Poster Session 1

Commons East, Easel 59

12:00 PM to 1:30 PM

The Effects of Light on Grass Epidermal Cell Shape

Thien Y Thi Le, Senior, Biology (Plant), Mathematics
Howard Hughes Scholar, Undergraduate Research Conference Travel Awardee
Mentor: Caroline Stromberg, Biology
Mentor: Regan Dunn, Biology

Phytoliths, microscopic plant silica bodies, inform us about the types of plants that remain in the fossil record, allowing for reconstruction of past flora, climate, and ecosystems. The existing method for reconstructing vegetative structure and habitat type (open vs. closed) using phytoliths depends on the presence of presumed open-habitat grass types. This method may not be able to reliably reconstruct vegetation type when open-habitat grass phytoliths are absent, and depends on the assumption that open-habitat grasses have always been restricted to open environments. Therefore, a taxon-free, morphological approach may be more informative for inferring habitat openness using fossil phytolith assemblages. This study looks at the effects of light variation on epidermal cell shapes in modern grasses as a first step in creating a proxy for determining habitat type from the fossil record. Based on patterns observed in dicotyledonous plants, we hypothesize that epidermal grass cells will be more undulated when grown in reduced lighting condition. To test this, five species of grasses were grown in varying light treatments (20%, 60%, 100% (control), and 120% relative to the control). We took morphometric measurements of long and short cell types from epidermal peels and calculated their degree of undulation (UI). Results show three species where long cells had higher UI in deep shade (20% light) than in enhanced light (120% light), though the relationship is non-linear. With short cells only one species displayed a continuous increase in UI as light levels decreased. Thus, data from long cells show the greatest promise for use in the fossil record. To further test this method for paleoecological work, the UI of epidermal cells in soil phytolith assemblages from known modern habitat types will also need to be examined to see whether this UI and light correlation persists under natural growth conditions.

Poster Session 1

Commons East, Easel 61

12:00 PM to 1:30 PM

Making a CD2-mCherry Construct to Visualize Tube Formation in Follicle Cells of the *Drosophila melanogaster* Egg Chamber

Elaine Lai, Senior, Biochemistry, Microbiology
Mentor: Celeste Berg, Genome Sciences
Mentor: Ariel Altaras (stariel@uw.edu)

Tube formation in the fruit fly (*Drosophila melanogaster*) egg chamber is an excellent model for vertebrate neural tube formation, as they closely resemble each other. During egg chamber development, a subset of cells, the roof cells and the floor cells, form two tubes that make eggshell structures called dorsal appendages (DAs). Roof cells, which express the protein Broad, constrict their apices (inner surfaces) to curve up and out of the epithelium. The floor cells elongate, dive under the roof cells, and zipper together to seal the floor; they are distinguished by expression of the protein Rhomboid. Defects in this process, especially in floor closure, create open tubes, similar to *spina bifida*. To observe cell movement in the developing egg chamber, we want to outline the shapes of cells with a fluorescent molecule. mCherry is a red fluorescent protein that has good fluorescence and a short maturation time (15 minutes), so we can observe the rapid process of tube formation. If one links the *CD2* gene, which encodes a cell membrane adhesion protein, to the *mCherry* gene, red fluorescence will appear all around the cell surfaces. Such a fusion protein lets us observe changes in cell shape and cell movements during tube formation. When the *CD2-mCherry* segment is connected to the regulatory region for the *rhomboid* gene, fluorescence occurs in just the floor cells. I have created a *rhomboid-CD2-mCherry* construct that I will introduce into flies through injection with a recombinase that will integrate the construct into the fly genome. With this construct I can visualize DA tube development live by observing fluorescence in the floor cells. Analysis of these cells can give insight into conserved tube-forming processes.

