Session 2F

Plant Form and Function: from Molecules to Fossils

Session Moderator: Caroline Stromberg, Biology
MGH 242
3:30 PM to 5:15 PM
* Note: Titles in order of presentation.

Testing the Utility of Plant Silica for Interpreting Ancient Palm Ecology and Taxonomy

Claire Grant, Senior, Biology (Ecology, Evolution & Conservation)
UW Honors Program
Mentor: Caroline Stromberg, Biology

Palms are a keystone species in tropical rainforests and are thought of as a model species due to their abundance and taxonomic diversity. Because over 90% of palm species diversity is concentrated in the tropical and subtropical biomes today, palm fossils are traditionally interpreted as indicators of warm and wet climate. However, recent work suggests that, in the past, palms may have played an important role also in other biomes. Palms produce great amounts of phytoliths (hardened silica bodies precipitated in and around plant cells), which, after the plant dies, are incorporated into the soil or sediment and preserved as fossils. Importantly, phytoliths are found in many environments where leaf impressions and other macrofossil are typically absent. Palm phytoliths are therefore a valuable potential source of information to reconstruct phylogenetic relationships and interpret the ecology of fossil palms and, by inference, paleoenvironments.Unfortunately, very little work has been done to comprehensively assess how much information about palm taxonomy and ecology can be inferred by palm phytolith morphology. To remedy this, we are conducting a morphometric study of palm phytoliths across the palm phylogenetic tree. We collected leaf samples from 80 palm taxa from herbaria and botanical gardens, then extracted phytoliths using strong oxidants and acids to decompose organic materials. Through measurement of their overall shape and size, as well as the density, size, and shape of phytolith ornamentation we hope to improve overall taxonomic resolution of the palm fossil record. In addition, for each of the taxa we recorded several habitat, climate, and ecology variables to test for biogeographical and ecological signal in palm phytolith morphology.

Poster Session 3

Commons East, Easel 70
2:30 PM to 4:00 PM

Using 3D Phytoliths to Reconstruct the Biogeographical History of the "Cool Season" Grasses (Pooideae, Poaceae)

Kari Christine Jessett, Senior, Biology (Plant)
Callie Mireille Zender, Junior, Biology (Plant)
Mentor: Timothy Gallaher, Biology
Mentor: Caroline Stromberg, Biology

Pooideae is the largest grass subfamily, comprising over one third of all grass species. Pooid grasses are dominant in C3 grasslands which were once more widespread, but today are restricted to temperate or high elevation areas. During the last 8 million years, many C3 Pooideae were replaced by C4 grasses as regional climates became hotter and drier at low- to mid latitudes, or by forests when local conditions became wetter. Understanding when and where C3 grasslands first formed and when they were replaced by tropical C4 grasslands or forests is important for reconstructing global ecosystems and tracking climate change through time. Since grass macrofossils are rare, microfossils, particularly phytoliths (solid silica particles formed in plant tissue), which can persist in soils for millions of years, are the best paleontological evidence for the presence and abundance of different grasses through time. Grass phytoliths form highly regular shapes which may be specific to clades at low taxonomic levels; however, phytolith shape variation in Pooideae has not been analysed using quantitative methods. To better understand differences in shape within the subfamily, we extracted phytoliths from 36 representative Pooideae species. The phytoliths were imaged using confocal microscopy, and processed into 3D surface meshes for geometric morphometric analysis. We used the meshes as a reference collection to compare similarly processed fossil phytoliths from paleontological sites. Our goal was to use quantitative methods to confirm that the fossil phytoliths were correctly assigned to Pooideae and then to classify the phytoliths to lower taxonomic levels when possible. We used these results to infer a new time sequence for Pooideae evolution. In the future, this reference collection could be used to study domestication and spread of agriculturally important species in the subfamily (e.g., wheat, rye and oats).

POSTER SESSION 4

Commons West, Easel 17

4:00 PM to 6:00 PM

Peptide-Enabled Fluorescent *in situ* Identification of Phytoliths in Contemporary Plants

Gwendolyn Joanna (Gwen) Xiao, Junior, Pre-Sciences
Mentor: Mehmet Sarikaya, Materials Science & Engineering
Mentor: Deniz Tanil Yucesoy, Materials Science and Engineering
Mentor: Caroline Stromberg, Biology

Phytoliths are microscopic silica bodies that form in many plants. Being resistant to organic decomposition, they can be used to track plant evolution and past vegetation changes. Although they were traditionally considered as non-functional cellular by-products, recent studies suggest that phytoliths may have photonic, structural, nutritional and defensive benefits in plant growth and survival. Grasses, which are large terrestrial producers of biogenic silica, are the suitable model system for studying the adaptive significance of silica accumulation in plants. Identification of phytoliths within the plants (for studying function) and inside the sediments (for studying evolution of vegetation) have so far been limited to optical microscopy-based methods where fluorescent dyes are commonly used to increase contrast between silica bodies and plant tissue. Due to their non-specific nature, however, fluorescent dyes often accumulate in different parts of the cells and silicified tissues, causing false positives and leading to incomplete staining and difficulties to construct 3D structures. With exquisite molecular recognition and assembly properties, solid-binding peptide tags (dubbed GEPIs) are surface functionalization moieties that can be chimerized with fluorescent and utilized as material-specific probes to selectively label variety of inorganic materials at surfaces and within interfaces. Our goal is to develop peptide-based phytolith-specific fluorescent probes to identify and delineate phytolith shapes with high precision and *in situ*. Using phytoliths-specific peptides probes, designed and chimerized with fluorescent molecules, our goal is to incubate different grass species, and visualize them using laser-confocal microscopy. We hypothesize that the novel molecular construct enable specific detection of phytoliths *in situ*. The method we are developing will offer a unique solution for fast and accurate identification and 3D organization of inorganic nano- and micro-structures in tissues from living plants and in paleontological samples.