Wesleyan University

42nd Mid-Continent Paleobotanical Colloquium

PROGRAM

May 17-18, 2025

Wesleyan University, Middletown, CT

Organizing committee: Dana Royer, Xiaoqing Zhang

Friday

5:30-9:00 pm dinner party at Dana Royer's house. For folks staying at the Inn, we will pick you up at 5:30 (two trips may be required). For everybody else, the address is 701 Pine Street in Middletown; we encourage carpooling. Please park at the top of the driveway, on the grass on either side of driveway along the hill, or in the cemetery parking across the street (see red areas in image below). There will be wine and beer.

Saturday

The program starts at 8:20 am, with a light breakfast starting at 7:45. **Please email Xiaoqing** if you would like a ride from the Inn of Middletown at 7:45 (it is otherwise a 0.6 mile walk); if it is raining we will make sure there is a shuttle available at 7:45. If driving, park opposite the Usdan University Center (see image below); we encourage carpooling. Our conference is in the Daniels Family Commons, which is on the third floor of Usdan. We will be there the entire day, including lunch and dinner (no alcohol, sorry).

- Each talk will be 10 minutes long, followed by 2 minutes for Q&A.
- Poster boards are 30 x 40" (you choose between portrait and landscape orientation).

Conference is in Usdan University Center (45 Wyllys Ave).
If coming by car, park in the two lots on either side of Wyllys (see red arrow; please note that Wyllys is one-way).
Enter building from Wyllys Ave. (see teal arrow)
Walk about 50 feet and take the elevator on the left to the third floor. This is the Daniels Family Commons.

42nd Mid-Continent Paleobotanical Colloquium

Wesleyan University, Usdan University Center, Room

Saturday, May 17, 2025

7:45-8:20	Light breakfast	
8:20-8:30	Welcome, Introduction	
8:30-9:54 Session 1 (7 talks)	Alexander Lowe	Miocene plant communities and climate of the Pacific Northwest (USA) using a refined morphotype and geochronologic framework
	Venanzio Munyaka	Assessing the relationship between leaf physiognomy and climate of African low-latitude floras
	Xiaoqing Zhang	Estimates of atmospheric CO_2 during the CPE (Carnian Pluvial Event, Triassic period) based on stomatal and isotopic analyses of fossil leaves from South China
	Rebecca DeKoster	Arthropod herbivore and pathogen damage associated with the Middle Pennsylvanian Mazon Creek Flora, Illinois, USA
	Parker J. Przybylski	Insect damage on the Indo-Pakistan collision front (Ghazij Formation, Balochistan, Pakistan): First tropical insect-feeding damage for the Early Eocene Climatic Optimum
	MacKenzie Smith	Leaf documentation and Digital Leaf Physiognomy estimate of the Coal Creek Member of the middle Eocene Kishenehn Formation in northwestern Montana, USA
	Li Zhang	Tracing palaeo-gaseous mercury variations through fossil plants: Preliminary analysis of mercury concentration data in extant Ginkgo and extinct ginkgoaleans
Until 10:30	Coffee break	
10:30-11:54 Session 2 (7 talks)	Walton Green	A systematic procedure for estimating supportable taxonomic resolution of fossils
	Gussie Maccracken	A time-tested system for morphotyping large fossil floras integrated with recent advances in leaf architecture scoring and databasing
	Theodore Matel	Spatial resolution, compositional fidelity, and isotaphonomy of leaf assemblages
	Paul Strother	The co-occurrence of Zygnema and a land plant spore in latest Ordovician deposits indicates “some (genomic) assembly required”
	Michael D'Antonio	Structure and development of the *Cormophyton rhizomorph*
	David Winship Taylor	A permineralized cycad stem, *Tianocycas yunnanensis* gen. et sp. nov. (Cycadales), from the Upper Permian in eastern Yunnan, China

	Antonietta B Knetge	Regional plant ecological turnover and diversity loss at the end-Triassic mass extinction at the Jameson Land Basin, East Greenland
Until 14:00	Lunch and posters session	
14:00-15:12 Session 3 (6 talks)	Yongdong Wang	The Jurassic Fossil Forest in the Sichuan Basin, China
	Hector Palma	A century of paradox: Re-investigating paradoxopterid ferns with new material from the Early Cretaceous of Northwestern Gondwana
	Ashley Hamersma	Revision of the fossil flower genus *Sahnianthus* Shukla (Myrtales) from the latest Cretaceous Deccan Intertrappean Beds of India
	Andrew Simpson	Reevaluating the relationship between dispersal mode and survivorship in the light of the Hattiesburg Flora
	Whitney Greaves	A Paleobotanical Overview of the Upper Cretaceous Neslen Formation with a focus on a new species of *Protodammara*
	Christopher West	Floristic Composition and Paleoclimate of the early Paleocene Highvale Mine Ardley Coal Zone Fossil Flora, Central Alberta, Canada
Until 16:00	Coffee break and Group photo	
16:00-17:00 Session 4 (5 talks)	Caroline Siegert	Not your average fruit cups: Fossil fruits and cupules with multiple development stages from the early Eocene of Argentine Patagonia
	Julian E Correa-Narvaez	Ferns resembling Thelypteridaceae from the Eocene of western North America: One Pinnate-Pinnatifid fern on the wall, one Pinnate-Pinnatifid fern. Take one down, pass it around, … two Pinnate-Pinnatifid ferns on the wall?
	L. Alejandro Giraldo	Organically preserved leaves from the Eocene Anglesea flora reveal first early Paleogene records of four angiosperm families in Australia
	Noah Crook	Taxonomic revision of *Gyrocarpus miocenica*: Fossil Malpighiaceae from the Miocene of Northwestern Venezuela
	Tengxiang Wang	Early Pleistocene flora from central Vietnam and its links to southern Indochina's extant tropical monsoonal forests
Until 20:00	Dinner & Keynote: Tammo Reichgelt	Vanished voyagers of Moa's Ark: Post-Miocene homogenization of New Zealand's vegetation

List of Posters

Sampling strategies and their influence on paleoecological interpretations at the Triassic–Jurassic boundary

Barbosa, C.; Knetge, A.; Glasspool, I. J.; Hesselbo, S. P.; Matthaeus, W.J.; Popa, M.E.; Sunderlin, D.; McElwain, J. C.

Calibrating the reconstructed Leaf Area Index method for Colombian Dry Forest using Cuticle Trace

Cham, M.; Cantu, C. ; Stiles, E.; Strömberg, C.

Plant-Insect Interactions from Oligocene Beaver Creek, South-Western Montana

Plant-Insect Interactions from Oligocene Beaver Creek, South-Western Montana

Gaarder, G.; Hamersma, A.

Investigating fossil seeds of the Paleocene of North America by means of micro-CT scanning

Krinsky, K.; Manchester, S. R., Tiffney, B. H.

Peltate leaf from Australia's Anglesea flora (middle Eocene, Victoria) supports an out-of-Gondwana history for the Macaranga-Mallotus clade (Euphorbiaceae)

Miller, A. S.; Giraldo, L. A.; Wilf, P.; Carpenter, R. J.

Leaf epidermal cells record the canopy response to changing climate during the late Paleocene to early Eocene in the Bighorn Basin, WY

Morgen, R. C.; Milligan, J. N.; Burke, L.; Barclay, R. S.; Dunn, R. E.; Wing, S. L.

Zircon U-Pb Geochronology and Paleofloristic Interpretations of the Maple Falls Member (Chuckanut Formation), Washington, USA

Nares, F. R.; Yasar, I. D., Manchester, S. R.

A New Fossil Fruit from the early-Cretaceous Dakota Formation of Nebraska, USA

Santiesteban, M.; Hamersma, A.; Manchester, S. R.

An investigation of tropical angiosperm genome sizes from the Albian-Cenomanian Une Formation of Colombia

Smith, B. A.; Zhang, X., Shi, G.; Jaramillo, C.; Carvalho, M.; Herrera, F.

