

## NECLIME annual meeting in Zagreb, Croatia — September 15<sup>th</sup> – 19<sup>th</sup>, 2025

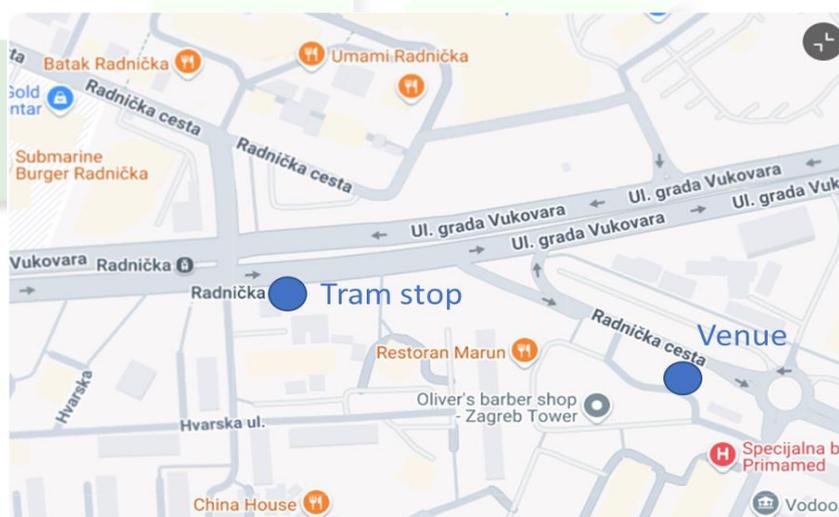


### CONFERENCE PROGRAM

Dear Colleagues and NECLIME members,

We warmly welcome you to the 2025 annual meeting of the **Network on Cenozoic Climate and Ecosystems** to be held from September 15<sup>th</sup> – 19<sup>th</sup>, 2025, in Zagreb, Croatia, jointly organized by the Croatian Geological Survey (HGI-CGS), Croatian Geological Society (HGD) and the University of Zagreb, Faculty of Science (Department of Biology and Botanical Garden). The meeting is followed by a three-day excursion to the Papuk UNESCO Geopark from September 17<sup>th</sup> – 19<sup>th</sup>, 2025.

### Venue



The NECLIME meeting will be held at the **Zagreb Tower**, in the meeting room **Cactus (Radnička cesta 80, 10000, Zagreb)**. Follow the directions to **Instant Offices** and room **Cactus** on floor 5.

**Please have your ID, passport with you as there will be an identity check at the entrance of Zagreb Tower. At the reception, say that you are participating at the NECLIME congress.**

The venue is located in the city centre of Zagreb that is easily accessible by public transport. Closest tram stop to the meeting venue is Radnička served by tram lines 2, 3, 13. The venue is about 5 minutes walking distance from the Radnička tram stop. Tram tickets can be purchased at any local newsstand (TISAK) or by scanning the QR codes on the trams with the ZET mobile app <https://www.zet.hr/tickets-and-fares/moj-zet-app/8111>.

You can use taxi, Bolt Taxi or Uber in Zagreb for getting around in the city.



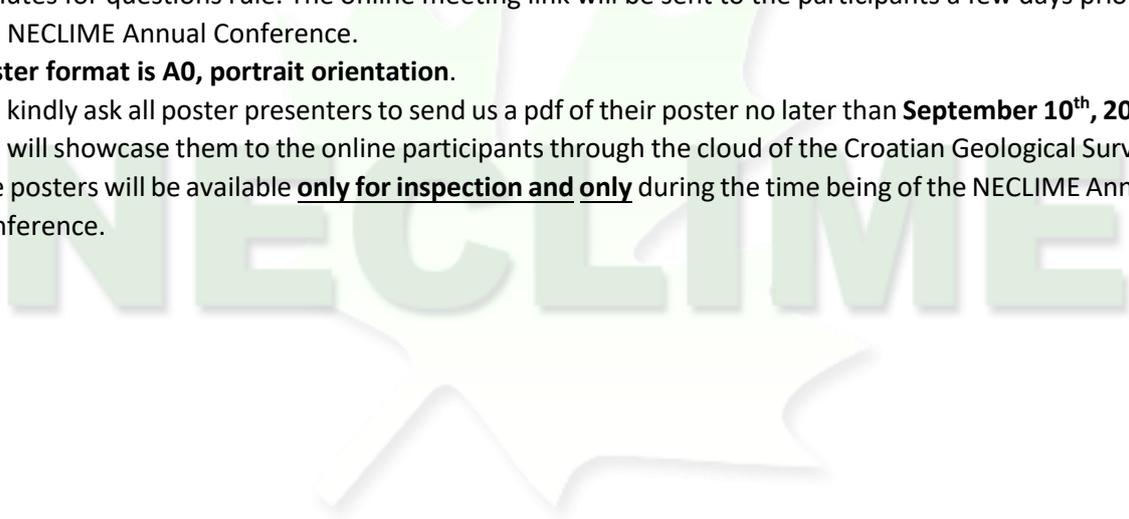
### Guidelines for presenters

Oral presentations format will be **15 minutes + 5 minutes** for questions and change of speaker. Participants that will overstep the 20-minute mark will be interrupted without room for questions.

Online participants are asked to send their recorded talks in advance together with their PowerPoint presentations no later than **September 10<sup>th</sup>, 2025**. They should also abide by the 15 minutes + 5 minutes for questions rule. The online meeting link will be sent to the participants a few days prior to the NECLIME Annual Conference.

**Poster format is A0, portrait orientation.**

We kindly ask all poster presenters to send us a pdf of their poster no later than **September 10<sup>th</sup>, 2025**. We will showcase them to the online participants through the cloud of the Croatian Geological Survey. The posters will be available **only for inspection and only** during the time being of the NECLIME Annual Conference.



## Conference Schedule

<b>Monday 15<sup>th</sup> 8:00—9:00</b>		
Registration, Zagreb Tower, meeting room Cactus (Radnička cesta 80, 10000, Zagreb)		
<b>Morning slot 1.</b>		
9:00—10:40 Welcome and key note speeches		Chair: Koraljka Bakrač
9:00-9:10	Koraljka Bakrač	Welcome note
9:10-9:40	Angela Bruch (Marianna Kováčová)	NECLIME news and introductory notes
9:40-10:10	Marijan Kovačić (key note)	Stratigraphic and sedimentary evolution of the Neogene in the Croatian part of the Pannonian Basin System
10:10-10:40	Jasenka Sremac (key note)	Neogene fossil floras of Croatia
10:40—11:00 Coffee break		
<b>Morning slot 2.</b>		
11:00—12:20 Scientific session		Chair:
11:00-11:20	Poonam Verma (online)	Fate of tropical rainforest under global warming: Lessons from the Early Paleogene greenhouse-gas-induced hyperthermal event
11:20-11:40	Nazim Deori (online)	Paleoenvironmental dynamics and tropical rainforest (TFR) response to the Middle Eocene climatic optimum (MECO): palynological and geochemical insights from Bartonian deposits of the Kachchh Basin, Western India
11:40-12:00	Shalini Parmar (online)	Distributional ranges of tropical freshwater wetlands over geological time: Insights from the Paleocene-Eocene <i>Myristica</i> swamp from western India
12:00-12:20	Nan Wang	The Eocene–Oligocene transition global climate and vegetation changes: Review of recent progress
12:20-13:30 Lunch break		
<b>Afternoon slot 1.</b>		
13:30—14:50 Scientific session		Chair:
13:30-13:50	Zhekun Zhou	The Discovery of the Eocene genus <i>Palibinia</i> from Xizang, China and its geological and biological significances
13:50-14:10	Xiaoyan Liu	Earliest <i>Calocedrus</i> from the Late Eocene Hunan Province, southern China and its biogeographic implications
14:10-14:30	Nguyen Ba Hung	Late Eocene ring-porous wood reveals early adaptation to monsoon climate of woody angiosperms
14:30-14:50	Jian Huang	The Tertiary Tethyan relict flora in East Asia
14:50—15:10 Coffee break		

<b>Afternoon slot 2.</b>		
<b>15:10—16:30 Scientific session</b>		<b>Chair:</b>
15:10-15:30	Olena Sirenko	Palynological studies of Upper Cenozoic fossil soils as an important tool for palaeogeographic reconstructions (on the example of Pliocene and Pleistocene of Ukraine)
15:30-15:50	Lisa Schiersch	Quantifying the relationship between the regional vegetation and the pollen record of Armenia and Georgia
15:50-16.10	Angela Bruch	Early Pleistocene vegetation dynamics in the Southern Caucasus driven by global climate and regional tectonics
16:10-16:30	Ivona Baniček	Coastal vegetation shift during the 8.2 ka event in the Eastern Adriatic (Kornati Islands)
<b>17:00—18:30 Visit to the Botanical Garden, <a href="#">Marulićev trg 9a</a>, 10000, Zagreb. Organized by Dario Hruševar (PMF).</b>		
<b>19:00—Conference Dinner, <a href="#">Stari Fijaker, Mesnička ul. 6</a>, 10000, Zagreb.</b>		

<b>Tuesday 16<sup>th</sup> 8:00—9:00</b>		
<b>Registration, Zagreb Tower, meeting room Cactus (Radnička cesta 80, 10000, Zagreb)</b>		
<b>Morning slot 1.</b>		
<b>9:00—10:20 Scientific session</b>		<b>Chair:</b>
9:00-9:20	Wilfried Konrad	Atmospheric CO <sub>2</sub> affects climate demands of plants
9:20-9:40	Jin-Jin Hu	Palaeo-CO <sub>2</sub> reconstructions based on calibration curves constructed by combining stomatal frequency of three oaks
9:40-10:00	Edoardo Martinetto	Expert help for leaf cuticle studies badly needed for a thorough understanding of Neogene continental ecosystem and climate evolution in NW Italy
10:00-10:20	Shu-Feng Li	Developing a Cenozoic paleoecological database for Eurasia: Insights from plant macro- and palynological fossils
<b>10:20—10:40 Coffee break</b>		
<b>Morning 2.</b>		
<b>10:40—12:00 Scientific session</b>		<b>Chair:</b>
10:40-11:00	Anjali Trivedi (online)	Deciphering modern pollen-vegetation relationships and land cover dynamics: Implications for Holocene paleoclimate reconstruction in the Northwestern Himalaya, India
11:00-11:20	Grzegorz Worobiec (online)	Fossil microsclerotia of dark septate endophytic fungi from Cenozoic deposits of Poland
11:20-11:40	Koraljka Bakrač	Non-pollen palynomorphs from Croatia: the role of cyanobacteria and algae in paleoecology

11:40-12:00	Jan Hinkelman	Non-pollen palynomorphs: insight from animal remains in the fossils record
12:00—13:00 Lunch break		
13:00—13:30 Poster Session		
Afternoon slot 1. 13:30—14:50 Scientific session <span style="float: right;">Chair:</span>		
13:30-13:50	Yan Wu	The loss and revival of the passion-flower family (Passifloraceae) in East Asia: Evidences from fossils and systematical biology
13:50-14:10	Li Wang	Bamboo fossils from Europe and West Asia and their paleophytogeographical and palaeoclimatical implications
14:10-14:30	Mengxiao Wu	Integrated fossil and molecular evidence revealed the spatiotemporal evolution of Betulaceae
14:30-14:50	Qiuyue Zhang (Yaowu Xing)	Asynchronous evolutionary dynamics of continent-specific diversity in the north temperate woody angiosperms
14:50:—15:20 Coffee Break		
15:20—16:50 NECLIME final discussion and closing remarks <span style="float: right;">Chair: Angela Bruch</span>		
From 17:30 h Geological walk through Zagreb. Organized by Karmen Fio Firi (PMF). Meeting at 18:00 h at the <a href="#">Statue of King Tomislav</a> in front of the <a href="#">main railway station</a> (Glavni Kolodvor).		

