NECLIME

NECLIME Online Conference 2022

November, 21-25

Conference Volume

Conveners:

Angela A. Bruch, Torsten Utescher, Marianna Kováčová & Martina Stebich

General Schedule

Monday to Thursday, November 21 – 24, 2022

Time	Country	Difference to CET	Time zone
09:00 – 12:00	UK	-1	Greenwich Mean Time (GMT)
10:00 – 13:00	**Croatia, Czech Republic, Germany, Italy, Poland, Slovakia, Switzerland**	**0**	**Central European Time (CET)**
11:00 – 14:00	Ukraine	+1	Eastern European Time (EET)
12:00 – 15:00	Turkey, St. Petersburg/Russia	+2	Turkey Time (TRT), Moscow Time (MSK)
13:00 – 16:00	Armenia	+3	Armenia Time (AMT)
14:30 – 17:30	India	+4:30	Indian Standard Time (IST)
14:45 – 17:45	Nepal	+4:45	Nepal Time (NPT)
15:00 – 18:00	Kazakhstan	+5	Qyzylorda Time (QYZT)
17:00 – 20:00	China	+7	China Standard Time (CST)
18:00 – 21:00	Japan	+8	Japan Standard Time (JST)
19:00 – 22:00	Vladivostok/Russia	+9	Vladivostok Time (VLAT)

Monday, November 21, 2022

10:00 CET **Angela A. Bruch & Torsten Utescher**
Welcome and technical Instructions
Introduction and news from NECLIME

Chair Torsten Utescher

10:30 CET **Tamara Fletcher**, Julia Tindall, Ran Feng, Alan M. Haywood, Ulrich Salzmann & Aisling M. Dolan
The Pliocene Arctic: Were winters warm?

10:45 CET **Tao Su**, Jian Huang, Jia Liu, Shu-Feng Li, Robert A. Spicer & Zhe-Kun Zhou
The evolution of plant diversity during the Eocene of central valley in Tibet, China

11:00 CET **Gaurav Srivastava**
Leaf physiognomy reveals orographic control over the Paleogene Asian monsoon

11:15 CET 15 min break

Chair Tao Su

11:30 CET **Olesia V. Bondarenko** & Torsten Utescher
Early Paleogene climate of the Pacific side of Eurasia

11:45 CET **Poonam Verma** & Yogesh Pal Singh
Evidences of floral diversity changes in the western Indian palaeo-equatorial region across the early Eocene warming event (ETM2)

12:00 CET **Svetlana Popova**, Anna Averyanova, Torsten Utescher, Valentina Tarasevich & Su Tao
Oligocene vegetation pattern of central Asia based on palaeobotanical data and application of the PFT technique

12:15 CET 15 min break

12:30 CET *Social gathering and open discussions in the* ***NECLIME wonder room***

Tuesday, November 22, 2022

Chair Marianna Kováčová

10:00 CET **Grzegorz Worobiec** & Elżbieta Worobiec
Fossil fungi as valuable proxies in paleoclimatic reconstructions

10:15 CET **Barbara Słodkowska** & Marek Widera
Sedimentary environment of phytogenic deposits recorded in the composition of pollen assemblages in the Tomisławice open cast mine (Konin Region, Central Poland)

10:30 CET **Elżbieta Worobiec**, Grzegorz Worobiec & Marek Widera
Middle Miocene palynoflora and non-pollen palynomorphs from the Drzewce lignite deposit, central Poland

10:45 CET **Sumana Mahato**, Taposhi Hazra & Mahasin Ali Khan
The first fossil record of coryphoid palm from Siwalik

11:00 CET 15 min break

Chair Gaurav Srivastava

11:15 CET **Sadanand Pathak**, Harshita Bhatia, Gaurav Srivastava & R.C. Mehrotra
Dioscorea Plum. ex L. leaf from the upper Siwalik sediments of eastern Himalaya and its phytogeographical significance

11:30 CET **Lopamudra Roy**, Amit K. Ghosh, Sarajit Sensharma & Ajoy Kumar Bhaumik
Tortonian Radiolarian Events from Northeast Indian Ocean (NGHP- 01- 17A)

11:45 CET **Stuti Saxena** & Amit K. Ghosh
Tortonian-Messinian calcareous nannofossils and silicoflagellates from northern Indian Ocean

12:00 CET **Amit K. Ghosh**, Lopamudra Roy, Rikee Dey & Arindam Chakraborty
Benthic calcareous algal diversity during middle Miocene to Pleistocene sequences in northeast Indian Ocean: their significance in deciphering depositional environment

12:15 CET 15 min break

12:30 CET *Social gathering and open discussions in the* ***NECLIME wonder room***

Wednesday, November 23, 2022

Chair Elżbieta Worobiec

10:00 CET **Elen Hakopyan**, Ivan Gabrielyan, Edoardo Martinetto & Angela A. Bruch
Middle to Late Holocene Wetland Dynamics at the Southern Shore of Lake Sevan, Armenia

10:15 CET **Arata Momohara**, Yuichiro Kudo, Nao Miyake, Fuyuki Tokanai & Minoru Tsukagoshi
Floral diversity in refugia of Tertiary relicts in central Japan during the last glacial maximum

10:30 CET **Edoardo Martinetto**
Possible advantages of a general survey of the late Cenozoic plant macrofossil record in NW Italy, regardless of uncertainties in dating

10:45 CET **Olena Sirenko**
Palaeolandscapes and climate of the Dniaper lowland (Ukraine) in the Gelasian time (according to palynological data)

11:00 CET 15 min break

Chair Tamara Fletcher

11:15 CET **Wilfried Konrad**, Christopher Traiser & Anita Roth-Nebelsick
Modelling photosynthesis and leaf ecophysiology in arctic forests of the Eocene

11:30 CET **Manuel Casas-Gallego**, Karen Hahn, Katharina Neumann, Sebsebe Demissew, Marco Schmidt, Stéphanie C. Bodin & Angela A. Bruch
Reconstructions of vegetation distribution in Ethiopia since the Last Glacial Maximum based on pollen records and ecological niche modelling

11:45 CET **Shumei Xiao**, Shufeng Li, Xiaojun Wang, Linlin Chen & Tao Su
Cedrus distribution change: past, present, and future

12:00 CET **Christine Hertler**, Ericson Hölzchen, Jan-Olaf Reschke, Alexandra van der Geer, Iwan Pramesti Anwar, Mika Puspaningrum, Nicolas Büscher & Emmanuel Kipruto Ngetich
Crossing seastraits - how mammals disperse across barriers

12:15 CET 15 min break

12:30 CET *Social gathering and open discussions in the* ***NECLIME wonder room***

Thursday, November 24, 2022

Chair Agathe Toumoulin

10:00 CET **Sanchita Kumar**, Taposhi Hazra, Robert A. Spicer, Manoshi Hazra, Teresa E.V. Spicer, Subir Bera & Mahasin Ali Khan
Coryphoid palms from the K-Pg boundary of central India and their biogeographical implications: Evidence from megafossil remains

10:15 CET **Kajal Chandra**, Anumeha Shukla, R. C. Mehrotra & Amit Kumar Singh
Oldest remnants of mahogany (family Meliaceae) from the early Paleogene of the Indian subcontinent