Sunday

42nd Mid-Continent Paleobotanical Colloquium

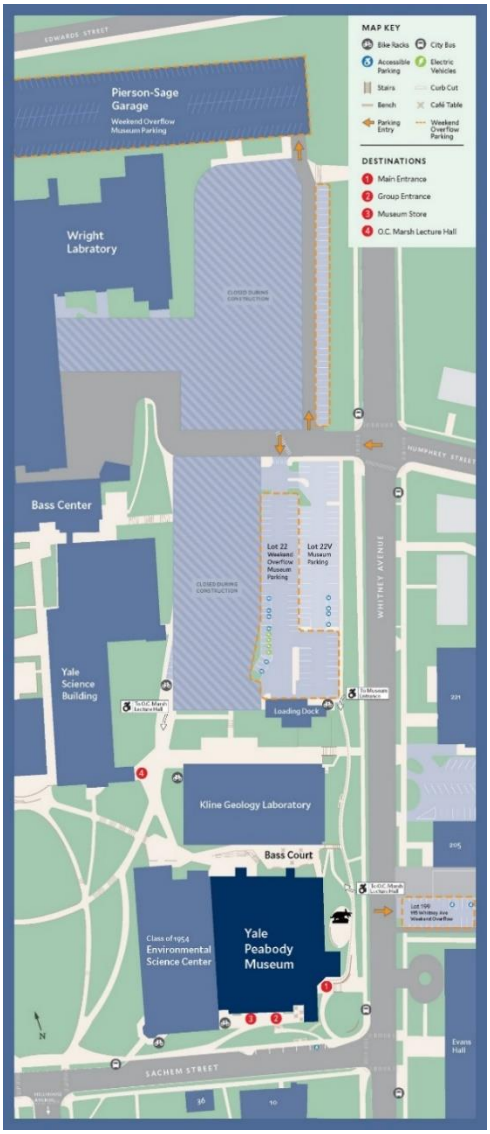
Field Trip: Powder Hill Dinosaur Park/Yale Peabody Museum

Sunday, May 18, 2025

9:30-10:00	**Optional** - Wesleyan Museum of Natural History (Joe Webb Peoples Museum) 4th floor of Exley Science Center
10:00	Meet vans at Exley Science Center Lawn Avenue parking lot, leave for field trip
10:00-11:00	Powder Hill Dinosaur Park
11:00	Arrive Yale Peabody
12:00	Peabody public visit opens; different options (see below) for lunch
14:00	Wesleyan vans leave Peabody

No food is provided. We will depart from the Lawn Avenue parking lot next to Exley Science Center at 10:00 (see red area in image below) and stop at the Powder Hill Dinosaur Park to view in-situ dinosaur footprints. Additionally, we will open up the Joe Webb Peoples Museum of Natural History on the 4th floor of Exley 30 minutes before departure. If you are staying at the Inn, we will shuttle you to Exley at 9:30.

If you have your own transportation, you can join the caravan or drive directly to the Yale Peabody Museum (see also image right)—the caravan will arrive shortly after 11:00 am. We will first have a tour of the Paleobotany Collections with Dr. Shusheng Hu. The public exhibits open at noon. There is no charge to enter the museum, so you can come and go as you please. The vans back to Wesleyan will leave at 2:00 pm sharp. There are multiple lunch spots close to the museum, including Olmo Bagels (bagels and bagel sandwiches; ~5 min walk), G Café (sandwiches and salads; ~5 min walk), and Nica's Market (wide range in sandwiches and soups; ~10 min walk).



Abstracts: 42nd Mid-continent Paleobotanical Colloquium, Oral Presentations

Ferns resembling Thelypteridaceae from the Eocene of western North America: One Pinnate-Pinnatifid fern on the wall, one Pinnate-Pinnatifid fern. Take one down, pass it around, … two Pinnate-Pinnatifid ferns on the wall?

Correa-Narvaez, J. E. (University of Florida); Holian, F. (University of Wyoming); Currano, E. D. (University of Wyoming)

The Eocene Kisinger Lakes flora of Wyoming, USA has fossil ferns including vegetative and reproductive 'twice pinnate-pinnatifid' fossil fronds. To accommodate for unknown frond dissection, we adopt the 'Holian-Currano' fern schema. Monomorphic fossil fronds segmented to at least tertiary ultimate level, with alternate-pinnate penultimate segments distally decreasing in size and complexity. Penultimate segments asymmetrical, oblong, apically tapering, upwards of ca. 10-15 cm, ca. 12-20+ pinnatifid ultimate segments, basally catadromous, and a short/absent, "stipolule." Ultimate segments symmetrical, oblong-falcate, ca. 5-15 mm long, entire margined, and blunt-rounded apexes. Ultimate segments have an axial vein curving apically, 6-10 free rarely forking lateral veins marginally terminating. The lower lateral veins form triangular areoles, and an excurrent vein that terminates at the cleft, with adjacent segment. These resemble fossils from other Western North American Eocene sites. There are two candidate fertile fossil fronds – with distinct reproductive structure – that match every other characteristic. Morphotype-1 fossils have round-bean sori on the laterals, midway from the axial vein to the margin, ca. 30-40 sporangia. Morphotype-2 has narrow marginal cup-like sori at the laterals, and excurrent vein; indusium possible. The taxonomy of similar fossils has a long-convoluted history due to poor diagnostic characteristics as preserved in fossil impressions.

Taxonomic revision of *Gyrocarpus miocenica*: Fossil Malpighiaceae from the Miocene of Northwestern Venezuela

Crook, N. (Virginia Tech); Siegert, C. (Cornell University); Gandolfo, M. A. (Cornell University)

In 1937, E.W. Berry described and identified a collection of fossil plants from Miocene-aged sediments in the Cumarebo Oil Field Venezuela. However, recent reviews of Berry's extensive publications on paleobotany have uncovered numerous incorrect identifications and descriptions, which complicate efforts to understand the Neotropical paleoflora. One example of this is the species '*Gyrocarpus miocenica*.' The lone fossil assigned to '*G. miocenica*' preserves many traits incorrectly described, prompting a complete reexamination. We redescribed the fossil and compared its anatomy with both modern and extinct members of Dipterocarpaceae, Anacardiaceae, Juglandaceae, Malpighiaceae, Betulaceae, and the fossil genus Raskya. Our investigation reveals strong similarities between the fossil specimen and *Tetrapterys* (Malpighiaceae) based on distinctive traits such as pericarpic wings and the schizocarpic condition. Our combined morphological and molecular phylogenetic analysis strongly supports placement of *Gyrocarpus miocenica* in the tribe Hiptagae, further expanding the known paleogeographic range of the clade.

Structure and development of the Cormophyton rhizomorph

D'Antonio, M. P. (Field Museum); Donovan, M. P. (Field Museum); Herrera, F. (Field Museum)

Isoetales is an ancient clade within Lycopodiophyta that includes the diminutive living *Isoetes* as well as a diversity of extinct forms ranging from small cormose plants to towering trees. An important feature of this clade is the rhizomorph: a shoot-like rooting organ from which centralized bipolar growth occurs. It has long been thought that all rhizomorphs within the clade are homologous—produced by a basal meristem—with differences in symmetry reflecting evolutionary modifications to the meristem. *Cormophyton mazonensis* is a small member Isoetales from the Upper Moscovian Mazon Creek flora in Illinois, USA. While its external morphology is well characterized, the rhizomorph symmetry and other key anatomical features could not be assessed from the type specimens. Here, we used X-ray micro-computed tomography to reconstruct *Cormophyton* from siderite nodules, providing new insights into its morphology and development. We find that this cormose rhizomorph was bilaterally symmetrical and likely developed through the activity of a basal meristem, with occasional lobing of the corm. These features are comparable to those seen in extant Isoetes corms. These findings strengthen the argument that the rhizomorph of *Cormophyton* was homologous to that of cormose lycopsids with lobed rhizomorphs including *Isoetes*, *Chaloneria*, *Pleuromeia*, and mature *Nathorstiana*.

