae) and two angiosperms: *Quercoxylon böckhianum* and *Castanoxylon bavaricum* (both Fagaceae) were identified in the volcanoclastic sediments of the Dobrná Formation. They represent the first occurrence of Pinaceae and Fagaceae fossil wood in the volcanic rocks of the České Středohoří Mts.

In addition, one angiosperm specimen of unclear origin, found nearby, but separately from the others with clear signs of transport through the riverbed, was identified as *Lithocarpoxylon* sp. (Fagaceae). Although *Pinuxylon parryoides* was originally compared by Gothan (1911) with the woods of section *Parrya* (subgenus *Strobus*), but its nearest living relative is not clear. An important variability in anatomical features of *T. gypsaceum*, together with decreasing number of tangential rows of earlywood vessels towards the stem margin observed in ring-porous Fagaceae, allows the discussion of the pitfalls of systematic palaeobotany. The research was supported by Cooperatio Programme Research Area GEOL and SVV (both Charles University).

Gothan, W. 1911. Über Braunkohlenhölzer des rheinischen Tertiärs. Jahrbuch der Königlich Preussischen Geologischen Landesanstalt 30 (1), 516–532.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-183 - Anatomically preserved wood of Pseudotsuga (Pinaceae) from the Lower Miocene of Lesvos, Greece, and its palaeogeographical and palaeoclimatic implications

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*Pseudotsug*a, commonly known as Douglas-fir, is a small genus of Pinaceae, encompassing four to six extant species, and exhibiting a disjunctive distribution in East Asia and western North America. *Pseudotsuga* possesses a limited fossil record of needled leaves, seed cones, and seeds; however, reliable fossil wood of this genus is extremely scarce in the geological past. In this study, we describe a new fossil species of *Pseudotsuga* as *P. lesvosensis* sp. nov. based on anatomically well-preserved petrified wood from the Lower Miocene of Lesvos Island, Greece. It is primarily characterized by the presence of axial and radial resin canals, as well as distinctive helical thickness in cell walls, lower rays, a greater number of secretory cells, and distinct helical thickenings. The presence of *P. lesvosensis* is not only the first report of *Pseudotsuga* in southern Europe, but also represents the second fossil wood record of the genus, extending the palaeogeographic distribution range of *Pseudotsuga* and offering new insights into the origin and evolutionary trend of this genus. The discovery of the current fossil conifer further enriches the species diversity of the Miocene petrified forest in Lesvos. The occurrence of *Pseudotsuga lesvosensis* fossil wood, combined with other palaeontological fossil evidence, indicated that the palaeoclimate in the Early Miocene of Lesvos was humid warm temperate to subtropical condition, which was completely different from the current Mediterranean climate.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-184 - New angiosperm woods and wood-decay fungi from the early Miocene Petrified Forest of Lesvos, Greece

Nicole Garten-Dölle[1], *Carole T. Gee*[1], *Nikolaos Zouros*[2], *Ilias Valiakos*[3]

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2 *University of the Aegean, Geography, Mytilene, Greece*
3 *Natural History Museum of the Lesvos Petrified Forest, Natural History Museum of the Lesvos Petrified Forest, Sigri, Greece*

The Petrified Forest of Lesvos is known for its impressive assemblage of upright tree trunks and fallen logs. The fossil trees were embedded in situ by several volcanic eruptions in the early Miocene. They are mostly well preserved, and research has been carried out on the standing trunks, wood, and leaf impressions. Through this research, it is known that a mixed forest of conifers and angiosperms existed on Lesvos some 17 million years ago. While most conifers have already been identified, little is known about the angiosperm trees. Here we present several species among the angiosperm woods: at least two different *Laurinoxylon* species, *Populoxylon*, and *Platanoxylon*. Moreover, we have found evidence for decay fungi in *Laurinoxylon* and *Populoxylon*. Common to all *Laurinoxylon* species is the presence of oil cells. Depending on the position of the oil cells, different groups of *Laurinoxylon* can be differentiated. Typical features for *Populoxylon* are exclusively uniseriate rays and medium-sized, rounded to angular, vessel-ray pits with much reduced borders. A special trait in the Lesvos poplar wood is the occurrence of prismatic crystals in the parenchyma, which is a very rare character among the Salicaceae. The genus *Platanoxylon* is easily to identify by its huge rays that are 10-seriate and over one millimeter high. This species can be considered as a new addition to the Miocene flora of Lesvos, as it has not been previously formally described from leaf and wood floras. With our results we provide deeper insight into the angiosperm flora growing in the mixed forests on Lesvos during the Miocene.

29/05/2024, 14:30–16:30, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-185 - Revealing the Cenozoic Petrified Forest of the Northeast Aegean Sea, Eastern Mediterranean: Lesbos, Lemnos and Gökçeada (Imbros) islands

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The investigation of crucial periods of Earth's history, such as the Miocene Climate Optimum (MCO) through the study of fossil wood anatomy is important for understanding the evolution of terrestrial palaeoenvironments.

Lesbos and Lemnos islands, located at the eastern part of the Aegean Sea, are well known for their Petrified Forests, the detailed palaeoxylotomical study of which reveal continuously valuable information regarding the palaeovegetation (Cupressaceae, Ginkgoales, Pinaceae, ?Podocarpaceae, Taxaceae, Arecaceae, Betulaceae, Cornaceae, Ebenaceae, Fagaceae, Jaglandaceae, Lauraceae, Platanaceae), palaeoclimate and palaeoecology of their numerous fossiliferous localities.

A new fossil wood assemblage of middle Miocene age from Gökçeada island with similar geology of Lesbos and Lemnos islands and in close vicinity with them, has extended the limits of the natural laboratory of the MCO to the broader area of the northeast Aegean, as well as our knowledge on the terrestrial palaeofloristic environments of this age and on the ecological signals of wood anatomy revealed from the biotic (arthropods, fungi), plant-insect interactions patterns) and abiotic factors (volcanism, light stress, rapid flooding) and the detailed anatomical studies of the material (Cupressaceae, Ginkgoales, Pinaceae, Arecaceae, Betulaceae, Fagaceae, Lauraceae, Platanaceae). Moreover, high amount of Lauraceous woods together with *Cupressinoxylon, Juniperoxylon, Pinuxylon, Platanoxylon, Alnoxylon, Fagoxylon, Ostryoxylon, Eucarpinoxylon* may show the presence of subtropical conditions, which have seasonality in Gökçeada.

The research on the Cenozoic eastern Mediterranean fossil wood hotspot (namely: Lesbos, Lemnos and Gökçeada islands) the last decade together with the reevaluation of historical and type material from the area hosted in european Museum collections has provided new insights on the palaeoxylotomical data (e.g. findings of extinct clades), the continuation of an extended study on wood idioblasts along with new extinct (?) species of an agromyzid cambium miner related to *Hesperocyparis-Xanthocyparis-Callitropsis* clade (genus host-specific arthropod herbivory during the endophytic phase of phytophagy).

Keywords: fossil wood anatomy, Petrified Forest, Aegean islands.

29/05/2024, 14:30–16:30, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-186 - Mutations in land plants during mass extinction events linked to large igneous provinces

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Magmatic activity during the formation of large igneous provinces (LIPs) are believed to have caused several major and minor mass extinction events in Earth's history. Volcanic emissions from LIPs affected land plant communities in a myriad of ways, including climate warming from CO_2 emissions, short-term cooling due to SO_2 emissions, acid rain, wildfires, sea-level changes, inhibition of photosynthesis from the release of aerosols, increased UV-B radiation due to thinning of the ozone layer by release of halocarbons, and toxic pollution including polycyclic aromatic hydrocarbons (PAHs), mercury (Hg), and other heavy metals. Alone, or cumulatively, these stressors caused ecosystem reorganizations and extinctions in terrestrial plant communities as recorded by palynological records. One of the more enigmatic features in palynological records contemporaneous with several LIP-associated extinction events is the presence of mutated spores and pollen. The mutations include various degrees of morphological malformations in dispersed specimens to fused tetrads in both spores and pollen. Different hypotheses have been put forward

regarding the causality behind the mutations, including increased UV-B radiation and Hg-poisoning. Here we review and compare the occurrence of mutated spores and pollen during two of the "Big Five" mass extinction events, namely the end-Permian and the end-Triassic mass extinctions and discuss the implications and causality of the mutagenesis.

29/05/2024, 14:30–16:30, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-187 - Continental-scale charring of biomass during the end-Triassic mass-extinction event

Teuntje Hollaar[1], Bas Van De Schootbrugge[1], Jurre Vermeer[1], Remco Bos[1], Matthew Kent[2], Jeffrey Benca[3], Thijs Vandenbroucke[4], Cynthia Looy[3], Ivo Duijnstee[3], Sofie Lindstrom[5], William Meredith[2], Claire Belcher[6], Stephen Hesselbo[7], Barry H. Lomax[2]

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Two-hundred-million years ago, the emission of an estimated 100,000 Gt of CO_2 during pulsed eruptions in the Central Atlantic Magmatic Province provoked large scale changes in Earth system functioning. These changes had dire consequences for the biosphere resulting in one of the largest extinction events of the Phanerozoic. Charcoal and Polycyclic Aromatic Hydrocarbons (PAHs) records suggest that extreme climate warming triggered widespread wildfires. Palynological assemblages exhibit remarkable darkening of pollen and spores that cannot be explained by thermal maturation during burial. Here, we investigate this latest Triassic "dark zone", using the Palynomorph Darkening Index (PDI) obtained from trilete fern spores and *Classopollis* pollen in cores from Germany (Schandelah-1) and the United Kingdom (ICDP Prees-2). Coinciding with a collapse of forest vegetation and the spread of pioneer fern vegetation, the fern spores' PDI reaches peak darkness in the uppermost Triletes Beds from Germany and in pollen from the upper Lilstock Formation in the UK. Fourier Transform Infrared Spectroscopy (FTIR) analyses of isolated fern spores do not support a role for UV-B in the darkening. Instead, palynomorph darkening is consistent with widespread wildfire activity and increased soil erosion. Controlled heating experiments of *Lycopodium* spores followed by PDI analyses suggest that palynomorphs experienced heating in the region of 400–600 °C, that we suggest is consistent with frequent surface fires carried in fern savannahs. The ensuing extreme soil erosion during wetter intervals resulted in mass removal of charcoal in coastal sediments. Together with records of this phenomenon from numerous palynological studies across NW Europe, our results provide empirical evidence for continental-scale charring of biomass during the height of the end-Triassic mass extinction.

29/05/2024, 14:30–16:30, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-188 - Teratology in conifer pollen points to volcanism driving pollution and carbon cycle during the end-Triassic extinction

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Establishing a causal link between past mass extinction events and their impact on groups of organisms or individual taxa, beyond basic chronostratigraphic and chemostratigraphic correlations, is a complex task. The end-Triassic mass-extinction (ETME; 201 Ma) is linked to the emplacement of the Central Atlantic Magmatic Province (CAMP) which significantly impacted both marine and

terrestrial ecosystems. The ETME is marked by two major negative carbon isotope excursions (CIEs), generally linked to CAMP volcanism and the associated release of CO2 and other volatiles into the atmosphere. Palynological analysis of sediments from St Audrie's Bay, Somerset, UK reveal a variety of malformations in conifer-produced *Classopollis* pollen. We have identified various types, including unseparated pollen, darker and/or dwarfed ones, and pollen with orbicules. High abundancies of malformations are contained within the interval identified as the "initial CIE" (onset of the ETME). Our study thus highlights the connection between major perturbations of the carbon cycle and their effects on terrestrial ecosystems through the analysis of malformed pollen grains from a broadly distributed gymnosperm group from a key ETME section. The correlation of these in vivo growth abnormalities with established and experimentally verified environmental triggers, concurrent with the Initial CIE, faunal changes and environmental shifts, allows us to establish cause-and-effect relationships. These findings demonstrate that malformed pollen grains are indicative of CO2-induced climatic changes impacting terrestrial flora, evidenced by widespread changes in the carbon cycle. Our research underscores the role of these malformations as indicators of climate change, providing valuable insights into the terrestrial impacts of carbon cycle disturbances during significant extinction events.

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B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-189 - Mercury analyses of fossil plant substrates as indicators of Jurassic atmospheric Hg loading and volcanism

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Large Igneous Province (LIP) volcanism emitted volcanic rocks onto the surface and large amount gasses into the atmosphere, and often induced fast-paced hyperthermal events and mass extinctions. However, it is difficult to reconstruct the individual volcanic pulses and the subsequent environmental responses. Previously, elevated levels of bulk sedimentary mercury concentrations across stratigraphic archives have been used as indicators of past large-scale volcanic activity, as volcanism is the largest source of natural Hg emission in the present-day environment. But this proxy is highly dependent on and impacted by variations in dominant lithology and/or depositional environment, and its usefulness is therefore debated.

Here, we present a new approach to reconstruct changes in past Hg-fluxes, more specifically past atmospheric Hg-concentrations, by analysing Hg-levels in modern and fossil leaf tissue. Terrestrial flora acts as an intermediate sink in the natural mercury cycle and importantly, leaves gain their Hg-concentration dominantly through direct atmospheric uptake. The adoption of fossil leaf material as a past atmospheric mercury proxy is here tested as an independent approach to the validation of mercury as a proxy for past volcanism.

We present new results on (i) the natural variability of Hg-concentration in modern *Gingko biloba* leaves, and (ii) the possible impacts of changes in pCO_2 conditions on leaf-Hg-concentrations utilizing leaves that were grown during controlled growth-chamber experiments. Subsequent analyses of the Hg-concentration in Early Jurassic fossil leaf-cuticle and wood fragments from two stratigraphic successions, spanning the Triassic–Jurassic transition at Astartekløft (Greenland) and the Toarcian interval in the Mochras core (Cardigan Bay Basin, UK), show 2–3 orders of magnitude variability in plant Hg-concentrations, significantly larger than the here observed natural variability. This suggests that plant tissue may be used to examine geochemical (Hg) variations in past atmospheres, and thus tracing possible temporal occurrences of past volcanic events.

O-190 - Imprint fossils of nannoplankton from intervals of past global warming

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Sedimentary strata spanning global warming intervals in the geological archive commonly record abundance declines in calcium carbonate ($CaCO_3$) and nannofossils. This has been observed for many events, including the end-Triassic mass extinction (ETE; ~201 Ma), the Mesozoic oceanic anoxic events (OAEs) and the Paleocene-Eocene thermal maximum (PETM; ~56 Ma). To explain these $CaCO_3$ and nannofossil abundance declines, many studies have invoked hypotheses of biotic responses of marine calcifiers to changes in seawater pH, temperature and oxygen-levels, among other reasons. However, the extent to which $CaCO_3$ diagenetic dissolution has played a role has remained difficult to determine. Investigations of imprint, or "ghost", fossils of nannoplankon preserved on organic matter represent a relatively new approach to examine the degree of diagenetic $CaCO_3$ dissolution, because unlike classical nannofossil analyses, ghost nannofossils can preserve in rocks without $CaCO_3$. Where this is the case, ghost nannofossils can therefore show that $CaCO_3$ has been removed from the rock record after deposition. So far, we have examined material from the ETE, OAEs and PETM, finding that the sedimentary strata spanning these events have undergone notably different diagenetic histories. Our studies show how fossil imprints of nannoplankton on organic matter can be used as a complementary approach alongside classical palynological preparations to better understand the taphonomic histories of several episodes of global warming in the geological record.

O-191 - Malformed and darkened: How teratology tells the story of the Toarcian in the North German Basin

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The Toarcian hyperthermal (~183 Ma) is characterized by widespread ocean deoxygenation coinciding with a global perturbation of the carbon cycle, suggesting changes in atmospheric composition, notably pCO_2. The effects of these changes on terrestrial vegetation remain poorly studied and understood. Here, we focus on teratology in pollen and spores in samples from the Schandelah-1 core, drilled in the North German Basin, spanning the entire Toarcian "Posidonienschiefer" Formation. We study the multifaceted effects of the Toarcian hyperthermal on the frequency of unusual spores and pollen grains production. Our analysis of the Schandelah-1 core reveals diverse malformations across different plant groups, although not in statistically significant elevated quantity. Nevertheless, the quantitative analysis highlights a notable surge in malformed fern spores (e.g. shape, size, and colour variation), of the *Deltoidospora* type, and significant variations in shape and size of Cheirolepidiaceae conifer pollen, of the *Classopollis* type. Morphological variations were observed before, during, and after the Toarcian hyperthermal, showing a higher sensitivity in certain genera relative to others in recording the extensive biotic crisis and an overall vegetation-scale ecological stress. This environmental instability has been tentatively linked due to the magmatic activity of the Karoo-Ferrar Large Igneous Province resulted in an increase in CO_2 and sulphur compounds into the atmosphere, causing temperature changes, humidity shifts, acidic rain and ozone depletion harmful to plants, making it difficult to understand which factor(s) is responsible for the malformations. Geochemical data and sedimentological assessments corroborate the preliminary teratological findings coinciding with the hyperthermal event. Amidst ongoing debates about the causes of malformed sporomorphs (ranging from volcanic gases to genotoxic substances, increased UVB-irradiation, and polyploidy) the field of palaeoteratology sheds light on the intricate ecological dynamics of the Toarcian hyperthermal, but also underscores the remarkable mechanisms exhibited by plant life in response to significant environmental disruptions.

O-192 - Exploring human impact on the environmental evolution of the Paliouras Lagoon in Macedonia, Greece

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The Paliouras coastal lagoon in Halkidiki (Greece) is a valuable site for investigating environmental changes and human impact over the past 4000 years. The Halkidiki peninsula witnessed human activities since the Neolithic period and hosted numerous civilizations during the last millennia. The area of Paliouras, located at the northwest part of the peninsula, close to Thessaloniki, experienced strong urbanisation from the Macedonian kingdom onwards.

Here we present a high resolution palynological study that improves our understanding of the lagoon's ecological evolution and human influence by combining pollen data with detailed historical sources. The pollen spectra reveal an environment characterised by Mediterranean vegetation, mixed deciduous forests, and pine stands from the Late Bronze Age until the 11th century CE. The Archaic period marks the initial signs of human impact, evident through the expansion of *Olea*, *Castanea* and *Vitis* in the inland areas of the study zone. Roman times experienced an intensive land management, marked by arboriculture and cereal cultivation (*Secale* and *Hordeum* group). Late Antiquity-Early Medieval times are characterised by reduced human pressure due to political-economic crises. As a consequent, the pollen record shows the expansion of forest and the abandonment of fields. A notable shift occurred during the Ottoman period, reflecting a substantial increase in pastoral activities, as indicated by high percentages of Cichorieae pollen, attributed to the immigration and establishment of nomads, and to the demographic growth of the nearby city of Thessaloniki in the 16th century CE.

Our study contributes to the knowledge of environmental history of the Halkidiki peninsula, showing the complex interaction between vegetation, climate and human activity in shaping the landscape. Combining pollen data with meticulous historical information, we offer a significant contribution to the study of paleopalynology in the coastal areas of the Mediterranean basin during the Holocene.

O-193 - Palynological analyses at the UNESCO pile-dwelling site Palù di Livenza (Northern Italy): New on-site and off-site data and preliminary land cover reconstructions

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Palù di Livenza is a pile-dwelling site in Friuli Venezia Giulia, Northern Italy, inscribed in the UNESCO world heritage list in the category "Prehistoric pile-dwellings around the Alps". The Late Neolithic village is dated at ~7000–5000 years BP and is one of the most interesting examples of prehistoric adaptation to changing climatic-environmental conditions, with stimulating analogies to the present. The main aims of the palynological study are reconstructing vegetation changes and human influence on the landscape and obtaining land cover maps from palynological data.

Three stratigraphic records have been analysed: 20 samples were taken from 2 on-site trenches from the western and eastern corner of a pile-dwelling and 21 samples were collected from an off-site core, 300 meters far from the site. The pollen spectra show

excellent pollen preservation and high plant biodiversity (>100 taxa). Before the onset of the Neolithic settlement, the environment was locally dominated by mixed oakwood, while conifer forests grew at higher elevation. With the village, human influence on the territory became visible, as testified by cereal pollen, confirming the existence of fields in the area and plant processing at the site. During 5th millennium BP, the site was no longer suitable for human occupation and the settlement was abandoned. This was probably due to climate change causing an increase of wet conditions and the development of peat. In this period, the recovery of the forest cover marked the expansion of a wooded swamp, showing the return to a natural assemblage.

A graphic visualisation of the land-cover reconstruction was made from high-res DTM, by analysing the distribution of different topographic parameters that may have influenced the vegetation distribution. These parameters have been used as input data, together with the palynological information, to produce land cover maps in GIS environment.

29/05/2024, 14:30–16:30, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-194 - Diversity of Tree Fern in "vegetational Pompeii" from Wuda, Inner Mongolia, China

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Fern as an important element of terrestrial vegetation has a rich fossil record in the Permo-Carboniferous and mainly been classified to eusporangiates and leptosporangiates according the annule of sporangia and thickness of sporangial wall. Most eusporangiate fern from Paleozoic has pinnate fronds and erect stem called as tree fern. Due to the incompleteness of plant fossils, most taxa of Paleozoic tree fern have been found only with single part of parent plant that makes a big trouble in reconstructing whole-plant and evaluating diversity of tree fern.

An autochthonous peat-forming flora was found from the early Permian in Wuda Coalfield, Inner Mongolia, which is buried by volcanic ash and named as "vegetational Pompeii". Vegetational Pompeii consists of two types of fern-dominated forests, namely *Cordaites-Psaronius* (C-P) forest in the southern part of the basin, and *Sigillaria-Psaronius-Paratingia* (S-P-P) forest in the northern part of the basin. Psaronius represents the main type of stems of tree fern in the vegetational Pompeii and bears pecopterid fronds. Beside stems, the reproductive organs and vegetative organs of most tree ferns species are both well-preserved in organic connection. According to the features of reproductive organs, there are at least six genera, nine species of tree ferns in this flora, including four species of *Scolecopteris*, one species of *Eoangiopteris*, one species of *Acitheca*, one species of *Asterotheca*, and two new genera with two new species. These six genera found in the vegetational Pompeii contain all reported symmetrical type of synangia of Paleozoic eusporangiates, which indicates that eusporangiates had reached a high degree of differentiation by the early Permian. Furthermore, diversities at the genus- and species-level of tree fern are higher than other woody groups in this peat-forming flora, including Lycopsida, Sphenopsida, Noeggerathiopsida, Cordaitopsida, Cycadopsida.

Keywords: reproductive organ, eusporangiate, peat-forming, Permian

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B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-195 - A new noeggerathialean whole-plant species from the early Permian Wuda tuff flora, Inner Mongolia, China

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Noeggerathiales, as the latest addition to the progymnosperm family, has three genera and four species reconstructed. However, the proportion of reconstructed members remains small, resulting in insufficient understanding of Noeggerathiales. Here, a new

whole plant of Noeggerathiales is described based on fossil remains from the Asselian Wuda Tuff Flora, also termed as Vegetational Pompeii in Inner Mongolia. Its crown consisting of compound leaf and pseudostrobili. Pinnules plagiotropically attached, arranged in two rows, wedge-shaped, with a semi-amplexicaul and strongly decurrent base. The lateral margin of pinnules is entire, and its apex is truncated and normally split into 5–6 tongue-shaped lobes. Several veins enter the base of each pinnules, dichotomize 1–2 times, then run parallel to each other and extend into the lobes. Rachis with a bilateral symmetrical C-shaped or Ω-shaped vascular bundle in cross section. Pseudostrobili are heterospory and bisporangiate, with the sporangia located on the adaxial surface of the disk-shaped sporophylls. Micro- and megaspores trilete, laevigate. Stem possesses a eustelic vascular system, and consists of pith, secondary xylem and cortex. By comparison, the new specimens are different from all other genera of Noeggerathiales. So that, it is reasonable to establish a new genus and a new species. This new discovery certainly promotes our understanding of the morphology, anatomy, palynology and species diversity of Noeggerathiales and Progymnospermopsida.

Keywords: Early Permian; Noeggerathiales; whole-plant taxon, Wuda

29/05/2024, 14:30–16:30, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-196 - A novel Bisporangiate Sigillarian Strobili from the Early Permian Taiyuan Formation, Wuda Coalfield, Inner Mongolia, China

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Sigillaria Brongniart is a Carboniferous-Permian genus of arborescent Lycopsids and most significant coal forming plant in Euramerica and Cathaysia. *Sigillaria* is believed to produce only monosporangiate strobili including *Sigillariostrobus* Schimper, *Mazocarpon* Benson, and *Nudasporestrobus* Feng et al, with megaspores of *Tuberculatisporites*, *Laevigatisporites* and *Sublagenicula nuda*-type and microspores of *Crassispora* type. Recently a new bisporangiate Sigillarian strobili organically connected with stem and leaves collectively forming a crown is reported from the Wuda Tuff Flora in the Early Permian Taiyuan Formation of Wuda Coalfield, also known as Vegetational Pompeii. The bisporangiate strobili are more than 210 mm long and around 15 mm wide with a slender incomplete peduncle. The sporophylls are helically arranged with horizontal pedicle on proximal side, vertical distal lamina and an abaxial heel between the transitional parts of sporophyll. The sporangia are borne on the adaxial surface of the sporophyll. The Megasporangia are oval in shape and located at the basal part of the strobili and retains >150 megaspores. The megaspores are of *Sublagenicula* type, circular to subtriangular in shape, laevigate exine, prominent trilete mark and gula, distinct contact face on the proximal side and have a diameter of 385 (480) 621 um. The Microsporangia are located at the middle to apex of the strobili. The Microspores are of *Crassispora* type with prominent trilete mark, echinate to conate ornamentation on the distal and equatorial side while the proximal side is laevigate and have a diameter of 50 (60) 70 um. The megaspores of Sublagenicula-type and Microspores of *Crassispora* type are here described for the first time in situ from an Early Permian bisporangiate Sigillarian strobili.

Keywords: *Sigillaria*, Bisporangiate strobilus, *Sublagenicula*, *Crassispora*, Early Permian

29/05/2024, 14:30–16:30, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-197 - Recent advances on the systematics and ecology of the early Permian climbing fern Hansopteris

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Hansopteris is a recently established climbing fern genus characterized by a paired structure of hooked tendrils and aphlebia growing proximally at the penultimate pinna. It exhibits a specific tendril-climbing habit and was presumed to have an additional twining

manner in the early Permian fossil forest "Wuda Tuff Flora." In this study, ample new information has been revealed based on recent collections from the type locality. Firstly, a new *Hansopteris* species is recognized as it shares similar gross morphology with the type species *Hansopteris uncinatus* but exhibits a different configuration of rachis anatomy (bar-shaped *vs*. U-shaped). Secondly, ontogenetic development has been observed on the sori of both the new and type species. In the early stage, the sorus is shielded by an indusium and contains small-sized sporangia and spores. In its mature state, the sorus lacks the indusium structure and houses relatively larger sporangia and spores. Thirdly, the presumed twining habit is now confirmed to be present in *Hansopteris*, as the previously documented twining plant is herein evidenced to be the new *Hansopteris* species. Lastly, coprolites and fungal remains have been discovered within one rachis of the type species, demonstrating plant–arthropod–fungus interactions in the late Paleozoic climbing ferns.

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B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-198 - A new species of Botryopteris from the early Permian Wuda Tuff flora and its evolutionary significance

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Botryopterids were a prevalent fern group that flourished primarily in the late Carboniferous of Euramerica and later migrated to the Permian of Cathaysia and Gondwana. In the early Permian Wuda Tuff Flora, a new species of *Botryopteris*, *Botryopteris sinensis*, was unearthed and detailed based on five tripinnate compressed fronds. The fertile pinnae are concentrated proximally on the frond, while vegetative pinnae mainly occur distally. Occasionally, they position proximally as the first ultimate pinna of the penultimate fertile pinnae. Fertile pinnules exhibit a strong curvature at the margin, presumably serving as protection for the reproductive organs. Fertile organs consist of six to ten sporangia grouped in a sorus with a receptacle. Individual sporangia have a stalk and a proximal horizontal biseriate annulus. *In situ* spores are trilete, ranging from triangular to circular, with baculate sculptures. Anatomically, the foliar trace resembles a rake, featuring up to eight median xylary ridges composed of mixed metaxylem and protoxylem tracheids. Although information on its stem morphology is lacking, the new species is hypothesized to be a small tree-fern residing in the forest understory. Furthermore, the new species bears a strong resemblance to late Paleozoic catenalean ferns, including *Rastropteris*, *Skaaripteris*, and several basal osmundalean genera, thereby providing an evolutionary link between members of the first and second evolutionary radiation of Paleozoic ferns.

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B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-199 - Fertile ferns and their spores from the Wuda locality, Inner Mongolia, China

Jiří Bek[1], *Josef Pšenička*[2], *Weiming Zhang*[3], *Jun Wang*[3], *Jana Votočková Frojdová*[1], *Dandan Li*[3], *Mingli Wan*[3], *Shi-Jun Wang*[4], *Milan Libertín*[5], *Stanislav Oplištil*[6]

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Six taxa of different fern types from the Wuda coalfield, Inner Mongolia, China, lowermost Permian studied mainly for *in situ* spores.

Synangium of *Scolecopteris libera* composed of fusiform exannulate sporangia with pointed apices. The sporangia are free among each other beyond the base of synangia. Trilete *in situ* microspores are of the *Cyclogranisporites leopoldii* type.
Scolecopteris minuta has the sporangia exannulate, elongate reniform to bluntly fusiform in shape. The outer facing sporangial walls are uniformly two cell layers thick; their cells are oval to rectangular. *In situ* spores are very small, trilete, camerate with microspinate and galeate sculpture.
Nemejcopteris haiwangii possesses pear-shaped sporangia, slightly curved along the long axis and round, or elliptical in cross-section with a bilateral symmmetry. Sporangia have a short pedicel. Globose forms of immature sporangia do occur in the immature primary pinnae. Trilete *in situ* spores are of the *Apiculatisporites* (scultured distal surface) or *Calamospora* (laevigate) type.
Leptosporangiate fern *Oligosporangiopteris zhongxiangii* has the pinna rachis shows a similar anatomy, whereas pinnules are of the cladophleboid type bearing *Oligocarpia* type of sporangia: sori consisting of 4–8 sporangia. Trilete *in situ* spores are of the *Granulatisporites minutus* type.
The fertile frond of *Hansopteris uncinnata* is tripinnate with pinnules that are identical to their sterile equivalents. Round reproductive organs are singly attached to each fertile pinnule. Trilete *in situ* spores are of the *Leiotriletes type.*
Fertile pinnules of *Scolecopteris zhoui* are entire and strongly enrolled to envelop 5–8 synangia along each side of the midvein. Synangia are radially symmetrical with 3–4 ovoid sporangia. Monolete *in situ* spores are of the *Punctatosporites minutus* type.
Fertile organs of *Botryopteridium sinensis* comprise six to ten sporangia grouped in a sorus with a receptacle. Individual sporangia are stalked and have a proximal horizontal biseriate annulus. Trilete *in situ* spores are of the *Horriditriletes* type.

29/05/2024, 14:30–16:30, Room: Zenit
A02 Advances in Devonian Paleobotany

O-200 - Archaeopteris in the Devonian of North East Greenland

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Archaeopteris is one of the key plants in the early development of forests in the Devonian, forming extensive stands in the Mid Devonian (Givetian) sometimes in association with cladoxylopsids (as at Cairo, New York), and going on to dominate Late Devonian terrestrial ecosystems. In Greenland, Givetian floras preserved in lake sediments on Ella Ø include only *Archaeopteris* as the tree element, preserved as compressions. In the latest Famennian of Ymer Ø, *Archaeopteris* remains dominant, but tree lycopods (including a complete *Stigmaria* root base) are a significant element. Initial *Archaeopteris* finds include leafy branches, but also a well preserved silicified trunk (*Callixylon*) showing typical large pith, extensive secondary wood, the cambial zone and secondary phloem.

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A02 Advances in Devonian Paleobotany

O-201 - The jewel in the crown – Reconstructing the Devonian lycopsid Protolepidodendropsis pulchra

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Arborescent lycopsids comprised a crucial part of the Mid – Late Devonian flora, forming extensive monospecific forest ecosystems that would have had a huge impact on the palaeoecology of an environmental system. West Spitsbergen, in the Svalbard archipelago, was equatorial during the Devonian and yields considerable evidence of such trees. *Protolepidodendropsis pulchra/Bergeria mimerensis* was first described by Høeg in 1942 and was partially reconstructed by Schweitzer in 1965. Schweitzer's reconstruction was based on a large number of specimens mostly representing the robust portions of the upper trunk (from the late Givetian Fiskekløfta Mbr) and disconnected parts of the crown (largely from the early Frasnian Plantekløfta Fm). Bases of the trees, forming monospecific stands, were reported in situ from the Plantekløfta Formation (Berry and Marshall 2015). Our extensive collecting from the original localities, along with the discovery of new sites spanning a wider range in time, has resulted in a much more complete picture of the architecture of *Protolepidodendropsis*. We believe we now have specimens that represent every portion of the tree,

with the exception of the fertile units. The most notable specimen is a more-or-less intact crown from the Estheriahaugen Member, the oldest Middle Devonian stratigraphic unit exposed in Dickson Land. In addition, field studies have revealed mixed stands where *Protolepidodendropsis* and *Archaeopteris* coexisted. Using photogrammetry, a reconstruction of these mixed forest ecosystems has been possible, providing a much more detailed insight into the overarching palaeoecology of these impressive forests in Svalbard during the Mid – Late Devonian.

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O-202 - A probably emergent sphenopsid from the Upper Devonian of South China

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Emergent plants, characterized by their lower parts being submerged and their upper parts extending above the water surface, play an important role in various ecosystems. Evidence of this emergent habit dates back to the Permian, when certain sphenopsids in swamp forests exhibited adaptive characteristics (e.g., anisophylly) to partial submergence. However, our understanding of the early evolution of this habit is limited. A Late Devonian (Famennian) sphenopsid, *Eviostachya* cf. *hoegii*, is discovered in the Guanshan Member of the Wutong Formation at the Yongchuan Section in Guangde, Anhui, China. This specimen displays distinct features, including erect main axes, slender lateral axes with lamellate leaves and clusters of adventitious roots at the nodes. The axes have a smooth surface with slender vascular strands. Lamellate leaves of *Eviostachya* cf. *hoegii* are characterized by a thin cuticle and sparse veins, with enlarged terminals suggesting probable hydathodes at the leaf margins. Clusters of undivided adventitious roots extend from one side of the creeping axes. In addition, thread-like appendages grow at nodes on secondary and higher-order axes, differing from adventitious roots by extending in all directions, displaying bifurcations, and occasionally co-occurring with lamellate leaves. These thread-like appendages are proposed to be aquatic roots submerged in water, induced by a flooded environment. This novel sphenopsid provides evidence for emergent adaptations in the Late Devonian, allowing the plant to thrive in paleoenvironments with higher water levels. It also indicates ecological diversification among contemporaneous sphenopsids, and dominated the local flora prior to the subsequent flourishing of the Xinhang Forest, primarily composed of tree lycopsids. This discovery provides insights into the early plant adaptations to emergent habits and their ecological roles in ancient ecosystems.

Keywords: *Eviostachya* cf. *hoegii*; sphenopsid; Late Devonian; roots; adaptations; emergent plant

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A02 Advances in Devonian Paleobotany

O-203 - Anatomical investigation and morphological reconstruction of two Late Devonian arborescent lycopsids

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Arborescent lycopsids dominated the Carboniferous peat-swamp forest ecosystem and could be traced back to the Devonian. *Guangdedendron micrum* and *Sublepidodendron grabaui* are considered as the first and the second highest Devonian lycopsids. Based on new specimens from the Famenian (Upper Devonian) Wutong Formation, Anhui Province and Zhejiang Province, China, we provide new insight into their stelar architecture and morphological reconstruction. As the major lycopsid trees that made up the Xinhang fossil forest, *G. micrum* represents a morphologically well-known species and consists of a column-like stem, Stigmaria-type rhizomorph, and a simple crown with rare branches. However, the stelar anatomy of *G. micrum* is unknown. Recently, we collected its anatomical materials of a medullated protostele with limited secondary xylem. *Sublepidodendron* is a widely distributed genus ranging from the Late Devonian to the Early Carboniferous, and *S. grabaui* has been investigated

from multiple perspectives. New compression and permineralized specimens of *S. grabaui* show a small crown with several times of branches bearing terminal strobili. The stem contains a protostele with secondary xylem, extensive three-zoned cortex, and a peripheral periderm. Comparing with Devonian and Carboniferous related species, new morphological and anatomical materials of these two tree lycopsids provide further knowledge about the evolution of arborescent lycopsids.

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A02 Advances in Devonian Paleobotany

O-204 - Morphological reconstruction of Pseudobornia ursina and systematic study of Late Devonian – Early Carboniferous sphenophytes unravelling their own evolutionary history

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Although currently represented by a single genus (Equisetum), Total group Sphenophytes showed a greater diversity across the late Paleozoic. They were widespread especially during the Carboniferous, when the coal swamp ecosystems thrived. Nonetheless, their origin and phylogenetic relationships with stem-groups monilophytes (Iridopteridales and Cladoxylopsids) still remain highly unknown. Up to now, three different orders of Sphenophytes are defined as follows: the Equisetales, Sphenophyllales and the Pseudoborniales. Pseudoborniales defined by the type species: Pseudobornia ursina (Nathorst, 1894) were arborescent stem-group sphenophytes mostly known from adpressed vegetative remains that show typical features like a ribbed and straight seemingly wood-lacking trunk, displaying typical whorls of primary axes which themselves bore whorls of secondary axes. Ultimate axes bore on their nodes, four several times forked leaves and little is known about their reproductive structures. Herein, it is proposed to make a critical redescription and reconstruct *Pseudobornia ursina*. The characteristic traits of this unique plant will be helpful to refine the systematic position of Pseudoborniales. They are compared with those of other plants belonging to Sphenophyllales, Equisetales and stem-groups monilophytes (Cladoxylales and Iridopteridales) to uncover their phylogenetic affinities and the basal position of Pseudoborniales, deep in the Monilophyte evolution. In order to shed light on their kinships, a phylogenetic analysis following both parsimony and bayesian approaches is performed. Based on this work, hypotheses are subsequently tested to define whether the main characteristic features of *Pseudobornia ursina* are considered as plesiomorphic or derived within the stem-group sphenophytes. This in turn enables a better understanding of Pseudoborniales and Sphenophytes evolutionary histories throughout the late Paleozoic times.

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A02 Advances in Devonian Paleobotany

O-205 - Adding to the diversity of a latest Devonian Gondwanan plant assemblage: A new anatomically preserved axis from Barraba, Australia

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Documenting a wide paleogeographic range of Famennian (latest Devonian) floras is essential to better understand the state of land plant diversity between the Kellwasser and the Hangenberg bio-events, two first-order global crises for the marine biota but whose impact on terrestrial organisms needs to be clarified.

There are few well-documented plant assemblages of Famennian age in Gondwana. One of them occurs in the Mandowa Mudstone Formation at Barraba, in New South Wales (Australia). The plant remains recovered at Barraba are dated from the late to latest Famennian and are preserved both as adpressions and permineralizations. A recent assessment of the permineralized assemblage indicates that the spore-producing plants are dominant and include lycopsids, cladoxylopsids, and one iridopterid (*Keraphyton)*.

This presentation describes a second anatomically preserved iridopteridalean plant, represented by a 50 mm long and 7.7 mm wide fragment of axis with no branch or appendage bases attached along its length. Its tissues are entirely primary. The vascular system is actinostelic. In transverse section, it shows three fundamental ribs that divide twice slightly unequally. The protoxylem strands occur at the rib tips. Metaxylem tracheids are scalariform. The cortex is aerenchymatous in its innermost part.

This new plant is the first iridopterid to show an adaptation to a wetland habitat. Together with *Keraphyton*, it confirms that a group of Iridopteridales characterized by a complex vascular system occurred beyond the Frasnian in Eastern Gondwana. This discovery is consistent with a limited impact of the Kellwasser bio-event on land plant diversity prior to the Devonian-Carboniferous boundary.

29/05/2024, 15:10–16:30, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-206 - Exploring late Holocene tropical peatland dynamics: A case study of the Bram Itam Peatland Protection Area in Coastal Sumatra, Indonesia

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Southeast Asia's crucial tropical peatland ecosystems, providing essential ecosystem services, face threats from sea level changes, climate change, and human activities. Despite their significance, understanding of the dynamics and origins of these tropical peatlands remains limited. To unravel their complexity, a multi-proxy paleoecological study has been conducted on a sediment core from the Bram Itam Peatland protection area of the Tanjung Jabung Barat regency on the eastern coast of Jambi Province on Sumatra Island. The palaeoecological investigation identified four distinct palynological periods: i) from approximately 4750 to 1250 cal yr BP, a dominant mangrove forest thrived during high sea levels; ii) from 1250 to 450 cal yr BP, as sea levels receded, the mangrove forest yielded to swampy vegetation, initiating peatland formation influenced by high precipitation; iii) subsequently, from 450 cal yr BP to AD 1950, matured peatland forests prevailed in the Bram Itam peatland forest; iv) post-1950, intensive human activities like logging, oil palm plantation intensively impacted peatland vegetation. The presence of cereal cultivation dating back to around 1250 cal yr BP and the introduction of oil palm since approximately AD 1950 highlight the enduring agricultural practices of indigenous people in the area. This study of peatland vegetation dynamics in the Bram Itam peatlands illuminates the transformation from a mangrove forest to a freshwater swamp and, eventually, to a matured peatland forest. It reaffirms the pivotal role of mangrove forests in developing tropical peatlands in Southeast Asia.

29/05/2024, 15:10–16:30, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-207 - Disruption of Miocene tropical forest: A palynological perspective from Fotan Formation, southeastern China

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The mid-Miocene Zhangpu biota (~14.7 Ma)—from the Fotan Formation in the Zhangpu area, southeastern China—reveals an outstandingly rich rainforest biome in East Asia, indicating that the mid-Miocene rainforest reached at least 24.2°N. Pollen analysis for two outcrop sections of this formation reveals two "fern spike", i.e., forest was transiently replaced by fern-dominant vegetation and then rapidly recovered, which represents the initial colonization by pioneer species following the massive destruction of vegetation, indicating that the mid-Miocene tropical forest in the Zhangpu area had been severely damaged at least twice.

Together with fern spikes there appeared opaque phytoclasts peaks (a portion of them are charcoals) as well as the hyphae peak (occurred along with the later fern spike, representing the inhibition of photosynthesis), indicating that these vegetation disruptions were closely associated with the frequent volcanic eruptions in the study area during the Miocene. In the meantime, *Concentricystes* (algae) bloomed along with the occurrences of fern spikes, demonstrating the eutrophication of the catchment due to the enhanced nutrient availability, which might be caused by a combination of increased runoff followed the vegetation disruption and the release of elements from the volcanic materials. Compared to the first fern spike, the later one was a result of more severe damage, which is characteristic of 1) the longer time for vegetation to recover, 2) the appearance of fungal spike, and 3) the much higher degree of eutrophication of the catchment (much more abundant *Concentricystes*) followed the vegetation disruption.

29/05/2024, 15:10–16:30, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-208 - Rain forest fragmentation in northern Madagascar during the past millennium – A result of intensified human impact and climate dynamics?

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3 *Institut für Geographie, Physische Geographie, Jena, Germany*
4 *Architecture – Civil Engineering and Environmental Sciences, Geosystems and Bioindication, Braunschweig, Germany*
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With its unique flora and fauna, Madagascar is one of the earth's biologically richest ecoregions. It is known that Madagascar's ecosystems have greatly been affected by human influence during past decades, thus making it one of the most endangered ecoregions as well. Despite the clearly visible recent changes, the exact timing of arrival of the first settlers and their impact on the environment remains a scientific debate. By analysing the sedimentary archive of Lake Amparihibe (Nosy Be Island) and Lake Ravelobe (National Park Ankarafantsika) our research contributes to shed light on the timing of early human impact on Malagasy natural ecosystems. Several proxies i.e., pollen, fungal spore, other non-pollen palynomorphs, charcoal and diatoms combined with high-resolution sediment-physical and geochemical data were considered to reconstruct paleoenvironmental dynamics during the past three millennia. Both sites indicate an environmental change between 1300 and 1100 cal BP, characterized by an increase of Poaceae pollen and at Nosy Be an increase of charcoal particles, indicating an abrupt transformation from a highly diverse forest to a grassy landscape associated with fire disturbance. This quick shift is interpreted as a strong early human impact on the environment. After 1000 cal BP, the vegetation is dominated by a fire-disturbed forest/grassland mosaic, which is maintained until today. However, the scarcity of continuous records hinders a comprehensive regional synthesis. Further research is needed to disentangle signals originating from human impact and/or climatic background, and ultimately detect potential (dis)similarities in climate dynamics, ecosystem responses and anthropogenic influences at the island's scale during the Holocene. This is urgently needed to understand the relationship of human influence and natural factors to current climate change and biodiversity loss, which is important to improve future conservation strategies for biodiversity hotspots such as Madagascar.

29/05/2024, 15:10–16:30, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-209 - Forest turning point during the late Holocene in Cameroon (Central Africa)

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Over the last few millennia, the tropical forests of Central Africa have undergone significant structural and compositional changes, particularly on the margins of the Congo Basin, where part of these forests have given way to more open ecosystems, such as the forest – savannah mosaics. The development of agricultural innovations, notably with the expansion of metallurgy linked to the spread of Bantu-speaking people throughout tropical Africa from ~ 3000 BP can be one of the plausible reasons for this change in vegetation, just as much as climate change, which a drying trend after the African Humid Period.

The question of human and/or climate impact triggering such a vegetation shift is still a matter of debate.

Based on a new study site located in North-West Cameroon (Lake Ndoumkain) we obtained a pollen record encompassing the past 7,500 years BP. Preliminary results have revealed a major grass development at the expense of forests around 3,000–2,500 years BP. The work in progress aims at providing high-resolution multi-proxy analyses (e.g. pollen, charcoal, XRF, isotopes) combined with a regional synthesis. The results of this project will contribute to improve our understanding of vegetation dynamics and to better disentangle the forcing factors of vegetation changes over long-time scale. This work is part of a PhD thesis started in 2023 within the research project PAST-17 funded by the French National Research Agency. In this context, the latest results focussing on the late Holocene forest turning point will be presented.

29/05/2024, 15:30–16:30, Room: Aquarius
M01 Modern pollen-vegetation studies

O-210 - Bat guano in caves: A palynological treasure trove for understanding vegetation dynamics in southeastern Amazonia

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The diverse feeding habits of bats foster ecological interactions, potentially documented in guano deposits. However, a lack of studies on the pollen signal from guano in the Amazon region hinders our understanding of processes influencing the origin, transport, and taphonomy of preserved pollen grains within caves. To assess the potential of cave pollen spectra for vegetation reconstruction, we compared modern pollen-rain records from surface bat guano in five caves with those from three lake sediments in the Carajás region, southeastern Amazonia. In comparing pollen assemblages from bat guano with modern pollen datasets from Lake Amendoim, Lake Violão, and Lagoa Trilha da Mata, we utilized the absolute number of morphotypes associated with arboreal, pioneer, non-arboreal, and palm elements found at each location, employing a multivariate analysis method. Results unveiled high pollen abundance and richness of arboreal elements in bat guano, dominated by chiropterophiles/entomophilous taxa that are rarely found in lake deposits. Arboreal taxa, reaching 97.1%, included Moraceae/Urticaceae, Melastomataceae/Combretaceae, Malvaceae, *Mabea*, *Senna*, *Ceiba*, and *Caryocar villosum*. Pioneer elements like *Cecropia*, *Alchornea*, *Piper*, and *Schefflera* ranged from 0.9% to 59.6%. Non-arboreal elements represented by Poaceae, *Borreria*, *Mimosa*, and Asteraceae exhibited values as high as 58.2%. Bats emerged as the primary pollinators transporting pollen into caves, with minimal contributions from airborne and waterborne transport. The heightened diversity of forest taxa (78 morphotypes) in bat guano compared to lake sediments (<49 morphotypes) underscores its efficacy as a natural trap for recording the composition and structure of local vegetation. Integrated with other natural traps, bat guano provides crucial additional information on environmental and vegetation changes in southeastern Amazonia.

29/05/2024, 15:30–16:30, Room: Aquarius
M01 Modern pollen-vegetation studies

O-211 - Pollen productivity estimates in Japan: Use of flower traps for major Pinaceae and Betula trees

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Pollen productivity estimate (PPE) are required for the Landscape Reconstruction Algorithm (LRA; Sugita 2007a, b) for reconstruction of the past changes in vegetation as one of the critical parameters. We use approaches for PPEs of a set of the major Pinaceae and *Betula* species in Japan, specifically using Saito's method with flower traps (Saito, 2012; Hayashi et al., 2022). Ten to twelve flower traps 50 cm x 50 cm in opening were set up in each of nearly monospecific stands. In order to use the flower trap method we collect male flowers (microsporangium) just before flowering, fix those with Carnoy solution (Ethanol : Acetic acid =3:1), and measure the number of anther per male flower (*An*) and the number of pollen grains per anther (*Pn*). Then, the number of pollen grains per male flower (*PFn*) is obtained as *An* x *Pn*. The number of male flowers per unit area (*Fn*) is estimated using the flower trap data. The PPEs of individual species per unit area are estimated as *PFn* x *Fn*. Thus far, PPEs of the following taxa (all in grains·ha^{-1}·yr^{-1}) are obtained: 6.3 x10^{12} (2015–2020) for *Pinus koraiensis,* 1.3 x10^{12} (2016–2022) for *Picea glehnii*, 0.2 x10^{12}(2016–2020) for *Picea jezoensis* var. *hondoensis,* 0.6 x10^{12} (2016–2019) for *Abies sachalinensis,* 0.3 x10^{12} (2017–2019) for *A. homolepis,* 0.3 x10^{12} (2017–2019) for *A. firma,* , 4.6 x10^{12} (2017–2019) for *Tsuga sieboldii,*1.0 x10^{12} (2018–2019) for *T. diversifolia,*5.3 x10^{12} (2019–2023) for *Betula platyphylla,* 0.9 x10^{12} (2019–2023) for *B. ermanii.* We already have made long-term studies for PPEs since 2015. For some of these species, for example, *Picea glehnii* and *Betula ermanii*, masting occurs every 3–5 years. For this reason, longer-term studies are needed to apply for the LRA-based reconstruction of vegetation.

29/05/2024, 15:30–16:30, Room: Aquarius
M01 Modern pollen-vegetation studies

O-212 - Exploring the representation of arboreal taxa using long records of surface pollen deposition

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An understanding of the representation of specific taxa is fundamental to the interpretation of pollen found in both surface samples and Holocene deposits. This paper examines the representation of arboreal taxa in surface pollen samples, notably the representation of *Pinus*, *Picea* and *Quercus*. Several studies have indicated that bisaccate pollen grains, such as those of *Pinus* and *Picea*, are frequently better represented in moss samples than in pollen traps (Pardoe et al. 2010, Litsitsyna et al. 2012). The paper draws on surface pollen data collected from modified-Tauber traps and moss samples situated in the mountains of Snowdonia National Park, North Wales, over a period of more than two decades. The results from North Wales are compared to those from similar Pollen Monitoring Programme sites in central and northern Europe.

Initial analyses suggest that there are significant differences in the representation of arboreal taxa in moss samples and traps which vary with time, vegetation cover and location. The evidence is reviewed to assess the consistency of trends in the data. Potential causes of differences in sampling efficiency, such as the roughness and height of the sampling surface or shape and texture of pollen grains, are studied. The significance of the results for the interpretation of past vegetation changes is considered.

Litsitsyna, O.V, Hicks, S. Huusko, A. (2012) Do moss samples, pollen traps and modern lake sediments all collect pollen in the same way? *Vegetation History and Archaeobotany*, 21, 187–199

Pardoe, H.S., Giesecke, T., van der Knaap, W.O., Svitavská-Svobodová, H., Kvavadze, E.V., Panajiotidis, S., Gerasimidis, A., Pidek, I.A., Zimny, M., Świeta-Musznicka, J., Latalowa, M., Noryskiewicz, A.M., Bozilova, E., Tonkov, S., Filipova-Marinova, M.V., van Leeuwen, J.F.N., Kalniņa, L., 2010. Comparing pollen spectra from modified Tauber traps and moss samples: examples from a selection of woodlands across Europe. *Vegetation history and Archaeobotany,* 19, 271–283.

29/05/2024, 17:00–17:20, Room: Aquarius
M01 Modern pollen-vegetation studies

O-213 - Modern pollen assemblages and dispersion process in the northeast of the Tibetan Plateau

Yongtao Zhao[1], *Yan Lei*[1], *Xiaoyu Lan*[1], *Zisha Wang*[1], *Jing Chang*[2], *Xuemei Chen*[1], *Ziyue Zhang*[1], *Xuelian Wang*[1], *Gen Wang*[1], *Yongli Wang*[3], *Yunfa Miao*[1]

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Pollen has played an important role in revealing climate and ecological changes at different time scales in the past. However, there is still a lack of systematic understanding of the modern pollen assemblages, the variability in pollen production and flowering phenology, dispersion and deposition processes under the complex basin-mountain terrain in arid regions. These affect the interpretations of historical patterns and spatial dynamics of vegetation in arid regions to a certain extent. In present paper, based on the analyses of data from modern air pollen collectors, rivers and surface soils, the effects of wind and river on the transport of different types of pollen are discussed. Furthermore, the sources of pollen in basin sediments and their implications for regional vegetation and climate reconstruction are discussed. The results show that: (1) the regional modern airborne pollen assemblages are dominated by near-source (local) vegetation types, and the proportion of exogenous long-distance transport is less; (2) the river has a strong ability to carry woody types in the upper reaches of the mountain, but with the increase of the river transport distance, the components of the mountain vegetation decrease; (3) when using the pollen assemblages of basin sediments to reconstruct past vegetation and climate, it is necessary to fully consider the change of pollen deposition process caused by runoff and river channel changes, and further to distinguish different information of mountains and basins. Out results are beneficial to reconstruct relationships between vegetation and climate applicable to arid areas, and to support future interpretations of paleoecological investigations.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-214 - A review of Miocene Pinuxylon species of Türkiye

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Many *Pinuxylon* W.Gothan 1905 (formerly described as *Lesbosoxylon* Süss & Velitzelos) fossil woods were identified from different parts of Turkey. After described 5 species from Lesbos island and one new species from Eastern Anatolia, new studies showed that this genus has more species, and this fossil genus had a wider area in the early Miocene through Turkey. The purpose of the present study is to focus the fossil species of this genus from the early Miocene of Turkey. The thin sections housed in the fossil collection of the Department of Forest Botany, Faculty of Forestry, Istanbul University-Cerrahpasa were used in the analyses. One new fossil species of *Pinuxylon* with pinoid type cross-field pits in very different sizes including very large and small pits was described as *Pinuxylon anatolica* Akkemik & Mantzouka sp. nov. Furthermore, *Pinuxylon diversiradiatum* (Süss & Velitzelos, 2010) Mantzouka & Akkemik, 2022 and *Pinuxylon ventricosuradiatum* (Süss & Velitzelos, 2010) Mantzouka & Akkemik, 2022 found in the same geological unit are reported for the first time in Turkey. As a conclusion, the fossil genus *Pinuxylon* had a rather wide distribution area throughout Aegean basin and eastern Anatolia with its seven species. The modern five species of *Pinus* L. in Turkey are different from the fossil Miocene species except *Pinus pinea* L., and cover about 12 million hectares through Turkey. An evaluation may be done such as pine trees are the main conifer species through Cenozoic of Turkey.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-215 - Exploring Neogene petrified forests in Myanmar and Thailand: Advances in Systematic affinities, education, and conservation

Nareerat Boonchai[1], *Than Htun*[2], *Pratueng Jintasakul*[3]

1 Friends of Fossil Forests, 705 SE 7th Ave, Gainesville – FL, USA
2 Myanmar Geosciences Society, No. 303 – Hlaing University Campus, Yangon, Myanmar
3 Khorat UNESCO Global Geopark, Khorat Fossil Museum – Suranaree Subdistrict, Mueang Nakhon Ratchasima, Thailand

Thailand's Khorat UNESCO Global Geopark and Mount Popa National Geopark in Myanmar's Mandalay are renowned for their abundant Neogene petrified trunks in mainland Southeast Asia. Thousands of them were unearthed and reported since the 1910s, but the majority were sold, especially during the 1950s-2000s. Research and conservation efforts were relatively scarce compared to the large quantity of fossils. The prominent sites in Mandalay are from the Irrawaddy Series, including Natogyi and Kyaukpadaung; despite little research on fossil wood and no local paleobotanist, a significant knowledge gap on the paleoflora of Mandalay remains. Recently, these sites have become protected and available for research, educational outreach activities, and geotourism through collaboration from local to international sources. To promote awareness and better protect these areas' natural and cultural resources, we have been researching the systematic affinities of petrified wood samples from both geoparks. Our findings indicate that the majority of these samples belong to Fabaceae, with distinctive features such as diffuse porous wood, simple perforations, alternate intervessel pits, vessel-ray pits similar to intervessel pits, axial parenchyma commonly broad sheath vasicentric to aliform or banded, and 1–3-seriate rays. Petrified palm stems are also commonly found. The paleofloras from both sites resemble mixed deciduous to dry evergreen forest types. We incorporate interactive activities using iNaturalist to explore past and present biodiversity, increasing locals' interest and engagement. We have successfully achieved geotourism goals and sustainable development and conservation for Khorat, and we are making progress in Myanmar to reduce the sale of their geoheritage abroad. Further studies on Mount Popa petrified woods are necessary to reconstruct the paleoenvironment and for additional comparative studies of paleofloras. Our next step involves training local scientists and students in wood anatomical research and paleoxylotomy, which will contribute to a more sustainable approach to preserving these resources in our countries.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-216 - Agua Blanca's petrified forest: Unveiling Guatemala's neogene environment through wood anatomy investigation

Osmin Vasquez[1], *Nareerat Boonchai*[2,3], *Markus Eberl*[4], *Marc Philippe*[5]

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3 Friends of Fossil Forests Corp., Friends of Fossil Forests, Gainesville – FL – 32601, USA
4 Vanderbilt University, Antropology Department, Nashville – Tennessee 37235, USA
5 Univ Lyon – Université Claude Bernard Lyon 1, Centre National de la Recherche Scientifique CNRS – ENTPE – UMR 5023 LEHNA – F-69622, Villeurbanne, France

Guatemala's Cenozoic was marked by intense volcanism, mountain uplift, and significant north-south migration, driven by the closure of the Central American isthmus, contributing to its rich biodiversity and geodiversity. Petrified trunks with diameter from approx. 50 cm to a meter and range from six to eleven meters long were found in Agua Blanca, southeast Guatemala. The fossil site is situated within the Padre Miguel Group, characterized by a thick sequence of predominantly Neogene volcanic rocks, including ignimbrites and tuffaceous sedimentary rocks, mostly rhyolitic in composition. Wood anatomy reveals most trunks are Pinaceae and other dicot woods including Fabaceae, Oleaceae (cf. *Fraxinus*), and other *incertae sedis*. Dicot woods are ring to semi-ring porous to diffuse porous, vessels predominantly solitary with short radial multiples, and narrow rays. The diffuse porous specimens include a 10-meter long Fabaceous wood with 80-cm trunk and 30 cm branch in diameters, respectively. Wood characterized by confluent to banded axial parenchyma with occasionally storied parenchyma and up to 5 vessels per millimeter with exclusively simple perforations. The other diffuse dicot wood specimen displays scaraliform perforations. *Fraxinus*-like wood is ring to semi-ring porous with various types of parenchyma from vasicentric to confluent. Additionally, two unknown marine invertebrate-like petrified wood

specimens were found. An ongoing investigation of Neogene paleoflora indicates tropical to subtropical climate through wood anatomy analysis. The sediment will be sent for dating to gain more accurate age. The fossil site is part of a proposed geopark where archaeological sites of Ancient Mayan are also found. The paleoflora here promises significant contributions to our understanding of the evolution and biogeography of Guatemala, Central America, and the Neotropics. This collaborative paleobotanical project, the first of its kind in Guatemala, involves local school teachers, archaeologists, geologists, and international paleobotanists, aiming to enhance local awareness of their natural resources.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-217 - Climate reconstruction based on fossil wood and the anatomical diversity of lowland tropical woods

Deborah Woodcock[1]

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Attempts to model wood:climate relationships to provide information useful in reconstructing paleoclimates have proven problematic for reasons including discontinuities between temperate latitudes and the tropics. It is instructive to look at these temperate-tropical discontinuities in more detail. A large wood flora from the southern Peruvian Amazon includes woods with anatomical features typical or limited to the tropics. The woods also demonstrate both 1) convergence of features relating to climate and habit and 2) divergence that can be related to niche diversification and the existence of distinct adaptive pathways. Identifying the distinct adaptive types occurring in different forests in this area of the wet lowland tropics is a way of organizing the diversity of wood structure. Past attempts to model wood:climate relationships attempted to identify variables with relationships to climate that could be used to generate quantitative climate estimates. Another approach is to use information from the wood anatomy to place fossil assemblages within specific forest types that are understood with respect to limiting climate variables. This is a workable approach where temperature is the important limiting factor, but we need a better understanding of relationships between moisture availability (seasonality of precipitation, length of the dry season) and wood structure, particularly in the tropics.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-218 - Fossil wood of Abies from the Middle Pleistocene Jilin Province, Northeast China and its paleoenvironmental implication

Leon Nahuel Torres[1], *Xiao Shi*[1], *Yuling Na*[2], *Bing Wang*[1], *Chi Tian*[1]

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2 Jilin University, Geological Museum of Jilin University, Changchun, China

During the Middle to Late Pleistocene, the Changbai Mountains volcano was active. Plant fossils, especially wood fossils, are excellent tools for exploring environmental fluctuations in Earth's history. Here, we present new wood fossils discovered from the Middle Pleistocene Huangshan Formation in Changchun City, Jil in Province, Northeast China. The preserved wood specimens exhibit distinct growth rings, uniseriate or biseriate opposite radial tracheid pits, uniseriate tangential tracheid pits, scarce axial parenchyma, 1 16 cells high uniseriate rays, 1 6 taxodioid or subtaxodioid pits per cross f ield and traumatic vertical resin canals. These features closely resemble the extant genus *Abies* , which is one of the largest genera in the Pinaceae family. In these first records of *Abies* fossil wood, numerous vertical traumatic resin canals are evident. It is intriguing to observe such a significant number of traumatic signs in plants adapted to the extreme cold of the Middle Pleistocene. These traumas, recorded in the growth rings year a fter year, could be attributed to various factors, including strong seasonal winds, periodic floods, freezing during particularly cold winters, or the activity of relatively nearby volcanoes. The volcanoes in the vicinity might have caused these traumatic events, leading to minor nuclear winter effects due to the substantial release of ash. Specifically, during the Pleistocene, the Changbai Mountains volcano, located on the China Korea border, exhibited intense and explosive activity. The unique structure a nd growth ring characteristics of these fir s wood fossils may be associated with the eruptions of the Changbai Mountains volcano during that time.