Poster Session 1

Commons East, Easel 60

12:00 PM to 1:30 PM

Vegetation Reconstruction of Southwest Montana During the Miocene Using Phytolith Analysis
Kimberly Johanna (Kim) Smith, Junior, Earth & Space Sciences
Mentor: Caroline Stromberg, Biology

The Middle-Miocene Climatic Optimum (MMCO) was a period of rapid warming that occurred 15 million years ago. The climate change likely affected plant community composition as grasses spread across North America, but because of the scarcity of plant macrofossils from the MMCO in North America, the response of vegetation in the area to this climate change is poorly understood. Many modern crops are C3 and C4 grasses (distinguished by their photosynthetic pathway), and thus, gained understanding of the response of forest vs. C3 and C4 grasslands in deep time may help us predict the possible response of modern plants to our changing climate. Plant silica microfossils (phytoliths) are abundant in fossil soil layers however, and can be used to reconstruct the biotic response to the warming event. Polled Herefords is a site in southwest Montana that has easily accessed fossil soil layers from the MMCO that are phytolith rich. Phytolith assemblages from previously collected samples are currently being analyzed. Preliminary results show on average 2/3 – 3/4 of the phytolith assemblage in a given sample is grass silica short cells, diagnostic of grasses. The remainder of the sample is made up phytoliths indicating palms, monocotyledons, dicotyledons, conifers, and other non-grass types of plant. This suggests a fairly open habitat, and a high abundance of C3 grasses within the grass indicators indicate a climate that was warm and wet. More samples will be collected to increase the spatial and temporal resolution of the study, and to help determine if changes in vegetation reflect spatial or temporal variability, or both.

Poster Session 1

Commons East, Easel 58

12:00 PM to 1:30 PM

Phytolith Record of Deep-Time Vegetation Dynamics: Late-Middle Miocene of Vasa Park, Washington
Anthony Patrick (Tony) Jijina, Senior, Biology (Plant)
Howard Hughes Scholar, Mary Gates Scholar
Mentor: Caroline Stromberg, Biology

The Middle-Late Miocene (˜11 million years ago) was a period of cooling following the Middle Miocene Climatic Optimum, the warmest period in the last 35 million years. However, because of the scarcity of fossil floras of that age, our understanding of vegetation response to this climate change is poor. The Middle-Late Miocene fossil flora from Vasa Park therefore adds invaluable information that allow us to better reconstruct how the vegetation and climate has changed over time in the Pacific Northwest. Previous work on the Middle-Late Miocene in this region has focused on macrofossils and pollen/spores; this study will add information about phytolith assemblages. Phytoliths form when silica from the ground is deposited within and around various types of plant cells. When the plant dies, the phytoliths from the plant gets preserved in sediment, retaining the shapes they had in the living plant. Our understanding of phytolith production in modern day plants and their climate preferences allows us to infer, from fossil phytoliths not just what kinds of plants they represent, but also something about the climate at that site. Specifically, Vasa Park will help us understand the flora of the Middle-Late Miocene in the Pacific Northwest and how it transitioned out of a very warm time into cooler current day temperatures. Based on our knowledge of the general climate during the Middle-Late Miocene, the Vasa Park assemblage should contain evidence of a more warm-adapted flora than what we see currently in the region. Indeed, preliminary evidence from phytoliths, macrofossils (leaves and flowers), and fossil palynomorphs (plant spores and pollen) indicate that the area was a relatively warm subtropical forest. The inclusion of the Vasa Park phytolith assemblage greatly adds to our understanding of Earth's most recent warming period and helps us infer how vegetation will change with current warming trends.

Poster Session 1

Balcony, Easel 116

12:00 PM to 1:30 PM

Quorum Sensing in *Burkholderia thailandensis*
Thao Truong, Senior, Microbiology, Biochemistry
Mentor: E Peter Greenberg, Microbiology
Mentor: Josephine Chandler, Microbiology