Arthropod herbivore and pathogen damage associated with the Middle Pennsylvanian Mazon Creek Flora, Illinois, USA

DeKoster, R. N. (University of Wisconsin-Milwaukee); Donovan, M. P. (Field Museum of Natural History); Wittry, J. (Field Museum of Natural History); Labandeira, C. C. (National Museum of Natural History, Capital Normal University, University of Maryland); Gallick, C. (Cleveland Museum of Natural History); McCoy, V. E. (University of Wisconsin-Milwaukee, University of Leicester)

During the Pennsylvanian Subperiod, terrestrial food webs were reshaped by the expansion of a variety of plant-arthropod interactions. The Mazon Creek fossil beds preserve one of the most diverse and well-studied Middle Pennsylvanian floras. However, associated arthropod herbivory historically has not been studied in detail or used a quantitative approach, limiting our understanding of the terrestrial food web at this important Lagerstätte. We examined over 20,000 Mazon Creek plant fossils across multiple museum collections for evidence of arthropod feeding damage and assigned them to standardized damage types (DTs), finding 12 DTs from five functional feeding groups: margin feeding, oviposition, piercing and sucking, galling, and pathogen damage. We also measured surface areas of a census subcollection of ~1,000 specimens, finding that feeding damage diversity (10 damage types from 4 functional feeding groups) and intensity (~0.28% total damaged surface area) fall within the lower range of previously analyzed Late Paleozoic floras. Pathogen damage contributes to ~0.15% of surface area damaged. Newly documented plant-arthropod associations from Mazon Creek, such as oviposition on calamitalean stems and piercing and sucking on pteridosperm pinnules, indicate the importance of analyzing large sample sizes to recognize rare associations.

Organically preserved leaves from the Eocene Anglesea flora reveal first early Paleogene records of four angiosperm families in Australia

Giraldo, L. A. (Pennsylvania State University); Wilf, P. (Pennsylvania State University); Miller, A. S. (Pennsylvania State University); Carpenter, R. J. (University of Adeleide)

The late middle Eocene flora from the former Alcoa coal mine at Anglesea (Salt Creek Formation, Victoria, Australia; paleolatitude 58°S) is renowned for its organically preserved plant fossils representing terminal-Gondwanan Australian ecosystems. During the 1970s, the late D.C. Christophel collected thousands of leaves and dozens of flowers and fruits at Anglesea, and most of the undescribed leaf fossils—mounted on large glass slides with accompanying cuticle preparations—are now housed at the Melbourne Museum. Here, we report the first new family-level identifications for the Anglesea flora in over 30 years, recognizing Atherospermataceae, Monimiaceae, Dilleniaceae, and Euphorbiaceae. Diagnostic features include, for Atherospermataceae, a multistranded midvein, festooned semicraspedodromous secondary venation, serrate teeth with glandular tips, and anomocytic stomata; for Monimiaceae, festooned semicraspedodromous secondary venation, irregularly spaced glandular teeth, and distinctive paracytic stomata; for Dilleniaceae, craspedodromous secondary venation terminating in prominent glandular teeth, reticulate tertiary venation, and paracytic stomata; and for Euphorbiaceae, peltate petiole insertion, small teeth, disc-shaped glandular scales, and sunken stomata. These fossils provide the first well-resolved early Paleogene macrofossil records of these families for Australia, offering new insights into their biogeographic histories and reinforcing the significance of the Anglesea flora as a window into terminal-Gondwanan ecosystems and early Australian rainforests.

A Paleobotanical Overview of the Upper Cretaceous Neslen Formation with a focus on a new species of *Protodammara*

Greaves, W. (Utah State University); Maccracken, G. (Denver Museum of Nature and Science); Lively, J. (The Prehistoric Museum at Utah State University Eastern)

The Upper Cretaceous (Campanian) Neslen Formation in the Book Cliffs of eastern Utah preserves a fossil assemblage that fills a major latitudinal gap in our understanding of the biogeography of Laramidia during the Campanian. In this contribution, we provide an overview of the Neslen Formation, including over 800 specimens of conifers, flowering plants, ferns and fern allies. Additionally, we discuss in detail a new species of conifer in the Cupressaceae family. Within this formation, we found ~50 individual ovuliferous scales from a new species of the genus *Protodammara*. These cone scales are small and flat (1-2 cm), with a narrow petiole and a fan shaped top. Along these structures are resinous canals that run from the petiole to the curved distal margin. These structures most resemble those from *Protodammara reimatamoriori* found in New Zealand with notable differences, particularly with the shape of the distal end. Previous reconstructions of similar species show that these structures would have flaked off of a central “core” during a fire. Additionally, this species is found only in fissile coalified shales where few other fossils have been found. This mode of preservation raises questions about the types of microenvironments in which this plant thrives, as well as how transport and deposition affect the preservation of these cones.

A systematic procedure for estimating supportable taxonomic resolution of fossils

Green, W. (Harvard University)

To what level of taxonomic precision can a given fossil be identified? In the case of so-called living fossils, such as *Ginkgo/Ginkgoites*, a fossil from the relatively remote past may have no morphological characters that clearly distinguish it from an isolated, monotypic modern genus. In such a case, we may feel justified in identifying a fossil to genus or even species level, though the *-ites* suffix testifies to a general reluctance to apply modern generic names to fossils. At the other extreme, in groups like the grasses, it can be taxonomically challenging to identify material to species level based on the phenotype of a single

specimen even given modern fertile material. When imperfectly preserved fossils of detached organs are concerned, even approximate identifications can be questionable. Traditionally, the decision of how much taxonomic resolution can be supported by a given fossil is a subjective one, based on the morphological detail in the preserved material, the size and plasticity of the group it is in, how old the fossil is, and often the training and methodological biases of the systematic botanist.

Here I present a simple graphical procedure, given a particular clade and some knowledge about its diversity through time, for estimating a reasonable level of taxonomic precision for which to aim. This estimate assumes a strictly branching phylogenetic tree and is sensitive to the quality of the input data, but is independent of how diversity is taxonomically divided: it applies equally to traditional Linnaean ranks and to rank-free hierarchical nomenclature. In its simplest form, this procedure merely provides a graphical framework and systematic explanation for an 'upward outlook' that is already common in practice. Given good input data on diversification through time, however, it has the potential to provide statistically defensible point estimates, confidence intervals, and even empirical distribution functions for maximum defensible taxonomic resolution.

Revision of the fossil flower genus *Sahnianthus* Shukla (Myrtales) from the latest Cretaceous Deccan Intertrappean Beds of India

Hamersma, A. M. (University of Florida); Karumanchi, C. (University of Florida); Kapgate, D. (J. M. Patel College); Pigg, K. B. (University of Arizona); Smith, S. Y. (University of Michigan); Graham, S. (Missouri Botanical Garden); Manchester, S. R. (University of Florida)

Interbeds of the Deccan traps, ca. 66 million years old, have long been known to contain cherts with anatomically preserved flowers, fruits and seeds. We studied numerous specimens of *Sahnianthus*, the iconic flower of Deccan Intertrappean cherts, by micro-CT scanning as well as traditional cellulose acetate peels and scanning electron microscopy of the in-situ pollen, to reconstruct the original floral and pollen morphology. The flowers were collected, in association with fruits of *Enigmocarpon*, from the type locality of Mohgaon Kalan in Chhindwara, Pradesh and other locations in Madhya Pradesh and Maharashtra, Central India. Using micro-CT scans to vary the orientation of virtual sections of complete flowers embedded in chert, we show that nine additional, previously described fossil flower genera represent the same plant and are thus synonyms of *Sahnianthus*. In addition, we suggest that much of the variation observed in the specimens is due to preservation at different developmental stages from bud to maturity. The combined characters of *Sahnianthus*, together with fruit and seed characters of *Enigmocarpon*, are consistent with placement within, or close to, Lythraceae, as previously suggested.

Regional plant ecological turnover and diversity loss at the end-Triassic mass extinction at the Jameson Land Basin, East Greenland

Knetge, A. B. (Trinity College Dublin); Barbosa, C. (Trinity College Dublin); Matthaeus, W. J. (Trinity College Dublin); Barclay, R. S. (Smithsonian Museum of Natural History); Glasspool, I. J. (Field Museum of Natural History); Gomez, B. (Université Lyon 1); Hesselbo, S. P. (University of Exeter); Popa, M. E. (University of Bucharest); Ruhl, M. (Trinity College Dublin); Sunderlin, D. (Lafayette College), Surlyk, F. (University of Copenhagen); McElwain, J. C. (Trinity College Dublin)

The end-Triassic event is associated with community change in both marine and terrestrial fossil records. Major macroecological change (80% species turnover) across this event has been previously interpreted at Astartekløft (Jameson Land Basin), a well-studied East Greenland site. However, a regional-scale floristic

turnover has not yet been evaluated using census collections at multiple localities.

Here we report, a new census collected fossil flora from South Tancrediakløft (Jameson Land Basin). The flora contains 2,369 well-preserved leaf specimens of 27 unique morphogenera, spanning the Tr–J boundary. Comparing these two Jameson Land Basin assemblages enables a wider comprehension of vegetation dynamics, characterising regional-scale responses to environmental change.