## Poster Presentations

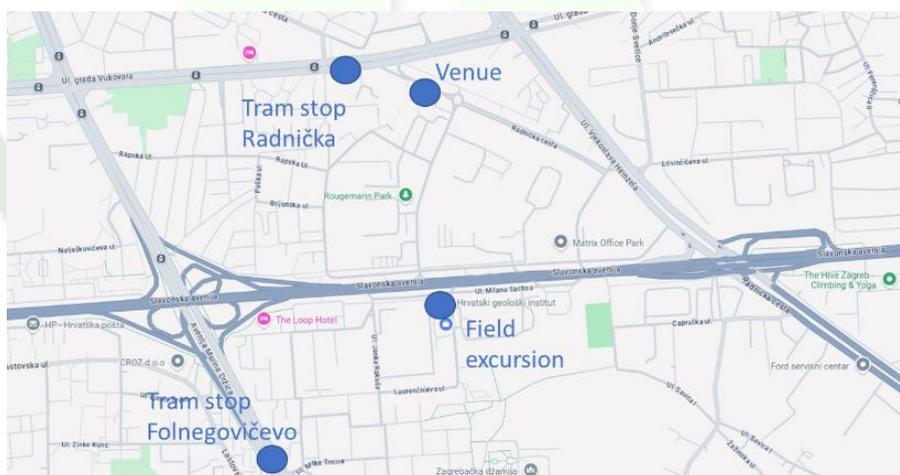
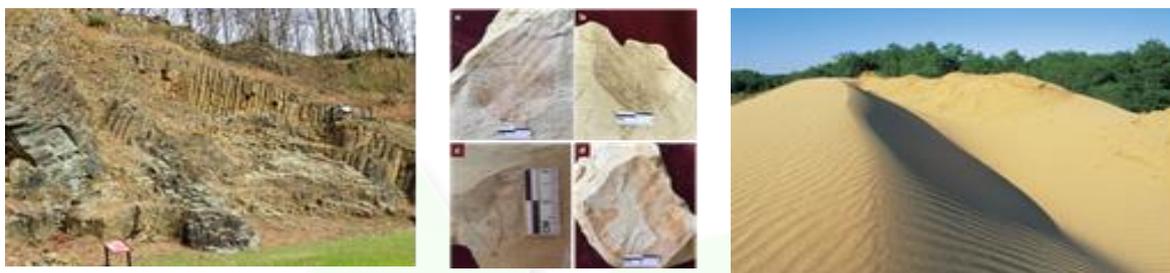
- Viktória Baranyi      Taxonomy, environmental and biostratigraphical implications of brackish-water dinoflagellate cysts from Lake Pannon (Late Miocene, Pannonian Basin System)
- Dario Hruševar      ZAG - three letters that denote a new era of Croatian palynology
- Marianna Kováčová      A multiproxy study of a sequence formed during Sarmatian/Pannonian isolation of an epicontinental basin (Vienna Basin, Slovakia)
- Tatyana B. Rylova,
- Anna V. Shidlovskaya      Vegetation and climate of the Belarusian Polesie area in the Muravian (Eemian) interglacial
- Samiksha Shukla      Unveiling ancient lineages: *Eriolaena* fossil leaf and phylogenetic insights into the evolutionary history of the winged seed clade
- Xinkai Wu      Earliest record of *Bauhinia* s.l. (Fabaceae): A Middle Paleocene naturally folded leaf from South China
- Yaowu Xing      Coevolution of seed size in Juglandaceae and body size of its dispersers
- Sadanand      Miocene *Combretum* from the Lower Siwalik and its biogeographic and paleoclimatic significance

## Field excursion

A three-day excursion to Papuk UNESCO Geopark from September 17<sup>th</sup>-19<sup>th</sup> 2025 is planned. A field guidebook will be provided to all participants. Accommodation, meals, and transport are all included in the price. Please make sure to bring field clothes, backpack, sturdy field shoes, a hat, water, water bottle, snacks. There will be a possibility to buy additional food on the way to Papuk and there is a store in Velika as well.

**Meeting Point:** Croatian Geological Survey, Ulica Milana Sachsa 2, Zagreb; **departure 17.09. at 8:00 am.**

The meeting point is accessible by tram lines 2, 3, 13 from the tram stop Radnička in about 20 minutes walk, or from the tram stop Folnegovićevo naselje served by lines 6,7 and 8, followed by ~10 minutes walk.



### Kutjevo wine tasting

Participants of the field excursion will have the opportunity to tour the famous old wine cellars of Slavonia and try local wines and delicacies in one of the oldest wineries of Croatia. Kutjevo has almost eight century old traditions offering top wine labels, which embody the wonderful Valis Aurea terroir in Slavonia. The winery is recognized around the world by its unique crystal-golden white wine, Graševina.

<https://www.kutjevo.com/en>

## Field Excursion Schedule

Wednesday 17 <sup>th</sup> September		Thursday 18 <sup>th</sup> September		Friday 19 <sup>th</sup> September		
7:00		7:00	Breakfast	7:00	Breakfast	
8:00	Drive from Zagreb to Papuk, Zvečevo and introduction to the Geopark	8:30		8:30		
9:00		9:00	House of the Pannonian Sea, Velika	9:00	Departure from Vila Štefica,	
10:00		10:00		10:00	Cabuna	
11:00		11:00	Poljanska Quarry and lunch (lunch paket), sturdy field shoes required, walking involved	11:00		
12:20	Trešnjevica Quarry	12:00			12:00	
13:00	Rupnica Geosite	13:00			12:40	Đurđevački pijesci site
13:30	Visitor centre Voćin	14:00			14:30	Đurđevački pijesci visitor centre
15:50	Lunch	15:00		15:00		
16:00		16:30	Kutjevo, wine tasting	15:40	Lunch	
17:00	Jankovac Forest Park	17:00		17:00		
18:00		17:30	Radlovac Quarry	18:00	Travel back to Zagreb, arrival in the evening hours	
19:30	Dinner and accommodation at Vila Štefica, Velika	19:00	Dinner and accommodation at Vila Štefica, Velika	19:00		

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Ivona Baniček, Croatian Geological Survey

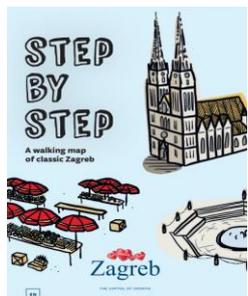
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Zagreb Tourist Information Brochure



Zagreb City Map

**We are looking forward to meeting you in Zagreb in September 2025!**



**Croatian Geological Survey (HGI-CGS)**  
**Croatian Geological Society (HGD)**  
**University of Zagreb, Faculty of Science**  
**(Department of Biology and Botanical Garden)**

## **Network on Cenozoic Climate and Ecosystems (NECLIME) Annual Conference**



### **Book of Abstracts**

**Zagreb, Croatia — September 15<sup>th</sup> – 19<sup>th</sup>, 2025**

Edited by

**Božena Mitić, Jan Hinkelman, and Viktória Baranyi**

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Chair: Koraljka Bakrač, *Croatian Geological Survey*

### **Organizing Committee Representatives**

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**STRATIGRAPHIC AND SEDIMENTARY EVOLUTION OF THE NEOGENE NORTH CROATIAN BASIN****Marijan Kovačić***Department of Geology, Faculty of Science, University of Zagreb, Horvatovac 102a, 10 000 Zagreb*

The Neogene North Croatian Basin (NCB) is located in the southwestern part of the Pannonian Basin System (PBS) and, with the exception of its northwesternmost section, geographically encompasses the whole of Pannonian Croatia. It is a rift type basin whose formation was controlled by tectonics, climate changes, volcanic activity and eustatic fluctuations. The deposits, up to 7 km thick, were first deposited in alluvial and lacustrine environments, then in marine environments and finally again in lacustrine and alluvial environments, so that a large transgressive-regressive sedimentation cycle can be observed.

Deposition within the NCB began in the Early Miocene in terrestrial sedimentary environments that were under the strong influence of cyclic changes between arid and humid climatic conditions. Alluvial sediments were deposited over an unconformity above the basement rocks of the NCB and are overlain in places by pyroclastics and loess deposits, while sediments deposited in a saline lake have also been documented. Terrestrial depositional environments persisted in the NCB until the early Badenian in lacustrine environments, where mainly clastic pelitic sediments with tuff layers were deposited. Their fossil record indicates deposition in alternating freshwater and brackish water lacustrine environments with no connection to the sea. Radiometric dating of tuff layers indicates that the lacustrine conditions prevailed in the NCB area for up to about 15 million years.

The marine phase of the NCB covers the middle to late Badenian and Sarmatian periods, during which the area formed the southwestern margin of the Central Paratethys (CP) sea. During the middle and late Badenian, various pelitic, carbonate and carbonate-clastic sediments with pyroclastic interbeds were continuously deposited on lacustrine deposits or over an unconformity covering various basement rocks. Following a late Badenian transgression, which marks the peak of the transgressive cycle in the NCB, a general regressive sedimentary sequence begins. Within this sequence, different Sarmatian clastic and carbonate sediments were deposited over the upper Badenian carbonate sediments under conditions of reduced volcanic activity and weakening of the connections between the CP and the surrounding marine areas. The gradual isolation of the CP and the reduction in the salinity of the water led to the extinction of stenohaline marine organisms at the Badenian–Sarmatian boundary and allowed the development of a new community adapted to life in a marine environment of reduced salinity.