29/05/2024, 17:00–19:00, Room: Leo
Z01 IAWA Fossil Wood Symposium

O-219 - Glacial expansion of cold-tolerant species at low latitudes: Megafossil evidence and species distribution modelling

Luliang Huang[1], *Shufeng Li*[2], *Weiye Huang*[3], *Jianhua Jin*[3], *Alexei A. Oskolski*[4]

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2 Chinese Academy of Sciences, Xishuangbanna Tropical Botanical Garden, Mengla, China
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Drastic climatic fluctuations of the Quaternary, especially last glaciation, had a profound impact on the distribution of modern flora and fauna. Many species contracted during the glaciation with persistence confined to refugia with favorable habitats followed by range expansion during interglacials. Some cold-tolerant species were able, however, to expand during cold periods, and contracted their ranges during the interglacial refugia. This glacial expansion model was supported by rich megafossil, pollen records and molecular evidence for Arctic-alpine species distributed in temperate zone of Europe and North America. Such scenario has also been suggested by molecular phylogeographic studies of several plant species occurred in subtropical zone of eastern Asia. However, so far no fossil evidence of glacial range expansion for plant species at low latitudes has been reported to date.

Recently, fossil woods of *Pinus armandii* Franch. (Pinaceae) *and Magnolia insignis* (Wall.) Bl. (Magnoliaceae) were discovered from the Upper Pleistocene (33–30 ka cal. BP, in last glaciation) of the Maoming, Guangdong, South China. This fingdings provide the first fossil evidence of glacial range expansion for plant species at low latitudes. In addition, we simulated the potential distribution areas of *P. armandii* and *Magnolia insignis* since the last glaciation by species distribution models (SDM). The results show that the potential distribution area of these two montane cold-tolerant plants expanded to the southeast during the last glaciation (30 ka and 20 ka) and even extended to the low latitude area of south China, followed by rapid contraction during the interglacial–Holocene (6 ka and 0 ka). Our findings, combined with the results of SDMs confirming the glacial range expansion of cold-tolerant montane species at low latitudes during the last glaciation. The scenario of glacial expansion suggested in this study might be common for other montane cold-tolerant plants and organisms distributed in subtropical and tropical regions.

29/05/2024, 17:00–17:20, Room: Nadir
B01 Palaeobotanical and palynological signatures of Earth's extreme climate events

O-220 - Palynofloral change through the Paleocene-Eocene thermal maximum in the Bighorn Basin, Wyoming

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2 Smithsonian Institution, Department of Paleobiology, Washington DC, USA

To better understand the effect of the Paleocene-Eocene Thermal Maximum (PETM) on continental ecosystems, we studied 40 new palynological samples from the Bighorn Basin (BHB), northwestern Wyoming, USA. We see palm and fern abundances increase in the last 20–40 ka of the Paleocene, then dramatically with the onset of the carbon isotope excursion (CIE) defining the base of the PETM. Palynomorphs of plant groups with modern temperate climate distributions are absent from the CIE body, and this is when tropical plants are most diverse and abundant. During the CIE recovery, pollen of mesophytic/wetland plants become more common while tropical taxa persist. In the post-CIE early Eocene tropical taxa are rare and temperate forms abundant, similar to the late but not latest Paleocene. Changes in the palynoflora are more easily detected if reworked palynomorphs are removed from analyses. We interpret palynofloral changes to indicate warming in the latest Paleocene, rapid warming and drying with the CIE onset, dry tropical climates through the CIE body, a return to wetter floodplains during a very warm CIE recovery, and cooler wet conditions in the post-PETM early Eocene. These inferences are consistent with geochemical and paleobotanical proxies. Strikingly similar patterns in the palynoflora and megaflora suggest changes in vegetation were a basin-wide phenomenon. These rapid, climatically forced changes in floral composition occurred without major extinction, perhaps indicating nearby refugia in which plants adapted to cooler and wetter climates persisted through the PETM.

29/05/2024, 17:00–18:40, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-221 - Tropical wetlands: Landscapes of change

Katherine Roucoux[1], *Ian Lawson*[1]

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Over the last decade our group has worked on mapping, modelling, and reconstructing the long-term history of forested, peat-forming wetland ecosystems in lowland Amazonia and central Africa. Through their rich palaeoecological records, these vast water-logged landscapes offer a unique opportunity to understand long-term vegetation dynamics in a tropical forest setting and, importantly, their interactions with the physical environment, the global carbon cycle, and the people who rely on their resources. We present our latest synthesis of results emerging from our interdisciplinary research which reveal the spatial and temporal patterns of Holocene vegetation change and the processes that drive them. We also show some of the ways in which our palaeoecological data are informing our conceptualisation of the processes of change in these landscapes, which in turn are finding applications in policy development and sustainable management at global, national and local scales.

29/05/2024, 17:00–18:40, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-222 - Holocene vegetation dynamics, carbon deposition, sea level changes, and human impact inferred from the blocked river channel core in the Baía de Caxiuanã region, northern Brazil

Bowen Wang[1], *Marcondes Lima Costa*[2], *Hermann Behling*[1]

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2 National Council for Scientific and Technological Development CNPq, The Geology and Applied Geochemistry Research Group GMGA, Belém, China

Tropical peat deposits as a potential carbon (C) stock are important to global climate change. Hence, it is necessary to explore the mechanism of formation and dynamics of tropical peat ecosystems. Up to the present, the paleoecology of peat ecosystems in eastern Amazonia is still little known. In this paper, we investigate the vegetation dynamics by pollen and spores, peat and organic C accumulation, macro-charcoal, mineral identification, and chemical composition based on multi-proxy analysis of a 395-cm-long radiocarbon dated sediment core, named Lagoa da Fazenda (LF), from a blocked river channel of the Caxiuanã Bay in eastern Amazonia, Brazil. This study site can be a representative of the net of former small river valleys with carbon-rich organic matter deposits in the Holocene in eastern Amazonia. The study results indicate that the onset of the peat with organic C deposits forming a local inundated forest was since ca. 7000 cal yr BP, which may be caused by the Atlantic sea level rise. Since ca. 5000 cal yr BP, the Atlantic sea level further rose. Peat and C accumulation rates remained at a high level since the start but became lower and more fluctuated since 2600 cal yr BP, which is influenced by river flooding, which may be caused by regional human activities causing soil erosion inferred from the previous lake-like Rio Curuá record in the study region. The local vegetation changed from the inundated forest to a Cyperaceae swamp since 1800 cal yr BP until the present. A strong local human influence was recorded since ca. 260 cal yr BP.

O-223 - Been there, done that: Pre-Columbian occurrence in the wet, aseasonal, lowland rainforest of Ecuadorian Amazonia during the Arcaic period

Encarni Montoya[1], *Molly Spater*[2], *Núria Cañellas-Boltà*[1], *Mª Carmen Trapote*[1], *Carmen X. Luzuriaga*[3], *Rommel Montúfar*[4]

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4 Pontificia Universidad Católica del Ecuador, Departamento de Biología Vegetal, Quito, Ecuador

Considering the vast extent they occupy, tropical South American lowlands represent a region largely understudied, limiting obtaining accurate information of the plant communities' dynamics of such an ecologically and economic important area. Some of the reasons for this low density of available studies are the difficulty of arriving and exploring the study area, or even once there, finding suitable locations. Among the problems for finding suitable records, western Amazonia has been highlighted as a very geomorphologically active location, preventing the development of long, continuous sediments spanning several thousand years without a sedimentary gap or hiatus. This region has also been highlighted as less likely to hold evidence in the present-day landscape of dense pre-Columbian populations. Here we present a Holocene sequence of western northern Amazonian lowlands, in the Ecuadorian Yasuní National Park, that spans the last 6000 years. The results show the continuous presence of a rainforest, but with a high dynamism changing the abundance of the dominant taxa several times during the last 6000 years. In this sense, the forest with a higher evenness is the present-day one, established during the last millennium. It is suggested that changes in the vegetation were primarily driven by geomorphological activity including shifts in the drainage system. Based on the occurrence of fire peaks and cultivars, the presence of humans in the study site around 5000 years ago seems quite plausible, which could have been only sporadic in the study area. However, it is noteworthy the absence of large changes in the vegetation coeval to the anthropogenic indicators. Today, the study site is inhabited by Waorani indigenous, and archaeological remains have been found nearby from the formative period, 3000 years later. The results showed here evidence the limitations to calculate pre-Columbian peoples only based on visible prints in present-day landscapes. Project reference: PID2022-138059NB-I00.

O-224 - Paleobiogeographic reconstruction in the Tropical High Andes: A multiproxy approach

Andra Stefania Serban[1], *Nicholas Branch*[1], *Joy Singarayer*[2], *Martin E. Timana*[3]

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3 Pontifical Catholic University of Peru – Applied Geography Research Center, Department of Humanities, Lima, Peru

The research focuses on reconstructing and understanding the cause of expansions and contractions in Andean Polylepis woodland distribution during the Early and Middle Holocene. *Polylepis* is a fire-intolerant genus that flourishes in areas with minimal human activities and grazing impact. There is currently debate in the literature concerning whether humans or climate were the primary cause of the contraction and fragmentation of these woodlands over the Holocene. We employ a multi-proxy approach, including pollen and microcharcoal analysis, as well as Species Distribution Modelling (SDM) to explore the influences of climatic change, fire, and human activities.

The potential past distribution of five endemic tree species is examined using an SDM approach with MaxEnt. Changes in woodland cover are explored by projecting the bioclimatic variables from the high-resolution global climate dataset CHELSA and the digital elevation model over the last 15 000 years. Preliminary results show that over this time, *Polylepis* woodlands, defined by the five selected species, experienced various "pulses" involving expansion, fragmentation, and more recently, significant contraction. Notably, the SDM reveals an expansion phase between approximately 11.5kya and 10kya, followed by a trend of contraction starting around 5.5kya. Previous studies have ascribed this contraction as a result of exponential human population growth in the region at this time. However, our results point to climatic change being a significant factor.

The SDM results are compared to those based on palynological evidence and proxy-based paleoclimatic evidence regarding temperature and precipitation trends to assess the influence of moisture balance and temperature variation, fire history, and human impact on *Polylepis* woodland distribution. The preliminary pollen analysis indicates a relatively high taxonomic diversity, with *Polylepis* and *Alnus* showing consistent presence throughout the Middle Holocene among the forest taxa. This underscores the importance of considering multiple proxies for comprehensive palaeoenvironmental reconstructions.

29/05/2024, 17:00–18:40, Room: Taurus
H06 Long-term tropical forest dynamics; critical knowledge in a changing world

O-225 - Ecological response on environmental change in tropical South America during the late Quaternary

Hermann Behling[1]

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Detailed records on vegetation and environmental changes during the late Quaternary, based on pollen, charcoal and multivariate data analyses, provide insights on past ecological response on environmental changes. Several examples from South America will be presented. Studies from the Ecuadorian Andes as well as from the lowlands and highlands of Brazil reflect interesting ecological responses to climate change, fire and human impact. Results from continental records from the lowlands and highlands in Brazil as well as marine records show that the response of ecosystems on large scale climate change can be within centuries or decades. Studies from different regions indicate how tropical ecosystems evolved to what they are today. Furthermore, they show how sensitive ecosystems are to climate change and how ecosystems responded to natural and anthropogenic environmental changes during the past. This knowledge will help us to understand how ecosystems might change under the ongoing Global Change.

29/05/2024, 17:00–17:40, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-226 - Large cordaitalean leafy branch with in situ pollen from the volcanic Whetstone Horizon (Radnice Member, early Moscovian, Plzeň Basin, Czech Republic)

Josef Pšeničkа[1], *Jan Bureš*[1], *Zbyněk Šimůnek*[2], *Jiří Bek*[3], *Jana Drábková*[2], *Jana Bruthansová*[4]

1 West Bohemian Museum in Pilsen, Centre of Palaeobiodiversity, Plzeň, Czech Republic
2 Czech Geological Survey, Geology, Prague, Czech Republic
3 Geological Institute of the Academy of Sciences of the Czech Republic, Laboratory of Palaeobiology and Palaeoecology, Prague, Czech Republic
4 National Museum, Palaeontological Department, Prague, Czech Republic

A record of a long cordaitalean branch bearing leaves and pollen producing organs was realized during palaeobotany research 2010 in the Kamenný Újezd locality, Plzeň Basin Czech Republic. Generally, cordaitales ranged from Carboniferous to Permian as cosmopolitan plants and were important parts of the Late Pennsylvanian tropical peat-forming and upland ecosystems in Cathaysia and Euramerica. The presented specimen came from *in situ* "Bělka" tuff in the lowermost part of the Whetstone Horizon, Radnice Member, late Duckmantian. The branch with attached leaves and pollen producing organs represents a unique preservation for this type of cordaitalean tree and has enabled this pollen producing plant to be reconstructed. The leaves were assigned to *Cordaites* cf. *borassifolius* because their precise determination due to preservation was not possible, but the transverse stomatal crypts on the abaxial cuticle compares favorably with *Cordaites borassifolius* stomatal forms. This idea is also supported by the identical stratigraphic occurrence in the in situ tuff of the Whetstone Horizon. The preserved anatomical features of the studied branch show secondary xylem, which has enabled its assignment to the fossil-genus *Cordaixylon.* The pollen producing organ to be described as new species *Florinanthus longiantheratus* distinguished on significant differences from other cordaitalean pollen producing cones. Pollen grains of *Florinanthus longiantheratus*. were classified as *Florinites pellucidus.* The data obtained from the find can better understand this interesting group of gymnosperms in a whole plant concept perspective.

29/05/2024, 17:00–17:40, Room: Virgo
B02 Permo-Carboniferous tropical forests from the Czech Republic and China

O-227 - Fertile leptosporangiate fern from Stradonice, a new locality of the Kladno-Rakovník Basin, Pennsylvanian age of the Czech Republic

Jana Votočková Frojdová[1], *Josef Pšenička*[2], *Jiří Bek*[1], *Stanislav Opluštil*[3]

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This study focused on new leptosporangiate fern from the tuff flora located in the new Pennsylvanian locality, the western part of the Stradonice ravine, Central Bohemian Region, Czech Republic (Bolsovian). We introduce a fertile ferns which has very nice preserved reproductive organs and part of cuticle. The fronds have preserved sphenopteroid type of pinnules and reproductive organs with four sporangial cells. The pinnules are bearing sori with up 47 sporangia with very distinctive annulus. The microspores are trilete, very small (10–16 µm) with microverrucate to microganulate sculpture and can be compared to the dispersed miospore species *Granulatisporites minutus*. This fern has unique arrangement sori, basis of ultimate pinnae have not sporangia, the upper part of pinnae contains one sori per pinnule. The grouped sporangia is covered almost whole pinnule. This study is still in progress.

The research is support by the research plan of the Institute of Geology of the Czech Academy of Sciences, v.v.i., RVO67985831.

29/05/2024, 17:00–19:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-228 - Selection by hydraulic failure in the early evolution of wood anatomy

Martin Bouda[1], *Brett Huggett*[2], *Alexandru Tomescu*[3], *Christine Strullu-Derrien*[4], *Ludwig Luthardt*[5], *Jonathan Wilson*[6], *Craig Brodersen*[7]

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4 The Natural History Museum, Science Group, London, United Kingdom
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7 Yale University, School of the Environment, New Haven – CT, USA

Over the course of the Devonian period, lignophytes evolved a form of arborescence based on woody gigantism: potentially unlimited growth of self-supporting secondary xylem. It was recently proposed that hydraulic failure selected for increasing complexity with xylem strand size in early tracheophytes. Here, we explore how such a selection pressure would have affected the evolution of secondary xylem anatomy including woody gigantism.

We reconstructed the xylem conduit networks of Devonian lignophytes and euphyllophyte relatives using anatomical information from available fossils, including tracheid size and arrangement, ray length and density, and pitting orientation where relevant. We then performed simulations of sap flow and embolism spread on the reconstructed networks over a range of sap tensions. We quantified the relative strength of selection by hydraulic failure due to conduit network topology by estimating the p88 mortality threshold in sap tension relative to an assumed distribution of conduit air-seeding pressures. We performed further simulations to investigate this dimension of the fitness landscape for relevant hypothetical wood anatomies as a function of size.

We found that the earliest known examples of secondary xylem had a network resistance to hydraulic failure on par with that of the more complex primary xylem anatomies of their time. Over the range of xylem strand sizes and arrangements found in the Early Devonian, these anatomies perform particularly well on improving resistance with increasing size. Subsequent innovations in ray height and density and pitting patterns observed through the Devonian extend the range of sizes over which a favourable size-resistance relationship is maintained.

As we add more taxa to our dataset tracing the evolution of secondary xylem, we expect to reinterpret aspects of wood anatomy evolution with respect to hydraulic safety. Ultimately, this work will set the hydraulic safety of modern woods in a broader evolutionary context.

29/05/2024, 17:00–19:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-229 - Secondary phloem from the Late Devonian cladoxylopsid Xinicaulis, Xinjiang northwestern China

Honghe Xu[1], *Christopher Berry*[2], *William Stein*[3]

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Cladoxylopsida represents the first tree on the Earth, appearing from the Eifelian to the Late Devonian. Cladoxylopsid trunk structure comprised a more-or less distinct cylinder of numerous separate cauline xylem strands connected internally with a network of medullary xylem strands and, near the base, externally with downward-growing roots, all embedded within parenchyma. The cladoxylopsid *Xinicaulis*, based on exceptionally preserved silicified fossils from the Upper Devonian of Xinjiang, northwestern China, shows the trunk with a large amount of wood containing both rays and growth increments concentrically around individual xylem strands. In our recent study on *Xinicaulis*, we demonstrate tissues conforming to the concept of secondary phloem were produced on the outside of the secondary xylem of cauline and root vascular stands from a bifacial vascular cambium. Secondary phloem is complex, consisting of presumed functional phloem, sclerified phloem, phloem fibres and parenchyma. Storied parenchyma was produced in large quantities between episodes of serial production of phloem fibres. This complex phloem tissue grew to fill the spaces between the xylem strands and roots in the expanding skeleton of the enlarging trunk. This emphasises the complex and unique developmental solution evolved within Cladoxylopsida to achieve the tree habit. The presence of secondary development by means of a bifacial vascular cambium, regarded as a uniquely evolved meristem in lignophytes, indicates that cladoxylopsids, as exampled by *Xinicaulis*, evolved a similar developmental pattern within an entirely unique functional context.

29/05/2024, 17:00–19:00, Room: Zenit
A02 Advances in Devonian Paleobotany

O-230 - Latest Famennian to mid Visean palynology from Guizhou, South China

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South China develops deposits with a serial of sedimentary facies during Late Devonian to Early Carboniferous. Palynology acts as a key role in corrlation of shallow marine sediments of South China. We here recognize four palynological assemblages from the latest Famennian to mid Visean sediments from Maoying, Mubiao, and Baihupo sections with different sedimentary facies in Guizhou, South China. These assemblages are correlated to coeval palynological zones in western Europe, and show similarities with that in Australia during the Visean Age.

The Mubiao and Baihupo secions consist of platform facies sediments of Devonian-Carboniferous Boundary. Their palynological results conrrespond with Hangenberg crisis occouring in shallow marine. The Maoying section lacks of sediments from Famennian (or latest Frasnian) to early Visean and it shows transgression-formed by the inter-glacier peroid after the glaciation from the latest Famennian to mid-Tournaisian.

Four assemblages are listed and briefly decribed as following.
Assemblage 1, latest Famennian: *Cymbosporites-Tumilispora*. Abundance of *Cymbosporites* spp. (*C. chinensis*, *C. microverrucosus*, *C. cornatus*, *C. munutus*) and *Tumilispora* spp. (*T. raritubercula*ta, *T. ordinaris*) are above 10%.
Assemblage 2, Tournaisian: *Densosporites rarispinosus-Knoxisporites literatus*. *D.* spp. (*D. rarispinosus*, *D. spinifer*) are of 10%. *Knoxisporite*s spp. first appear, less than 10%.

Assemblage 3, Tournaisian: *Leiotriletes-Punctatosporites*. With abandant *Leitriletes* spp. (*L. crassus*, *L. labiatus*) and *Punctatisporites* spp. (*P. camaratus*, P. *recavus*, *P. jiangsuensis*), *Punctatosporites* sp. first appear and less than 2%. *Apiculiretusisporites* spp. (*A. gannanensis*, *A. conica*, *A. granulata*) are more than 5%.
Assemblage 4, mid Visean: *Lycospora pusilla-Heteroporispora subtriangularis*. *Lycospora* spp. are abundant (26% to 49%), especially *L. pusilla*. Auriculate spores and zonate spores with interadical spinae are less than 5%.

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O-231 - The diversity of architectural models in cladoxylopsids: Insights from anatomically preserved Cladoxylon taeniatum specimens from France

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The cladoxylopsids *s.l.* are an extinct group famous for including some of the species that formed the first forests during the Middle Devonian. The group encompasses several arborescent taxa for which different architectural models have been proposed in the literature. However, all these models have focused on tree-sized cladoxylopsids (i.e., *Pietzchia* or *Calamophyton*) and none has been proposed to date for smaller representatives of the group. In this study, we address this gap by analyzing 30 anatomically preserved specimens of *Cladoxylon taeniatum* from the early Carboniferous (Tournaisian) Lydiennes Formation of Southern France to investigate the habit and development of this species.

The specimens are axes 5–11 mm in diameter, up to 95 mm long. They are assigned to *C. taeniatum* based primarily on their dissected stele shape, the presence of secondary xylem, and their trace emission pattern coming from multiple ribs. Some specimens show the base of lateral organs that can be followed after their individualization from the main axis. The adaxial-abaxial polarity of these second-order axes and the terete and dichotomous emissions they produce lead to the interpretation of *Cladoxylon taeniatum* as a stem with helically arranged rachis-like laterals that bear alternate, non-planated ultimate appendages. Quantitative characters of the stele (e.g., number of ribs, diameter, primary and secondary xylem surface) were investigated using a principal component analysis coupled with a hierarchical clustering method on a sub-sample of well-preserved specimens. These analyses recover 4 groups that may correspond to different developmental stages of the plant. Combined with qualitative findings from all the *Cladoxylon* specimens found in the Lydienne formation (n = 53), these results allow us to propose two possible architectural models for *Cladoxylon taeniatum*.

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O-232 - Down by the water- Aerenchyma in Devonian and early Carboniferous plants

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Aerenchyma is a specialized plant tissue containing enlarged gas spaces formed either by differential growth and cell separation (schizogeny) or by cell death (lysigeny). Today, aerenchyma is formed constitutively in the roots, shoots, and leaves of aquatic plants, and in response to poor soil aeration in wetland plants. Its presence can thus be used as a proxy for plant adaptation to flooded and aquatic habitats in the fossil record. This talk will review selected occurrences of aerenchyma in Devonian and early Carboniferous plants based on the litterature and on new data to (1) provide a new understanding of the evolution of this tissue, and (2) discuss the anatomical evidence for the oldest aquatic vascular plants.

Aerenchyma is present in early Devonian plants, including in the cortex of taxa from the Rhynie chert such as *Asteroxylon*. It has been reported in several cladoxylopsid s.l. stems, and is particularly well-developed in the central ground tissue of *Pietzschia levis.* Aerenchyma is also present in an unnamed iridopteridale from the Late Devonian of Australia, where it is located in the inner part of the cortex. One of the best examples of aerenchyma in late Devonian-early Carboniferous plants however is the enigmatic genera

Periastron, known from the New Albany Shales in Kentucky, Erin Slate in Alabama (USA), the Russchiefer of Saalfeld (Germany) and the Lydienne Formation (France). Additional specimens from the Lydienne Formation bring new information on the structure of the aerenchyma and on the way it was formed. The extensive presence of aerenchyma in an organ interpreted as a petiole suggests that the parent plant was aquatic. While the plant fossil record is known to have a strong bias towards the preservation of wetland taxa, this is the oldest anatomical evidence of a complex vascular plant adapted to fully aquatic life.

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O-233 - Ecology and diversity of a new anatomically preserved flora around the Devonian/Carboniferous transition of Argentina

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The end of the Devonian is marked by important environmental changes that led to a major biodiversity crisis in the marine realm. Their effects on the continental ecosystems seems to have regularly been overestimated in the past. The timing of the event on continents are still poorly constrained, but data on plants tend to show that the continental ecosystems were more resilient, even if undoubtedly affected by environmental changes. In this presentation, we will document a new plant locality within the precordillera of La Rioja (Argentina) that will help us address these questions. The here discussed sequence was discovered in the course of an ongoing effort to investigate the Sierra de las Minitas (La Rioja Province, Argentina), a small mountain range of fossiliferous rocks exposing sediment from the Lower Devonian to the Late Tournaisian. This locality yields abundant plant and animal fossils as well as many phosphatic nodules presenting anatomically preserved plant remains. The plant assemblage is relatively diverse. It is dominated by four species of both arborescent and herbaceous Cladoxylopsida and by three species of Lycopsida. Other plants belong to the Filicophyta and Spermatopsida. This flora presents clear transitional traits between the Devonian and the Carboniferous and remains diverse despite its position after the Devonian – Carboniferous transition. This provides further evidence for a clear decoupling between the extinction dynamics in the marine and continental realms

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D01 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-234 - Matching Messel flowers with their insect visitors via pollen

Christian Geier[1], *Johannes Martin Bouchal*[1], *Silvia Ulrich*[1,2], *Reinhard Zetter*[1], *Jürg Schönenberger*[1], *Dieter Uhl*[3], *Sonja Wedmann*[4], *Torsten Wappler*[5,6], *Fridgeir Grimsson*[1]

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The Messel Pit, a UNESCO World Heritage site, is famous for its exceptional preservation of Central Europe's Middle Eocene terrestrial biota. Countless findings of various fossil mammals, reptiles, amphibians, birds, insects, and plants document a species-rich and complex ecosystem thriving under a hot and humid paratropical climate. Most of the buds/flowers/inflorescences collected from this site are still not taxonomically assigned, and only little is known about their insect visitors. In order to clarify the taxonomic placement of flowers, flower-insect interactions, and the foraging and feeding behaviour of insects, we extracted in situ pollen from anthers of flowers as well as in situ and/or adhering pollen from insects. So far, we have studied 715 flowers (205 with pollen) and 1126 insect specimens (225 with pollen). Pollen from the flowers suggests they represent at least 50 different angiosperm taxa, including, among others, representatives of Anacardiaceae, Araliaceae, Arecaceae, Cornaceae, Euphorbiaceae,

Fabaceae, Hamamelidaceae, Malvaceae, Nympheales, Rosaceae, Rutaceae, Sapotaceae, and Vitaceae. The insects we investigated represent the four extant main pollinator groups: Coleoptera (476 specimens/101 with pollen), Diptera (220/19), Hymenoptera (327/78), and Lepidoptera (37/9). Pollen was discovered both internally and externally in Coleoptera, Diptera, and Hymenoptera, but only externally in Lepidoptera. Even though we managed to match many of the pollen types extracted from insects to those from flowers, there were still several pollen types associated only with insects. Some insects had only one pollen type filling their gut or adhering to their exoskeleton, while others had up to eight different pollen types. Using the pollen, we inferred oligolectic or polylectic behaviour for visiting insects, as well as, generalized versus specialized pollination syndromes for the flowers. For example, *Parthenocissus* (Vitaceae) pollen was discovered in situ or adhering to various insects from all four major pollinator orders, implying a generalist pollination syndrome for this plant genus.

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D01 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-235 - Reinvestigating the Messel palynoflora using combined LM and SEM

Johannes Martin Bouchal[1], *Silvia Ulrich*[1,2], *Christian Geier*[1], *Reinhard Zetter*[1], *Volker Wilde*[3], *Olaf Lenz*[3,4], *Fridgeir Grimsson*[1]

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The dispersed Eocene palynoflora from Messel, Germany, continues to spike interest and provide new insights into the ancient paratropical ecosystem that prevailed in Central Europe at that time. With this revisit of the palynoflora, using combined light- (LM) and scanning electron microscopy (SEM), we aim to conclude the following: (I) if additional spore/pollen types can be discovered, (II) if previously identified spores/pollen can be taxonomically placed with more certainty, (III) how is the composition and species richness of the palynoflora, (IV) what is the proportion between pollen types from zoophilous versus anemophilous angiosperms, (V) how does the palynoflora correlate with the macro- and mesofloras, (VI) is it possible to adjust the vegetation reconstructions based on the revised palynoflora, (VII) do new plant taxa add any relevant data for the paleoclimatic evaluation, and finally (VIII) how does our combined LM/SEM method compare to previous results using classic LM counting. Until now, our ongoing investigation has revealed various new pollen types, especially of angiosperms, adding considerably to the microfloral list of this locality. We have also been able to adjust previous LM-based segregations into single taxons and amend the taxonomic placement of some spore/pollen types. So far, we have discovered three algal palynomorphs, 31 spore types, seven types of gymnosperm pollen, and about 185 angiosperm pollen types in a single sample, adding ~45 new pollen types for this locality. When comparing the palynoflora to the meso/macroflora, expectedly, several taxa are present in both records, but many of the spores/pollen do not have representatives in the meso/macroflora and vice versa – indicating the importance of combining micro/meso/macrofloras when reconstructing paleovegetation and evaluating paleoclimate. Considering the angiosperms, pollen from zoophilous plants is more diverse than pollen from anemophilous plants. Vegetation reconstructions and paleoclimate evaluation await further investigation until the palynological work is finished.

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D01 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-236 - Combined LM and EM investigations of pollen from compressed fossil flowers aid in their taxonomic assignment

Silvia Ulrich[1,2], *Christian Geier*[1], *Johannes Martin Bouchal*[1], *Zetter Reinhard*[1], *Jürg Schönenberger*[1], *Dieter Uhl*[3], *Fridgeir Grimsson*[1]

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Flowers are delicate structures that are relatively rare in the fossil record compared to other plant organs such as dispersed pollen, leaves, fruits, or seeds. Also, due to their fragile state, fossil flowers are seldom complete, mostly with parts or complete stamens,

petals, sepals, or stigma missing. Besides amber inclusions, most Cenozoic flowers discovered so far are preserved as compression fossils with diagnostic features often obscured or deformed. This makes in situ pollen grains, still present and extractable from anthers of these flowers, essential to determine their taxonomic placement. Palynology and the study of fossil pollen are primarily focused on morphology observed with light microscopy (LM) and, in some cases, scanning electron microscopy (SEM). This is despite the fact that taxonomic assignment of pollen to a particular family, genus or species is sometimes only possible using additional information related to the ultrastructure of the pollen wall. We have adjusted previous preparation methods so that a transmission electron microscope (TEM) can easily be applied to single fossil pollen grains, which have previously been investigated with both LM and SEM. The combined LM- and SEM-based morphological characteristics and the ultrastructural features documented for single pollen grains provide a higher taxonomic resolution and a more reliable affiliation to extant and/or extinct taxa. For example, we present several Paleogene pollen-bearing buds/flowers/inflorescences which were either noted as unidentified prior to our study, or the pollen suggested they should be placed in a different taxon. In some cases, the combined morphological and ultrastructural features allow for direct comparison with pollen of extant species. In this way, applying our method on previously unidentified fossils, we were able to assign a flower bud to *Ludwigia* (Onagraceae), flowers to *Alangium* (Cornaceae) and Euphorbiaceae, and an inflorescence to *Ascarina* (Chloranthaceae).

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O-237 - Palynoflora of the Insect Limestone, late Eocene, UK

Reinhard Zetter[1], *Christian Geier*[1], *Johannes Martin Bouchal*[1], *Silvia Ulrich*[1,2], *Peta Hayes*[3], *Margaret Collinson*[4], *Shabir Ahmad*[5], *Fridgeir Grimsson*[1]

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The latest Eocene (late Priabonian; c. 34 Ma) Insect Limestone, that outcrops on the Isle of Wight, UK, is known for its exceptional preservation and diversity of fossil insects. The fauna and flora from the Insect Limestone has the potential to provide a unique window into the paleoenvironment, biodiversity, and plant-insect interactions near the end of the Eocene. Much of the earlier Eocene was characterized by a hot and humid climate with paratropical conditions, even at mid to high latitudes. The Insect Limestone macroflora has been described but, in order to acquire a more complete representation of the plants thriving in the Isle of Wight area during the latest Eocene, we investigated dispersed spores and pollen from the Insect Limestone using combined light- and scanning electron microscopy. Our study so far has revealed spores from six different fern taxa, representing Osmundaceae, Polypodiaceae, Pteridaceae, and Schizaeaceae. Various pollen of gymnosperms includes Cupressaceae (both papillate and ulcerate types), Pinaceae (*Cathaya*, *Picea*, *Pinus*, *Tsuga*), Sciadopityaceae (*Sciadopitys*), and Ephedraceae (*Ephedra*). The angiosperm component is by far the most diverse, with about 115 different pollen types assignable to at least 40 families. These include various basal angiosperm/monocot pollen of Arecaceae, Chloranthaceae, Lemnaceae, and Typhaceae, as well as an overwhelming number of dicot pollen types demonstrating the presence of, among others, Adoxaceae, Apocynaceae, Araliaceae, Clethraceae, Ericaceae, Euphorbiaceae, Icacinaceae, Loranthaceae, Malvaceae, Moraceae, Nyctaginaceae, Oleaceae, Rosaceae, Rutaceae, Santalaceae, Sapotaceae, and Thymelaeaceae. This first account attempts to describe and assign the spores and pollen taxonomically. Future work will focus on comparing the previously described macroflora with the microflora, reconstructing the vegetation units around the accumulation site, and evaluating the paleoclimate under which the respective plants and insects lived during the latest Eocene in the Isle of Wight region.

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D01 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-238 - Flowers and insects with in situ and/or adhered pollen from Eckfeld (Eocene) and Enspel (Oligocene), Germany

Fridgeir Grimsson[1], *Christian Geier*[1], *Johannes Martin Bouchal*[1], *Silvia Ulrich*[1,2], *Jürg Schönenberger*[1], *Dieter Uhl*[3], *Sonja Wedmann*[4], *Reinhard Zetter*[1], *Torsten Wappler*[5,6]

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The Middle Eocene Eckfeld maar (c. 44 Ma) and the Late Oligocene Enspel crater lake (c. 24 Ma) localities, both in Germany, are renowned for the numerous well-preserved fossils they have yielded until the present day. Among these records, hundreds of angiosperm flowers have not been taxonomically affiliated. In addition, thousands of insects have also been recorded which potentially provide direct evidence for flower visitations and entomophilic pollination processes. To assign the flowers to a taxonomic system, we extracted in situ pollen from their anthers and studied them with light- (LM) and scanning electron microscopy (SEM). We also extracted pollen from fossil insects to obtain data on flower visits and possible pollinator roles. We investigated 943 buds/flowers/inflorescences from Eckfeld, of which 401 (c. 42.5%) contained in situ pollen. Based on the pollen processed so far, they represent at least 38 different angiosperm taxa. These include, among others, representatives from Anacardiaceae, Euphorbiaceae, Fabaceae, Menispermaceae, Onagraceae, Sapotaceae, and Vitaceae. We also studied 404 insect specimens from Eckfeld. These include 332 Coleoptera (19 with pollen), 43 Hymenoptera (13 with pollen), and 20 Diptera (1 with pollen). Within Coleoptera, pollen was most frequently associated with members of Sagrinae, a subfamily of leaf beetles (Chrysomelidae), and Agrilinae, a subfamily of jewel beetles (Buprestidae). Within Hymenoptera, the clade of corbiculate bees comprised most of the adhered pollen. From Enspel, we investigated 107 buds/flowers/inflorescences, of which 32 (c. 30%) contained in situ pollen. Our analysis indicates that they represent around nine different angiosperm taxa. These include, among others, Malvaceae, Rosaceae, and Sapotaceae. So far, we have investigated 22 insect specimens (15 with pollen) from Enspel, including 17 Apidae (11 with pollen), one Blasticotomidae (with pollen), and a single Pamphiliidae (with pollen). These fossil records provide a unique insight into flower visitation during the Paleogene of Central Europe.

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M03 "Extra microfossils" in pollen slides: environment and biotic interactions

O-239 - Challenges in establishment of NPP reference collections with special case of dung fungi spores

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Reference collections are basis for morphological identifications. In case of pollen, reference collection can be easily obtained from flowers both in herbaria and in the field. Reference collections for non-pollen palynomorphs (NPP) are very rare. Usually identifications are made based on palynomorph descriptions in various papers without proof with any recent reference material. The major challenge in establishment of NPP reference collection is a taxonomic variety of NPP, including wide range of taxa belonging to cyanobacteria, green algae, dinoflagellates, vascular plants, testate amoebae, foraminifers, sponges, different worms, birds, insects, asco- and basidiomycetes as well as artificial material. Establishment of a reference collection for each specific group of interest faces the second challenge – collection of taxa requires specialist knowledge. Establishment of reference collections for fungi, including coprophilous fungi, rusts and smuts, was undertaken during the last years by the author. Collection of dung fungi spores is the most challenging one. It starts with collection of dung, its incubation in wet chambers and identification of fungi during few weeks or months, collection of fruiting bodies and spores, acetolysis and embedding of acetolysed spores. Since one fruiting body contains sometimes less than one hundred spores, loss of material during all the steps of preparation occur frequently. Morphological comparison of acetolysed and non-acetolysed spores indicate change in spore size after laboratory treatment for most

of taxa. This evidence questions the using of acetolysis and suggests a search for other techniques allowing comparison of fossil and recent spores. Furthermore, the results indicate that spore size from mycological literature should be carefully applied to palaeoecological fungal records. Nevertheless, reference collection of fungi spores opens new possibilities in increasing of taxonomical resolution of palynological records.

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M03 "Extra microfossils" in pollen slides: environment and biotic interactions

O-240 - Diversity of modern fungal non-pollen palynomorphs and factors shaping their structure in a European lowland forest

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Non-pollen palynomorphs (NPPs) play a crucial role as environmental indicators in paleoecological research, enhancing the interpretation of fossil data. In this study, the composition and taxonomic richness of NPPs of fungal origin (fNPPs) were analyzed from moss samples from European lowland forest. The relationship between fNPPs and local environmental variables was explored. These variables included forest type, canopy openness, volume of dead wood, richness of herbaceous plants, and management intensity. In 114 moss samples, collected in various forest types in Białowieża Forest (NE Poland), 98 types of fNPPs were identified constituting high taxonomic richness. The majority of them were saprotrophs displaying preferences for specific substrates (wood, bark, herbaceous plant remains, litter, and freshwater habitats), while the rest were plant pathogens and undetermined taxa. Dominant taxa, in terms of frequency across forest types, included HdV-96A and EMA-24, particularly pervasive in deciduous forests. 20 morphotypes were considered new and not previously described. Half of the newly identified morphotypes were successfully classified to species or genus level, enabling assignment of their ecological indicator value. Various ecological factors, including forest type, herbaceous plant diversity, canopy openness, and dead wood components, were found to be significant in shaping the composition and taxonomic richness of fNPPs within this forest ecosystem. Forest type emerged as the most important predictor, with deciduous forests having higher richness and diversity of fNPPs compared to coniferous forests. Comprehensive microhabitat studies would lead to a better understanding of forests' impacts on fungal communities, ultimately contributing to improved knowledge about forest ecosystem dynamics.

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M03 "Extra microfossils" in pollen slides: environment and biotic interactions

O-241 - Analysis of modern palm phytoliths

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Palms (Arecaceae) are one of the several families that can accumulate silica in their cells and produce phytoliths. Thus analysis of palm phytoliths in sediments can provide important evidence for understanding the evolutionary and biogeographic history of palms. Accurate identification of palm phytoliths in sediments relies on better knowledge of phytolith morphology in modern palms. Previous studies recognized two types of phytoliths in modern palms: spheroid echinate and conical echinate, while the morphology of phytoliths among different genera is poorly known. Here we investigated modern phytoliths from 60 species of Arecaceae, representing 43 genera across five subfamilies which are widely distributed in tropical and subtropical regions of the world. Morphometric measurements were made to the spheroid echinate and the conical echinate types. Morphometric parameters including diameter, roundness, number of spines, length of spines, and distance between spines. We have recognized 17 sub-types within the two types of phytoliths in palms. Most palm genera can not be distinguished based on phytolith morphology; only the genera *Arenga*, *Chuniophoenix* and *Licula* have unique phytoliths that is distinct from other genera. The results of our analysis provide important evidence for understanding the relationships among extant palm genera and are also helpful for identifying palm phytoliths in geological record.

O-242 - Heterocysts of Rivularia as a bioindicator in palaeoenvironmental contexts (Late Quaternary, northern Italy)

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Rivularia (Nostocales, Cyanobacteria) is an excellent bioindicator of trophic stages and environmental conditions in current and past habitats. *Rivularia* spp. can fix atmospheric nitrogen (N_2) into biologically available NH_3, providing new nitrogen to nitrogen-limited systems; N fixation takes place in heterocysts that are usually the best-preserved morphotypes of cyanobacteria in palynological slides. In palaeoenvironmental studies, *Rivularia* heterocysts (*Rivularia* type; HdV-170) improve in understanding the environmental dynamics inferred by pollen spectra, indicating eutrophication (high concentration of organic phosphorus-P and combined N) which is dependent on mild temperatures and humidity.

This paper presents new results from the palynological study of two terrestrial cores (PVG-N-S3, PVG-C-S1) drilled in the area surrounding the Terramara S. Rosa di Poviglio (Po Plain, Italy), whose samples (total: 97) showed significant and recurring presence of *Rivularia* heterocysts.

Heterocysts were divided into categories based on morphology (ellipsoidal or elongated) and state of preservation of sheaths surrounding the trichome (presence or absence). The presence/absence of *Rivularia* type provided essential ecological data on local trophic and environmental conditions. However, with current knowledge, the occurrence of different morphologies of heterocysts is difficult to attribute to the presence of many species. Further morphological investigation of these structures and comparison of modern examples could improve the taxonomic identification of *Rivularia* heterocysts.

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O-243 - The Early Holocene onset of one of the oldest peatlands in Central Europe in the light of multi-proxy studies

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The Linje peatland is a unique Central European lowland refugium of *Betula nana*, a relict species from Late Weichselian, which is characteristic of tundra vegetation. This study aims to reconstruct the environmental settings for the beginning of the peatland functioning that enabled this species to overcome unfavourable interglacial conditions. Within this study, we investigated the bottom section of the 12.3 m long peat profile collected from the central part of the peatland, where the peat is the thickest. We analysed the profile for the presence of pollen, non-pollen palynomorphs (NPP), plant macrofossils, testate amoebae and macrocharcoal. The lithological screening of the profile pointed to the onset of peat accumulation directly on the sandy bed without traces of lacustrine sediments, whereas age-depth modelling revealed the probable start date – ca. 11,550 cal. BP. Analysis of pollen and non-pollen palynomorphs (NPP) showed that the accumulation basin was a shallow lake and/or rich fen before the stable peatland conditions were established. Ca. 11,390 cal. BP, an increase in the water level resulted in the development of a shallow eutrophic lake, as visible in the high percentages of *Tetraëdron minimum* and *Pediastrum* sp. The lake finally infilled ca. 11,260–11,210 cal. BP and an ombrotrophic bog/poor fen developed, as proved by numerous NPPs, e.g., *Archerella flavum*, *Assulina* sp., *Tilletia*

sphagni, HdV-13, and others. Pollen data indicate terrestrial vegetation openness when the rich fen/telmatic peat accumulation started. This pattern is similar to the vegetation changes characteristic of Younger Dryas. At this stage of our research, data suggest that the local environment suppressed vegetation changes in the Linje mire surroundings for ca. 270–180 years. In the next step, we plan to carry out additional 14C AMS dates and look for volcanic ash to verify absolute chronology and to establish the timing of vegetation changes.

29/05/2024, 17:40–19:00, Room: Virgo
D03 Global insights into the evolutionary origin of Mediterranean-type ecosystems: taxonomy, palaeoecology, palaeogeography, and taphonomy

O-244 - Integrating fossil and contemporary data to trace ecosystem changes in Mediterranean forests through insect-galls

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Mediterranean forests, critical hotspots of modern biodiversity, face significant threats due to Global Change. This study presents an innovative perspective by integrating paleoecological and contemporary data to understand ecosystem changes through plant-insect interactions, with a specific focus on insect galls. Utilizing a morphological guide for plant-insect interactions, our approach enables a direct comparison between 2,500 fossil and 4,000 contemporary leaves spanning 20 million years from the Aegean Sea region. In an in-depth analysis of contemporary leaf samples, we assessed the preservation of plant-arthropod interactions on abscised leaves in the litter layer in comparison to those still on the tree. Our findings indicate a significant loss of all interactions data post-fall, with gall interactions exhibiting the highest fidelity of preservation, retaining approximately 75% of interaction data. Insect galls structures thus are essential in tracing the evolution of plant-arthropod interactions. These distinctive structures with their specialized nature and enhanced preservation in the fossil record significantly reduce biases, providing a clear and detailed insight into historical ecosystems. Galls effectively indicate the adaptive responses of host plants to varying climates, especially in arid environments. We observed a notable relationship between gall diversity and climatic conditions, reflecting how these interactions evolved in response to environmental changes. Our findings demonstrate the value of gall-based analysis in tracing the long-term evolution of plant-arthropod interactions, offering vital insights into the ecological dynamics and resilience of Mediterranean forests under Global Change pressures.

29/05/2024, 17:40–19:00, Room: Virgo
D03 Global insights into the evolutionary origin of Mediterranean-type ecosystems: taxonomy, palaeoecology, palaeogeography, and taphonomy

O-245 - The tribe Ampelopsideae (Vitaceae) in the Cenozoic of Eurasia: Paleobiogeographic implications

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The grape family Vitaceae Jussieu is composed of 15 genera and about 950 species mainly distributed in Southern Asia, Africa, Australia, and the Pacific islands. Only a few species occur outside these areas, especially in temperate regions. Phylogenetic studies of Vitaceae indicate five major clades, referred to as tribes: (1) Ampelopsideae, (2) Parthenocisseae, (3) Viteae, (4) Cisseae, and (5) Cayratieae.

Here a new *Nekemias* fossil-species (tribe Ampelopsideae) from Eurasia is described. Comparison with extant Ampelopsideae suggests that the extant North American species *Nekemias arborea* is the most similar to the new fossil-species. Paleobiogeographic data indicates that during the middle Eocene, Ampelopsideae was already present in Eurasia with *Ampelopsis protoheterophylla* found in Russia. In the late Eocene, this tribe diversified and three species occur in Eurasia, i.e., *Nekemias* sp. nov. (Czech Republic), *A. hibschii* (Kazakhstan), and *A. cercidifolia* (Russia). Later, in the Oligocene, *A. schischkinii* and *A. angulata* occurred in Asia,

while *Nekemias* sp. nov. spread eastwards and southwards while *A. hibschii* spread westwards. *Nekemias* sp. nov. became a relict in the Iberian Peninsula during the late Oligocene while *A. hibschii* last occurrence was in the Middle Miocene in Bulgaria. This locality acted as a refuge for *A. hibschii* along with *A.* aff. *cordata*. Meanwhile, in the Middle Miocene of Russia, two new species appeared (*A. populifolia* and *A. amgensis*). The compilation of paleobiogeographic data support the hypothesis that the North Atlantic and Bering land bridges were important dispersal routes for Ampelopsideae. However, the dispersion of Ampelopsideae would occur during the Paleogene instead of Neogene, as previous authors suggested.

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29/05/2024, 17:40–19:00, Room: Virgo

D03 Global insights into the evolutionary origin of Mediterranean-type ecosystems: taxonomy, palaeoecology, palaeogeography, and taphonomy

O-246 - Introduction and fossil history of subtropical semi-humid vegetation in southwestern China

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Nowadays, certain types of vegetation adapted to subtropical semi-humid climates are widely distributed in southwest China, particularly in the Yunnan Plateau, the Himalaya-Hengduan Mountain valleys, and the karst regions of southwest China. They have a species composition and community appearance similar to those of present-day vegetations in the Mediterranean, such as sclerophyllous forests and semi-arid shrublands.

This study involved the examination of species composition, community structure, and leaf physiognomy characteristics of plateau sclerophyllous forest and limestone dwarf forest vegetation. The investigation utilized large-scale and extensive modern botanical sampling. The results indicated a strong kinship with Tethys flora, as determined by Quercus sect. Ilex-Olea-Pistacia constitutes the main body of the community. In this type of community, the leaves of plants exhibited a prominent trend of miniaturization and sclerophyll.

Several fossil assemblages from Oligocene to Pliocene have been found in this area , including the Wenshan flora of Yunnan. A series of fossil evidence suggests that the climate in East Asia gradually became more humid during the Cenozoic era due to the intensified monsoon. The Mediterranean-type vegetation, which is adapted to the subtropical semi-humid climate, was gradually replaced by the subtropical evergreen broad-leaved forest plant community of paleotropic origin, which is adapted to the humid environment.

The comprehensive evidence shows that these plant communities in southwest China are the surviving descendants of the flora on the east coast of the Tertiary Tethys, and they have a very long geological history and long-term stability. They may have served as a source of biodiversity for the Mediterranean-type ecosystems of Eurasia during the Cenozoic.

29/05/2024, 17:40–19:00, Room: Virgo
D03 Global insights into the evolutionary origin of Mediterranean-type ecosystems: taxonomy, palaeoecology, palaeogeography, and taphonomy

O-247 - Mesozoic and Early Cenozoic palynofloras on the Qinghai-Xizang plateau with reference to palaeogeography and palaeoclimatology

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The Qinghai-Xizang plateau is comparable to the Mediterranean or western Tethyan area in terrane constituents and geology. The Bangong Co – Nujiang and Yarlung Zangbo sutures separate the Qiangtang, Lhasa-Gandise, and Southern Xizang Himalaya terranes which successively accreted to the north with the ancient Eurasia. Recent studies suggest that the Mediterranean-type flora may have developed on the Qinghai-Xizang plateau during the past. Therefore, the palaeoflora on the plateau is of special importance for the origin and evolution of the modern Mediterranean flora. In recent years we have focused on the palynology of the Triassic to Paleogene strata on the plateau for the palynofloristic evolution. Our work shows the Southern Xizang Himalayan Terrane has experienced an evolution of palynofloras from the austral in Triassic to the northern African affinity in late Late Cretaceous as a result of the northward rift and drift of the Indian plate. On the opposite side of Tethys or the southern margin of ancient Eurasia, a palynoflora of hot and humid climate was developed on the Lhasa-Gandise Terrane during the Middle Jurassic, which later turned to be a hot and dry climate preferred since Late Jurassic. It was different from that of Europe but comparable to that of China. This situation has continued at least to the early Paleogene when the India and Eurasia plates fully collided and the Tethys evolved from an ocean to a remnant sea. In early Eocene, the palynoflora was noticed by oak and palm for a warm and humid climate. After that, drought was strengthened in the region, with xerophytic pollen being much developed. In Oligocene, the local vegetation was markedly changed, with pines being very abundant. A much cooler climate was implied.

This work was supported by CNNSF (42372019, 42288201) and the Second Tibetan Plateau Scientific Expedition and Research (2019QZKK0706).

30/05/2024, 08:30–09:30, Room: Aquarius
D01 + D02 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-248 - Did beetles visit Pseudanthus (Picrodendraceae) flowers in the Eocene of Europe?

Angelika Till[1], *Christian Geier*[1], *Johannes Martin Bouchal*[1], *Silvia Ulrich*[1], *Sonja Wedmann*[2], *David Cantrill*[3], *Fridgeir Grimsson*[1]

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During ongoing investigations of flower-insect interactions in the Eocene of Central Europe we discovered two different beetles, a Scarabaeidae (scarab) and Cerambycidae (longhorn) beetle from the Middle Eocene of Messel (Germany), with their bellies full of the same peculiar pollen type. In light microscopy (LM), the pollen grains are small, spherical, echinate, and pantoporate. Additional studies applying scanning- (SEM) and transmission electron microscopy (TEM) show that the extracted pollen is also perforate in SEM, and with a complex, structured sporopollenin pollen wall in TEM. Based on the combined morphological and ultrastructural features observed with LM/SEM/TEM, the fossil pollen is comparable to pollen of extant *Pseudanthus*. Today, *Pseudanthus (*Picrodendraceae) comprises eight to nine species that are all endemic to the subtropical, seasonally dry tropical, or dry tropical biomes of East Australia. The plants are small subshrubs or shrubs and monoecious. *Pseudanthus* grows on sandy soils, sandstones and rocks (often of volcanic origin) in various habitats that include open forests and woodlands, shrublands, heathland, rainforests (rarely), gorges, along creek banks, in crevices, on hillsides, cliff faces, and mountain tops. *Pseudanthus* are considered entomophilous, but little is known about their insect visitors and main pollinators. Our findings prove that both scarab and longhorn beetles visited *Pseudanthus* flowers in the Middle Eocene of Europe to feast on pollen. The plants were likely growing on sandy or rocky volcanic substrate in the vicinity of the Messel lake maar. The amount of pollen filling the guts of the beetles and the adhered pollen discovered on their exterior suggest long and careful feeding visits within the male flowers. To prove that

the beetles also visited/came into contact with female flowers is unrealistic, but if they did, the amount of pollen discovered supports the theory that they were true pollinators of *Pseudanthus* back in the Eocene of Europe.