Our study uses relative abundance data, measures of biodiversity, taphonomic interpretations, and stable carbon isotopic data to assess ecological shifts. We demonstrate a floral turnover occurring before the Rhaetian – Hettangian boundary, and before the 'main' negative stable carbon isotope anomaly correlated to St. Audrie's Bay, UK. Further, our data indicates a 54% loss of macrofossil leaf generic richness and loss of the lower and mid-canopy habits before the Jurassic. These findings, paired with those of Astartekløft, support a major regional-scale ecological restructuring of vegetation across the Jameson Land Basin associated with the end-Triassic event.

A permineralized cycad stem, *Tianocycas yunnanensis* gen. et sp. nov. (Cycadales), from the Upper Permian in eastern Yunnan, China

Li, H. (Frostburg State University); **Taylor, D. W.** (Indiana University Southeast)

Only three anatomically preserved cycad Permian stems have been reported. We describe a fourth from the upper Permian, southwestern China. *Tianocycas yunnanensis* gen. et sp. nov. exhibits numerous anatomical characteristics: (1) a wide pith and thick cortex with parenchyma, scattered sclereids, idioblasts, mucilage cavities and canals, many filled with hyphae and other fungal structures; (2) a narrow monoxylic stem cylinder; (3) a foliar trace system started from pith-periphery vascular bundles, extended horizontally through medullary rays, developed secondary vascular tissue and a sclerenchymous bundle sheath in cortex, then divided into direct and ascendingly girdling foliar traces as they gradually stopped producing secondary tissue, finally with three traces from different origins divided into 9-11 parallel veins in each foliar base; (4) an extrafascicular vascular system started with numerous bundles emitted out from medullary rays along half side of the stem cylinder, expanded into centrifugal and centripetal extrafascicular vascular segments, and finally coalesced into a possible peduncle stele; (5) araucarioid-type tracheids; (6) cuticle lamellae; (7) amphistomatic epidermis with perforated epidermal cells and sunken haplocheilic stomata. The characteristics suggest affinity to cycads and are used in a phylogenetic analysis that places the fossil at the base of the Cycas clade or the non-Cycas clade.

Miocene plant communities and climate of the Pacific Northwest (USA) using a refined morphotype and geochronologic framework

Lowe, A. (National Museum of Natural History, Smithsonian Institution); Dillhoff, R. (Burke Museum of Natural History and Culture); Dillhoff, T. (Burke Museum of Natural History and Culture); Schmitz, M. (Boise State University); Schiller, C. (Burke Museum of Natural History and Culture); Fields, P. (Orma J. Smith Museum of Natural History); Reichgelt, T. (University of Connecticut); Nares, F. (University of Florida), Cohen, L. (University of Washington); Rember, W. (Independent Researcher, Fernwood, ID); Strömberg, C. A. E. (University of Washington, Burke Museum of Natural History and Culture)

The US Pacific Northwest (PNW) hosts a suite of well-preserved Miocene paleobotanical sites that span Earth's most recent period of sustained global warmth, the Miocene Climatic Optimum (MCO; 17-14 Ma), and the Middle Miocene Climatic Transition (MMCT; 14-12 Ma). An understanding of how these global

events manifested in PNW terrestrial environments is currently limited by conflicting evidence from varying fossil types, a reliance on outdated methods, and a lack of precise age control. This study integrates new and historic macrofossil, palynomorph, and phytolith records to reconstruct plant community ecology and climate across 14 PNW fossil sites. A chronological framework was first established with U-Pb of zircons using CA-ID-TIMS. Within this framework, we find the PNW during the MCO was characterized by warm temperate closed canopy forests dominated by deciduous angiosperms. Lowland annual temperature was ~4 °C warmer than modern, while annual precipitation was like that west of the Cascades today. Across the MMCT, inland floras modernize with a loss of exotic genera, a decrease in diversity, and a greater prevalence of deciduous angiosperms. Vegetation structure becomes more open alongside a drying and cooling regional climate. Climate and vegetation changes across the MMCT are however more tempered near the coast.

A time-tested system for morphotyping large fossil floras integrated with recent advances in leaf architecture scoring and databasing

Maccracken, S. A. (Denver Museum of Nature & Science); Butrim, M. (University of Wyoming); Barclay, R. (Smithsonian National Museum of Natural History); Currano, E. (University of Wyoming); Farver, L. M. (University of Wyoming); Holian, F. (University of Wyoming); Johnson, K. R. (Smithsonian National Museum of Natural History); Miller, I. M. (National Geographic); Robertson, S. S. (University of Wyoming); Tenney, Z. (University of Wyoming); Bugos, B. V. (University of Wyoming); Lyson, T. R. (Denver Museum of Nature & Science)

Research utilizing large paleobotanical collections (> 10,000 specimens) requires extensive protocols and tools for data collection, curation, and databasing of fossil floras. At the forefront of these challenges is the need to sort specimens into discrete taxonomic units, which in turn allows paleobotanists to study other important aspects of fossil plant assemblages (i.e. plant evolution, diversity, extinctions and radiations, ecology, biogeography, morphological plasticity and its drivers, paleoclimate, phylogenetic relationships, and more). Through decades of trial-and-error in the paleobotanical collections at the Denver Museum of Nature & Science, protocols for morphotyping have been refined and streamlined. Recent advances in character scoring for leaf architecture and paleobotanical morphotype databasing are also now integrated with this morphotype schema to produce high-quality paleobotanical collections and datasets.

We present a workflow and rationale for morphotyping macrofloral fossils into morphologically constrained ‘bins’ and floral series, which allow for efficient scoring/tabulation of leaf architecture and disseminating morphotypic data via a new online paleobotanical database. Paleobotanical research will benefit from augmented morphotyping procedures that also incorporate digital tools for leaf architecture analyses and data dissemination. This workflow highlights and improves the utility of morphotype schemas that we hope will be useful for the paleobotanical community.

Spatial resolution, compositional fidelity, and isotaphonomy of leaf assemblages

Matel, T. (University of Michigan); Azevedo-Schmidt, L. (University of California Davis); Carvalho, M. (University of Michigan)

Fossil leaf assemblages are a direct but biased source of evidence on plant diversity through time. This record represents a key line of evidence for testing hypotheses about the ecological limits to species richness but must be interpreted in light of the taphonomic and biological factors that influence the

formation of leaf assemblages. Here, we analyzed in situ, transported, and buried leaf litter collected across a latitudinal gradient of modern forests to isolate the contributions of taphonomic and biological controls on assemblage diversity. This work produced three important results for interpreting richness in fossil leaf assemblages. First parautochthonous leaf assemblages that have undergone moderate transport and accumulate in anoxic environments tend to have greater richness than in situ (autocthonous) or highly transported (allochthonous) assemblages. Second, tropical forests deviate from multinomial sampling of the source forests, indicating a stronger preservation bias in the tropics. Third, parautochthonous leaf assemblages sampled across a latitudinal gradient of forests accurately reconstruct their modern diversity gradient. Based on this work, two future priorities for plant taphonomic studies are (1) testing what processes contribute to greater preservation selectivity in the tropics, and (2) identifying unequivocal signatures of parautocthonous preservation in the fossil record.

Assessing the relationship between leaf physiognomy and climate of African low-latitude floras

Munyaka, V. (Baylor University); Baumgartner, A. (University of Michigan Herbarium), Strömberg , C. (University of Washington, Burke Museum of Natural History and Culture); Uno, K. T. (Harvard University); Eamma, M. (Datapoint, Fort Worth, TX); Kinyanjui, R. N. (National Museums of Kenya, Max Planck Institute, Smithsonian National Museums of Natural History); Reichgelt, T. (University of Connecticut), Peppe, D. J. (Baylor University)

Leaf morphology responds plastically to climate across short and long timescales, and the relationship between leaf size and shape (physiognomy) and climate is widely used in paleoclimate reconstructions. Global empirical patterns suggest that similar climates produce similar woody plant leaf forms; however, this relationship is poorly documented in low-latitude African floras. Applying global correlations may therefore lead to inaccurate paleoclimate estimates in African paleofloras. Here, we present a leaf trait calibration dataset scored using Digital Leaf Physiognomy (DiLP), which uses continuous leaf morphological characters, from 30 low-latitude African sites. These sites span major western and eastern African biomes. Pearson correlation matrices reveal a strong positive correlation between leaf physiognomy and mean annual precipitation, and a weaker correlation with mean annual temperature, suggesting that African physiognomic responses to climate differ from global patterns. Canonical correspondence analysis shows African leaf physiognomy partially fits within the global climate-physiognomy ordination space. However, biome classifications based on the global DiLP calibration poorly match African biomes. Ongoing work explores how incorporating African floras into the DiLP calibration affects climate correlations and examines taxonomic disparity among sites to assess the relative influence of taxonomy versus climate on leaf morphology.