The continuing fragmentation of the waterbodies in the Central Paratethys region, led to the complete isolation of the PBS from the surrounding marine areas, the termination of marine sedimentation and the formation of the brackish-water Lake Pannon. A stratigraphically unclear endemic biota developed in the newly formed lake. This circumstance and the lack of pyroclastics led to problems in the subdivision of the thick succession of Upper Miocene lacustrine deposits in the NCB area and their correlation with neighbouring regions. The deposition of the Upper Miocene lacustrine sediments in the NCB is characterised by a transgressive-regressive cycle. Limestones predominate in the older, transgressive part of the cycle. These are overlain by marly sediments with rare sand and gravel intercalations, while the younger, regressive part of the cycle is characterised by the deposition of sandy-

silty clastic detritus that entered the lake through deltaic systems. These systems prograded into the area of the NCB from the north and north-west and led to a gradual shallowing of the lake and its final infilling. The northern and north-western part of the NCB in particular was transformed into an alluvial plain before the end of the Miocene. In the south-eastern part of the basin, Lake Pannon remained until the early Pliocene, when it was replaced by the freshwater Lake Slavonia. Various clastic sediments were deposited in this lake from the middle Pliocene to the early Pleistocene, which were formerly known as *Viviparus* layers and represent a new, independent phase in the development of the basin. Since the early Pleistocene, the entire area of the NCB is again represented by terrestrial sedimentary environments.

## NEOGENE FLORAS OF CROATIA

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Findings of fossil floras in Croatia are not very common, but they occur in deposits ranging from the Late Carboniferous to the Quaternary age.

The most diverse and best known are Neogene floras from the Pannonian Basin, preserved in lacustrine and shallow marine deposits of the ancient lakes and seas. Floral assemblages point to the increasingly pronounced zonal distribution, as a consequence of the tectonic movements and uplifts, and were highly influenced by the Neogene climate changes. Conifers occupied the high altitudes, mixed deciduous forests were common at medium altitudes, while wetland and riparian vegetation, the most abundant in the fossil record, grew near water bodies and watercourses. Lauraceae, legumes and grassland vegetation were more commonly present during the arid periods.

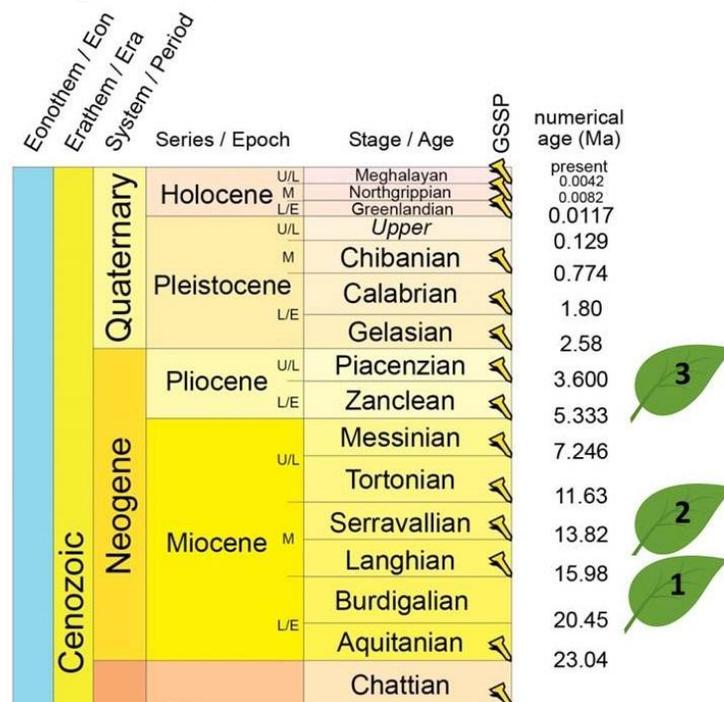


Figure 1: Stratigraphic position of the three types of best preserved Neogene fossil floras in Croatia: (1) Flora of the Miocene Climatic Optimum (MCO); (2) Flora of the Middle Miocene Climatic Transition (MMCT) and (3) Pliocene flora. Chronostratigraphic chart from International Commission on Stratigraphy (<https://stratigraphy.org/chart#latest-version>, August 2025)

Croatian Neogene fossil floras can be roughly grouped into the three groups (Figure 1). The Early Miocene-early Middle Miocene floras were found at the localities Planina, Laz Bistrički and Poljanska. At the locality Planina in the Medvednica Mt. plant fossils were collected since the 19<sup>th</sup> century (Polić, 1935 and references therein; Đerek, 1985 unpublished; Đerek & Japundžić, 2017). The most abundant species is *Myrica lignitum* (Unger) Sapporta, occurring along with Lauraceae (*Daphnogene*) and Leguminosae, *Eucalyptus oceanica* Unger,

*Zizyphus paradisiacus* Unger, *Andromeda protogea* Unger and *Pinus* sp. div. The associated climate was described as subtropical, wet. Similar plant assemblage was found at another locality in the Medvednica Mt., Laz Bistrički (Horvat, 2017, unpublished). Flora from the Poljanska locality (Slavonia region) was collected during the last few decades (Majetić, 2011; Grganić-Vrdoljak et al., 2017). The megaflora shows a lot of similarities with the assemblages from the Medvednica Mt., but the detailed sampling points to the alteration of arid and humid periods in this area. Palynomorphs studied from this locality comprise *Pinus*, *Carya* and ferns (*Echinatisporis*, *Mecsekisporites*, *Bifacialisporites*), associated with warm-temperate elements, such as the genera *Ulmus*, *Carpinus* and *Quercus* (Hajek-Tadesse et al., 2023). Numerous late Middle Miocene (Serravalian) plant fossils have been collected since the 19<sup>th</sup> century at the localities Radoboj (Hrvatsko Zagorje region) (Unger, 1869; Ettingshausen, 1870) and Podsused (Medvednica Mt) (Pilar, 1883). The assemblage from Podsused comprises more than 230 taxa, including the tropical and subtropical genera, such as *Ficus*, *Laurus*, *Persea*, *Daphnogene*, Mediterranean-type oaks, and palms along with floral elements typical for the temperate climate. Brajković (2011, unpublished) studied the palynomorphs from the vicinity of Podsused, determining 94 form taxa, including several new. In his further research he recorded the changes in palynomorph assemblages at the two open sections in the same area, pointing to the climatic change with more arid climate conditions and slightly lower temperatures (Brajković, pers. comm). The paleoflora from Radoboj is also highly diverse and exhibits a high degree of similarity to the Podsused site; however, Radoboj is also notable for the fossil vine leaf, which is the oldest of its kind in the wider area. The locality is also famous for the rich collection of fossil insects.

Pliocene plant fossils were found at the Cabuna locality in the Podravina region, comprising a megaflora dominated by maple leaves and hornbeam fructifications (Mrinjek, 2006). Bakrač & Sremac (2013) analyzed the additionally found macrofossils and palynomorphs discovered in the same area. They found abundant leaves and fructifications of fagaceans and betulaceans together with some ancient floral relics, such as *Ginkgo*, *Cathaya* and *Carya*, which are no more present in Europe. In addition to that, the rich palynomorph assemblage points to a vegetation originally organized in altitudinal belts, but preserved in freshwater marshes and oxbow lakes within the flood-plain of the paleo-Sava River.

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Non-pollen palynomorphs (NPPs) are organic-walled remains of microscopic organisms 10–250 µm in size, which are regularly found in palynological slides. The need for NPP research arose as a result of numerous samples poor in sporomorphs that are at the same time relatively rich in NPPs. Considering their various biological origin and ecological preferences, NPPs provide powerful tools in paleoenvironmental reconstructions, even in sediments that are poor in microremains of vascular plants such as pollen and spores.

Among the non-pollen palynomorphs identified in the Neogene and Quaternary sediments of Croatia, Cyanobacteria, Chlorophyta, and dinoflagellate cysts are most commonly observed. In the Neogene strata of Croatia, often representing marine to brackish-water and freshwater environments, NPPs are of particular importance as they can be utilized in tracking temporal and spatial shifts between these environments. Moreover, dinoflagellate cysts form the basis of the biostratigraphical subdivision of the Neogene strata in the Pannonian Basin System (Bakrač et al., 2012). In freshwater environments, green algae (e.g., Botryococcus, Pediastrum, Zygnemataceae), euglenids, and cyanobacteria have greater value for paleoecology. Cyanobacteria have been the focus of paleolimnological studies due to their significance in environmental monitoring and potential toxic blooms. This group has long geological history, and they also played a prominent role in the Neogene. A case study showed that high abundance of the cyanobacterium Gloeotrichia was linked to a decrease in nutrient levels, while a higher relative proportion of the green algae Coelastrum polychordum indicated a shallow, nutrient-enriched freshwater environment with low light conditions. The ongoing project of the Croatian Science Foundation “Non-pollen palynomorphs and palynofacies in paleoenvironmental reconstruction (Non-Poll)” will investigate the potential of NPPs and palynofacies in paleoenvironmental and paleoclimatic reconstruction as well as their applicability in the study of archeological materials.

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## COASTAL VEGETATION SHIFT DURING THE 8.2 KA EVENT IN THE EASTERN ADRIATIC (KORNATI ISLANDS)

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The 8.2 ka cooling event represents one of the most significant abrupt climate shifts of the Holocene, yet its ecological imprint on Mediterranean coastal ecosystems remains poorly documented. This study presents new high-resolution multi-proxy evidence from the Kornati Islands (Eastern Adriatic) to explore the environmental consequences that ensued. Palynological data reveal a marked decline in mesic forest taxa, including *Quercus* and *Fagus*, coupled with an expansion of xerophytic and steppe-like vegetation (*Artemisia*, Poaceae, Chenopodiaceae), indicating a rapid shift toward drier conditions. Parallel increases in micro-charcoal concentrations point to heightened fire activity, likely driven by drought-induced landscape flammability. Geochemical proxies, including grain size and magnetic susceptibility, record elevated terrestrial input and sediment variability, reflecting enhanced erosion and hydrological instability that is additionally supported with the presence of *Chomotriletes*.

These environmental transformations would have profoundly influenced human communities in the region, as archaeological evidence indicates dense Mesolithic–Neolithic occupation in the Kornati hinterland. Reduced freshwater availability, declining forest resources, and altered game habitats may have prompted shifts in settlement location, dietary strategies and technological adaptation. The combined signal of vegetation change, fire activity, and sedimentary disruption influenced by the rising sea positions the Kornati Islands as a key site for understanding the complex interplay between abrupt climate change and human–environment interaction in the Mediterranean. Our findings underscore the need for detailed regional reconstructions to clarify the scope and mechanisms of ecological and societal responses to Holocene climate extremes.