10:30 CET **Samiksha Shukla**, Kajal Chandra, Anumeha Shukla & R.C. Mehrotra
First fossil record of Eriolaena (subfamily Dombeyoideae, family Malvaceae) from the early Paleogene of Rajasthan: Insight into its evolutionary history and diversification

10:45 CET **Harshita Bhatia**, Gaurav Srivastava & R.C. Mehrotra
Duabanga (Lythraceae) from the Oligocene of India and its implication on the evolution of biodiversity hotspots in south Asia

11:00 CET **Shalini Parmar** & Vandana Prasad
Effect of early Paleogene climate and tectonics on the evolution of family Arecaceae on the Indian Plate

11:15 CET 15 min break

Chair Angela A. Bruch & Torsten Utescher

11:30 CET NECLIME final discussion

Forthcoming events, conclusions, comments, and discussion

Abstracts

Duabanga (Lythraceae) from the Oligocene of India and its implication on the evolution of biodiversity hotspots in south Asia

Harshita Bhatia[1,2,*], Gaurav Srivastava[1,2] & R.C. Mehrotra[1]

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Understanding the evolutionary history of biodiversity hotspots has important implications for their survival in future. India encompasses four biodiversity hotspots in the Western Ghats of south India, Andaman and Nicobar Islands, Eastern Himalaya, and the Indo-Myanmar region. Northeast India (NEI) is an important region that provides shelter to 43% of the total plant species occurring in India of which ~39% are endemic. This region also acts as a gateway for the biotic exchange between south and southeast Asia. The area also receives exceptional rainfall during the pre-monsoon (MAM), in addition to the summer monsoon (JJAS) season. The rainforests of NEI nurture the biodiversity hotspot of this region. Understanding the evolutionary history of rainforests of NEI has implications for the conservation of biodiversity hotspots. We report an important evergreen rainforest genus *Duabanga* Buch.-Ham. of the family Lythraceae from the late Oligocene sediments of Assam, NEI. The fossil records of the genus from south Asia and southeast Asia suggest its gondwanan origin, while its modern distribution is dominantly controlled by moisture availability.

Early Paleogene climate of the Pacific side of Eurasia

Olesia V. Bondarenko[1] & Utescher Torsten[2,3]

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Early Paleogene latitudinal continental temperature and precipitation gradients and patterns along the Pacific coast of Eurasia are studied in time and space using the Coexistence Approach, for the first time applied on the large palaeobotanical record of this region. The palaeobotanical data used in this reconstruction are compiled from literature resources on 110 reasonably well-dated floras from a total of 73 localities, covering early Paleocene (Danian) to early Eocene (Ypresian). The studied localities are located along the Pacific coast of Eurasia, including the Far East of Russia, Eastern Siberia, China, and Japan. According to our data, the latitudinal temperature gradient was very weak during the early Paleogene. Based on mean annual and cold month mean temperatures, two different regional climatic zones can be distinguished in the Paleocene representing in each case the cooler and warmer (subtropical) part of warm temperate climate. In the early Eocene, the gradient became more pronounced and in addition, a cool temperate zone can be distinguished. The early Paleogene precipitation gradients were also very weak. Based on means of mean annual precipitation (MAP) data, climate was equably humid during the early Paleocene. In the late Paleocene, a minor MAP gradient from mid- to high latitudes can be observed. In the early Eocene, this gradient became more clearly pronounced, and a larger arid zone can be distinguished in the mid-latitudes. The presence of mangroves in early Eocene records is largely in line with our climate reconstruction and possible can be related to the PETM and EECO global hyperthermal events. Our quantitative climatic reconstruction supports the existence of early Paleogene warmth in the High Arctic as was already suggested in earlier reconstructions, based on a variety of proxy data.

The study was carried out with the support of the Russian Science Foundation (project No. 22-27-00098, https://rscf.ru/project/22-27-00098/).

Reconstructions of vegetation distribution in Ethiopia since the Last Glacial Maximum based on pollen records and ecological niche modelling

Manuel Casas-Gallego[1,2], Karen Hahn[1], Katharina Neumann[2], Sebsebe Demissew[3], Marco Schmidt[4], Stéphanie C. Bodin[2] & Angela A. Bruch[5]

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Understanding the changing plant ecosystems that existed in East Africa over the last millennia and how they were affected by climate is crucial to how they can be managed at present. It is also essential for identifying links between habitats and past humans' adaptation and dispersal across the region. In the Horn of Africa, this task is hampered by the scarcity of fossil botanical data. Here we present modelled past vegetation distributions in Ethiopia since the Last Glacial Maximum (LGM) at high spatial and temporal resolution. The simulations show that, contrarily to long-standing hypotheses, the area covered by Afromontane forests in the LGM was significantly larger than at present. This scenario persisted throughout most of the late glacial. The combined effect of low temperatures together with the relative rainfall contribution sourced from the Congo Basin and Indian Ocean emerges as the mechanism that controlled the migration of Afromontane forests to lower elevations. This process may have enabled the development of continuous forest corridors connecting populations that are currently isolated in mountainous areas over the African continent. Starting with the Holocene (~11 ka), the expansion of forests began to reverse in the eastern mountain ranges. This decline intensified over the second half of the Holocene (5 ka to present) leading to a retreat of the forests to higher elevations where they are restricted today. The simulations are consistent with proxy data derived from regional pollen records and provide a key environmental and conceptual framework for human environmental adaptation research.

Oldest remnants of mahogany (family Meliaceae) from the early Paleogene of the Indian subcontinent

Kajal Chandra[1,2,*], Anumeha Shukla[1], R. C. Mehrotra[1] & Amit Kumar Singh[2]

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The Meliaceae genus *Swietenia* (usually called mahogany) is currently distributed in neotropics indicating a narrow geographical range. *Swietenia* has rare representation in deep time with just two fossil flowers known from the mid Tertiary and late Oligocene-early Miocene sediments therefore evolutionary and paleobiogeographic history of this genus is partly understood. We report a well preserved fossil leaflet comparable to the extant genus *Swietenia* from the late Paleocene–early Eocene sediments of Gurha lignite mine, Rajasthan (western India). The fossil leaflet is characterized by an asymmetrical microphyll-sized lamina with an entire margin, festooned brochidodromous venation, mixed percurrent as well as (predominantly) alternate tertiary veins and freely ramified quaternary veins. The fossil leaflets recovered from the Indian subcontinent are the oldest known fossil records of the genus *Swietenia* and add a new perspective to its paleobiogeographic distribution in Southeast Asia during the early Paleogene. We also hypothesised the possible reason for the extinction of this genus from the Indian subcontinent. Although, the study area (Rajasthan) was under a wet climate regime during the early Paleogene supporting the wet forests of *Swietenia*, however, their existence might have ceased as the Indian plate moved further north, experiencing dry desertic conditions.

The Pliocene Arctic: Were winters warm?

Tamara Fletcher[1], Julia Tindall[1], Ran Feng[2] Alan M. Haywood[1], Ulrich Salzmann[2] & Aisling M. Dolan[1]

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The models used to predict future climate are tested by comparing their simulations of recent climate to a wide range of observational and instrumental records. However, recent records do not cover the full span of conditions that we will face as climate changes this century. The ability of models to accurately predict climate outside the range of recent observations can be assessed by using the models to simulate warm climates of the past.