A century of paradox: Re-investigating paradoxopterid ferns with new material from the Early Cretaceous of Northwestern Gondwana

Palma-Castro, H. D. (University of Illinois Chicago, Field Museum of Natural History); Carvalho, M. R. (University of Michigan); Jaramillo, C. (Smithsonian Tropical Research Institute); Mason-Gamer, R. J. (University of Illinois Chicago), Bomfleur, B. (University of Münster); Herrera, F. (Field Museum of Natural History)

The Cretaceous vegetation contained a rich diversity of extinct tree ferns, many of which are known from well-preserved stems. Despite detailed anatomical knowledge, the systematic relationships of these arborescent ferns remain poorly understood. Among the more enigmatic forms are the paradoxopterid

ferns, an informal group that includes structurally preserved stems (i.e., *Paradoxopteris* and *Alstaettia*) and sterile and fertile frond compressions (*Weichselia*).

Here, we present a well-preserved fern stem from the Early Cretaceous (late Aptian) La Paja flora of Northwestern Gondwana (Colombia) that provides new insights into this group of Cretaceous tree ferns. Collected in the 1970s but never studied, the stem was analyzed through classical thin-section preparation, enabling detailed anatomical and structural comparisons with other Cretaceous tree ferns. The La Paja specimen shares several similarities with *Paradoxopteris*, originally described from Egypt, as well as with *Weichselia* and *Alstaettia*. However, key differences, such as the lack of secretory canals and strictly parallel vascular architecture, set this stem apart from previously described taxa.

By analyzing discrete morphological characters and conducting phylogenetic analyses, our ongoing study aims to resolve a century-old question regarding the evolutionary relationships among paradoxopterid ferns, shedding new light on their classification and paleoecology of these extinct Mesozoic tree ferns.

Insect damage on the Indo-Pakistan collision front (Ghazij Formation, Balochistan, Pakistan): First tropical insect-feeding damage for the Early Eocene Climatic Optimum

Przybylski, P. J. (Pennsylvania State University); Giraldo, L. A. (Pennsylvania State University); Spagnuolo, E. J. (Pennsylvania State University); Wilf, P. (Pennsylvania State University); ul-Haq, M. (Geological Survey of Pakistan); Wing, S. L. (Smithsonian Institution); Clyde, W. C. (University of New Hampshire)

Insect diversity and herbivory increase toward lower latitudes in the present, but a scarcity of tropical fossil insect-damage surveys limits testing of past latitudinal herbivory gradients. Here, we describe the insect-feeding traces on 405 fossil leaves of ca. 40 morphotypes, collected in 2000 from 15 magnetostratigraphically-constrained sites from the early Eocene (ca. 54–50 Ma) Ghazij Formation (Balochistan, Pakistan; 0–5° N paleolatitude), well-known for its fossil mammals. The sites, now inaccessible due to violent regional conflict, record the biotas of northwest Indo-Pakistan during the Early Eocene Climatic Optimum (EECO) and the onset of the India-Asia collision. These data represent the only quantitative analysis of tropical insect damage for the early Eocene hothouse or Cenozoic Asia. The complete Ghazij sample preserves 47 damage types (DTs) spanning eight functional feeding groups. Upper Ghazij dicot leaves held 34 DTs; 74.1% of leaves had insect damage and 49.8% had specialized damage, including a high prevalence (42.3% of leaves) and richness (9 DTs) of galls. These values, adjusted for sample size, are comparable to other tropical sites (Colombia and Ethiopia) but exceed temperate EECO sites (western USA and Argentina), broadly consistent with a latitudinal gradient in herbivory despite the global warmth of the EECO.

Vanished voyagers of Moa's Ark: Post-Miocene homogenization of New Zealand's vegetation

Reichgelt, T. (University of Connecticut)

The Zealandian subcontinent separated from Gondwana in the late Cretaceous and has remained isolated, leading to a highly endemic biota. However, Miocene deposits in southern New Zealand reveal that today's biota represents only a remnant of a once much larger diversity of plant groups and ecosystems. While modern lowland forests are typically closed-canopy evergreen with dense understories, Miocene forests included open deciduous forests and pyrophilic woodlands. Their disappearance resulted in the loss of entire families (e.g., Casuarinaceae) and within-family extinctions (e.g., Proteaceae). Even within evergreen forests, substantial diversity loss is recorded at multiple taxonomic levels, e.g., the loss of

Celastraceae, Sloanea (Elaeocarpaceae) and Malloranga (Euphorbiaceae), and species diversity in Lauraceae. This decline is often attributed to late Neogene cooling and the retreat of flora into limited refugia, though new evidence suggests that reduced seasonality greatly contributed to vegetation homogenization. In contrast, New Zealand's alpine flora rapidly diversified in response to newly emerging habitats post-Miocene. Interestingly, contemporary climate change and anthropogenic species introductions are reestablishing Miocene ecosystem dynamics—for example, summer drought now triggers wildfires in Eucalyptus and Pinus plantations. However, rather than restoring Miocene diversity, these human-driven ecosystem changes only threaten a further decline in New Zealand's endemic biota.

Not your average fruit cups: Fossil fruits and cupules with multiple development stages from the early Eocene of Argentine Patagonia

Siegert, C. (Cornell University); Gandolfo, M. A. (Cornell University)

One unfortunate effect of the rapid sedimentation during the fossilization process is a general lack of organ developmental data among plants captured in these snapshots in time. Through a careful analysis of the morphology of a set of fruit and cupule fossils from the early Eocene Laguna del Hunco fossil locality in Argentine Patagonia, it was possible to track the development of these fruiting structures and compare them to the development of extant fruits with similar morphology. These pedicellate fruiting structures are composed of five centralized nutlets basally attached to a cupule of five bracts characterized by acute apices and long marginal hairs. Some specimens display fine hairs covering the nutlets, which could be a part of the development and is seen as an early stage of development in other cupule bearing fruits. The fine hairs could, however, be a later pubescence seen in non-cupule bearing fruits, or be an unusual byproduct of the preservation in which some fossils preserved these and some did not. The fruits and their attached structures bear no convincing commonalities with any known families extinct or extant and thus remain unassigned to any family.

Reevaluating the relationship between dispersal mode and survivorship in the light of the Hattiesburg Flora

Simpson, A. G. (Anne Arundel Community College), Tiffney, B. H. (University of California Santa Barbara)

Animal-mediated seed dispersal and pollination have long been suggested as cornerstones of the success of the angiosperms during the Cretaceous and Cenozoic. Evidence in support of this hypothesis has now been levied from floristic analyses, phylogenetic methods, and comparison of extinction risk using the fossil record. In previous work, I showed that possession of animal-mediated seed dispersal reduces extinction risk at the genus level from the Miocene through recent of western North American floras, but that this correlation is not observed in eastern North American floras. However, due to the small number of Miocene and younger floras in the eastern half of the continent, it is possible that the absence of a statistically significant effect of dispersal may be due to insufficient sample size.

Here, I reevaluate the above relationship following the addition of data from the recently published Hattiesburg flora of Mississippi, which adds several genera new to the fossil record of eastern North America and some new to North America as a whole. The incorporation of Hattiesburg genera does not alter the initial conclusion: the effect of animal dispersal on extinction resistance remains statistically insignificant in eastern North America, but remains significant in western North America.