30/05/2024, 08:30–09:30, Room: Aquarius
D01 + D02 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-249 - Lower Triassic plant fossil record of the Western USA

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The Lower Triassic plant fossil record is extremely sparse in some regions where taphonomic conditions inhibit the preservation of organic matter. One region that was long known to be devoid of Lower Triassic plant fossils is the Western US. Here we present two different datasets from different localities opening a rare window into the Lower Triassic vegetation of this region.

Plant microfossils are described from samples of a core, drilled near Georgetown, Idaho. The cored interval encompasses sediments of the Thaynes Group deposited in the Sonoma basin. Samples from the basal Dinwoody/Woodside Formation are characterized by spore and pollen assemblages with Permian and Early Triassic affinity (e.g. *Lueckisporites* spp., *Klausipollenites schaubergeri*, *Luntisporites pellucidus*). Whereas samples from the overlying *Meekoceras* limestone are dominated by lycophyte spores (*Densoisporites* spp., *Lundbladisporites* spp.). Rare Ammonoids and conodonts assign the Meekoceras limestone to the middle Smithian. The plant microfossils from Georgetown suggest the presence of lycophytes, Gnetales, conifers, and seed ferns of the order Peltaspermales during the time interval from the Griesbachian/Dienerian to middle Smithian.

The second location with a rare plant fossil, is in the Humboldt Range of Nevada. The reproductive organ of a lycopsid was found in volcanogenic turbidites of the Koipato Group. This fossil is slightly younger than the microfossils of Idaho. Ammonoids indicate a mid-Spathian age. The morphology of the sporophylls is best compared with *Pleuromeia*.

Presumed in-situ spores have been extracted from the cone. They are covered by muscovite, which hinders observations. Nevertheless, their morphology can be described as monolete and cavate, resembling dispersed *Aratrisporites*. Tetrads are present, suggesting immaturity. This is the first find of the iconic Lower Triassic plant genus *Pleuromeia* in the US.

30/05/2024, 08:30–09:30, Room: Aquarius
D01 + D02 In situ and adhered pollen/spores from fossils plants and animals and their associated paleofloras

O-250 - Conifer remains from the Upper Triassic Poręba site in south-western Poland

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Poręba is an important and interesting Late Triassic plant-bearing and vertebrate bone-bearing locality in south-western Poland. The strata belong to the upper part of the Patoka Member of the Grabowa Formation and represent a braided river system. Among the animal fossils found were bones of one of the oldest European turtles, invertebrate cuticles, clitellate cocoons, and numerous coprolites containing plant and animal cuticles, tracheids, invertebrate eggs and bone remains, pointing to complex biotic interactions, including intra-intestinal parasites. Plant remains are numerous at this locality but so far only fossil wood has been described taxonomically and geochemically. Published palynological data are rather cursory but have allowed the site to be dated as of Norian age. The plant macroremains belong almost exclusively to conifers. *Brachyphyllum-Pagiophyllum* leafy shoots predominate; also present are isolated female seed scale–bract scale complexes from at least three genera and isolated male cones also from at least three genera. As reproductive structures and sterile remains are not preserved in organic connection it is very difficult to correlate them together. All sterile leaves differ very slightly in gross morphology and have almost identical cuticle structure. Seed scale–bract scale complexes probably represent new genera and/or scales described so far from the European Triassic but without cuticle details.

All male cones are very small; in contrast to the majority of Triassic conifers, they are 5–15 mm in length. Male cones have pollen grains preserved in situ in pollen sacs; the pollen from one type belongs to the dispersed genus *Brachysaccus*, and from the other cone type to *Classopollis*. Based on in situ pollen and female scale morphology, some early members of Cheirolepidiaceae and so far unknown members of Voltziales may be present in this material.

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30/05/2024, 08:30–10:10, Room: Leo
A05 Late Palaeozoic continental ecosystems of Gondwana

O-251 - A new appraisal of the fossil plant assemblage from the Mississippian of Egypt: Preliminary results and future perspectives

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Recent fieldwork in the Sinai Peninsula in Egypt revealed a new plant macrofossil assemblage. The new fossils were discovered in the Um Bogma area, Sinai within dark-gray and buff-coloured siltstones of the lower member of the Abu Thora Formation. According to previous palynological studies, this lithostratigraphic unit was deposited during the late Visean. The assemblage comprises fronds of *Nothorhacopteris* and fragments of small defoliated lycopsid axes, representing distinct morphotypes as suggested by the shape of their leaf cushions. None of the lycopsid specimens exhibit convincing evidence of ligule and parichnos. As the fossils are mostly preserved as impressions in rather fine-grained sedimentary rocks, vinyl polysiloxane replicas of their surfaces were made, revealing epidermal details from the *Nothorhacopteris* pinnules and from the leaf cushions of some lycopsid axes under SEM. In a general aspect, the studied assemblage comprising nothorhacopterids and small lycopsid axes resembles Mississippian floras from other parts of Gondwana, falling within the so-called Paracas warm-temperate floral realm. Although the fronds could be assigned to *Nothorhacopteris*, we avoided classifying the lycopsid axes into distinct taxonomic units so far. The Carboniferous lycopsid macrofossils from Egypt were outside the focus of research for several decades. A brief literature review on these plants reveals a myriad of poorly circumscribed names. The published descriptions must be seen as outdated, and these taxa are usually poorly illustrated in the literature, precluding detailed comparisons with the lycopsid fossils found in the new assemblage. The recently discovered fossils, therefore, motivated us to start a detailed revision of the Carboniferous (i.e. Mississippian) lycopsids from Egypt, clarifying their taxonomy and providing an updated look into these poorly known plants from the northern Gondwana.

30/05/2024, 08:30–10:10, Room: Leo
A05 Late Palaeozoic continental ecosystems of Gondwana

O-252 - Synthetic lithological and palynological modeling of Late Paleozoic Ice Age collapse: Canning Basin, Western Australia

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The collapse of the Late Paleozoic Ice Age (LPIA) resulted in major shifts in global biomes, especially in formerly ice-proximal high latitude environments. In eastern Gondwana, palynological records provide the most powerful expression of terrestrial biotic change during this crucial interval.

We here present a high-resolution, spatially expansive reconstruction of early Permian deglaciation and floral succession in western Australia. The total data available consist of 15,634 occurrences of palynological taxa in 578 assemblages across 60 stratigraphic sections in the subsurface of the intracratonic Canning Basin (Western Australia). We emphasize assemblages contained within

the latest Carboniferous to early Permian Grant Group (?Gzhelian to Asselian), where palynofloras lie amongst sediment packages previously interpreted to represent the last glacial tills of the LPIA in the basin.

Our analysis consisted of a two-step modeling procedure. We first reconstructed lithofacies in the subsurface Grant Group using an XGBoost machine learning model, trained on geophysical attributes of ca. 2.7 kilometers of cored Grant Group sediments. This model allowed us to infer the distribution of major facies throughout all sections furnishing palynological data—even petroleum wells without associated cores. Next, we used the biostratigraphic model Horizon Annealing to ordinate all palynological assemblages in these wells into a single composite sequence. We then calibrated that sequence to the geologic time scale by way of high-precision U-Pb CA-TIMS dates directly associated with the assemblages in the basin.

The result is a time-calibrated composite sequence of palynological changes in direct association with a reconstructed lithological succession signifying glacial retreat from the basin. This unique synthetic model provides novel insights into the rate and magnitude of vegetation changes associated with the demise of the LPIA, and invites comparison with similar sequences elsewhere in Gondwana.

30/05/2024, 08:30–10:10, Room: Leo
A05 Late Palaeozoic continental ecosystems of Gondwana

O-253 - Palynofloristic investigation of the newly explored lower Gondwana sediments of Damodar basin, eastern India: Inference on the age and environment of deposition

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Palynofloristic analysis of the Lower Gondwana sediments from three bore cores MK-19, MK-20 and MK- 43 of Damodar basin in Madhukunda area (23 º 38′00″N, 86 º 51′ 00″E), Purulia district, West Bengal, Eastern India, revealed the dominance of striate disacccate genera *Striatopodocarpites, Striatites,* followed by *Faunipollenites.* Other genera such as *Leiotriletes, Cyclogranisporites, Granulatisporites, Brevitriletes, Vittatina, Gnetaceaepollenites, Ginkgocycadophytus, Guttulapollenites, Marsupipollenites* also occur in the assemblage. Occasional presence of acritarch taxa *Peltacystia*, is also noteworthy as it indicates marine signatures. *Ghoshiasporites manjuae*, a new varimonolete spore initially reported from MK-19, has also been encountered in the other two bore cores, indicating a Marker zone. The distribution pattern of the mioflora in all the samples indicates one major climatic phase dominated by striate disaccate *Striatopodocarpites*, occasionally replaced by *Striatites* pointing towards a warm-humid depositional condition during sedimentation. In addition to microfossils several mega fossils like species of *Glossopteris*, *Vetebraria*, *Schizoneura*, several Equisetalean stems and Filicopsid fronds were also recovered from the bore cores. Comparative studies with similar palynoassemblages known from other Indian Lower Gondwana sediments of Damodar, Satpura, Son–Mahanadi, Rajmahal and Wardha–Godavari basins suggests the age of this zone to be of Raniganj Formation (late Roadian to Changhsingian Age) of the late Permian Period.

O-254 - Paleofloristic, palynofacies and petrographic characteristics of the Ashoka coal-bearing succession of North Karanpura Basin, India

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The coal-bearing succession of North Karanpura Basin has been studied to determine the palaeovegetation, palaeoecology and depositional settings during the peat accumulation. Besides assessing the thermal maturity and hydrocarbon potential of these deposits. The study reveals that the diverse megafossils retrieved from sediments show rich Glossopteris flora and the assemblages include four genera – *Gangamopteris, Glossopteris, Vertebraria,* Equisetalean axis and 19 other species. Interestingly, one specimen featuring a remarkably well-preserved fructification, which signifies a juvenile (unexpanded) male cone of *Glossopteris*, is reported for the first time in the North Karanpura Basin. The palynomorphs processed from the sediment are categorized by the dominance of the non-striate bisaccate pollen *Scheuringipollenites* sp. and sub-dominance of the striate bisaccate pollen *Faunipollenites* (=*Protohaploxypinus*) sp. associated with the Barakar Formation (Artinskian to Kungurian) suggesting that the warm and humid tropical condition prevailed during deposition.

Further, the samples exhibit the dominance of opaque phytoclasts (av. ~32%) and the inertinite group of macerals (av. 44 vol.%) suggesting the prevailing oxic condition. However, the frequencies of vitrinite (~34 vol.%) and liptinite (~8 vol.%) groups of macerals indicate that the peat-forming vegetation (mainly higher plants) accumulated in the anoxic condition. The moderately high contents of degraded organic matter (av. ~29%) and macrophyte-tissue-derived amorphous organic matter (av. ~29%) indicate significant alteration of organic matter, either due to the herbaceous input (decompose easily) and/or elevated bacterial activity during the peat accumulation. Moreover, the various petrographical indices suggest deposition in fluctuating hydrological conditions. While conducive to organic matter preservation, significant variations in petrographical indices imply repeated changes. Elevated mineral content (up to 50.7 vol.%) suggests rheotrophic shifts, possibly linked to flooding during peat accumulation. The studied samples are characterized by low-moderate GCV values. The values of vitrinite reflectance (0.52–0.60%) classify the studied coal as Medium-Rank 'D', reaching the mature zone of hydrocarbon generation.

O-255 - Late Palaeozoic wildfires on Gondwana – an update

Dieter Uhl[1], *Deepa Agnihotri*[2], *Haytham El Atfy*[3], *Srikanta Murthy*[2], *Rafael Spiekermann*[4], *André Jasper*[4]

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Fossil charcoal is widely accepted as a direct indicator of the occurrence of palaeo-wildfires. The published record of such remains from Upper Palaeozoic deposits of Euramerica and Cathaysia, is relatively comprehensible with abundant evidence ranging from the Mississippian up to the Permian-Triassic boundary. However, although high inertinite coals have long been known from the Permian of Gondwana, there was a long-lasting debate about whether these inertinites were of pyrogenic origin or not and studies on macro-charcoal were long missing. During the last two decades, a large number of studies has dealt with macro-charcoal from the Permian of Gondwana, demonstrating the common occurrence of wildfires in large parts of Gondwana (i.e., Antarctica, Brazil, India, the Middle East, and South Africa). A number of these studies dealt with macro–charcoal, and inertinites from coal deposits, adding further convincing evidence that wildfires produced the inertinites in these coals. Based on these data, together with data from Euramerica and Cathaysia, it became evident that, on a global scale, wildfires were a common source of disturbance during the Permian.

The picture for the Carboniferous is however different: although a considerably large number of studies has dealt with evidence for palaeo-wildfires from the northern hemisphere, e.g., the Euramerican coal measures, there is a considerable lack of such studies

from Gondwana. This lack is probably due to more extensive studies on the Carboniferous strata in the northern hemisphere, as well as a lack of fossil-bearing sediments on Gondwana. The latter was caused by the widespread glaciations and by a scarcity of biomass/vegetation in large periglacial areas. A recently described assemblage of fragmentary macro–charcoal remains from the Pennsylvanian Itararé Group (Paraná Basin, Brazil), remains the so far only published direct evidence of wildfires for the entire continent during the Carboniferous.

30/05/2024, 08:30–09:10, Room: Nadir
M03 "Extra microfossils" in pollen slides: environment and biotic interactions

O-256 - Humans and their environment in the palaeobotanical data from the multicultural archaeological site Bruszczewo (W Poland) between 2000 BCE and 1200 CE

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Palaeoecological multi-proxy reconstructions are vital to understand past settlements and human impact on the local environment. In this study, we focused on the archaeological microregion of Bruszczewo village in Greater Poland (western Poland; Central Europe), which was inhabited by people from cultures of the Bronze and Iron Ages, organised around the lake and mire, and later by Slavs. In this study, analyses of pollen, non-pollen palynomorphs (NPP), plant macrofossils, and geochemical and sedimentological markers were applied to reconstruct vegetation changes and human impact on local ecosystems. The results revealed that increase in human impact, manifested by relatively low arboreal pollen percentages and an increase in Cerealia type values at ca. 1630–1570 cal. BCE was probably related to the presence of representatives of Unetice Culture. At that time, *Carpinus betulus* became a much more important forest component, perhaps, at the cost of *Corylus avellana*. The second intensification of human impact, marked by pollen and NPP data, was identified at ca. 1020–910 cal. BCE (Lusatian Urnfield culture). Both phases of increased human activity were characterised by the presence of diatom frustules in sediments. The lake terrestrialisation between ca. 810±30 and 670±130 cal. BCE did not affect the people who settled on former lake shores, as revealed by pollen and archaeological data. Together with peat accumulation, the amount of coprophilous fungi distinctly increased, especially during the potential presence of people of Pomeranian and afterwards Przeworsk cultures (Iron Age). Later, the formation of early Polish state seems to explain changes in the dynamics of local population impact on the environment.

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30/05/2024, 08:30–09:10, Room: Nadir
M03 "Extra microfossils" in pollen slides: environment and biotic interactions

O-257 - Non-pollen palynomorphs as a comprehensive indicator of paleoenvironment and human impact: A case study from the mid-Kama region, Urals, Russia

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The spatial and temporal scale of paleoecological studies necessitates the use of integrated research methods. One of the most informative paleoecological methods is the analysis of non-pollen palynomorphs (NPPs), acting as a bridge between ecology, biology, and archaeology. Taxonomically, NPPs belong to a wide range of groups such as algae, fungi, testate amoeba, vascular plants, and more. Representatives from all these groups found in terrace peat bogs on the mid-Kama allowed us to reconstruct the Holocene changes of climatic regimes, hydrological conditions, and fire dynamics. Moreover, we established the periods of active anthropogenic impact on the Kama landscapes during the Bronze and Iron Ages, and reconstructed the habitat conditions of these ancient communities. Here, using a multi-proxy paleoecological approach, we present a high-temporal resolution Holocene history of paleoenvironment and human impact in the mid-Kama region during the last ~10,000 years.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-258 - The isolated subalpine vegetation in Central Europe in the last millennium: Changes and challenges

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The history and utilisation of the Central European subalpine vegetation outside the Alps and Carpathians remains surprisingly little known. This lack of knowledge is alarming considering changes and loss of this rare vegetation, caused by cessation of management and recent global climate change. To fill this gap, we chose the Eastern Sudetes mountain region with a natural subalpine zone, continuously existing throughout the Holocene.

We present 2800 calibrated years long history documented with pollen, non-pollen palynomorphs, plant macro-remains, charcoal, geochemistry and associated written archival records. We identified six periods of subalpine vegetation development:

1) before AD 1000 species-rich subalpine grasslands, with one huge fire event;
2) AD 1000–1330 expansion of forest and reduction of treeless area, occasional fires around AD 1100 and AD 1300;
3) AD 1330–1630 first signs of possible human activities in vegetation, confirmed by fire events since AD 1530, by historical records of ox grazing during the 16th century and later, and by disturbances leading to erosion recorded by geochemistry;
4) AD 1630–1760 deforestation and expansion of subalpine grasslands due to new type of management – hay cutting along with ox grazing, less erosion;
5) AD 1760–1950 strong human impact – hay cutting led to maximal extent of subalpine grasslands, cessation of grazing and burning (absence of charcoal); since AD 1850 'alpine style' cow grazing and tourism;
6) after AD 1950 abandonment, reduction of treeless area, expansion of forest, planted *Pinus mugo* and dwarf shrubs.

In the last millennium, the subalpine vegetation of Eastern Sudetes has undergone many changes in connection with various types of identified management. The oldest one is probably grazing, associated with fires extensively used to increase the extent of treeless area. The documented types of management and their impact on vegetation can be used in nature conservation to prevent the current overgrowth of subalpine grasslands.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-259 - Vegetation changes in the Ethiopian highlands through the last 22,000 years related to climate change and human impact

Manuel Casas-Gallego[1,2], *Angela Bruch*[3], *Katharina Neumann*[1], *Stéphanie Bodin*[1], *Sebsebe Demissew*[4], *Marco Schmidt*[5], *Karen Hahn*[6]

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Ethiopia is an ideal location to study changes in the tropical mountain ecosystems as it comprises an extraordinarily diverse orography and harbours the largest area of Afromontane forests in Africa. Our understanding of the vegetation history of the Ethiopian highlands is rather limited to date, mainly due to the scarcity of fossil botanical data. To help filling this gap in information, we used ecological niche modelling to simulate the distribution of the main vegetation types in Ethiopia throughout the past 22,000 years. The models were then validated using regional pollen records. The simulations show the effect of climatic changes on the vegetation through time. According to the models, the altitudinal vegetation belts moved downwards significantly during the Late Glacial. In particular, the Afromontane forest-savanna ecotone is estimated to have laid at around 1400–1600 m asl (200–400 m below present day). This allowed the forests to cover a significantly larger area than today. Starting with the Holocene, Afromontane forests began to migrate to higher elevations driven by increasing temperature and decreasing precipitation. As this climate-driven process intensified during the second half of the Holocene, the area covered by forests declined and became restricted to the highlands. This trend continues until today, when anthropogenic activities add further enormous pressure to these ecosystems. Paleobotanical analyses of wood charcoal and phytoliths performed on the Sodicho archaeological site in SW Ethiopia show that humans disturbed the highland vegetation by using fire to clear the forest between 4,750 and 1,750 BP. However, significantly for the future of Afromontane forests, the charcoal record shows that they are able to recover when human disturbance cease or it is reduced. After 1,750 BP, when the intensity of the occupation at Sodicho decreased, forest taxa became dominant in the charcoal record again, highlighting the resilience of the Afromontane forest.

30/05/2024, 11:00–11:20, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-260 - Multidisciplinary approach for reconstructing past local land-use practices: Case studies from Ligurian Apennines, north-western Italy

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Pollen, charcoal and non-pollen-palynomorphs analyses at several sites located in the Ligurian Appenines (north-western Italy) have been carried out since 1990s by the Laboratory of Archaeology and Environmental History (LASA) of Genoa University and, more recently, in the frame of the research project "ANTIGONE – Archaeology of sharing practices: the material evidence of mountain marginalisation in Europe (18th–21st century AD)" (ERC Stg 2019).

Within this context, the aim of the present contribution is to add new information on LASA previous studies by the reconstruction of most important vegetation dynamics and the identification of biostratigraphical information about the local management of environmental resources during medieval and postmedieval periods in two sites located in the mountain areas of Trebbia valley, eastern Ligurian Apennines. Thanks to additional information from historical documents and archaeological excavations, these studies clarified how different kind of land-use now completely disappeared (e.g., woodland management, clearance for arable and pastoral land, "slash-and-burn", browsing and grazing by domestic animals, transhumance systems, agricultural practices, etc) changed

through time, also in relation to the organisation of local social groups and the transformation in the access right to common-lands. Furthermore, for exploring the relative importance of potential drivers on selected groups of pollen taxa associated with different management practices identified for the specific study area, we statistically compared our palynological results with independent datasets of temperature variations, fire dynamics, changes in arboreal coverage, water level fluctuations and grazing pressure.

Thanks to an interdisciplinary research team (botanists, palaeoecologists, historians and archaeologists), our results allowed to assess the role of main variations in land-use on vegetation diversity and how this might be managed for future ecosystems enhancement by local stakeholders.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-261 - Pleistocene theatre of ice age dynamics in the tropical northern Andes: Evolutionary mechanisms

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Raising deep cores in oceans, ice caps and sedimentary basins for climate research started in 1957–58[a]. The Bogotá basin was drilled up to 195 m depth. In 1988 a 586 m deep core Funza was drilled showing nearly all ice age cycles of the Quaternary[b]. The 58-m deep Fúquene basin core was analysed at 1-cm sample distance for pollen, grain-sizes, and XRF showing two ice-age cycles with 60-year resolution. Altitudinal vegetation shifts, (non-)analog vegetation associations, fast rates-of-change, millennial-scale environmental change, changes in lake-level stands, and changing energy levels of the drainage system documented the anatomy of an ice age cycle in the tropics[c, d]. Using Upper Forest Line reconstructions from the pollen records as input in a Digital Elevation Model we quantified changes in elevational range, surface and fragmentation of the páramo ecosystem. We introduced the 'mountain fingerprint' and the 'flickering connectivity system' of this ecosystem[e] to explain the operating processes of speciation, further explained in a youtube documentary[f]. We proposed a mechanism for how páramo biodiversity hotspot developed during the Quaternary.

[a] Hooghiemstra, H. et al., 2022. **60 years of scientific deep drilling in Colombia; the north Andean guide to the Quaternary**. *Sci. Dril.* 30, 1–15. [b] Hooghiemstra, H., 2023. **Making a long continental pollen record, a fabulous and bizarre enterprise**. *Palynology*. [c] Hooghiemstra, H., Flantua, S.G.A., 2019. **Colombia in the Quaternary; an overview of environmental and climatic change**, In: *The Geology of Colombia book* 4, 43–104. [d] Hooghiemstra, H. et al., 2024. **Pollen records of northern South America: Quaternary history**. *Encycl. Quat. Sci. (3rd ed.)*, Elsevier. [e] Flantua, S.G.A. et al. 2019. **The flickering connectivity system of the north Andean páramos**, *J. Biogeogr.* 46, 1808–1825. [f] Giraldo-Pastrana C, et al., 2019. **Sky Islands a time travel through the Andes**. English: https://www.youtube.com/watch?v=OWQOvLckL-g. Spanish: https://www.youtube.com/watch?v=7UbikbP1J6U.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-262 - ENSO, solar activity, and megadrought patterns in the Southwestern USA over the past 11,000 years

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2 Northern Arizona University, School of Earth & Sustainability, Flagstaff, USA
3 University of Wyoming, Department of Geology and Geophysics, Laramie, USA

The El Niño Southern Oscillation (ENSO) remains a pivotal element in understanding climate system variabilities. Yet, the brevity of instrumental ENSO records poses challenges to grasping its natural long-term patterns. Thankfully, paleoclimate data offers insights into ENSO's behavior throughout the Holocene on centennial and millennial scales. Such knowledge is vital for deciphering extensive multidecadal to millennial shifts. In our research, we leveraged climate-sensitive piñon pine (*Pinus edulis*) pollen records

from the Southern Rockies, USA. This allowed us to create a comprehensive, uninterrupted account of effective precipitation and ENSO-like variability spanning 11,000 years. Intriguingly, the Early Holocene era was characterized by La Niña dominance, while the subsequent 6,000 years witnessed a growing prevalence of El Niño conditions. This evolution was modulated by millennial-scale hydrological activity and ENSO-like cycles of 900–1,000 years, with increasing amplitudes over time. Throughout history, the Southern Rockies endured intensified La Niña episodes and associated multidecadal megadroughts around 10.0, 8.0, 6.8, 5.8, 4.8, 4.0, 3.0, 2.2, and 1.0 thousand years ago. These ENSO-related climate shifts and vegetation changes likely stemmed from variations in insolation and solar output. Analyzing recent robust La Niña episodes, which mirror historical conditions, we observed consistently dry annual climates, resulting in extended droughts detrimental to piñon pine growth. In line with the thermostat hypothesis and the Sun-ENSO connection, our projections suggest that such arid conditions may intensify in the future, exacerbated by rising temperatures. This escalation could potentially trigger megadroughts in the southwestern USA. By decoding these ancient climate patterns and pinpointing the primary influencers of ENSO variability, our study offers critical insights into the long-term implications of climate change in the southwestern USA. Emphasizing the value of understanding historical climatic shifts, our findings highlight the necessity of proactive measures to navigate future challenges.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-263 - Disturbances mediated European mountain forest diversity and stability

Petr Kuneš[1], *Helena Svitavská-Svobodová*[2], *Eva Jamrichová*[3], *Marion Lestienne*[4], *Amanda Mateo Beneito*[1], *Gabriela Florescu*[5], *Niina Kuosmanen*[6]

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Recent studies have shown that latitude predicts Europe's primary long-term diversity gradient, controlled by climate and human impact combined, the latter being more prominent in recent millennia. The diversity trends may also vary regionally depending on the biogeographical regions. The disturbance, such as fire, pathogen outbreaks or windstorms, is essential for maintaining or even increasing diversity in many ecosystems in the long term. In recent decades, the European mountain forests dominated by spruce and beech have been affected by many threats, increasing their vulnerability to losing biodiversity and stability.

We reconstruct long-term diversity trends on the longitudinal gradient in central-eastern Europe across several biogeographical regions. We use richness in fossil pollen taxa as an index of vegetation alpha diversity and Simpson's diversity index. We reconstruct the fire disturbance using charcoal data to understand the diversity dynamics better. Moreover, we also calculate the stability index of the ecosystem based on change point analysis of dominant taxa and their variability assessment.

Our results support the previous findings of increasing diversity gradient throughout the middle and late Holocene and reaching higher values at the gradient towards the east. Generally, forests with low disturbance and reduced diversity are more stable. Surprisingly, much higher fire disturbance is linked with higher beech representation in forests in the east than in the west despite their relative stability.

Moderate human activities in the late Holocene may be beneficial in maintaining mountain forest stability. Still, in all cases, higher stability suppresses forest diversity, which may enforce the Conservation Paradox and pose additional threats to mountain forest diversity in the near future.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-264 - Cretaceous Diversification of callitroid Cupressaceae: A permineralized Fitzroya-like conifer from the Late Cretaceous of Antarctica

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The Callitroideae (Cupressaceae) are important components of arid and rainforest environments across the Southern Hemisphere. Their extensive Cenozoic fossil record in Australia, South America, and Antarctica have made them an ideal study system for macroevolutionary studies. However, while molecular divergence time estimates indicate that crown-group Callitroideae originated and diversified by the Early Cretaceous, there has only been a single Cretaceous report (ovulate cones from Australia) that supports this hypothesis. As part of an initiative to better understand Antarctica's role in the evolution of Southern Hemisphere plant lineages, we report permineralized callitroid seed cones attached to an articulated branching system of leafy shoots from the Late Cretaceous of Antarctica. The fossil was recovered from the Beta Member of the Santa Marta Formation, which is early Campanian (~80 Ma) in age and exposed on James Ross Island in West Antarctica. The peel technique was used to prepare and study the specimen. In addition, Bayesian total evidence and tip-dated phylogenetic analyses using a novel morphological matrix were conducted to infer relationships of the fossil described here and other extinct callitroids. The shoot bears elongate leaves arranged in pseudo-whorls of three. Leaves are amphistomatic. Each cone is open and roughly discoid with six fertile cone scales arranged in alternating whorls of three. Cone scales are spathulate with a distal adaxial swelling. There is a conspicuous umbo near the tip of each cone scale. An uppermost whorl of vestigial cone scales is present in each cone. This combination of characters is diagnostic of the extant callitroid genus, *Fitzroya*. Preliminary phylogenetic analysis recovers the Antarctic fossil as sister to *Fitzroya* and support that, by the Campanian, the early evolution of the Callitroideae was well underway. This work provides a fossil inclusive framework for understanding the macroevolutionary history of these ecologically important conifers.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-265 - Fossil Keteleeria, Associated Fungi and Mite in the Miocene of the Guiping Basin, Guangxi, China

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The genus *Keteleeria* Carr., a member of the subfamily Abietoideae within the Pinaceae family, comprises evergreen trees and consists of three species. It thrives primarily in semi-humid to humid regions of the warm temperate zone in China and is also found in Taiwan, Hainan Island in China, as well as the tropical highlands of northern Laos and southern Vietnam, reaching elevations of up to 3000 meters. While the modern distribution of the genus *Keteleeria* is now confined to East Asia and Southeast Asia, it previously had an extensive presence across Europe, North America, and Asia since the Cretaceous. Fossil records mainly include branches, leaves, and female cones, with scarce reports of male cones and fossils of fungi and mites associated with leaves. Here we report the newly collected *Keteleeria* leaf and male cone from the Miocene of the Guiping Basin, Tengxian, Guangxi, China. A new species is identified based on leaf and in situ pollen characteristics. This finding indicates that *Keteleeria* were already thriving in the South China low-latitude subtropical region during the Miocene, representing the earliest fossil evidence of this genus in its extant distribution center. Furthermore, the identifying of fossil leaf-inhabiting fungi and mites offers crucial material for investigating the origin and evolution of interactions within plant-animal-fungi ecosystems.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-266 - Past diversity and distribution of agathioid Araucariaceae: Insights from a Late Cretaceous ovulate cone from Antarctica

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The presence of Araucariaceae, Podocarpaceae, and Cupressaceae as canopy components in Cretaceous Antarctic temperate rainforests is documented from fossil wood, pollen, and leaves. Here, a permineralized Late Cretaceous (Campanian) ovulate cone recovered from marine calcareous concretions from the Baculites Hill locality, James Ross Island (Beta Member, Santa Marta Formation), offers an opportunity to contribute insights in the biodiversity and geographic distribution of members of these extinct forests. The ellipsoid cone is complete, about 7 mm long and 6 mm wide with ca. 50 helically-arranged cone scale complexes attached to the cone axis at right angles and that distally expand, thicken, and bend upwards. Cone scales are asymmetric with a narrow sclerotic proximal stalk and an expanded distal half that is slightly fleshy. Each cone scale contains a single vascular bundle and an abaxial resin canal. There is a single seed per cone scale, oriented with the micropyle facing towards the cone axis and attached to the scale at the chalazal end by a short stalk on an elevated pad of tissue. Seeds have symmetric integumentary lateral wings and a chalazal wing. Spheroidal pollen grains with granular sculpturing were observed in or near the micropyle of several seeds. Cone scale morphology, the single stalked winged seed per scale, and a conifer-wide phylogenetic analysis all indicate affinities with agathioid Araucariaceae. Bayesian and parsimony phylogenetic analyses with living and extinct Araucariaceae recovered the new cone in a monophyletic group with extinct *Wairarapaia* and *Emwadea* and extant *Wollemia*. A tip-dated phylogenetic analysis suggests the crown group of Araucariaceae diversified in the Cretaceous, with increased evolutionary rates at this time. The fossil described here adds to the diversity of Cretaceous agathioids, which are not as well-known as extinct *Araucaria*, and provides strong support that conifers closely allied with *Wollemia* were components of Cretaceous Antarctic rainforests.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-267 - Reconstruction of the ancestral niches of main plant clades based on the fossil record: What sample to use?

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The reconstruction of the ancestral state of different aspects of extant plant groups is often inferred by phylogenetic approaches. This method can be misleading when the fossil record is not included, which is often the case, especially for early plant lineages, where elapsed time becomes very significant. The reconstruction of the ecological niches of fossil plants is not straightforward, but certain habitat conditions can be inferred by studying plant traits associated to ecological adaptations, the sedimentology of the host rock, or stable isotope analysis of fossil remains and sediments. We propose the characterization of ancestral ecological niches of extant plants from a palaeobotanical perspective, based on the aforementioned data, which implies the use of a sample that must meet certain requirements to ensure consistency and comparability in future research. The species must present enough characters to be unequivocally identified as part of the clade it represents and must be the oldest representative of the clade that meets all the requirements. The Formation where the plant was extracted must be well characterized from a sedimentological point of view or, at least, be accessible for future characterizations of the depositional environment. Ideally, in significantly heterogeneous localities, the horizon the plant was recovered from will be known. The plant part, size, and availability (permits to access existing collections or to extract more material) must be suitable for isotopic analyses. In the case of taxa that are widely spread, the sample will include specimens from at least two localities preserving the plant, which will be representative of the older part of the temporal range of the plant.

We present suitable candidates for the reconstruction of the ancestral niche of 15 of the main plant clades, using the taxa commonly used for the calibration of the land plant phylogenetic tree as a starting point.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-268 - Whole-plant reconstruction of a Cheirolepidiaceae from the Early Cretaceous of Arkansas (USA) and phylogenetic relationships of the family in a whole-conifer phylogeny

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Living conifer families typically show compact compound megasporangiate cones, simple microsporangiate cones, and leaves usually single- or two-veined. Among extinct conifer groups, the Cheirolepidiaceae are the most similar to extant families. The Cheirolepidiaceae ranged from the Permian to the earliest Paleocene and were distributed worldwide, with numerous described genera. However, the affinities of the family are still debated and have not been thoroughly tested in a phylogenetic context. Here we present the most complete plant concept of a Cheirolepidiaceous conifer, recovered from the Lower Cretaceous Holly Creek Formation (Arkansas, USA), based on remains of wood, leafy shoots of the pseudofrenelopsid type, microsporangiate cones with *Classopolis* pollen, megasporangiate cones and isolated ovuliferous complexes. Organs of this taxon were previously described as *Pseudofrenelopsis parceramosa* and *Classostrobus arkansensis* (Axsmith, Krings, & Waselkov 2004; Axsmith, 2006), but the megasporangiate organ was never formally published. Megasporangiate cones are elliptical, and bear helically arranged ovuliferous complexes with a distally lobbed ovuliferous scale bearing an inverted seed embedded in the ovuliferous scale tissue. Bracts are not preserved. We included this new taxon in total evidence phylogenetic analyses together with five other Cheirolepidiaceae species, extant and extinct species representing all living conifer families, voltzialeans, and Cordaitales. The analyzed matrix includes four molecular markers and 119 morphological characters from megasporangiate cones, leaves, microsporangiate cones, pollen, and pollination. The matrix was analyzed under Maximum Parsimony and Bayesian approaches, with varying character schemes to test the monophyly of Cheirolepidiaceae and the robustness of our results, and to infer the relationships among cheirolepidiaceous taxa and their position within conifers. We most frequently recover the Cheirolepidiaceae as non-monophyletic, with *Pararaucaria* outside of the family. The monophyletic core of the family is most frequently recovered as sister to all conifers, and alternatively either as sister to crown group Araucariales (Araucariaceae+Podocarpaceae) or within Araucariaceae.

30/05/2024, 08:30–10:30, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-269 - Embracing uncertainty: The way forward in plant fossil phylogenetics

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Although molecular phylogenetics remains the most widely used method of inferring the evolutionary history of living groups, the last decade has seen a renewed interest in morphological phylogenetics. This has mostly been driven by the promises that integrating the fossil record offers to our understanding of macroevolutionary processes and dynamics, as well as the possibility that the inclusion of fossil taxa could lead to more accurate phylogenetic hypotheses.

The plant fossil record presents some challenges to its integration in a phylogenetic framework. Phylogenies including plant fossils often retrieve uncertain relationships with low support, or lack of resolution. This is due to the pervasiveness of morphological convergence among plant organs and the fragmentary nature of many plant fossils, and it is often perceived as a fundamental weakness reducing the utility of plant fossils in phylogenetics.

I will discuss the importance of uncertainty in morphological phylogenetics, and how we can identify important information from different patterns and types of uncertainty. I will also review a set of methodologies that can allow us to understand the causes underpinning uncertainty, and how this can help us to further our knowledge of plant fossils.

I also propose that a new visual language, including the use of networks instead of trees, represents an improvement on the old visualization based on consensus trees, and more adequately serves phylogeneticists working with plant fossils. This set of methods

and visualization tools represents an important way forward in a fundamental field for our understanding of the evolutionary history of plants.

30/05/2024, 08:30–10:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-270 - On the recognition of non-marine palynomorphs from the Ordovician of Saudi Arabia

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A set of eleven samples from the Hirnantian of Saudi Arabia, all of which contain the freshwater euglenid fossil, *Moyeria* Thusu, were examined for their organic-walled microfossil (OWM) content. Although these samples are dominated by sphaeromorph acritarchs of unknown phylogenetic and geographic provenance, they also contain members of both the Hydrodictyeaceae (*Proteolobus*, *Scenedesmus, Tapetisphaerites*) and the Zygnemataceae (*Lecaniella*, *Stigmozygodites*, ?*Zygnema,* and a new genus possibly related to *Gelasinicysta*). The closest living members of all these green algae are restricted to fresh water settings. Their recovery here extends the geological record of first occurrences for several taxa, including members of the Zygnemataceae, the sister group to the embryophtyes, which are here shown to be coeval as far back as the Late Ordovician. Cryptospores (*Quadrisporites*, *Velatitetras*, *Abiditusdyadus*, *Rimosotetras* and *Tetrahedraletes*) are common, but other than a single specimen of *Imperfectotriletes*, and a poorly preserved specimen of *Ambitisporities*, the lack of trilete spores in this deposit is curious, especially given reports of their prior antiquity. The association of some envelope-enclosed tetrads and dyads with freshwater algae lends support to suggestions that *Quadrisporites* and related forms to be classified with the chlorophycean green algae, not as cryptospores.

30/05/2024, 08:30–10:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-271 - A synthesis of Saudi Arabian Devonian palynological data generated from the scientific cooperation between CIMP and Saudi Aramco

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5 University of Sheffield, Department of Animal and Plant Sciences, Sheffield, United Kingdom
6 Saudi Aramco, Exploration Technical Department – Biostratigraphy Group, Dhahran, Saudi Arabia

We present a review of Devonian palynology in Saudi Arabia based on the study of palynological samples from the subsurface of northern and central Saudi Arabia collected from the Tawil, Jauf and Jubah formations.

Saudi Arabian Devonian palynological assemblages are dominated by abundant, well-preserved, and diverse miospores characterized by low thermal maturity (translucent yellow to brown in colour). Marine palynomorphs such as acritarchs and chitinozoans occur only rarely in these Devonian assemblages, and have not been studied taxonomically. Early Devonian (Lochkovian to Emsian) miospore assemblages are characterized by an abundance of endemic species; as a consequence, a regional biostratigraphic scheme applicable to Saudi Arabia has been developed. In the Middle and Upper Devonian, Saudi Arabian miospore assemblages become more and more dominated by cosmopolitan taxa, allowing close comparison with previously established zonations from the Old Red Sandstone continent.

The present miospore-based biostratigraphy shows that the upper half of the Tawil Formation is Lochkovian to early Pragian in age. The Jauf Formation spans an age from mid Pragian to late Emsian. The boundary between the Jauf and the Jubah formations

is latest Emsian in age, while the top of the Jubah Formation extends beyond the Famennian, into the early Tournaisian (Early Carboniferous). These boundaries do not appear to be diachronous across the entire study area.

The taxonomic analysis of these abundant, diverse, and exceptionally well-preserved palynological assemblages also has enabled to gain insights into the biodiversity, palaeoenvironment, and palaeophytogeography of the Devonian vegetation of Saudi Arabia. For example, the observed breakdown of bioprovincialism may be attributed to a narrowing Rheic Ocean between Gondwana and Euramerica and/or to homogenization of climatic conditions. Interestingly, booms of leiospheres occur in association with flooding events in the Emsian (Jauf Formation), and can be used to track maximum flooding events in sequence stratigraphic studies.

30/05/2024, 08:30–10:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-272 - Palynology of the Permo-Carboniferous succession of Saudi Arabia

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Understanding of Permo-Carboniferous palynology of Saudi Arabia is entirely dependent on analysis of subsurface samples from exploration and stratigraphic test wells. An operational palynozonation was developed and comprises ten palynozones and eleven palynosubzones, spanning the Tournaisian to Changhsingian. These assemblage zones are the results of latitudinal and altitudinal changes on megafloral communities, which is a manifestation of complex interplay of palaeoclimate and palaeogeography. The occurrence of chronostratigraphically significant palynomorphs enables broad correlation with global standards, except around the Carboniferous-Permian boundary, which remains to be debated. This palynozonation proves to (1) provide a robust stratigraphic framework, (2) infer missing sections due to unconformities or structural highs, and (3) demonstrate apparent diachroneity of some lithostratigraphic units. However, the clear evidence of phytopaleogeographic provincialism adds to the challenge of fully understanding the Permo-Carboniferous palynostratigraphy of the Arabian Plate.

The Mississippian succession (uppermost Jubah and Berwath formations) was deposited in very shallow marine and marginal marine coastal plain environments. Rich palynofloras suggest a warm humid palaeoclimate, with persistent marine influence throughout the succession. Above, the Unayzah Group (Juwayl and Nuayyim formations) ranges in age from Pennsylvanian (Bashkirian) to Early Permian (Artkinsian-Kungurian), and is bound by tectonically-driven significant surfaces. The Juwayl Formation encompasses a range of depositional facies associated with fluvio-glacial and glacio-lacustrine processes in response to glacial advances and retreats. The Nuayyim Formation also comprises a range of depositional facies associated with the post-glacial succession. The Middle Permian-Early Triassic (Khuff Formation) reflects an overall marine transgression, following the initial phase of the rifting associated with the opening of Neotethys. Coarse clastic fluvial sediments and overbank paleosols represent the base of the Middle Permian (Roadian-Wordian). These are followed by thin transgressive tidally influenced shallow marine sandstones, shales and limestones (Wordian-Capitanian) and the transition to dominantly limestone deposition throughout the remainder of the formation.

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B03 CIMP Palaeozoic palynology

O-274 - Acritarch Palynomorph Darkness Index (PDI): Some applications

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Palynomorph Darkness Index (PDI) is a fully quantitative method for characterizing the colour of palynomorphs in transmitted light that is calculated from the red, green and blue intensities of images captured using standard digital cameras. Unlike estimates

of maturity based on schemes such as Spore Colour Index, which rely on visual assessment of colour, numerical PDI values can be used in basin and petroleum system modelling. This method has been applied to simple smooth spores and calibrated successfully to vitrinite reflectance (VR). However, an important potential application of PDI is for assessing the thermal maturity of pre-Late Devonian rocks that do not contain vitrinite suitable for VR determination but which typically contain abundant acritarchs. An investigation of acritarch PDI in cored well sections of varying thermal maturity from the early Silurian Qusaiba Member of the Qalibah Formation in Saudi Arabia has been completed, with PDI correlated to Tmax- and graptolite reflectance-based vitrinite reflectance equivalents (VREs) that are commonly used proxies for VR in sections lacking or deficient in vitrinite. Results from this study have been augmented by a small number of paired PDI / VR results from latest Devonian and earliest Mississippian samples containing both acritarchs and vitrinite. The relationship between acritarch PDI and VRE is complex but useful, including, for example, an extremely rapid increase in PDI from ca. 10% to ca. 25% towards the more mature end of the oil window. Three examples of the application of acritarch PDI are presented. The first demonstrates how the relative maturity of sections of Qusaiba Member "hot shales" in Saudi Arabia can be determined using acritarch PDI independently of other VREs. The second and third show how the thermal maturity of Devonian thrust sheets in Northern Spain and the Precambrian Nonesuch Shale in North America, can be tentatively estimated.

30/05/2024, 08:30–10:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-275 - On-going studies on vegetative and encysted fossil euglenids

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It is not uncommon for morphologically similar palynomorph types extracted from different stratigraphic horizons to receive different taxonomic names. But, there are few examples of this phenomenon that are quite as prominent as the concentrically striated forms that go by the names *Chomotriletes* (Paleozoic), *Pseudoschizaea* (Mesozoic), and *Concentricystes* (Cenozoic – Recent). Due to their morphological similarity with a report of encysted *Euglena*, it has recently been proposed that these palynomorphs may have been produced by an ancient protist belonging to the Euglenophyceae. But, it is possible that these fossils represent the encysted form of the more stratigraphically restricted, but equally distinctive, taxon *Moyeria* Thusu. *Moyeria* is the vegetative (free-swimming) form of these ancient protists, and morphologically is clearly related to extant Euglenophyceae; this has been demonstrated by analysis using transmission electron microscopy. Establishing this link using solely extant euglenids has been challenging since the taxonomy of the group is based exclusively on the vegetative forms, and knowledge of encystment in the group is practically non-existent. The discovery of both encysted and vegetative morphologies in a single horizon from the Hirnantian of Saudi Arabia provides a rare and crucial link in the ongoing effort to cement this relationship, and further expand upon the existing utility of these fossils as paleoenvironmental indicators. Finally, the recent discovery of encysting euglenids in coastal ponds in Australia offers the possibility of definitively demonstrating the link between these fossil taxa and the Euglenophyceae.

O-276 - The enigmatic ovulate reproductive structures of Dordrechtites are recurved cupules fundamentally comparable to the cupules of Doylea and similar plants

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Recent paleobotanical discoveries have renewed interest in the distinctively recurved, seed-bearing cupules of Mesozoic plants, which are important for understanding seed plant phylogeny and the origin of the second integument of the angiosperm ovule. Reanalysis of the enigmatic seed-bearing organ *Dordrechtites elongatus* from the Triassic of South Africa, the type species of the genus, combined with information from similar material from Antarctica and Argentina, indicates that *Dordrechtites* is a part of a highly modified lateral branch of seed cone, each of which consists of one to several *Dordrechtites* units. Each unit consists of a long, curved stalk bearing a straight to somewhat recurved cupule with a long distal projection that extends well beyond the cupule apex. Each cupule is dorsiventrally flattened in a plane perpendicular to the long stalk and distal projection and contains up to two seeds. Structural similarities between *Dordrechtites* and the cupules of Doyleales indicate that they are homologous, supporting earlier suggestions of a close relationship for *Dordrechtites* to corystosperms. The long persistent cupule stalk and apical extension of *Dordrechtites*, combined with the flattened cupule, suggests modification for dispersal by wind, and perhaps also by water, which contrasts with probable modifications for animal dispersal seen in other cupule-bearing seed plants from the Mesozoic.

O-277 - Unpacking Araucauria: Phyllotaxy of Araucaria mirabilis (Araucariaceae) from the Middle Jurassic Cerro Cuadrado Petrified Forest of Patagonia, Argentina

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As a result of rapid burial and silicification, the fossil seed cones of *Araucaria mirabilis* show well-preserved, stunningly beautiful, fine details in their gross morphology and cellular-level fossilization of internal features. Originating from the Cerro Cuadrado Petrified Forest in Patagonia, Argentina, these Middle Jurassic seed cones also occurred in impressive abundance. As such, the anatomical details of this species are well-documented, and the taxonomy is well-established. The cones are typically spherical or ellipsoid, measure from four to eight centimeters in both height and diameter, and contain a broad, fibrous pith. The phyllotaxis of these cones has been studied in recent years. However, the mathematical, phyllotactic data has yet to be integrated with biological information. Here we analyze the phyllotaxis of seventeen *Araucaria mirabilis* seed cones, using both external and internal features. For each cone, the number of clockwise and counterclockwise parastichies (spirals) was determined based on the positions of the cone scales. The seed cones were then scanned with microCT to analyze their internal construction and organization of the seeds. For comparison, the number of parastichies was also determined from microCT orthoslices. Additionally, Avizo was used to segment clockwise and counterclockwise parastichies in each cone to determine the extent and rotation angle of the spirals in three-dimensional space. Although variable, the most common number of parastichy pairs were 13 and 21. The most common angle of rotation was 360°, although it could be as low as 180° or as high as 900°. The number of seeds in any given spiral was between 18 and 48. Further data on the directionality of ontogenetic growth, morphometrics, and the efficiency of the seed packing in the cone as a function of phyllotaxis will be presented.

O-278 - Seed cone architecture of Pararaucaria (Cheirolepidiaceae) from the Late Jurassic Morrison Formation of Utah, USA, and comparison of phyllotaxis with Araucariaceae and Pinaceae cones

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Seed cones of *Pararaucaria* in the extinct conifer family Cheirolepidiaceae remain enigmatic. While the anatomy of the bract–ovuliferous scale complexes is well-known from the seven taxa described worldwide, little is understood about the architecture of the seed cones. The bract–scale complex is distinctive, with three distal lobes and pocket-forming tissue containing one or two seeds. While a spiral arrangement of the bract–scale complexes is evident on the cone surface, not much else is known about the 3D organization of the bract–scale complexes in the cone. Here we elucidate the seed cone architecture of *Pararaucaria* sp. from the Late Jurassic Morrison Formation in Utah, USA, using microCT integrated with 3D visualization. These small cones are ovoid to ellipsoid, and seeds are enclosed in a pocket of tissue. CT orthoslices show one pair of seeds per bract–scale complex. In segmented reconstructions of the smallest long cone, two seeds per bract–scale complex are also clearly evident, except at the cone apex where seeds can be single, smaller, and presumably immature. Progression from immature to mature seeds illustrate a counterclockwise ontogenetic spiral of seed development. Also remarkable is the seed arrangement in three spirals wrapping nearly once around the cone; each spiral contains 6 pairs of seeds, although the seventh, uppermost pair may have not formed. Phyllotaxis of three spirals in a 360º turn distinguishes this *Pararaucaria* sp. from Araucariaceae cones, which bear seeds in multiple spirals that wrap around the cone in a wildly variable number of times, from 180º to 360º, to 540º or even 900º, and from Pinaceae cones, which have only three seed spirals that wrap multiple times around the cone. Since plant architecture is taxon-specific and under strict genetic control, cpharacteristic bract–scale complex phyllotaxis underlines basic biological differences between conifer families.

O-279 - The La Paja Flora from Colombia: An Early Cretaceous heyday of low-latitude gymnosperms

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Early Cretaceous fossil plants from the La Paja Formation in Colombia are part of the Ricaurte Alto Lagerstätte. This remarkable deposit in northern South America preserves a thick sequence of shales, claystones, and limestones containing abundant ferruginous-calcareous concretions formed in shallow near-shore marine environments. Fossil diversity is represented by marine reptiles, ichthyosaurs, turtles, crocodylomorphs, dinosaurs, and ammonoids. Paja fossil plants have been known since the late 1960s and contain leaves, wood, and diverse, three-dimensional permineralized reproductive structures with well-preserved anatomical and morphological details. However, modest systematic and taxonomic work has been completed to elucidate the affinity of the fossil plants. Here, we reviewed (photographed and partially CT-scan) all the historical collections of Paja fossil plants housed in Colombian institutions. This preliminary review allowed us to recognize ~50 plant organs so far. Among the Paja fossils, we confirm Araucariaceae (*Araucariostrobus*) and Cupressaceae, some of the earliest examples from the northernmost part of South America, and several kinds of seed cones of Bennettitales, probable Gnetales, and cycads as well as undescribed reproductive organs and leaves of Cheirolepidiaceae. Particularly significant are seed cones (misidentified as Passifloraceae) and leaves (*Taeniopteris*) of probable Pentoxylales, an enigmatic group of seed plants so far only described from Antarctica, Australia, India, and New Zealand. Another example includes one of the Paja fossils initially described as "*Sphenophyllum colombianum*" corresponding to a hatchling turtle's carapace. Our preliminary review shows the significance of revisiting the La Paja flora to identify obscure fossils correctly and for the future recognition of new plant taxa. More importantly, this unique coastal flora from northwestern Gondwana has the potential to reveal the enigmatic Early Cretaceous low-latitude gymnosperms of the Tree of Life.

30/05/2024, 09:30–10:30, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-280 - Lycopods vs. conifers: Experimental life-history response of ancient plant clades to UV-B stress foretell winners and losers of the Permian-Triassic biotic crisis

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The pulsed, terrestrial Permian-Triassic crisis (P-Tr), which extended deep into the Triassic, wreaked havoc among many important autogenic ecosystem-engineering plant clades. Unfortunately, we lack a megafossil record with enough detail and spatiotemporal continuity to analyze extinction dynamics. However, important information can be gleaned from comparing biological characteristics of the interim winners and ultimate losers of the upheavals. Interestingly, during this interval, whenever seed plant lineages were in decline or went extinct, isoëtalen lycopods proliferated.

Among the many global environmental stressors that likely played a role in the end-Paleozoic mass extinction, repeated failure of Earth's stratospheric UV-B shield has been implicated as a major culprit in the terrestrial crisis. We have experimentally tested the effect of UV-B levels suggested to have existed during the P-Tr-crisis on various aspects of the biology of extant representatives of Paleozoic plant clades. Here we show how life history and population dynamics in these different plant groups under elevated UV-B stress may explain the differential impacts of the P-Tr biotic crisis.

30/05/2024, 09:30–10:30, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-281 - Overview and insights from Jurassic and Cretaceous fossil forest records

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Through the Mesozoic, plant taxa with tree stature included at various times tree ferns, pteridosperms, a variety of gymnosperms, and angiosperms. Fossils of *in situ* tree stumps are preserved at several different sites and provide our best evidence of the individual spacing of tree forms along the landscape. They have the potential to capture significant paleoecological information about forest composition, structure, and paleoenvironmental setting. For this research, data from Jurassic and Cretaceous sites with known *in situ* fossil stumps was compiled to examine the extent of existing records for these time periods and identify those sites needing further study. Information including taxonomy, geolocations, time frame, stratigraphy, and sedimentology were determined for each record. Taphonomic biases in these records were considered. The greatest shift in forest composition is from the Jurassic to the Cretaceous, and subsequent changes through the Cretaceous are related to the diversification of angiosperms and their expanding roles as trees in forested environments. The nature of this expansion and the role of changing paleoclimates and environments will be discussed.

30/05/2024, 09:30–10:30, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-282 - Azolla across the K-Pg boundary in Patagonia

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Azolla Lamarck is a genus of aquatic heterosporous ferns characterized by its small floating sporophyte that carries indusiate sori on short stalks. The sori are homosporangiate and bear a single megasporangium, which in turn produces a solitary viable megaspore,

or several microsporangia, each one containing 3 to 10 pseudocellular massulae with multiple microspores. About six extant species are attributed to *Azolla*, with tropical and temperate worldwide distribution; they are found freely floating and forming extensive communities in low-energy freshwater environments such as swamps and ponds. The genus has a worldwide fossil record that extends back to the Late Cretaceous Epoch, but the stratigraphic range of individual species is relatively short. About 70 fossil species have been recorded; most of them are known only from dispersed megaspores and massulae, while the fragile vegetative structures are rarely preserved. *Azolla* fossils are excellent indicators of low-movement and freshwater environments as they currently do not tolerate high salinity waters. In Patagonia, the Late Cretaceous record is abundant although it is based principally on microspore massulae, which are frequently found in palynological samples and have little systematic value. In contrast, megaspores, which have a high taxonomic value, are scarcely recorded and represented only by four species. We evaluate the fossil record of *Azolla* across the K–Pg boundary in Patagonia in a paleoenvironmental context, and contrast the diversity and distribution of the genus through time worldwide.

30/05/2024, 10:10–10:30, Room: Leo
H03 Application of palynological and palaeoecological information in conservation and restoration

O-283 - A lesson from the past: Vegetation dynamics and forest biodiversity in Italy during the Little Ice Age (LIA)

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Among the climatic anomalies occurred in Europe during the last millennia, the Little Ice Age (LIA, 15th–19th cent. AD) strongly impacted on the vegetation and is often associated with changes in land use. During these centuries Europe experienced cooler temperatures and altered precipitation patterns, causing shifts in plant distribution and community composition. In Italy the main effect of the LIA was the expansion of mesophilous plants into lower elevations and latitudes, as well as the contraction of thermophilous trees to the advantage of conifers.

We present the application of pollen data from lakes of Central and Southern Italy for the palaeoecological reconstruction of the effects of LIA climatic change on past vegetation patterns. Our aim is to investigate the response of forest trees in the study regions by using a statistical approach to paleopalynology in terms of both qualitative and quantitative reconstruction. We applied statistical analyses to assess changes in forest composition and structure resulting from prolonged cool and wet climatic conditions and reduced human pressure on the landscape. Our results show a general change in forest ecosystems with different scenarios driven by local paleoenvironmental conditions and cultural developments. Although an increased forest biomass is widely attested, the recurring lower biodiversity suggests the impact of human activities during Medieval times. Such vegetation dynamics are being further investigated by a national project that aims to study the past ecology of some Italian protected areas for management and conservation planning.

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O-284 - Palynological analysis of the Cretaceous deposits in southeast Zella Trough, Sirt Basin, Libya

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Cretaceous deposits in the Sirt Basin of Libya occur in several troughs that formed during a major phase of rifting related to the opening of the Tethys, and the Zella Trough is one of such troughs that located in western Sirt basin. Deposits include continental deposits that belong to the Nubian Sandstone Formation and marginal to fully marine deposits that belong to the?Etel, Rachmat formations and probably part from Sirt formations.