The Pliocene (2.8–5.3 million years ago) is an interesting target due to its similar geography, global warmth, and current to near-future CO_2 levels. However, Pliocene simulations disagree with climate reconstructions in key regions – particularly the Arctic. Data-model comparison has commonly focused on mean annual temperature. To understand the possible cause of Pliocene Arctic data-model mismatch, we explored the signal in greater detail.

Our recent work suggests data-model mismatch in the Arctic is largely limited to cold-season temperature. Here the temperatures obtained from models and different proxies can vary by more than 20°C. Possible causes of the mismatch are considered, including potential impacts of cloud, uncertainties in reconstruction methods, and the lack of a modern analogue for these high-latitude climates. Summer temperature data-model comparison, however, is in good agreement, and further narrows the possible causes of Pliocene Arctic data-model mismatch.

Benthic calcareous algal diversity during middle Miocene to Pleistocene sequences in northeast Indian Ocean: their significance in deciphering depositional environment

Amit K. Ghosh[1], Lopamudra Roy[1,2], Rikee Dey[1] & Arindam Chakraborty[1,3]

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In the oceanic realm, amongst the benthic plant communities, calcareous algae namely corallinacean red algae, desicladalean and halimedacean green algae are the most dominant contributors. The calcareous algae are very significant as they are responsible for maintaining the global carbon budget. These calcifying macroalgae are made up of magnesium-calcite skeletons within their intracellular spaces. In the marine ecosystem around the world they provide structural support to bind the reefs. In the perspective of global climate change, calcareous algae are receiving renewed attention in ecological and geological sciences as they are important organisms in the context of ocean acidification. Calcareous algae, specifically coralline red algae are increasingly used to interpret palaeoecology and palaeoenvironment. The diversification of the algal forms reveals the ability of this group to colonize in a wide range of light, temperature and energy conditions. This group of algae are typically used in the reconstruction of tropical carbonate environments. So, the calcareous algal assemblages of the middle Miocene to Pleistocene sequences in northeast Indian Ocean and the sedimentological characteristics can be useful for the interpretation of shallow water benthic ecology and depositional environment. Calcareous algae represented by coralline red algae and halimedacean green algae are the chief components in the shallow marine carbonate sediments of Serravallian (middle Miocene), Piacenzian (upper Pliocene) and Gelacian (Pleistocene) sequences exposed in the Hut Bay (Little Andaman), Car Nicobar and Niel islands of the Andaman and Nicobar Basin in the northeast Indian Ocean. The algal assemblages and different facies types identified in the studied sections reveal the ecological perspectives, bathymetry and depositional environments.

Middle to Late Holocene Wetland Dynamics at the Southern Shore of Lake Sevan, Armenia

Elen Hakobyan[1], Ivan Gabrielyan[1], Edoardo Martinetto[2] & Angela A. Bruch[3]

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Wetlands are the transient links between terrestrial and aquatic systems. They have a high preservational potential, and consequently are an important archive of past biodiversity. As conservation of wetlands is very important therefore, to study the Holocene history of Lake Sevan wetlands may also contribute to their future conservation.

Paleocarpological material from the Tsovinar peat bog that is located in the southern shore of Lake Sevan, provides a possibility to distinguish wetland types and follow wetland dynamics over Middle to Late Holocene. Radiocarbon dating of the peat bog deposits of the Tsovinar section reveals an Holocene age starting from c. ~6200 BC (~8150 BP) to ~1000 AD.

After processing of all 21 samples 80 taxa were determined from the deposits, where from 67 taxa were identified up to species level. A big part of the identified remains belongs to aquatic macrophytes and wetland angiosperms. The assemblages show distinct changes through time based on their taxonomic composition and relative abundance of taxa. Therefore, it was possible to establish low and high lake level phases over Middle to Late Holocene.

The main wetland types that occurred during low lake level phases in the Tsovinar area were marshland, freshwater mire and wet meadow. Wet meadow and saline steppe vegetation were observed in correlation with dry climate. A peat bog paleoenvironment or freshwater mire developed only from ~2060 BC to ~1500 BC, when climate was warmer than today.

Crossing seastraits - how mammals disperse across barriers

Christine Hertler[1], Ericson Hölzchen[1,2], Jan-Olaf Reschke[1,3], Alexandra van der Geer[4], Iwan Pramesti Anwar[5], Mika Puspaningrum[5], Nicolas Büscher[3] & Emmanuel Kipruto Ngetich[1,3]

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The first response of mammals to worsening conditions in their habitats, in the sense that they are unable to access critical resources or that they lack altogether, is to relocate their habitats and to settle in areas where they previously did not occur. Environmental barriers, like mountain ranges, rivers, and sea straits, direct and constrain their movements. In reconstructions of dispersal events such barriers are frequently judged prior to the reconstruction proper. For example, when terrestrial routes are (at least temporarily) traversable, maritime alternatives are frequently ignored.

The SEAcross ABM permits to quantify crossing success of sea straits by simulating the outcome of crossing attempts by mammals (Hertler et al. 2022). The resulting variable is the crossing success rate permitting to measure crossing success (Hölzchen et al. 2021).

Crossing success evidently depends on the specific features of the sea strait, for instance its width, and current direction and speed. More critical are possibly the capabilities of the agents to cross sea straits. In a first model, we considered swimming by quadrupedal paddling, a swimming style performed by dogs and elephants, and open to all terrestrial mammals. We calculated swimming speed, mechanical power requirements, as well as the energy deposits available for locomotion by a physiological swimming model (Meijaard 2001). The agents also differ in their willingness to enter the sea straits.

We applied the SEAcross ABM to examine the question how successful stegodons may disperse across the Sunda Shelf and Wallacea under conditions comparable to present sea level and currents. Because stegodons undergo island dwarfing while they settle on islands of smaller geographic size and restricted resource availabilities, we combined the SEAcross ABM with a shrinking model. As a result, we identified routes across Sunda Shelf and Wallacea which are more likely than others. In addition, we predicted geographical limits to disperse to islands of the Sahul Shelf.

The SEAcross ABM can now be applied to examine a variety of dispersal scenarios, for instance dispersals in the opposite direction performed by marsupial taxa or to examine and compare arrival scenarios in particular places. Furthermore, it may act as a template for measuring crossing success across other kinds of barriers like mountain ranges, provided that the performances of mammals depend on physiological and behavioral capabilities.

References
Hertler C, Reschke J-O, Hölzchen E, Anwar IP, Puspaningrum MR, Büscher N, Ngetich EK. 2022. SEAcross ABM V1.0 (1.0). Zenodo. DOI: 10.5281/zenodo.6833780.
Hölzchen E, Hertler C, Mateos A, Rodríguez J, Berndt J-O, Timm IJ. 2021. Discovering the opposite shore: How did hominins cross sea straits? PLoS One 16(6): e0252885. DOI: 10.1371/journal.pone.0252885.
Meijaard E. 2001. Successful sea-crossing by land mammals; a matter of luck, and a big body: a preliminary and simplified model. Special Publication of the Geological Research and Development Centre 27: 87-92.