Leaf documentation and Digital Leaf Physiognomy estimate of the Coal Creek Member of the middle Eocene Kishenehn Formation in northwestern Montana, USA

Smith, M. (Sacred Heart University); Zhang, X. (Wesleyan University)

The Kishenehn Formation is a series of Eocene through Oligocene deposits spanning from southeastern British Columbia, Canada to northwestern Montana, USA. Mammals and freshwater mollusks have been documented from the formation but it is better known for its insect assemblage from the 44 Ma paper shales of the Coal Creek Member along the Middle Fork Flathead River in northwestern Montana. Recently, a paleoclimate reconstruction was performed using the Bioclimatic Analysis/Mutual Climate Range Technique, a coexistence approach, using the fossil plants from the Coal Creek Member. Here, Digital Leaf Physiognomy is employed to subsidize any inherent bias from nearest living relative techniques including extinct taxa, taxa not having a representative living relative, taxa not utilizing their full modern climatic tolerance and incomplete modern data. Efforts were undertaken to identify the leaves. *Alnus* appears to be the dominate leaf component which juxtaposes with *Carpolithes lunatus* (Cercidiphyllaceae) being the dominate disseminule component. These differences might be explained by a combination of 1. The abundance of each tree 2. The abundance of each element on tree 3. The distance between the trees and depositional basin and 4. The transportability of each element from the tree to the depositional basin. Preliminary attempts to quantify any arthropod damage on leaves was done to aid in assessing ecological interactions with known faunal elements and illuminate those which have yet to be found or might not be preserved. Margin and hole feeding were the most common classes of damage types. Alnus was the most frequently damaged leaf, continuing a trend from earlier in the Eocene. These efforts flush out our understanding of an ancient ecosystem that is regionally important.

The co-occurrence of Zygnema and a land plant spore in latest Ordovician deposits indicates “some (genomic) assembly required”

Strother, P. (Weston Observatory of Boston College)

By using Moyeria as a freshwater marker, we were able to view a set of Hirnantian assemblages from Saudi Arabia, as being of freshwater origin. We recovered species of Hydrodictyaceae, Scenedesmaceae, Zygnemataceae, and cryptospores. Vegetative colonies of the chlorophyte, Scenedesmus are poorly preserved, but they are a strong indicator of freshwater settings capable of preserving phytoplankton. We have recognized several new species of zygospores with affinity to Zygnema, and have erected a new fossil genus, Stigmatocystia to accommodate some curiously pitted forms that are similar to the Pliocene genus, Gelasinacystia. Although cryptospores are reasonably abundant, only one trilete spore was recovered, which brings into question issues of the identification of trilete spores in Sandbian and Katian strata in Gondwana and elsewhere. Finally, we address the issue of the co-occurrence of embryophytes (spores) and Zygnema in the latest Ordovician – their common ancestor must have lived well before the arrival of plant axes on land during the Wenlock, indicating that considerable prior genomic assembly was required to achieve embryonic plant development.

Early Pleistocene flora from central Vietnam and its links to southern Indochina’s extant tropical monsoonal forests

Wang, T. (Pennsylvania State University), Wilf, P. (Pennsylvania State University), Van Do, T. (Vietnam National Museum of Nature), Giraldo, L. A. (Pennsylvania State University), Spagnuolo, E. J. (Pennsylvania

State University)

The evolution of southern Indochina's biodiverse tropical monsoon forests is poorly understood due to a lack of regional fossil evidence. We have discovered several Plio-Pleistocene floras from the Kon Tum Formation (KTF) in central Vietnam that provide novel insights. The first site, "HP," discovered in 2020, yielded 44 leaf morphotypes with small sizes and mostly entire margins from fluvial facies. The assemblage showed close floristic affinity to extant regional lowland forests, including species of *Syzygium*, *Ficus*, *Dipterocarpus*, *Barringtonia*, and *Sindora*. Our 2024 expedition revealed seven new KTF sites (WTX2402–WTX2408), all within a 20 km radius; these quarries collectively yielded 648 specimens, many with exceptionally preserved venation or cuticles. From the most prolific site, WTX2406, we recovered 478 specimens from lacustrine facies with tabular mudstones and siltstones and freshwater fauna, directly overlying an early Pleistocene basalt flow (~2.4 Ma; UW-Madison WiscAr lab). We preliminarily classified the 2024 collection into 69 total and 43 new morphotypes, including *Ficus*, *Bauhinia*, *Calophyllum*, and *Castanopsis* species, with *Syzygium* dominant as at HP. These discoveries represent the only substantial Cenozoic paleobotanical collections from southern Indochina, documenting well-dated ancient tropical monsoonal forests with heterogeneous composition, floristically comparable to today's threatened regional ecosystems.

The Jurassic Fossil Forest in the Sichuan Basin, China

Wang, Y. (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences); Xie, A. (Senckenberg Forschungsinstitut und Naturmuseum Frankfurt); Tian, N. (College of Paleontology, Shenyang Normal University); Jiang, Z.（Chinese Academy of Geological Sciences); Xie, X. (School of Geography and Tourism); Xi, S. (The 11th Geological Brigade of Sichuan)

Diverse wood fossils have been reported in China over the past few decades. In the Jurassic, about 20 genera 40 species mainly distributed in the Northern China, but they are rare in Southern China. In recent years, some new data on fossil wood have been documented from a variety of localities in China. One of the major fossil forest localities is located in the Sichuan Basin, southern China. The Jurassic fossil wood specimens are mainly found at the central to southern regions of the Sichuan Basin, such as in Shehong, Zigong in Sichuan Province and Qijiang in Chongqing City.

Recent study progresses were reported on the fossil wood studies in the two localities in Shehong and Qijiang in this basin. The fossil wood specimens in these localities are rich and their anatomical structure is well preserved. Such abundant fossil wood records are very important to show the systematic diversity and the reconstruction on Jurassic fossil forest in the region. Over 100 fossil wood specimens were investigated from the Middle Jurassic Shaximiao Formation in Qijiang of Chongqing City, as well as the Late Jurassic Penglaizhen Formation in Shehong City of Sichuan Provence. Systematically, these fossil wood could be ascribed to two conifer genera, i.e. *Brachyoxylon* Hollick et Jeffrey belonging to Cheirolepidiaceae? and *Agathoxylon*, including *Brachyoxylon qijiangense* Xie, Wang et Tian, *Brachyoxylon trautii* (Barale) Philippe and *Brachyoxylon* sp., and *Agathoxylon* sp..

These fossil wood records not only enrich our understandings to the diversity of wood diversity, but also provide robust evidence for exploring the paleoenvironment reconstruction of the Jurassic fossil forest. The tree height models are applied to ancient araucariaceous and related conifer trees so as to reconstruct the Late Jurassic forest in Shehong, Sichuan Basin. In Shehong City, over 500 wood specimens were documented, and in the Wangjiagou site locality, up to 56 large fossil wood upright stumps, fallen logs were found in a single site of in situ position, some are together with tree roots. This fossil forest community is formed by flooding events during the Late Jurassic showing significance for understanding

the vegetation and paleoenvironmental changes.

Floristic Composition and Paleoclimate of the early Paleocene Highvale Mine Ardley Coal Zone Fossil Flora, Central Alberta, Canada

West, C. K. (Royal Tyrrell Museum of Palaeontology, Canada); Reichgelt, T. (University of Connecticut); Hoffman, G. L. (G. Hoffman Consulting Services, Canada).

The Highvale Mine near Edmonton, Alberta, preserves a sequence of coal seams known as the Ardley Coal Zone, part of the upper Scollard Formation. These seams represent the first ~2 million years following the K–Pg boundary, with the base of the coal zone situated directly above the boundary. Interbedded mudstones preserve a diverse early Paleocene (~64 Ma) fossil flora, representing a post–K–Pg assemblage. Such floras offer critical insights into vegetational recovery and climate conditions after the mass extinction. This study presents a preliminary analysis of the flora, paleoclimate, and paleoenvironment of the Highvale Mine site. A total of 26 fossil taxa are identified, including 19 broadleaf dicots, 2 deciduous conifers, 2 pteridophytes, and several fruits and seeds. Paleoclimate was reconstructed using CLAMP, LAA, LMA, and NLR methods, integrated through an ensemble approach. Results yield MAT = 10.6 ± 4 °C, CQT = 2.8 ± 4.3 °C, MAP = 141.3 cm year-1, and DMP = 4 cm, with RH at 76.7% and NPP at 718 gC m^{-2} yr^{-1}. Sedimentological and palynological data suggest a wet, potentially swampy, forest. The climate reconstructions are broadly consistent with this, though cooler and drier than previously thought. Regional comparisons are also explored.