Quorum sensing is cell density-dependent communication that regulates many functions in bacteria. Signal synthases (I) produce acyl-homoserine lactones, which diffuse into the environment and activate signal receptors (R) when they reach a critical concentration. Synthases and receptors often form cognate pairs. The soil bacterium *Burkholderiathailandensis* encodes three I-R pairs. The I-R1 system controls cell-cell aggregation and activates many putative aggregation factors including the bce genes that likely encode an exopolysaccharide. The I-R2 system controls antibiotic production. The antibiotics are members of the bactobolin family and are effective against both Gram-positive and Gram-negative bacteria. Both aggregation and antibiotics are believed to promote competitiveness in the diverse soil communities where *B. thailandensis* is found. We have developed genetic screens to learn more about quorum-controlled antibiotics and aggregation in *B. thailandensis*. The first screen identified bactobolin-resistant isolates of the soil bacterium *Bacillissubtilis*, which is normally sensitive to bactobolin. We submitted these mutants for whole genome sequencing to investigate the mutations that confer resistance, and with our results we hope to gain insight into how bactobolin acts on target cells. The second screen was designed to isolate variants that overproduce aggregation factors. Quorum sensing mutants do not wrinkle but variants arise that produce aggregation factors by other means. We are isolating such variants and identifying the underlying mutations to understand how they compensate for the loss of quorum sensing regulation. This may reveal the elements involved in regulating aggregation. These variants will also be useful to learn about the advantages of aggregation in different contexts. Through our two screens we hope to better understand quorum-controlled aggregation and antibiotic phenotypes. Our findings will be useful in further studies of the importance of each of these in competition.

POSTER SESSION 2

Commons West, Easel 22

2:00 PM to 3:30 PM

Work Towards Complexes of Rhodium and Iridium for C-H Activation

Alex Colton (Alex) Mac Rae, Senior, Chemistry (ACS Certified)
NASA Space Grant Scholar, Undergraduate Research Conference Travel Awardee
Mentor: Karen Goldberg, Chemistry
Mentor: Kate Allen, Chemistry

The selective activation and functionalization of the C-H bonds of arenes and alkanes would directly yield products that are of importance to industry. Late transition metal complexes have shown great promise in the selective activation of C-H bonds. Coordinated acetate has also been shown to facilitate thermolytic C-H activation by electrophilic metal centers. The results of our studies concerning the reactivity of high valent tridentate rhodium and iridium bis-acetate complexes with unactivated arenes and alkanes will be presented. Specifically, the reactions of the complexes (NCN)Ir$(OAc)_2(H_2O)$ (1) and (NOCON)M$(OAc)_2(H_2O)$ (2; M= Rh, Ir) under a variety of conditions will be discussed. Novel complex 2 was synthesized in 65% yield and characterized using 1H and 13C NMR spectroscopy and X-ray crystallography.

SESSION 2D

PLASTICS TO PLANTS TO TEETH: READING EARTH'S HISTORY

Session Moderator: Caroline Stromberg, Biology

Mary Gates Hall 238

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Ecological Reconstruction of the Great Plains Region During the Late Oligocene

Erik K Fredrickson, Senior, Earth & Space Sciences (Physics), Physics
Mary Gates Scholar
Mentor: Caroline Stromberg, Biology

Many plants, as part of their growth process, accumulate groundwater-derived silica that is deposited into inter- and intracellular spaces, forming what are known as phytoliths. Due to a combination of preservational and diagnostic characteristics, phytoliths found in the fossil record serve as a powerful paleontological tool for the reconstruction of past environments and climates. For this study, rock samples containing phytoliths were collected from a site called Everson Creek in southwest Montana, once part of the Great Plains region of the United States, which spans in age from 25.3 to 24.5 million years and corresponds to an interval of warming worldwide. The samples have been processed for phytoliths using heavy liquid flotation, whereby silica bodies are separated from other material by means of their unique density. Currently, the phytoliths are in the process of being counted and divided into various diagnostic groups according to morphology. The results of these counts, when viewed in temporal order throughout the site, will shed light on the floral and climatic history of the region based on the prominent plant groups and their growth preferences. This research, which covers a time interval previously unstudied for phytoliths aims to clarify the timing of the rise to dominance of open-habitat grasses in the region, a subject that is currently disputed in the literature. The spread of grasslands is an important event in plant history because it represents the development of open habitats and is intimately linked to the expansion and evolution of various other biota. Since grasses are large producers of highly diagnostic phytoliths, any change in their ecological role will easily be seen in this study.