Modelling photosynthesis and leaf ecophysiology in arctic forests of the Eocene

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

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One of the most striking differences between current climate conditions and the greenhouse climate of the past is the existence of polar forests which covered large regions in high latitudes well into the Eocene. The polar regions of the Eocene were no-analogue habitats, featuring special conditions which cannot be found today. The high latitudes featured a combination of moderate temperatures and substantially elevated atmospheric carbon dioxide concentration with extremely different daylight lengths during a year. Photosynthesis was not possible during the lightless winter period, leading to a "photic seasonality". Various fossil dicot taxa of these arctic forests showed quite large leaves signaling wet conditions, which is mainly supported by other sources of palaeoclimate information. A detailed analysis of leaf function and productivity of the deciduous polar vegetation of the Eocene arctic is, however, lacking so far. The presented study sets out to improve our understanding of the ecology of arctic broad-leaved angiosperms, by analyzing leaf ecophysiology under conditions of Eocene climate and high latitude insolation. For this purpose, two well-studied polar Eocene fossil sites were selected: Ellesmere Island (Northern Canada) and the Svalbard archipelago around Spitsbergen (Norway). For comparison, a mid-latitude continental European site will also be considered whose modern climate is very similar to that of the Eocene arctic sites.

Coryphoid palms from the K-Pg boundary of central India and their biogeographical implications: Evidence from megafossil remains

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Keywords: Coryphoideae, Leaf fossils, late cretaceous-early paleocene, Paleobiogeography, Paleoclimate, Madhya Pradesh

Ten palm leaf impressions are documented from the latest Maastrichtian (late Cretaceous) to early Danian (earliest Paleocene) sediments (K-Pg, c. 66e64 Ma) of the Mandla Lobe of the Deccan Intertrappean Beds, Madhya Pradesh, central India. The palmate leaf shape along with a definite wellpreserved costa support their placement in the subfamily Coryphoideae of the family Arecaceae. We place all recovered palm leaf specimens in the fossil genus *Sabalites*, report seven species of coryphoid palms and describe two new species namely, *Sabalities umariaensis* sp. nov. and *Sabalites ghughuaensis* sp. nov. The fossils indicate that coryphoid palms were highly diverse in central India by the latest Cretaceous. These and earlier reported coryphoid palm fossils from the same locality indicate that they experienced a warm and humid tropical environment during the time of deposition. These discoveries confirm the presence of a diversity of Coryphoideae in Gondwana prior to the India-Eurasia collision and provide information about coryphoid biogeographical history over geological time. Based on megafossil remains, we trace coryphoid palm migration pathways from India to mainland Southeast (SE) Asia and other parts of Asia after the docking of the Indian subcontinent with Eurasia early in the Paleogene.

The first fossil record of coryphoid palm from Siwalik

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Although coryphoid fossil palms are well-known from Late Cretaceous sediments of India, there is no fossil evidence of coryphoid palm from Siwalik sediments to date. Here, we report for the first time coryphoid palm fronds from the lower Siwalik strata (middle Miocene) of Darjeeling foothills of eastern Himalaya. The leaf architecture, as well as epidermal anatomy of the Siwalik specimens, suggests their resemblance with those of modern members of the palm sub-family Coryphoideae (family: Arecaceae). The Siwalik specimens are characterized morphologically by palmate fan-shaped leaf with a well-preserved costa (costapalmate), prominent leaf segments emerging at an acute angle from the costa and numerous parallel secondary lateral veins on either side of the mid-vein, and anatomically by hypostomatic leaf blade, rectangular to polygonal epidermal cells, tetracytic or cyclocytic type of stomata and the presence of characteristic trichome bases. Based on a thorough comparison with earlier reported coryphoid palm leaves bearing epidermal anatomy, we placed our specimens under a new fossil species *Sabalites siwalicus* sp. nov. The present fossils indicate that coryphoid palms were present in eastern Himalaya by the Siwalik time and they experienced a warm and humid tropical environment during the time of deposition.

Possible advantages of a general survey of the late Cenozoic plant macrofossil record in NW Italy, regardless of uncertainties in dating

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Identification of isolated remains of plants which disappeared from a given territory (extinct or extirpated) may pose serious challenges to palaeobotanists, so that the literature is full of names left in open nomenclature and of questionable occurrences of genera or species; these are widespread in the old works, whose taxonomic interpretations have often not been confirmed by subsequent studies. It is suggested that an abundance of fossil sites in a given area and a delimited time interval may provide good conditions for a general survey of the plant macrofossil record, that can offer some solutions to the taxonomical problems. A good example is provided by the Messinian to Gelasian sediments of NW Italy, that crop out in a not-too-broad area, influenced by rather homogeneous climate conditions. The general survey of all the 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, regardless of the possibly uncertain age of the last ones. A wealth of remains often provided a great help to palaeobotanical identifications, and co-occurrence of leaves, fruits and seeds throwed light on the correct taxonomy of less diagnostic parts, thus confirming uncertain determinations. Finally, thanks to such general survey, several groups of isolated fossilized plant parts where conceptually assembled in a list of hypothetic "Whole-Plants" that grew in the studied area in the Messinian to Gelasian time interval.

Floral diversity in refugia of Tertiary relicts in central Japan during the last glacial maximum

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During the last glacial maximum (LGM, 30-19 ka) Pinaceae trees prevailed in the most areas of Japan and distribution of temperate trees have been assumed to be confined mainly in coastal lowlands based mainly on pollen data. However, plant macrofossil assemblages from areas far from the coast also include diverse temperate tree taxa accompanying with subalpine conifers. Macrofossil assemblages dated to 23-20 ka in Tado (42m a.s.l.) near Nagoya situated at the mid-point between the Pacific Ocean and Sea of Japan coasts, include diverse temperate tree taxa including Tertiary relicts (Momohara et al., 2021). They are *Abies homolepis*, *Tsuga sieboldii*, *Chamaecyparis obtusa*, *Corylopsis* sp., *Cercidiphyllum japonicum*, *Pterocarya rhoifolia*, *Carpinus cordata*, *Ostrya japonica*, *Fagus crenata*, *F. japonica*, *Stewartia* sp., *Aesculus turbinata*, and *Acer japonicum*. Meanwhile subalpine conifers such as *Abies veitchii*, *Larix kaempheri*, *Picea jezoensis* var. *hondoensis*, and *Tsuga diversifolia* are also included. The results of pollen analysis of the sediment exhibit an expansion of the temperate coniferous forest surrounding mixed coniferous and deciduous broadleaf forests that developed along river. Assemblages from Egota in Tokyo, dated to 25-20 ka, also includes divers temperate taxa including *Fagus crenata*, *Quercus serrata*, *Carpinus cordata*, *Phellodendron amurense*, *Tilia japonica*, and *Acer diabolicum* with abundant subalpine conifers (Momohara et al., in press). The distribution of thermophilous plants such as *Selaginella remotifolia* and *Styrax japonica* and subalpine plants overlapped widely in the distribution ranges of temperate trees during the LGM. In addition to temperature, dryness was an important environmental factor that controlled plant distribution, restricting temperate broadleaved trees to the humid places, and promoting expansion of subarctic conifers to warmer regions (Momohara et al., 2016). Glacial refugia of temperate plants were distributed in humid places along valley also in inland and retained high plant species diversity.