Tracing palaeo-gaseous mercury variations through fossil plants: Preliminary analysis of mercury concentration data in extant *Ginkgo* and extinct ginkgoaleans

Zhang, L. (Nanjing Institute of Geology and Palaeontology); Wang, Y. (Nanjing Institute of Geology and Palaeontology); Ruhl, M. (Trinity College Dublin); Kovács, E. B. (Trinity College Dublin)

Vegetative leaves have long been considered a significant receiver of gaseous Hg in the atmosphere, offering the potential to passively monitor palaeo-atmospheric Hg concentrations; however, few constraints on this exist. We conduct Hg measurements on three *Ginkgo* leaf collections: i) modern leaves from ten sampling sites across China, ii) modern leaves collected monthly across one growing season in Nanjing (China), iii) fossil ginkgoaleans leaves from the Middle Jurassic (China). The results from this study reveal that the foliar Hg concentrations (with an average concentration of 61 $ng \cdot g^{-1}$, N = 272) were higher than those observed in *Ginkgo* leaf samples previously studied from Ireland and the USA. Additionally, the leaf age and atmospheric Hg concentrations represent two primary factors impacting foliar Hg contents in *Ginkgo*. Hg concentrations in fossil cuticular samples (with an average concentration of 585.5 $ng \cdot g^{-1}$) were observed notably higher than those in modern *Ginkgo* leaves (avg. 61 $ng \cdot g^{-1}$) and sediments from the same layers (avg. 113 $ng \cdot g^{-1}$). Considering possible Hg migration during fossilization, we suggested that the elevated Hg concentrations in fossil cuticles were attributed to both the retention of Hg in leaves and the loss of leaf content during fossilization. Based on 23 fossil ginkgoalean samples from 6 beds of the Dameigou section (spanning from the Early to the Middle Jurassic), Qaidam Basin, China, we detected a Hg anomaly through Hg concentrations in fossil cuticles during the presumed palaeo-volcanic event (the Karoo-Ferrar Large Igneous Province, LIP). This preliminary test supports the notion that variations in Hg concentrations in fossil cuticle may potentially reflect the gaseous Hg variations in the Jurassic palaeo-atmosphere, triggered by LIP volcanism at this time. This finding highlights the possibility of using fossil plant cuticle as a Hg proxy of palaeo-atmospheric Hg loading.

Estimates of atmospheric CO_2 during the CPE (Carnian Pluvial Event, Triassic period) based on stomatal and isotopic analyses of fossil leaves from South China

Zhang, X. (Wesleyan University and Nanjing Institute of Geology and Palaeontology); Royer, D. L. (Wesleyan University; Zhang, L. (Nanjing Institute of Geology and Palaeontology); Wang, Y. (Nanjing Institute of Geology and Palaeontology)

The Carnian (237–227 million years ago) marks the earliest phase of the Late Triassic. A key event during this time was the Carnian Pluvial Episode (CPE), a climate change event associated with negative carbon isotope excursions, global warming, and the eruption of the Wrangellia large igneous province. During the CPE, many terrestrial climates transitioned from dry to humid, with rapidly flourishing plant communities.

In the Nanling region, located on the border of Guangdong and Hunan provinces in southern China, the coal-bearing layers of alternating marine and terrestrial deposits are extensively developed, which yield a variety of terrestrial and marine fossils, such as ammonites, bivalves, ostracods, and plenty of plants. Notably, fossil plants from the Carnian Hongweikeng Formation in the Nanling region have preserved leaf cuticles, offering the potential for reconstructing CO_2 levels.

Our estimated CO_2 concentration is 391 ppm (265-576 at 95% confidence) based on stomatal and isotopic analyses of fossil leaves using the Franks leaf gas-exchange CO_2 proxy. The fossil leaves analyzed include Bennettitales like *Pterophyllum* Brongniart (2 leaves of *Pterophyllum kochi* Harris and 1 leaf of *Pterophyllum xinanense* Yang) and *Ptilophyllum* Morris (4 leaves of *Ptilophyllum lechangense* Wang emend. Zhang), and seed ferns like *Ptilozamites* Nathorst (2 leaves of *Ptilozamites chinensis* Hsü) from single bed (single site) in the Nanling region, South China.

Only a small number of CO_2 records for the Carnian, Triassic have been published, primarily based on paleosol, stomatal index, and liverwort proxies. These estimates range from 116 to 1140 ppm. Although there is variability within and between species in our results, all estimates suggest lower CO_2 concentrations, which indicates that the CPE likely occurred during a period with lower paleo-CO_2 levels.

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Sampling strategies and their influence on paleoecological interpretations at the Triassic–Jurassic boundary

Barbosa, C. (Trinity College Dublin); Knetge, A. (Trinity College Dublin); Glasspool, I. J. (Field Museum of Natural History, Chicago); Hesselbo, S. P. (Camborne School of Mines and Environment and Sustainability Institute, University of Exeter); Matthaeus, W.J. (Trinity College Dubin); Popa, M.E. (Faculty of Geology and Geophysics, University of Bucharest); Sunderlin, D. (Department of Geology and Environmental Geosciences, Lafayette College); McElwain, J. C. (Trinity College Dublin)

The end of the Triassic period is marked by an extraordinary faunal mass extinction and multiple co-occurring regional floral extirpations including in East Greenland. However, inferences of paleoecological turnover may be sensitive to basic methodological choices, such as counting strategies and sampling intensity. We conducted a plant community survey of a new, census-collected fossil flora from the Triassic-Jurassic boundary East Greenland (South Tancrediakløft (STan), Jamesonland). STan is temporally equivalent and geographically proximal to Astartekløft, making them ideal for methodological comparisons. We applied two counting approaches to a database of 737 hand specimens and 28 generic occurrences: Method A (one occurrence per taxon per hand sample) and Method B (up to five occurrences per taxon per hand sample). These methods produced significantly different datasets, with Method B more than doubling the total occurrence counts. Rarefaction curves indicate that increased sampling intensity with Method B yields more representative assemblages in individual beds. To assess methodological impacts further, we reconstructed a hypothetical Astartekløft dataset using Method A. Notably, relative abundance rankings of dominant taxa shifted between methods, underscoring how sampling strategies can affect interpretations of floral turnover. Our results highlight the importance of standardized counting protocols in paleoecological studies of extinction and recovery.

Calibrating the reconstructed Leaf Area Index method for Colombian Dry Forest using Cuticle Trace

Cham, M. (University of Washington); Cantu, C. (University of Washington); Stiles, E. (University of Washington); Strömberg, C. (University of Washington)

Tropical dry forests are lowland ecosystems shaped by pronounced seasonal drought, and partial or full deciduousness among many plant species. Due to their unique ecosystem functions and physiological adaptations, the impacts of climate change remain poorly understood. Elucidating the evolutionary history of dry forests and their growth strategies is critical to interpreting the future of tropical vegetation under global environmental change, yet we lack well documented modern analogs to interpret the occurrence and ecology of such plant communities in the fossil record.

Plant cuticles, often preserved in fossil records, are used to reconstruct different aspects of the paleoenvironment, from atmospheric CO_2 levels to vegetation structure and taxonomic composition. We examine cuticles from leaves of the 20 most common tree and shrub species in extant dry forests along the Upper Magdalena River Valley in Colombia as a paleoecological tool. Specifically, we seek to calibrate a method to use epidermal cell size and shape to reconstruct canopy openness (rLAI, or reconstructed Leaf Area Index). Canopy openness can be reconstructed using epidermal cell morphology, which changes in response to the light environment experienced during development. We will create an image reference

set from the extant leaves and use the automated toolkit CuticleTrace to segment and measure the epidermal cells on these images. The calibration of the rLAI method can then be applied to the dry forest fossil record to reconstruct vegetation openness. The collection of images will also aid in the taxonomic identification of paleofloras in the Neotropics and elsewhere.

Plant-Insect Interactions from Oligocene Beaver Creek, South-Western Montana

Gaarder, G. (University of Florida); Hamersma, A. (University of Florida)

The Oligocene Beaver Creek flora is located in Powell County, southwestern Montana, in the northern U.S. Rocky Mountains, and has been collected for several decades by researchers and field trips depositing material in several repositories including the two visited for this study, the University of Florida and Denver Museum of Nature and Science. The site consists of well-preserved adpression fossils of leaves and plant reproductive structures as well as occasional invertebrates, fishes, and amphibians in light, fine-grained lacustrine shales. The locality produces fossil leaves with abundant and identifiable insect damage, of interest in determining various ecologies and interactions preserved within the flora. Plant hosts were identified, and studied for the presence of plant-insect interactions (excluding detritivory) and insect damage determined, first grouped by functional feeding group and secondarily to specific damage type. Based on preliminary and ongoing observations of a subset of collected specimens, damage has been determined to belong to at least 18 damage types representing 9 FFGs, present on over twenty plant species, with many specimens displaying more than once type of damage.