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**TAXONOMY, ECOLOGY, ENVIRONMENTAL AND BIOSTRATIGRAPHICAL IMPLICATIONS OF BRACKISH-WATER DINOFLAGELLATE CYSTS FROM LAKE PANNON (LATE MIOCENE, PANNONIAN BASIN SYSTEM)**

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The biota of the brackish-water Lake Pannon in the Pannonian Basin is characterized by remarkable endemism due to the isolated evolution of the lake for 8 myr after the last Miocene marine connection ceased (~11.6 Ma). A conspicuous feature of this endemism is the large, probably ecophenotypic variation in the morphology of brackish-water dinoflagellate cysts that challenges taxonomy and complicates biostratigraphical and ecological interpretations. Key members are primarily related to the marine genera *Spiniferites*, *Achomosphaera*, *Impagidinium* and *Pyxidinosia*. The genus *Pontiadinium* and several species e.g., *Thalassiphora balcanica*, *Galeacysta etrusca* and possibly *Spiniferites cruciformis* originated from the lake and were later also recorded in the Ponto-Caspian realm, hence understanding their taxonomy, origin and ecology has widespread interregional implications. Despite the plethora of data from all parts of the Pannonian Basin their taxonomy and consequently their biostratigraphical and paleoenvironmental implications are not well understood. Although the taxa are separated as different species for the purpose of biostratigraphy, they likely belong to few motile cell genera that produced different cyst as a response to changing environmental conditions in Lake Pannon and were genetically closely related.

From new materials from Hungary and Croatia we demonstrate how this ecophenotypic variation led to the development of new species in the endemic genus *Pontiadinium*. We revise the taxonomy of species originally described as *Spiniferites*, albeit their morphology makes them more comparable *Achomosphaera*. Integration of the biostratigraphical data with magnetostratigraphy and/or authigenic Be dating has helped revise the dinoflagellate cyst-zonation but also highlighted potential issues about the presence of facies dependent dinoflagellate cyst assemblages and limitations to their use in zonation. Comparison of latest Pannonian assemblages from Croatia, Serbia and Hungary revealed also still some discrepancies in the chronostratigraphic subdivision of the Pannonian stage in different areas of the Pannonian Basin System.

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## EARLY PLEISTOCENE VEGETATION DYNAMICS IN THE SOUTHERN CAUCASUS DRIVEN BY GLOBAL CLIMATE AND REGIONAL TECTONICS

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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. Pollen analysis was conducted for a part of the sequence spanning from MIS 33 to MIS 30. 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 needle-leaved 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.

**PALAEOENVIRONMENTAL DYNAMICS AND TROPICAL RAINFOREST (TFR) RESPONSE TO THE MIDDLE EOCENE CLIMATIC OPTIMUM (MECO): PALYNOLOGICAL AND GEOCHEMICAL INSIGHTS FROM BARTONIAN DEPOSITS OF THE KACHCHH BASIN, WESTERN INDIA**

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The Middle Eocene Climatic Optimum (MECO; ~40.6–40 Ma) represents a transient global warming event that significantly influenced marine and terrestrial ecosystems. The Harudi Formation deposited during a marine transgression, offers a valuable archive for reconstructing palaeoenvironmental conditions during this interval in the Kachchh Basin, Western India. This study integrates palynological and geochemical (carbon isotopic) data from the Bartonian succession to assess the impact of MECO on tropical rainforest dynamics and depositional environments. The palynological assemblages revealed a rich diversity of tropical angiosperms and ferns indicating warm-humid conditions conducive to dense evergreen forests. A distinct negative carbon isotope excursion ( $\delta^{13}\text{C} \sim -2.5\text{‰}$ ) aligns with the MECO peak, suggesting increased atmospheric  $\text{CO}_2$  and heightened climatic stress. Evidence of deciduous elements and subdued mangrove communities during peak warming points to changes in rainfall seasonality and salinity fluctuations. The re-establishment of evergreen flora marks post-MECO recovery, though overall diversity declined. These findings underscore the sensitivity of tropical rainforests and coastal ecosystems to short-term climate perturbations under high  $\text{CO}_2$  regimes.

**NON-POLLEN PALYNOFORMS: INSIGHTS FROM ANIMAL REMAINS IN THE FOSSIL RECORD****Jan Hinkelman***Croatian Geological Survey, Milana Sachsa 2, 10000, Zagreb, Croatia, email: [jhinkelman@hgi-cgs.hr](mailto:jhinkelman@hgi-cgs.hr)*

Non-pollen palynomorphs (NPPs) can be divided into the following taxonomic groups: Acritarcha, Algae, Animalia, Bryophyta, Fungi, Planta, Protozoa, Pteridophyta, Spermatophyta, unknown and unorganic remains (Shumilovskikh et al., 2021). Zoological NPPs are usually overlooked in samples, and include elements such as eggs, cuticular fragments, hair, mouth parts, shells and diverse fragmented insect remains. These can serve as valuable proxies for reconstructing palaeoenvironmental conditions such as temperature, depth, pH, productivity, pollution, and salinity, among others. The most common zoological remains belong to Chironomidae (Diptera), Cladocera (water fleas), Turbellaria (Platyhelminthes), diverse insect fragments (hair, claws, teeth etc.) and many unknown morphotypes.

Chironomidae, preserved as larval head capsules and mandibles (Kutluk, 2019; Shumilovskikh et al., 2021), are used to reconstruct past lake temperatures, depth, salinity and production. Cladocera, small aquatic crustaceans, another common zoological NPP, are also important for reconstructing past environmental changes, especially since they are sensitive to nutrient changes, physical and chemical stressors (Suhett et al., 2015). In some studies, Turbellarian egg capsules showed variation in abundance between shallow coastal areas and marine off-shore areas (Matsuoka and Ando, 2021). Other remains, even in small amounts, can point to increased production and parasitic relationships (Solhøy and Solhøy, 2000).

Overall, zoological NPPs are important complementary palynomorphs which should be taken into account together with pollen during palaeoenvironmental reconstructions.

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**ZAG - THREE LETTERS THAT DENOTE A NEW ERA OF CROATIAN PALYNOLOGY****Dario Hruševar<sup>1\*</sup>, Koraljka Bakrač<sup>2</sup>, Božena Mitić<sup>1</sup>, Ivona Baniček<sup>2</sup>, Olga Druzhinina<sup>3</sup>**

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In collaboration between palynologists (who mainly deal with pollen analyses) of the Faculty of Science, University of Zagreb and the Croatian Geological Survey, 23 new non-pollen palynomorphs (NPPs) have been described and published over the last three years. Therefore, the aim of this work is to present (with photos and a short description) those newly described non-pollen palynomorphs, marked in the literature with the abbreviation ZAG. Almost all of described NPPs (eg. ZAG-1 to ZAG-19) belong to fungi (including fungal remains or hyphae, ascospores or conidia), only one ZAG-20 belongs to algae and the last three (ZAG-21 to ZAG-23) are of unknown origin yet, although they also look similar to algae. First three non-pollen palynomorphs were isolated from the peat polder of archaeological site Graft in the central North Holland and published in *Interdisciplinaria Archaeologica* (Druzhinina, Hruševar et al. 2023). The following 20 non-pollen palynomorphs were isolated from the loess and loess-like deposits of Gorjani-Topole archaeological site in the Slavonia region and published in *Geologia Croatica* (Hruševar et al. 2024). Although additional geochemical analyses were lacking to clearly indicate the ecological value of the newly described palynomorphs, taphonomic processes that characterized the analysed sediment samples indicate a strong alternation of moisture and drought, changes in oxic and anoxic conditions, and deterioration of pollen grains (which is beyond the focus of this abstract), which speaks in favour of relatively dry habitats for all newly described fungal NPPs (ZAG-4 to ZAG-19), except for ZAG-1 to ZAG-3, which were associated with less moisture habitats.

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**THE TERTIARY TETHYAN RELICT FLORA IN EAST ASIA****Jian Huang**<sup>1,2</sup>

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In the early Cenozoic, there was a vast ocean in the center of Eurasia, namely the Neo-Tethys. Affected by the subtropical high pressure, some areas here have a subtropical to warm temperate semi-humid and semi-arid climate, which gave birth to a series of biomes and plant taxa adapted to this environment. Later, due to the formation of the Qinghai-Tibet Plateau, the Alpine-Himalayan orogeny, and the aridification of the center of Eurasia, the Neo-Tethys Ocean gradually receded, forming the Mediterranean Sea, the Black Sea, the Caspian Sea, etc. There are special relict plant taxa in these Neo-Tethys Ocean relict areas. Today, they generally have a distribution pattern of Mediterranean to West Asia (or Central Asia) & East Asia disjunct.

Although the Tethys Ocean has completely disappeared in East Asia, the diverse topography and climate environment still preserve many plants of this type. They grow in the semi-humid "shelter" of the subtropical-warm temperate zone in East Asia and have habitats and life forms significantly different from typical plants in the East Asian monsoon zone. For example: *Zelkova*, *Celtis*, *Parrotia*, *Pistacia*, *Carpinus*, *Ostrya*, *Quercus* sect. *Cerris*, *Quercus* sect. *Ilex*, *Buxus*, *Cotinus*, *Olea*, *Brandisia*, etc. With the progress of molecular systematics in recent years and the discovery of more fossil records in East Asia, we have provided more complete evidence for understanding the history of the decline of this biome that was once the largest in Eurasia.

We summarized the possible Tethyan relict taxa in East Asia. Their modern distribution, phylogenetic evidence, and fossil records are outlined. Preliminary results show that many of these plant taxa's diversity center or origin is on the Neo-Tethys Ocean's eastern coast. East Asia is not only a relict of the subtropical evergreen broad-leaved forest in the Northern Hemisphere during the Cenozoic, but also a museum of the Tertiary Tethyan flora.