A total of thirty-seven core and cutting samples were selected for this study. The subordinate shales in the Basal Sandstone/?Nubian sequence and ?Etel, Rachmat formations and probably part from Sirt formations yield diverse assemblages of poorly to well-preserved palynomorphs. Most of the assemblages contain non-marine palynomorphs (spores, pollen, and freshwater algae) although some contain dinoflagellate cysts marine elements.

Diagnostic terrestrial palynomorphs were recovered from the Basal Sandstone sequence such as *Crybelosporites pannuceus, Cretacaeiporites polygonalis* indicating an Albian-Cenomanian age. However, the absence of known Albian-early Cenomanian Northern Gondwana *Elaterates* gymnosperms pollen supports an Albian age for the Basal Sandstone sequence. Accordingly, this suggests that the Basal Sandstone sequence is equivalent to the Nubian Sandstone Formation.

Diagnostic marine palynomorphs were recovered from the overlying Late Cretaceous Etel and Rachmat deposit suc as *Trichodinium castanea* and *Xenascus ceratiodes* indicating Campanian-early Maastrichtian age. Of particular interest in the Late Cretaceous deposits is the provision recognition of missing stratigraphic sections, where the late Cenomanian-Santonian biozone section is apparently missing. Probably related to local uplift and subsidence events.

Three depositional environments have been recognized based on palynomorph and palynodebris contents, their depositional environments vary from fluviatile deposits in the Early Cretaceous deposits to marine and marginal marine environments in the overlying Late cretaceous deposits. This may indicate a progressive rise in sea level with higher flooding surfaces related to the opening of the Tethys.

O-286 - Evolution of the diversity in interactions between plants, insects and other pathogens in the early European Cenozoic

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The study of plant-insect interactions in the fossil record is of particular importance, as it not only allows us to better understand the evolution of such relationships through time and space, but also provides information on how these interactions, and by extension the wider ecosystem, responded to ancient global changes. In particular, the Cretaceous-Paleogene (K/Pg) extinction is an event whose drastic effects on interaction diversity are well documented from North American data. Recent studies in other parts of the world, such as South America and Europe, have shown that these effects may have been more regionalised than previously assumed. Unlike South America however, published data on European assemblages are limited to the Paleocene.

In this study, we describe results from two Late Cretaceous assemblages, the Santonian flora of the Aachen Sands (located on the border between Belgium, the Netherlands and Germany) and the Campanian flora of Grünbach, Austria. The interaction data from these two assemblages are compared with the previously published Menat (France) and Gelinden (Belgium) floras to provide a preliminary outline of the evolution of insect and plant communities across the Cretaceous-Paleogene boundary in Europe. In particular, these European data seem to indicate an intermediate state between North America, where the effects of the K/Pg extinction are drastic, and South America, where they are barely perceptible, at least in the realm of plant-insect interactions.

O-287 - Overview of the remarkable diversity of "seed ferns" from the Jurassic of the Cañadón Asfalto Basin, Patagonia, Argentina

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The so-called "seed ferns" comprise several gymnosperm lineages with contentious phylogenetic positions across the seed-plant phylogeny, not forming a natural group as a whole. Notwithstanding, they constitute a cornerstone in our understanding of seed-plant palaeoecology, systematics and deep-time evolution. In this contribution I present the state of the art in the study of the seed ferns from the Jurassic successions of the Cañadón Asfalto Basin, Chubut, Patagonia, Argentina. Three out of the four major groups of Mesozoic seed ferns are recognized in the Basin —i.e., Umkomasiales, Caytoniales and Peltaspermales— as well as taxa with dubious affinities to any of these groups. Caytoniales and Peltaspermales are represented by their most well-known organ associations (i.e., *Sagenopteris-Caytonanthus-Caytonia* and *Lepidopteris-Antevsia-Peltaspermum*)in the Lower and Middle-Upper Jurassic, respectively. Umkomasialeans are represented in the Lower and Upper Jurassic by fronds of contentious affinities with the group, such as *Archangelskya* (two species), *Pachypteris,* and *Komlopteris*, with the latter being potentially associated with the pollen organ *Stachyopitys*. Additionally, and having uncertain affinities, fronds assigned to *Rhaphidopteris* are also present in the Lower Jurassic of the Basin. The putative affinities of *Pachypteris*, *Komlopteris* and *Archangelskya* with umkomasialeans are discussed, as well as the affinities of additional Mesozoic seed ferns organ-associations that have been suggested as putative peltasperms (i.e., *Dejerseya-Matatiella-Townrovia*), umkomasialeans (*Pachydermophyllum-Pteroma*) and Caytoniales (*Ruflorinia-Ktalenia*). The presence of over 10 genera of seed ferns, which extend and remain abundant throughout the Jurassic, strongly suggests that the Cañadón Asfalto Basin was a diversity hotspot for the group. Further study of the Cañadón Asfalto seed ferns has the potential to provide us with valuable information to better understand their palaeoecology, the dynamics diversification and decline of their lineages, infer additional organ associations to reconstruct whole-plants, and help us to discern their evolutionary relationships to other groups in the seed-plant tree of life.

O-288 - Re-investigations of the Early–Middle Jurassic flora from the Qaidam Basin, northwestern China: With emphasis on the biostratigraphy and palaeoclimatic implications

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The Qaidam Basin is one of the major coal-bearing basins in northwestern China. The Jurassic strata mainly crop out in the northern margin of the basin. The Dameigou section represents the most complete Jurassic sediments in the basin, and yields abundant fossil plants. About 181 species of 57 genera of plant fossils have been documented, belonging to horsetails, ferns, Cycadopsida, Ginkgopsida, and conifers. Based on the previous and recent collections, we hereby make re-investigations on theses Early–Middle Jurassic floras, with emphasis on the biostratigraphy and palaeoclimate implications. Two fossil plant assemblages can be recognized, i.e., *Neocalamites-Cladophlebis* and *Coniopteris-Phoenicopsis*. In the *Neocalamites-Cladophlebis* assemblage, the Filicopsida is predominant and characterized by high species diversity of *Cladophlebis*. Among the gymnosperm groups, the Conifers rank the second of the flora, and the Ginkgopsida is the third. According to the stratigraphical ranges of the known species, the absence of typical Triassic taxa, the abundance of *Cladophlebis*, the diversity of *Equisetites*, and the first appearance of *Coniopteris* at the upper part of strata with low diversity and small size, the age of the assemblage can be attributed to the Early Jurassic. The *Coniopteris-Phoenicopsis* assemblage is dominated by Ginkgopsida and ferns and characterized by the high abundance and diversity of Dicksoniaceae and Ginkgopsida, decrease of *Neocalamites* and increase of *Equisetites*, and the existence of Cheirolepidiaceae at the upper part. The age of the assemblage can be attributed to the Middle Jurassic. The composition of the flora suggests a warm and humid temperate-subtropical climate in general, but a short interval with hot and arid conditions in late Early Jurassic, indicated by the increase of thermophilous plants like Dipteridaceae and Cheirolepidiaceae. The variation

of the floral composition could be the response of the terrestrial ecosystem to the climate changes related to the Toarcian Oceanic Anoxic Event.

30/05/2024, 11:00–13:00, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-289 - New Elatides (Cupressaceae) materials from the Early Cretaceous of Liaoning, China and their evolutionary significance

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Cupressaceae *sensu lato* (*s.l.*) are one of the most important components of global forests since the Mesozoic, and their relatively high diversity during the middle to late Mesozoic could reflect the evolution of the crown group members of this family. *Elatides* Heer 1876 (Cupressaceae *s.l.*) is an extinct genus which was widely distributed in the Northern Hemisphere from the Triassic to the Cretaceous. A study on this genus could provide a better understanding of the evolution and diversity in the crown group of Cupressaceae *s.l.* Recently, we collected abundant fertile shoots with seed cones of *Elatides* from the Early Cretaceous of Tiefa and Fuxin basins in Liaoning Province, northeastern China. Here we describe a fertile shoot of *Elatides* from the Early Cretaceous of Tiefa Basin as *Elatides chenianus* sp. nov., which closely resembled *Elatocladus manchurica* (Yokoyama) Yabe in vegetative leaves. The co-occurrence of the two species in the same fossil locality and similar morphologies suggested that the latter species might represent sterile parts of the former species. Furthermore, we made a revision of *Elatides harrisii* Zhou based on several fertile shoots with seed cones at different developmental stages from the Early Cretaceous of Fuxin Basin. Phylogenetic analysis shows that *Elatides* is a member of the crown group of Cupressoideae *s.l.* and is sister to the modern *Cunninghamia* in Cunninghamioideae. Morphological comparison between *Elatides harrisii* and *Cunninghamia lanceolata* (Lamb.) Hook at different developmental stages not only supports our phylogenetic results, but also provides clues for further evo-devo palaeobotanical studies on these extinct taxa. These findings give new insights into how to speculate and comprehend the plant diversity and evolution of the Early Cretaceous flora in northeastern China.

30/05/2024, 11:00–13:00, Room: Leo
H03 Application of palynological and palaeoecological information in conservation and restoration

O-290 - The late Holocene pollen record from Lake Butrint (Albania)

Laura Sadori[1], *Alessia Masi*[2], *Adele Bertini*[3], *Marta Marchegiano*[4], *Mario Morellon*[5], *Daniel Ariztegui*[6], *Flavio Anselmetti*[7]

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Located in the western Balkan peninsula (39°47’ N, 20°1’ E) Lake Butrint characterizes the southern coastal Albanian landscape, along the shores of the Ionian Sea. UNESCO World Heritage Site since 1992, Butrint boasts significant cultural, historical and natural value, evolving into a National Park in 2000.

A 12-meter-long core of mostly laminated sediments offers a detailed glimpse into the past 4400 years. Unearthing the lake paleo-archive, the lacustrine stratification has fostered the accumulation of varved sediments, dated by seven AMS radiocarbon dates and 137Cs dating, constructing a robust age-depth model.

Thorough the lake paleoarchive has yielded a wealth of data, including, besides pollen, and microcharcoal, sedimentological, geochemical, ostracod, dinocyst, insights. These findings contribute to reconstruct a vivid picture of a coastal environment, initially influenced by the sea, gradually transforming into a more terrestrial environment. Periodic seismic activity disturbed the sedimentation process, introducing homogeneous turbidites that temporarily interrupted the sediment lamination.

In the Mid-Holocene, Lake Butrint resembled a vast embayment open to the sea. However, the progradation of the Pavllo River Delta over time resulted in the gradual isolation of the basin from the sea. Consequently, the Vivari Channel has stood as the sole link to the Ionian Sea since Roman times.

Climatic fluctuations further shaped the landscape, with arid conditions prevailing during warm epochs like the early Roman Warm Period (500 BC – 0 AD) and the Medieval Climate Anomaly (800–1400 AD), as well as after the 19th century AD. Conversely, fresher conditions characterized cold intervals, namely the Late Roman-Early Middle Ages (0–800 AD) and the Little Ice Age (1400–1800 AD).

The paleoenvironmental history of Lake Butrint emerges as a multifaceted mosaic shaped by the interplay of climate variability, riverine dynamics, tectonic events, and human influence — all weaving together to feature the region's history across millennia.

30/05/2024, 11:00–13:00, Room: Leo
H03 Application of palynological and palaeoecological information in conservation and restoration

O-291 - Applications of palynology and associated studies to the history and restoration of the Indigenous Budj Bim landscape in SE Australia

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Budj Bim is the landscape of the native Gunditjmara people that has recently been added to the UNESCO World Heritage list as a remarkably complex cultural and socio-economic lifestyle system within a country that was considered to have been inhabited almost entirely by nomadic hunter-gathers. The system, is considered to have modified the Mt Eccles volcanic lava flow to provide connectivity between all the wetlands within the landscape for the purpose of eel aquaculture. This likely involved the construction and maintenance of numerous weirs and fish traps to control lake levels and stream flow in order to manage, trap, harvest and store kooyang (short-finned eels). Archaeological attention has focused on evaluating the distribution and operation of fish traps and associated collections of stone circles, controversially considered villages but some uncertainty results from the brutal disconnect of the Gunditjmara from their land and disruption of their culture with European arrival in the last 200 years. Pollen and associated analyses are being employed to provide a picture of changing environments that can inform on the history and timing of Aboriginal occupation and likely activities since their arrival in the region at least 46,000 years ago and to contribute to the re-establishment of conditions that will allow the re-operation of eel aquaculture. Geological dating of the basalt flow indicates that the landscape is about 10,000 years younger than human arrival, a quite unusual situation but one that supports Aboriginal dreamtime stories. The lava flow emanated from proto-Lake Surprise, the site of our major study that provides a very detailed palynological record from 30,000 BP, presumably when volcanic activity ceased, to present. Major insights are provided into the degree of landscape change between extremes of the last glacial cycle and the most likely time and conditions for eel-farming to have come into operation.

O-293 - Peat-bogs Holocene trajectories on the sandstone Northern Vosges (France): Insights for conservation

Vincent Robin[1], *Ruffaldi Pascale*[2], *Anne Véronique Walter-Simonnet*[2], *Duchamp Loïc*[3]

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A key issue for on-site biological conservation is about the on-going and future ecosystem trajectories. Such trajectories are directly related to past process and therefore conservationists need insights about ecological legacies and past references states. Such insights should guide them to define conservation strategy. This is what we have conducted in the low mountain range of the Northern Vosges (north-eastern France) throughout a closely related collaborative work between local conservationists and scientists. We carried out a multidisciplinary paleoenvironmental study on three peat bogs in order to reconstruct the long term history of the vegetation in the region. Our approach includes palynological, anthracological, macro-remains and geochemical analyses.

The main results show, throughout the Holocene, the succession of forest vegetation (pine and hazelnut forests, reduced oak forest, beech forest, oak-beech forest) was largely dominated by pine. Human presence was tenuous during the Neolithic period, then well marked from the Bronze Age onwards with the introduction of crops and livestock crops in the region. From the Middle Ages onwards, anthropic pressure increased dramatically, with a major ecosystem opening, inducing change in the hydrologic state of local wetlands which have changed their functional type. The Modern period is characterized by a gradual return of the forest, with decreasing anthropogenic pressure. Over time, occupation phases were interspersed with abandonment phases during which human activities regressed or disappeared. The rarefaction analysis carried out on pollen data shows that human presence led to a gradual increase in plant diversity, which peaked in the Middle Ages, whereas the forest lost some of its resilience to human disturbance over time.

Finally, these insights are discussed in the light of on-going stakes for the on-site conservation and preservation of the natural/cultural heritage.

O-294 - Vegetation recovery is not reaching the near-natural state in northeastern China

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The differences in the vegetation composition after ecological restoration (ER) compared to the natural vegetation cover (NVC) are still unclear, which hinders the prediction of future vegetation changes in the context of ER with the framework of near-natural forestry. Here, we present precisely dated, high-resolution pollen records from Sihailongwan Maar Lake (SHML) in northeastern China during the past 250 years and spanning ~430 years around the eruption of the nearby Jinlongdingzi Volcano in 466 CE, respectively. According to changes in arboreal pollen/non-arboreal pollen (AP/NAP) values, a proxy of deforestation, the past 250 years can be divided into three stages: NVC (~1760–1932 CE), human deforestation (HD) (~1932–1992 CE) and ER (~1992–2020 CE), coinciding well with historically documented forest area changes in the region. The AP/NAP values increased rapidly after the beginning of the ER, and after ~2000 CE, were closed to those during the NVC stage, showing the effect of ER policy. However, the dominant species during the NVC stage was *Pinus*, while during the ER stage was *Betula*, indicating that the vegetation recovery is not reaching the near-natural state. Using volcanic eruption disturbance as an "analog" for human disturbance, the region is projected to have gradually increased conifer trees and decreased broadleaf trees, and potentially return to the near-natural state after ~120–140 years, without considering other factors.

30/05/2024, 11:00–13:00, Room: Leo
H03 Application of palynological and palaeoecological information in conservation and restoration

O-295 - Millennial and centennial pollen records comparison from a mixed fir-beech forest, conservation history of a priority habitat: Insights from Lago del Pesce and STAPE (Pollino National Park, southern Italy)

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3 University of Tuscia, Department of Ecological and Biological Sciences, Viterbo, Italy

This contribution provides palynological insights into the past vegetation dynamics of a remnant mixed European beech-silver fir forest in the mountain elevation belt of the Pollino National Park (southern Italy). We focused on silver fir: a forest species featuring a fragmented distribution along the Apennines due to populations decline and local extinctions occurred in the Late Holocene. Silver fir pure and mixed forests constitute two priority habitats of conservation in Europe (Natura 2000 Network). We compared two pollen records in the area to examine vegetation dynamics at different spatial and temporal scales and detail the historical evolution of the forest habitat.

The Lago del Pesce pollen record covers the last 1100 years and highlights the establishment of a pure silver fir forest in the 11thcentury, after intense land exploitation. In the 14thcentury, wetter climate conditions and human population decline due to plagues led to forest cover increase and rewilding. Pollen percentages and accumulation rates suggest higher ecosystem complexity, and the establishment of a mixed beech-silver fir forest. The 18thcentury marked a new human-induced exploitation phase with the decline of silver fir, then mitigated by resource-use regulations in the 19thcentury.

The STAPE pollen record provides a local signal detailing the last about 300 years. Silver fir and beech show a dynamic balance in combination with wetter conditions. This balance is maintained until recent times, when the anthropic signal is detected, and silver fir pollen percentages decreased.

The establishment of a State Forest and the National Park (1910–1993) preserved silver fir, which never abandoned the area. These records exemplify the rewilding history of a priority habitat following land exploitation phases and underscore their contribution in forest ecological restoration and biodiversity conservation.

The study of STAPE is part of the project NBFC-NRRP; Mission 4 Comp.2 Inv 1.4, of MUR funded by NextGenerationEU. Project code CN00000033.

30/05/2024, 11:00–13:00, Room: Nadir
T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-296 - Identifying the most prevalent but enigmatic fruit of the Miocene Brandon Lignite (Vermont, USA)

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The Brandon Lignite of Vermont, USA, provides the only Neogene plant megafossil record in northeastern North America, including lignified wood and fruits and seeds, complemented by a diverse palynoflora. Fruits and seeds are represented by over 6,000 specimens, nearly half of which are of one unidentified taxon known as the “round fruit”. Identification of the affinities of this fruit would clarify the ecology and geographic affinities of the flora. The fruits average 1.5 cm in height and 1.25 cm in diameter. They possess a thin exocarp that erodes to reveal a woody mesocarp. This is initially smooth, but with degradation, the inter-locular areas erode to create a more star-shaped cross section. The mesocarp is composed of isodiametric to elongate sclereids interspersed with possible secretory cells. There are 5–9, most commonly 7, carpels; the narrow locules are enclosed by a 1–2 seriate layer of resistant cells that extend to the surface of the mesocarp. The complex vascular system includes a central axis with a basal whorl of traces passing between the locules to the exterior and an apical whorl arching, umbrella-like, over the locules. This suggests that the single

enclosed seed of each locule was anatropous with a dorsal raphe. Mature seeds are uncommon. They are lenticular, with a thin, blue-black, vitreous seed coat. An apical protrusion suggests the fruits were superior, but there is no further data to support this. Families currently under consideration include the Euphorbiaceae, Guttiferae and Linacaeae; however, no clear familial assignment has been achieved for these fruits. To this end, we present this fossil in the hopes that a colleague may have encountered a similar morphology at another paleobotanical site, and/or may offer additional clues to its systematic position.

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T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-297 - A Story of Chinese Lanterns and American Chilies: Fossil seeds and fruits resolve the evolutionary history of the Nightshades (Solanaceae)

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Solanaceae or the nightshade family stands out for the stark incongruences between molecular dating estimates and recent fossil discoveries. Divergence time estimates based on the few reliable fossils placed the stem age of the family around 49 Ma. However, the subsequent discovery of Eocene lantern fruits (*Physalis*) from Patagonia, physaloids fruits from Colombia (*Eophysaloides*), and chili peppers (*Lycianthoides*) fossils suggests the family may have much earlier origins, in Gondwanan South America. Although these recent discoveries are very informative, most nightshade fossils are seeds with a very limited number of traits to analyse and score and are not confidently assigned to the family. Nonetheless, advances in imaging and visualization, such as X-ray micro-Computed Tomography (μ-CT), have made it possible to non-destructively score fine-scale structural variation in these fossils. During my talk, I will be presenting a review of the fossil record of Solanaceae, from small Russian seed fossils analysed with μ-CT to compressed fruits from South and North America that entirely change the narrative of the family. Clustering analyses (NMDS), based on discrete and continuous morphological characters from seven fruit and 106 seed fossils and more than 300 extant species of Solanaceae, showed the strong morphological similarity of some fossils to clades of extant taxa, like *Lycianthoides* to the *Capsicum*/*Lycianthes* clade. The geographic spread of these lineages, from southern South America to the Green River Basin of North America (present-day Wyoming and Colorado) and Europe, indicates that the tomato family diversified much earlier and may have spread northward through Late Cretaceous island-hopping, opening the possibility of spreading to Europe and Asia through land connections. In addition to providing insight into the deep history of the family, these seed and fruit fossils hint at a previously rich solanaceous flora in northern North America that has now disappeared.

30/05/2024, 11:00–13:00, Room: Nadir
T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-298 - Phosphate fossilization in Quercy: Revealing the exceptional preservation of reproductive organs

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1 CR2P – Centre de Recherche en Paléontologie – Paris, MNHN – Sorbonne Université – CNRS, Paris, France

The Quercy phosphorites have long been renowned for their diverse fossil vertebrate fauna, which were used to characterize the “grande coupure” at the Eocene/Oligocene boundary. This boundary is linked with an abrupt cooling climate, profoundly altering the vegetation. In this unique paleokarstic context, typically associated with vertebrate mineralization, the fossilization process has yielded mineralized (phosphate-enriched) plants exhibiting a distinctive appearance. This study focuses on the exceptional preservation of fossilized plant specimens, including flower buds, fruits, and seeds, found in the Quercy region. These fossils have occurred under unusual terrestrial circumstances, enabling them to preserve fine, high-resolution visible anatomical structures. The research effort involved the selection of over 800 well-preserved plant fossil samples, spanning the late Eocene to early Oligocene periods. Notably, the collection includes several flower bud fossils and a substantial number of Vitaceae and Anacardiaceae fruit and seeds. The study is based on the employment of micro-CT scanning for high-resolution reconstruction as well as anatomical slides. They reveal distinct morphotypes among the flower bud samples, such as trimerous, tetramerous, and pentamerous structures. The stamens and gynoecia are, in particular, perfectly preserved. The internal structures of the analyzed fruits show that they belong to the fruit types capsules and drupes. Additionally, this research confirms the identification of Anacardiaceae at the genus level (*Pentoperculum*) and identifies two morphotypes within Vitaceae, potentially linked to *Vitis* or closely related

genera. The unique preservation characteristics of phosphate fossils are highlighted, emphasizing their utility in preserving internal structures. The application of micro-CT with high resolution enhances species identification. Overall, the findings underscore the significance of Quercy phosphorites as an invaluable source for advancing our understanding of ancient ecosystems and plant evolution. This not only contributes to paleodiversity reconstructions but also aids in systematic phylogenetic studies.

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T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-299 - At the foot of the Eiffel Tower: The fossil flora of Passy (early Eocene), new discoveries, and challenges

Cédric Del Rio[1], *Léa De Brito*[1], *Steven Manchester*[2]

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2 Florida Museum of Natural History, University of Florida, Gainesville, USA

The fossils from Passy, in Île-de-France, correspond to a temporary excavation during the construction of a building in 1999. This construction revealed layers of lignite sediments belonging to the "sables d'Auteuil" (middle Ypresian). Only two species of Icacinaceae from this site have been published to date. The purpose of this study is to comprehensively examine the plant megafossils from this site and infer the paleoecology and the biogeographic history of this flora. Although limited to a few bags of sediment, the site reveals 144 fruits, seeds and cones specimens that are suitable for morphological study. They have been photographed and compared with existing literature in Eocene of Northern Hemisphere. All specimens were classified into ca. 50 morphotypes. The difficulty in studying Passy arises from the fact that fossil fruits, seeds and cones are generally extremely compressed, making their identification at the family or genus level sometimes challenging. The internal anatomy is generally crushed, and size measurements are affected, making direct comparisons with other fossil sites difficult. Nevertheless, some of the specimens are easily identifiable. Angiosperm remains dominate in abundance and specific diversity, accounting for approximately 90% of the total. In particular, the site has an abundance of fruits and seeds corresponding to lianescent groups such as Vitaceae, Menispermaceae, and Icacinaceae, as well as generally tropical groups such as Arecaceae, Anacardiaceae, and Apocynaceae. Conifers are represented by isolated cone parts or scales from possibly Taxodiaceae and Pinaceae. The composition of this assemblage demonstrates the existence of a tropical to subtropical climate during the early Eocene in Paris. This flora likely evolved in a swampy area and formed dense, humid forests. The potential allochthonous conifer remains could indicate a continental flora with a cooler to subtropical appearance. These results agree with previous palynological finding at the Paris Basin scale.

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T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-300 - New methods for recovering hidden details from impression and compression fossils using micro-CT scanning

Steven Manchester[1]

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With the technological advances of micro-computed tomographic processing of x-ray data (micro-CT) about two decades ago, paleobotanists soon recognized that this technique was especially helpful for non-destructive investigations of exquisitely preserved, often fragile, charcoalified or permineralized reproductive remains such as cones, flowers, fruits and seeds, allowing for virtual sections and surface renderings of internal structures such as seeds within fruits and cones, and embryos within seeds. Another useful application of micro-CT scanning is found in the study of "uglier" fossils preserved only as molds, casts or impressions in clastic sediment. By CT-scanning such specimens, we have the opportunity to observe exquisite structures of flowers, fruits and seeds that are partially or completely hidden within the sediment that previously would have been almost impossible to observe without destructive methods. Micro-CT scans of specimens preserved in shale, siltstone, and even sandstone have yielded highly informative results when processed with appropriate 3d visualization and analysis software (e.g., Amira, Avizo, VG Studio Max, Dragonfly). In this presentation, I would like to compare and contrast imagery obtained from standard reflected light microscopy, with the results from micro-CT processing of the same specimens, with examples from the mid-Cretaceous Dakota Sandstone of Kansas, Paleocene Fort Union Formation of Wyoming, Eocene Trinity flora of Texas, and Oligocene Bridge Creek flora of Oregon, USA, as examples to demonstrate the utility of this approach for documenting more characters useful for taxonomic placement of the fossils.

30/05/2024, 11:00–13:00, Room: Nadir
T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

O-301 - Seeing further – The challenges of art-sci visualisations of Cenozoic fruits and seeds in research papers and use in exhibitions to highlight the importance of plants, both extinct and extant, to wider state, national and international audiences

Anita Milroy[1], *Andrew Rozefelds*[2]

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Seeing comes before words. The child looks and recognises before it can speak. But there is another sense in which seeing comes before words. It is seeing which establishes our place in the surrounding world; we explain that world with words, but the words can never undo the fact we are surrounded by it. The relationship between what we see and what we know is never settled. The way we see things is affected by what we know or what we believe. (Berger 1977, p.7)

Australia has many enigmatic Cenozoic palaeobotanical specimens, including those permineralized by silicates. Many have been the subject of study and investigation and will be discussed as an exemplar using contemporary and traditional visualisation techniques and as curated exhibition items. The art-sci artefacts produced range from traditional pencil sketches to digital methods: 3d, photogrammetry, synchrotron and neutron computed tomographies. Each technique may provide new knowledge and a means by which this can be communicated e.g., animations, jewellery.

The specimens are first 'seen' with the eye and then via other methods to 'see further'. This has led to publication in traditional outputs (TOs) such as journals and have also contributed to non-traditional research outputs (NTROs) including visual art, music, and exhibitions. A key feature of these NTROs is that they require a high degree of engagement, particularly between researchers and importantly, research end-users outside of academia, for the mutually beneficial transfer of knowledge, technologies, methods or resources. These NTROs are, we believe, important tools for community engagement and propose these could be a potential 'cure' to what has been term 'plant blindness' (Wandersee, Schussler, 1999). We agree with Berger, that seeing comes first, and seek to communicate the importance of plants – in the biosphere, in climate change and in human existence via innovative exhibitions. We welcome international collaborations.

30/05/2024, 08:30–10:30, Room: Taurus
H07 The past and future of mountain ecosystems: perspectives through palaeoecology

O-302 - Holocene vegetation and climate changes of Kashmir Valley (NW Himalaya, India)

Salman Khan[1], *Torsten Utescher*[1], *Sushma Prasad*[2], *Anoop Ambli*[3], *Praveen K Mishra*[4], *Arshid Jehangir*[5], *Birgit Gaye*[6], *Martina Stebich*[1]

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Ongoing climate change is a major threat to ecosystems, biodiversity, and rain-fed agriculture of the Indian subcontinent. Given the uncertainties in future projections of the Indian Summer Monsoon (ISM) and extreme events within a global warming scenario, understanding past vegetation and climate dynamics including their underlying drivers is crucial.

Here we present new palaeoecological data from Manasbal Lake, belonging to the Western Himalayas Ecoregion. The annual precipitation ranges between ~200 and ~700mm with contributions by the mid-latitude westerlies and the Indian summer monsoon. The climate-sensitive position of the study area may allow deciphering the interplay of both climate components.

According to radiocarbon data, the presented pollen diagram provides information on changes in regional vegetation and land use during the last approx. 12,500 years. The proportion of tree pollen varies between 30 and 70%. Over the studied period, minor fluctuations and a slightly increasing trend of the arboreal taxa in the recent past can be observed. A continuous occurrence of mixed coniferous-deciduous forests is indicated by Pinus accompanied by temperate deciduous trees. During the last millennium, higher proportions of Platanus, Juglans, and Morus can be observed. Regular occurrences of (sub)-tropical taxa likely result from long-distance transport during the monsoonal season.

Widespread occurrences of open habitats are evidenced by abundant Artemisia, Poaceae, and other open-ground taxa from the beginning of the Holocene. Agricultural activity is suggested by Cerealia-type pollen and Plantago lanceolata type from about 4500 years BP.

In contrast to the terrestrial vegetation, larger variations in the riparian and aquatic component, in total pollen concentration as well as in geochemical proxies indicate significant changes in the sedimentation regime, lake level and in the riparian habitats.

30/05/2024, 11:00–12:00, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-303 - Fossils of Liquidambar from the Eocene and Oligocene of South China

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Liquidambar L. (Altingiaceae, Saxifragales) has been an essential component of the Cenozoic floras in the Northern Hemisphere. Extensive fossil record of *Liquidambar* leaves, reproductive structures, woods, and pollen have been reported from Asia, Europe, and North America. The distribution of *Liquidambar* species today is discontinuous, with the highest diversity being in Asia. Examined *Liquidambar* fossils were obtained from three sedimentary basins in South China: Changchang Basin in Hainan (Changchang Formation, middle Eocene), Maoming Basin in Guangdong (Huangniuling Formation, upper Eocene), and Nanning Basin in Guangxi (Yongning Formation, upper Oligocene). Fossil leaves, associated infructescences, and pantoporate pollen grains, dispersed or attached to the carpel surface, show a combination of morphological features characteristic of the extant species of the formerly recognized genera *Liquidambar* s. str., *Semiliquidambar*, and *Altingia*. The co-occurrence of these fossils supports recent taxonomic changes based on molecular markers. Our data provide evidence for the occurrence of diverse ancestral polymorphic group of *Liquidambar* species in South China and corroborate the view that South China could have been a center of *Liquidambar* speciation in the Eocene. The morphological similarity between the Eocene and Oligocene species from Eastern Asia and some extant and fossil species from Western Asia and North America supports the importance of both the North Atlantic Land Bridge and the Bering Land Bridge for the dispersal of *Liquidambar*.

Keywords: *Liquidambar*, Plant fossil, Eocene, Oligocene, South China

This study was supported by the National Natural Science Foundation of China (Grant nos. 42072020, 42372016).

30/05/2024, 11:00–12:00, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-304 - Fossil flowers support a Cretaceous diversification of crown-group Laurales

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The angiosperm order Laurales comprises 2800 species within seven families: Calycanthaceae, Siparunaceae, Atherospermataceae, Gomortegaceae, Monimiaceae, Hernandiaceae, and Lauraceae. The extensive fossil record of Laurales extends back to the Albian of the Early Cretaceous (~113 Ma) and contains numerous systematically informative flowers. Some fossil flowers were previously analyzed in a phylogenetic framework using morphological datasets that broadly sample across the angiosperm phylogeny, but do not completely capture the floral diversity within an order or family. Thus, phylogenetic positions of fossil flowers within

Laurales remain uncertain. Here, we use our novel morphological dataset of 49 floral characters that samples the taxonomic and floral diversity of 197 extant taxa of Laurales with an extensive outgroup sampling of magnoliids to test the phylogenetic relationships of lauralean fossil flowers. Twenty-three lauralean fossil flowers were selected from the literature and two new Cretaceous flowers from western North America were analyzed in a phylogenetic framework. The flowers were initially analyzed using the phyloscan method to assess all potential angiosperm affinities. Of the 25 fossil flowers we tested, we confirmed lauralean affinities for 23 fossil flowers. After confirming lauralean affinities, we conducted Bayesian phylogenetic analyses with our novel morphological dataset to test the phylogenetic positions of the fossil flowers. Fifteen fossil flowers were recovered within crown-group Lauraceae, but phylogenetic relationships of the fossils among extant Lauraceae remain uncertain. Two Early Cretaceous taxa were recovered among stem and crown group Hernandiaceae. One fossil flower was recovered as stem-group Atherospermataceae. Five fossil flowers previously thought to be members of Laurales were recovered in phylogenetic positions among other magnoliid groups. Our results indicate that the diversification of crown-group Laurales was well under way during the Cretaceous and provide new evidence on the Cretaceous record of magnoliids.

30/05/2024, 11:00–12:00, Room: Virgo
Z03 Phylogenetic Palaeobotany

O-305 - Vegetative organization of early angiosperms

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The systematic of angiosperm is mostly based on reproductive organs. Nevertheless, vegetative structures provide crucial information on systematic and ecology. Here I review some key feature of early angiosperms from the Cretaceous of tropical area combined with living early diverging angiosperms. Characters studied include mostly the architecture (position of branching, monopodial vs. sympodial) as well as the phyllotaxis and the position of reproductive organs. The characters were mapped on a phylogeny and compared to lower Cretaceous fossil angiosperms.

Among Magnoliids, *Endressinia* and *Schenkeriphyllum* retained axillary flowers in contrast to living Magnoliaceae but already displayed a spiral phyllotaxis on reproductive branches.

Among eudicots, *Santaniella* display terminal flower with more or less synchronous flowering of several branch order suggesting a determinate growth. Such a growth pattern is apparently typical of herbaceous plants, especially herbaceous Ranunculales.

All in all, architectural characters found in fossil plants are useful both for elucidating systematic affinities and for reconstructing their growth habit.

30/05/2024, 11:00–13:00, Room: Zenit
B03 CIMP Palaeozoic palynology

O-307 - The Choteč Event in the Early-Mid Devonian transition in Northern Spain: Discovering the intricacies of an insular region during the Mid Paleozoic

Gilda M. R. Lopes[1], *Silvia Blanco-Ferrera*[2], *David Bodman*[3], *David P.G. Bond*[4], *Sarah Greene*[5], *Jason Hilton*[5], *John Marshall*[6], *Javier Sanz-López*[2], *Charles Wellman*[1]

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In the Devonian, the Armorican Terrane Assemblage was a group of isolated islands between the supercontinents of Laurussia and Gondwana. In northern Spain (Asturias-Leon), Devonian sequences were widely deposited around these islands. At the Emsian-Eifelian transition, there are significant facies change, with the extensive carbonate sequences of the Moniello Fm (Asturias) and equivalent Santa Lucía Fm (León) rapidly transitioning into the sandstones/shales of the Naranco Fm (Asturias) and equivalent

Huergas Fm (León). This conspicuous transition is interpreted as the regional manifestation of the Basal Choteč Event, a global anoxic pulse. This report presents the geochemistry and rare palynological assemblages recovered from the Moniello/Santa Lucía formations' carbonate platform deposits and more abundant assemblages from the transitional beds at the contact with the Naranco/Huergas formations. The geochemical data, which includes carbon isotope, major and trace elements analysis, reveal that the Basal Choteč Event is characterised by a negative carbon isotope excursion, enhanced weathering, and a brief pulse of elevated productivity, eutrophication and anoxia. The palynological assemblages are independently dated using conodonts and invertebrate macrofaunas (e.g. brachiopods). All of the samples are from marine sediments and include marine elements (acritarchs, prasinophycean cysts, chitinozoans, scolecodonts) in addition to allochthonous terrestrial elements (spores). Spores are surprisingly common at certain levels in the carbonate sequence and remain productive in the sandstones/shales above. Analysis of the acritarchs, chitinozoans, and spores suggests that the assemblages are somewhat impoverished and have a moderate-high degree of endemism, which is unsurprising considering their isolated location. This report explores whether changes in the palynological assemblages at the Choteč Event relate to environmental changes (facies) or reflect an extinction event.

30/05/2024, 11:00–13:00, Room: Zenit
B03 CIMP Palaeozoic palynology

O-308 - The Silurian-Devonian boundary interval in the Eastern Taurides, Turkey: Palynological, isotopic and conodont analyses

Sinem Tanrikulu[1], *Sevinç Özkan Altıner*[2], *Charles Wellman*[3], *Ayse Atakul Ozdemir*[4], *Demir Altiner*[2]

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The Ordovician-Devonian sequence is well exposed in the Eastern Taurides, Turkey. To determine the boundary between the Silurian and Devonian in this sequence, palynological, isotopic and conodont analyses were performed. To accomplish this purpose, the Halevikdere Section was measured in Sarız District, Kayseri, Turkey. The section comprises alternations of gray to dark gray shale and *Orthoceras*-bearing limestones belonging to the Yukarı Yayla Formation.

Palynological analysis yielded rich palynomorph assemblages containing abundant, poorly preserved palynomorphs. These assemblages are characterized by Silurian index taxa, such as *Visbysphaera bonita*, *Ancyrochitina ancyrea*, ?*Urnochitina urna*, *Urnochitina kameli* and *Pterochitina perivelata*, and Early Devonian (Lochkovian) index taxa, such as *Pterochitina megavelata*, *Ancyrochitina asterigis*, *Ancyrochitina tomentosa*, *Eisenackitina bohemica*, *Streelispora newportensis* and *Chelinospora verrucata*. Based on marker bioevents (FO and LO), the chitinozoan *Pterochitina perivelata* Taxon Range Biozone (Pp) and *Pterochitina megavelata* Interval Biozone (Pm) are defined in the upper Silurian (Pridoli) and the Lower Devonian (Lochkovian), respectively. Regarding spores the *Streelispora newportensis* Interval Biozone (N) and *Emphanisporites microrнatus* var. *microrнatus* Interval Biozone (M) are recognized in the Lower Devonian (Lochkovian). In addition to the palynological analyses, this study also presents the conodont fauna that is recovered throughout the studied section. The succession yields latest Silurian-earliest Devonian conodont associations, that are poorly diversified and of low abundance, of the genera *Panderodus*, *Pseudooneotodus*, *Wurmiella* and *Zieglerodina*.

Isotopic analysis demonstrates positive carbon isotope excursion, which is the globally recorded, from -2.59 to -0.07 ‰ above the boundary point.

Palynological analyses indicate that the Silurian-Devonian boundary occurs between samples ST2017-47 and ST2017-48 in the Halevikdere Section.

Keywords: palynology, Silurian, Devonian, carbon isotope, conodont

30/05/2024, 11:00–13:00, Room: Zenit
B03 CIMP Palaeozoic palynology

O-309 - Exceptionally well-preserved chitinozoans from the lower Silurian Measley Ridge roadcut (Ohio, USA)

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The Measley Ridge section, a roadcut located in southern Ohio (USA) provides a remarkable example of Silurian strata. The middle and upper part of the Estill Shale is exposed in this outcrop and the Llandovery-Wenlock boundary is tentatively placed low within this unit. The lithology is composed of reddish-brown to maroon shales with lenticular calcareous siltstones at the base, turning into greenish-gray to olive shales at the top and deposited in an open marine outer ramp with high sedimentation rates (McLaughlin et al., 2008). The Llandovery-Wenlock (late Telychian-early Sheinwoodian) age of this section is based upon conodonts (Kleffner, 1987), although it is accepted that this dating is not particularly precise. The aim of this study is to produce a high-resolution chitinozoan biostratigraphical scheme for the section, in order to provide further age constraint of the unit and to confirm the position of the Llandovery-Wenlock boundary. Twenty-five samples from the middle and upper part of the Estill Shale in the Measley Ridge section were processed for chitinozoans and yielded a diverse and well-preserved assemblage. Ten genera and sixteen species were recognized with typical Llandovery-Wenlock species such as P*ogonochitina djalmai* and *Ramochitina angusta* observed through all the section. Long-ranging species such as *Ancyrochitina ancyrea*, *Ancyrochitina primitiva*, *Margachitina margaritana* and several *Conochitina* and *Euconochitina* species were also distributed within the unit. However, *Cingulochitina burdinalensis* is observed in the lower and middle part of the section but does not reach the upper strata. Since this species is restricted to the Llandovery, its last appearance datum in the section may indicate the position of the Llandovery-Wenlock boundary. The chitinozoan assemblage overall from the Estill Shale in the Measley Ridge section confirms the Llandovery-Wenlock age of the section.

30/05/2024, 11:00–13:00, Room: Zenit
B03 CIMP Palaeozoic palynology

O-310 - Chitinozoan biostratigraphy provides additional insights about the Valgu Event (early Silurian) on Anticosti Island, Eastern Canada

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The rich body of work on biogeochemical events of the upper Silurian provide opportunity to rapidly advance understanding of less studied events in the lower Silurian (Llandovery). Exciting new discoveries indicate that these events were potentially as environmentally devastating, but much work remains to be done. Within the Llandovery, the Late Aeronian and Valgu biogeochemical events occur on opposite sides of the Aeronian – Telychian stage boundary, a horizon typically marked by a globally traced unconformity. On Anticosti Island, however, the Aeronian – Telychian record represents an expanded shallow water carbonate succession without any obvious stratigraphic breaks. Focusing on this stage boundary interval, our study aims to fine-tune local and global chitinozoan biostratigraphy. 25 samples from the upper Jupiter (Ferrum and Pavillon members) and lower Chicotte formations were collected at the well-exposed, coastal Jumpers Cliff section in the south-central part of the island. Most samples produced well-preserved and age-diagnostic chitinozoans. 22 taxa were present and three new species were defined. Taken at face value, the Ferrum Member was interpreted as Aeronian, marked by the presence of *Ancyrochitina ramosaspina* and *Conochitina elongata*, while the Pavillon Member and the Chicotte Formation were considered Telychian in age due to the presence of *Eisenackitina dolioliformis*. Cryptic disconformities associated with abrupt lithological changes are present in the middle of the Pavillon Member and at the base of the Chicotte Formation. These disconformities were detected by the chitinozoan distributions and the stable carbon isotope record offsets. Similar features are reported from the Baltic, Michigan and Appalachian basins. Ongoing efforts are now towards developing a wider Aeronian-Telychian chitinozoan biostratigraphic framework. This refined age model for the Aeronian

and Telychian strata of Anticosti Island offer the necessary control for future studies, including our own work using brachiopod geochemistry to recognize environmental factors acting in the Valgu Event.

30/05/2024, 11:20–13:00, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-311 - On the origin of the Oriental plane tree (Platanus orientalis L.)

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Oriental plane tree (*Platanus orientalis*) is native to the East Mediterranean region and sister to three western North American species, together forming the Pacific North American-European (PNA-E) clade. Its sister clade comprising several eastern North American-Mexican species has been termed Atlantic North American (ANA) clade. The origins of *P. orientalis* and the western North American-western Eurasian disjunction in the PNA-E clade are poorly understood with the North Atlantic and Beringian land bridges being possible corridors for trans-continental migration. Molecular phylogenetic studies suggested ancient hybridisation between the ANA and PNA-E clades prior to differentiation of modern species' lineages. We traced ANA and PNA-E specific leaf traits in the fossil record to locate areas of possible ancient hybridisation. Leaf traits characteristic of the PNA-E clade occurred in western North America (late Eocene of Montana, Early Miocene of Alaska) prior to appearing in the European fossil record. Fossil-species with mixed PNA-E/ANA leaf traits occurred in the Oligocene of Central Asia and Eocene and Miocene of western North America. In contrast, eastern North America and the Atlantic region hosted fossil-species with leaf traits characteristic of modern ANA clade members. We propose that precursors of *Platanus orientalis* migrated to Europe via Beringia and through Central Asia. Initially, these Eurasian ancestors possessed ancestral PNA-E clade leaf morphologies, which were gradually replaced by *P. orientalis*-specific traits. Treated as single fossil-species, we document the evolution of *P. academiae* from predominately three-lobed leaves in Miocene strata to narrowly 5-lobed leaves resembling modern *P. orientalis* in younger deposits of southern Greece. Using a morphology-based species concept, it is difficult in Neogene fossil-species to draw the border between extinct sisters and representatives of extant species. Hence, the fossils-species *P. academiae* could be paraphyletic, its older members representing extinct sister taxa, while the youngest members could already represent the extant *P. orientalis*.

30/05/2024, 11:20–13:00, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-312 - Palaeoecological transition from Neanderthals to Homo sapiens: The Late Pleistocene pollen record of Uluzzo C Rock Shelter (Apulia, southern Italy)

Juan Ochando Tomás[1], *Donatella Magri*[2], *José S. Carrión García*[1], *Manuel Munuera*[3], *Gabriela Amorós*[1], *Matteo Romandini*[4], *Enza Elena Spinapolice*[5], *Stefano Benazzi*[4]

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The southern Italian Peninsula plays a crucial role as a biogeographical hotspot in Southern Europe, influenced significantly by a Mediterranean climate. This environment acted as a refuge for a diverse flora and fauna, fostering the persistence of Neanderthals and facilitating the arrival of modern human populations around 43 to 39.9 thousand years ago. This study employs pollen analysis on late Mousterian and Uluzzian sediments from Uluzzo C Rock Shelter in the Salento peninsula (southern Italy) to reconstruct the vegetation landscapes encountered by Italian Neanderthals and early modern humans during Marine Isotope Stages (MIS) 3–2. Indeed, recent studies have attributed the Uluzzian technocomplex to modern humans, while up to now European Neanderthals seem associated to Mousterian technocomplexes. Our palynological analyses reveal a distinctive semi-forested environment

within the Mediterranean landscape. This environment is characterized by a rich flora mainly composed of evergreen elements. Additionally, heliophytes such as Amaranthaceae, *Artemisia*, and Poaceae are observed. The consistent presence of pollen taxa such as *Quercus macrolepis/trojana* type, *Juglans*, and *Pinus halepensis/pinea*, among others, highlights the importance of this coastal area of Apulia for the long-term persistence of Mediterranean species during the Late Pleistocene. These taxa could be supported by a generally mild climate, as suggested by the occurrence of *Olea*, *Myrtus*, and *Cistus*. These semi-forested environments would undeniably have offered various opportunities for the survival of Neanderthals and early Upper Palaeolithic hominins, especially during the warm phases and, critically, the cold events of the Late Pleistocene. The new data from the Uluzzo C Rock Shelter offers novel information about the autochthony of plant species currently living in Apulia and, more in general, on the biogeographical history of Mediterranean tree taxa.

30/05/2024, 11:20–13:00, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-313 - Gondwanan fossil woods from the Paleogene of southeast Asia

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Gondwanan elements have long been recognized in the fossil flora of southeast Asia, but their history and dispersal route remain highly debated. Myanmar sits at the crossroads for biotic exchanges between India and Laurasia during the Cenozoic. Burmese fossil woods thus provide an opportunity to document these exchanges. Various angiosperm families have so far been documented in the Paleogene of Myanmar in the mid-Paleocene Paunggyi Formation and the mid-Eocene Pondaung Formation. The first geological unit has yielded remains that are hardly identifiable, while the second has already yielded about 40 wood specimens from 16 different taxa that are all related to extant Asian or nearly pantropical species or genera. This study explores 36 new specimens from the Pondaung Formation and 15 specimens from a new locality belonging to the early Oligocene Shwezetaw Formation. Although not all specimens can be identified with certainty, many morphotaxa are related to the families Fabaceae, Malvaceae, Anacardiaceae, Combretaceae, Dipterocarpaceae, Moraceae, Meliaceae and Lauraceae. Among them, some are related to extant genera with a Gondwanan repartition: *Cola*, *Detarium*, *Eucalyptus* or *Entandrophragma*. Their presence, sometimes in both Eocene and Oligocene formations (those with an affinity to *Cola* and *Eucalyptus*) highlights the complex evolution of forested ecosystems in the region and the biogeographical history of these taxa. The collision between the Indian Plate and the Burma Terrane might have favoured the dispersion of many Gondwanan taxa to Asia and beyond, whereas the dramatic global climate changes of the Cenozoic as well as the rise of the Himalaya and the setup of a monsoon regime shaped their distribution that previously extended outside the Gondwanan area.

30/05/2024, 11:20–13:00, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-314 - Unraveling early Neolithic regional forest and human impact in the Lower Yangtze Valley, eastern China: New pollen insights

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The Lower Yangtze Valley, a key region in understanding regional vegetation and early Neolithic human activities, presents a big challenge to detect early possible presence of human signals archived in deep sediments and to determine regional forest pattern mainly attributed to highly changeable pollen sources in this widespread marine-flood interaction plains.

This study reconstructs the vegetation-environmental history based on a well-dated new pollen record recovered from a sheltered lake surrounded by hills during 10.1–7.2 cal kaBP and determine regional forests and potential signals of human activities through combined analyses of AMS ^{14}C dates, pollen data, and grain size. Our results show that: a) during the period from 10,100 to 8270 cal a BP, a stable deciduous *Quercus* forest as the regional forest flourished in Lower Yangtze; b) After 8270 cal a BP, evergreen oak trees and other woody types expanded, while deciduous oak trees receded, resulting in the regional vegetation transitioning to a regional mixed evergreen-deciduous broad-leaved forest up to 7230 cal a BP. c) Moreover, early indications of human activity were uncovered by high abundance of Poaceae including rice (*Oryza sativa*) type. Together with a previously reported rice phytolith record from neighboring areas, this research provides compelling pollen evidence suggesting that human activities in the Lower Yangtze Valley likely at least dated back to 8200 cal a BP, around 1200 years earlier than current archaeological records.

30/05/2024, 11:20–13:00, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-315 - Parrotia (Hamamelidaceae): Pollen, the fossil record and historical biogeography

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Parrotia once had a much wider geographical range during geological time. However, assigning fossil pollen of *Parrotia* is yet difficult. In this study, we present new results on the pollen morphology of *Parrotia*, and also compared the reticulum sculptures and nanoscale ornamentations on the muri around lumina for six genera in the tribe Fothergilleae with the representative genera from the neighbouring tribes Hamamelideae and Eustigmatea. Hamamelidaceae fossil pollen from Miocene sediments in SE China were examined. We found that 1) pollen of *Parrotia persica* and *P. subaequalis* have significantly different dimensions of lumen size and density of lumina, and the lengths of polar axis, equatorial axis, colpus, respectively; 2) the peculiarities of reticulum, microechinae on the muri and arrangement pattern are useful diagnostic features to differentiate Fothergilleae pollen to genus level from two neighbouring tribes; 3) two sister species of *Parrotia* show identifiable characteristics of reticulum and microechinae, however, it should be noted that assigning fossil pollen to Fothergilleae still need caution, because of some similar looking close genera; 4) inter- and intraspecific pollen variations need to be carefully considered, when identifying dispersed or fossil pollen grains of *Parrotia*; 5) nanoscale structures of pollen sculptures are important keys to distinguishing different fossil pollen types of Hamamelidaceae. Most of fossil sites of *Parrotia* are concentrated in Europe-Eurasia and Japan in East Asia, but there are relatively fewer in China and America. To have an insight into the historical biogeography of *Parrotia*, the global fossil records of *Parrotia* were comprehensively reviewed. The palaeophytogeography of *Parrotia* in light of fossil pollen in East Asia is also generally discussed. Further investigations of the fossil record of *Parrotia* are expected prior to fully picturing its past phytogeography and species diversity through time, particularly some missing links during Pliocene and Quaternary in China.

30/05/2024, 12:00–13:00, Room: Virgo
M05 Molecular proxies in palaeoecology

O-316 - Nitrogen isotopes in fossil organic matter as a proxy for symbiotic nitrogen fixation: Cycads as a case study

Michael Kipp[1], *Eva Stüeken*[2], *Caroline Strömberg*[3], *William Brightly*[3], *Victoria Arbour*[4], *Boglárka Erdei*[5], *Robert S. Hill*[6], *Kirk Johnson*[7], *Jiří Kvaček*[8], *Jennifer McElwain*[9], *Ian Miller*[10], *Miriam Slodownik*[6], *Vivi Vajda*[11], *Roger Buick*[12]

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While the stable isotopic composition of organic carbon in fossil plants has been explored as a proxy for atmospheric composition and photosynthetic physiology, the next most abundant constituent of biomass – nitrogen (N) – has received much less attention. This is in part due to the analytical difficulty of measuring N concentration, let alone isotopic composition, in small fragments of fossil organic matter. With new analytical approaches, however, N isotope analysis of fossil organic matter is not only feasible, but routine. Here we present the promise of this new proxy by focusing on a case study: the use of N isotopes to track the development of symbiotic N fixation in cycads. The results surprisingly show that symbiotic N fixation arose late in cycad evolution, after divergence of extant families. This implies that access to limiting nutrients was important for evolutionary dynamics through the late Mesozoic and Cenozoic, and also highlights the power of this new tool for deciphering changes in ancient nutrient cycling.

30/05/2024, 12:00–13:00, Room: Virgo
M05 Molecular proxies in palaeoecology

O-317 - Estimates of past UV-B radiation using pollen biomarkers

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Stratospheric ozone provides protection from excess quantities of UV-B radiation (ultraviolet-B, 280–315 nm) reaching the Earth's surface. Solar activity, the geomagnetic field strength, and atmospheric composition all influence ozone production in the atmosphere so that the amount of surface UV-B radiation has not been constant throughout history. Because exposure to excess UV-B can have negative effects on organisms through DNA damage, variations in UV-B radiation at the Earth's surface are likely to have been a major evolutionary driving force for life on Earth.

The outer walls (exines) of pollen grains are composed the complex biopolymer, sporopollenin. Sporopollenin is partly composed of UV-B absorbing compounds, which have been found in increased abundances in pollen grains whose parent plant has been exposed higher levels of UV-B irradiance. Since sporopollenin is chemically stable over long time periods and is resistant to corrosion in lakes and bogs, a number of studies have proposed and that quantification of these compounds can be used to reconstruct UV-B radiation in the past.

Here, we present results from a series of field and greenhouse experiments where we attempted to quantify the effects of UV-B radiation on sporopollenin-based biomolecules from the genus *Pinus* L.. We use a combination of gas chromatography mass spectrometry and infrared spectroscopy to characterise and quantify the abundance of potential UV-B absorbing compounds in the sporopollenin. So far our results indicate inconsistent results across the multiple experiment types. Such results highlight the importance of specific validation tests on relevant pollen taxa before being applied to fossil settings.

30/05/2024, 12:00–13:00, Room: Virgo
M05 Molecular proxies in palaeoecology

O-318 - Evolution of plant terpenoids on a rafting continent

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Plants are master chemists. They synthesize a wide range of natural products that have fundamental physiological and ecological processes. There has been considerable progress in documenting plant terpenoid biosynthetic pathways at the gene and enzyme levels. However, the biosynthetic evolution of these natural products in deep time is poorly understood.

Indian plate was separated from Gondwana during Late Jurassic and started moving towards the northern hemisphere during the Early Cretaceous and remained as an isolated continent during the entire Cretaceous until it collided with Asia in Early Eocene. It is believed that such prolonged periods of physical isolation of the Indian plate from the rest of the world might have resulted in endemic animal biota. However, the evolution of higher plants on the rafting continent is poorly documented.

Organic matter-rich sediments from Permian to Eocene of India were investigated to understand the evolution of plant-derived terpenoids. A brief outline on evolution of plant terpenoids from Permian to Eocene on the Indian continent will be furnished during the presentation. The Permian sediments and coals are characterized by tricyclic and teracyclic diterpenoids. The possible source of these compounds is extinct seed ferns. The biomarker composition of Jurassic and early Cretaceous sediments suggests that the vegetation was contributed by conifers (e.g. Arucariaceace, Podocarpaceae) during the period. The aromatic triterpenoids derived from angiosperms are detected in high abundance in the sediments of Late Cretaceous age. Drastic reduction of coniferous vegetation and proliferation of angiosperms in early Palaeogene are found in the present study. The terpenoid signatures of early Palaeogene coals and crude oils suggest that the western and north eastern India was covered by widespread thick closed rain forests dominated by family Dipterocarpaceae.

30/05/2024, 14:30–16:30, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-319 - Turning over a new leaf: Palaeoecological analysis of an East Greenland plant community spanning the Triassic/Jurassic boundary

Catarina Barbosa[1], *Antonietta Barbara Knetge*[1], *William J. Matthaeus*[1], *Richard Barclay*[2], *Ian Glasspool*[3], *Stephen Hesselbo*[4], *Mihai Popa*[5], *David Sunderlin*[6], *Finn Surlyk*[7], *Jennifer McElwain*[1]

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The end of the Triassic is marked by an extraordinary faunal mass extinction, however its effects on the flora have not been quantified to the same extent. South Tancreadikløft (STan) is a fossiliferous locality spanning the Triassic/Jurassic extinction event in the Primulaelv formation, Kap Stewart Group, Jamesonland, East Greenland. The palaeoecology of which is previously undocumented provides the opportunity for observing floral responses to extinction and macroecological change at the local level.

STan is made up of seven fossil plant beds ranging from the Rhaetian (Beds 1, 2a-c) to the Hettangian (Beds 3b and 4), with some doubt as to the exact temporal position of Bed 3.