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Effect of early Paleogene climate and tectonics on the evolution of family Arecaceae on the Indian Plate

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Arecaceae (Palms), a highly diverse primitive plant family, comprises 181 genera and c. 2500 species. Worldwide, the five palm subfamilies Arecoideae, Calamiodeae, Ceroxyloideae, Coryphoideae and Nypoideae show distinct spatial patterns of species richness. Presently, the greatest biodiversity of palms is confined to the tropical rainforests (TRF) of Neotropics and Southeast Asia followed by reduced diversity in Madagascar, Australia-Southwest Pacific, Africa, India-Sri Lanka and Seychelles. Ancient palm fossil distributions contrast with their current distributional ranges that requires the understanding of its paleobiogeographic history. Palms are also ideal for the evolutionary and ecological studies of TRF biomes. Many pollen fossils were recovered from the early Paleogene lignite bearing sedimentary facies of Sonari Lignite Mine, Barmer Basin, Rajasthan, India. Some of these recovered fossils closely resemble with diverse extant palms belonging to four palm subfamilies (Arecoideae- *Oncosperma*, *Hydriastele*; *Calamoideae- Eugeissona*, *Metroxylon*, *Korthalsia*, *Lepidocaryum* and *Daemonorops*; Coryphoideae- *Arenga*, *Borassus-Hyphaene* and Nypoideae- *Nypa*). The discovery of various palm fossils suggests their greater diversity on the Indian plate during the early Paleogene period as compared to present day. Currently, few species of genera *Nypa*, *Arenga* and *Borassus-Hyphaene* are left in Indian TRF biomes. In contrast, a genus *Lepidocaryum* is now endemic to the Neotropics and rest of the extant palms are restricted to Southeast Asia. The great biodiversity of palms on the Indian plate during the early Paleogene call attention to the effect of climate and plate tectonism on the evolution of palms on the Indian plate. During the early Paleogene, the global warming (Paleocene-Eocene Thermal Maxima) and equatorially placed Indian plate provided wet and humid conditions that led to ecological release by the efficient diversification of various palms, therefore, suggesting Indian plate being an evolutionary cradle during the period.

Dioscorea Plum. ex L. leaf from the upper Siwalik sediments of eastern Himalaya and its phytogeographical significance

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The Siwalik flora is important in understanding the orogeny of the Himalaya. The Siwalik is considered a Group which is further divided into sub-groups, namely Lower, Middle, and Upper Siwalik. Abundant plant fossils have been reported from the Lower and Middle Siwalik of the eastern and western Himalayan regions. However, plant fossil records from the Upper Siwalik are still far from satisfactory. In this communication, we report a new fossil leaf of *Dioscorea* Plum. ex L. of the family Dioscoreaceae from the Kimin Formation of the Upper Siwalik of eastern Himalaya. This is the first fossil record of *Dioscorea* from the Neogene sediments of Asia. The fossils of *Dioscorea* have been reported from the early Eocene of India and France, the early Oligocene of Hungary, the late Oligocene of Ethiopia, and the Miocene of Chile and Kenya. The modern distribution and fossil records of the genus suggest that it migrated from India to southeast Asia after the collision of the Indian Plate with the Asian Plate.

Oligocene vegetation pattern of central Asia based on palaeobotanical data and application of the PFT technique

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The Eocene -Oligocene boundary represents a transitional time period when vegetation changed from subtropical to warm temperate, under a widespread climate cooling which caused changes of the biosphere and led to the extinction of different groups of living organisms, not only plants.
Paleobotanical records allow to characterize the Oligocene vegetation of Central Asia, including Kazakhstan, as deciduous warm temperate with a predominance of Pinaceae, Cupressaceae, Betulaceae, Salicaceae, Fagaceae, etc. (Averyanova et al., 2021). Rupelian vegetation still has a heterogeneous appearance, with subtropical elements still present as relics to the south of the Aral Sea (Boytsova and Panova, 1973). By the Chattian (late Oligocene), the heterogeneity had smoothed out; Betulaceae and Pinaceae, which formed mixed mesophilic forests, became the main dominants there (Akhmetjev, 1993). Here we present the result of the comprehensively studied Buran palaeoflora which originated from the eponymous formation of eastern Kazakhstan, developed immediately after the Eocene-Oligocene transition (EOT). This flora can be regarded as a key flora for the Kazakhstan region which allows to trace the origin of the warm-temperate Turgai flora type, widespread by the end of the Oligocene - beginning of the Miocene in the mid-latitudes of Eurasia and which can be considered as an ancestress of modern warm temperate vegetation types. Based on the revovered original macrofossil and microfossil records, various quantitative approaches have been performed. The vegetation is interpreted in terms of Plant Functional Types (PFTs) that allow discussing the results in the context of previous studies on coeval palaeofloras from neighboring areas. Climate parameters are calculated using the Coexistence Approach (CA). Tge palaeoclimate is reconstructed as seasonal, ranging from cool to moderately warm temperate. Quercus and Castanea spp., dominated at the very beginning of the Rupelian, as well as Comptonia, Salicaceae, and Betulaceae, and this community was replaced in the middle of the Rupelian by Carya and Cotinus, with the participation of Ulmaceae and Betulaceae. The PFT method, based on data from fossil leaves, shows a local predominance of woody vegetation attaining 85% of total diversity. The ecospectra of the microfloras reflecting a regional signal additionally reveal a significant diversity of conifers. To compare the vegetation pattern based on microfloras in latitudinal direction eleven palaeofloras from western Siberia, Dzungariya, northwest China and Primorye were analysed in addition. The changes that took place on the territory of Kazakhstan were the result of regional biospheric restructuring associated with the retreat of the meridional Turgai Strait, which connected the tropical and Arctic latitudes and contributed to the transfer of heat to the latter.

The gradual rise of the Tibetan Plateau, located to the east of the investigated area, which led to the retention of moist air masses from the southeast, played an important role in climate aridification. As a local result of these movements, there was an almost complete change of plant communities at the EOT boundary in Kazakhstan.

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Tortonian Radiolarian Events from Northeast Indian Ocean (NGHP- 01- 17A)

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The significant planktonic protozoa radiolarians use opaline silica to build their skeleton. The radiolarians are used as significant index microfossils to establish the biostratigraphy of the marine sediments both regionally and globally because of its wide geographical distributions, short time span and considerably high species diversity. Depending on the first and last occurrences (FO and LO) of index radiolarians, different biostratigraphic events with respect to geological time scale can be determined. The present study on radiolarians has been carried out from the NGHP sediment core (NGHP-01-17A) of northeast Indian Ocean. Detailed study on the samples from the bottommost subunit Ic of the sediment core (684.09 mbsf to 369.62 mbsf) has been carried out for radiolarian content. The overall preservation potential of the radiolarians is moderate to good. The significant radiolarian events are marked by the evolutionary transition (ET) from *Didymocyrtis laticonus* to *Didymocyrtis antepenultima* (8.77 Ma), FO of *Diartus hughesi* (8.77 Ma), LO of *Diartus hughesi* (7.70 Ma) and ET from *Didymocyrtis antepenultima* to *Didymocyrtis penultima* (~7.60 Ma). Based on these events the studied sequence of the core has been dated as Tortonian. Other significant radiolarian species are represented by *Acrobotrys cribosa*, *Acrobotrys disolenia*, *Acrobotrys tritubus*, *Anthocyrtidium zanguebaricum*, *Botryostrobus auritus-australis*, *Cornutella profunda*, *Eucyrtidium acuminatum*, *Phormostichoartus doliolum*, *Siphocampe lineata*, etc. Owing to the presence of radiolarian species Phormostichoartus doliolum at the base of this core, the age of the bottommost sample (684.09 mbsf) can be assigned to younger than 11.1–11.9 Ma. As there is no evidence of evolutionary transition from *Stichocorys delmontensis* to *Stichocorys peregrina* in the topmost sample (369.62 mbsf), the age of the upper most sample should be estimated from 7.70 Ma to > 6.71 Ma. The radiolarian assemblage of the present study has been correlated with the known assemblages of late Miocene, specifically Tortonian from DSDP, ODP, IODP expeditions, onshore sediments of Indian Ocean and equatorial Pacific Ocean. To estimate the sedimentation rate during the Tortonian, an age-depth model has been proposed based on the significant events (FO, LO and ET) of index radiolarians along with the index diatoms and calcareous nannofossils recorded from the same samples.