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**PALEOPOLYPLOIDY PROMOTED ANCIENT ADAPTATION OF TIBETAN SCLEROPHYLLOUS OAKS TO ARIDITY TRIGGERED BY THE RISE OF THE HIMALAYA**

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Polyploidy is an important evolutionary force increasing plant diversity and environmental resilience. Reconstructing genome size (GS) and ploidy of plant fossils advances our understanding of plant evolution and stress adaptation. Palaeopolyploidy is usually inferred from molecular data, but precise timing of polyploidy events requires improvement. So far there has been no strong fossil evidence for palaeopolyploidy in angiosperms. Here, the GS of late Eocene (~34.6 Ma, the Markam flora) and middle Miocene (~15 Ma, the Namling flora) sclerophyllous oaks (*Quercus* sect. *Heterobalanus*) fossils from southern Tibet, and three late Pliocene fossils from Yunnan, China, were derived using the strong positive correlation between guard cell length and GS. The estimated GS of the Namling fossils was approximately double those of late Eocene and late Pliocene fossils as well as extant samples, indicating that the Namling fossils probably experienced a polyploidisation event. These polyploids seemingly conferred greater resilience to aridity-induced stress after ~15 Ma, reflected by two distinct fossil assemblages preserved in this flora, coincident with uplift of the Himalaya sufficient to block moist air from the Indian Ocean. Our discovery of sclerophyllous oak polyploids provides first compelling fossil evidence for palaeopolyploids in angiosperms, and demonstrates plant adaptation at the genome level to regional climatic change triggered by the rise of the Himalaya.

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## LATE EOCENE RING-POROUS WOOD REVEALS EARLY ADAPTATION TO MONSOON CLIMATE OF WOODY ANGIOSPERMS

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Understanding the origin and evolutionary history of the Asian monsoon is key to deciphering how ancient terrestrial ecosystems responded to climatic shifts. Wood formation is a critical physiological process in trees, reflecting adaptations to environmental constraints, particularly those related to water availability and mechanical support. One such adaptation is the ring-porous strategy, which is characterized by distinct differences in vessel size between earlywood and latewood, typically associated with seasonal drought or temperature stress, but relatively scarce in tropical trees. We recently discovered an exceptionally preserved ring-porous fossil wood from the late Eocene Na Duong Formation of northern Vietnam, identified as belonging to the Salicaceae family based on detailed anatomical observations and comparisons. The fossil wood is characterized by exclusively simple perforation plates, alternate intervessel pits, septate fibres, rare and scanty paratracheal axial parenchyma, and heterocellular rays with 1 to 4 cells in width composed of procumbent, square and upright cells mixed throughout the ray. Moreover, the fossil wood, characterized by a sharp transition between large earlywood vessels and narrow latewood vessels, exhibits classic traits of ring porosity with a maximum value of the mean sensitivity of growth rings of 0.19, suggesting a weak seasonal climate with abundant rainfall prevailed in northern Vietnam during the late Eocene. This discovery represents the earliest known record of ring-porosity in a tropical Asian context and suggests that monsoon-like climatic seasonality already prevailed in this area during the late Eocene. Together with other evidence of ring-porous wood fossils in East Asia, our study suggests that the Cenozoic development of a monsoon over southern Asia has driven the evolution of xylem architecture in woody angiosperms since the late Paleogene.

**ATMOSPHERIC CO<sub>2</sub> AFFECTS CLIMATE DEMANDS OF PLANTS****Wilfried Konrad<sup>1</sup>, Anita Roth-Nebelsick<sup>2</sup>**

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Soil water availability and atmospheric humidity are fundamental environmental factors for plants. This is due to the coupling of photosynthesis and transpiration. Both processes are coupled because both CO<sub>2</sub> entering the leaf and water vapor escaping from it diffuse through the same open stomata, linking their diffusion rates inevitably. In addition, temperature is involved in water demand, because potential evapotranspiration increases with temperature. To optimize carbon gain by photosynthesis against water loss by transpiration, plants regulate stomatal conductance constantly. However, CO<sub>2</sub> also affects stomatal conductance: an increasing CO<sub>2</sub> level reduces stomatal conductance and therefore water loss by transpiration. There is ample evidence for a lower water demand of plants under elevated CO<sub>2</sub>. These effects can potentially affect palaeoclimate reconstruction based on climate demands of extant relatives.

A mathematical optimisation model which quantifies these effects is based on relations between plant transpiration, assimilation and atmospheric CO<sub>2</sub>-concentration and asserts that plants adjust stomatal conductance in such a way that assimilation is maximised and transpiration is minimised. Since stomatal conductance is related to plant leaf anatomy the model leads eventually to expressions for stomatal conductance, transpiration rate and assimilation rate in terms of variables representing (a) the environment, (b) leaf anatomy, and (c) photosynthesis.

The model can also be utilized to calculate the environmental niche of a species in terms of temperature and humidity, based on species-specific assimilation rates. These are derived from living (ecological) relatives, assuming that they represent the required carbon gain to maintain vital and to be competitive against other species.

The model was applied to *Quercus petraea* and *Ginkgo biloba*. The results demonstrate a substantial shifting of the "viability space" to warmer and drier conditions. It is suggested to take these effects into account when reconstructing palaeoclimate based on environmental niches of extant plants.

## A MULTIPROXY STUDY OF A SEQUENCE FORMED DURING SARMATIAN/PANNONIAN ISOLATION OF AN EPICONTINENTAL BASIN (VIENNA BASIN, SLOVAKIA)

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This study yields a detailed multiproxy analysis of a transition from marine environments of the Paratethys Sea to the isolated Lake Pannon through a period of incision and hiatus.

Sarmatian azonal vegetation community indicates the presence of diversified coastal vegetation of marshes with Cyperaceae, halophytes of Chenopodiaceae, local lakes with the occurrence of freshwater algae with *Pediastrum*, Cyanobacteria and floodplain forests with local bogs with *Alnus*, *Ulmus*, *Myrica*, *Glyptostrobus/Taxodium* or with *Craigia*, *Liquidambar* or *Sparganium* lining the river system. Zonal vegetation dominantly represented by evergreen taxa from the Fagaceae family, e.g. *Quercus Ilex*, or the presence of *Mastixia* or Arecaceae palms indicates general paratropical climatic conditions and a fading climatic optimum. The rare presence of the genus *Ephedra* clearly points to the presence of more extreme habitats in the country and the local oscillation of aridity and humidity, probably due to the microclimatic effect. The Pannonian 8 horizons consisted of both terrestrial and marine elements. A change in the sedimentary environment is indicated by the occurrence of dinoflagellates *Pontadinium*, *Virgodinium*, *Chytroeisphaeridia* and *Spiniferites* group. The subtropical nature of the climate is supported by the common occurrence of thermophilic elements of zonal vegetation such as *Symplocos*, *Engelhardia*, *Castanea/Castanopsis*.

In the palynospectra related to the Pannonian 7 horizons with well-preserved palynomorphs, dinoflagellates and conifers, which form a facies typical of marine/brackish environments, were very abundant. *Virgodinium asymmetricum*, *Nemathosphaera*, *Chytroeisphaerida tuberosa*, *Spiniferites oblongus* (S. oblongus/Pontadinium peecsvaradense biozone) were mainly present.

Dinoflagellates are an important biostratigraphic age indicator of the Pannonian successions. The association present in the 8-Pan interval only proves the Pannonian age of the strata. The assemblage observed in the transgressive strata of 7-Pan interval includes *Virgodinium asymmetricum*, *Chytroeisphaerida tuberosa*, and *Spiniferites oblongus*, which can be assigned to the S. oblongus biozone with the proposed age range of ~11.2–10.8 Ma.

## DEVELOPING A CENOZOIC PALEOECOLOGICAL DATABASE FOR EURASIA: INSIGHTS FROM PLANT MACRO- AND PALYNOLOGICAL FOSSILS

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Understanding past ecological dynamics and environmental changes is crucial for predicting future responses to climate shifts. This study presents the development of a comprehensive Cenozoic paleoecological database (PEDB, <http://pd.xtbg.ac.cn>) for Eurasia, integrating diverse paleobotanical records to reconstruct ancient terrestrial ecosystems. The database currently comprises 831 fossil occurrences from across the Eurasian continent, including 393 palynological fossil records and 438 plant macrofossil records, spanning various Cenozoic epochs. This systematic compilation provides a foundational resource for high-resolution paleoenvironmental reconstructions.

The database is designed with a user-friendly web interface offering robust data querying capabilities, allowing users to filter by fossil type (e.g., plant macrofossils, palynological fossils), environmental variables, spatiotemporal parameters (e.g., time period: 35-20 Ma, stage). Interactive visualizations, including dynamic maps, time series, and scatter plots, facilitate the exploration of trends such as species richness through time. For broader research utility, data are available for download in various formats (e.g., CSV), and a programmatic API is provided for advanced data access and integration. The underlying data management framework is capable of processing, cleaning, and loading paleoecological data, particularly from CSV formats, ensuring data integrity and accessibility. Beyond core paleoecological data, the platform also integrates tools for accessing paleoclimate and modern climate data, alongside a dedicated leaf cuticle database, further enhancing its utility for interdisciplinary paleoenvironmental research. This evolving database will significantly contribute to refining our understanding of Cenozoic floral evolution and climate-vegetation interactions in Eurasia.

## EARLIEST *CALOCEDRUS* FROM THE LATE EOCENE HUNAN PROVINCE, SOUTHERN CHINA AND ITS BIOGEOGRAPHIC IMPLICATIONS

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*Calocedrus* Kurz (Cupressaceae) is a form of evergreen conifer tree with flattened branches and decussate and dimorphic leaves which almost in whorls of 4 including flattened facial pairs and boat-shaped lateral pairs. This genus is now disjunctly distributed in a typical East Asia and North American and comprises four living species, including *Calocedrus macrolepis* Kurz distributed in southeastern and southwestern China, northern India, northeastern Myanmar and Thailand, as well as Vietnam; *Calocedrus rupestris* Aver., T. H. Nguyễn et P. K. Lê endemic to northern Vietnam; and *Calocedrus decurrens* (Torr.) Florin confined to western North America. The fossil record of *Calocedrus* is known mainly from branches rarely with fruits. The earliest fossil record of the genus was founded from the Oligocene of South China, western North America and central Europe. In this study, we investigated fossil branches of *Calocedrus* from the Eocene of Xiangxiang Basin, Hunan Province, southern China. The morphology and microstructures of the present fossils and extant specimens of *Calocedrus*, *Thuja*, *Platyclusus* and *Fokienia* are studied. The result shows that the present fossils can be assigned to *Calocedrus*. The discovery of the genus from the Eocene of southern China suggests that it is the earliest fossil record of the genus, indicating that the genus had arrived in southern China at least by the Eocene and providing further evidence for the study of the origin and evolution for the genus. In addition, the potential distribution of the genus during the geological past is reconstructed using Species Distribution Model (SDM), suggesting a most likely migration route through North Atlantic land bridges for the genus. The result also shows that Bio 11 (mean temperature of coldest quarter) is the climatic factor that contributed the highest rate to the distribution of *Calocedrus*.