Here we present a preliminary palaeoecological study of the leaf macrofossils present. Our study utilises generic relative abundance to determine ecosystem dominants and rare genera.

The material was collected census-style in 2004 but was only curated, quantitatively assessed and databased in 2023, resulting in a 1025 plant generic occurrence data set. Occurrences per bed range from 370 to 2 (Bed 2a), which is significant given the collection method. Initial analysis based on presence/absence of *Lepidopteris* and *Thaumatopteris* point to the lower sediments

of Bed3 as being the base of the Hettangian. However, Detrended Correspondence Analysis revealed that, compositionally, it is closer in floral composition to Triassic beds of equivalent formations. Additionally, isotope data for Bed3 is missing the 'main' negative carbon isotope excursion that marks the T/J boundary in other comparable localities. An examination of the ratios between *Podozamites*, Bennettitales, and Gingkoales shows a very clear trend of Bennettitalean decay and extinction (Bed 3b) and replacement by *Podozamites*, with ginkgophytes only being established well into the Hettangian (Bed4). These findings are in line with previous studies from the Astartekløft locality in East Greenland and point to turnover in the dominant species over the Triassic/Jurassic.

30/05/2024, 14:30–16:30, Room: Aquarius

C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-320 - Mesozoic climate changes and CO2 concentration variations - Paleobotanical evidence from China

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The Mesozoic (252 myr – 66 myr) is characterized by a hot Greenhouse climate. As one of the primary greenhouse gases, CO_2 plays a major role in global warming, which affects the surface temperature of the Earth. Reconstruction of atmospheric CO2 using proxies is crucial for understanding the Mesozoic "Greenhouse". However, at present, CO_2 concentration data are less common before the Cenozoic, thus it can be difficult to reliably connect changes in the Earth's environment with changes in paleo-atmospheric CO_2.

Palaeobotanical proxies based on the stomatal features of leaf cuticles show great application value for reconstructing the deep time CO_2 level in recent decades. In recent years, several fossil localities from China have been further studied, such as the Upper Triassic Yanchang Formation and the Middle Jurassic Yan'an Formation in Huating County, eastern Gansu Province, and Lower and Middle Jurassic in Dameigou profiles of the Qaidam Basin, northwestern China, the Lower Jurassic Xiangxi Formation in Zigui of western Hubei Province, South China, and the Upper Triassic Hongweikeng Formation in Nanling region, border of Guangdong and Hunan Province. Based on *Ginkgo*, *Ginkgoites* and *Sphenobaiera* leaves, our estimated paleo-CO_2 values are 1962 ppm in the Late Triassic, 900–1200 ppm in the Early Jurassic, and 1320 ppm in the Middle Jurassic.

To test the congruence of paleo-CO_2 estimates, all three methods applied to different Ginkgoalean fossil species collected from the same fossiliferous bed. Considering the potential effect of guard cell size to the mechanistic method, the result demonstrates that a likely occurrence of polyploidy in *Sphenobaiera huangii* may result in underestimated paleo-CO_2 when applying mechanistic method due to an increase in the size of the stomatal complex.

O-321 - Plant diversity and taphonomy: Across the end-Triassic biotic crisis at South Tancrediakløft, Greenland

Antonietta Barbara Knetge[1], *Catarina Barbosa*[1], *William J. Matthaeus*[1], *Stephen Hesselbo*[2], *Mihai Popa*[3], *Finn Surlyk*[4], *Ian Glasspool*[5], *Richard S Barclay*[6], *Dave Sunderland*[7], *Jennifer McElwain*[1]

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The end-Triassic mass extinction event caused distinct change in both terrestrial and marine ecosystems and according to previous research, a floral turnover of over 80% is observed in present day East Greenland. Stable carbon isotope data and the palynological record supports a transitional period (boundary) between the latest Rhaetian and earliest Hettangian.

Observing paleodiversity change across the Tr-J boundary allows for insights on how plant diversity is affected over time, and how such conditions cater to an ecosystem's collapse and recovery. Measures of biodiversity, richness and evenness, are valuable for assessing ecosystem stability over critical intervals. Estimating evenness in the fossil record is particularly advantageous as it is much less influenced by sample size.

The fossil flora of South Tancrediakløft (south-east Greenland, Jameson Land basin), situated in the Kap Stewart group and Primulaelv formation offers highly preserved leaf specimens of 26 unique genera, ranging the specified transitional period. Macroecological change across the Tr-J boundary for this region has been previously interpreted (Astartekløft), although a targeted view of how such change impacted specific genera remains undescribed.

By comparing South Tancrediakløft to Astartekløft, the data from this collection enables a wider comprehension of vegetation dynamics and environmental change, scaled-up to the whole Jameson Land basin.

Our study utilises generic relative abundance to estimate occurrences alongside measures of biodiversity via evenness and richness to determine ecosystem dominants and rare genera. Generic richness and evenness are obtained utilising rarefaction analysis and Shannon Index respectively. Our findings reveal higher generic richness and more evenness than those of Astartekløft although, South Tancrediakløft has fewer collected specimens.

The site's taphonomy is considered as well, illustrating the relationship between plant preservation quality and variation in depositional setting per fossiliferous bed. The taphonomy of South Tancrediakløft suggests a higher variation in habitat type to Astartekløft, further supporting the estimated higher generic richness.

O-322 - The Cretaceous Resinous Interval (CREI). An outstanding resin-production interval from the late Mesozoic

Eduardo Barrón[1], *Xavier Delclòs*[2], *Enrique Peñalver*[3], *Carlos A. Bueno-Cebollada*[4], *David Peris*[5], *Mónica Solórzano-Kraemer*[6], *Sergio Álvarez-Parra*[2], *Jiří Kvaček*[7], *Antonio Monleón-Getino*[8], *Daniel Peyrot*[9], *Constanza Peña-Kairath*[2], *Alba Sánchez-García*[3], *Ana Rodrigo*[1], *Rafael P. Lozano*[1], *José María Postigo-Mijarra*[10], *Ricardo Pérez-de la Fuente*[11]

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7 National Museum – Prague, Palaeontology, Prague, Czech Republic
8 Facultat de Biologia – Universitat de Barcelona, Genètica – Microbiologia i Estadística, Barcelona, Spain
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11 Oxford University Museum of Natural History, Palaeontology, Oxford, United Kingdom

Cretaceous ambers are very relevant because they usually contain fossilized biological remains (bioinclusions) in exceptional detail, providing relevant information about past ecosystems in a period of terrestrial biotic revolution related to the transition from Mesophytic to Cenophytic times. Amber is fossilized resin, which during the Cretaceous was produced by conifers (Araucariaceae, Pinaceae, Cupressaceae s.l., Podocarpaceae or Cheirolepidiaceae, or more than one of these group simultaneously). These integrated biodiverse resiniferous forests, together with other gymnosperms (Cycadales, Bennetittales, Erdtmanithecales), vascular cryptogams (lycopods and ferns) and angiosperms. Resiniferous forests developed close to transitional sedimentary environments and this circumstance have led to the discovery of a large number of amber-bearing outcrops, particularly in the Northern Hemisphere. These resinous forests grown at least during an interval of about 54 million years, since the Barremian to the Campanian. We referred this interval of mass resin production by conifers during the late Mesozoic as 'Cretaceous Resinous Interval' (CREI). The causes of the extensive resin production that is related to the remarkable Cretaceous amber record, is currently under discussion, and they might correspond to abiotic (p.e., atmospheric gas composition, temperature, wildfires, hurricanes, volcanism, changes in sea level, oceanic physicochemical properties) and biotic (p.e., arthropod damage, pathogenic activity, the emission of volatile compounds by the resins to attract pollinators and other insects) factors. All these potential factors for the CREI are complex and most of them could be interrelated. From now, future studies on the CREI as a relevant Cretaceous interval will need to delve into the relative importance of each of these potential abiotic and biotic factors, enhance the spatial and temporal resolution of the succession of paleoevents to be considered, increasing prospective efforts – particularly in the Southern Hemisphere–, and improve the taphonomic knowledge of Cretaceous amber deposits.

O-323 - A rare lycopod macrofossil from the Triassic of Antarctica

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The rhizomorphic lycopod lineage (Isoetales herein) has a history that extends over 400 million years and persists today. During the Carboniferous, arborescent lycopods dominated the Earth's landscape and left an abundant fossil record, however climatic and geologic changes triggered a decline in their diversity in terrestrial ecosystems and created conditions unfavorable to plant fossilization. In concert, these events obscure key data necessary to delineate the finer details of isoetalean evolutionary history, including pivotal evidence on the origins of the extant genus *Isoetes*. The Triassic yields only a small fraction of known isoetalean macrofossils, and an even smaller portion of these macrofossils are anatomically preserved. Antarctic floras reflect this global trend, and no permineralized isoetalean macrofossils are known from the Triassic of Antarctica. Here we report a new lycopod fossil from

the Fremouw Formation (Triassic, Antarctica). This specimen is permineralized in a silicified peat matrix and was studied using the cellulose acetate peel technique. The fragment is partially compressed and incompletely preserved; nonetheless this specimen offers a unique insight into the anatomy of Triassic isoetaleans. The primary vascular tissues are not preserved but the secondary xylem cylinder is present, measuring approximately 15–20 cells (3.2 mm) thick. To the outside of the secondary xylem is a multilayered cortex composed of homogenous, parenchymatous cells. On the periphery of one side of this axis, regularly arranged isoetalean rootlet traces are found, providing strong support for its isoetalean affinity. Fossil processing is ongoing, however owing to the rarity of permineralized Triassic isoetalean macrofossils, this specimen provides crucial data on the anatomy and diversity of Mesozoic Isoetales and shows significant promise in contributing to our understanding of evolution in the group.

30/05/2024, 14:30–16:30, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-324 - Calm before the storm: Hidden diversity of ginkgophytes in the Late Jurassic Morrison Formation of the western United States

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Before terrestrial diversity underwent the angiosperm revolution in the Early Cretaceous and major ecological changes at the Cretaceous/Paleogene extinction boundary, ginkgophytes were common throughout the Northern Hemisphere during the Jurassic, especially in Asia and Europe. Strangely, relatively few have been reported from North America or from one of the most prolific Late Jurassic deposits in the world, the Morrison Formation in western USA. For many years, the Morrison Formation was thought to contain just two species of ginkgophyte: *Ginkgoites cascadensis* and possibly *Ginkgo pluripartita*. Later, *Czekanowskia turneri* was described from the Montezuma Creek flora (MC), Utah, and *Baiera* from the Temple Canyon flora (TC), Colorado. However, with the recent discovery of new assemblages, it is being recognized that the ginkgophyte diversity of the formation must have been considerably higher. Here we report on the occurrence of six genera of ginkgophytes in the Morrison Formation: the above four, plus *Sphenobaiera* and an *Eretmophyllum*-like leaf. The Jurassic Salad Bar (JSB), Utah, and TC floras each contain four of these six: *Ginkgoites*, *Czekanowskia*, the *Eretmophyllum*-like plant, and *Sphenobaiera* (JSB) or *Baiera* (TC). *Czekanowskia* occurs in 7 floras in the Morrison Formation, *Ginkgo* in 5, *Ginkgoites* in 3, the *Eretmophyllum*-like plant in 2, and *Sphenobaiera* and *Baiera* in 1 each. *Czekanowskia* is extremely abundant at MC and JSB. Thus, ginkgophytes are neither rare nor low in diversity in the Morrison Formation but can be very abundant and diverse in individual floras. The association of *Ginkgoites*, *Sphenobaiera*, and *Eretmophyllum* with specific riparian subenvironments such as oxbow lakes, overbank ponds, and deltas, as well as the occurrence of these taxa at JSB, suggest that ginkgophytes may have been environmentally widespread on the Morrison floodplain. This, and their tendency to thrive in humid environments, suggests that the aridity of the Morrison's paleoclimate sometimes has been previously overstated.

30/05/2024, 14:30–15:10, Room: Leo
H03 Application of palynological and palaeoecological information in conservation and restoration

O-325 - The contribution of past plant biodiversity to conservation and restoration: The case study of two valleys in southern Tuscany, Italy

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Detailed palynological analyses of four terrestrial cores drilled in the coastal plains of the Cornia and Pecora rivers, southern Tuscany, Italy (C3 and C7 - Cornia Valley, ~last 7500 years; P3 and P4 - Pecora Valley, ~last 3200 years) are presented. This study provides information on long-term landscape transformations, with focus on Medieval times (between the 7th-12th centuries AD)

when settlement patterns and land use contributed to the onset of the current landscape. Palynological analysis offers a meaningful contribution to the ERC nEU-Med Project describing changes related to the combination between local biodiversity and environmental features, resources availability, and historical trajectories. The similarities and dissimilarities between the two valleys will be shown in relation to high diversity and percentages of woody taxa and lower diversity with higher percentages of Anthropogenic Pollen Indicators. Moreover, the palynological investigation of the Vetricella archaeological site, located in the Pecora Valley, will also be presented. Comparison between on-sites and off-sites is a formidable knowledge tool for reconstructing the relation between past flora, vegetation traits and past cultures as a key starting point for biodiversity conservation and restoration assessments and strategies.

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30/05/2024, 14:30–15:10, Room: Leo

H03 Application of palynological and palaeoecological information in conservation and restoration

O-326 - Late Holocene palaeoecological variations and depositional pattern in the upper Brahmaputra region of Assam, northeast India using biotic and abiotic proxy assessment

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Majuli Island (world's largest River Island) lies beneath the Eastern Himalayan foothills which constitute an important part of the Indo-Burma hotspot due to their richness in biodiversity and representative nature for the region. A 150 cm deep sedimentary section from an endangered wetland of Majuli Island has been palynologically analyzed, to decode palaeovegetation and climatic condition in relation to the palaeoflood episodes. The quantitative palaeoclimatic reconstruction along with the Granulometric analysis have been performed as an auxiliary tool to interpret the palaeoecological variations and grain size distribution. The study reveals relatively dense forest in the Island during the first phase between 2150 to 320 BCE, under the warm and humid climate recorded by the presence of mixed deciduous tree pollen taxa. The recovery of *Rhododendron, Castanopsis* in the palynoassemblage is suggestive of the flood activity in the region. During second phase i.e. 320 BCE to 860 CE, conversion of mixed cover under relatively less warm and humid climate, corresponding to the Dark Ages Cold Period (DACP). During the third phase from 860 to 1450 CE (1090–500 cal. BP), the gradual revival of moist and dry deciduous taxa were observed under increased warm and humid climatic conditions which coincide with the Medieval Warm Period (occurred globally from 900 to 1300 CE). During 860 to 1450 CE max MAP was highest recorded (≈2500 mm). The anthropogenic marker pollen taxa like Cereal, *Brassica* and *Coriandrum* flourish well for the last 1450 CE along with scarce tree pollen, indicating tropical savannah type vegetation around the island. The low to moderate energy level indicates the sorted to poorly sorted sedimentary settings, which is significant indicator of the fluvial systems. This multiproxy approach could aid in understanding the future climatic condition in this flood prone region along with the anthropic influence around the Majuli Island.

O-327 - Newly discovered syncarpous fruits from the Oligocene Capella flora suggest links to the Moraceae

Andrew Rozefelds[1], *Anita Milroy*[2]

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Fruits composed of a many individual fruitlets that are united into a complex structure can be described as a syncarpium or a sorosus (sensu Spjut, 1994). Spjut (1994) recorded sorosi in diverse, and phylogenetically unrelated families, such as in the monocots, Araceae, Bromeliaceae, Cyclanthaceae, Pandanaceae, and dicots, Balanophoraceae, Bataceae, Cornaceae, Moraceae, Rafflesiaceae, Rubiaceae and Urticaceae. Permineralised fruits from the Oligocene Capella locality consists of many fruitlets, and the seeds occur in the upper portion of each fruitlet. The fruitlets form connate radiating segments, which are interpreted as being derived from the perianth. These radiating segments extend from the centre to the margin of the fruit and adjacent perianth apices appear to be fused apically, forming an irregular pentagonal-hexagonal imbricate surface which shows no consistent phyllotactic pattern. It was possible to exclude the monocot families and Balanophoraceae because the arrangement of seeds in the fruits of these families typically exhibit a regular phyllotaxy, which is less evident in the Pandanaceae. The structure of the fruit and seed shape in the fossil differs from that in Rafflesiaceae. The fossil also has a complex internal structure consisting of connate radiating thin elements that are closely aligned together and in this respect they differ from the internal fruit morphology of Cornaceae, Rubiaceae, Bataceae and Urticaceae. The morphology of the syncarpous fruits is considered to lie with the Moraceae, with the closest links to the subfamily Artocarpaeae although fruits with five-merous symmetry are not known from this family.

Spjut, R.W. (1994). A systematic treatment of fruit types. Memoirs of the New York Botanical Gardens, vol 70. New York.

O-328 - Why analytical paleobotany needs accurate taxonomic identifications of fruits and seeds

Andrew Simpson[1]

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Ever since the publication of the Red Queen hypothesis by Van Valen in 1971, paleontology has evolved increasingly from a specimen-based descriptive field to an analytical "big data" science in which individual studies analyzing up to hundreds of localities, thousands of taxa, and millions of specimens within a single publication. Because the invertebrate fossil record is taphonomically more prolific than that of other groups, vertebrate paleontology and paleobotany have lagged behind invertebrate paleontology, but in time, the plant fossil record has been the target of analytical work on extinction dynamics, global paleoclimate and carbon dioxide levels, vegetation structure, and more. However, many have noted that these synthetic studies all depend on one thing: accurate alpha taxonomic descriptions of the what, the where, and the when that supply the raw data for more inclusive work.

Neobotanists have historically relied on reproductive structures to describe plant taxa due to rampant convergent evolution characterizing vegetative structures. Contrastingly, paleobotanists have focused more often on vegetative structures (particularly leaves) due to the fact that plant organs are so often found separately in fossils. Fruit and seeds do represent important components of many fossil floras, and like their living counterparts, tend to be more useful for taxonomic identifications than vegetative anatomy. Because of this, continued systematic study of fossil fruits and seeds is an essential cornerstone of analytical, "big data" paleobiology. Journal editors, hiring and tenure committees, and funding agencies alike should value both descriptive and analytical science.

O-329 - Fossil seed of Sargentodoxa from the Miocene of the Guiping Basin in Guangxi of South China and its palaeogeographical significance

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Sargentodoxa Rehder & E.H.Wilson is a monotypic genus of the family Lardizabalaceae, which contains only one species, *Sargentodoxa cuneata* (Oliv.) Rehder & E.H.Wilson. This genus is mainly distributed in Central, East, South and Southwest China, with occasional occurrences in Laos and Vietnam. Reliable fossil records of this genus are rare, only reported from the Eocene and Miocene of North America, the Eocene, Miocene and Pliocene of Europe and the Miocene of Japan in Asia. Up till now, no fossil of this genus has been reported from China. In this paper, fossil seeds of *Sargentodoxa* from the Miocene Erzitang Formation of Guangxi, South China are reported. The current fossil seeds are generally oval-shaped, with a prominent hilum, which cut at a right angle to the long axis of the seeds, creating a truncated apex. The surface of the seed is black and smooth without any visible cellular structure. Based on these unique features mentioned above, the current fossil can be classified into the genus *Sargentodoxa*. This marks the first discovery of seed fossils attributed to the genus *Sargentodoxa* in China and represents the first-time fossils of this genus have been found within its modern distribution. Based on the growth environment of the living species of *Sargentodoxa*, we infer that the climate during the Miocene of the Guiping Basin in Guangxi was similar to that of present-day tropical and subtropical regions in Asia. Additionally, we simulate the distribution of *Sargentodoxa* using Maximum Entropy (Maxent) Modeling since the Neogene, based on the modern distribution of this genus and related environmental variables, along with paleoclimate data to constrain its theoretical geographic Northern Hemispheric distribution. Combining fossil records, the results indicate that since the Eocene to the Pliocene, *Sargentodoxa* has had a widespread potential distribution in the Northern Hemisphere.

O-330 - Earliest record of Malpighiaceae: Four-winged fruits from the early Eocene of Patagonia, Argentina

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A set of four winged fruits with characters suggesting a strong affinity to the tetrapteroid clade of Malpighiaceae were collected from the early Eocene Laguna del Hunco (LH) site, Huitrera Formation, Chubut, Argentina. LH represents a 52 Ma caldera lake assemblage deposited during the early Eocene climate optimum with an extensive and highly diverse flora indicative of a warm mesic forest. Many species found at LH have biogeographic connections to Australasia, including genera previously only found living or fossil in Australasia. The fossil fruits are samaras with four planar spathulate dimorphic wings attached equatorially to a globose central structure interpreted as a nut or nutlet. The wings are bisymmetrical, with a larger and smaller wing on each half, that are irrigated by veins that dichotomize from the central point at the wing attachment. Surrounding the center are hair-like structures, probably remnants of the stamens and styles. Fossils were compared to several families producing multi-winged fruits, but only those of Malpighiaceae are consistent with the characteristics observed in the fossils. Malpighiaceae is a family of over 1300 species found throughout the tropics and subtropics. The fossils share characters with members of the tetrapteroid clade and were compared to *Tetrapterys*, *Glicophyllum*, *Heteropterys*, *Hiptage*, *Jubelina*, *Malpighiodes*, *Mezia*, *Niedenzuella*, and *Tricomaria*. Fruit features were coded into a morphological matrix of Malpighiaceae, and a phylogenetic analysis was conducted to explore their phylogenetic position. The fossils were placed within the Tetrapteroid clade.Because of the age of the fossils and the considerable overlap of characters between *Tetrapterys* and *Glicophyllum*, erecting a new genus and species is justified. The few records of Malpighiaceae fossil fruits are from the Middle Eocene of United States and the Oligocene of Europe, making the Patagonian fossils the first fossil fruit from the Southern Hemisphere and the oldest uncontested Malpighiaceae worldwide.

O-331 - Earliest fossil record of the Ilex cornuta lineage from Korea reveal its leaf traits evolution and biogeography

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Naturally occurring in the subtropical regions of China to Korea, the Chinese holly (*Ilex cornuta* Lindl. & Paxton, Aquifoliaceae) is widely cultivated as an ornamental in Asia, in part owing to its diverse leaf morphology, which ranges from one to 11 spines. However, the evolutionary origins of this morphological diversity and its geographical history remain unclear. Here we report 50 exceptionally well-preserved fossil leaves of the *I. cornuta* lineage from the middle Miocene of South Korea. These fossils exhibit detailed characteristics of both the adaxial and abaxial leaf surfaces, as well as the quinary veins and free-ending veinlets. Our findings indicate that the morphological diversity of the *I. cornuta* lineage was already established by the middle Miocene. Given that fossils from this lineage have been found in Europe, ranging from the early Oligocene to the Pliocene, we suggest that the lineage may have directly exchanged between Asia and Europe, facilitated by the regression of the Turgai Strait during the Paleogene. Ecological niche modeling using MaxEnt shows that the *I. cornuta* lineage once had a broad suitable habitat range that spanned across Europe and Asia from the late Eocene to the middle Oligocene. However, in Europe, suitable habitats began to decline from the late Eocene onward. Highly suitable habitats had disappeared by the end of the Oligocene, and even areas of lower suitability were lost after the Last Glacial Maximum, culminating in the lineage's extinction in Europe. In contrast, East Asia has retained suitable habitats for the lineage up to present, despite a reduction in its geographical range. Our research offers a model for combining fossil evidence with ecological niche modeling to elucidate the biogeographical history of plants.

O-332 - Tracing the Miocene Triplochiton lineage (Helicterioideae, Malvaceae): Infructescence of Banisteriaecarpum ginanteum from the lower Miocene of Japan

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Byttneriophyllum tiliifolium is a leaf fossil-species of the Malvaceae, which is widely reported from the lower Miocene to upper Pliocene in the northern hemisphere. We recently proposed a biological connection between *Wataria parviporaw*ood and *By. tiliifolium*, based on an exceptionally preserved site with predominantly *Wataria* stumps (ca. 95%) covered by a leaf litter almost exclusively of *By. tiliifolium* (ca. 98%). The wood characteristics of *Wataria* suggest a possible relation of *By. tiliifolium* to *Triplochiton* (Helicterioideae), a hypothesis that requires further investigation. In this study, we report an infructescence bearing a *Banisteriaecarpum ginanteum* samara from the lower Miocene Nakamura Formation (19 Ma) in Hiragaito, Kani City, Gifu Prefecture, central Japan. The infructescence, as well as many detached samaras, were collected from a monodominant leaf bed of *By. tiliifolium*, supporting a hypothesis proposed in Europe that *Ba. giganteum* and *By. tiliifolium* constitute a whole plant. The infructescence, containing a samara and three detached scars, indicates that four samaras were originally clustered, similar to extant *Triplochiton*. In contrast, *Mansonia*(Helicterioideae) typically has two, and *Heritiera* (Sterculioideae) one or two samaras per infructescence. Molecular phylogenetic analyses reveal that extant *Triplochiton* and *Mansonia* form a clade within Hericterioideae. *Triplochiton* is endemic to Africa's tropics, while *Mansonia* spans the tropics of both Africa and Asia. These findings suggest ancestral plants of the extant *Triplochiton-Mansonia* lineage were present in mid-latitudes during the warmer early Miocene. Additionally,

Triplochiton-like woods from the middle Eocene of the USA and the lower Oligocene of Japan indicate a broader pre-Miocene distribution for this lineage. This distribution likely narrowed during the cooling trend that began after the mid-Miocene.

30/05/2024, 14:30–16:10, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-333 - Population dynamics of Arbutus in its Mediterranean-Atlantic range over the past 30 ka: A longitudinal trend

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The genus *Arbutus* (Ericaceae) occurs with four species in the Old World, ranging from the Canary Islands to Crimea and from Ireland to the Levant, being an emblematic element of the Mediterranean broadleaved evergreen biota. We investigated how its complex distribution developed since the last glacial period, focusing on the locations and extent of refuge areas, long-term persistence, postglacial dynamics in relation to dispersal capacity history, response to climate fluctuations and human pressure, and potential vulnerability. Understanding these issues is essential for effective conservation measures.

We analysed the fossil record and compared it with the present-day distribution. A total of over 1100 fossil sites, including pollen and macrofossils, were collected from literature and databases. Pollen grains of the genus *Arbutus* are distinct from other Ericaceae, although not identifiable at the species level. Range maps of past distribution were produced for the last 30 ka at 1000-year intervals. In addition, modern pollen data was collected from both databases and literature to link fossil pollen records to modern distribution.

The dynamics of the Mediterranean-Atlantic distribution of *Arbutus* reveal two clear spatiotemporal patterns. In the Northern and Western Iberian Peninsula, *Arbutus* is consistently represented throughout the last 30 ka, with pollen and macrofossils records even during the Last Glacial Maximum. In the Western and Central Mediterranean regions, it gradually appeared at the beginning of the Holocene, emerging showing up along the coasts of the Black Sea and in the Levant, during the Middle to Late Holocene transition.

The general feature that emerges from these gradual onsets is a peculiar west-east-oriented longitudinal pattern. The population dynamics of *Arbutus* over the last 30 ka appears consistent with the biogeographical divides known for other plant species, namely the east-west Iberian divide, the Rhone delta, the Amphi-Adriatic divergence, and the Intra-Anatolian Suture Zone.

30/05/2024, 14:30–16:10, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-334 - Conservationist lessons from a Historically Contingent Dynamics (and Epistemology) for the Iberian Peninsula

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Paleofloristic and paleoecological research in the Iberian Peninsula and Balearic Islands offer valuable insights for conservation strategies of tree taxa within the framework of international initiatives aimed at restoring ecosystem dynamics and functionalities to pre-anthropogenic conditions. It is of paramount importance to integrate data of various kinds to effectively characterize Pleistocene glacial plant refugia. These refugia can be considered biodiversity sinks and sources for geographic expansion during inhospitable stages in the climatic history of the western Palearctic. In our case study, these areas can also be seen as hydrorefuges rather than thermorefuges, given that aridity likely played a limiting role across extensive territories of the southern Mediterranean peninsulas, especially the Iberian Peninsula. Refugial areas appear to have been situated along intramountain valleys at low

or medium elevations and across coastal shelves. The impact of herbivory on Pleistocene and early Holocene plant communities is another point of contention and should be methodologically addressed in specifically oriented projects. This influence is now gaining consideration in the renaturation of protected or pilot areas. During the Holocene, particularly from the mid-Holocene onwards with the advent of metallurgic societies and new exploration methods for natural resources, it is essential to consider the connections between ecological changes and cultural collapses. We describe the ecocide associated with the Argaric collapse in the southwest. The relationships between modern communities, defined floristically, and past assemblages are finally discussed in the light of a thorough review of previously published records and new pollen records as well.

30/05/2024, 14:30–16:10, Room: Taurus
Q01 Biogeographical history of tree taxa: past trends and modern frameworks

O-335 - Painting tree landscapes to learn serendipy: The Pleistocene of Early hominins in the Far West of Eurasia

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There is a noticeable lack of visual representations specifically focused on the Quaternary vegetation of the Iberian Peninsula. Nevertheless, recent decades have witnessed significant advancements in our paleobotanical understanding of the region, establishing a robust scientific basis that can serve as a wellspring of creativity. Here, we present outcomes of paleoartistic exploration with the goal of visually reconstructing the vegetation landscapes surrounding the Orce Archaeological Zone (OAZ), dated between 1.6 and 1.2 million years ago in the Early Pleistocene of the Guadix-Baza Basin in southern Spain. The OAZ is situated in a depression bordered by forested areas of the Betic cordillera, whereas the current landscape is characterized by badlands and predominantly treeless vegetation. However, during the Early Pleistocene, the region featured wetlands when the expansive Baza Lake was active and cyclically receded, resulting in the formation of freshwater springs, ponds, and pools. It is within this context that numerous mammalian remains are located. Notably, OAZ includes human remains among the oldest in western Eurasia for the Homo genus. The scientific basis supporting the artwork relies on fossil pollen data from three OAZ sites: Venta Micena 1, Barranco León, and Fuente Nueva 3. We consider the potential distribution of vegetation zones and the taxonomic and structural diversity of the vegetation, encompassing taxa with widely disparate current biogeographic definitions, those that became extinct in the Iberian Peninsula in later phases, or those that had previously gone extinct in higher latitudes on the European continent. This paleoartistic endeavor also seeks to depict the coexistence of mesophytic, thermophytic, and xerophytic plant communities during the early Pleistocene at this convergence point in the southwestern corner of the European continent.

30/05/2024, 14:30–14:50, Room: Virgo
M05 Molecular proxies in palaeoecology

O-336 - Impact of sediment and burial on microbial community composition of Ginkgo leaf biofilms: Insights into leaf compression fossilization

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The formation of leaf compressions depends on the type of sediment in which the leaves are buried and on burial depth because greater burial depth leads to a more anoxic environment conducive to fossilization. Recent research has hypothesized that a microbial biofilm on leaf surfaces in the early stages of decay enhances preservation. In decaying leaves, the biofilm community is likely influenced by the same factors: sediment type and burial depth. Here we investigate experimentally the microbial community composition of microbial biofilms formed on floating and buried leaves of living *Ginkgo* in four sediment types—montmorillonite

clay, kaolin clay, quartz sand, and pond mud. Leaves were placed in aquariums with pond water under identical light conditions and room temperatures for three months. The leaves, sediments, and pond water were then evaluated with 16S and ITS sequencing to identify the bacterial and fungal communities. We found that the biofilms on the floating and buried leaves differed in their basic microbial community composition. The leaves buried in the kaolin clay showed the most distinctive microbial communities, while the montmorillonite clay buried leaves contained several genera noted for biomineralization. In general, the buried leaves had microbial communities that were more diverse than those on the floating leaves and richer in anaerobic microbes and biomineralizers. These results suggest that biofilms form best in very fine-grained sediments with low organic content, such as kaolin and montmorillonite clays, and under burial conditions fostering anaerobic environments and the incorporation of minerals that enhance biomineralization on leaf surfaces. Our results provide new insights into the role of microbial biofilms and microbe –sediment interactions in the early stages of leaf fossilization.

30/05/2024, 14:30–16:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-337 - Spatial dynamics of phytoplankton biodiversity in the early to middle Paleozoic

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Phytoplankton are fundamental components of marine food webs, sustaining the diversity of numerous microbial and metazoan groups. Thus, they are responsible for half of the world's primary productivity and are key players in many important biogeochemical cycles. Geochemical evidence suggest phytoplankton were already present in ancient seas around 2.7 Ga, with the first known organic-walled microfossils occurring in rocks 1.6 to 1.8 Ga. Their radiation in the early Paleozoic coincides with the rise of zooplankton groups such as radiolarians, graptolites and chitinozoans; paving the way towards the eventual development of modern marine ecosystems. Recent work show climate as a major control on phytoplankton diversity in the early to middle Paleozoic with global trajectories reflecting marine mass extinction events related to cooling and warming. This is supported by the emergence of a latitudinal diversity gradient in the fossil record during the early Paleozoic (Cambrian to Ordovician). Other important factors may come into play, requiring further in-depth analysis of biodiversification centers in the past oceans coupled with macro-ecological modelling. This spatial analysis is essential to better understand the mechanisms behind mass extinctions or, conversely, favoring the resilience of organisms. The present study will trace the evolution of phytoplankton hotspots from the Cambrian to the end of the Devonian, an interval spanning two of the three major biotic crises in Paleozoic; namely the Hirnantian (444 million years ago) and Frasnian-Famennian (~359 million years ago) mass extinction events.

30/05/2024, 14:30–16:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-338 - Acritarch distribution in the Middle Ordovician of Öland, Sweden: Ecostratigraphical not biostratigraphical signals

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The Middle Ordovician of the palaeocontinent Baltica provides some of the best preserved and most diversified acritarch assemblages of the Lower Palaeozoic. A great number of widely used acritarch genera and species have been described since the 1960s and many of these taxa are considered as biostratigraphically useful, for both regional and international correlations. Here, we document the morphological plasticity and diversity of acritarch morphotypes through the Middle Ordovician of Öland, Sweden. Progressive changes of morphological characters (such as process length, for example), but also the relative abundances of different

morphotypes are continuous throughout the sections. It is difficult, if not impossible, to distinguish different species that could be stratigraphically useful, because gradual transitions exist. The progressive change within the acritarch populations confirms the transition of assemblages from deeper to shallower water environments. Previously recorded biostratigraphical signals can at best be interpreted as ecophenotypical responses to the changing palaeoenvironment. The morphological plasticity challenges the validity of biostratigraphically useful taxa, questioning their accuracy and validity for precise correlation.

30/05/2024, 14:30–16:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-339 - A multiproxy approach to the Devonian-Carboniferous Boundary in the Eastern Taurides of Turkey at the Northern Gondwana Margin

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The Devonian-Carboniferous interval of the Gümüşali and Ziyarettepe formations is palynologically characterized and integrated with conodont and carbon/oxygen isotopes to establish a more accurate biostratigraphic boundary and its environmental evolution. Based on the first occurrences of species five palynozones are recorded. *Apiculiretusispora verrucosa* interval biozone, *Knoxisporites literatus* interval biozone, *Indotriradites explanatus* interval biozone, *Verrucosisporites nitidus* interval biozone and *Densosporites variomarginatus* interval biozone are recorded thorugh the section. Conodonts are not abundant within the selected limestone samples and in light of the determined species three biostratigraphic intervals have been recognized including *Icriodus cornutus- Polygnathus brevilaminus* biozone, *Po. communis collinsoni- Po. semicostatus* biozone and *Bispathodus aculeatus aculeatus-Bi. costatus* biozone. Therefore, although the occurrence of *Retispora lepidophyta* continue from *K. literatus* biozone (upper *Po.communis colinsoni- Po. semicostatus* Zone) up to the upper part of the section, the occurrence of *Densosporites variomarginatus* and other Tournasian spores tentatively marks the Devonian-Carboniferous boundary into the Ziyarettepe Formation. A quantitative palynofacies study carried out in the section based on quantitative distribution of terrestrial organic matter composition. Inertinite and spores dominate all the assemblage, while marine organic matter fluctuates. Accordingly, the section starts with high terrestrial input that diminishes whereas marine components increase upward in the section. $\delta^{13}C_{carb}$ yielded values ranging from -5.24‰ to +2.81‰, which includes the Hangenberg positive excursion located within the Ziyarettepe Formation from 0.86 ‰ to 1.82 ‰. After small fluctuations, it reaches its highest (2.81 ‰) above the boundary at 174 m. $\delta^{18}O_{carb}$ stable isotope values ranges from 8.27‰ to -3.79 ‰ showing a similar fluctuation pattern. Hence, considering a broad sequence stratigraphy in the Taurides, the relationship between organic facies and relative sea-level changes is marked by a maximum flooding surface right at the top of the Devonian-Carboniferous boundary interpreted as a regional sequence boundary in the regional context.

30/05/2024, 14:30–16:30, Room: Zenit
B03 CIMP Palaeozoic palynology

O-340 - The fossil-rich radiometrically- constrained Copacabana Formation in Bolivia as a potential standard section in Gondwana correlatable with northern hemisphere successions

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The Copacabana Formation crops out in sharp stream bends along strike and waterfalls at Chullpanimayu Creek (c. 3043 m elevation, 17.86669°S, 066.24495°W) close to Apillapampa town in west-central Bolivia. This well-exposed section of 310 m thick overlies Silurian-Devonian rocks. Paleontologic and radiometric data obtained from field trips in 2007 allowed the reassignment of the section between c. 40 m and 242 m to the Sakmarian, previously dated as Artinskian (Leonardian) based on *Eoparafusulina* and palynology. The U-Pb zircon data from volcanic tuffs in the lower interval of the Copacabana Formation at 120 m (295.2 Ma) and 154 m (293.3 Ma) also constrained the conodont *Sweetognathus* cf. *obliquidentatus* (132 m) to the Sakmarian. The first appearance (FAD) of *Lueckisporites virkkiae* at 69 m dates as Late Asselian disagrees with those FADs in the early Sakmarian or mid-Artinskian documented in Brazil, Uruguay, Argentina, Africa, Australia, Oman, and Saudi Arabia also radiometrically constrained. If U-Pb and conodont ages are correct at Apillapampa, Bolivia may have been an older center of dispersion for some striate and taeniate pollen grains and monolete spores including *Lueckisporites virkkiae*. To further test and develop these data, in July 2023 we collected more than fifty samples from the marine to transitional deposits of the Copacabana Formation at Apillapampa for a detailed taxonomic revision and regional stratigraphic distribution of microfossils (conodonts, fusulinids, palynomorphs) and brachiopods and other invertebrates and ichnofossils and plants. The recognition of 'bridge taxa' in Gondwana is the main purpose of the Permian Stratigraphy Working Group "Cisuralian Gondwana to Euramerica Correlations," which started in 2022. This fossil-rich Copacabana Formation will enable us to make more accurate correlations between Gondwanan successions bearing radiometric data as well as 'standard sections' (including GSSPs) in Russia, the USA, and China. Therefore, this section can be proposed as a standard for Gondwana.

30/05/2024, 14:50–16:30, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-341 - Differences in the intensity of interglacials in long pollen sequences from S Europe

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"Past interglacials can be thought of as a series of natural experiments in which climate boundary conditions varied considerably, with consequent effects on the character of climate change" (Tzedakis et al. 2009, p.751). Closer examination has revealed a large diversity in the intensity, duration and internal variability of interglacials, with a general theory accounting for this diversity still in the process of development. Here, we use pollen-based climate reconstructions to explore differences in the intensity of different interglacials as this is registered in long sequences in southern Europe. We consider underlying causes, including summer insolation forcing and atmospheric CO_2 concentrations, as well as strength of the previous glacial.

Tzedakis, P.C., Raynaud, D.R, McManus, J.F., Berger, A., Brovkin, V. & Kiefer, T. (2009) Interglacial diversity. *Nature Geoscience* 2, 751–755.

30/05/2024, 14:50–16:30, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-342 - Vegetation changes during MIS 11c. Palynological analysis from a sediment succession from the Fucino Basin (Central Italy)

Pablo Vera Polo[1,2], *Laura Sadori*[1], *Gonzalo Jiménez Moreno*[2], *Alessia Masi*[1], *Biagio Giaccio*[3], *Chronis Tzedakis*[4], *Giovanni Zanchetta*[5], *Bernd Wagner*[6]

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3 Consiglio Nazionale delle Ricerche, Istituto di Geologia Ambientale e Geoingegneria, Monterotondo, Italy
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The study of sedimentary records can provide insight into past climatic patterns and how ecosystems adapted to warmer temperature conditions. The Marine Isotope Stage (MIS) 11c (ca. 426–396 kyr) emerges as one of the most unusually lengthy and warm interglacials of the past 800 kyrs, with a global temperature ca. 0.5–0.7 ºC higher than the pre-industrial Holocene. The Fucino Basin (Central Italy) contains a continuous lacustrine succession for the last 445 kyrs including MIS 11 and the Mid-Bruhens Event (MBE) dated using tephrochronology. Palynological analysis is a proxy for environmental and paleoclimatic interpretations through the observation of the evolution in vegetation and algae assemblages driven by precipitation and temperature changes. Here we present preliminary palynological results of the Fucino sedimentary succession between MIS 11c and the glacial termination V (glacial-interglacial transition between MIS 12 and MIS11). Our results suggest that fluctuations in humidity are primarily responsible for vegetation changes, as evidenced by the exponential growth of *Abies* pollen. Furthermore, the warm interglacial was characterised by millennial-scale climate variability, with several periods when the temperature decreased and the aridity increased, as testified by the decrease in *Abies* population and the increase of *Poaceae*, *Artemisia*, *Amaranthaceae*, *Hippophäe*, *Ephedra* and *Pinus*. We were able to reconstruct the evolution of the lake level and its productivity by analysing the non-Pollen Palynomorphs, such as algae, and geochemical proxies. The study of the sedimentary record of the Fucino basin has then allowed us to reconstruct the evolution of plant and hydrological systems and their response to environmental factors during a period that was warmer than the pre-industrial Holocene, which could be used as analogous for current climate conditions.

30/05/2024, 14:50–16:30, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-343 - Eemian versus Holsteinian pollen sequences and their palaeoecological implications: Case studies from Poland

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High-resolution pollen successions representing two Pleistocene interglacials, Eemian and Holsteinian, revealed major differences in the sequence of trees expansion and in the composition of forest communities during climate optima. Specific features of the Eemian succession are: very high values of *Corylus*, the expansion of trees and shrubs in the following sequence: *Betula–Pinus*, *Ulmus*, *Quercus–Fraxinus*, *Corylus-Alnus-Tilia*, *Carpinus*, and *Picea* as well as a marked increase in *Carpinus* coupled with high co-occurrence of *Corylus*. The migration of plants into the territory of Poland during the Eemian was reconstructed on the basis of isopollen maps using 187 profiles. Only *Corylus*, *Carpinus*, and *Abies* arrived from the south and west, while *Ulmus*, *Quercus*, *Alnus*, *Tilia* and *Picea* from the east and/or north-east. This suggests the existence of Saalian refugia of these last trees in Eastern Europe and differentiates the Eemian from the Holocene, during which the majority of trees migrated from the south and west.

Several high-resolution Holsteinian successions in the Polish Lowlands allowed detailed characterization and identification of intra-interglacial climate oscillations expressed by fluctuations in pollen percentages of forest-forming trees. Holsteinian pollen succession features are: the expansion of *Picea* and *Alnus*, followed by *Taxus* in the older part of the interglacial and subsequent *Pinus* increase as a response to climate cooling and/or drying (Older Holsteinian Oscillation). Younger part of the climate optimum is charactierised by *Abies* and *Carpinus* domination with frequent presence of shrubs – indicators of warm and humid climate.

The two fundamentally different pollen successions illustrate the different order of tree encroachment into forest communities, which depended on several factors. In addition to the distribution of refugia, mention should also be made of the extent and duration of preceding glaciations, as well as numerous, not entirely identified factors related to the ecological tolerance of individual tree species.

30/05/2024, 14:50–16:30, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-344 - Four interglacial (MIS 5e, 5c, 5a, Holocene) vegetation records from the Sokli Basin (N Finland): New insights from a multi-proxy perspective

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A sequence of thick fossil-bearing lacustrine and fluvial deposits that survived multiple glaciations at Sokli (N Finland) reveal four interglacial vegetation successions dated to MIS 5e, 5c and 5a (Last Interglacial Complex) and the Holocene. Multi-proxy data show a rapid response of tree populations (birch, pine, spruce, larch) to newly deglaciated terrain and record the establishment of birch forest in the ice-marginal environment. Subsequently, pioneer birch forest persisted c. 1 millennium despite overwhelming evidence from aquatic taxa for warm summers. The shortest duration with birch forest (c. 800 yr) is recorded in early MIS 5c, i.e. the only warm stage that was not preceded by glaciation and soil formation had long been started. The longest birch phase (c. 1500 yr) occurred in Early Holocene under relatively low summer insolation. Local stands of spruce are detected during the following pine-dominated boreal forest, when aquatic taxa point to warm summers, but mixed boreal forest with spruce only developed late in MIS 5c and the Holocene. In contrast, mixed boreal forest with spruce and larch established at Sokli early in MIS 5e, to persist throughout major part of the interglacial. A likely explanation for the latter lies in the distinctly continental climate conditions in early MIS 5e, which might have enabled conifers to occupy vital niches. MIS 5e further stands out by the local presence of hazel. The 9 m-thick lake deposit additionally depicts millennial-duration vegetation changes with the early MIS 5e ‘Tunturi event’ recording significant

cooling under warmer-than-present climate conditions. Finally, alder shows an erratic pattern. Within a certain climatic envelope, it behaves like a wetland plant, rapidly responding to habitat availability followed by gradual decline. The detailed studies at Sokli expose a number of factors (e.g. pollen sum composition, vegetation-climate disequilibrium, non-analogue pioneer vegetation) that pose challenges for pollen-based climate reconstructions.

30/05/2024, 14:50–16:30, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-345 - Palynostratigraphy of a key Middle-Late Pleistocene alluvial sedimentary sequence from the Po Plain (Northern Italy)

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During the Middle and Late Pleistocene, the Po Plain underwent prominent palaeogeographical transformations marked by marine transgressions/regressions that left imprints on the landscape and subsurface architecture. The impact of these geological processes can be identified through distinctive cyclic stratigraphic trends in alluvial deposits, outlining vertical stacking patterns related to fluvial depositional processes and shifting facies tracts. The discontinuous sediment accumulation of alluvial settings, coupled with generally poor chronological control, makes it difficult to stratigraphically identify and characterize glacial and interglacial periods. Pollen analysis can provide crucial biostratigraphical information and contribute to deciphering the climate signature related to distinctive stacking patterns.

As part of the Geological Mapping Project of Italy (CARG – Sheet 184 'Mirandola'), we present a new 175-m-long pollen sequence from the Po Plain, near Modena, spanning the Middle and Late Pleistocene. The pollen analysis of core 184-S15 reveals a series of environmental shifts characterized by substantial reorganizations of forest ecosystems. Seven forested vegetational phases, alternating with sterile fluvial-channel sands, were identified and interpreted in terms of warm climatic phases, corresponding to Marine Isotope Stages 5, 7, 9, 11, 13, and 15. *Abies* and deciduous *Quercus* are often dominant during these phases. They are accompanied by different taxa in different interglacials, the most significant being *Olea, Vitis, Hedera, Corylus, Carpinus betulus*, *Fagus, Tilia*, and *Picea*. Sharp increases in *Alnus*, coupled with rises in helophytic/aquatic plants, point to the development of swamp environments, indicating phases of sea-level rise. In contrast, high percentages of *Pinus* are observed in association with the fluvial-channel sands, providing evidence for the vegetation of glacial periods. The detection of regionally extinct taxa, including *Zelkova*, *Carya*, *Pterocarya,* and *Tsuga*, provides new palynostratigraphic markers and contributes refining the chronological framework of the Po Plain, as well as enriching our understanding of the palaeobiogeography of Northern Italy.

30/05/2024, 15:10–16:30, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-346 - Diverse early Miocene flora from brown coals, southeast Australia

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2 University of Adelaide, School of Botany, Adelaide, Australia
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The early to mid-Miocene experienced a warm, wet climate regime, resulting in maximum advance of rainforests into higher latitudes by the mid Miocene Climatic Optimum. Few early Miocene coals of the Southern Hemisphere have been studied, as few host identifiable macrofloras. Rare, well-preserved leaves with cuticles were extracted from brown coal seams of the Latrobe Group in the Gippsland Basin, southeast Australia. For the first time, the diversity of macrofossils and mesofossils from continuous stratigraphic sections through the Morwell Formation are illustrated. These fossils are hosted in repetitive lithotype cycles of two different aged coal seams: the early Miocene M1B seam and the early to mid-Miocene M1A seam. Three main lithofacies

are represented: laminated dark, dark and medium dark; these were analysed for macrofossils (yielding leaves, wood, seeds) and mesofossils (yielding cuticles, charcoal, megaspores).

A highly diverse flora is recognised. Conifers include Araucariaceae (most abundant in basal horizons of the M1B seam) and Podocarpaceae that co-occurred with angiosperms. Monocots, e.g. Typhaceae, were preserved with the ferns, *Gleichenia* c.f. *G. dicarpa* and c.f. *Blechnum*, in charcoalified horizons throughout M1B and M1A coal seams. Leaf litter layers preserve a different, more diverse angiosperm flora, reflecting advanced ombrogenous ecosystems. Key elements of abundant Elaeocarpaceae, Lauraceae and *Oleinites willisii,* less abundant Myrtaceae, Casuarinaceae, Proteaceae and Cunoniaceae, and rare seeds, wood and bark were preserved. New evidence from floras within the Morwell Coal Seams is consistent with a cool-temperate and wet climate. Terrestrial climate impacts of the Mi1 glaciation are little studied, highlighting the critical nature of these Southern Hemisphere coals for understanding climate impacts on floral changes during the Miocene.

30/05/2024, 15:10–16:30, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-347 - Following Darwin's footsteps: Brief history of the Fuegian land's paleobotany

Maria Del Carmen Zamaloa[1], *M. Alejandra Gandolfo*[2]

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2 Cornell University, LH Bailey Hortorium – Plant Biology Section – School of Integrative Plant Science, Ithaca, USA

Discovered by Magellan in 1520, the island of Tierra del Fuego is situated in the southernmost of South America between the Magellan Strait at the north and the Beagle Channel at the south and approximately 1000 km from the Antarctic Peninsula. Because of its geographic location, difficult access, and harsh climate, few paleontological collections have been carried out since its discovery. Darwin studied its geology, extant flora, and fauna and collected fossil leaves in exposed sediments of San Sebastian Bay during his trip on the H.M.S. Beagle between 1831 and 1836. He gave the fossil leaves to Hooker who identified them as the Austral beech while recognizing they were quite different from those of the extant beeches. Nordenskjöld visited the Fuegian coast in 1895 and collected mostly *Nothofagus* fossil leaves at its Atlantic cliffs (currently the Cullen and Carmen Silva Formations) that were later published by Dusen in 1907. Almost 150 years after this report, there are still scarce paleobotanical collections even though due to its latitudinal position, its proximity to Antarctica (past and present), and the influence of the Pacific and Atlantic Oceans and the Antarctic Circumpolar Current, Tierra del Fuego fossiliferous sediments are strategic to link Antarctica, continental South American, and Australasia paleo and extant floras. Tierra del Fuego fossils are crucial to contrast biogeographic and evolutionary hypotheses and to detect centers of origins and dispersion in the Southern Hemisphere. In this contribution, we will present an integrated timeline focused on the current state of our knowledge about the Tierra del Fuego paleofloras (macrofossils and palynology) from their discovery to the present.

30/05/2024, 15:10–16:30, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-348 - Neogene marine incursions in the Western Amazonia disclosed by palynology from boreholes in the Marañon Basin, Peru

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4 Centro de Investigaciones Científicas y Transferencia de Tecnología CICYTTP-CONICET-ER-UADER-, Laboratorio de Palinoestratigrafia y Paleobotanica, Diamante, Argentina
5 Perupetro, Departamento de Exploración, Lima, Peru

Palynological analyses were carried out on seventy-seven cutting samples from Arabela-1X, Maynas-1, Tucunare-1X, Tigrillo-30X, Nahuapa-24X, and La Frontera-1 boreholes in the Marañon Basin, north-eastern Peru with the aim of investigating Neogene marine

incursions. The palyno-assemblages including spores, pollen, freshwater algae, fungi and marine palynomorphs as dinoflagellate cysts, micro foraminiferal test linings, copepod eggs, oligohaline algae and others as amorphous organic matter and debris are significant to recognize four marine incursions events revealing four marine events characterized by four maximum flooding surfaces and separated by intervals of continental sedimentation in the Marañon basin. The first one (ME-1) during the Aquitanian and Early Burdigalian 23/20–17 Ma (all wells), the second (ME-2) during the Late Burdigalian 17–16.8/16.9 Ma (Arabela-1, Maynas-1); 17–16.1 Ma (Tucunare-1, Tigrillo-1, Nahuapa-24X, La Frontera-1), a third marine incursion event (ME-3) occurred during latest Burdigalian to latest Serravallian in three wells at 16.1–11.9 Ma (Maynas-1), 16.1–13 Ma (Nahuapa-24X), 14–11.6 Ma (La Frontera.1). A fourth marine incursion (ME-4) Tortonian to Messinian event was recorded only in southernmost La Frontera-1 well at 11.6–5.48 Ma culminating in mangrove environment at Zanclean time (~5.5–3.6 Ma). Potential pathways for ME-1 to M-3 are from the West through the Marañon portal or from the North through the Llanos-East Venezuela portal and are related to the Proto Pebas and Pebas systems. The ME-4 marine event probably came from the South through the Paraná portal and is related to the Acre phase. Contrary to previously thought, our data suggest that Miocene shallow marine incursions in Western Amazonia are not short-lived features and have affected the proto Pebas and the Pebas system during most of their time life. This may suggest that these marine incursions may have acted as a long-lived barrier to species dispersion and might have played a prominent role triggering the Miocene biodiversity in Western Amazonia.

30/05/2024, 15:10–16:30, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-349 - Latitudinal gradients in Miocene macrofloras of southern South America

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Plant fossils are key sources of evidence for reconstructing the evolution of terrestrial biomes. Plants are more susceptible to the effects of climate change because their ability to move to more favorable climates is constrained, resulting in a phenomenon known as “migration lag” The climate of South America was affected by significant changes during the Miocene, among them the uplift of the Andes, the rise of the Isthmus of Panama, and the final stages of the opening of the Drake Passage. These geological events had profound impacts on terrestrial and oceanic environments that shaped current ecosystems and drove the evolution of plant and animal clades. Unfortunately, only a few Miocene macrofossil floras have been described from southern South America; thus, inferences about its Miocene vegetation are based largely on palynological data. We compare a suite of Miocene macrofloras along a latitudinal gradient (25° to 53°S) to determine their taxonomical, biogeographical, and paleoclimatic similarities and differences. We identified four zones that show a latitudinal gradient among these Miocene floras. The paleofloras of zone 1 (low latitude) are characterized by the lack of gymnosperms, with dominant elements that are indicative of drier ecosystems, such as the typical monte and chaco vegetational types. The other three zones are characterized by paleoassemblages composed of two Southern Hemisphere gymnosperms (Araucariaceae and Podocarpaceae), and angiosperms, with the dominant angiosperm being the iconic genus *Nothofagus* and Myrtaceae as the second most abundant component. These paleoassemblages of zones 2 to 4 are typical of the Valdivian forests. This preliminary study confirms the need for more investigations on southern South American Miocene macrofloras. Additionally, comparisons are needed with Australian and New Zealand Miocene floras to understand the Miocene vegetational history of the Southern Hemisphere.

30/05/2024, 15:50–16:30, Room: Nadir
T04 The evolution of plant diversity under palaeoenvironmental changes in the Qinghai-Tibetan Plateau Region

O-351 - Vegetation and environmental changes in the central Tibetan Plateau since the Last Deglaciation

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The central Tibetan Plateau is located in the monsoon and westerly transition zone, which is a sensitive area for vegetation and climate change response. PCA analysis of surface pollen showed that Cyperaceae (Cy), Poaceae (P), *Artemisia* (A), Chenopodiaceae (C) were significantly controlled by humidity. Based on this, the Cy / (P+A+C) ratio was constructed as a reliable pollen humidity

index. The paleovegetation and paleoclimate in the central Tibetan Plateau since the last deglaciation were reconstructed by pollen study of Cuona Lakes core. The results of pollen studies showed that the vegetation in the central part of the Qinghai-Tibet Plateau during the last deglaciation period was alpine grassland dominated by *Artemisia* and Poaceae, and the ratio is low, reflecting cold and dry environment and representing the climate of the last glacial period. After the Holocene, the alpine meadow vegetation was dominant, and the ratio increased, indicating that the humidity increased and reached the best period in the early Middle Holocene, and then the humidity decreased. In the late Holocene, the ratio began to rise slowly and continued until 630 cal yr BP, indicating that the humidity in the region began to rise again. The condition of late Holocene humidity change trend obviously did not conform to the monsoon region model, but is very similar to the humidity change pattern in the core area of the westerlies. Therefore, we believe that the central part of the Qinghai-Tibet Plateau was affected by the westerly wind in the late Holocene, and the humidity did not continue to decrease, but gradually became wet. This study reconstructed the paleovegetation and paleoenvironment of the central Tibetan Plateau since the last deglaciation, and revealed the interaction process of monsoon and westerly in this area, which providing a new evidence for the study of monsoon and westerly interaction.