Tortonian-Messinian calcareous nannofossils and silicoflagellates from northern Indian Ocean

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The present study deals with calcareous nannofossils and silicoflagellates from the Neogene sequence of Sitapur Village Section, Neil Island. Calcareous nannofossils make up a principal component of the marine phytoplankton. The nannofossil assemblage recovered from the samples consists of 45 species. The assemblage is dominated by *Sphenolithus abies* (19.19%), *Reticulofenestra minuta* (16.59%), *Sphenolithus moriformis* (15.21%), *Helicosphaera carteri* (8.64%), *Calcidiscus leptoporus* (2.98%), *Reticulofenestra haqii* (2.98%), *Pontosphaera discopora* (2.56%), and *Umbilicosphaera rotula* (2.29%). Biostratigraphically, the base of this outcrop cannot be assigned to any numerical age owing to the presence of index calcareous nannofossil species. In the present study, *Amaurolithus primus* is present near the base of the section. The base of *Amaurolithus primus* is present just below the Tortonian-Messinian boundary at 7.39 Ma. In the present study, *Discoaster berggrenii* is present throughout the sample which implies that the section is not older than 8.20 Ma. On the basis of *Discoaster quinqueramus* it can be ascertained that the top of the section is less than 5.53 Ma. Hence, the section may be assigned to CNM16- CNM19 of Backmann et al. (2012). Reworked species of older age viz., *Calcidiscus* cf. *premacintyrei*, *Chiasmolithus grandis*, *Cyclicargolithus floridanus*, *Discoaster* cf. *saipanensis*, *Helicosphaera ampliaperta*, *Reticulofenestra bisecta*, *Reticulofenestra lockeri* and *Sphenolithus heteromorphus* were identified in a number of samples. The nannofossil assemblage is dominated by warm water species e.g., *Sphenolithus* and *Helicosphaera*. Presence of small reticulofenestrids as well as *H. carteri* indicates upwelling environments. Abundance of sphenoliths along with small reticulofenestrids indicates warmer well-stratified environment. The reduced relative frequency of discoasters in the samples signifies that deposition took place in marginal sea setting.

Along with calcareous nannofossils well preserved silicoflagellates, the marine, unicellular algae, represented by 15 species belonging to 4 genera have been identified from the samples. The silicoflagellate taxon *Dictyocha extensa* (33.4%) is dominant in the samples followed by 6 sided *Stephanocha speculum* (24.18%) and *Dictyocha fibula* (11.68%). Silicoflagellates are sensitive to environmental changes and are used as tools for deducing palaeonvironment and palaeotemperature. *Dictyocha*/*Stephanocha* ratio has been used in this study to deduce paleotemperature that indicates warm conditions.

First fossil record of *Eriolaena* (subfamily Dombeyoideae, family Malvaceae) from the early Paleogene of Rajasthan: Insight into its evolutionary history and diversification

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Subfamily Dombeyoideae (Malvaceae s.l., cotton family) includes around 380 plant species distributed in the paleotropical regions, with the highest diversity found in Madagascar and neighboring islands. The present fossil leaves belong to the genus *Eriolaena*. This genus comprises about 50 species and is currently distributed in India, Madagascar, Thailand, Southeast China, Mozambique, Myanmar, Nepal, Vietnam, West Himalaya, Laos, and Sri Lanka. A detailed morphological study of fossil leaves comparable to, *Eriolaena wallichii* and *Eriolaena candollei*, from the early Paleogene sediments of the Gurha lignite mine, Bikaner district, Rajasthan is conducted here. Morphological features viz., actinodromous venation, cordate shape, serrate-dentate margin, reflex base, compound agrophic veins, and other characteristics show its close affinity with the genus *Eriolaena* of the family Malvaceae. This study suggests that the genus *Eriolaena* was a component of paleotropical evergreen-deciduous forests growing in a warm humid climate in north-western India during the early Paleogene contrary to the dry and desertic conditions prevailing today. The present fossils would further help to understand the paleobiogeographic history of this genus.

Paleolandscapes and climate of the Dnieper lowland (Ukraine) during the Gelasian time (according to palynological data)

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The presented research is based on the results of detailed palynological studies of the Siversk and Beregovo climatoliths of the Dnieper lowland, which according to the modern International Stratigraphic Scale belong to the Gelasian stage. In terms of paleolandscape reconstructions of the Gelasian time, the region of the Dnieper lowland is the least studied in Ukraine.
During the paleolandscape reconstructions, the method of A.V. Holbert et al. (1977) was partially used with corrections proposed by us for the Upper Cenozoic deposits of Ukraine. According to this method, cyclograms of the ecological structure of the complexes are constructed for the deposits of each section followed by their analysis. We constructed and analyzed the following cyclograms for the reference section of the Gelasian deposits of the Dnieper lowland.
When performing paleoclimatic reconstructions, we used the following criteria, which enable to reconstruct the humidification regime: the ratio of the pollen sectors of woody tree species, herbaceous plants, and spore on cyclograms; the ratio of pollen sectors of dark conifers, light conifers and deciduous plants of the cold-temperate and cool-temperate zones; the size of the herbaceous sector and its relationship with the pollen sectors of the Asteraceae and Chenopodiaceae families. When reconstructing the heat supply regime, the ratios of the pollen sectors of deciduous plants of the cold-temperate zone, broad-leaved plants of the cool-temperate zone, and the sector of thermophilic plants were taken into account.
For the reconstruction of the paleotemperature of the Beregovo time, we used the arealogram method proposed by V.P. Hrychuk (1987).
The global climatic event (the formation of the Arctic ice cover) that took place at the level of 2.58 Ma also affected the composition of the vegetation of Ukraine. In particular, in the early Siversk time, there were meadow-steppe associations within the Dnieper lowland. The few forest groups were limited mainly to river valleys. There were practically no thermophilic and broad-leaved species in their composition, with the exception of single *Tilia* cf. *cordata*. In the middle Siversk time, an increase in the temperature regime and humidity of the climate is recorded. The number of forest communities increased in the vegetation cover of the middle Siversk time, and their composition included thermophilic and broad-leaved species. At that time, there were also a large number of large and small freshwater reservoirs, on the banks of which Cyperaceae, Sparganiaceae, Liliaceae, Potamogetonaceae grew. In the late Siversk time, there was a decrease in temperature and aridization of the climate, which led to the disappearance of almost all thermophilic elements from the composition of plant communities, as well as the expansion of the role of herbaceous cenoses in the structure of the vegetation cover.

In the early Beregovo time, there was an increase in the temperature regime and the humidity of the climate. In the vegetation cover of the early Beregovo time, woody tree and herbaceous plants demanding to moisture played a leading role. Forests spread over large areas. The forestless areas were covered with meadow-steppe communities. As in the middle Beregovo time, within the research region there were numerous freshwater reservoirs, on the banks of which *Typha* sp., *Sparganium* sp., *Potamogeton* sp, and *Alisma* sp. grew.