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**EXPERT HELP FOR LEAF CUTICLE STUDIES BADLY NEEDED FOR A THOROUGH UNDERSTANDING OF  
NEOGENE CONTINENTAL ECOSYSTEMS AND CLIMATE EVOLUTION IN NW ITALY**

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In the late 20th century a growing number of palaeobotanical studies increased our knowledge of the Neogene continental ecosystems and climate evolution in NW Italy. The main contribution was obtained from carpological materials, which are very abundant in the Pliocene, but scarce in the Miocene. However, large collections of Late Miocene fossil leaves were assembled and partially studied. The abundant laurophyllous leaves of these assemblages are still not well-framed from the systematic point of view, and this hampers the thorough understanding of Neogene continental ecosystems of these areas. It is well known that cuticle analysis, so far poorly applied in NW Italy, can provide useful information in these situations. Hundreds of samples would be already available for such a work, but presently it seems impossible to locate persons that could accept this task. In this presentation, I would like to give an impression about the high diversity of the Late Miocene leaf assemblages and present the results so far obtained on the basis of leaf gross-morphological characters, in order to stimulate some expert in leaf cuticle studies to join the research and provide some help for the identification of enigmatic taxa.

**DISTRIBUTIONAL RANGES OF TROPICAL FRESHWATER WETLANDS OVER GEOLOGICAL TIME: INSIGHTS FROM THE PALEOCENE-EOCENE *MYRISTICA* SWAMP FROM WESTERN INDIA****Shalini Parmar<sup>1\*</sup>, Vandana Prasad<sup>2</sup>**<sup>1</sup>CSIR-Centre for Cellular and Molecular Biology, Hyderabad, Uppal Road, India 50007, email:[shalinigary02@gmail.com](mailto:shalinigary02@gmail.com)<sup>2</sup>503 Beverly Park apartment, New Hyderabad, Lucknow, India 226007

*Myristica* swamps are among the most sought-after tropical freshwater wetland ecosystems due to their natural resources holding indispensable economic, social as well as ecological value. Once widely distributed all over the low-lying regions of Western Ghats, *Myristica* swamps are now rapidly shrinking to small patches, imposing grave extinction threats to its several endangered biotas (Chandran and Mesta, 2001). Fossil studies offer direct insights of the geological and climatic past to determine various factors driving their spatial distribution in deep time, and can also help in identifying the target areas of *Myristica* swamps for future conservation. Fossil pollen of Myristicaceae, a predominant plant family (32%) of *Myristica* swamps accommodating four endemic species (*Gymnacranthera canarica*- 78%, *Myristica fatua*- 19%, *Knema attenuata*-2% and *M. malabarica*-1%), from the Maastrichtian Deccan Intertrappeans of central India and early Paleogene deposits of western India show ranges of paleo-*Myristica* swamps spread over the central and western parts of India in deep time (Late Cretaceous-Paleogene). Paleoclimate and plate tectonic reconstructions imply that the early Paleogene warming helped to flourish moisture-loving Myristicaceae taxa on the paleoequatorially aligned Indian Plate. Subsequently, the expansion of seasonal climate on the Indian Plate during the Neogene cooling and Himalayan upliftment (Clift et al., 2008) retreated the *Myristica* swamps to the perhumid regions of Western Ghats as relics of ancient vegetation. *Myristica* swamps like tropical freshwater wetlands are thus inferred to be highly sensitive to climate change. Numerous studies (Chandran et al., 1998; Chandran and Mesta, 2001; Ranganathan et al., 2022) have asserted that human activities are to blame for the disruption of these wetlands. However, *Myristica* swamps, being an evolutionary relict, have impact from deep time geological processes and climate change than to be solely affected by the recent anthropogenic activities.

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## VEGETATION AND CLIMATE OF THE BELARUSIAN POLESIE AREA IN THE MURAVIAN (EEMIAN) INTERGLACIAL

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Numerous works of Belarusian researchers are devoted to the study of the vegetation and climate of the Muravian (Eemian) interglacial on the Belarusian Polesie Area. The floristic composition of interglacial vegetation and successive stages of its development made it possible to obtain an idea of paleotemperature changes in the Polesie Area throughout the interglacial.

To reconstruct paleotemperature, a method of combining climatic areas basing on the analysis of the taxonomic composition of forest-forming species was used (Grichuk, Zelikson, Borisova, 1987). In order to detail the composition of dendroflora, we conducted an additional study of tree pollen in the Muravian sediments of the Belarusian Polesie Area. As a result, the following taxa were identified: *Larix* sp., *Picea obovata*, *Picea abies*, *Abies alba*, *Taxus baccata*, *Pinus sylvestris*, *Betula pendula*, *B. pubescens*, *Alnus incana*, *A. glutinosa*, *Quercus robur*, *Q. pubescens*, *Q. petraea*, *Tilia cordata*, *T. platyphyllos*, *T. tomentosa*, *Ulmus laevis*, *U. minor*, *Carpinus betulus*, *Fraxinus excelsior*, *Acer platanoides*, *A. campestre*, *Corylus avellana*, *Vitis sylvestris*, *Buxus sempervirens*, *Ilex aquifolium*, *Ephedra distachia*, *Hedera helix* and also *Acer tataricum* L., *Corylus colurna* L., *Carpinus orientalis* Mill. Pollen of the last three species was identified in Muravian deposits for the first time. New data made it possible to refine the temperature parameters both on the western and eastern parts of the Belarusian Polesie Area.

The reconstruction of paleotemperatures for the optimal phase mr 4 *Corylus–Quercus–Ulmus–Carpinus* (+*Taxus+Hedera*) of the Muravian interglacial in the western part of the Belarusian Polesie showed following results:  $T_{VII} = +19...+23^{\circ}\text{C}$  (average  $+21^{\circ}\text{C}$ ,  $2^{\circ}\text{C}$  higher than the modern one),  $T_I = -4...+4^{\circ}\text{C}$  (average  $0^{\circ}\text{C}$ ,  $4^{\circ}\text{C}$  higher than the modern one). The same parameters were obtained for the corresponding phase mr 4 *Corylus–Quercus–Tilia–Fraxinus* for the eastern part of the Belarusian Polesie, despite the absence of some species. If we take into account minor presence of the Turkish hazel (*Corylus colurna*), we can assume that the paleotemperatures could have been even higher.

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## MIOCENE *COMBRETUM* FROM THE LOWER SIWALIK AND ITS BIOGEOGRAPHIC AND PALEOCLIMATIC SIGNIFICANCE

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The discovery of *Combretum palaeoapetalum* leaf fossils from the Lower Siwalik sediments of Bihar, India, provides valuable insights into the biogeographic history and paleoclimatic conditions. Morphological analysis indicates a strong resemblance to the extant species *Combretum apetalum* Wall. ex Kurz, currently distributed across tropical and subtropical regions of Africa, Asia, and Australia. The occurrence of these fossils in the Siwalik strata suggests that the region supported a warm, humid, tropical to subtropical forest ecosystem during the Miocene. This discovery highlights potential floristic links between the Siwalik flora and present-day African and Southeast Asian vegetation, offering evidence of ancient plant dispersal routes and broader historical distributions of the genus *Combretum* in southern Asia. The findings further suggest that the Himalayan orogeny and monsoonal intensification, played a significant role in shaping regional vegetation patterns. The presence of *Combretum* in the Siwalik Hills supports the hypothesis of historical biotic exchanges between Africa and Asia and underscores the impact of Neogene tectonic and climatic events on plant evolution and migration. These results enhance our understanding of paleobiogeography and the dynamics of Neogene ecosystems in South Asia.

## 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 paleoenvironmental reconstructions. In this study modern subfossil soil surface samples will be the base to establish a regional statistical relationship between the standing vegetation, climate and the pollen record. This method will be applied to the fossil record to detect regional differences in plant communities, as well as their development during different time periods indicating climatic changes.

Preliminary results show strong correlations between vegetation type and pollen assemblage. Open environments, represented by steppes and alpine meadows are characterized by grasses and herbaceous plants, especially Asteraceae, with little to no woody vegetation. Semi-deserts stick out due to a high abundance of Amaranthaceae and other herbaceous plant pollen. Whereas closed environments are characterized by a high abundance of woody plants, primarily trees including few herbaceous plants and grasses.

The resulting statistical correlation will be applied on fossil assemblages from Pleistocene sites of Armenia (e.g. Upper Paleolithic site Aghitu-3 cave) and Georgia to reconstruct the past vegetation and climate for the different groups of hominins occupied this region.

Preliminary results confirm, that this method is a useful tool for palaeoecological reconstructions, providing information about the dynamics of vegetation and climate during the Pleistocene in the Southern Caucasus.

**PALYNOLOGICAL STUDIES OF UPPER CENOZOIC FOSSIL SOILS AS AN IMPORTANT TOOL FOR PALAEOGEOGRAPHIC RECONSTRUCTIONS (ON THE EXAMPLE OF PLIOCENE AND PLEISTOCENE OF UKRAINE)**

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The predominant types of Upper Cenozoic sediments of Ukraine are subaerial red-brown-coloured Pliocene and loess-soil Pleistocene formations. Soils, vegetation, and climate are the main components of palaeolandscapes, which are inextricably linked. Vegetation reconstruction is the most important task in palaeogeographic reconstructions, and spore-pollen analysis is one of the key methods for accomplishing this task.

Palynological data indicate that during the early optimums of Pliocene and Pleistocene soil formation, woody species, dark coniferous elements, and moisture-loving plants became most important. The peak of warming is confined to the late optimums of soil formation. At this time, the role of herbaceous plants, including mesophilic herbs and thermophilic broadleaf species, increased in the composition of the vegetation cover. The final stages of soil formation were characterised by climate cooling and aridification and, accordingly, by an increase in the number of deciduous small-leaved plants and a decrease in the role, and partially complete disappearance, of thermophilic elements. The vegetation of the early endothermal cooling of the Pleistocene, although impoverished, was still close to the vegetation of the early interglacial optimums. The vegetation of the late endothermal cooling was already similar to those of the subsequent stages of loess formation. It was established that the peculiarities of the composition of plant cover of cold stages began to form at the final stages of the previous interglacials, during short-term endothermal cooling.

The development stages of vegetation of Ukraine in the Pliocene – Early Pleistocene are reconstructed. Not only distinctive features of reconstructed stages, but also the regularities of vegetation composition change during each warm and cold stage, and the regional differences of plant cover structure within the stages are established. Analysis of palynological data also made it possible to construct paleoclimatic curves for the Pliocene and Early Pleistocene, and to characterize climatic optimums and pessimums.

