

On a general level, this increase probably reflects greater functional demands on reproductive structures in some lineages, combined with specialization in how these demands are met. But understanding when and how complexity has changed through time, and how that may relate to differences in reproductive function, is challenging because lineages produce disparate reproductive structures that are difficult to compare. We quantify changes in reproductive complexity across plants using two simple aspects that can be applied to any lineage: the total number of parts present in a given structure and how many times these structures are repeated. We score fossil and living genera for eleven characters that tally the sterile and fertile components in reproductive structures and record the degree to which these components are clustered, and we then ask how the number and arrangement of parts has changed over time and across lineages with different reproductive biology and functional demands. We find a rapid rise in complexity to the Pennsylvanian, as many lineages evolved a basic set of structures to support and protect sporangia, followed by a more gradual rise in complexity over the Mesozoic associated with diversification in seed plants, particularly with regards to structures related to pollination syndromes and ovule enclosure. In both seed plants and pteridophytes, reproductive structures that perform more reproductive functional roles tend to have a greater number of parts and a greater number of unique part combinations. These results suggest that shifting the performance of reproductive functions away from sporangia is one of the primary patterns in plant reproductive macroevolution, and the extent to which this process occurs generates the patterns of morphological complexity and disparity that we see across plant lineages.

## Plant community and climatic response to middle Miocene environmental change in the Pacific Northwest (USA)

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The US Pacific Northwest (PNW), including Washington, Oregon, and Idaho, hosts an extensive <sup>①</sup> ~~success~~ of Oligocene–Miocene fossil plant sites, spanning in time across several pronounced environmental perturbations. The Middle Miocene Climatic Optimum (MMCO) was a period of

basalts, the Columbia River Basalts (CRBs), erupted ~95% of its volume in the Pacific Northwest from 16.7 to 15.9 Ma. This collaborative study focuses on 18 PNW fossil sites spanning ca. 32 to 10 Ma, many of which have extensive pre-existing macrofossil collections, studied by paleobotanists such as Chaney, Axelrod, and Wolfe. In re-visiting these earlier works, we will radiometrically date interbedded ashes at these sites to establish a high-resolution temporal framework, using U-Pb CA-ID-TIMS methods which can produce  $\pm 20$  ka resolution. Within this framework, we plan to: 1) better document the regional manifestation of climate change in the PNW during the MMCO and MMCT using paleobotany-based paleoclimate proxies, 2) provide an integrated perspective on the response of plant communities to these middle Miocene environmental changes by combining macrofossil, palynomorph, and phytolith evidence, and 3) shed light on the CRBs' potential role in MMCO warming by producing CO<sub>2</sub> estimates from fossil leaf cuticle. This project will provide a comprehensive and vital example of long-term regional responses to global climatic change and regional volcanism.

### Reconstructing spatio-temporal patterns of vegetation change in the Permian of Gondwana: a model-based palynological approach

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We recently described three new voltzian conifer taxa from the middle Permian South Ash Pasture flora, Texas, based on morphological characteristics of ovuliferous cones (*Pseudovoltzia sapfloreensis*), isolated dwarf shoots (*Wantus acaulis*) and numerous broad, parallel-veined leaves (*Johniphyllum multinerve*). The discovery of these conifers is significant for five reasons. (1) The ovuliferous *P. sapfloreensis* cones are the earliest members of this genus in western Euramerica. (2) The broad, parallel-veined leaves of *J. multinerve* have a macro-morphology that was thus far not known from Paleozoic conifers, but well known from other taxa—including Cordaites. Similar-shaped leaves from early to middle Permian compression floras may thus have been routinely misidentified in the past as non-coniferous. (3) The macro-morphology of *J. multinerve* leaves resemble younger Mesozoic voltzian conifer lineages, however, their epidermal features are comparable with late Permian taxa. (4) All 476 *J. multinerve* specimens were found as isolated, dispersed leaves. When preserved, their swollen leaf bases suggest that they were actively abscised—a functional trait that is unusual in Paleozoic conifers. (5) With five potential sporophylls and 10 intermediate sterile scales, the dwarf shoot *W. acaulis* is unlike those of other late Paleozoic conifers, and may be an early, basal member of a clade that potentially includes Triassic conifers