In the middle Beregovo time, there was a slight aridization of the climate, which was reflected in the expansion of the vegetation cover of the areas occupied by meadow grasses. An increase in the temperature regime is evidenced by the presence of broad-leaved plants of the cool-temperate zone in the forests, their taxonomic diversity, as well as the participation of thermophilic plants of the families Juglandaceae (*Juglans* cf. *cinerea*, *Juglans* sp.), Moraceae, and Araliaceae (*Hedera helix*) in the forest communities. The average July temperature was +20.5 at that time, the average January temperature was up to +1. The climate of the middle Beregovo time was probably moderately warm. In the late Beregovo time, there was a decrease in the temperature, as a result of which the composition of plant communities became significantly poorer, especially due to broad-leaved and thermophilic plants. In general, the climate of the Gelasian time of the research region was more moderate compared to the climate of the southern and southeastern regions of Ukraine.

Sedimentary environment of phytogenic deposits recorded in the composition of pollen assemblages in the Tomisławice open cast mine (Konin Region, Central Poland)

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Palynological analysis in the Tomisławice open-cast mine allowed reconstructing the plant communities and investigating the evolution of sedimentary environments at various stages of lignite-forming marsh development, recorded in the composition of pollen assemblages from sediments of the 1st Mid-Polish lignite seam (MPLS-1). Rich pollen communities from a c. 9 m thick section enabled a study of the succession of plant communities and evolution of phytogenic sedimentation. The pollen succession indicates that the assemblages in the whole lignite seam represent the VIII Celtipollenites verus pollen zone. Slight differences in the composition of the communities point to different stages of basin development, depending rather on the variable water dynamics than climatic oscillations. Lignite of the MPLS-1 developed in a continental regime on alluvial plains. Changes in the succession of plant communities in the Tomisławice section record flooding - drainage cycles caused by groundwater level oscillations. Peat bog accumulation took place in basins associated with river facies, whereas the lack of evident horizons of mineral deposits within the dense lignite seams points to a low dynamics of these rivers. Rise of groundwater level and/or surface water resulted in flooding of the marshes and formation of a vast shallow lake basin, documented by the presence of freshwater algae and pollen of aquatic plants. Certain regularities can be observed in the succession of plant communities. Swamp forests with little drainage transform into shrub bogs, which means that the marsh forest plants are replaced by peat bog vegetation with Cyrillaceae, Ericaceae, *Ilex* and *Sphagnum*. At that time, the margin of the mesophilous forest approached the mire, with a distinct contribution of trees of warm temperate climate: *Quercus*, *Fagus*, *Betula*, *Pinus* and *Sciadopitys*. This type of plant community transformations can be observed throughout the Tomisławice section. Does not record an increased contribution of plant taxa with high thermal requirements. The flora was dominated by warm-temperate and thermophilous species, without the participation of highly heat-loving vegetation, which proves that the lignite seam from the Tomisławice open-cast mine was formed in fairly stable conditions of warm-temperate climate.
The conducted research has indicated that the composition of the pollen spectrum is not influenced by the lithological type of lignite, which indicates that the lignite lithotype is shaped by post-depositional transformations of the organic lignite-forming matter, and the palynomorphs contained in it are a permanent element.

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Leaf physiognomy reveals orographic control over the Paleogene Asian monsoon

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Understanding the evolutionary history of the Asian Monsoon System (AMS) is challenging due to the different forcing factors. The recent developments indicate that the topography of south Asia and the middle east have the dominant role in shaping the modern AMS during the Neogene. However, debates have arisen about the presence of the modern Asian monsoon during the Paleogene. Globally, the monsoonal climates are mainly restricted to tropical regions and are divided into eight domains such as North America Monsoon (NAmM), South America Monsoon (SAmM), North Africa Monsoon (NAfM), South Africa Monsoon (SAfM), South Asia Monsoon (SAM), East Asia Monsoon (EAM), Western North Pacific Monsoon (WNPM) and Indonesia-Australian Monsoon (I-AM). The climate leaf analysis multivariate program (CLAMP) reveals that the dicot leaf morphological traits are useful in understanding the adaptation of leaves in monsoonal as well as non-monsoonal climates. These traits are also useful in decoding the particular type of monsoonal domains. The fossil leaves recovered from five geological ages from the Late Maastrichtian-Paleogene of India suggest that the leaf morphological traits have adaptations to Indonesian-Australian Monsoon (I-AM). However, late Oligocene leaves show some adaptations to the South Asian Monsoon (SAM). This suggests that modern SAM is a phenomenon of the Neogene

The evolution of plant diversity during the Eocene of central valley in Tibet, China

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Recent evidence based on fossils and geochemistry suggest an east-west trend valley existed during the Paleogene of central Tibet, and bear unexceptionally rich plant diversity. For the middle Eocene (~47 Ma) Jianglang flora in Bangor Basin, there are more than 80 morphotypes in forms of leaf, fruit/seed, flower and tuber, which is a flora with the highest species richness among all reported Cenozoic floras. In the Jianglang flora, some are the earliest fossil record in Asia, even worldwide to our current knowledge. Very interestingly, the Jianglang species assemblage is most similar to that of the Early-Middle Eocene Green River flora in the western interior USA 16 taxa in common at the genus/family level, including some with unclear taxonomic affinities to modern plants. The Jianglang flora also contains eight taxa in common at the genus/family level with the Middle Eocene Messel flora in Germany. The late Eocene (~39 Ma) Dayu flora in Lunpola Basin is represented by woody and herbaceous species, as well as plenty of spiny plants, indicating open woodlands instead of the subtropic forest of Jianglang flora. Another younger flora (35 Ma) in Xiongmei, Lunpola Basin has the similar floristic components to the Dayu flora. All these Eocene floras evidenced the significant changes of both floristic components and vegetation during the Eocene accompanying by the paleoenvironmental changes there.

Understanding fossil leaf traits: TRYing another reference for comparison with modern vegetation, first results

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Early Paleogene latitudinal continental temperature and precipitation gradients and patterns Fossil leaf traits are commonly used to reconstruct paleoenvironments and paleoclimate, and compare fossil localities. Existing methods use various leaf morphological and anatomical features, some described as "functional traits" (i.e., whose variation across environments provides an advantage to the individual, such as leaf area or leaf mass per area), others with possible adaptive function not demonstrated, although sometimes an empirical relationship with climate/environment has been documented or hypothesized (e.g., type of margins, length / width ratio, apex shape). Many functional traits documented in modern vegetation are not visible on fossil leaves, and except for leaf size, the traits that are present in modern vegetation have received limited study. The relevance of most of fossil leaf traits for reconstructing paleoenvironments is therefore potentially underestimated.

Here we present the first results of our study combining information on the distribution of leaf traits from the databases TRY (modern vegetation; Kattge et al., 2019) and MORPHYLL (fossil leaves; Traiser et al., 2018) to (1) describe the distribution of traits visible on fossil leaves in modern environments, (2) assess the sensitivity of these traits to environmental characteristics, and (3) discuss their relevance for paleoclimatic reconstruction.