**UNVEILING ANCIENT LINEAGES: *ERIOLAENA* FOSSIL LEAF AND PHYLOGENETIC INSIGHTS INTO THE EVOLUTIONARY HISTORY OF THE WINGED SEED CLADE**

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This study investigates the earliest known fossil of the genus *Eriolaena* (Subfamily Dombeyoideae) and its implications for understanding the evolutionary history of the winged seed clade (WSC) within the Malvaceae family. The fossil leaves, identified as *Eriolaena palaeowallichii* were discovered in early Paleogene sediments at the Gurha lignite mine in Rajasthan, India. These fossils provide key evidence for reconstructing the historical biogeography of *Eriolaena* and its related genera, *Helmiopsis* and *Helmiopsiella*. This winged clade shows a palaeotropical intercontinental disjunction (PID), mainly located in Southeast Asia, India, and Madagascar with only a single species in Africa. The study conducted by the phylogenetic analysis suggests that (1) WSC likely originated in Madagascar in around 79 Mya; (2) jump-distance dispersal events were inferred between Madagascar to India and Madagascar to Africa; (3) 'Out of India dispersals' mainly occurred in the Miocene, allowing this clade to colonize in Southeast Asia. The findings highlight that the Miocene was a pivotal period for the global diversification of the WSC. This research not only introduces the earliest fossil record of *Eriolaena* but also sheds light on the paleotropical intercontinental disjunction of the winged seed clade, suggesting that ancient origins and long-distance dispersal mechanisms have played a crucial role in its evolutionary trajectory.

**DECIPHERING MODERN POLLEN-VEGETATION RELATIONSHIPS AND LAND COVER DYNAMICS:  
IMPLICATIONS FOR HOLOCENE PALAEOCLIMATE RECONSTRUCTION IN THE NORTHWESTERN  
HIMALAYA, INDIA**

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Palynology is an important tool for reconstructing past climate and vegetation. This research marks the modern pollen rain research conducted in the foothills of Northwestern (NW) Himalaya of Himachal Pradesh, India. This research assists in better comprehending the relationship between pollen and vegetation, as well as pollen representation and deposition in sediments for palaeo records. Pollen analysis conducted on 30 soil samples and moss cushions, reveals the dominance of dry deciduous taxa, followed by extra-terrestrial taxa and moist deciduous taxa. Dry deciduous taxa such as *Aegle marmelos*, *Acacia spp.*, *Anogeissus latifolia*, *Bauhinia spp.*, *Bombax ceiba*, etc. were found in soil samples and moss cushions. Land Use Land Cover (LULC) analysis performed using satellite data reveals that *Shorea robusta* mixed forest covers ~30% of land, followed by Himalayan Pine Associates (~20%) and *Pinus* (~5%). Since *Shorea robusta*, a mixed deciduous taxon, is entomophilous and easily attributed to chemical and microbial decomposition, it records low pollen counts. This study uses a comparative database that correlates pollen data with modern vegetation patterns to build an excellent foundation for evaluating sedimentary pollen sequences. This approach aims to shed light on past vegetation dynamics and estimate climate changes in the NW Himalaya.

**FATE OF TROPICAL RAINFOREST UNDER GLOBAL WARMING: LESSONS FROM THE EARLY PALEOGENE GREENHOUSE-GAS-INDUCED HYPERTHERMAL EVENT****Poonam Verma\*<sup>1</sup>, Gaurav Srivastava<sup>1</sup>, Harshita Bhatia<sup>1</sup>**

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The Indian Plate is a quintessential illustration of a drifting isolated island subcontinent within the equatorial region during the Paleocene-Eocene epoch. Its eventual collision with Eurasia, which occurred during the early Paleogene period, exerted a profound impact on global climate and also contributed significantly to the transformation and distribution of biodiversity. In conjunction with geodynamics, the early Paleogene global warming also led to the widespread proliferation of tropical flora and fauna across the Indian subcontinent.

Globally, the Paleocene-Eocene has been the focus of geoscientists for several decades, resulting in considerable information from mid- and high-latitude regions, whereas data from the low equatorial latitude remain sparse. The lignites and associated sediments of western India offer invaluable insights into the early Paleogene warming during a key period in India's drift history. To trace the floristic changes during the warming phase, such as the Second Eocene Thermal Maximum (ETM-2, approximately 53.7 million years ago) near the palaeo-equator (~0.6°N), palynological records from the Panandhro lignite mines of Kutch Basin, Western India, have been analysed. It has been found that the proportion of deciduous taxa rose from 3% to 12% during ETM-2, while evergreen taxa diminished from 83% to 74%, indicative of an extended dry season. These trends were reversed in the post-hyperthermal phase. Using palynological data, the quantitative climatic reconstructions have also been done, indicating a significant change in the hydrological regime that induced the vegetational shift. A key finding reveals a marked reduction in mean annual precipitation, which decreased from approximately 2870 mm prior to ETM-2 to around 1450 mm during the event. This reduction is linked to elevated atmospheric CO<sub>2</sub> levels exceeding 1000 parts per million by volume (ppmv). Consequently, this precipitation decline resulted in increased seasonality of rainfall and a notable expansion of deciduous vegetation, adversely affecting tropical evergreen rainforests. The study emphasises that hydrological changes induced by global warming can destabilise equatorial ecosystems, providing critical insights into the potential future impacts of anthropogenic climate change on biodiversity hotspots in tropical regions.

**BAMBOO FOSSILS FROM EUROPE AND WEST ASIA AND THEIR PALEOPHYTOGEOGRAPHICAL AND PALAEOCLIMATICAL IMPLICATIONS**

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The palaeophytogeography of the Bambusoideae has long been obscure, largely due to the lack of sufficient bamboo fossils and the difficult identification of them. East Asia, South Asia and South America, where are in high modern bamboo diversity, have a certain amount of bamboo fossil records (Wang et al., 2013). However, Europe and the adjacent West Asia, have no modern native bamboos despite a past wide geographic and stratigraphic distribution of them in these regions, attested by fossils. Therefore, bamboo fossils from Europe and West Asia not only provide important evidence for the palaeophytogeography history of the group, but also could play a key role in revealing the palaeoclimate tolerance of the Bambusoideae. The systematic classifications of the European and West Asian bamboo fossils are not clear. Worobiec and Worobiec (2005) suggests that Poland bamboo fossils are similar to *Arundinaria*, while bamboo fossils in other east Europe and West Asia are assigned to *Sasa* or other genera. The above classifications are based on the macro-morphology and/or paleoenvironmental information. In order to further identifying these bamboo fossils, more morphological evidences including the leaf venation or epidermis features are needed. Based on our bamboo morphological classification system established recently, bamboo fossils from Europe and West Asia are likely under the tribe Arundinarieae (temperate woody bamboos), because they have tessellate leaf venation and a relatively low length-width ratios of small vein squares. The taxonomic study of the European and West Asian bamboo fossils will reveal their position in phylogeny trees, and could link the relationship between the European bamboo fossils with those from other regions. This study also helps reconstruct the paleo-environments of these bamboo fossils and reveal their biodiversity evolutionary histories, as well as the reasons of the extirpation of bamboo fossils from Europe and West Asia under the ancient climate changes.

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## THE EOCENE-OLIGOCENE TRANSITION GLOBAL CLIMATE AND VEGETATION CHANGES: REVIEW OF RECENT PROGRESS

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The Eocene-Oligocene Transition (EOT) represents a pivotal epoch of profound transformation in both global climate and terrestrial ecosystems during the Cenozoic. This period witnessed a fundamental climate regime shift from a “warmhouse” state, characterized by high CO<sub>2</sub> concentrations and warm, humid conditions, to a “coolhouse” climate, marked by reduced CO<sub>2</sub> concentrations and progressively cooler, drier conditions. This review synthesizes global paleobotanical fossil records and climate model simulations to outline the global transition from the relatively warm and humid late Eocene to the ensuing early Oligocene, marked by sustained cooling and increasing aridity. We emphasize the consequential impacts of these environmental and climatic changes during this period on vegetation and plant diversity. Overall, the EOT was characterized by a pronounced global cooling trend, superimposed upon which were significant regional variations in climatic responses. While late Eocene vegetation was predominantly characterized by warm and humid forest biomes, the Oligocene witnessed a notable expansion of grass and drought-tolerant shrub in high-latitude regions and within regions experiencing cooler or drier climates. Furthermore, we comprehensively examine the synergistic interplay between climatic and regional environmental factors in shaping vegetation dynamics during the EOT. We critically evaluate the applicability and limitations of different research approaches, and provide perspectives to guide future research directions. Ultimately, this synthesis provides critical paleoecological insights and establishes a robust scientific framework for understanding the responses of terrestrial ecosystems to contemporary climate change.

**FOSSIL MICROSCLEROTIA OF DARK SEPTATE ENDOPHYTIC FUNGI FROM CENOZOIC DEPOSITS OF POLAND****Grzegorz Worobiec<sup>1</sup>, Elżbieta Worobiec<sup>1</sup>, Marek Widera<sup>2</sup>, Wojciech Granoszewski<sup>3</sup>**<sup>1</sup>*W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland*<sup>2</sup>*Adam Mickiewicz University, Institute of Geology, Krygowskiego 12, 61-680 Poznań, Poland*<sup>3</sup>*Polish Geological Institute – National Research Institute, Carpathian Branch, Skrzatów 1, 31-560 Kraków, Poland*

Endophytic fungi are considered crucial for the colonisation of terrestrial ecosystems by plants (Strullu-Derrien et al. 2018). During palynological studies of Cenozoic deposits of Poland, remains of microsclerotia (melanised aggregations of hyphal cells produced by dark septate endophytic fungi inside root cells) were found in the lower Oligocene marine deposits of the Grabówka PIG-1 borehole, the Middle Miocene lignite deposit from Drzewce, and the Lower-Middle Miocene lignite seam from Chłapowo (Worobiec et al. 2025). Modern dark septate endophytic (DSE) fungi are thought to provide various benefits to their hosts. They colonise the roots of plants worldwide, appearing to be common in virtually all ecosystems, but especially in extreme environments with low nutrient levels and high salinity (Santos et al. 2021). The fossil record of DSE microsclerotia has so far comprised microfossils (including non-pollen palynomorphs), which have been found during palynological investigations, but have mostly not been assigned to these endophytic fungi. The oldest reliable fossils of DSE microsclerotia date back to the Eocene and have been found on all continents except the polar regions (Worobiec et al. 2025). Similar to modern ones, dark septate fungal endophytes were probably key components of Cenozoic terrestrial ecosystems in the past. The presence of fossilised microsclerotia of DSE fungi confirms the existence of dense terrestrial vegetation in the past, particularly when found alongside the fossils of other soil organisms. The presence of DSE microsclerotia in marine deposits indicates the influx of terrestrial material into the marine environment originating from coastal vegetation. The abundance of DSE microsclerotia fossils, together with the presence of other types of terrestrial fossils in marine deposits, can be indicative of the proximity of fossil-bearing sediments to the shoreline.