30/05/2024, 16:10–16:30, Room: Taurus
M06 Morphological disparity and evolution in the plant fossil record

O-352 - Morphometrics of modern and fossil Poaceae pollen from South America

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5 Donald Danforth Plant Science Center, Donald Danforth Plant Science Center, Saint Louis – Missouri, USA

Poaceae (the grass family) is one of the most diverse angiosperm families on Earth, comprising close to 12,000 species. The history of grass-dominated biomes extends back over 20 million years, yet the spatial and temporal development of these biomes and the underlying drivers remains unresolved. We address these questions in South America by investigating a series of modern grass pollen and ancient samples dating from the early Miocene to the present. The study reveals several key points: (i) Grass pollen size varies significantly both among genera and species and within species. Pollen size shows no correlation with (a)biotic factors, indicating its limited utility as a generally applicable proxy for reconstructing past vegetation and climate; (ii) Grass pollen exhibits a highly diverse surface ornamentation. The morphotypes identified by descriptive terminology are well-supported by a combination of SEM images of pollen surface patterns and computational image analysis. The findings reveal that pollen sculpture is unrelated to (a)biotic variables but is diverse across the phylogeny; (iii) Tropical grass pollen morphology suggests a gradual rather than punctuated evolution, based on the trend toward a less dense ornamentation of the exine since c. 23 Ma. We hypothesize that changes in the exine of grass pollen since the early Miocene were driven by evolutionary processes (evolutionary drift and/or directional selection), and potentially migration at the continental scale. The high diversity in surface ornamentation is likely related to their evolutionary success in the Neogene. This is the first time that the true morphological variation in Poaceae pollen becomes apparent.

O-353 - Plant fossil cuticle as a possible palaeo-Hg proxy? Implications from Hg concentration data on both extant Ginkgo L. and extinct ginkgoaleans

Li Zhang[1], *Yongdong Wang*[1], *Micha Ruhl*[2], *Emma Blanka Kovács*[2], *Yuanyuan Xu*[1], *Yanbin Zhu*[1], *Ning Lu*[3], *Hong-Yu Chen*[1]

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3 *Shenyang Normal University, College of Paleontology, Shenyang, China*

Vegetation leaves have long been considered a significant receiver of gaseous Hg in the atmosphere, offering the potential to passively monitor paleo-atmospheric Hg concentrations. Despite this potential, the idea has been discussed very little. In this study, we conducted Hg measurements on two *Ginkgo* leaf collections: one containing leaves from ten sampling sites across China, and the other comprising leaves collected monthly for one year in Nanjing. The results reveal that the foliar Hg concentrations in this study (an average of 61 $ng \cdot g^{-1}$, $N = 272$) are higher than those observed in previous *Ginkgo* leaf samples collected from Ireland or the USA. Additionally, the study suggests that leaf age and atmospheric Hg concentration are two primary factors impacting foliar Hg contents in *Ginkgo*. These results prompted further investigations into fossil ginkgoaleans. Hg concentrations in fossil cuticular samples (avg. 585.5 $ng \cdot g^{-1}$) were observed notably higher than those in modern *Ginkgo* leaves (avg. 61 $ng \cdot g^{-1}$) and sediments from the same layers (avg. 113 $ng \cdot g^{-1}$). Consideing possible Hg migration during fossilization, we suggest that the elevated Hg concentrations in fossil cuticles are attributed to both the retention of Hg in leaves and the loss of leaf content during fossilization. Based on 23 fossil ginkgoalean samples from 6 beds of the Dameigou section (spanning from the Early to the Middle Jurassic), Qaidam Basin, China, we detected an Hg anomaly through Hg concentrations in fossil cuticles during a presumed paleo-volcanic event. This preliminary test supported that variations in Hg concentrations in fossil cuticles could potentially reflect the gaseous Hg changes in the paleo-atmosphere triggered by paleo-volcanism, highlighting the possibility of using fossil plant cuticles as a Hg proxy of the paleo-atmosphere.

O-354 - A quantitative palynological study of the Carnian successions, Upper Triassic in the Glamoč unit (Southwest Bosnia and Herzegovina)

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2 *Vienna University, Department of Palaeontology, Vienna, Austria*
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During the Carnian Period of the Late Triassic, the widespread dry climate is supposed to be interrupted by abnormally humid climate fluctuations. This humid period was called the Carnian Pluvial Episode. The Carnian sequence is exposed continuously in the Glamoč area of Bosnia and Herzegovina, which covers the parts of Julian I, Julian II, and Tuvalian I - III. The palynostratigraphic assemblage zones are calibrated with marine biochronology based on ammonoids and conodonts and correlated with a bulk C-isotope curve. The palynomorphs are well preserved, providing important material for exploring climate changes during the Carnian. A comprehensive and quantitative study on palynology has been conducted here. A total of 121 species in 72 genera of the spore and pollen taxa together with some other palynomorph categories were identified, including 3 genera of Acritarchs and 2 genera of algae. Based on the quantitative palynological analysis, three palynological assemblages were divided from bottom to top: 1. *Enzonalsporites-Taeniaesporites-Samaropollenites* assemblage zone, with an age of approximately Julian 1–2; 2. *Vallasporites-Aulisporites-Camerosporites* assemblage zone, with an age of approximately Tuvalian 1–2; 3. *Classopollis-Granuloperculatipollis* assemblage zone, Tuvalian 3.

Paleoclimatic analyses using sporomorph ecogroup (SEG) model and hygrophyte/xerophyte ratio show that the climate was generally warm and semi-arid. Palynomorph assemblages do not show a pronounced change to a more humid climate as suggested in the Carnian Pluvial Episode (CPE) scenario. This may be related to the palaeogeographic position and depositional sedimentary setting of this record. Besides, climate change during the CPE may have been much less uniform than previous studies suggested.

30/05/2024, 17:00–19:00, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-355 - Palaeoenvironmental analysis of the Late Triassic in the Barents Sea: Plant community changes leading into the End-Triassic-Extinction

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The Barents Sea in Arctic Norway contains thick sedimentary successions spanning the entire Triassic Period. These strata offer a continuous record of plant evolution and palaeoenvironmental change in the Triassic. This provides an opportunity to observe changes in the plant community leading up to the End-Triassic-Extinction (ETE). The effects of the ETE have been observed in areas such as Greenland and the Germanic Basin and show a clear shift in the dominant plant groups. This study analysed 44 palynological samples from well 7219/12–1 spanning a 52-meter section of the Late Triassic in the southwestern Barents Sea (Ringvassoy-Loppa Fault Complex). The samples encompass 52m of the Late Triassic (Snadd, Fruholmen and Tubaen Formations), containing 3 distinct lacustrine sections with oil-rich sandstones interspersed. A sampling frequency of 0.5m was utilised within the lacustrine sections. The dense vertical sample distribution enables a detailed palynological investigation of the Late Triassic of the area, focusing on key palynological assemblages and their implications for paleoclimatology and vegetation dynamics. The assemblages from this study are compared to previous palynological studies from the Barents Sea and North Sea to gain more understanding of the Triassic climate and depositional settings along the margins of Fennoscandia. They also allow a window into the resilience and adaptability of plant life in the face of severe environmental challenges.

30/05/2024, 17:00–19:00, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-356 - Late Cretaceous (Campanian) bryophyte flora: A permineralized moss from James Ross Island, Antarctica

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Four specimens of an anatomically preserved moss gametophyte have been discovered in a calcium carbonate concretion from the “Baculites Hill” locality, James Ross Island, Antarctica. The concretion is derived from the Late Cretaceous, Beta Member of the Santa Marta Formation, dated as early to middle Campanian (ca. 80 Ma). The moss has actinomorphic stems with alternate branching, spiral, patent leaf arrangement and large numbers of attached rhizoids. Stems are 210 µm in diameter with the largest branch measuring up to 3.7 mm long and 90–100 µm wide. Most stems appear to contain a distinct conducting strand. Cross sections show that the leaves are strongly plicate with a simple D-shaped costal anatomy and unistratose laminae typically with bistratose margins. Leaves range from 650–700 µm wide and at least 700 µm long. The costa appears percurrent, 90 µm wide and 55 µm thick. Laminar cells are elongate, rhomboidal, L/W= 5:1. No ornamentation or papillae have been observed on the upper medial cells of the leaf. These fossils show morphological similarities to several orders of acrocarpous mosses, in the Dicranidae including species of the Grimmiales, Dicranales and Pottiales with respect to leaf morphology and costal anatomy. While these characters do not fit into any known genus, they suggest that this moss might represent a basal member of the clade.

30/05/2024, 17:00–19:00, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-357 - Why is the Cretaceous rich in resin, but not the Jurassic?

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Amber (fossilised plant resin) is best known for its exceptional preservation of organisms (inclusions). Amber itself is a chemofossil as it can retain information about its original botanical source. Amber occurs as four amber 'bursts' in the fossil record, with minor exceptional occurrences outside of these times. The Cretaceous is one of these amber bursts and is very rich in amber deposits, many of which are highly fossiliferous. The amber deposits are mainly found from the Barremian to Cenomanian. This contrasts sharply with the Jurassic that is almost devoid of amber, despite the presence of the presumed same amber source plants (Cheirolepidiaceae, Araucariaceae) in both periods.

As palaeobotanists, the two biggest amber-related mysteries are (1) identifying the actual botanical source for each amber deposit, and also to be able to evaluate whether there is more than one potential botanical source per deposit, and (2) is understanding why the plants exuded the resin in significant amounts or not, and the role of taphonomy in amber bursts or absences.

There is accumulating evidence that relying on amber chemistry alone is not sufficient to determine the botanical source for Mesozoic ambers. This is due to their actually highly similar chemistries meaning that we cannot distinguish ambers deriving from very different plant sources. This is at odds with the fact that most Cretaceous ambers are thought to have either an Araucariacean or Cheirolepidicean source, based on associated palynolgical or macrofossil remains. We will look at this issue deeper and try to understand why the preceeding Jurassic has an amber gap.

30/05/2024, 17:00–19:00, Room: Aquarius
C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

O-358 - Changes on palynoflora and paleoclimate during the latest Cretaceous in Jiaolai Basin, eastern China

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Cretaceous-Paleogene boundary (K-Pg boundary) has been a long-time hot topic in geoscience. The global scale and abruptness of the major biotic turnover at the K-Pg boundary was widely recognized by paleontologists. Pollen analysis can be an important index marking the K-Pg boundary. The LK1 core in Jiaolai Basin, Shandong Province provides us the possibilities looking for the paleoclimatic clues during Late Cretaceous, especially around the K-Pg boundary. Detailed palynological study, accompanied with analysis on integrated chemical weathering indices, were carried out on the LK1 core. Abundant sporo-pollen fossils were yielded from 16 samples of LK1 core, three palynological assemblages can be identified from bottom top. Zone I (*Schizaeoisporites-Classopollis-Tricolpopollenites* assemblage), Zone II (*Ulmoideipites-Aquilapollenites- Tricolporopollenites* assemblage) and Zone III (disaccate pollen-*Ulmoideipites-Aquilapollenites* assemblage). The palynomorphs in Zone III showed typical transitional characteristics from Mesozoic to Cenozoic, and the geological age should be the latest Maastrichtian. A significant cooling event can be observed in the 518.5 m – 515.3 m interval according to the geochemical results, which was supposed to be the response of the "impact winter" caused by the meteorite impact during the latest Cretaceous. The Cretaceous/Paleogene (K/Pg) boundary in LK1 core should be located shortly above assemblage Zone III (515.4 m).

30/05/2024, 17:00–19:00, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-359 - Palynology in Colombia, advances in the Cenozoic from the Caribbean area

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In Colombia, the study of palynology began in the 1950s. Although a substantial number of palynological publications exist in Colombia (approximately 111 articles in indexed journals), most are concentrated in areas related to petroleum exploration, such as the Llanos Orientales, Piedemonte Llanero, Valle del Magdalena, Cordillera Oriental, and Catatumbo. However, much data cannot be disclosed due to the confidentiality inherent in the industry, resulting in areas of the country with restricted or limited information. In the Colombian Caribbean region, the Sinú-San Jacinto basin (SSJB) has been considered a frontier basin and has undergone thorough study over the past decade, presenting a unique opportunity to fill the knowledge gap. The University of Caldas, the Instituto de Investigaciones en Estratigrafía (IIES), the Agencia Nacional de Hidrocarburos (ANH), and the Ministry of Science and Technology of Colombia, has designed a program allowing the publication of a significant portion of the data obtained in the last decade of research.

The palynological study of a composite section of 14 cores drilled from SSJB (NW South America) provides for the first time a Cenozoic palynostratigraphic zonation scheme for this region. In addition, the study of calcareous nannofossils and planktonic foraminifera allowed an independent calibration of the palynomorph assemblages to the international chronostratigraphic chart. Twelve late Paleocene-Pliocene palynological zones are proposed for the Caribbean, some of which differ from those proposed for the Llanos and Llanos Foothills basins. Variations in the biostratigraphic ranges of some palynomorphs, new species with stratigraphic value are described. High diversity and abundance of dinoflagellates cyst in some stratigraphic intervals require more detailed study. Evidence of reworking in some stratigraphic interval makes it necessary to be careful about the last appearance record if microfossils in exploration and geologic mapping.

30/05/2024, 17:00–19:00, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-360 - The Austral Antarctic Forest during the Early Eocene Climatic Optimum – Biogeography, diversity and the fate of polar lineages

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The biogeographic patterns evident in the floras of the Southern Hemisphere have long fascinated naturalists. To explain these patterns, hypotheses have been proposed that invoke either vicariance through Gondwana's break-up or long-distance dispersal.

The fossil plant assemblage of the Macquarie Harbour Formation (MHF) in Tasmania, southeastern Australia, offers a unique window into this complex puzzle. Situated at subpolar palaeolatitudes (65–70°S), and dating back approximately 53–50 million years to the Early Eocene Climatic Optimum (EECO), it represents one of the oldest post-Cretaceous plant assemblages in Australia. Importantly, it predates the final break-up of Australia while Tasmania formed the last land connection to Antarctica.

We present new data from a near-polar forest, including systematics, diversity and ecophysiological adaptations to the high latitudes. Furthermore, we reveal taxon- and ecosystem-scale biogeographic patterns across the Southern Hemisphere.

We identified at least 10 conifer species (e.g., *Araucaria*, *Araucarioides*, *Retrophyllum*, *Podocarpus*), two cycads (*Bowenia, Pterostoma*), one fern (*Lygodium*), abundant remains of the relict umkomasialean 'seed fern' (*Komlopteris*) and several angiosperms (e.g., *Nypa*, *Ripogonum*, and Australia's oldest *Eucalyptus*).

Intriguingly, many of these taxa are extant relicts with small populations in Australasia (mostly tropical Oceania) and South America (mostly the neotropics), often confined to high-altitude and/or humid habitats. The presence of these lineages in the early Eocene

assemblages of South America and Australia, as well as the Palaeocene of Antarctica, demonstrates a continuous extent of the Austral Antarctic Forest, thus favouring the vicariance hypothesis for many taxa that are today shared between these continents.

Furthermore, the assemblage contains extinct lineages, Mesozoic relicts, such as *Araucarioides* and *Komlopteris*, that appear to have had a Gondwana-wide distribution. We correlate their extinction with northward continental migration, and the rise of the Andes in South America, which led to significant aridification, changes in insolation and an increased competition with angiosperms.

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T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-361 - Andean Paleoclimate: Early – Middle Miocene of Chucal Formation (18 °s, Chile)

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The Chucal Formation is a sequence of sediment outcrops in the high Andes of Chile (18 °S). It is ~ 600–450 m thick and composed of sandstone, conglomerate, and mudstone, with numerous pyroclastic intervals. Depositional environments include lacustrine facies and coarse fluvial sediments with abundant fossil records of mammals, pollen, and leaf remains. The mammal's fossil record discovered so far includes taxa of relatively open dry habitats. Previous palaeobotany fossil records suggest lowland subtropical forests with long-distance dispersed *Nothofagus* pollen grain. However, no quantitative climate estimate or climate-leaf physiognomy analysis has been conducted. The Chucal Formation spans ~21 Ma to 16 Ma. when the central Altiplano plateau had a low elevation (<1,500 m.a.s.l.), as suggested by paleo altitude estimates, it is coetaneous with the Potosí fossil flora in Bolivia (20 °S) that, in turn, shows the presence of lowland semiarid vegetation with a mean annual temperature estimate of 21 ºC and mean annual precipitation of ~ 500 mm. We hypothesize that the pre-Quaternary Altiplano plateau uplift and warm/high CO2 Late Miocene-Pliocene Climate triggered the birth of the Puna Biome, predicting the presence of lowland semiarid vegetation in the Chucal Formation with a climate that will be semiarid-with-annual-temperature ~20 ºC and annual precipitation >200 mm. The availability of late Neogene geological analogues in the Chilean Altiplano offers a unique opportunity to understand the response of the high Andes biota to the challenging future climate changes. In this work, we present the first paleoclimate estimations on the Chucal Formation using both Leaf physiognomy analysis and Climate leaf analysis multivariate program to estimate paleoclimatic parameters using a regional (South American physiognomy dataset) and a global dataset (CLAMP3b SA). These methods are based on the well-known relationship between leaf morphology and Climate.

Acknowledges: FONDECYT 1221214

30/05/2024, 17:00–19:00, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-362 - Evidence for a warm Eocene in the southern high latitudes: A new macroflora from Seymour Island, Antarctica

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Situated on the northern Antarctic Peninsula the La Meseta Formation of late early Eocene to late Eocene age contains an unparalleled record of plant life from the southern high latitudes. The sediments accumulated in a shallow marine estuarine environment with material derived from an emergent continental island arc system to the west. Here we report a new macroflora that recorded a presumed short-lived warm interval where species normally associated with more northerly regions in southern South America were able to colonise the Antarctic. The flora contains an abundance of large *Nothofagus* leaves that are similar to those seen in *Nothofagus* section *Brassospora*, and fragments of palm leaves.

30/05/2024, 17:00–19:00, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-363 - The Miocene Ethiopian record of a cryptogam community in amber

Valentine Bouju[1], *Kathrin Feldberg*[2], *Ulla Kaasalainen*[2], *Alfons Schäfer-Verwimp*[3], *Lars Hedenäs*[4], *William R Buck*[5], *Bo Wang*[6], *Blazej Bojarski*[7], *Jacek Szwedo*[7], *Vincent Perrichot*[8], *Alexander Schmidt*[2]

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Botanical specimens fossilized in plant resin display a high resolution and three-dimensional preservation state. This enables the observation of fine morphological structures, making amber an exceptional source of past flora diversity.

As most part of the fossil record, regardless of the fossilization mode, amber deposits are mostly known from the Northern Hemisphere. The disparity in the amber record distribution can be explained by limited exploration and/or limited access to the fossiliferous layers in the Southern Hemisphere. In the last decades, two new amber deposits have been reported in the Cretaceous of Congo and the Miocene of Ethiopia. These are the first fossiliferous ambers known from Africa.

When it comes to the investigation of amber inclusions, one can notice that the arthropod diversity is more extensively described than that of the botanical inclusions. This can be explained by a lesser abundance (if not scarcity) of plant inclusions compared to that of arthropod specimens in most of the known amber records. In some cases, it also illustrates a primary focus on the arthropod specimens at the expense of the botanical record. Nonetheless, in most of these cases, the botanical record now benefits from extensive investigation and greatly contributes to our understanding of the environmental context of amber forests.

From Miocene Ethiopian amber, numerous arthropod inclusions have already been described. The amber is also rich in botanical inclusion, particularly cryptogam specimens. A published description of an assemblage of mosses, liverworts, and a lichen provided a first insight into this cryptogam community (Bouju et al., 2022). Here we further describe this assemblage and provide updates on its paleoenvironmental implications and geological context, in the light of supplementary studies of palynological specimens, associated arthropod inclusions, and field observations.

Bouju et al. 2022. Miocene Ethiopian amber: A new source of fossil cryptogams. *Journal of Systematics and Evolution*, *60*(4), 932–954.

30/05/2024, 17:00–19:00, Room: Leo
T05 Insights on Southern Hemisphere Cenozoic Paleobotany

O-364 - Late Miocene woodlands in the Peruvian desert

Diana Ochoa[1,2], *Juan-Felipe Montenegro*[2], *Dayenari Caballero-Rodríguez*[3], *Oris Rodriguez Reyes*[3,4], *José-Abel Flores*[1], *Matthieu Carré*[2,5]

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Coastal xeric ecosystems face a major threat under the current global warming trend. Changes in water availability and precipitation patterns can contribute to the development of new landscapes and affect existing biotic interactions. The late Miocene, characterized by warm climates and comparable pCO2 values (~400–600 ppm), presents an opportunity to understand future warming

scenarios for dry coastal ecosystems. In this study, we present the first-known late Miocene paleobotanical record from the Peruvian coast, where a vast desert is found today. Recalibrated leaf-based precipitation estimates indicate that coastal rainfall values were 5 to 10 times higher than today; while significant wetter conditions compared to the present existed on the western slopes during the austral summer. The combined paleobotanical record reveals a diverse community dominated by elements typical of modern dry forests rather than desert-like habitats, including a mixture of lowland and Andean wooded taxa. These findings suggest a substantial shift in the ecosystem that allowed the development of a greener woodland landscape along the central Peruvian coastal region during the warmth of the late Miocene. Although the sources of extra humidity remain uncertain, warmer sea surface temperatures in the eastern Pacific and local convection may have contributed to the additional moisture. Moreover, intensified or even a permanent El-Niño state during the warmer late Miocene could have potentially served as an additional moisture source. Regardless of the mechanism, our results provide compelling evidence of reduced aridity, leading to a greening of the coastal Peruvian desert and large-scale biome and landscape changes in response to the Miocene greenhouse climate.

30/05/2024, 17:00–18:40, Room: Nadir

T04 The evolution of plant diversity under palaeoenvironmental changes in the Qinghai-Tibetan Plateau Region

O-365 - The evolutionary history of plant diversity in central Tibetan Plateau from the late Oligocene to the early Miocene

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The Tibetan Plateau experienced a complex geological evolution, leading to dramatic paleoenvironmental changes both locally and regionally, which has caused a profound influence on the biodiversity and vegetation pattern. Numerous geological and paleontological studies revealed that there existed an East-West trending valley in central Tibetan Plateau during the Paleogene, where subtropical forests grew in the then warm and humid climate. With the continuous convergence of the Indian and Eurasian plates, the central valley of Tibetan Plateau rose gradually, and until today, forming a landform with high altitude and low relief, where the vegetation is dominated by alpine steppe. Understanding how the vegetation of central valley evolved from once moist forests to alpine steppe today is crucially important for comprehending the evolutionary history of plant diversity and Earth's environment. In this study, the vegetation of central Tibetan Plateau was reconstructed by well-preserved phytolith assemblages found in the strata of Lunpola Basin. From the late Oligocene to early Miocene, broadleaved species reduced, while gymnosperms began to flourish, accompanied with abundant understory grasses belonging to Pooideae. This represents a mixed coniferous and broad-leaved forest vegetation, which is also supported by the megafossils found in the sediments. Combined with isotope study, this study shows that regional aridification and cooler environment, which was caused by the uplift of central Tibetan valley, may have promoted the development of mixed coniferous and broadleaf forest during the late Oligocene to early Miocene.

30/05/2024, 17:00–18:40, Room: Nadir

T04 The evolution of plant diversity under palaeoenvironmental changes in the Qinghai-Tibetan Plateau Region

O-366 - Vegetation changes across the Eocene-Oligocene transition: Global signals vs. regional development in Eurasia

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The Eocene–Oligocene transition (EOT, 34.44 – 33.65 Ma) is one of the most important climatic transitions associated with global cooling during the Cenozoic. Influenced by factors such as tectonic activity and paleogeographic configurations, the magnitude and impact of regional climate change on paleoecosystems during this transition showed considerable variation. We examined nine macrofossil assemblages from seven fossil localities ranging from the latest Bartonian and Priabonian (37.71–33.9 Ma) and Rupelian (33.9–27.82 Ma) on the southeastern margin of the Tibetan Plateau and mid-latitude Europe. The two regions represent of the high-altitude montane zone and the low-altitude near-sea zone to global climate change in the late Eocene and early Oligocene respectively. We reviewed the fossil records in general level, applied Integrated Plant Record (IPR) vegetation analysis to detect vegetation types and Trait Combination Types (TCT) to trace the leaf architectural characters. Paleoclimate parameters derived from

the Climate-Leaf Analysis Multivariate Program (CLAMP) were reviewed to study the drivers of changes in floristic heterogeneity. The results showed that percentages of the broad-leaved evergreen component decreased and general change in the overall type of vegetation is from broad-leaved evergreen forests in the late Eocene to broad-leaved deciduous forests or mixed mesophytic forests in the early Oligocene. The simultaneous increase in the percentage of deciduous taxa is interpreted as an adaptation to the increasing temperature seasonality towards the early Oligocene. Global cooling at the EOT led to a decrease in mean annual temperature and an increase in mean annual temperature range at the southeastern margin of the Tibetan Plateau and in mid-latitudinal Europe. Sea-level changes in mid-latitudinal Europe and the uplift of the Tibetan Plateau have led to heterogeneous response in paleovegetation and leaf architecture in these two regions.

30/05/2024, 17:00–18:40, Room: Nadir

T04 The evolution of plant diversity under palaeoenvironmental changes in the Qinghai-Tibetan Plateau Region

O-367 - Abrupt greening of the desert in Central Asia at the Paleocene-Eocene Thermal Maximum (PETM)

Amber Woutersen[1], *Niels Meijer*[2], *Faez Robin-Champigneul*[3], *Julia Gravendyck*[4], *Hanna van den Hil*[5], *Amaia Villagrasa*[3], *Roy Erkens*[3], *Natasha Barbolini*[6], *Guillaume Dupont-Nivet*[7], *Carina Hoorn*[1]

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During the early Eocene global greenhouse conditions dominated the Earth's climate. In Central Asia evidence for these conditions is provided by the sedimentary record of the Xining Basin, situated on the North-eastern Tibetan Plateau (China). This basin holds an extensive and well-dated Paleogene (c. 66 to 34 Ma) sedimentary sequence, which shows a large negative isotope excursion at the PETM (56 Ma) indicating high temperatures and temporal doubling of rainfall during the early Eocene. The sedimentary record also contains abundant fossil sporomorphs (i.e. pollen and spores) that enabled us to reconstruct past vegetation composition. The palynological record shows that during the PETM broadleaved forest trees and ferns increased in abundance and diversity, leading to a (temporal) partial replacement of the dominant steppe-desert vegetation by a forested ecosystem. Furthermore, the sediments contain conifer pollen, suggesting a northward expansion of southern hemisphere-temperate forest taxa. The palynological record thus shows that increasing temperatures and precipitation lead to an abrupt greening of the Central Asian deserts, and alter species composition in this region. Learning more about the non-linear responses of the Central Asian interior in the past, will help us to better understand its reaction to future changes. For more information, see Robin-Champigneul et al. (2023) https://doi.org/10.1016/j.revpalbo.2023.104914.

O-368 - Cenozoic plants from Tibet: An extraordinary decade of discovery, understanding and significance

Zhekun Zhou[1], *Jia Liu*[2], *Linlin Chen*[3], *Robert Spicer*[4], *Shufeng Li*[2], *Jian Huang*[3], *Shi-tao zhang*[5], *Yong-jiang Huang*[6], *Lin-po Jia*[6], *Jin-jin Hu*[6], *Tao Su*[2]

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Within the last decade, paleobotanical investigations within the Tibet Region have led to a paradigm shift in our understanding of how the present plateau formed and how this affected the regional climate and biota. This is because: 1) Numerous new taxa have been reported. Of all the Cenozoic records of new plant fossil species reported from the Tibet (Xizang) 46 out of 63 (73%) were documented after 2010. Among these, many represent the earliest records from Asia, or in some cases worldwide. 2) These fossils show that during the Paleogene, the region now occupied by the Tibetan Plateau was a globally significant floristic exchange hub. Based on paleobiogeographic studies, there are four models of regional floristic migration and exchange, i.e., into Tibet, out of Tibet, out of India and into/out of Africa. 3) Plant fossils evidence the asynchronous formation histories for different parts of the Tibetan Plateau. During most of the Paleogene, there was a wide east-west trending valley with a subtropical climate in central Tibet bounded by high (> 4 km) mountain systems, but that by the early Oligocene the modern high plateau had begun to form by the rise of the valley floor. Paleoelevation reconstructions using radiometrically-dated plant fossil assemblages in southeastern Tibet show that by the earliest Oligocene southeastern Tibet (including the Hengduan Mountains) had reached its present elevation. 4) The coevolution between vegetation, landform and paleoenvironment is evidenced by fossil records from what is now the central Tibetan Plateau. From the Paleocene to Pliocene, plant diversity transformed from that of tropical, to subtropical forests, through warm to cool temperate woodland and eventually to deciduous shrubland in response to landscape evolution from a seasonally humid lowland valley, to a high and dry plateau.

O-369 - Changing environment in the western Bengal Basin, India during Eocene to Pliocene: A palynological approach

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The westernmost part of the world's largest geosynclinal basin, the Bengal Basin is situated in the West Bengal Province, India. Based on the recovered palynofloral assemblages consisting of both pollen and non-pollen palynomorphs from seven Bore holes (PGD 1, 4, 5, 6, 7, 8 and 9), six palynoassemblage zones namely, Bengal Cenozoic Palynological Assemblage Zones-I to VI (BCPAZ-I to VI) are identified. The BCPAZ-I having dominance of *Palmaepollenites, Araliaceoipollenites, Psilodiporites* represents nearshore deltaic depositional environment during Middle to Upper Eocene; BCPAZ-II dominated by *Spinizonocolpites, Couperipollis, Longapertites* indicates back mangrove swampy environment having fresh water influence during Oligocene in the area. In BCPAZ-III sub-tropical-temperate taxa like *Pinuspollenites* and *Laricoidites* indicate influence of temperate climate during Early Miocene (Aquitanian) and appearance of dinocysts (*Achomosphaera, Spiniferites*) and microforaminifera (*Globoquadrina*, *Globigerinoides*) of shallow marine to marine environment suggests transgressional phase of the shoreline during deposition. BCPAZ-IV characteristically with tropical to sub-tropical brackish water and coastal elements and microthyraceaous fungal remains indicate deltaic mangrove environment having marine influence and high precipitation during Early Miocene (Burdigalian); BCPAZ-V characterized by higher frequency of dinoflagellates suggest strong marine influence during Middle Miocene (Langhian). Finally, in BCPAZ-VI sudden decline in dinoflagellates and increase in freshwater components indicate the initiation of shoreline regression during Late Miocene (Tortonian) to Pliocene. It is apparent that the freshwater back mangrove continental facies of deposition started to get submerged in sea during Aquitanian of Early Miocene and high-altitude forest elements started appearing perhaps due to the uprise of the Himalaya during this time. Subsequently, the area experienced marine retreat during Tortonian of Late Miocene to Pliocene.

Thus, the palaeoenvironmental dynamics inferred from the palynoassemblage analysis can be attributed to sea-level fluctuations experienced by the western margin of Bengal Basin during the time of deposition.

30/05/2024, 17:00–19:00, Room: Taurus
M06 Morphological disparity and evolution in the plant fossil record

O-370 - Structurally preserved rhizomes of osmundaceous ferns from the Triassic of Antarctica – An example of evolutionary stasis in Royal Ferns

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Osmundaceae (the Royal Fern family) is a rather primitive family of leptosporangiate ferns with a nearly worldwide distribution and an extensive fossil record dating back to the Permian. While there are only about 20 extant species belonging to six genera, over 150 species are known from fossil rhizomes, trunks, foliage and spores. Following a remarkable radiation during the late Paleozoic and early Mesozoic, Osmundaceae diversity declined and a noticeable anatomical stasis can be observed, as most taxa from the mid-Cretaceous onwards only differ in small details from extant species.

Here, we describe structurally preserved osmundaceous rhizomes from a silicified peat deposit in the Helliwell Formation (Middle to Upper Triassic) in the central Rennick Glacier area, northern Victoria Land, Antarctica. They belong to the genus *Claytosmunda*, marking only the second appearance of a rhizome of this genus in the Triassic. The rhizomes share similarities with both the extant Interrupted Fern (*C. claytoniana*) as well as *C. beardmorensis* from the Triassic of the Beardmore Glacier area, Antarctica. These new findings hereby not only link the hitherto poorly known *C. beardmorensis* to a modern-day species and help to resolve its systematic and phylogenetic position, but also demonstrate the remarkable evolutionary stasis of the Royal Fern group in general and the genus *Claytosmunda* in particular. Also, it supports the hypothesis that *Claytosmunda* may be the most primitive extant genus of the Osmundaceae family.

30/05/2024, 17:00–19:00, Room: Taurus
M06 Morphological disparity and evolution in the plant fossil record

O-371 - Changes in morphological disparity of angiosperm pollen across the Cretaceous–Palaeogene boundary in North America

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The Cretaceous–Palaeogene (KPg) mass extinction famously had a big impact on animals, while its effect on plants was apparently less severe, but non-negligible. Floral changes with varying magnitude and character have been reported from different localities. One possible explanation for these differences would be the distance to the Chicxulub impact site, especially in terms of latitude. Questions remain, e.g., regarding the selectivity of extinctions. The most complete records of vegetation across the KPg boundary are available from palynostratigraphic studies in numerous sections in North America (USA and Canada), which span a considerable range of latitudes. Most of these records represent angiosperm pollen. Here we present a network-based analysis of the morphological disparity of angiosperm pollen from these sections. The analysis uses an aggregated dataset of >5.000 previously published occurrences of Maastrichtian and Palaeocene angiosperm pollen taxa. Our aim is to test for changing patterns in morphospace occupancy, which could indicate selective extinction in general and links between reproductive biology and differences in resilience in particular.

30/05/2024, 17:00–19:00, Room: Taurus
M06 Morphological disparity and evolution in the plant fossil record

O-372 - Quantifying pollen morphology: A comparison of methods

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Sporomorphs (pollen and spores) have evolved into a wide variety of shapes and sizes, with a similarly broad range of wall structures and surface ornamentation. They are therefore an ideal test case for understanding the patterns and processes of morphological evolution. Most previous studies of sporomorph morphological evolution and diversity (=disparity) have been based on discrete character data, although some have used continuous characters or a mix of the two. Recent studies have also introduced the use of computer vision approaches for quantifying morphological information, including extraction of image features (i.e. size, shape and surface texture) and using learned feature vectors derived from convolutional neural networks. It is not yet known whether these different approaches capture similar patterns of morphospace occupation and disparity. To address this question, we use a dataset of 80 species from across the angiosperm phylogeny and compare two methods for quantifying pollen morphology: discrete character data, and extracted feature data from images generated by a Classifynder automated microscope system. We then use these two sources of data to compare the relative positions of taxa in ordinated morphospaces, and estimates of disparity through time and among groups of taxa. This research will shed light on how the methods used to generate morphological data influence our understanding of evolutionary dynamics, and the potential for high-throughput, automated imaging and data acquisition systems to generate data for macroevolutionary studies.

30/05/2024, 17:00–19:00, Room: Taurus
M06 Morphological disparity and evolution in the plant fossil record

O-373 - Evolutionary mysteries in the Plane Tree (Platanaceae) fossil record

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The sycamore or plane tree family (Platanaceae) is renowned for its fossil record, which dates back more than 100 million years and includes an incredible array of morphological diversity. However, the sequence of trait evolution in this family remains largely unknown. Here, I discuss some of my research on the family and some of the most compelling mysteries pertaining to its diversity and evolution. In particular, I focus on what we know about stipule evolution, the evolution of basilaminar lobes, compound leaf evolution, the diversification of lineages with unlobed leaves, the evolution of globose capitula, and transitions in inflorescence sexuality, flower symmetry, and evolutionary stability based on the fossil record of this plant family. Stipules, foliar and showy in modern *Platanus,* are unknown for many Platanaceae lineages; putative stipules are presented for *Macginitiea*. The developmental and evolutionary relationship between basilaminar lobes and stipules is uncertain, but consistent patterns develop between basilaminar lobes and typical leaf lobes. Compound leaves evolved in multiple lineages of Platanaceae, but the relationship between these lineages and to modern *Platanus* remains unknown. Elongate inflorescences like those in *Distefananthus* and *Tanyoplatanus* could represent a plesiomorphic condition preceding globose inflorescences. However, this presents further complications, since *Distefananthus* is associated with *Sapindopsis* leaves in the Dakota Formation, whereas *Sapindopsis* occurs with globose inflorescences at other localities. Morphospace approaches could be used to better quantify the transitions in this family's history. Phylogenetic analyses using morphology could help infer the sequence of evolution in this family, but this requires reconciling with many challenges, including how to interpret homology in a group known for hybridization and high intraspecific variation (polymorphism).

O-374 - Diversity, relationships, and adaptive morphology of the Mesozoic tricostate mosses

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Tricostate mosses are an entirely extinct group known exclusively from gametophytes possessing leaves with unique morphology, characterized by a central costa and two symmetric lateral costae that originate separately at the base of leaves. The stratigraphic range of tricostate mosses spans the Mesozoic and they are known from eastern Asia and western North America. The group currently consists of seven species: four species included in family Tricostaceae (which comprises two genera, *Tricosta* and *Krassiloviella*) and three species included in the genus *Tricostium*, whose relationship to family Tricostaceae is unknown. The Tricostaceae belong unequivocally in Supraorder Hypnanae and, within it, most likely in Order Hypnales. Their diversity is reflected in vegetative gametophyte morphology (leaf shapes and sizes, presence/absence of conducting tissues) and reproductive features (number of antheridia per perigonium). In contrast to the Tricostaceae, the affinities of genus *Tricostium* remain obscure, due to a lack of family-level diagnostic characters. Uncertainty about the relationships among tricostate mosses (whether monophyletic or otherwise) leaves unanswered the question of whether tricostate leaves, which are known only in these extinct mosses, have a single origin or have evolved convergently in different groups. Independent of this, we can assess the role of adaptive change in the evolution of tricostate leaves. Taken together, the habitats inferred for the different species of tricostate mosses and those that favor their closest morphological analogs among living mosses support the hypothesis that tricostate leaves evolved in response to the selective pressures of variable rheophytic conditions, to minimize leaf damage due to friction and to desiccation-induced shrinkage. The fossil record is likely to provide answers to many of the questions concerning the tricostate condition as additional tricostate mosses are currently studied and fossiliferous strata with good potential for preserving bryophyte fossils have been identified and will be targeted by future studies.

O-375 - A distinctive lycopsid megaspore assemblage from the Middle Triassic in Hunan Province, China

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Lycopsids played a pivotal role in the re-establishment of the terrestrial ecosystems during the aftermath of the end-Permian mass extinction. However, most previous investigations of the Triassic lycopsids have focused on adpressed macrofossils, with limited attention devoted to their dispersed megaspores. Given that lycopsids during this critical time interval are herbaceous and are not easily to be fossilised. Therefore, the diversity and the evolutionary history of lycopsids in the Triassic are less well understood. Recently, a total of 38 rock samples were collected from Member V of the Middle Triassic Badong Formation in Sangzhi County, Zhangjiajie City, Hunan Province, Central China. Standard palynological maceration method (HCl + HF) has been conducted on the rock samples, and seven types of dispersed lycopsid megaspores were recognized using an Ultra-Depth-Three-Dimensional microscope, a scanning electron microscope, and a transmission electron microscope. Morphologically, the present megaspore assemblage consists of one *Flabellisporites*-type, one *Narkisporites*-type, one *Otynisporites*-type, two *Trileites*-type, and two types that have yet to be assigned to certain genera, according to the extine ornamentation. Spore wall ultrastructure investigation indicates that most of the megaspores possess three layers, i.e., a foot layer comprising several parallel basal laminae, a thin and dense inner layer formed by stacked plate-like sporopollenin grains, and a thick and somewhat homogeneous outer layer. The distinctive characteristics of the spore wall are similar to some of the megaspores from the Devonian and Carboniferous but different from most of the Mesozoic megaspores. The morphological and ultrastructural characteristics, collectively, indicate that the present megaspore assemblage probably represents an enigmatic megaspore assemblage and differs from all known Mesozoic megaspore assemblages.

Keywords: Lycopsids, megaspores, wall ultrastructure, Badong Formation, Middle Triassic, Central China

30/05/2024, 17:00–18:40, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-376 - Early Pleistocene Glacial-Interglacial vegetation changes in Southwest Europe

Vasiliki Margari[1], *David Hodell*[2], *Joan Grimalt*[3], *Phillip Gibbard*[4], *Chronis Tzedakis*[1]

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Before 1.2 Ma, glacial-interglacial cycles occurred with a period of ~41 kyr, with maximum ice volumes ranging between one half and one third of the Last Glacial Maximum value. The smaller ice sheets and shorter glacial periods of the Early Pleistocene have been linked to smaller decreases in temperature and precipitation compared to the Middle and Late Pleistocene. A lengthening and intensification of glacial-interglacial cycles took place over the Early–Middle Pleistocene Transition (EMPT, ~1.25–0.70 Ma), after which ice volume varied with a dominant ~80–120-kyr periodicity. We present the results of joint marine-terrestrial analysis from core U1385 from the Portuguese Margin for two time-windows representing distinct climatic contexts: a 41-kyr cycle, MIS43–42 (~1.380–1.338 Ma) and one cycle from the early EMPT, MIS35–34 (~1.192–1.123 Ma) (1). The results show that both interglacial periods were characterised by the persistence of mild and relatively stable conditions with a mosaic of Mediterranean and temperate plant communities present on land. The evidence from the two glacials, however, reveals distinct differences. While MIS42 was short (~12 kyr) and relatively mild with residual woodland communities, MIS34 was a long glacial (~31 kyr) characterised by significant millennial-scale climate variability with a series of pronounced and increasingly colder stadial-interstadial oscillations. This culminated in a long terminal stadial comparable to the most extreme events of the last 400 kyr, with sea surface temperatures below 6 °C and steppe communities dominating on land. We suggest that the long duration of MIS34 promoted the intensification of glaciation, with ice sheets expanding beyond Scandinavia possibly for the first time. The subsequent deglaciation, sustained by extensive meltwater fluxes, led to AMOC weakening and the extreme conditions of the terminal stadial.

1. Margari et al. (2023). Extreme glacial implies discontinuity of early human occupation of Europe. *Science*, 381 (6658), 693–699, doi: 10.1126/science.adf4445.

30/05/2024, 17:00–18:40, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-377 - Global climate and regional tectonics as drivers of Early Pleistocene vegetation history in the Southern Caucasus

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The spatially complex area of the Southern Caucasus is a unique laboratory to study the regional impact of global climatic changes on vegetation. Pollen archives from the Armenian Highlands and western Georgian lowlands reflect the diversity of landscapes as well as the regional differences of Early Pleistocene Glacial-Interglacial variability.

In southern Armenia, pollen data provide detailed information on environmental changes during late Early Pleistocene. Due to a precise age control based on magnetostratigraphic and radiometric dating, high-resolution pollen analysis was conducted for a part of the sequence spanning from MIS 33 to MIS 30 with a mean resolution of ca. 250 years per samples. Results document a clear vegetation response on orbitally forced climatic changes with open vegetation during the less pronounced cycles MIS 33/34, the expansion of broadleaved deciduous forests during very warm and humid MIS 31, and the expansion of needleleaved forests during the long, cool and humid MIS 30. Furthermore, the age of the numerous macro floral assemblages could be constrained to warm and humid parts of the climatic phases, most of them connected to MIS 31 confirming the expansion of forests at that time. Climate quantifications point to several degrees warmer and clearly more humid conditions for the most pronounced interglacials.

At the same time, pollen data from western Georgia lowlands show no change in vegetation cover despite some fluctuations in pollen assemblages. Climate remained warm and humid throughout the Early Pleistocene supporting broadleaved mixed beech forests. Here, the uplift of the Caucasus mountain range counteracted global climatic changes. This unique interplay of global climate and regional tectonic effects led to favorable climatic conditions for the development of the Colchic vegetation refuge in western Georgia.

30/05/2024, 17:00–18:40, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-378 - Vegetation and climate change in the Amazon during Pleistocene glacial-interglacial cycles

Caio Alves De Moraes[1], *Paulo Eduardo De Oliveira*[1], *Thomas Kenji Akabane*[1], *Cristiano Mazur Chiessi*[2], *Aline Govin*[3]

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Amazonian vegetation and climate history remains remarkably fragmented and confined to limited temporal intervals. Most of the existing information is restricted to (i) the Miocene (23–5 million years before the present), marked by the formation of the current drainage system as a result of the Andean orogeny, and (ii) the period since the Last Glacial Maximum (23–19 thousand years before present), marked by the transition from large ice sheets over the Andes and northern North America and Europe until the warm conditions of the late Holocene. However, little attention has been given to vegetation and climate change during other glacial-interglacial cycles. The last interglacial (LIG), from 129 to 116 thousand years before the present, a period termed the Eemian, temperatures were around 1 °C higher than preindustrial, and sea level was between 6 and 9 m higher than modern levels. However, there is no high-resolution information on how Amazonian vegetation reacted to these changes. This study aims to reconstruct paleoenvironmental conditions of Marine Isotope Stages 6–5 in the Amazon. Therefore, we are analyzing the palynological content of a 50 m-long marine sediment core collected off the mouth of the Amazon River. The core was collected in 2023 during the AMARYLLIS-AMAGAS II cruise and integrated the palynological signal of the Amazon basin. This sediment core preserves a continuous record, making it suitable for reconstructing the history of the Amazon in this specific interval with high temporal resolution. The new data will allow answering three central questions: (i) how resilient was the Amazon Forest during the transition from the penultimate glacial to the last interglacial? (ii) what were the environmental conditions in the region during the globally warmer-than-present last interglacial? and (iii) what were the main vegetation differences between the last interglacial and the Holocene?

30/05/2024, 17:00–18:40, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-379 - CO2 and orbital forcing of Indian monsoon and vegetation dynamics from the late Pliocene to early Pleistocene

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The Indian Summer Monsoon is intricately connected to orbital variations; however, the primary orbital cycles influencing the Indian Summer Monsoon (ISM) exhibit regional variations in East Asia. In this study, we examine geochemical data from a fluvial-lacustrine succession (~3.350–2.4 Ma) in the Dali basin, southwest China, to understand how vegetation responds to long-term climate changes. Our analysis includes measurements of $\delta^{13}C$ and $\delta^{18}O$ on bulk carbonates, TN, total organic carbon, C/N ratio, palynological analysis, and climate simulation. The results reveal significant variations in oxygen isotope following an astronomical-controlled pattern, with the dominant cycle occurring approximately every 41 kyr around ~3.3–2.72 Ma, suggesting an Obliquity-dominated pattern. While Precession and Eccentricity also play a role, their influence is comparatively minor. Between 3.350 and 2.700 Ma, high TOC levels suggest a potential link to reduced fluvial erosion due to the development of terrestrial vegetation. The ISM reflects the interglacial (warm/humid)-Glacial (cold/dry) climate transition around ~2.72 Ma, marking a shift from a 41-kyr dominated climate to a non-orbital climate pattern. The warm period (3.3–2.72 Ma) and cold period (2.72–2.4 Ma) appear to be influenced by different factors. During the cool stage, *Tsuga* and *Pinus*-dominated vegetation gives way to a more complex ecosystem,

incorporating warm to cold-adapted elements. CO_2, potentially linked to tectonic activities, may contribute to the climate change observed around ~2.72 Ma. Our reconstructions highlight that summer precipitation in Southwest China is predominantly driven by obliquity. Considering climate model results, we propose that CO_2 forcing and obliquity-driven variations may originate from the boreal insolation gradient, modulating thermal contrast between the Asian continent and surrounding oceans.

30/05/2024, 17:00–18:40, Room: Virgo
Q03 Glacial-Interglacial cycles as natural experiments

O-380 - Cold and dry, not humid, Younger Dryas in northeastern China indicated by pollen data analysis

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The Younger Dryas (YD, about 12.9–11.7ka BP) is a prominent millennial abrupt climate event during the last deglaciation. It left a climate record of cold and arid conditions in most areas of the Northern Hemisphere, while some regions exhibited different patterns. In northeastern China, the regional hydroclimatic of the YD remains unclear. While most geomorphological records suggest a dry climate, vegetation related indicators exhibit markedly different expressions regarding moisture conditions, usually with increases in alder and birch and a decrease in C_4 plants. Supporters of "humid YD" have proposed several hypotheses, such as the monsoonal rainbelt shifted northward, or the Okhotsk high increased the northeast monsoon water vapor transport, attempting to explore the mechanisms of local precipitation increasing during the YD period, however the conflicting conclusions and confusing patterns are still difficult to explain.

This study reconstructed the paleoclimate during the YD period in northeastern China and the surrounding areas based on pollen records using random forest and modern analog technique, and explored the climate change fingerprints in this region. We find that climate became cooler and drier or didn't change significantly from the Bølling-Allerød (BA) to YD. Yet, both temperatures and precipitations increased after YD. The signal of YD climate change is stronger in the southern temperate forest than in the northern boreal forest. Furthermore, we disentangled the relationships between arboreal pollen population, forest coverage, and annual precipitation under a cold environment. We suggest using ecological processes rather than climate processes to explain the variations in moisture conditions observed in different proxies in the region.

30/05/2024, 17:00–18:20, Room: Zenit
Q02 Exploring ecological concepts in the Quaternary

O-381 - Dark diversity reveals expansion lags in palaeoecological data

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In addition to the observed species present in a site (or taxa present in a pollen sample), there are species that can potentially be found in the site – its species pool. Dark diversity is the difference between the observed diversity and the species pool identifying the taxa that are locally suitable but absent. Dark diversity links regional and local scales and allows to reveal taxa under expansion lags by depicting the potential biodiversity that remains suitable but is locally absent. Since global change effects on biodiversity are both spatially and temporally scale-dependent, examining long-term temporal dynamics in observed and dark diversity helps to assess the biodiversity change.

We used sedimentary pollen data to examine the change of taxonomic and functional observed and dark diversity over the past 14 500 years in northern Europe. We found that both taxonomic and functional observed and dark diversity increased over time, especially after the Late Glacial and during the Late Holocene. However, dark diversity dynamics revealed expansion lags related to species' functional characteristics (dispersal limitation and stress intolerance) and an extensive functional redundancy when compared to taxa in observed diversity.

30/05/2024, 17:00–18:20, Room: Zenit
Q02 Exploring ecological concepts in the Quaternary

O-382 - Implications of Oryzoideae grass phytoliths in reconstructing late Quaternary deltaic environmental changes in the Sunderbans, India

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Grass phytoliths, owing to their abundant occurrence, diverse characteristics specific to subfamilies, extreme durability in sediment and high responsiveness to various environmental factors, play a pivotal role as a proxy in the reconstruction of past environments and climates. A study was undertaken on modern Oryzoideae grasses and surface soil samples collected from the Sunderbans, India, to assess the effectiveness of grass phytolith morphotypes in interpreting different deltaic sub-environments. The observation revealed that phytolith assemblages of Oryzoideae grasses can effectively distinguish various deltaic sub-environments, particularly true mangrove zones from mangrove-associated and non-mangrove zones. It was further established that within the retrieved phytoliths, the prevalence of RONDEL ELLIPSOID, RONDEL FOUR HORNED, TOWER FLAT and TOWER SPOOL/HORNED morphotypes signifies a true mangrove environment, while the predominance of BILOBATE, CROSS and SADDLE morphotypes indicates mangrove associated and non-mangrove environments and the data was in conformity with that of surface soil samples. Furthermore, the potential of modern Oryzoideae grass phytolith data in reconstructing past changes in deltaic environments was successfully evaluated through the analysis of two late Quaternary sedimentary profiles from the Sunderbans spanning sedimentary records for the last 4.8 ka and 13.6 ka respectively.

30/05/2024, 17:00–18:20, Room: Zenit
Q02 Exploring ecological concepts in the Quaternary

O-383 - The Pheneos palaeolake (north Peloponnese, Greece) and its palaeoshoreline history based on charophytes

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The Pheneos palaeolake is located in an intramountainous area at the north of Peloponnese (Greece). The first historical record of this palaeolake is found in the manuscript of Eratosthenis' Geography, that was written in the 3rdcentury B.C. Today, the remnants (sediments and shorelines) of this paleolake can be found in the mountain scarps at the southern margins of the polje (flat-floored depression in limestone karstic areas usually surrounded by mountains). Thirty-seven samples consisting of surface sediments were collected in this area and later analyzed for microfossils. Moreover, seventeen samples were collected from three sections located at a natural stream that runs across the southern polje. Microfossils obtained include ostracod valves, aquatic gastropods and up to 5 charophyte species i.e. oospores of *Nitella* cf. *hyalina* and gyrogonites of *Sphaerochara prolifera*, *Chara vulgaris*, *Chara* sp., and *Nitellopsis obtusa.* Based on the ecological requirements of these living charophyte species, up to three limonological conditions were distinguished:1) stable and permanent lake with cold and oligotrophic waters dominated by *N. obtusa*, 2) ephemeral lake with an annual cycle rich in *S. prolifera*, and 3) meso-eutrophic lake with warmer water dominated by *C. vulgaris* and *Chara* sp. The charophyte assemblages studied herein indicate that significant changes regarding the trophic status, temperature and hydrodynamics of the Pheneos lake took place during the mid-late Holocene.

30/05/2024, 17:00–18:20, Room: Zenit
Q02 Exploring ecological concepts in the Quaternary

O-384 - The impact of climate change on the distribution of Cedrus and Tsuga since the Quaternary

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The Quaternary climate change has exerted an important impact on the distribution of species in the Northern Hemisphere. Glacial and interglacial variations have caused dramatic effects on species distributions, including migration, retreat and extinction. Two notable examples are the genera *Cedrus* and *Tsuga*, which have been profoundly influenced by the Quaternary climate fluctuation. *Cedrus* disappeared in southern Europe, while *Tsuga* became extinct in Europe, both due to dramatic climate change during the Quaternary. Presently, *Cedrus* exhibits a disjunctive distribution in North Africa, the eastern Mediterranean, and western Himalaya, while *Tsuga* shows disjunct distribution in East Asia, eastern North America, and western North America. Previous studies either relied on modelling or utilized fossil data, typically focusing on several species in local regions. Consequently, a comprehensive understanding for the driving factors behind the distribution dynamics of *Cedrus* and *Tsuga* since the Quaternary remains elusive. To address this knowledge gap, we collected large amount of species distribution data and pollen fossil data for both these genera, combined with a species distribution model (MaxEnt), to explore the important climate variables affecting the distribution of *Cedrus* and *Tsuga*, identifying climate threshold and understanding their distribution dynamics under the background of major climate changes since the Quaternary. Our simulation results highlight that that winter precipitation is the key factor that determines the distribution of *Cedrus*, followed by winter temperature. And, precipitation has an important impact on the distribution of *Tsuga*. Specifically, in East Asia, summer precipitation is the key driver, while in North America, winter precipitation exerts greater importance. The declines in summer precipitation and winter temperature were major factors contributing to the extinction of *Tsuga* in Europe. We propose conservation suggestions for these two genera, emphasizing the importance of considering the identified key climate variables in conservation efforts.

28/05/2024, 14:30–16:10, Room: Leo
M07 Applied palynology: methodological innovations

O-385 - Determining the correlational signatures of pollen assemblage on UV-Vis absorption spectra of honey aiding the honey authentication tool development

Sudha Gupta[1], *Prashanta Mitra*[1]

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The study aimed to evaluate how the composition and frequency of pollen taxa in honey affect its UV-Vis absorption spectrum, with potential implications for monitoring honey quality and authenticity. A total of 144 honey samples were collected in 2021 from Uttar Dinajpur, West Bengal, India, from both wild hives and apiaries. Of these, 40 samples were from apiaries and 104 from wild hives. The study involved melissopalynological analysis, generating UV-Vis absorption spectra (ranging from 200 nm to 700 nm) of diluted honey (100 µL honey in 900 µL distilled water), and measuring organoleptic parameters (color, smell, taste). Data analysis included exploratory analysis, spectral data processing, Fast Fourier Transformation for Neural Network modelling, and Principal Component Analysis. The study identified 33 pollen taxa, including *Brassica nigra*, *B. campestris*, *B. oleracea*, and *Aegeratum conyzoides* as sources of unifloral honey. The exploratory data analysis revealed signal differences in the spectra concerning the season, hive source, and unifloral pollen type. Fourier transformation and Neural Network predictions supported the results of the exploratory data analysis. Principal Component Analysis showed that pollen types present in honey at over 45% frequency significantly influenced its characteristics, while less frequent pollen had minimal impact on absorption spectra. Further, the plant being both nectar and pollen sources for a honey sample, as for example *Brassica*, was found to be a key determinant factor for honey characteristics, which may be used in detecting honey authenticity. The study also highlighted the evident impact of month and seasonal transition on the pollen spectra of honey and its subsequent effect on absorption spectra. Additionally, the source of honey (wild hive or apiary) was found to have a significant effect on its characteristics. The findings have great potential in discriminating assessment of honey quality and authenticity.

Posters

P-001 - Morphology and stratigraphy of Ordovician cryptospores with focus on the research in the Czech Republic

Kateřina Fučíková[1], *Vojtěch Kovář*[1], *Oldřich Fatka*[1]

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The origin of earliest terrestrial plants is a complex and highly debated issue. One of the key sources of information regarding this topic is the study of cryptospores (Steemans & Wellman 2018). Cryptospores are a group of spores defined on the basis of their specific morphology (e.g. distinctive configurations, symmetry, structure and sporoderm, envelope, ornamentation, line of attachment, size of spores). The origin of cryptospores is still intensely debated. Originally, they have been assigned to an unknown group of Bryophyte-like plants (Gray 1985). Recently, the term Eophyta has been coined to describe a separate group of fossil plants supposedly producing cryptospores (Edwards et al. 2022). While cryptospores have been reported from the Cambrian (Strother 2000), their earliest undisputed record dates back to the Darriwilian (Middle Ordovician), ca. 460 million years ago in Saudi Arabia. Ordovician cryptospores in general have been reported from sedimentary rocks around the world, including localities in Argentina, Brazil, Canada, Iran, Russia, Saudi Arabia or Sweden. Among the oldest occurrences of cryptospores are also those described from the Barrandian area (Czech Republic; Vavrdová 1984). In the course of the research conducted by Dr. M. Vavrdová (Institute of Geology of the Czech Academy of Sciences) mostly during the 1980s and 1990s, cryptospores in the forms of monads, dyads, and tetrads were reported from the Darriwilian Šárka Formation (Vavrdová 1990) and the Hirnantian Kosov Formation (Vavrdová 1988; 1989) contributing notably to the knowledge of Ordovician cryptospores in general.