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Evidences of floral diversity changes in the western Indian palaeo-equatorial region across the early Eocene warming event (ETM2)

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The Indian plate is a typical example of a drifting isolated island subcontinent during the Paleocene-Eocene. Its ultimate collision with Eurasia somewhere in the early Paleogene had an intense effect on the global climate as well as biodiversity and its distribution. Coupled with geodynamics, the early Paleogene warming also resulted in prolific spread of tropical flora and fauna over the Indian subcontinent. Across the globe, Paleocene-Eocene has been the area of focus among the palaeoscientists for past several decades leading to ample information from mid-high latitudinal regions whereas the low equatorial latitude's data are sparse. The western Indian lignites and the associated sediments provide ideal source of information from the Paleocene to the middle Eocene warming in the course of the crucial phase in India's drift history. To trace the changes in palaeofloristics and diversity pattern of palaeotropical vegetation across the global warming events, palynological records from lignite mines of Kutch Basin, Western India have been analyzed. The study shows highly diverse tropical rain forest was present during early Eocene whereas presently xeric shrub-land and grassland eco-region is thriving. In the present palynological study, a total 74 morphospecies were used to trace the changes in palaeofloristics and diversity pattern of palaeotropical vegetation across the second early Eocene Thermal Maximum (ETM2, ~53.7Ma) event in Panandhro lignite mine. A distinct increase in palynofloral diversity has been observed across the ETM2 event. The standing diversity calculated using Range-through method yielded the mean diversity of 27.5 spore/pollen species per sample during pre-ETM2 warming (samples PLM 1-6), whereas this diversity increased to 44 spore/pollen species per sample during the ETM2 phase (samples PLM 7-26). Interestingly, the mean diversity per sample of post-ETM2 warming (PLM 27-40) again decreased to 31.2 spore/pollen species. The distinct increase in taxonomic diversity during high temperatures of early Eocene can be attributed to high precipitation and low seasonality due to lesser dry periods that contributed to success of megathermal tropical rainforests families in palaeotropical region during extreme warming events.

Middle Miocene palynoflora and non-pollen palynomorphs from the Drzewce lignite deposit, central Poland

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A detailed palynological analysis of 36 samples from the 1st mid-Polish lignite seam at Drzewce, Konin region was carried out. Lignites of the 1st group (MPLS-1) developed in the middle Miocene across a large area of the Polish Lowlands and this group is the youngest among the main Neogene lignite seams in Poland. The spore-pollen analysis indicates that the area studied was overgrown by palustrine, wetland communities, similar in composition to the modern pocosins from the south-eastern USA. Their most characteristic elements were shrubs from the Ericaceae, Clethraceae and Cyrillaceae families as well as *Myrica* and *Ilex*. Similar plant communities occurred at that time in the neighbouring Adamów, which is also located in the Konin Basin (Worobiec et al. 2021). The climate was warm temperate and humid, which was inferred from the palynoflora composition, and the estimated mean annual temperature (MAT) for the lignite seam at Drzewce is 15.7–17.8 °C.
Non-pollen palynomorphs (freshwater algae and fungal microremains) were also used as a source of data for palaeoclimatic and palaeoenvironmental interpretations. The presence of the zygospores of desmids *Desmidiaceaesporites cosmarioformis* most probably indicates relatively nutrient-poor (ombrotrophic) conditions. Small, flooded depressions, such as pools in bogs, could be a habitat for filamentous green algae from the Zygnemataceae family, including the *Spirogyra*, *Mougeotia*, and *Zygnema* genera. The presence of their resting cells (zygospores) indicates that the peat-forming environment periodically might have dried out or was subjected to seasonal warming. The fossil fungal assemblage from Drzewce indicates dense vegetation on damp, swampy soils and the presence of small, shallow-water bodies with variable water level or periodic reservoirs. Fluctuations in the frequency of trees (e.g. *Pinus*, *Sequoia* and *Sciadopitys*) are likely to reflect changes in water level and trophic conditions, rather than climate (Worobiec et al. 2022).
Miocene NPPs can be obtained by means of standard palynological procedure and potentially are valuable palaeoenvironmental indicators but they require further research. Therefore, palynologists should study them in detail more often.

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Fossil fungi as valuable proxies in palaeoclimatic reconstructions

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Fossil fungi are usually found attached to plant macroremains (usually on leaf cuticles) and as non-pollen palynomorphs (NPP) in palynological samples. Pre-Quaternary fungal non-pollen palynomorphs are rarely investigated and their potential as palaeoclimatic proxies is frequently neglected in the palynological investigations. Usually are investigated remains of phylloplane (epiphyllous) fungi, especially various types of their sporocarps (mostly microthyriaceous fungi). These fungi, however, are not very precise as climatic proxies because modern microthyriaceous fungi have a wide climatic amplitude. Unfortunately, in many papers these fungi are considered as proxies of warm (even tropical) climate while their living representatives are found from tropical to arctic localities. Moreover, many fossil microthyriaceous fungi are described as artificial fossil-taxa not related to specified modern fungal genera. For this reason, better climatic proxies are those fossil fungi that have been assigned to modern genera with narrow climatic amplitudes. Examples of credible fungal climatic proxies are fossil representatives of the modern genera *Neomycoleptodiscus* and *Potamomyces*. Fossil *Neomycoleptodiscus pertusus* and several fossil-taxa of *Potamomyces* are credible proxies of warm and humid climate of the past (Worobiec et al. 2020, 2022). Conidiomata of *Neomycoleptodiscus pertusus* and ascospores of *Potamomyces* are found in the Palaeogene and Neogene deposits. *Neomycoleptodiscus pertusus* is found both on fossil leaf cuticles and in palynological samples contrary to ascospores of *Potamomyces* reported only during palynological investigations (Worobiec et al. 2022). In the case of *Potamomyces*, it is probable that palynologists analyzing palynological samples often do not take this fungus into account as non-pollen palynomorph important for palaeoclimate reconstruction. More attention to the Palaeogene and Neogene fungal NPP is suggested considering their value as palaeoclimatic proxies.

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Cedrus distribution change: past, present, and future

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Cedrus Trew (Pinaceae) includes four species, which are disjunctively distributed in the Mediterranean region and western Himalaya. Understanding the historical distribution of *Cedrus* and the driving factors can provide valuable information for the conservation of these species. In this study, we collected current distribution data and pollen fossil records for *Cedrus*. We used MaxEnt to simulate the distribution of *Cedrus* in the Mediterranean region and western Himalaya during the Last Glacial Maximum (LGM), the middle Holocene (MH), present and future in response to different climate scenarios. Our simulation results indicate that winter precipitation is the key factor that determines the distribution of *Cedrus*, followed by winter temperature. The results also show that summer precipitation had a more important impact in the Mediterranean region than in the western Himalaya. The results indicate that climate change exerts a significant impact on the distribution of *Cedrus* in the Mediterranean, but not as much as in the western Himalaya. This could be attributed to the greater availability of microclimates (climate niche space) in the latter region. The availability of microclimates associated with the complex topography in the western Himalaya. The simulated results are generally consistent with fossil data. In the Mediterranean region, the suitability of the habitats for *Cedrus* decreased continuously from the LGM to the year 2070, with a distinct drop from the LGM to the MH. In the western Himalaya, the potential suitability of habitats for *Cedrus* increased from the LGM to the MH, but might fluctuate in the future. In general, this study identifies the key climate factors restricting the natural distribution of *Cedrus*. It shows that the distribution of *Cedrus* would be reduced in response to global climate change in the future, which indicates an urgent need for the protection and management of *Cedrus* populations.

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