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**INTERGRATED FOSSIL AND MOLECULAR EVIDENCE REVEALED THE SPATIOTEMPORAL EVOLUTION OF BETULACEAE****Mengxiao Wu<sup>1</sup>, Qiuyue Zhang<sup>1</sup>, Zhekun Zhou<sup>1</sup>, Shufeng Li<sup>1</sup>, Lutz Kunzmann<sup>2</sup>**<sup>1</sup>*Yunnan Key Laboratory of Forest Ecosystem Stability and Global Change, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan, 666303, China*<sup>2</sup>*Senckenberg Natural History Collections Dresden, Königsbrücker Landstraße 159, 01109 Dresden, Germany*

Betulaceae (the birch family) widely distributed in North Hemisphere and a few species extend to highlands of Central and South America. It is one of the most important components of temperate forest and is of great significance to investigate the biogeographic history of North Hemisphere. Morphological and molecular analyses support its subdivision into subfamilies Betuloideae (*Alnus*, *Betula*) and Coryloideae (*Carpinus*, *Ostrya*, *Corylus*, *Ostryopsis*). However, the origin of Betulaceae, the divergence of the two subfamilies, and the emergence of modern genera are still controversial. Some molecular results are inconsistent with fossil records. In the present study, we combined fossils and extant species, integrated molecular and morphological data to infer the origin and divergence time of Betulaceae based on the fossilized birth death model. We reconstructed the ancestral range evolution based on the dispersal extinction cladogenesis model and estimated the spatiotemporal diversification dynamics of this family to assess the roles of dispersal and extinction in establishing its current distribution. Combined phylogenomic and fossil evidences. Present study supported the boreotropical origins of Betulaceae in North America and Europe. Since the early Eocene Eurasia played as an important role in Betulaceae evolution and experienced frequent migration events, acting as both main sources and sink of Betulaceae dispersal. Since the early Eocene, the present-day lineages number in East Asia exceeded all distribution areas, indicating that East Asia has been a diversification center for Betulaceae since a very early period, persisting to present day.

**EARLIEST RECORD OF BAUHINIA S.L. (FABACEAE): A MIDDLE PALEOCENE NATURALLY FOLDED LEAF FROM SOUTH CHINA**

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The genus *Bauhinia* Plumier ex Linnaeus s.l. (Fabaceae) includes c. 380 species of trees, shrubs, lianas and herbs, distributed in pantropical regions and with previous fossil records from the late Paleocene to the Pliocene, mainly recovered from Asia. Here we report the earliest fossil record of *Bauhinia* s.l., in the form of a naturally folded leaf from the middle Paleocene of the Sanshui Basin, Guangdong, South China. Based on detailed morphological comparisons, the fossil is named *Bauhinia sanshuiensis* sp. nov. Its discovery indicates that *Bauhinia* s.l. had already appeared in its modern diversity centre at least by the middle Paleocene. The results of Biomod2 species distribution modelling quantitatively support the significance of the Kohistan-Ladakh Island Arc in facilitating the floristic exchange of *Bauhinia* s.l. between Africa and Asia. The diversification and modernization of *Bauhinia* s.l. in China are discussed in detail based on substantial fossil evidence, underscoring China's crucial role in the phytogeographic history of this genus. Nearest relative analysis for *Bauhinia sanshuiensis* suggests that it may have been a vine or shrub, adapted to temperatures similar to those of modern Sanshui, but with less precipitation.

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THE LOSS AND REVIVAL OF THE PASSION-FLOWER FAMILY (PASSIFLORACEAE) IN EAST ASIA:  
EVIDENCES FROM FOSSILS AND SYSTEMATICAL BIOLOGY

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The passion-flower family (Passifloraceae) is a diverse pantropical family primarily exhibits life forms of climbing herbs or lianas, occupying mainly rainforest habitats. Despite the wide modern distribution and high diversity of Passifloraceae, fossil records of this family is sparse, previously been reported from the Eocene to the early Pleistocene of Europe, North and South Americas. Here, we report the seed fossils of the genus *Passifloroidesperma* (Passifloraceae) from the middle Paleocene Sanshui Buxin Formation of Guangdong, and the middle Eocene Niubao Formation of Tibet, China. These fossils represent the first megafossil records of this family in East Asia. In addition, the Sanshui fossil seed is the earliest fossil record of Passifloraceae, pushing the family's record back by about 15 Ma. We integrated phylogenetic, biogeographic, and ecological niche analyses to reconstruct the diversification and dispersal patterns of Passifloraceae. Results indicate our fossils from the early Cenozoic of East Asia represent a lost lineage within Passifloraceae. These discoveries reveal a much earlier origin and wider distribution of this family in deep-time that would have remained unrecognized without fossil evidence. Our analysis suggests this lineage may have migrated from Africa to Asia during the Paleocene via the Tibetan region, with the Kohistan-Ladakh island arc (KLIA) serving as a corridor. Our study demonstrates that Passifloraceae had already migrated to East Asia by the early Cenozoic, but this early lineage was likely extirpated from Asia by the late Eocene. The modern East Asian Passifloraceae are the result of independent migration events after the Oligocene, suggesting a more complex migration and extirpation dynamic than previously thought. The Old World *Passiflora* species most likely formed their current distribution via direct transoceanic long-distance dispersal from the Neotropics. Furthermore, major global warming events may have acted as significant drivers, promoting the speciation and lineage diversification within the passion-flower family.

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**COEVOLUTION OF SEED SIZE IN JUGLANDACEAE AND BODY SIZE OF ITS DISPERSERS****Jie Zhu<sup>1,2</sup>, Qiuyue Zhang<sup>2</sup>, Andressa Cabral<sup>3</sup>, Daniele Silvestro<sup>4,5</sup>, Bruna Farina<sup>6</sup>, Yaowu Xing<sup>2,7\*</sup>**

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Seed size is an important species trait, affecting life-span, dispersal syndrome, and other plant ecology. Evolutionary patterns of seed size vary greatly among seed types due to divergent selection pressures. Since the Paleocene, the onset of global cooling may have driven directional shifts in seed size across multiple clades as an adaptive response to environmental change. Beyond environmental factors, species interactions may impose additional selective pressures on seed size evolution, as most seeds rely on animals for dispersal. Juglandaceae offers an ideal system for studying the macroevolutionary dynamics and underlying drivers of seed size evolution, given its two distinct seed types characterized by animal-dispersed nut group and wind-dispersed winged-nut group, along with exemplary fossil record. Here, we combine phylogenetic, seed size and distributional data of the walnut family (Juglandaceae) to unravel the mechanisms of seed size evolution from both temporal and spatial scales. We found that the nut and winged-nut group exhibit markedly distinct evolutionary trajectories. Macroevolutionary analyses indicate a significant increase in seed size for nut group since the late Eocene, influenced by temperature seasonality and their disperser body size, a pattern further supported by spatial analyses. In contrast, seed size in the winged-nut group has remained relatively stable over time. Our results demonstrate that seeds with different dispersal modes have distinct evolutionary histories, owing to differing selective pressures. Animal-dispersed seeds, in particular, undergo long-term reciprocal adaptation with their dispersers in matched traits, which facilitate co-diversification ultimately.

**ASYNCHRONOUS EVOLUTIONARY DYNAMICS OF CONTINENT-SPECIFIC DIVERSITY IN THE NORTH TEMPERATE WOODY ANGIOSPERMS****Qiuyue Zhang<sup>1</sup>, Daniele Silvestro<sup>2,3</sup>, Yaowu Xing<sup>1,4,\*</sup>**

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Current biogeographic patterns show a clear hierarchy of biodiversity across continents, with Asia hosting the highest diversity, followed by North America and then Europe. However, the evolutionary processes driving this disparity remain poorly understood. Integrating palaeobotanical evidence with geohistorical environmental changes offers critical insights into these diversification trajectories. In this study, we compiled a dataset of 680 fossil floras of Northern Hemisphere woody angiosperms, representing 110 families and 697 genera (including 237 extinct genera). Using the DeepDiv model, we reconstructed continent-specific diversity dynamics over time. Additionally, we applied community ecology approaches to assess intercontinental diversity differences and their responses to paleoenvironmental changes. Our results show that plant diversity in Asia and North America began to decline after the Oligocene, whereas Europe experienced more pronounced losses following the Middle Miocene. Our results also indicate significant phylogenetic turnover across different continents during the Oligocene. These findings reveal asynchronous diversification dynamics among continents, shaped by their unique geological and climatic histories, and provide a more comprehensive understanding of the formation of Northern Hemisphere plant biodiversity.

## THE DISCOVERY OF THE EOCENE GENUS *PALIBINIA* FROM XIZANG, CHINA AND ITS GEOLOGICAL AND BIOLOGICAL SIGNIFICANCES

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The genus *Palibinia* Korovin is an extinct group of angiosperms that was widely distributed across China during the Paleogene and recorded in center Asia, Europe and America from the Middle Eocene to the Late Oligocene. It was initially recognized as an indicator of arid environments based on its morphological traits and geographical distribution; recent studies have challenged this assumption.

This research analyzed leaf fossil specimens previously identified as “cf. *Banksia* leaf” from the Jianglang flora in the Niubao Formation, Jianglang Basin, Xizang. The study utilized the HadCM3 climate model, to simulate paleoclimates over five periods from the Paleocene to the Oligocene.

The results revealed that the leaf shape, size, and venation pattern of “cf. *Banksia* leaf” specimens closely resemble *Palibinia laxifolia* Korovin, leading to their reclassification. Despite thorough the detailed morphological analysis, the phylogenetic relationship of *Palibinia* to modern groups remains undetermined. According to fossil records, *Palibinia* initially appeared in the Paleocene strata of Sanshui in Guangdong, Hengyang in Hunan, and Yizheng in Jiangsu. During the Middle Eocene, its distribution expanded to the Qinghai-Tibetan Plateau, Central Asia, Europe, and North America. However, by the Late Eocene, its range contracted, eventually culminating in its extinction during the Late Oligocene. *Palibinia* played a crucial role in the terrestrial ecosystems of Southeast China during the Paleogene. Although previous studies linked that *Palibinia* to arid conditions based on its morphological features, our simulations of paleoclimate data from 24 global fossil sites suggest that *Palibinia* occupied a broad ecological niche. Paleoclimate reconstructions of the Middle Eocene fossil assemblages from the Jianglang flora (Xizang) and the Relu flora (Sichuan) demonstrate that *Palibinia* also thrived in humid environments, challenging its classification as an arid indicator.

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