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Primary Contact:
Brielle Ann Canares, University of Washington
Renton, United States

All Authors:
Brielle Ann Canares, University of Washington **(Primary Presenter)**
Kit Heath, University of Washington
Juan Torres, University of Washington
William Brightly, University of Sheffield
Regan Elizabeth Dunn, Natural History Museums of Los Angeles County
Alexander Lowe, University of Washington
Elena Stiles, University of Washington
Caroline A E Strömberg, University of Washington

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A new North American calibration for predicting canopy structure in deep time using epidermal phytolith morphology

Formatted Title:

A new North American calibration for predicting canopy structure in deep time using epidermal phytolith morphology

Abstract:

Degree of canopy cover is linked to transpiration, carbon cycling and primary productivity of an ecosystem. In modern ecology, canopy structure is often quantified as Leaf Area Index (LAI), which is the amount of overstory leaf coverage relative to ground area. Although a key aspect of vegetation, the degree of canopy cover has proven difficult to reconstruct in deep time. One method, Reconstructed Leaf Area Index (rLAI), was developed to infer canopy structure using the

relationship between non-grass leaf epidermal phytolith (plant biosilica) morphology, and leaf coverage in modern forests. This method leverages the observed correlation between epidermal phytolith size, shape (margin undulation), and light availability. When more light is available in a canopy, epidermal phytoliths tend to be smaller and less undulate, whereas less light availability is linked to larger and more undulate epidermal phytoliths. However, the calibration set used to develop this method was compiled from field sites and samples from localities in Costa Rica and it remains unclear how applicable it is to temperate North American fossil sites due to lack of data from relevant vegetation types and taxonomic differences between plant communities in the Neotropics vs. mid-latitude North America. For example, preliminary results measuring rLAI in phytolith assemblages from the Miocene of the North American Great Plains have yielded surprisingly high degrees of canopy density despite containing high relative abundances of open-habitat grasses. To test whether vegetational and taxonomic differences impact the calibration set, we constructed a new North American calibration using 24 quadrats from six sites, representing reasonable modern analogs for Miocene vegetation in eastern North America. Specifically, we sampled in Bennett Springs State Park in Lebanon, MO; Mark Twain National Forest in Rolla, MO; Tellico in Franklin, NC and Congaree National Park in Hopkins, SC. All sites include a range of canopy covers and vegetation types, from oak savannas and oak woodlands to mixed hardwood forests, pine savannas, and old growth bottomland forests. From each quadrat, we collected a soil sample and took hemispherical photos of the local canopy. From modern soil samples, biosilica was extracted in the lab, yielding phytolith assemblages which were scanned for epidermal phytoliths using a compound microscope. Recovered epidermal phytoliths size and margin undulation were measured and assemblage averages were used to predict measured LAI at each quadrat. Hemispherical photographs were processed using the software Gap Light Analyzer to obtain LAI values. We hypothesize there will be a linear relationship between actual LAI and LAI calculated from epidermal phytolith morphology, but its relationship will differ from that found in South America. Results will be used to reevaluate canopy coverage in sites within the Great Plains Miocene as well as applied to Pacific Northwest Miocene sites, both to understand changes to vegetation during global climatic events in their respective regions.

Video Recording of Presentations:
Yes

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No

Judging Presentations:
No