P-002 - Imaging techniques in the study of fossil scolecodonts

Petra Tonarová[1], *Olle Hints*[2], *Marek Zemek*[3], *Martina Nohejlová*[4], *Ondřej Švagera*[5], *Michal Kubajko*[1], *Tomáš Zikmund*[3], *Jozef Kaiser*[3]

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Polychaetes are segmented worms common throughout the marine environments. Thanks to their resistant jaws (scolecodonts), which can be commonly found in various lithologies since the early Paleozoic, we can assume that their role in marine ecosystems was important also in the past. Nevertheless, there are still gaps in their research and the employment of the latest imaging methods awaits more testing.

Nowadays, there is a boom of computed tomography (CT) based research in palaeontology. The technique is non-destructive and brings unique information about the subjects of study. Still, the method is rather time-consuming (counting also data interpretation) and costly. The small size and fragility of scolecodonts implied only a rare employment of CT methods. For example, Eriksson *et al.* (2017) used CT scanning for the reconstruction of the biggest maxillae known (over a centimetre in length) embedded in Lower-Middle Devonian sedimentary rock. However, the „normal" average size of scolecodonts is usually from 0.2 to 0.5 mm, which is below or on the edge of the limits of micro-CT scanners.

In the present study, we aim to compare the pros and cons of various visualisation techniques, using scolecodonts from the Baltic region (Estonia), Gondwana (Spiti Valley, India; and the Prague Basin). We have employed submicron-CT, micro-CT, digital microscope Keyence, and scanning electron microscopy (SEM). The goal of our study is also to make the collections of high-resolution microphotographs and 3D models, including a trial application of photogrammetry from SEM images, accessible to a broader audience and to build an image collection of scolecodont type specimens.

This research was supported by the Czech Science Foundation through project 23-05944K and Strategic Research Plan of the Czech Geological Survey DKRVO/ČGS 2023–2027 (project 311410).

Eriksson, M.E., Parry, L.A. & Rudkin, D.M. 2017. Earth's oldest 'Bobbit worm' – gigantism in a Devonian eunicidan polychaete. *Scientific Reports 7(1),* 43061.

Poster session A02 Advances in Devonian Paleobotany

P-003 - Bowerophylloides: Land plant, algae or graptolite?

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Bowerophylloides is a genus established to encompass sterile axes covered by densely packed, narrow, elongated projections directed towards the apex. Its initial discovery is documented in the Lower Devonian Villavicencio Formation (Mendoza, Argentina). Additional specimens were unearthed in the Río Seco de los Castaños Formation (San Rafael Basin), also ascribed to the same genus, accompanied by a commentary on its relationship to lycophytes. This discovery prompted a reevaluation of the type material of *Bowerophylloides*. Holotype LPPB 12211: observations of the lateral appendages revealed spatulate projections without venation. Some lateral appendages exhibited a lobed margin, while others displayed a v-shaped mark along with a serrated margin. All appendages were observed to be truncate, with a cylindrical basal section. On the stem, the insertion bases of the appendages were visible in certain areas. These bases appeared elongated, with a circular insertion at the top, appearing aligned and almost horizontal. In the lower part of the stem, a minute oval, calcified structure was discovered, resembling an oogonium, measuring 206 µm in length and 141 µm in width. The surface of this structure exhibited helical cells composed of rectangular cells measuring 21 x 26 µm. In the distal sector, a 42 µm high crown was observed. Circular, flattened structures in the same sector were identified, formed by concentric cells reminiscent of the anteridial globes of Charophyta. While the appendages exhibited characteristics that complicate their classification as algae or graptolites, they appear to carry reproductive structures typical of algae. Regarding the material from San Rafael, the two best-preserved specimens LPPB 13817a and LPPB 13829a showed helically arranged lateral appendaged and axillar to adaxial sporangia or spores, confirming their affinity with lycophytes. This material is therefore excluded from *Bowerophylloides*. These findings contribute to the understanding of plant diversity in the Devonian of Argentina.

Poster session A02 Advances in Devonian Paleobotany

P-004 - A clonal creeping plant in the Late Devonian Xinhang Forest, South China

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Clonal growth is common in extant plants and has been reported in early terrestrial vascular plants, such as *Rhynia*, *Zosterophyllum* and *Drepanophycus*. However, due to fossil preservation and other factors, there has been relatively limited studies on the clonal plants in the understory since the establishment of the earliest forest ecosystem. In recent years, we have discovered fossils of a Late Devonian clonal plant in the Xinhang Forest in South China, preserved together with the tree lycopsid *Guangdedendron* at several localities in the Jianchuan and Yongchuan mining areas. The fossil plant exhibits creeping, multiply dichotomized axes, covering a significant ground area with a single individual. It bears adventitious roots along the axis but lack leaves. The anatomy and reproductive organs are not clear yet. The internodal lengths of the axes vary greatly, with regions of shorter internodes producing more adventitious roots. This variability may reflect the plant's plastic response to environmental changes, such as hydrotropic growth of roots, and the clonal growth strategy transitioning between guerrilla and phalanx types.

Poster session A03 Permian plant succession and the global climate changes

P-005 - Lopingian palynofloral succession in sub-Angara area: Evidence from Linxi Formation in Northeastern China

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The Lopingian terrestrial deposits are represented by Linxi Fm., rich in plants, palynomorphs, bivalves and conchostracans in north-eastern China. Lopingian palynomorphs in the Linxi Fm. can be divided into three assemblages in ascending order:

1) *Kraeuselisporites spinulosus – Falcisporites sublevis* assemblage, in the Lower part of Linxi Fm., aged early Wujiapingian. It is composed of 12 spore and 10 pollen species, and characterized by diverse spores and pollen, represented by *Kraeuselisporites spinulosus*, *Cyclogranisporites orbicularis*, *Falcisporites sublevis* and *Vesicaspora wilsonii*. Common palynomorphs are *Kraeuselisporites spinulosus*, *Cyclogranisporites micaceus*, *C. orbicularis*, *C. staplinii*, *Calamospora pedata*, *Granulatisporites piroformis*, *Anaplanisporites telephorus*, *Verrucosisporites microtuberosus Leiotriletes levis*, *Falcisporites sublevis*, *Protohaploxypinus parviextensisaccus*, *Alisporites communis*, *Sulcatisporites ovatus*, *Potonieisporites* sp., *Pilasporites* cf. *calculus*, *Platysaccus papilionis*, *Vesicaspora wilsonii*, *Cycadopites caperatus*.
2) *Cyclogranisporites staplinii – Sulcatisporites ovatus* assemblage, in the Upper part of Linxi Fm., aged late Wujiapingian. It is composed of 6 spore and 9 pollen species and one algal species, and is characterized by dominant non-striate bisaccate pollen such as *Sulcatisporites ovatus*. Fern spores *Cyclogranisporites staplinii*, *Calamospora breviradiata*, *Leiotriletes adnatus*, and gymnosperm pollen *Sulcatisporites rectangulus*, *Falcisporites sublevis*, *F.* cf. *zapfei*, *Solisisporites coalensis*, *Jugasporites rimatus* are common. Algal spores *Schizosporis* sp. are rare.
3) *Cyclogranisporites aureus – Lueckisporites virkkiae* assemblage, in the uppermost of Linxi Fm., aged Changhsingian. It is composed of 3 spore and 18 pollen species. Gymnosperm pollen are dominant, such as *Lueckisporites virkkiae*, *Alisporites cacheutensis*, *A. circulicorpus*, *A. parvus*, *Klausipollenites* sp., *Piceapollenites* sp., *Pinuspollenites* sp., *Platysaccus* sp., *Pristinuspollenites* sp., *Protoconiferus* sp., *Pseudopicea* sp., *Psophosphaera* sp., *Quadraeculina* sp., *Sulcatisporites rhombicus*.

An obvious decline of ferns and thriving of gymnosperms, especially conifers show the climate is getting arid and seasonal rainless roll up the high latitudinal area in northern Pangea during Lopingian.

This work is supported by the National Natural Science Foundation of China (31670215).

Poster session A06 Palaeozoic palaeobotany: taxonomy, diversity and palaeoecology

P-006 - An exploration of the palaeobotanical collection at Geosphere Austria

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This presentation aims to showcase the rich palaeobotanical collection housed at Geosphere Austria (Vienna), offering an overview of the diverse plant fossil assemblages curated within its repository. The collection, spanning various geological periods, provides a unique glimpse into the evolution of plant life and environmental changes over millions of years.

Our collection encompasses plant fossils from the Palaeozoic to the Neogene. The Palaeozoic material consist in about 1300 specimen drawers. The majority of the drawers contain plant fossils from the Silesian and Bohemian coal basins, but there are also smaller complexes from the Carboniferous of Austria, Germany, and France, as well as plant fossils from Permian sediments from Bohemia and Moravia.

The Mesozoic consists of approximately 400 drawers. A significant amount of the fossil material comes from the Romanian Lias (Steierdorf, Anina). Furthermore, there are larger collections from the Dogger of Poland (Grojec), from the Triassic of Austria (Lunz), Italy (Raibl), Slovenia (Idria), and from the Cretaceous of Croatia (Lesina), Italy, and the Czech Republic.

Approximately 700 drawers cover the Paleogene and Neogene. The majority of the material was collected in the first decades of the Geological Survey of Austria and therefore originates from the countries of the former Austro-Hungarian Monarchy. Large collections come from the Oligocene and Eocene of Slovenia (Trbovlje, Zagorje, Sotzka) and from the Styrian Tertiary Basin

(Parschlug, Eibiswald, Fohnsdorf, Leoben). Furthermore, there are extensive materials from Greece (Kymi), Croatia (Monte Promina, Radoboj), and the Czech Republic (Bílina, Přísečná).

By sharing insights from Geosphere Austria‘s palaeobotanical collection, we aim to contribute to the broader scientific community‘s knowledge of ancient plant life and foster discussions on the significance of such collections in addressing contemporary challenges, such as climate change and biodiversity conservation.

Poster session B01 Palaeobotanical and palynological signatures of Earth’s extreme climate events

P-007 - Testing a mechanistic leaf gas-exchange model for a phylogenetic bias in pCO2 reconstructions

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Palaeo-CO2 proxies are essential for reconstructing past atmospheric pCO2 and understanding its relation to extreme changes in Earth‘s climate, in order to predict future effects of climate change. Plants respond to pCO2 variations via changes in their stomatal distribution and are therefore an ideal basis for palaeo-CO2 proxies. The Franks et al. (2014) mechanistic leaf gas-exchange model uses stomatal parameters and the carbon isotope composition of fossil leaves to reconstruct pCO2. Although it has already shown promising results, its applicability to different plant groups remains unclear, especially in terms of whether there are consistent off-sets in pCO2 estimates among major plant clades. In this study, we sampled 16 plant species from the University of Münster Botanical Garden (Münster, Germany), including five ferns, five angiosperms, and six gymnosperms, in order to assess the performance of the model across different phylogenetic groups. In addition, measurements of the stomatal parameters in gymnosperm taxa were compared between epidermal peels and isolated leaf epidermises in order to test for systematic off-sets that would be expected given the more deeply sunken guard cells. The results of this study provide information on the broad-scale applicability of the Franks model.

Poster session B01 Palaeobotanical and palynological signatures of Earth’s extreme climate events

P-008 - Revisiting the Eocene flora from the Claiborne Group in western Kentucky, USA

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During the early Paleogene Earth experienced a long-term global temperature increase punctuated by hyperthermal events. The warming resulted in a reduction of the latitudinal temperature gradient, in addition to a global increase in seasonality and drought. Changes in faunal and floral distribution and composition have been well documented in the western part of North America. Several studies have supported the hypothesis that a widespread band of thermophilic plant communities existed and expanded into the mid latitudes, consistent with biota tracking climate change. It is not clear how well these floras are connected, and how exactly they responded during these rapid and long-term global warming events. My goal is to gain insight in the response of Eocene Gulf Coastal Plain plant communities to these warming events using various leaf physiognomic traits (e.g., DILP, leaf mass per area, leaf margin analysis, leaf area analysis, and leaf area index) and systematic census of several floras. For this, I have visited and collected floras from several well-preserved deposits from the Claiborne group in Tennessee and Kentucky. I will use cuticular analysis to describe leaf morphotypes and narrow down their botanical affinity, as well as measure SD, SI, and δ13C to reconstruct paleoatmospheric CO2 concentrations. Initial analysis of floras from one collection suggests at least 7 morphotypes indicative of a warm environment and a fairly open canopy structure. There are two leaf morphotypes that appeared at all three localities, but more sampling and cuticular analysis is needed to confirm they belong to the same taxa.

P-009 - Early Devonian palynomorphs in western Gondwana sediments from the Salsipuedes Well, Norte Basin, Uruguay: Would they give clues about paleoecological conditions?

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This contribution describes the presence of organic-walled microfossils in the subsurface of the Norte Basin (Uruguay) from continuous rock cores (borehole) and cutting samples from Salsipuedes Well (UTM, x=551297; y=6406835). Prospection in the last decade led to identify Devonian sediments in an old well drilled by the national hydrocarbon company ANCAP in 1956 in Tacuarembó Department. The Devonian sedimentary rocks in the Paraná and Chaco Paraná basins are characterized as an almost complete transgressive-regressive cycle that progressively increases thickness from West to East. Devonian sediments in Uruguay are grouped in the Durazno Group, subdivided, from base to top, into the Cerrezuelo (140m), Cordobés (90m) and La Paloma (35m) formations. Lithological revision of the basal samples of Salsipuedes Well considered here allowed to assign them to the upper part of the Cerrezuelo Formation deposited in shallow marine to tidally-influenced littoral conditions. Samples are dominated by organic-walled paleomicroplankton, with subordinated terrestrial palynomorphs. Among relevant paleomicroplankton taxa are *Bimerga acharii, B. paulae, Cordobesia oriental-uruguayensis, Diexallophasis denticulate, Diexallophasis remota* group, *Estiastra uruguaia, Evittia sommeri* ‚early form', *Navifusa bacilla* 'short form', *Polyedryxium fragosulum, Polyplanifer turbatum, Pterospermopsis circumstriata, Pterospermopsis sp., Quadisporites horridus, Schizocystia pilosa, Striatotheca* sp., *Tasmanites* sp., *Tunisphaeridium tentaculaferum, Triangulina* species, *Veryachium woodii, Winwaloeusia distracta.* Among relevant spore taxa are *Biornatispora elegantula, Brochotriletes foveolatus, Dibolisporites* spp., *Dictyotriletes richardsonii, Knoxisporites riondae,* morphon *Dictyotriletes emsiensis, Retusotriletes maculatus, Scylaspora costulata, Synorisporites papillensis, Synorisporites verrucatus, Verrucosisporites polygonalis.* According to the stratigraphic distribution of palynomorphs, a Pragian-early Emsian age is suggested for the analysed interval, which agrees with the age assigned in previous publications. Correlation with other Gondwana and peri-Gondwana associations can be made based in elements in common. Events into palynological assemblages would reveal ecological signals in response to complex transgressive-regressive cycle and global processes across the Pragian-Emsian transition.

P-010 - The first Permo-Carboniferous palynomorphs from the Železné hory Mountains (Czech Republic)

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The borehole P-PMS/4 situated west from Prachovice (Kraskov Relic) reached the base of the Permo-Carboniferous deposits in depth 62.25 m. Relatively coarse clastics are traced till 35 m. They are predominantly conglomerates and sandstones with red-brown to violet-brown mudstones. In the lower part of drill core prevail grey claystones and mudstones passing to the sandstones and conglomerates at the base. These rocks lie unconformably on the early Palaeozoic limestones.

Twenty samples of grey claystones (depth 51.7–40.1m) have been palynologically processed and preliminary evaluated. Palynofacies contain woody detritus, charcoal, megaspores and microspores, occasional cuticles and sporangia. Pyrite is abundant. Spore content in assemblages roughly correspond to the content of gymnospermous pollen.

These microspores are the most common: *Crassispora kosankei* together with megaspores *Laevigatisporites glabratus* representing sigillarias. The following typical trilete spores are e.g. *Punctatisporites bifurcatus*, *Cyclogranites jelenicensis*, *Gillespieisporites*, *Verrucosisporites sinensis. Reistrickia* spp. and *Angulisporites minor*. Typical monolete spores are *Thymospora pseudogranulata, Laevigatosporites minimus* and *L. vulgaris* and *L.maximus*. The most typical pollen are *Florinites, Guthörlisporites, Wilsonites, Potonieisporites, Illinites, Kosankeisporites, Hamiaipollenites Protohaploxypinus* and *Cycadopites*. The most common are *Florinites* and *Protohaploxypinus*.

Thesse strange palynological assemblages differ from the previously known assemblages from the continental basins of the Czech Republic. The genera *Lycospora* typical for the Stephanian and *Vittatina* typical for Autunian were not been found in the studied samples up to now. However, *Laevigatosporites glabratus* and *Crassisspora* (sigillarian spores) have not been found higher than

in the Stephanian, what together with spores of the Stephanian character support the Stephanian age of the deposits. These assemblages will be further studied and also mesofossils and dispersed cuticles will be used for refining of the age of these deposits.

Poster session B03 CIMP Palaeozoic palynology

P-011 - Permian geological-palynological section of Southwest Turkey, Antalya Bay

Ellen Stolle[1]

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A Permian section in a deep, difficult to access gorge near Kemer, western Antalya Bay, southwestern Turkey, is under palynological investigation.

E. Akyol first published in 1975 on this area. He found well-preserved palynomorphs, identified Permian strata and correlated these with the Permian of other regions.

The current work bases on a detailed, in total 176 m long, measured section, taken largely in continental Permian deposits. The sampled rock material bears plant remains, coal particles, and more or less well-preserved palynomorphs. Palynological taxa such as *Florinites*, *Plicatipollenites*, *Potonieisporites*, *Thymospora*, *Torispora*, and *Vittatina* species can occur. A few palynological events are recognized and part of the section can be compared with strata from Southeast Turkey, deposits of the northern Arabian Plate, approximately 1000 km to the east.

Poster session B04 Gymnosperm cones across time&phylogeny

P-012 - Araucariaceous and cheirolepidiaceous cones with in situ pollen from the Lower Cretaceous deposits of western Portugal

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Conifers are particularly abundant in the Early Cretaceous floras of Portugal. The group is very well represented in the fossil record by twigs and cones, as well as dispersed pollen grains assigned to the families Araucariaceae and Cheirolepidiaceae. The present work concentrates on the occurrence of araucariaceous and cheirolepidiaceous microsporangiate cones recovered from the upper Aptian – lower Albian deposits of the Lusitanian Basin, located in the westernmost sector of the Iberian Peninsula. The araucariaceous pollen cone *Callialastrobus sousai* is reported from sedimentary deposits of Catefica, located about 4 km south of Torres Vedras, belonging to the Almargem Formation. The material comprises a single dispersed microsporangiate cone showing peltate deltoid microsporophylls arranged in a helix, each microsporophyll bearings three pollen sacs with *Araucariacites* and *Callialasporites* pollen-types *in situ*. Another two cheirolepidiaceous microsporangiate cones assigned to the *Classostrobus* genus have been recognized in Carregueira mesofossil flora, close to the small village of Juncal. The fossil specimens were recovered from sedimentary rocks ascribed to the Famalicão Member of the Figueira da Foz Formation. One of the cheirolepidiaceous cone was recently described as *Classostrobus archangelskyi*. This microsporangiate cone is ovoid and small, comprising only a few microsporophylls, each with a stalk and deltoid head bearing 4–5 pollen sacs. The size of the preserved pollen grains observed *in situ* in this cone does not reach 20 µm, the circumpolar canal and cryptopore on distal side are visible. These grains share strong similarities with *Classopollis martinotii*, *Classopollis torosus*, but particularly with *Classopollis noeli*. The other cheirolepidiaceous cone identified in the Carregueira mesofossil flora is small and ovoid in outline shape. The pollen grains observed *in situ* in the microsporangiate structure are almost triangular in equatorial outline and assigned to the species *Classopollis triangulus*.

P-013 - Characterisation of conifer cones from the Lower Cretaceous of France

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The Angeac-Charente site in western France represents a *fossil-Lagerstätte* comprised of exclusively continental deposits dating back to the Berriasian − early Valanginian stage. It represents a diverse swamp ecosystem preserved over a relatively brief time span. Notably, the site has yielded significant fossilized remains, including plants, over the course of excavations conducted over the past thirteen years. The process of rock sieving has facilitated the extraction of numerous micro- and meso-remains. Simultaneously, the excavations have revealed various conifer mega-fossils, particularly wood, twigs, leaves, and cones. The examination of these cones, using nano- and micro-X-ray tomography, alongside their detailed description, has enabled the identification of several distinct morphotypes exhibiting different types of preservation. This study outlines and identifies three of these specific cone morphotypes. Presently, these morphotypes cannot be classified at the species level due to the absence of comparative data concerning similar structures from the same age. Typically, the description of such fossil types is limited to the family or genus level. The comprehensive understanding of the Angeac-Charente site's environment furnishes us with extensive information regarding the identified taxa, their age, and the conditions in which they lived and were deposited. Given the thoroughness and instantaneous nature of the fossilization, a thorough analysis of the plant community could potentially reconstruct the entire plant assemblage of an early Early Cretaceous swamp. This reconstruction would be particularly valuable as it pertains to a crucial time preceding the colonization of angiosperms.

P-014 - Microsporangiate cones of Cheirolepidiaceae conifers from the Cretaceous of the Bohemian Cretaceous Basin, Czechia and Lusitanian Basin, Portugal

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Microsporangiate cones assigned to the extinct coniferalean family Cheirolepidiaceae are common in many Cretaceous mesofossil floras. The cones are generally rounded to oval shaped consisting of a central axis with a helically arranged microsporophylls. In these cheirolepidiaceous microsporangiate cones pollen sacs are found on the abaxial side of microsporophylls bearing distinctive pollen grains attributed to the genus *Classopollis*. This contribution focuses on two microsporangiate cones of the genus *Classostrobus* associated with two different conifer leafy shoots ascribed to Cheirolepidaceae.

The microsporangiate cone associated with *Frenelopsis alata* twigs is assigned to *Classostrobus* sp. and was recovered from the Cenomanian Peruc Korycany Formation of the Bohemian Cretaceous Basin, Pecínov locality. This male structure exhibits helically arranged triangulate microsporophylls that are about 12 per cone. Each microsporphyll shows a fringe of long trichomes on its margin. Microsporophylls show stomatal complexes that are more prominent on the abaxial cuticle. Each stomatal chamber is surrounded by prominent papillae.

The microsporangiate cone associated with *Watsoniocladus cunhae* foliage is assigned to *Classotrobus* cf. *archangelskyi* and was recovered from the upper Aptian–lower Albian strata of the Figueira da Foz Formation, near the village of Juncal, in the Estremadura region, central-western mainland Portugal. The microsporangiate cone is small, oval to round in shape and shows helically arranged triangulate microsporophylls with obtuse apex. The number of microsporophylls is about 12. The microsporophylls frequently bear long unicellular trichomes in marginal parts.

P-015 - Reconstructing the coastal vegetation of Cenomanian southwestern Appalachia: An integrated study of plant fossils and sediments of the Lewisville Formation (Woodbine Group), Dallas-Fort Worth Texas, USA

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The Cretaceous rise of flowering plants marked a critical, transformative period for terrestrial landscapes, ultimately leading to modern vegetation types and ecosystems. However, key Cretaceous time intervals and localities remain poorly studied, leaving our understanding of the ecological transformation of landscapes incomplete. The Cenomanian Woodbine Group (Lewisville Formation), deposited along the southwestern Appalachian coast provides opportunities for interdisciplinary approaches to paleoecology through palynological, meso- and macrofloral, and sedimentological studies of approximately 13 m exposed near Lake Grapevine, Tarrant County, Texas. Combined sedimentological and fossil evidence indicate deposition in a shallow-marine to continental-terrestrial setting. Palynological samples from the lower half of the stratigraphic succession mostly have compositions dominated by conifer pollen and fern spores; samples from the upper part of the succession have a higher diversity of conifers, ferns, and angiosperms. These upper strata contain abundant plant fossils of all types in highly organic drapes within tidal channels and in organic muds of tidal flats and lagoons. Mats of compressed foliage in the tidal drapes, all with well-preserved cuticles, contain mostly angiosperms. Charcoalified woods from drapes include both conifers and angiosperms. Similarly, angiosperms are most abundant in fine-grained laminated mud flat mudstones, with much lower abundance of conifers and ferns. Overall, fossil data are consistent with conifer-fern swamp forests on the coastal plain. However, abundant and diverse angiosperms suggest that some coastal areas rich in angiosperms may not be well represented in the palynological record, and ecological heterogeneity is likely represented differently across sample types. Abundant charcoal indicates significant wildfires. The Lake Grapevine fossil plant record refines our understanding of Western Interior Seaway coastal vegetation during the Middle Cenomanian. Combining this dataset with ongoing work on the diverse vertebrate record in these same deposits allows for refinement of the complex ecosystems of the time.

P-016 - Palynochronostratigraphy and depositional paleoenvironment of Codó Formation, Aptian, Parnaíba Basin, Brazil

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The siliciclastic deposits of the Codó Formation have important potential generators of the Lower Cretaceous of the Parnaíba Basin. The temporal positioning and the understanding of the depositional paleoenvironment and paleoclimate through the identification of age and environment diagnostic palynomorphs help in the characterization of the formation. Based on the study of 44 samples from well 9-PAG-8-MA, drilled by Petromisa in Joselândia (MA), it was possible to understand the formation in this region of the basin. From the palynofloristic association analyzed, 96 different palynomorph species were identified, predominantly of continental origin, with good representation of the genera *Afropollis*, *Araucariacites*, *Cicatricosisporites*, *Classopollis*, *Crybelosporites*, *Deltoidospora*, *Equisetosporites*, *Gnetaceaepollenites* and *Sergipea*. The presence of the guide species *Sergipea variverrucata*, *Gnetaceaepollenites pentaplicatus* and *Equisetosporites maculosus* allowed the biostratigraphical position of the strata in the P-270 and P-280 biozones of the standard palynostratigraphic framework for the Brazilian Cretaceous deposits, corresponding to the Aptian. Dinoflagellates of the genus *Subtilisphaera* were identified, attesting to the occurrence of marine ingressions along the sedimentation, and reworked palynomorphs from the Devonian, represented by the genus *Maranhites*. The results of the analyzes show that the sediments of the Codó Formation were deposited in a predominantly continental environment (fluvial-lacustrine), grading to a transitional coastal to restrict marine environment, with records of peaks of marine ingressions and under an arid to semi-arid paleoclimate,

evidenced by the predominance of palynomorphs of the genera *Classopollis*, *Gnetaceaepollenites* and *Equisetosporites*. Two semiarid phases were evidenced by the increase in the relative frequency of *Crybelosporites* and *Cicatricosisporites*. In these intervals, there is a reduction in salinity, suggested by the increase in the relative frequency of *Afropollis* and decrease in *Classopollis*. The palynofloristic content identified presents characteristics that allow its inclusion in the palynofloristic province *Dicheiropollis etruscus*/*Afropollis*.

Poster session C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

P-017 - Plant macrofossils from the aftermath of the end–Triassic extinction, Skåne, southern Sweden

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In the last two centuries, plant remains from Skåne, southern Sweden, have been collected, curated, and studied. Particular attention has been paid to fossil plants from the late Triassic and Early Jurassic given that the end-Triassic mass extinction occurred at this boundary which triggered a significant turnover of vegetation. However, the paleoflora from the lowermost part of the Helsingborg Member, Höganäs Formation (Lower Jurassic: Hettangian) is poorly understood. Here, a taxonomic study is presented of two novel plant assemblages collected from the Boserup beds (latest Rhaetian-earliest Hettangian transitional beds) in Norra Albert Quarry, Skåne. The exposures in Skåne are among the few localities in the world that record the terrestrial ecosystem aftermath of the end–Triassic extinction event. Plant macrofossils were studied using macrophotography and fluorescence microscopy. The flora is composed of sphenophytes (*Neocalamites* sp.), ferns (*Cladophlebis* sp., cf. *Eboracia*), ginkgophytes (*Czekanowskia* sp., cf. *Pseudotorellia*, cf. *Ginkgoites*), and conifers (*Pityophyllum* sp., *Brachyphyllum* sp.). A comparison with the Rhaetian Bjuv Member and the Hettangian Helsingborg Member floras is presented, revealing a relatively low-diversity-flora in the aftermath of the end-Triassic extinction but a fast recovery later.

Poster session C02 The Legacy of Plant diversity and environmental background across the critical intervals of the Mesozoic

P-018 - The Upper Triassic plant fossils and palynomorphs of the Polzberg Konservat-Lagerstätte in Austria

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The Upper Triassic Polzberg *Konservat-Lagerstätte* in the Northern Calcarous Alps (Austria) is famous for its exceptionally preserved marine invertebrates (e.g., ammonoids, belemnoids, bivalves, arthropods, gastropods, branchiopods, crustaceans, polychaetes, conodont clusters) and vertebrates (e.g., acytinopterygians and cartilaginous fishes among others). These were deposited under calm and oxygen-depleted conditions on the sea floor. However, the Reingraben Shales preserve also plant remains washed in from the islands. These plant remains are dominated by plant debris and conifer remains. The conifer shoot fragments belong to the genus *Voltzia*, broad leaf fragments to two different morphotypes of *Pelourdea*. Also putative *Elatocladus*-type of conifer shoots are present. The palynological assemblages of the Reingraben Shales include terrestrial and marine palynomorphs (spores, pollen and acritarchs and dinoflagellate cysts respectively). The sporomorphs reflect a much more diverse regional flora then reconstructed from the plant macrofossils. The spores belong to ferns and cycadophytes typical of a swamp or marsh vegetation whereas the Circumpolles and bisaccate pollen grains are typical of a coastal pioneer vegetation and interland upland elments. Acritarcs and algae are the marine elements.

P-019 - Comparison between palynological and macrofossil plant records from the Upper Triassic Poręba site in south-western Poland

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Poręba is a recently discovered Late Triassic plant-bearing and vertebrate bone-bearing locality in south-western Poland (Upper Silesia). The outcropping strata belong to the upper part of the Patoka Member of the Grabowa Formation. Plant macroremains are numerous but belong almost exclusively to conifers. *Brachyphyllum-Pagiophyllum* leafy shoots predominate and their associated female seed scale–bract scale complexes and male cones are also present but very rare. Male cones have pollen grains preserved in situ in pollen sacs. Frequently found wood fragments also belong to conifers. The palynology of this site is still under investigation; the data published so far are rather cursory but have allowed the site to be dated as of Norian age. In the sporomorph assemblage, besides numerous conifer pollen (especially *Classopolis* and *Tradispora*) there are spores of lycopsids (numerous *Densosporites*, *Anapiculatisporites*), sphenopsids (*Calamospora*) and ferns. Also frequent are megaspores of heterosporous lycopsids. The anatomy of preserved conifer macroremains point to a rather dry climate. Sporomorphs show that numerous hygrophilous plants were present, but have not been recorded as macroremains; this is especially true for heterosporous lycopsids represented by numerous micro- and megaspores. This taphonomic bias is interesting, considering that the fossil-bearing sediments are mudstones and siltstones of a braided river system. Hygrophilous plants probably grew along rivers and waterbodies but, surprisingly, their macrofossils are not present at the Poręba site. Additionally, a large amount of well-preserved phytoclasts were observed on palynological slides. They represent small fragments of plant cuticle, wood remains, and isolated tracheids.

The Late Triassic saw important evolutionary innovations and plant diversification. New data from Poland widen our understanding of floristic changes soon before Triassic-Jurassic boundary mass extinction.

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P-020 - New Triassic plant-fossil assemblages from the Prince Albert Mountains, East Antarctica

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The Transantarctic Basin system records an up to 4-km-thick sequence of Palaeozoic and Mesozoic sedimentary rocks that contain significant fossil deposits. Of particular interest are Permian and Triassic plant fossils that include both silicifications and cuticle-bearing compressions, allowing detailed investigations into the systematics, biology, and ecology of Permian and Triassic vegetation in the high latitudes of Gondwana. During the 13th GANOVEX Expedition 2018/2019, new Triassic plant-fossil deposits were discovered in the Prince Albert Mountains. The most species-rich assemblage comes from a small, unnamed nunatak west of Timber Peak; it contains five species of the seed-fern frond *Dicroidium* with associated pollen organs (*Pteruchus africanus*) and dispersed seeds (*Feruglioa*) as well as the conifer *Heidiphyllum elongatum* and other seed-fern leaves (*Dejerseya lobata, Linguifolium* spp.). Another horizon from this site yielded large quantities of excellently preserved cuticles of a single *Dicroidium* species with needle-like leaflets. Further plant-fossil assemblages occur along the edge of the Polar Plateau southeast of Timber Peak; in addition to one level with strongly altered compression remains of *Heidiphyllum* and *Linguifolium*, there is a mass accumulation of two foliage species—one needle-like *Dicroidium* species and a narrow-leaved *Linguifolium* species—with associated dispersed seeds (*Feruglioa* and *Carpolithus* respectively) and a tiny *Pteruchus* species. In addition, another species-rich plant fossil assemblage was found at Benson Knob in the Ricker Hills, southern Prince Albert Mountains, consisting of four *Dicroidium* species and minor occurrences of *Heidiphyllum*, *Linguifolium* and horsetails. The study of these new sites reveals an even greater diversity of the Triassic floras of the Transantarctic Mountains than previously known. Moreover, the species-poor assemblages in particular offer great potential for reconstructing organ relationships and thus contributing to whole-plant reconstructions. Together, this promises to lead to a better understanding of the polar forests of Gondwana during the Mesozoic era.

Poster session C05 Recent advances in the study of Cretaceous angiosperms

P-021 - The stepwise rise of angiosperm-dominated terrestrial ecosystems

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Flowering plants are the most recently diverging major clade of land plants. They rapidly diversified during the mid-Cretaceous, but only reached ecological expansion and prominence in the late Cretaceous and Paleogene, with considerable spatiotemporal heterogeneity. Although the angiosperm terrestrial revolution restructured terrestrial ecosystems towards a modern appearance from the late Cretaceous onward, the majority of extant angiosperm genera and species that make up the modern terrestrial biodiversity only evolved since the late Paleogene. Here, we summarize when and how angiosperms shaped terrestrial ecosystems, leading to the formation and development of modern-type angiosperm-dominated floras and latitudinal diversity gradients. We highlight six major phases of angiosperm evolution that took place against a background of dynamic palaeogeography and global climatic changes.

Poster session C05 Recent advances in the study of Cretaceous angiosperms

P-022 - From Shoreline Survivors to Upland Champions: The Rise of the Adaptable Angiosperms in the Late Cretaceous of Bohemian Cretaceous Basin, Czechia

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Imagine the Late Cretaceous: a world dominated by dinosaurs, yet silently witnessing the rise of a new dynasty: the angiosperms, conquering diverse habitats from salty shores to sun-drenched plains. In locality Pecínov (Czechia), we utilized a multifaceted approach, studying plant adaptations across an environmental gradient encompassing braided rivers, salt marshes, and mangrove-like coasts. Combining leaf morphology with compound-specific stable carbon isotope analysis revealed fascinating insights.

On harsh coastal realms, *Pseudoasterophyllites cretaceus*, a small herb, thrived in high salinity. Its succulent leaves and epidermal papillae suggest resilience against water stress and salty spray. Nearby, the shrub-like „*Diospyros*“ *cretacea* displayed a contrasting strategy: thick cuticles suggesting efficient water management, coupled with potential CAM photosynthesis for enduring fluctuating salinity and drought in marginal salt marshes.

Shifting our focus towards drier landscapes, we meet *Papillaephyllum labutae,* a coriaceous angiosperm thriving in uplands. Its robust cuticle and resin-filled papillae are suggesting adaptation to environments with limited water availability. In contrast, *Ascarinophyllum pecinovense*, reveals that it likely thrived on river valley slopes or floodplains, with its wider range of isotopic values reflecting its exposure to a combination of salinity and drought stress depending on its specific location.

Venturing into the realm of freshwater-fed habitats, we encounter the Lauroid leaves, represented by *Myrtophyllum geinitzii* and *Eucalyptolaurus* sp.. Their thin cuticles and light isotopic signatures suggest minimal water stress while growing in moderate conditions offered by alluvial braided river plains. Similarly, *Ettingshausenia laevis*, a platanoid foliage, and its associated reproductive structures thrive in these relatively non-stressful habitats of the floodplain, supported by their delicate cuticles and light isotopic values.

By combining morphological and biogeochemical approaches, this study demonstrates the effectiveness of such a multifaceted strategy in achieving individual plant habitat reconstructions. This opens doors for further exploration of past plant communities and environmental dynamics across diverse ecosystems.

P-023 - New material of Coniopteris simplex from the Middle Jurassic of the Ordos Basin, Inner Mongolia, China and implications on its spatio-temporal distribution and paleogeography

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Coniopteris simplex is a common component in many Jurassic floras. However, due to morphological variations in sterile fronds and incomplete preservation of reproductive organs, its classification has been controversial for a long time. Here, we present new material collected from the Middle Jurassic Yan'an Formation in the Ordos Basin, Inner Mongolia. The new material reveals important morphological characters, including hemi-dimorphic fronds, two forms of sterile pinnae, short-stalked sori and sporangia on fertile fronds, annulus of sporangium composed of about 30 cells, *in situ* rounded triangular spores with protruded suture, and the lips of trilete laesura encircled by one or two rows of small ostioles. Based on these observations, we emend the diagnosis of this common species. The tempo-spatial distribution of *C. simplex* shows that the iconic species was restricted to the paleolatitudes ranging from 19.5° to 48.9° in the Northern Hemisphere during the Early-Late Jurassic, mainly distributed in the tropical to paratropical zones, and the paleolongitude ranging from 9.6° E to 129.3° E, which may be limited by the opening of the Viking Corridor and the splitting of the Central Atlantic Ocean.

P-024 - New research on Cretaceous fossil wood in Jiaolai basin, Shandong Province and its Palaeoclimate implications

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Cretaceous fossil wood are very well preserved and widely distributed in China. 65 species of 29 genera have been reported until now. Cretaceous wood fossils are distributed in Northeast China, Yunnan Province, Inner Mongolia Autonomous Region, Heilongjiang Province, Shandong Province, Zhejiang Province, and Tibet Autonomous Region. However, in Shandong Province Cretaceous fossil wood are rarely documented. So far, only 2 species of 1 genus were reported. In this paper new materials of fossil wood are described from the Early Cretaceous Zhifengzhuang Formation of Laiyang group in Jingzhi area of Anqiu City, Jiaolai Basin, Shandong Province. The present specimen has araucarioid radial wall pittings, araucarioid cross-field pitting and other characters. This discovery contributes to a better understanding of fossil wood diversity in Jiaolai Basin during the Cretaceous period. The paleoclimate of the Early Cretaceous in Shandong Province can be analysised by the well preserved growth rings of these specimens.

P-025 - Palynoflora and in situ pollen grains from Wólka Bałtowska, Upper Jurassic, Poland

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Wólka Bałtowska is a unique Upper Jurassic locality in Poland (north-eastern margin of the Holy Cross Mts.) with macrofossils, dinoflagellate cysts and spores and pollen grains (Liszkowski, 1972, Gedl & Ziaja, 2004). The plant macro- and microremains derived from epicontinental sea islands and are preserved in oolithic limestones. Palaeobotanical research on material from this site is proceeding. The dispersed spores and pollen grains from six samples are not diverse. Fern spores are infrequent: e.g., single specimens of *Cyathidites* (Cyatheaceae or Dicksoniaceae), *Gleicheniidites* (Gleicheniaceae) and *Klukisporites* (Schizaeaceae). Among the pollen grains, *Eucommiidites* from Erdtmanithecaceae and *Alisporites* from seed ferns were found. Pollen grains of conifers are dominant, mainly *Classopollis* (Cheirolepidiaceae), *Araucariacites* and *Callialasporites* (Araucariaceae). Bisaccate pollen grains (e.g., *Podocarpiidites* and *Pinuspollenites*) are also present. *Classopolis* pollen grains are sometimes preserved in undivided tetrads, and some tetrads show size differences in pollen grains, which according to Kürschner et al. (2013) may indicate environmental disturbances. Pollen grains from Araucariaceae often occur in clusters, which may indicate land proximity. The same kind of pollen grains are present *in situ* in pollen sacs of a male cone found among the specimens of macroflora. Probably this cone belonged to the parent plant of dispersed *Araucariacites australis*.

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P-026 - Floristic changes in a Peruvian montane forest in response to climate change and anthropogenic activities between ~1003 – 383 BP

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The Pomacochas Lake is situated in the eastern Andes (5°49'16" S, 77°57'22" W), with its waters draining into the Amazon Basin and being influenced by the South American Monsoon System (SMSA). This region has been inhabited since pre-Hispanic times by various human groups, including the Chachapoyas (~1150 – 480 BP). Our study focuses on the sedimentological, XRF and palynological records of Pomacochas Lake, aiming to describe the floristic composition and lake dynamics from ~1003–383 BP. This interval includes part of the Medieval Climate Anomaly (MCA) and the first half of the Little Ice Age (LIA). The palynoflora

recorded in the sediments is diverse, including vegetation from swampy areas, grasslands and crops, shrubs and meadows, pre-forests, and forests. Analysis of the floristic changes, combined with sediment elemental composition, indicates that during the MCA, Pomacochas Lake experienced a dry environment and a low-water level lake with a singular intense rainfall event recorded. This period sustained a diverse grassland-dominated flora in the lake´s surroundings. In contrast, during the first half of the LIA, the environment became more humid, leading to a higher water table in the lake. This allowed the development of a more homogeneous but less-diverse flora dominated by Alnus. We found that the ecological legacy of the Chachapoyas, including Alnus associated with pre-forest and maize cultivation around the Lake Pomacochas, existed at this time. Finally, the relative abundances of certain species such as Poaceae and Alnus, as well as the Ti/Al ratio, suggest that the lake sediments also preserve information related to changes in the intensity of the SMSA during the study period.

Keywords: Pollen, Elemental Composition, Paleoecology, Chachapoyas, Medieval Climate Anomaly, Little Ice Age

Poster session H01 Quantitative reconstruction of Holocene land-use and land-cover change: advances and applications

P-027 - Pollen to pixels: Working towards geospatial vegetation reconstructions in complex Tasmanian environments

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First Nations land activities, such as cultural burning, can explain ancient vegetation structures and patterns in many regions. Our work aims to spatialise the palynological signature left by millennia of First Nations cultural landscape activities across Tasmania and Australia. However, traditional palynological study must evolve through novel quantification and spatialisation techniques to achieve this goal. This poster introduces a recently developed approach for spatially reconstructing vegetation, The Extended Downscaling Approach (EDA), to the complex topographical landscapes of western Tasmania.

Our methodology involves 1) merging several abiotic spatial datasets, including elevation, slope, aspect, landscape roughness, and soil types; a calculated Topographical Wetness Index, Mass Balance Index, and averaged solar irradiation and wind trajectories, into a single spatial dataset providing bespoke landscape classes. 2) Region-specific pollen productivity estimates (PPEs) and fall speeds for 19 Tasmanian PPE taxa. 3) Pollen records spanning the Holocene from 18 different sites across western Tasmania, and 4) Current vegetation survey data. By running the EDA with the data from components (1–3), PPE vegetation is assigned percentage cover to our landscape classes until the modelled pollen deposition from the landscape best matches the 18 pollen records.

Comparing percentage vegetation cover data from the EDA outputs of lake surface pollen against current vegetation survey data (4), we aim to validate the EDA's ability to reconstruct vegetation within western Tasmania's complex topography. Upon validating our model, we aim to begin disentangling climate from anthropogenic controls on vegetation composition in a novel spatial manner, a first for the Southern Hemisphere, providing valuable insights into the practices that have shaped *Country* (First Nations term to describe the interconnections between place and people).

P-028 - The Sybaris Plain (Italy) evolution during the late Holocene: The interplay of climatic, hydrological and anthropic factors

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Coastal deltaic plains are sensitive environments to climatic and anthropogenic changes. Natural processes (e.g. land subsidence and sea level rise) are often associated with the anthropogenic pressure of past populations in the land-use and exploitation of resources, often difficult to discriminate. Nowadays the human impact in coastal subsiding plains is exacerbated by the water pumping and the land salinization. The Sybaris Plain (north-eastern Calabria, Southern Italy) is a perfect case study of a coastal subsiding plain in the Mediterranean basin. The plain was inhabited since the Early and Late Neolithic and becomes afterwards part of the agrarian and funerary landscape of the Greek colonies of Sybaris and Thurii. After the Roman colony of Copiae the area was inhabited also during the Medieval and early modern times. A sediment core (S4 TER, 39°73'N; 16°40'E, at 13 m a.s.l) was recently drilled for the paleoenvironmental reconstruction of the plain. Lithological and palynological analyses are associated with 3-cm spacing magnetic susceptibility measurement and radiocarbon dates. Results of pollen analysis show different phases of the vegetation cover, from swamps and marshy lagoon surrounded by a belt of humid trees (e.g. *Salix* and *Alnus*) to open environments dominated by herbaceous plants. Pollen of Cichorieae, in combination with the presence of microcharcoals and fungi spores, point out the presence of pastoralism and human impact on vegetation, as confirmed by the archaeological evidence. Fast lithological changes between gravels, sands, and silts with peat levels, confirm different hydrological assets of the plain during the last millennia. Nowadays natural hazards like the swamping and flood hazards events, affect the plain. Investigate the environmental evolution through time and the human resilience in these areas could be useful to identify key signals in the fossil record.

P-029 - Vegetation changes and grassland history during the last 3000-years in the Hiruzen region, the Chugoku Mountains, western Japan

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The Hiruzen region, which located in the Chugoku Mountains on the western part of Honshu Island, Japan is known as open grassland landscape. Even forest vegetation is dominant in Japan, there were semi-natural grasslands maintained by mowing and controlled fire, to feed draft animals and get grass fertilizer etc. until 1960's, in this region. Although semi-natural grasslands are decreasing with changes of lifestyle and social system, grassland patches are still conserved as a cultural landscape and habitat of endangered species. To elucidate human impacts on vegetation and history of semi-natural grasslands, sediment samples from four sites in the Hiruzen region were analyzed for pollen, charcoal and phytolith. Pollen and phytolith records from the Yohkaichi (440m a.s.l.) suggest that open landscape had been developed before ca. 3800 cal yr BP. Pollen and charcoal records from the Tendani (590m a.s.l.) suggest that *Quercus* subgenus *Lepidobalanus* forest had been developed before ca. 1100 cal yr BP. At ca. 1100 cal yr BP, *Q*. subgenus *Lepidobalanus* pollen decreased markedly, and Poaceae and *Artemisia* pollen increased coincidentally with an increase of charcoal. Pollen and phytolith records from the Ikeganaru (600m a.s.l.) indicate that woodland of *Q.* subgenus *Lepidobalanus* with dwarf-bamboo changed to open *Miscanthus* grassland at ca. 1000 cal yr BP. Charcoal and pollen records from the Orogatawa (680m a.s.l.) show that *Q*. subgenus *Cyclobalanopsis* and *Lepidobalanus* forests with *Fagus crenata* had been developed at ca. 3000 cal yr BP. From ca. 1900 to 700 cal yr BP, *Q*. subgenus *Cyclobalanopsis* decreased coinciding with charcoal increase. After ca. 1000 cal yr BP, *Q*. subgenus *Lepidobalanus* started decrease, and Poaceae, Compositae and *Artemisia* pollen were

increased. These records suggest that open landscape was previously established at lower elevation, and then expanded to higher elevation, and grassland landscape has at least 1000-year history in the Hiruzen region.

Poster session H04 Back to the Future? Sub-boreal vegetation and climate as a reference for future environmental dynamics

P-031 - The importance of pollen deposits in rare peat habitats of Southeast Europe – A case study from continental Croatia

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Rare peat bogs in the area of the southern part of Central Europe and the Balkan Peninsula were insufficiently researched. Therefore, the aim of this work was to analyse one of the few such areas with preserved palynomorph deposits in continental Croatia, on the border of Central and South-eastern Europe. A pollen deposit (in a 210 cm long core) from the largest mire in mid-continental Croatia (Đon Močvar) served as a case study. According to the 14C AMS dating, the deepest section of the core belongs to the Preboreal interval (~9800 cal yrs. before present). The interpretation of vegetation dynamics in the narrow area of Central Croatia was based on the analysis of 31.036 pollen grains (76 pollen taxa). The following local zones were identified: *Pinus – Fagus/Quercetum* mixtum (210–175 cm), *Fagus – Corylus* (175–150 cm), *Alnus – Fagus* (150–95 cm), *Alnus-Fagus/Quercus* (95–75 cm), Poaceae – *Fagus/Quercus* (75–45 cm) and Poaceae – *Carpinus/Quercus* (45–5 cm). Local mire communities form the next subzones: Cyperaceae – Polypodiales (210–180 cm), Polypodiales – *Sphagnum* (180–90 cm), *Sphagnum* – Polypodiales (90–40 cm) and Cyperaceae (40–5 cm). On the regional level, during the first thousand years *Pinus* dominated in the woodlands, later on succeeded by *Fagus* forest with extra local domination of *Alnus*, and finally by mosaic of *Carpinus* forest and grasslands. On the local level, the next transition was observed: from the sedge-dominated mire, through the alder carr with peatland dominated vegetation, and again the sedge dominated mire. Although the high share of non-arboreal pollen, type was observed from the 6th century AD (Migration Period), direct human impact on vegetation (e.g. Cereal pollen) can only be traced from the Late Middle Ages. This research should complete data and knowledge about the dynamics of vegetation on the border of Central Europe and the Balkan Peninsula.

Poster session H05 Changing Island Ecosystems

P-032 - Holocene vegetation dynamics in large islands of the Mediterranean

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During the last few decades, palynological research highlighted the exceptional value of islands sedimentary archives to trace long-term effects of climate changes and human impact on isolated vulnerable ecosystems. This is of particular interest for the large islands of the Mediterranean, globally known as biodiversity hotspots under the ever-increasing threat of climate warming.

Our study provides a comprehensive review of pollen records from the largest islands of the Mediterranean Basin, namely Sicily, Sardinia, Corsica, Crete, and Balearic Islands. The aim is to define the role of natural environmental changes and human pressure in the evolution of mediterranean vegetation, and identify long-term palaeoecological trends in island ecosystems.

We performed Bayesian age-depth modelling for each pollen record, to provide an accurate and consistent age estimation method, enabling the direct comparison of vegetation dynamics across multiple sites.

Our analysis reveals a complex vegetation history, often influenced by the legacy of floristic associations dating back to the Pleistocene. Millennial-scale climate changes mostly related to insolation produced a progressive transformation in vegetational patterns of these islands, with a direct influence on fire regime. Rapid Climate Changes (RCCs) exerted dramatic effects on forest ecosystems, especially when associated to drought, leading to deforestation. However, it is interesting to note that the past vegetation of some sites remained unchanged. This can be explained by both a complex geographical expression of major RCCs and the resistance and resilience of some vegetation types to climate perturbations. Impact of human activity on island ecosystems dates to the Neolithic, but in most cases human-induced woodlands depletion manly occurred since the Roman period.

P-033 - Rain forest dynamics under changes in climate and human impact during the past millennia in northern Madagascar

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Although it is obvious that humans substantially altered ecosystems, the timing of the arrival of humans in Madagascar as well as their impact is not well resolved. In this context, this research aims to study the influence of early human impact and climate change on rain forest dynamics in northern Madagascar. Palaeoenvironmental reconstructions from lake sediments in a montane environment support a major drought 1,100 years ago. This drought caused significant changes in lake levels and vegetation dynamics. Human impact, evidenced by fires, started a few decades later. Limited to the low-altitude areas, fires were therefore not the driving force behind these early changes observed in the lake catchment areas. Although this does not dismiss the strong impacts humans subsequently had on the Malagasy ecosystems, this demonstrates that the late Holocene drought significantly impacted the ecosystems independently of anthropogenic activities. This research points to the importance of a multi-site and multi-proxy comparison for deciphering the nature and succession of past environmental changes.

P-034 - Composition and diversity of pollen collected by stingless bees (Tetragonula laeviceps) in different rainforest transformation systems on Sumatra

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Large-scale transformation of tropical forests is associated with critical loss of habitat and ecosystem functions. Elucidating plant-pollinator interactions is paramount to understand ecosystem dynamics and assess the impact of habitat fragmentation. Stingless bees (Meliponini) represent an important group of animal pollinators in tropical ecosystems. However, knowledge on stingless bee plant-interactions, e.g. diet and flower-visiting behaviour, is still limited. Furthermore, the impact of rainforest transformation on specific bee species and their developmental plasticity has received little attention so far. In this study, we analyse pollen collected by worker bees of *Tetragonula laeviceps* in four distinct land-use systems (rainforest, shrub, rubber and oil palm) via light microscopy. We test for differences in pollen diversity and composition between land-use systems and examine influences of landscape heterogeneity (Edge Density) and amount of surrounding forest cover. Palynological analysis reveals a variety of foraging resources, including native tree taxa, cultivated crops and weeds. Samples are largely dominated by one or two pollen types, reflecting the high floral constancy of *T. laeviceps.* Non-metric multidimensional scaling (NMDS) shows no clear differentiation in pollen composition between land-use types. Instead, compositional changes are associated with the forest cover gradient representing the surrounding landscape. These findings reflect the generalist foraging habit of *T. laeviceps* and confirm the role of stingless bee pollen as proxy for landscape connectivity.

P-035 - Late Holocene vegetation and environmental dynamics in Tripa Peat Swamp Forest – Leuser Ecosystem, Aceh, Indonesia

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The Tripa Peat Swamp Forest (TPSF) is a part of the Leuser Ecosystem in Aceh Province, Sumatra, Indonesia. It is known as one of the largest carbon stocks in Sumatra and a biodiversity hot spot that provides environmental services to the community, but it is now threatened by land use change, especially for oil palm plantations. Peatland conversion has already fragmented the primary peat swamp forest which is a habitat for the critically endangered Sumatran Orangutan (*Pongo abelii*) and caused severe haze and air pollution due to forest and land fires. Human activity has been recorded since the 15th century indicated by an archaeological site of the *Seuneuam* Kingdom. The TPSF is also located near the coastal zone and ancient volcanos. Vegetation and environmental dynamics since the Holocene period in this location is poorly studied. For palaeoecological studies a 2.5 m long peat core was collected in 2022 and pollen, spores, and Non-Pollen Palynomorphs (NPPs), as well as microcharcoals were analysed. To understand the local fire regime, macro-charcoal has been analysed separately. Chronology of the peat core ages were determined by radiocarbon dating of 5 samples. There are two main periods: between 2237 and 1582 cal yr BP, at the beginning occurred a mix of dipterocarp – peat swamp vegetation types in the study area followed by a *Pandanus*-dominated peat swamp. In the second period after 1582 cal yr BP, the study area was dominated by a more stable and climax plant community of the family Anacardiaceae, Myrtaceae, and Fagaceae. At the TPSF, natural disturbances such as volcanic eruptions, affect the vegetation and ecosystem in the first period and human activity acts as a disturbance factor in the second period.

Keywords: Palaeovegetation, Leuser, Tripa, Seuneuam Kingdom, peatland

P-036 - Early Miocene plant diversity in fluvial and lacustrine environments of the Colombian Amazon

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About 40 percent of the area covered by tropical rainforests is situated in the Amazon. However, the Amazon is under threat, and species are facing a large-scale extinction. To effectively predict and plan for protection, it is important to know how the extremely rich species richness in the Amazon evolved over time. In the Miocene, the western Amazon was characterized by a fluvial landscape and a mega-wetland known as the 'Pebas System'. These ecosystems were highly species-rich both in terms of fauna and flora. In this study, we conducted a high-resolution palynological analysis to reconstruct past plant diversity on samples from the Agua Negra section (Yari River) and La Tagua section (Caquetá River). These study sites are situated on either side of the Paleozoic Tablemountains (Serrania de Chiribiquete) and were provisionally dated as early Miocene. We also performed a provenance study, by means of a geochemical analysis, to investigate the former connectivity between the sites and determine the sediment source area (i.e. Andes and/or Amazon craton). Tentatively, the palynological assemblage suggests that the environment in the early Miocene western Amazon was a tropical humid forest and swamp vegetation with no indication of marine influence. Our data will provide information on past plant diversity and vegetation dynamics during a phase of global warming and provide an analogue for scenarios of future global warming.

P-037 - Palaeoecology, Palynology and Palaeoethnobotany of two prehistorical Rock Shelters from the Muota Valley, Canton of Schwyz, Switzerland

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Palaeoecological analyses of Palaeolithic/Mesolithic rock shelters are rare for Europe. Since 2006, archaeological prospections/excavations were perfomed in the Muotathal (Switzerland) with financial support of the Canton of Schwyz. Here we present palynological and palaeoecological results for two anthropogenic rock shelters inhabited in multiple summers throughout prehistory. The dry rock shelter of Flözerbändli is famous for its unique/decorated antler fragment (Epi-Palaeolithic 10519–10028 BC). During Early Mesolithic the local vegetation consisted of a mixed forest containing pine, birch, juniper, alder, lime, and hazelnuts, the latter were revealed to have been an important staple food. Also, some charred seeds of herbs (*Hypericum* cf. *perforatum*) point at the possible use as plant remedies. Interestingly, yew wood (*Taxus baccata*) was used as firewood in the rock shelter as revealed by abundant charcoal finds. This may hint at the intentional use of this wood by prehistorical people not wanting to be detectable themselves through clouds of smoke, given that yew wood is burning in a relatively smoke-free way. The palynological context confirmed the typical Younger Dryas and Early Holocene flora and vegetation expectable in central Alpine valleys at 740 m a.s.l.. In addition, micro-algae finds (*Trachelomonas*/*Mougeotia)*, living in stagnant water, do point to the transport of water to the rock shelter, possibly using leather or birch bark vessels. The second, nearby rock shelter Steinweidband was also used from the Mesolithic until Modern Times, but did provide less palaeoecological results. However, some unusual finds (charred stems from *Equisetum hyemale)* dated to the Medieval Period (AD 1025–1150), revealed the use of this cryptogam by people. Given that this plant is growing in alluvial environments near the Muota River, far below the rock shelter, an intentional carrying uphill has to be implied. Most likely, these poisonous stems were used for polishing metal/wood, or as an anti-inflammatory/immune remedy against coughs.