SESSION 2D

PLASTICS TO PLANTS TO TEETH: READING EARTH'S HISTORY

Session Moderator: Caroline Stromberg, Biology

Mary Gates Hall 238

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Climatic Influences on Leaf Shape in Early Vascular Plants

Jeffrey (Jeff) Benca, Senior, Biology (Plant)
Levinson Emerging Scholar
Mentor: Caroline Stromberg, Biology

Understanding modern climate changes hinges upon our ability to assess past climates. While relatively few analogs to present climatic shifts are represented in recent geological history, the Paleozoic Era (542-251 Ma) may offer more. Investigating such transitions in the more distant past though will require expansion of existing techniques. Several methods use fossil leaf morphology to infer past climatic conditions. One such approach, DiLP (Digital Leaf Physiognomy Approach) uses leaf margin serration (toothiness) and leaf shape to infer past mean annual temperature. This technique has proven successful in using modern plant communities to estimate regional climates but can only assess past temperatures as far back as 120 Ma since it currently only utilizes leaves of recently-evolved flowering plants. However, other, more ancient groups of vascular plants have also evolved leaves with toothed margins. With toothed leaves and a fossil record exceeding 350Ma, lycopsids (clubmosses and allies) and ferns have potential to extend paleotemperature assessments back to the Late Paleozoic. To determine whether climate (in particular, temperature) influences leaf shape in living representatives of these lineages, three species of lycopsid (Lycopodium clavatum, Lycopodiella alopecuroides, and L. appressa) and two species of fern (Polystichum munitum and Blechnum brasiliense) were cultivated in a growth chamber under two temperature regimes: 15C and 25C, each trial lasting five months. Several leaves were selected from each specimen, laminated on overhead transparencies, and scanned for digital measures using a modified DiLP measuring protocol. While quantitative leaf measurements remain ongoing, preliminary qualitative assessment has shown that lycopsids radically change their growth habit when grown under different temperature regimes. If leaf margin toothiness or shape changes significantly in the leaves of these plants in response to temperature, fossil representatives of these ancient lineages could potentially be implemented to better assess climatic changes long-preceding the age of flowering plants.

SESSION 2E

MODELS, MAPS AND THE MAKING OF GLOBAL HEALTH

Session Moderator: Matthew Sparke, Geography
Mary Gates Hall 242
3:30 PM to 5:00 PM
* Note: Titles in order of presentation.

Modeling the Human Ecosystem

Mollie Holmberg, Junior, Biology (Ecology, Evolution & Conservation), Mathematics
Mentor: Luke Bergmann, Department of Geography

The magnitude of trade in food within an increasingly globalized world has contributed to a situation where the populations that produce food often do not receive the ultimate benefits of their labor. For example, food production in one place might primarily support the production of manufactured goods and services that benefit people in distant places. The degree to which agriculture in a certain region supports economic activities abroad varies enormously across the globe. This study aims to understand how food production supports flows within the global economic system and contributes to unequal relationships between different regions of the world. To do this, global economic flows are modeled by entering production and consumption data into an interregional Social Accounting Model and analyzed within a geographic information system. From this, we have been able to identify the most important globalized croplands and categorize regions by the "function" they serve in global webs of production and consumption similar to an ecological trophic level analysis. These results suggest that uneven flows of embodied food production between regions may be related to global patterns of poverty and health, as well as to the prospects for a more sustainable human ecosystem.

SESSION 2J

SURFACES, INTERFACES, AND SOLAR CELLS

Session Moderator: Cody Schlenker, Chemistry
Mary Gates Hall 271
3:30 PM to 5:00 PM
* Note: Titles in order of presentation.

The Effect of Silane Treatments on the Surface Properties of Silica

David S (David) Bergsman, Senior, Chemical Engineering
Mary Gates Scholar, NASA Space Grant Scholar
Mentor: John Berg, Chemical Engineering