Investigating fossil seeds of the Paleocene of North America by means of micro-CT scanning

Krinsky, K. (University of Florida); Manchester, S. R. (University of Florida), Tiffney, B. H. (University of California, Santa Barbara)

During the Paleocene, ecosystems in western North America adjusted to end-Cretaceous mass extinction and subsequent climate change. The late Paleocene Sand Draw locality in central Wyoming contains numerous plant fossils that can provide more context to the Paleocene flora. Past research has been limited by traditional methods that require surface exposure; damage can result from hammers, and photography can be limited by shadow. Micro-computed tomography (micro-CT) now facilitates discovery and documentation of fossil material inside matrix rocks as well as on the surface without risking damage. This project uses micro-CT to produce three-dimensional imagery and cross sections of fossils. In the process of inventorying the paleobotanical content of fruit and seed fossils from the Paleocene of Big Sand Draw, Wyoming many previously unknown angiosperm genera were encountered. Based on the modern distribution of related genera, the fossils indicate mostly subtropical plants, supporting the idea that this flora was adapted to a warm, humid environment during the late Paleocene. From these fossils, a more extensive record of various flowering plant families can be recognized.

Peltate leaf from Australia's Anglesea flora (middle Eocene, Victoria) supports an out-of-Gondwana history for the Macaranga-Mallotus clade (Euphorbiaceae)

Miller, A. S. (Pennsylvania State University); Giraldo, L. A. (Pennsylvania State University); Wilf, P. (Pennsylvania State University); Carpenter, R. J. (University of Adelaide)

The *Macaranga-Mallotus* clade (MMC; Euphorbiaceae) comprises >400 species of shrubs and trees

ranging from Australia to South Asia and Africa. A biogeographic debate concerns whether the MMC evolved in Asia and dispersed into Australia, or had a reverse, out-of-Gondwana history, as supported by leaves and fruits from West Gondwana (early Eocene Patagonia). MMC fossils from early Paleogene Australia (East Gondwana) would provide direct biogeographic evidence from the clade's extant range. The middle Eocene Anglesea site (Victoria, Australia; paleolatitude 58 degrees S) is the source of a large collection of organically preserved leaf fossils held at the Melbourne Museum. Here, we report an Anglesea leaf with a distinctive character combination, including peltate petiole insertion, cordate base, toothed margin, craspedodromous secondaries, disc-shaped glandular scales, and large sunken stomata (<50 micrometers) with ornate subsidiary cells. After surveying over 6,500 digital herbarium sheets of peltate species from >400 living genera in 40 families, we found close similarities to the fossil only in *Macaranga* species, including *M. amissa* (SE Asia), *M. caladiifolia* (Borneo), and *M. vitiensis* (Fiji). This occurrence of an MMC fossil at sub-polar paleolatitudes of Australia, at great distance from Asia, directly links MMC Eocene and extant distributions and supports Gondwanan origins.

Leaf epidermal cells record the canopy response to changing climate during the late Paleocene to early Eocene in the Bighorn Basin, WY

Morgen, R. C. (Washington College); Milligan, J. N. (Washington College); Burke, L. (Denison University); Barclay, R. S. (National Museum of Natural History); Dunn, R. E. (Natural History Museums of LA County); Wing, S. L. (National Museum of Natural History)

Canopy structure - the openness of the vegetation - is a critical component of ecosystems. Changes in canopy structure can influence the Earth's climate and play a role in ecological interactions. Despite its importance, few studies have looked at canopy structure in deep time. Here, we studied the relationship between canopy structure and climate change during the late Paleocene-Early Eocene (~59-53 Ma) in the Bighorn Basin (BHB), Wyoming. We used a new canopy structure proxy based on leaf epidermal cell morphology to reconstruct leaf area index, a measure of canopy density (LAI; foliage area (m2)/area of ground(m2)). Our preliminary results find a ~65% decrease in LAI from the late Paleocene to the Paleocene-Eocene Thermal Maximum (PETM) hyperthermal (Paleocene, 2.89 m2/m2; PETM, 1.02 m2/m2) and an increase in LAI to 3.92 m2/m2 within the PETM recovery interval. A decrease in LAI during the PETM is coincident with evidence for increased mean annual temperature and increased water stress within the BHB. However, there can be large variations in LAI between sites within a given time interval. Future work will increase sample sizes to determine if trends are related to climate or spatial heterogeneity of the landscape.

Zircon U-Pb Geochronology and Paleofloristic Interpretations of the Maple Falls Member (Chuckanut Formation), Washington, USA

Nares, F. R. (Florida Museum of Natural History, University of Florida); Yasar, I. D. (Department of Geological Sciences, University of Florida), Manchester, S. R. (Florida Museum of Natural History, University of Florida)

The Chuckanut Formation in western Washington, USA, is host to several fossiliferous members reported to span the Paleocene-Eocene epochs. The Maple Falls Member is one of the last remaining members to not be radiometrically dated, leaving its stratigraphic position debated for decades. Leading stratigraphic hypotheses based on lithologic and floristic analyses have placed it in the Late Eocene, with proposed ages ranging from 50-40 Ma and possibly overlapping the Middle Eocene Climatic Optimum (MECO).

Determining its age could clarify its relevance to paleoclimate reconstructions and paleofloristic analyses of the MECO. LA-MC-ICPMS detrital zircon U-Pb geochronologic analysis on sandstones collected from Coal Creek, the type locality of the Maple Falls Member, yielded a youngest zircon population at 82 Ma, with older population peaks at 140 Ma and 180 Ma. Euhedral shapes of the zircons, oscillatory zoning patterns observed on cathodoluminescence images, and Th/U ratios (0.1-0.8) indicate a magmatic origin for these zircons. These ages appear to contrast sharply with index fossils found at this locality, such as Lygodium kaulfussi Heer, previously reported in different Chuckanut Members and other Eocene Formations. We therefore suggest a new stratigraphic hypothesis, integrating both paleofloristic and radiometric evidence.

A New Fossil Fruit from the early-Cretaceous Dakota Formation of Nebraska, USA

Santiesteban, M. (University of Florida); Hamersma, A. (University of Florida); Manchester, S. R. (University of Florida)

Rose Creek is a fossiliferous shale situated on the margin of the Cretaceous Midcontinental Seaway of North America, within the larger Dakota formation where it extends into Jefferson Co. Nebraska. The site has produced abundant plant reproductive material including fruits, seeds, and flowers— one of which is the earliest-known bisexual flower. Taxa described from this site are integral to understanding early angiosperm diversity and evolution. Fossil material was scanned using three-dimensional micro computed-tomography scanning (microCT) at the University of Florida, and reconstructed in VG Studio in order to observe fruit characteristics and determine affinities.

An Investigation of Tropical Angiosperm Genome Sizes from the Albian-Cenomanian Une Formation of Colombia

Smith, B. A. (University of Chicago and Field Museum); Zhang, X. (Wesleyan University), Shi, G. (Nanjing Institute of Geology and Paleontology); Jaramillo, C. (Smithsonian Tropical Research Institute); Carvalho, M. (University of Michigan); Herrera, F. (Field Museum)

Ancestral character estimation suggests that angiosperms downsized their genomes in their early evolutionary history. In angiosperms, genome size and guard cell length generally strongly and positively correlate. However, modern tropical angiosperms generally have smaller genomes than angiosperms from higher latitudes. Genome downsizing benefited angiosperms physiologically and ecologically relative to gymnosperms and ferns, which ancestral character estimation suggests did not downsize their genomes during the Early Cretaceous. However, there are not yet sufficient Early Cretaceous guard cell length data to ground truth ancestral character estimates for Early Cretaceous angiosperm genome sizes and guard cell lengths, especially for tropical angiosperms. We are currently measuring guard cell lengths on abundant angiosperm cuticles from the Albian-Cenomanian Une Formation (Colombia) to infer paleogenome sizes. Ultimately, we hope to infer possible sources of genome size variation (e.g., in relation to Long Terminal Repeat retrotransposons) and whether Early Cretaceous angiosperms had especially small genomes consistent with modern latitudinal trends.