P-038 - Past climate reconstruction based of biotic proxies and stable isotopes using the peat archive of the largest West-Carpathian bog

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The past climate changes may provide lessons for understanding current anthropogenic global climate change. Ombrotrophic bogs are excellent ecosystems for climate humidity reconstruction, in which the water table depth (WTD) varies exclusively with the balance between precipitation and evapotranspiration. We selected the largest West-Carpathian bog, Puścizna Wielka, to trace long-term local ecosystem development and changes in species composition of hydrological indicators such as testate amoebae (TA) and plants preserved as plant macrofossils (PM) and pollen (PO), together with δ13C in Sphagnum stems as another proxy of moisture conditions. Transfer functions calibrated by the recent relationships between the WTD and species composition of TA and PM were applied to quantify climate-induced hydrological changes. All these reconstructions were compared against the selected climate variables from the downscaled CCSM3 model. Locally, the Scheuchzeria-Sphagnum (sect. Cuspidata) peat with the oldest testate amoebae shells, mostly Archerella flavum, started to accumulate ca 7000 cal years BP. The most distinct change occurred at the Middle/Late Holocene boundary (ca 4300–4200 cal BP), when the permanent hollow was transformed into the bog lawn with Sphagnum magellanicum and Eriophorum vaginatum with species-rich TA communities. The distinct decrease of Picea and increase of Abies pollen were 100-200 years delayed. Quantitative reconstruction of the high-resolution record of TA has shown several distinct decreases of the WTD, which correlated with the δ13C values (ca 500, 900, 1900, 2100–2300, 3050, 3200 and 4300–4500 cal BP). From tested climate variables, annual precipitation best correlated with δ13C and TA-inferred WTD. Contrary, WTD inferred from the PM was sometimes idiosyncratic, plausibly because of the slower and less sensitive response of long-lived

plants contrary to short-lived microscopic TA. The S. rubellum hummocks with dwarf shrubs and TA taxa Assulina muscorum or Hyalosphenia elegans, which dominate the bog recently, have developed as late as ca 350 cal BP.

Poster session H07 The past and future of mountain ecosystems: perspectives through palaeoecology

P-039 - The role of humans in the long-term dynamics of a mountain ecosystem: A preliminary report from the Pelister Mountains (North Macedonia)

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Although the vegetation, climate and settlement history in the southern Balkans has been studied for decades, continuous sedimentary records covering the entire Holocene are still scarce. Furthermore, this area is known for its growing archaeological record, which allows it to be confronted with palaeoecological data. As a result, there are many unresolved questions about the Holocene vegetation development and human-environmental interactions in this part of the Balkans. Here we present a new palaeoecological record from a mountain peatland located in the Pelister Mountains (North Macedonia). The base of the record clearly captures an open glacial landscape with *Artemisia*, Chenopodiaceae and Poaceae. Early Holocene is characterized by a gradual expansion of mixed deciduous forest (composed mainly of *Alnus*, *Corylus* and *Tilia*) and a decrease in steppic vegetation. The presence of demanding tree species (such as *Quercus*, *Fraxinus* and *Ulmus*) in the early part of the Holocene can be related to favorable climatic conditions in the area, which allowed the tree expansion from nearby refugia. Secondary anthropogenic indicators (Cichorioideae, *Rumex* type) and fungal spores appear at ca. ~8.0 ka BP. High percentages of open-land vegetation (e.g. Chenopodiaceae, Poaceae) together with presence of cereals, coprophilous fungi (*Sporormiella*-type, *Delitschia*-type) and increase in charcoal since ca. 4.0 ka BP suggests intense pastoral and arable activities during the Late Holocene. Overall, it has been confirmed that mountainous areas of North Macedonia provide a valuable record of environmental changes that is important for further paleoenvironmental reconstructions in this area.

Poster session H07 The past and future of mountain ecosystems: perspectives through palaeoecology

P-040 - Human and climatic impacts on Holocene vegetation in the Southern Rocky Mountains, USA

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Forests in the Southwestern USA experienced major increases in fire activity and drought-related mortality during recent decades. These events are attributed not only to anomalously warm and dry conditions, but also to land-use changes including fire suppression. Maintaining mountain forests in this drought and fire-prone region requires understanding the long-term interactions among vegetation, climate, disturbance, and people. We developed a multiproxy record for Santa Fe Lake, New Mexico (3532 m a.s.l.), the southernmost natural lake in the Rocky Mountains. Subalpine *Picea* (spruce) forests surround the lake, with mixed coniferous forests, woodlands, shrublands, and grasslands downslope. The surrounding region is also home to long-established indigenous communities. Santa Fe Lake formed following the recession of alpine glaciers after 14,500 cal yr BP. Spruce forests arrived after 12,300 cal yr BP as the climate warmed. Abundant *Pinus* pollen, especially *P. ponderosa*-type, suggests regional upslope expansion of pine forests at this time. *Pinus* percentages are lower after 9000 cal yr BP when increasing spruce, *Abies* (fir), and *Pinus aristata*-type (bristlecone pine) and declining *Artemisia* (sage) indicate closed subalpine forests. Increases by first *Juniperus*-type (juniper) then *Pinus edulis*-type (pinyon pine) indicate pinyon-juniper woodlands expanded at lower elevations. Pulses of erosion indicated by detrital minerals, peaks in Polypodiaceae spores, and degraded pollen occur between 5100 and 3900 cal yr BP. Spruce and herbs typical of alpine meadows (e.g., *Veratrum*) increase after 3700 cal yr BP, when erosion declines, possibly due to increasing winter precipitation and a weakening North American Monsoon. However, charcoal influx increases, suggesting more regional biomass burning, especially after 2000 cal yr BP. *Zea mays* (maize) pollen first appears at 800 cal yr BP (1150 AD), coincident with

the onset of Puebloan migration. Maize pollen is present through 1600 AD when Spanish conquest brought cultural upheaval and population loss from indigenous communities.

Poster session H08 Success and Adaptation Strategies of Ancient Populations to Climate Changes

P-041 - Floodwater management strategies of Pre-Columbian societies in the Bolivian Amazon during the Holocene

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Pre-Columbian earthworks such as raised fields, habitation mounds and weirs are found throughout Llanos de Mojos, Bolivian Amazon. The Mojos is a 135,000 km^2 sub-basin Amazon that floods seasonally due to its low relief and comprises a vegetation mosaic of tropical forests, seasonally inundated savannahs, and permanent wetlands. The relict earthworks are hypothesised to have been constructed to, in part, manage floodwaters in this seasonal environment. Whilst previous palaeoenvironmental studies have focused on the impact of earthwork construction on the terrestrial components of this flooded landscape, few have investigated how aquatic environments were managed. Within the Mojos lies the Quinato Wetland (13°38‘46“S, 65°35‘04“W), a permanent wetland situated within a ca. 320 km long palaeoriver channel surrounded by the earthworks (raised fields, forest islands, and weirs). Previous investigations from the Quinato Wetland imply that societies adapted to increasing precipitation that occurred during the late Holocene through construction of earthwork weirs to manage floodwaters. This study uses a multi-proxy approach of charcoal, diatoms, pollen, and organic geochemistry and provides new evidence from two unpublished records, including one from a relict weir. The results obtained from these additional records aim to determine the extent that landscape modification has altered the ecology and hydrology of the wetland. Initial results suggest there were other factors beyond changing climatic conditions that resulted in the changes identified in the palaeoenvironmental records, suggesting past societies created and maintained these environments.

Poster session M01 Modern pollen-vegetation studies

P-042 - Subrecent pollen spectra and modern aquatic vegetation from the Kurgalsky Peninsula lakes, Baltic Sea, Russia

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First paleolimnological researches have been recently started on the Kurgalsky peninsula in order to reconstruct the Holocene history of two lakes, Lipovskoye and Beloye. Pollen data from the lake’s sediment are the main basis for paleoenvironmental reconstructions. An important question in such studies is how adequately the subrecent pollen spectra reflect modern vegetation and therefore how accurate are the paleoreconstructions. This especially significant for macrophytes which pollen are worse preserved and less common in lake sediments.

The lakes are located on the southern coast of the Gulf of Finland, Baltic Sea. Lake Beloye is a fully isolated ultra-oligotrophic lake with a developed community of the rare species *Lobelia dortmanna* L. Lake Lipovskoye still has a connection with the Baltic Sea. It is a brackish lake with both freshwater and brackishwater species. During few expeditions in 2019 and 2023, the species composition and spatial distribution of macrophytes were studied and over 30 surface samples were collected. Thus, we have tracked the long-term changes in the species composition of macrophytes.

According to the results of comparing the pollen data and floristic diversity, the species composition of submerged hydrophytes in Lake Lipovskoye and floating hydrophytes in both lakes are well reflected. The helophytes composition is weaker. Pollen of *Lobelia dortmanna* weren’t found in sediments of Lake Beloye. Qualitative diversity indices show an average level of similarity across all macrophytes for both lakes. Generally, subrecent pollen spectra reflect modern vegetation and partly reflect modern aquatic vegetation of the lakes. Now the research is continues. The results obtained provide a better interpretation of paleolimnological data.

This research was funded from grant of the Russian Science Foundation No. 23-27-00128.

P-043 - Distribution and sources of surface soil pollen in different coastal wetlands and their relationship with land cover: A case study of northwest Bohai Bay, North China

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Understanding the relationship between modern pollen and vegetation in coastal wetlands is essential for reconstructing long-term land cover changes, and for determining the response of coastal wetland ecosystems to global changes. We selected 68 sampling sites in different types of coastal wetland in northwest Bohai Bay, North China, for palynological analysis, and hence to determine the relationships between pollen and environmental factors, such as soil grain size, salinity, and pH. A back-trajectory model and remote sensing LUCC data were used to reveal the pollen source area and the pollen representation for different land cover types. The results show that the pollen assemblages of these coastal wetlands are dominated by Chenopodiaceae and Poaceae. The pollen assemblages are significantly different between silty and sandy coastal wetlands, and they also reflect different vegetation landscapes. Chenopodiaceae pollen is a potential indicator of saline-alkali soil environments in coastal areas. In addition to the vegetation coverage and sedimentary environment, pollen concentrations are negatively correlated with the grain size of the surface soil. The pollen diversity is higher in areas with strong human influences (e.g., cultivated land, villages, roads), but lower in natural wetlands with a high vegetation coverage. The arboreal pollen is generally sourced from the northern and northwestern mountains, while the major dispersal area of halophyte and hygrophyte pollen is on a local scale, constrained by the local vegetation canopy and its settlement characteristics. Fern spores are mainly waterborne, carried by rivers and surface runoff from mountain areas. The arboreal and upland herbaceous pollen is over-represented for forest and grassland landscapes. Halophyte and hygrophyte pollen show a good correlation with the area of coastal wetland, and they can be used as an indicator of the extent of coastal wetland influenced by climate change and human activities.

P-044 - Temporal and spatial changes in pollen-based climate reconstructions for Lateglacial and Holocene in mid-Baltic region

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Pollen-based reconstructions of summer and winter temperatures and precipitation, for the sites located in mid-Baltic region reveal trends in temporal and spatial variability of climate change during the Lateglacial (LG) and Holocene. The reconstructions utilized the Modern Analog Technique with a transfer function integrated with the Rioja package (Juggins, 2020) for R, employing the European modern pollen dataset (Davis et al. 2020). For the stratigraphical subdivision we used the LG and Holocene boundary sets proposed in Lowe et al., 2008 and Walker et al., 2019. Lacustrine sediments show that sites deglaciated simultaneously and therefore were chosen to represent S-N, and Baltic Sea-continental transects.

Lowest mean winter temperatures (MWT) were reconstructed for the site (Lieporiai paleolake) located in N Lithuania. During LG, MWT decreases to -18.1 ºC. MWT remained low during the Early and Middle Holocene, increasing to -15.2 ºC and to -8.5 ºC accordingly. Surprisingly, in the southernmost analysed point (Čepkeliai peatbog), reconstructions show the second coldest MWT during LG, though it is 4 ºC higher in comparison with northernmost site. For Kamyshovoye Lake (Kaliningrad region) located in the west, and Duksteliai paleolake, located in the east on the Baltic Sea- continental transect, one of the mildest MWT for LG period were reconstructed. In average, MWT variates from -6.1 ºC to -11.2 ºC for Kamyshovoye and from -12.6 ºC to -10.3 ºC for Duksteliai. Holocene MWT for these objects are also the mildest. However, the reconstructed summer mean temperatures exhibit contradictory trends with the warmest temperatures observed at north and south sites during LG and Early Holocene.

Opposing trends are observed between mean winter and summer temperatures for Duksteliai paleolake. The most pronounced ones are associated with increases in precipitation, notably at about 14000, 12700, 9700, 8400, 3200, 2700, 2400, and 1400 cal yr BP.

P-045 - A modern pollen-climate dataset from South Korea and its application for pollen-based quantitative climate reconstruction during the Holocene

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The occurrence of extreme weather events in response to climate change has become a global concern. To prepare for the intensifying climate crisis, it is imperative to comprehend past extreme climate fluctuations, control factors, and triggers. In this study, we conducted a pollen-based quantitative reconstruction of the Northeast Asia paleohydroclimate. We collected 387 surface soil samples from 89 mountains in South Korea to produce a modern pollen assemblage dataset. As the dataset indicated that pollen samples from South Korea reflected the regional vegetation well, we applied a weighted modern pollen analogue technique to quantitatively reconstruct the mean annual temperature (T_{ann}), annual precipitation (P_{ann}), and summer precipitation (P_{sum}) in the Gwangyang area. The reconstructed T_{ann} increased by ca. 4000 cal BP and gradually decreased thereafter. Long-term T_{ann} trends in the Gwangyang area, along the East Asian continental and Northwestern Pacific margins, appear to have been influenced by oceanic climate conditions, particularly the Kuroshio Current, whereas short-term trends were significantly correlated with the continental climate, the East Asian winter monsoon, and Bond events. P_{ann} and P_{sum} have gradually decreased during the Holocene, which is consistent with the induction of the East Asian summer monsoon by a northward shift of the Intertropical Convergence Zone. After ca. 5000 cal yr BP, the decrease in P_{ann} slowed in association with strong typhoon activity of the El Niño–Southern Oscillation. Analysis of hydroclimate proxy data from southern South Korea revealed wet events at ca. 8900, 7800, 5900, 4500, 3200, 1900, and 1300 cal yr BP, and dry events at ca. 9300, 8200, 6200, 5200, 2800, 2200, and 1400 cal yr BP. Notably, we also confirmed the occurrence of a flooding event in southern South Korea at ca. 8900 cal yr BP.

P-046 - PPEs from a transect of pollen records across central Europe produced with ROPES

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Pollen productivity estimates (PPEs) are usually produced using using modern pollen-vegetation datasets. The results therefore ideally do reflect the pollen productivity of plants in the modern landscape. However, the pollen productivity of plants is not a constant, but changes in response to many factors, including the climate and land use. For example, while the biomass productivity of modern grasslands has increased due to improved management and fertilisation, their pollen productivity has decreased, e.g. due to more frequent mowing. The age structure of managed forests is also very different from that of natural forests, which is likely to have a major impact on pollen productivity.

Instead, ROPES estimates pollen productivity from fossil pollen records themselves. The method therefore allows PPEs to be produced for distinct periods of the past. It avoids the limitations of PPEs produced from modern pollen-vegetation datasets. In a first example application, ROPES is applied to 12 pollen records from large lakes along a transect from northern Germany to eastern Poland. Besides application with the original pollen data, extensive simulations are used to test the suitability of each records.

The results show overall consistent PPEs. For some taxa, prominent trends along the transect suggest that their pollen productivity is changing, most likely due to increasing continentality from west to east. Some outliers are probably related to inhomogeneous vegetation arrangement and overrepresentation of lakeshore vegetation. Based on these results and the simulations, conclusions are drawn about the overall suitability of ROPES for the production of PPEs.

P-047 - Subtilisphaera Ecozone records from the late Aptian of the Parnaíba Basin – Brazil: Their paleoenvironmental meaning

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In the Codó Formation lower cretaceous formation of the Brazilian Parnaíba Basin, there was undoubted *Subtilisphaera* Ecozone occurrence, a phytoplanktonic assemblage dominated by dinoflagellate cysts belonging to this genus. The recognition of this ecozone in the Parnaíba Basin consolidates the hypothesis of the marine ingression in the Araripe Basin via the São Luís and Parnaíba Basins. Such register is observed here in an expressive way in the middle and upper portion of the Codó section, corresponding to the upper Aptian and registering more clearly the inception of the first marine incursion in the basin. This record becomes increasingly important throughout the sedimentation with the several peaks of dinoflagellates identification with frequencies in the order of 10–20%. Nevertheless, in addition to these more modest peaks, particularly rich dinoflagellate levels were identified, where monospecific dominance of the *Subtilisphaera* group occurs, which becomes a dominant element in the association. Distinctly recognized in 9-PCR-1-MA at a depth of 13.20m and 9-PCR-3-MA depth of 10.50m wells, these levels reach peaks of 90% and 60% of *Subtilisphaera*, respectively. The high *Subtlisphaera* frequency, sometimes accompanied by a high continental palynomorph frequency, validates shallow, coastal, and low salinity marine environment interpretations. This bioevent is probably due to the opportunistic nature of the genus, capable of tolerating variations in salinity, resulting from the beginning of the emplacement of a marine environment, where there were constant fluctuations, given the recurring advances and retreats of the sea. In the present study, this ecozone was detected in the upper Aptian, corroborating several records by several authors in Brazilian Cretaceous basins. The early Aptian age is supported by the occurrence, throughout the entire section, of the *Sergipea variverrucata* and *Equisetosporites maculosus* species.

P-048 - Non-pollen palynomorphs (NPPs) from Quaternary sediments, Croatia

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Non-Pollen Palynomorphs (NPPs) are very useful as environmental and climatological indicators. NPPs are common in Croatian Quaternary sediments but they were not considered in the analysis and there are no publications about it. They were mentioned in the papers with different topics, mostly about ecology or climate. In the frame of palynofacies, fungi spores, hypha, algal cells, and cysts are counted regularly. Also, some parts of plants that are results of plant degradation are found: epiderms, ascospore, fragments of perforation plate in hardwood vessels, fragments of spiralic tracheid, phyllovitrinite. Palynomorph *Pseudoschizaea* as well as green algae *Botryococcus braunni* and foraminiferal lining (HdV-700) are common parts of the palynological assemblage since Neogene. In Blatuša mire, the NPPs are represented by the spore fungi *Diporotheca webbiae* (HdV-143), *Valsaria variospora* (HdV-140), *Byssothecium circinans* (HdV-16B) and *Glomus*. The most common algae is *Spirogyra*, and the most abundant amoebas are *Amphitrema flavum* and *Assulina seminulum*. Remains of *Acari – Oribatei* (HdV-36), Copepode, or Protozoa (HdV-179) are also found. In Vransko jezero near Biograd green algae *Botryococcus* and cyanobacteria *Gloeocapsa*, flatworm *Neorhabdocoela* oocytes with very rare zygospore of desmids (Type 983 and 990) were important parts of the palynomorphs assemblage. Green algae *Coelastrum polychordum* and *Pediastrum* as well as *Rotifera* egg *Filinia longiseta* and testate amoebae played some role in Baćinska jezera. Last but not least, NPPs are very useful in archaeological research. In the Stari Grad site material, fungi *Alysidium resinae*, *Glomus,* and zygospore of desmids cf. *Euastrum oblongum* were found. In material from the Sopot site teliospores *Tilletia* and *Pseudoschizaea* help to reconstruct the environment.

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P-049 - Microbiomorphs of an archaeological settlement in Azerbaijan as indicators of local ecological features

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The incompleteness of the geological record increasingly motivates researchers to apply new methods and solutions in reconstructing the natural environment, encrypted in various environmental components. 14 samples were studied from the Neolithic settlement (5730–5450 thousand years BC – 6–8 kyr ago) Ismayilbeytepe Azerbaijan (N40°08′09.18″ E47°07′48.78″ absolute height – 123 m). The lack of palynological material and the diversity of additional microfossils – phytoliths, fungi, zooplankton, etc. (non-pollen palynomorphs: NPP) made it possible to restore the ecological conditions of the settlement.

The drainage of part of the floodplain valley and the riverbed rampart was the time when settlers came here. The predominant presence in the NNP spectra of the fan-shaped morphotype of phytoliths indicates that the plant basis of the building material was reed (*Phragmites communis*). The most favorable conditions, expressed in the distribution of mesophilic herbs and riverine forests, are observed during the period of the first (bottom) building horizon, when the groundwater level optimally decreases. Further increase in groundwater led to flooding: in the spectra of samples of the second building horizon, spores of aquatic liverworts and reed phytoliths with the participation of zooplankton predominate. There were no traces of grain farming in the cultural layers of the settlement, nor of keeping domestic animals. Steppe grasses are represented only by phytoliths. A large amount of the toxic morphotype of the black mold fungus *Stachybotrys chartarum* in all samples from the settlement indicates sufficiently humid conditions necessary for its habitat. Only in the samples from the first and second construction horizons, where the floors were covered with ocher, their number decreases. Perhaps the use of ocher in the dwellings of the settlement was a limiting factor in the spread of fungal spores. And as a fact, the inhabitants of the settlement already knew about the disinfecting properties of ocher pigment.

P-050 - Non-Pollen Palynomorphs in coastal deposits: Clues and enigmas

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The study of Non-Pollen Palynomorphs (NPPs) in palynological slides has become increasingly important in the last decades due to the complementary information they can provide. Indeed, the study of palynomorphs in natural deposits has great potential for interpreting environmental conditions, as well as discerning land use and anthropogenic fingerprints in the landscape.

In the past year, a new palynological record obtained from La Janda basin (SW Iberia) was studied, revealing a dynamic succession of environments during the Holocene. The characteristics of the sediments and depositional conditions led to poor pollen preservation in some sections of the cores. However, some NPPs appeared to be more resistant, and their identification allowed us to infer natural and anthropogenic processes. Nevertheless, the potential interpretation of some of these NPPs is not clear enough.

We would like to present a synthesis of the NPPs identified in this natural deposit and extend an invitation to the scientific community to discuss the potential meanings of some of them.

Poster session M04 Fire as an ecological and evolutional driver

P-051 - Long-term existence of the oak-beech transition zone in the Western Carpathian forests

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Major changes in understorey species composition have been reported from the contact zone between oak- and beech-dominated forests in the Western Carpathians. In particular, beech and hornbeam are currently expanding into the lower canopy of oak forests. This reduces the diversity of species in the understorey by suppressing the amount of light. In addition to the more obvious causes, such as nitrogen deposition or climate change, some argued that changes in the way how forests were managed in the past are also important. However, little is known about how long these species coexisted at the forest stand level during the Holocene. Using multi-site pollen analysis, we traced the regional expansion trajectory of major tree taxa in the Holocene. The coexistence of beech and oak in the same forest stand was tested using soil charcoal record and extensive 14C dating. We have found evidence that beech has been growing in a mixed stand with oak ever since it first arrived in the area.

Poster session M07 Applied palynology: methodological innovations

P-052 - Much Faster Counting! (PolyCounter 3.2 software and special keyboard – an addictive system)

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Pollen counting is so time-consuming and labor-intensive exercise, that all palynologists are hoping to make it faster and easier. A combined system of 'PolyCounter' software and a keyboard specifically designed for the software provide a dramatic solution to this problem. The software can take counts of a total of 135 pollen taxa by single key action (with or without shift keys). The keyboard is ergonomically designed that the operator normally does not need to check the position of his/her fingers (which saves time).

Below here are essential links.

- The 'PolyCounter' software: <http://polsystems.rits-palaeo.com>
- The keyboard: <http://polproducts.rits-palaeo.com>
- The introduction video: <https://youtu.be/fs_hgkj0IYE>

Poster session M07 Applied palynology: methodological innovations

P-053 - Immunological approach for the detection of Parietaria pollen in the atmosphere

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Parietaria pollen is small in size, so it remains in the atmosphere for long periods of time. This pollen contains at least six identified allergens that can be used for its detection in the atmosphere. The main allergens are Par j1 and Par j2, belonging to the family of non-specific lipid transfer proteins. The molecular weight of these proteins is 15 kDa for Par j1 and 10–14 kDa for Par j2. Nowadays the detection of pollen in the atmosphere is very important since allergy episodes caused by pollen proteins in the air have a increased clinical impact throughout the world.

The study was conducted from 2009 to 2018. Pollen sampling was performed using a Lanzoni VPPS-2000 volumetric trap and allergen quantification using a multivial cyclonic sampler. The allergen content in the samples was detected using a 2-site-specific ELISA and Parj1–2 antibodies. Principal Component Analysis (PCFA) and Correlation analysis were applied to determine the interrelationship between pollen, allergens and climatic variables.

Parietaria pollen and allergens were detected in the atmosphere from May to August. The highest total pollen concentrations were recorded in 2016 with 2988 pollen grains and a pollen peak with 212 pollen/m3 on June 23, 2018. On the other hand, the highest total allergen concentration was recorded in 2014 with 0.435 nanograms, and the maximum peak of allergens was detected in 2016 with 0.014 ng/m3 on June 21. From the PCA analysis, 4 principal components have been extracted representing together around 83.9% of the variability of the data set. The correlation analysis noted that the variables that exert the greatest positive influence on pollen concentrations were temperatures, whereas negative influence the rainfall and relative humidity.

New methodologies to detect pollen in the atmosphere represent a modern tool for predict the allergy risk periods to *Parietaria* and alert sensitize people.

Poster session Q02 Exploring ecological concepts in the Quaternary

P-056 - Witnessing the Holocene Heat: Temperature shift in the alpine region of the eastern Himalaya, India through grass phytolith analysis

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In the present study, grass phytolith assemblages and indices, rIc (revised climatic index Ic, specific to eastern Himalaya) and Iph (Humidity-aridity index) are utilised to quantify the temperature change around a lacustrine deposit at Penga Tengo Tso (PTSO) from Arunachal Himalaya spanning approximately 7.1 ka and to understand the fluctuation of C3/C4 grasses in the area. Based on the variation of MAT, several alternative warm and cool periods were recorded. The MAT was generally 0.8 °C warmer between 7.1 and 6.3 ka than the current average temperature near PTSO. There was a 0.3 °C decline in MAT from 6.3 ka to 5.5 ka compared to the previous phase. This was followed by another warmer phase between 5.5 ka to 4.5 ka. A subsequent drop of MAT was observed between 4.5 ka to 3.6 ka suggests a cooling trend and a minor increase of C3 grasses. Iph has also shown a rising trend during this phase indicating a cool and comparatively drier phase, potentially linked to the globally recognised 4.2 ka event. A cool and humid phase predominated between 3.6 ka and 1.4 ka, as evidenced by the progressive decline in MAT and lowering trend in Iph values. From 1.4 ka to 0.8 ka, an abrupt drop in rIc values suggested a warming trend, with MAT increasing by approximately 0.4 °C compared to the previous period linking this phase to Medieval Warm Period (MWP). In the subsequent period from 0.8 ka to 0.4 ka, a dominance of C3 grasses was observed, and MAT was about 1.4 °C cooler than the phase that came before, linking this phase to Litte Ice Age (LIA). This study coincides with two late Holocene climate events, namely WMP and LIA, that occurred in the northern hemisphere. However, the timing and duration of these two phases deviate from overall global trends.

Poster session Q03 Glacial-Interglacial cycles as natural experiments

P-057 - Rapid climate changes in the central East European Plain during the transitional phases of the last interglacial-glacial cycle

Olga Borisova

The oxygen isotope curves from ice and deep-sea cores show that at the transitional stages of the interglacial-glacial macrocycles series of secondary climatic fluctuations occurred. The palynological data on sections with continuous sequences of interglacial and early glacial deposits of the last macrocycle allow tracing such short-term oscillations in the central region of the East European Plain. To estimate their duration, changes in the arboreal pollen content were correlated with the Dansgaard-Oeschger (DO) events on the NorthGRIP oxygen-isotope curve (NorthGRIP Members, 2004). Reconstructions based on the modern geographical analogues of fossil pollen floras showed that during the post-optimal cooling of the Last Interglacial the mean annual temperature (*Ta*) decreased by an average of 0.003 °C / 10 years. The main cooling at the transition from the interglacial to the first cold stage of the Last Glaciation corresponds to the cold phase of DO 26. For 2–4 thousand years *Ta* in the central East European Plain decreased by about 7 °C with the rate of cooling up to 0.02 °C / 10 years. Brief interphase warming inside this first cold stage of the early glacial corresponds to the warm phase of DO 24. The estimated duration of the subsequent major interstadial (Upper Volga = Brørup), correlated with the warm phase of DO 23, exceeded six thousand years. The highest rates of temperature change over the entire last interglacial-glacial cycle occurred at the transition from the Last glaciation to the Holocene. The difference in *Ta* between successive warm and cold phases of the Lateglacial reached 3–4 °C. The average rate of *Ta* decrease from the Allerød

interstadial to the Younger Dryas cold stage was about 0.07 °C / 10 years. Temperature rises at the transitions from the Oldest Dryas to the Bølling and from the Younger Dryas to the Preboreal were equally rapid.

Poster session Q03 Glacial-Interglacial cycles as natural experiments

P-058 - Intra-Saalian vegetation changes in Central Europe – New insights from Thuringian pollen profiles

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The dynamic nature of the glacial environments including erosive impact of the continental ice sheets left a complex and fragmentary sedimentary record in Central Europe during the late Middle Pleistocene. The resulting chronological gaps in the palaeoenvironmental evidence and the lack of reliable numerical ages still give rise to controversial discussion about the (bio-)stratigraphic classification of many Pleistocene deposits and their position within the framework of the marine isotope stages (MIS).

According to the marine oxygen isotope record, the intra-Saalian MIS 7 stages can be interpreted as a glacial-interglacial complex with weakly pronounced warm periods. In the continental realm, a number of sedimentary sequences have so far been assigned to this isotope stage, whereby the individual palynological sequences partly show considerable floral differences. This could indicate regional differences in the vegetation at that time or stratigraphic misclassifications.

The lake sediments recovered from the Neualbenreuth Maar provide the first biostratigraphic sequence from Central Europe that covers at least MIS 8 to 5 and thus enables an unambiguous biostratigraphic assignment of the pollen record to MIS 7. Recently, several new sediment profiles were recovered from the Central German dry region, which show similar palynological features as the Neualbenreuth record. The most comprehensive sequence from northern Thuringia comprises a total of three post-Elsterian warm periods, each representing rather mild interglacial conditions. Eight infrared radiofluorescence datings support the biostratigraphical assignment of the two younger interglacial sections to MIS 7a and c, but suggest a classification of the oldest warm phase preserved in this core to MIS 9. In order to significantly improve the biostratigraphic framework for the reconstruction of vegetation and climate patterns of the Middle Pleistocene, including palaeoecological gradients, a further extension of the spatio-temporal data coverage is urgently required.

Poster session Q03 Glacial-Interglacial cycles as natural experiments

P-059 - Quantifying the relationship between the regional vegetation and the pollen record of Armenia and Georgia

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The Southern Caucasus, a biodiversity hotspot and rich in all kinds of resources, plays an important role for scientific investigations, as various groups of hominins occupied the region during the Pleistocene. In order to get a wider understanding of the circumstances and behaviors of our ancestors it is necessary to understand the paleoenvironmental conditions.

Pollen analysis provide information about vegetation and climate processes and can be used for paleoclimatic reconstructions. Applied to the fossil record, regional differences in plant communities can be detected as well as their development during different time periods indicating climatic changes. In this study modern soil surface samples will be the base to establish a regional statistical relationship between the standing vegetation, climate and the pollen record. With the aim of covering the most widespread vegetation units of western Georgian lowlands to southern Armenian highlands, recent soil samples were taken from known vegetation units as identified by using the European Vegetation Map (EuroVegMap).

Preliminary results show strong correlations between vegetation type and pollen assemblage. Open environments, represented by steppes and semi-deserts, are characterized by grasses and herbaceous plants with little to no woody vegetation. Closed environments are characterized by an abundance of woody plants, primarily trees, but also include ferns, herbaceous plants and grasses.

The resulting statistical correlation were applied on fossil assemblages from Paleolithic sites of Armenia (of Late, Middle, and Early Pleistocene age) to reconstruct the past vegetation and climate for different groups of hominins in the Southern Caucasus. This

method is a useful tool for the palaeoecological reconstructions, providing information about the dynamics of vegetation and climate as well as other environmental changes during the Pleistocene.

Poster session Q03 Glacial-Interglacial cycles as natural experiments

P-060 - Vegetation response to climate change since the last glacial period in the coastal area of the Sea of Japan in central Japan

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Recently, a detailed analysis of pollen during the last glacial period was performed using lake and peat samples in Japan. The resultant vegetation response to millennial climate events, such as Heinrich and Dansgaard–Oeschger (D–O) events, has been revealed. However, there are insufficient palynological data during the cold period for the coastal area of the Sea of Japan in central Japan. The study of vegetation change in this area is vital for determining the development of the Sea of Japan during the glacial period. In this study, we present new palynological data from the Hokuriku region covering the past 44,000 years. We used a 5.0-meter core extracted from Kashiwazaki, Niigata Prefecture (240 m a.s.l.) for pollen analysis. The age at the bottom of the core was 44,170 ± 630 cal yr BP. *Fagus crenata* and deciduous *Quercus* pollen were dominant from 44 to 25 cal kyr BP. *Betula* pollen was more than 60% dominant and coniferous taxa, such as *Pinus Haploxylon*-type, *Tsuga*, *Abies*, and *Picea*, increased from 25 to 18 cal kyr BP. Following 18 cal kyr BP, *F. crenata* and deciduous *Quercus* pollen increased with deciduous broadleaved taxa such as *Carpinus*/*Ostrya* and *Pterocarya*. The dominance of deciduous broadleaved forests, such as *F. crenata*, *Quercus,* and *Betula*, reveals the cool climate during marine isotope stage (MIS) 3. The expansion of *C. japonica* to 40 cal kyr BP may indicate warmer and more humid conditions during D–O 11–9. There was wide coverage of birch and subarctic coniferous forests during the last glacial maximum. Deciduous broad-leaved forests expanded again since the late glacial period. In comparison with other inland Hokuriku regions, there was more *Betula* pollen and less coniferous pollen during MIS 3–2. Differences in elevation and the distance from the Sea of Japan may cause different vegetation responses.

Poster session Q03 Glacial-Interglacial cycles as natural experiments

P-061 - The East Asian Summer Monsoon: Dynamics and interaction with vegetation during the last glacial period

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The cyclic alternation of glacials and interglacials enforced by the Earth‘s orbit, is the outstanding climatic feature of the Quaternary. On a sub-orbital scale, the recurrent Dansgaard-Oeschger events are the most striking changes during the last glacial period. First discovered in the Greenland ice core records, their occurrence in the Asian monsoon realm has been proven. However, the spatial fingerprint of these variations and their interaction with local vegetation remain uncertain.

Here, we present vegetation and climate reconstructions from a pollen record obtained from the Sihailongwan Maar in NE-China covering the last 70kyr with sub-centennial resolution. A precise chronology was established by combining varve counting and AMS radiocarbon age determinations.

Today, the site is located at the northernmost edge of the East Asian summer monsoon. The area belongs to the temperate mixed-forest region comprised of evergreen conifers and deciduous broadleaved trees, representing one of Chinas main woodland areas.

During the last glacial, tree communities primarily include *Betula*, *Larix*, *Alnus fruticosa* and *Picea*. In addition, the regular occurrence of *Ulmus* and *Fraxinus* point to the existence of favourable habitats for (cool-)temperate trees. The position at the ecotone between cool mixed/taiga forest and steppe led to a pronounced imprint of past climate changes in the local vegetation.

Quantitative reconstructions reveal that vegetation changes are mainly driven by hydroclimate changes, which occurred synchronously with oxygen isotope variations in Chinese speleothems. However, the ratio of orbital- to millennial-scale vegetation variations is higher in the pollen than in the isotope record. This suggests that orbital- and millennial-scale variations of the Asian monsoon possess different spatial patterns: insolation forcing leads to stronger changes in the northern monsoon domain, while the Dansgaard-Oeschger cycles manifest most pronounced in the southern monsoon areas.

Poster session T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

P-062 - Systematic palynological studies of Lower Miocene sediments from Moravian part of the Carpathian Foredeep (Czech Republic)

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The environment in the studied region was extraordinarily variable. Due to the existence of lagoonal and deltaic facies, palynomorphs have been preserved better than in the fully marine environment of higher stratigraphic levels of the Carpathian foredeep. Palynomorphs could be identified using a combination of methods of the optical and electron microscope (LM/SEM) according to Zetter (1989).Palynospectra documented a warm-subtropical climate of the Miocene Climatic Optimum (MCO). All the studied palynospectra are rich in thermophilous elements: Sapotaceae, Palmae, *Engelhardtia*, *Lygodium.* The higher representation of *Symplocos* and Rutaceae pollen (f.e. *Ptelea, Citrus limon)* were detected.Due to oscilations in salinity and occasional higher levels of evaporation, halophilous vegetation of salt meadow grew on the coast (up to 37% Chenopodiaceae, *Tamarix*, Caryophyllaceae, *Ephedra*). These had been repeatedly replaced by different stages of coal swamp and riparian plants Taxodiaceae, Myricaceae, *Alnus*, *Fraxinus*, *Salix, Platanus*). The aquatic flora appeared regular locally – *Sparganium*, *Potamogeton*, *Nelumbo*, Cyperaceae. The pollen often found in clumps (Myricaceae, Chenopodiaceae, Caryophyllaceae, Oleaceae, Onagraceae, *Platanus*) support the low water dynamics and a short transport. (Doboš 2023, Doláková et al. 1999, Kováčová et al. 2011).

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Poster session T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

P-063 - Vegetation and climate oscilations during MCO/MCT in Central and Eastern Paratethys

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Originally, we analyzed the Late Burdigalian to Serravalian pollen spectra from the Czech and Slovak regions of the Central Paratethys, as well as the Mura-Zala basin and Transylvanian basin. These were compared with spectra from Eastern Paratethys in Turkey. The climax of the Miocene Climatic Optimum (MCO) revealed oscillations in climatic factors, such as increasing seasonality in temperatures and precipitation. Subsequent cooling and observable precipitation fluctuations were documented as evidence for the Miocene Climate Transition (MCT) (Doláková, Kováčová, Utescher, 2021, Vernzhorova et al. 2023). The vegetation

character in Central Paratethys underwent significant changes due to the Alpine uplift of the western Alps and Carpathians, initiating altitudinal zonality. Differences mainly in quantitative representation of zonal elements between northern localities (Czechia and Slovakia) and southern parts of this are (Slovenia, Romania) indicates increasing of latidudinal zonality. In Eastern Paratethys, palynospectra indicated an earlier trend of gradual cooling and a notable shift towards more arid and continental climate conditions. This trend may be linked to the presence of the vast moderate Eurasian continent.

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Poster session T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

P-064 - Reconstructing the evolution of Eocene ecosystems in southern Eurasia to better understand past mammalian dispersals

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During early and middle Eocene, the Balkans and Anatolia formed an endemic biogeographic province called Balkanatolia that was separated from mainland Eurasia. This isolation ended around 40 Ma when Asian ungulates dispersed into the province and endemic taxa declined. The paleoenvironments of this biogeographic province remain yet poorly known. The goal of this PhD project is to characterize the flora and the local climate of Balkanatolia (rainfall seasonality, aridity) to better understand what could have favoured these biogeographic changes. The work presented here is twofold. First, we will present an overview of the current knowledge about the Eocene flora of Balkanatolia. This review will include all kind of vegetal structure preserved in the fossil record (pollen, wood, seeds…). Second, we will present preliminary results on pollen assemblages and fossil wood specimens of different Eocene localities in Central Anatolia yielding endemic Balkanatolian taxa (Çamili, Çiçekdaği, Büyükteflek, Bultu-Zile, Yeni-Çeltek and Eski-Çeltek). Through a taxonomical identification, these palynological results will draw a first reconstruction of forested assemblages before the arrival of Asia-derived mammal fauna. These paleobotanical results will be compared and interpreted with contemporary geochemical proxies and paleontological data to highlight the environmental evolution through the development and demise of Balkanatolia.

Poster session T01 Challenges in studying Cenozoic vegetation history: In memoriam Zlatko Kvaček

P-065 - Plio-Pleistocene flora of the travertine mound of the Dreveník site in Slovakia

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Travertine is specific chemogenic sediment, which is known for an extraordinary fossilization potential, among other things. The Dreveník travertine mould site is located in the Eastern Slovakia. Based on biostratigraphy the age is estimated to late Neogene – early Pleistocene. These Slovak travertines contain a unique impressions of fossil flora, mainly leaves, seeds and conifer female cone. The floral composition is a combination of typically Tertiary (*Carya* sp., *Ginkgo adiantoides*, *Liquidambar* sp. etc.) and Quaternary (*Carpinus betulus*, *Parrotia persicaI* etc.) elemenets with many others taxa (*Ulmus cocchii*, *Fagus* sp. etc.). The main aim of this study is to prepare a detailed systematic review based on the external plant morphology. The systematic review is necessary in order to get an exact depiction of the Slovak Plio-Pleistocene flora and vegetation. This knowledge will enable us to set this site in a broader context of the Plio-Pleistocene plant exchange. Comparison this study site with other Late Neogene localities

from Europe (Italy, Germany, Czech Republic, Poland and others) will help us to understand the plant exchange that affected Central Europe at the end of the Neogene.

Poster session T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

P-066 - New Miocene fruits from Panama and Peru provide insights into the evolutionary history of Cocoseae palms

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6 *California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, USA*
7 *University of Michigan, Museum of Paleontology and Department of Earth and Environmental, Ann Arbor, USA*
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Neotropical fossils are essential for understanding the evolutionary history of key plant groups in megadiverse tropical forests. Particularly relevant are fossil plants from the Early to Middle Miocene, offering essential insights before and after the closure of the Panamanian Seaway and the emergence of the Amazon basin's mega-wetland. Here, we present new well-preserved palm fruits based on calcareous permineralizations of the Cucaracha Formation (~19.5 Ma) from Panama and coalified specimens of the Pebas Formation (~13 Ma) from northeastern Peru. The fossil endocarps were compared with extant members of the palm family using herbarium specimens. The fossils and modern fruits were also studied anatomically and morphologically using computed tomography scanning. The fossil fruits were identified to belong to the tribe Cocoseae because of the presence of thick endocarps with three circular germination pores. The two new taxa are distinguished by overall size and shape, and distance and position of germination pores. These fossils enhance our understanding of the presence of Cocoseae in the Neotropics during the Miocene and contribute valuable information on potential dispersal scenarios.

Poster session T03 Identifying Cenozoic fossil fruits and seeds: challenges and progress

P-067 - Hamamelidoideae fossil seeds from Neogene of Central Europe – Preliminary observations

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Seeds of members of the subfamily Hamamelidoideae are some of the most common and easily identifiable carpological fossils in the Neogene of Central Europe. So far, one fossil genus *(Hamamelidoidea* Kirchheimer) and seven living genera have been identified, including *Corylopsis*, *Hamamelis*, *Parrotia*, *Distylium*, *Fothergilla*, *and Fortunearia*. However, considering the general morphological uniformity and the poor knowledge of the diagnostic traits of seeds among living Hamamelidoideae, distinguishing between genera and identifying fossil seeds is often problematic. To resolve at least part of this problem, seed morphologies of 22 living genera (except members of the tribe Dicorypheae) were investigated based on literature and comparative materials. Preliminary analysis suggests that seed morphology has limited use. Morphological features selected as potentially diagnostic enabled us to identify only *Hamamelis* and *Loropetalum*. The remaining genera could be divided into two morphological groups: 1) the tribe Eustigmateae, and 2) a group that encompasses the tribes Fothergilleae and Corylopsideae.The second group could be further divided, but only into smaller groups with two or more genera.

When the selected diagnostic features were applied to fossil seeds, they allowed us to confirm the presence of *Hamamelis* (*H. lusatica* Mai) and *Corylopsis*. However, living representatives of the latter seem to share seeds morphology with *Parrotiopsis*. More problematic is distinguishing between the rather numerous fossil *Corylopsis* species. Furthermore, at least one representative of the tribe Eustigmateae could be identified („*Fothergilla" europaea* Szafer, of uncertain generic affinity), while the presence of *Fortunearia* [*F. altenburgensis* Mai & Walther, *F. europaea* (Zabłocki) Mai] needs confirmation based on the type material. The presence of representatives of the tribe Fothergilleae is probable but affinities with living genera may be difficult to prove.

In effect, the obtained results highlight the necessity to re-examine the diversity among Hamamelidoideae in the Cenozoic of Europe.

P-068 - Chemical signals in modern pollen assemblages across elevation gradients from Trans Himalaya

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Previous paleo elevation models of the Himalaya were derived from the stable isotope paleoaltimetric methods. However, doubt has been cast on this method due to its dependence on several climatic factors (composition of moisture sources, evapotranspiration) and tectonic assumptions which introduce uncertainties in the inferred ages. At the same time, other fossil-based methods are imprecise or hard to apply due to the lack of appropriate calibrations. Recently, it has been shown that the biopolymer that comprises the outer wall of pollen grains is regulated by the amount of ultraviolet-B (UV-B) irradiance, because plants at higher elevations receive a higher UV-B input. We applied Fourier transform infrared spectroscopy (FTIR) to measure the UV-B signal recorded in the modern pollen samples across an elevation gradient from the Tans Himalaya and Herbarium specimens. The dataset generated from this approach can be a reliable proxy to infer the elevation gradients using pollen and fossil samples later on. Thus, our results can be applied to identify the timing and pace of the Himalayan uplift and test additional biogeographic hypotheses related to this mountain system.

P-070 - Preliminary description of anatomically preserved Pseudofrenelopsis sp. from the Crato Fossil Lagerstätte, Araripe Basin, northeastern Brazil

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The genus *Pseudofrenelopsis* belongs to the family Cheirolepidiaceae and is an important element of the Cretaceous flora of the world. Its epidermal characteristics are highly variable and therefore of great taxonomic significance. However, knowledge of the anatomy of the stem is limited and only available for a few species. In this work, we provide a preliminary description of the anatomy of a well-preserved specimen of *Pseudofrenelopsis* sp. from the Crato Formation of the Araripe Basin. The analyses were carried out by SEM and light microscopy. The specimen is 17 cm long, has sunken cyclocytic stomatal complexes, with 4–6 non-papillate ellipsoid subsidiary cells. Stomata are arranged in longitudinal rows that converge towards the apex. Within a row, stomata are separated by 2–4 common cells. The stomatal rows are separated by 2–3 rows of common cells, which are rectangular or square in outline possibly carrying papillae. The hypodermis is formed by fibrous cords, which are interrupted in the stomatal region. In the cortex there are spongy parenchyma cells and resin canals. The xylem is composed of rounded tracheids, which are larger in the primary xylem and smaller with thicker walls in the secondary xylem. The radial tracheid pits are bordered, usually uniseriate and sparse, rarely contiguous. It's possible to observe a row of alternating biseriate pits, but without contact with each other. The cross-fields are araucarioid, composed of more than 10 individual cupressoid pits. The rays are uniseriate with one or two cells high. The variety of characteristics presented by a single specimen shows the potential for another whole-plant study in the Araripe Basin and can help improving our understand about the Cheirolepidiaceae wood, since the majority of attributions of wood for this extinct family come from organs associates but not connected. Funding: [FUNCAP-BP5-0197-00135.01.00/22 and 00424072/2022; CNPq-PQ313946/2021–3].

Poster session Z01 IAWA Fossil Wood Symposium

P-071 - First record of Brachyoxylon Hollick et Jeffrey from Early Cretaceous Crato Fossil Lagerstätte, Brazil

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The Araripe Basin, situated in northeastern Brazil, is a significant sedimentary deposit that contains a wide variety of fossils related to several taxonomic lineages, particularly in the strata of the Crato Formation. The fossils found in this unit are often very well-preserved, making it one of the most important fossiliferous deposits in the world. Among plant fossils, gymnosperms are the dominant group. However, taxonomy based on the anatomy of their woods is still poorly understood and explored. Coniferalean and gnetalean gymnosperms are overall diverse within the Crato Fm. flora based on other macro remains and pollen. In this contribution we present the first occurrence of the fossil-genus *Brachyoxylon* Hollick et Jeffrey 1909 in the Araripe Basin. The specimens were found in the Crato Formation at *Três Irmãos* quarry near downtown of Nova Olinda, State of Ceará, NE Brazil. They were examined by scanning electron microscopy (SEM). The secondary xylem is composed of tracheids and parenchymatous rays. Bordered pits on the tracheid walls are exclusively uniseriate, contiguous and distant. These pits are round in outline with a circular aperture. Cross-field pitting is araucarioid with three to ten cupressoid oculipores per cross-field and contiguously arranged. The rays are uniseriate with approximately 1–4 cells in height. *Brachyoxylon* is a common wood-taxon with a worldwide distribution in the Mesozoic xylofloras and has been putatively associated with the extinct conifer family Cheirolepidiaceae. However, only a single record of this fossil-genus has been found in Brazil, from Cretaceous deposits of the Maceió Formation, Sergipe-Alagoas Basin. Our results thus expand its paleobiogeographic distribution during the Cretaceous in Brazil. In addition, this research improves our understanding of the composition of the xyloflora found in the *Crato Fossil Lagerstätte* but also worldwide. Funding: [FUNCAP- 00424072/2022; BP5-0197-00135.01.00/22 and Process PQ313946/2021–3].

Poster session Z03 Phylogenetic Palaeobotany

P-072 - Exploring the phylogenetic relationships of fossil Cupressaceae

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Cupressaceae, the most widely distributed conifer family in the modern flora, has an unequivocal fossil record dating to the Early Jurassic. During the Late Cretaceous the family reached its peak morphological diversity and by the Cenozoic all sub-families were present. Despite the extensive geographic and stratigraphic range of Cupressaceae, the phylogenetic relationships of fossils are not well understood. Here we explore the phylogenetic relationships of twelve fossils, which range from the Miocene to the Lower Jurassic, using parsimony and Bayesian methods. Our preliminary Bayesian and parsimony analyses are broadly concordant in their placement of fossil taxa, but the Bayesian analyses are characterized by greater uncertainty. *Glyptostrobus rubenosawensis* and *Yubaristrobus nakajimae* are placed within the taxodioids and *Krassilovidendron fecudum* within sequoioids, as suggested in the original publications. *Austrohamia asfaltensis* is either sister to *Taiwania* or within the taxodiaceous grade. In the Bayesian analysis *Archicupressus nihongii*, *Mesocyparis sinica*, *Mesocyparis umbonata*, *Papuacedrus prechilensis* and *Tetraclinis salicornioides* are all recovered in a polytomy with the Callitroideae and Cupressoideae. However, the parsimony analysis provides more resolution: *Archicupressus nihongii*, *Papuacedrus prechilensis*, and *Tetraclinis salicornioides* are nested within the Cupressoideae; *Mesocyparis sinica* and *Mesocyparis umbonata* form a clade that is sister to the Callitroideae. *Yezosequoia shimanukii* comes out within the taxodiaceous grade but its precise placement is uncertain. Two undescribed taxa are a seed cone from the Cretaceous of Antarctica, which comes out sister to Callitroideae, and a seed cone from Eocene of Washington State (USA) that is placed as sister to Cupressoideae-Callitroideae. Although further work is needed to resolve the relationships of fossil species, many of these fossils have never been considered in a phylogenetic context before. This work is therefore an important step in better understanding the phylogeny of Cupressaceae and major morphological changes in its evolutionary history.

P-073 - Miocene paleoelevation and plant-insect associations in the northeast Tibetan Plateau

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Phytophagous insects and plants play a pivotal role in preserving the equilibrium, with their symbiotic interactions being highly responsive to elevation and biodiversity conditions. Investigating the evolutionary dynamics of insect phytophagy in terrestrial ecosystems across geohistorical periods serves as an important entry point to investigate the ecological response of regional environments to climate change. Nevertheless, studies of interactions among vegetation, elevation, climate change, and insect phytophagy interactions on the Tibetan Plateau are constrained by the scarcity and disjointed nature of research materials, with only two existing records from the eastern TP. In this study, we obtain the two floras in the Middle to Late Miocene (~16–7.6 Ma) of the Qaidam Basin in the northeastern TP, denoted as the HTTL and NG flora. The results show that: (1) The two floras demonstrate a high degree of floristic similarity primarily dominated by taxa from the deciduous broad-leaved vegetation; (2) Utilizing the CLAMP for climatic parameter derivation, and employing the enthalpy of humidity method based on the sea level enthalpy of humidity (337 kJ/kg) simulated at the equivalent latitude, the successive elevations in the region estimated are: ~1,120 ± 300 m (16 Ma), ~1,300 ± 500 m (15 Ma), ~2,300 ± 700 m (11 Ma) and ~2,800 ± 900 m (7.6 Ma); (3) The initial assessment of the overall frequency of insect feeding damage stands at 65%, with predominant feeding patterns encompassing hole, surface, sucking, margin, skeletonization and mining feeding. These feeding patterns can be subdivided into 48 DTs, reflecting a diverse array of insect types. The warm and humid climate and the lower basin elevation in the Middle Miocene are coupled with other records, suggesting that the uplift of the Tibetan Plateau and global cooling potentially played pivotal roles in the observed decline of insect feeding diversity.

P-074 - Climatic and environmental reconstruction from an old-growth forest of fagus sylvatica

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Understanding climatic variability and how it affects long-term vegetation dynamics is essential to face the uncertainties of the current global change. For this purpose, we performed a paleoclimatic reconstruction for the last 2,600 cal. years BP in the Morské oko lake, located in the Inner Eastern Carpathian Mountains, Slovakia. This lake is surrounded by an old-growth forest of *Fagus sylvatica*. We used branched glycerol dialkyl glycerol tetraethers (brGDGTs), which are membrane lipids of some soil bacteria, to reconstruct mean annual temperatures, and the deuterium composition in the leaves waxes to reconstruct the precipitation. Moreover, geochemistry data was used to assess changes in the catchment, pollen analysis to reconstruct the vegetation dynamics, and macro charcoal for the fire regime. There is considerable temperature stability in the lake and the range of the temperatures oscillates only about 2 °C. The lake, which originated from a landslide, presents the greatest changes in erosion rates, climatic oscillations, and fire activity during its onset. After *Fagus sylvatica* was established, changes in temperature and fire regime seemed to not affect the pollen assemblages significantly. This study helps us to understand the forest dynamics and how they relate to temperature changes in this primaeval beech forest in the Vihorlat Mountains, proclaimed by UNESCO as a World Heritage Site.

P-075 - Plant diversity of terrestrial vegetation preserved in marine sediments (lower Wenlock, Sheinwoodian) of Barrandian area, Czech Republic

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Cooksonia barrandei Libertín, J. Kvaček, Bek, Žárský et Štorch was described from the locality Loděnice – Barrandovy jámy. The locality consists of individual excavations forming a discontinuous strip between the sites of Loděnice – Špičatý vrch and Sedlec – U Stydlé vody. Sites extending over 120 m in length were excavated by workers hired by J. Barrande in the 19th century. The age of the outcrop rocks (432 Myr) is derived from the associated graptolite fauna including the zonal index graptolite *Monograptus belophorus*. This marine faunal assemblage allows a direct assignment to the globally correlatable *belophorus* Biozone (Štorch 1994, Loydell 2012) of the middle Sheinwoodian stage of the Wenlock series. Fossiliferous layers containing these fossils are products of coastal marine sedimentation of volcanic islands, the largest of which was the present-day St. Jan Volcanic Centre (Havlíček and Štorch 1990, Kříž 1991). In the studied profile situated in the original Barrande excavation, six fossiliferous positions containing an early terrestrial plant assemblage were recorded. The species *Coksonia barrandei* and *Cooksonia* sp. were detected there. They occurred together with fragmentary thalli of algae of the genus *Nematothalus* sp. A dispersed spore assemblage prepared from the same sediment samples bearing *Cooksonia* fossils yielded at least four additional trilete spore types, indicating that more cooksonioid and similar plants were present in the terrestrial ecosystem. Two species (smaller and larger forms) of *Apiculiretusispora*, one of *Ambitisporites* and one *Scylaspora* were detected in the spore spectrum. Described fossils document diversity of plants that existed even at the time when the first proven representative of the genus *Cooksonia* appeared, and together with dispersed spores, provide an important argument that a diversified terrestrial plant ecosystem developed in the Barrandian Volcanic Archipelago of the Peri-Gondwana Realm by the end of the Sheinwoodian.

P-076 - Functional diversity and paleoclimate drive the plant and insect herbivore community variation across the early Oligocene–late Miocene

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Plant–insect associations have been a significant component of terrestrial ecology for more than 400 Myr. This interaction not only reflects the ecological relationships among species but also reveals how they collectively adapt and influence the environment. We compare the diversity of insect herbivory on the leaves of woody dicot plants in low-latitude regions of southern China from the Early Oligocene to the Late Miocene. It reconstructs the plant-insect interaction network, quantifies the diversity and richness of different plant functional groups across different periods, and reveals the mutual relationships between plant functional groups and insects. It also examines how these relationships evolve in response to environmental conditions and climate changes.

The research findings indicate that changes in plant functional traits, especially those related to water use efficiency and photosynthetic types, significantly influence the co-evolution of plants and insects. Furthermore, variations in temperature and precipitation

patterns lead to substantial structural changes in the plant-insect interaction network. These changes reflect how plants and insects adapt to environmental fluctuations and how these adaptation strategies shape their co-evolutionary paths. In this study, demonstrating how plant functional traits and climate changes jointly affect the structure and evolution of ecological networks, offers a unique perspective for understanding the interplay between biodiversity and ecosystem stability on geological timescales.

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