A growing number of applications seek to use electrostatic effects in non-polar media. However, the science behind particle charging in such systems is not fully understood. Previous work has suggested that the presence of surface hydroxyl groups, when combined with certain surfactants, can induce charging on particles. These surfactants also serve to prevent particle aggregation through steric stabilization. However, dispersing these particles typically requires extended sonication or some other dispersive technique. One possible solution for decreasing the dispersion time is to first hydrophobically surface-treat the particles. Unfortunately, this process has the potential to remove the hydroxyl groups necessary for particle charging. Therefore, our group has investigated the effects of surface modification on particle hydrophobicity and chargeability. Silica particles on the micron and submicron scale were surface treated with tri-methoxy(octyl)silane and methoxy(dimethyl)octylsilane in order to create hydrophobic silica particles with varying amounts of hydroxide groups on their surfaces. The resulting surface energy and acid/base characteristics of these particles were then tested using Inverse Gas Chromatography, with the intent of comparing these properties to the particles' chargeability. This was assessed by measuring their electrophoretic mobilities using a Zeta Potential Analyzer. Our results indicated that particles could both be made hydrophobic and chargeable after surface treatments. However, further investigation is required in order to better understand the mechanism behind this charging. If the surface modification of these particles can preserve their chargeability while adding a steric barrier, this process could be used to reduce dispersion time for charged particles in non-polar media.

SESSION 2M

MODERN QUANTITATIVE METHODS FOR REAL WORLD PROBLEMS

Session Moderator: J. Nathan Kutz, Applied Mathematics

Mary Gates Hall 288

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

The Ihara Zeta Function on Graphs

Elizabeth Landicho (Elizabeth) Wicks, Senior, Mathematics (Comprehensive), Physics
Mary Gates Scholar
Mentor: Ralph Greenberg, Mathematics

The Ihara Zeta Function (IZF) of a finite graph encodes its spectral, combinatorial and number theoretic properties. Our aim is to calculate the IZF of the Cayley graph of the modular group PSL(2,Z), which can be thought of as a special group of square matrices. Since this group plays a central role in number theory and other areas of mathematics and physics, we hypothesize that the zeta function will reflect important information about modular forms and elliptic curves. Our previous research has yielded an algorithm that computes the IZF of a sequence of finite approximations of this group, but it does not give the IZF of the entire graph. The IZF can be expressed as a product of L-functions, which encode how successive graphs in the sequence are related. Our ultimate aim is to use the L-functions of the finite approximations to compute the IZF of the modular group. We are currently exploring L-functions of simpler Cayley graphs, in the hope that the methods can be generalized to calculate the IZF of PSL(2,Z).

POSTER SESSION 3

MGH 241, Easel 135

4:00 PM to 5:30 PM

Mechanisms of Tubular Organ Formation: Inducing a Deletion within the Fly Gene *Tiggrin* to See its Effect on Organ Formation in Oogenesis

Tanya Rio (Tanya) Dodgen, Senior, International Studies: Latin America, Biology (General)
Mentor: Celeste Berg, Genome Sciences
Mentor: Robert Matlock, Genome Sciences

Understanding the genetic and molecular mechanisms behind development is necessary for identifying and treating genetic disorders. A key developmental process is tube formation (tubulogenesis), which produces structures such as the vascular system, bronchi, and the embryonic neural tube. Our lab uses the model organism *Drosophila melanogaster*, a fruit fly, to study the formation of a tubular organ called the dorsal appendage (DA). Two DA tubes form during oogenesis, creating extensions of the eggshell used for gas exchange once the egg is laid. DA formation resembles neural tube formation in vertebrates. To understand the molecular mechanisms that underlie DA formation, we disrupt specific genes and proteins and then analyze how their loss affects DA formation. This project focuses on tiggrin, a gene that encodes an extracellular matrix protein that interacts with cell surface receptors to shape tissues. A previous genetic screen identified tiggrin as a potential regulator of DA formation. To understand tiggrin's role, we have made 24 potential deletions of the tiggrin gene by excising a P-element transposon just upstream of tiggrin. We are using the polymerase chain reaction (PCR) to determine if we have produced any actual deletions of or within tiggrin. Once we determine which lines contain deletions, we will analyze their effect on DA formation. We are breeding lines with potential tiggrin deletions to determine if they are homozygous viable or fertile. We are crossing any lines that do not result in adult tig/tig individuals to a previously established line with a large deletion that removes tiggrin (and neighboring genes) to see if the resulting flies are viable and fertile. Also, we will determine the spatial and temporal expression of tiggrin protein during oogenesis using immunostaining. Adding tiggrin to our study of DA formation will broaden our holistic understanding of the molecular mechanisms of tubulogenesis.