Online Proceedings

SESSION 1L

QUANTIFYING THE EFFECTS OF HUMANS ON THE ENVIRONMENT

Session Moderator: Bonnie Becker, Academic Affairs (Tacoma)

271 MGH

1:15 PM to 2:45 PM

* Note: Titles in order of presentation.

The Limits of Federal Regulatory Authority over Agricultural Land Use Are Drawn by the Distinction of Nonpoint Source Water Pollution in the Clean Water Act

Robert Stewart Marsh, Senior, Environmental Studies
Mentor: Gregory Hicks, School of Law

The Clean Water Act (CWA) divides water pollution into two categories based on source: point sources (discernible end of pipe discharges), or nonpoint sources (diffuse runoff including agricultural nutrients/sediments). But federal regulatory provisions for the enforcement of water pollution control are made only for the point source pollutants. The primary reason for the resulting voluntary basis of federal nonpoint source pollution laws is the inherent land use controls required to regulate landowner practice. Authority to regulate land use is traditionally left to State governments in the American federalist division of powers, and consequently nonpoint source pollution control has also been delegated to State authority in the CWA. The federal government only addresses nonpoint water pollution through planning provisions which incentivize State programs and landowner compliance with federal funds. The CWA can be used as a case study for the statutory limits of federal authority to regulate land use in order to reveal the political culture driving this federalist division which preserves agricultural landowner property rights. Furthermore, an internship at the Environmental Protection Agency (EPA) provided unique insight into the consequent regulatory limitations of the nonpoint source distinction, but also into the internal regulatory culture which mirrored the same federalist land regulation issue, highlighting similar underlying cultural choices. At the EPA there is still some discretion for State program funding along a spectrum of regulatory or assistive approaches to agricultural environmental policy. Therefore, the federalist boundaries for nonpoint pollution control can be compared in statute (CWA) and administrative practice (EPA) to juxtapose the cultural drivers for policy. Both cases reflect an established political culture of property rights that is sacred in the history of federal agricultural policy.

SESSION 2J

INFECTIOUS DISEASES

Session Moderator: James Mullins, Microbiology

254 MGH

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

Drug Screening for Malaria Yields Securinine-Related Compounds that Activate *Plasmodium falciparum* dUTPase

Jack Mo, Senior, Biochemistry
Mentor: Gregory Crowther, Medicine
Mentor: Wes Van Voorhis, School of Medicine

Malaria is a prominent parasitic disease that afflicts 300 to 500 million people and results in 1 to 2 million deaths each year, approximately 90% of which are young children under the age of 5 and pregnant women in sub-Saharan Africa. New therapeutic compounds for treating malaria are urgently needed due to the emergence of multidrug-resistant parasites including *Plasmodium falciparum*, the most fatal Malaria causing species that infects humans. A mass spectrometry-based screening of a natural product library yielded seven securinine-based compounds that were determined to bind to *Plasmodium falciparum* 2'-deoxyuridine 5'-triphosphate nucleotidohydrolase (*Pf*dUTPase). This enzyme catalyzes the formation of deoxyuridine monophosphate (dUMP) from deoxyuridine triphosphate (dUTP) which has important implications on DNA replication and thus makes dUTPase a good target enzyme for drug discovery. These seven compounds were tested using a standard biochemical assay and enzyme activity was measured through the detection of pyrophosphate, a product of the catalyzed reaction. Detection was done with two independent detection kits: indirectly through the detection of inorganic phosphate (pyrophosphatase and Malachite Green Kit) or directly through the detection of pyrophosphate (PPiLight Kit). In most drug screens, the goal is to discover possible drug-like molecules that inhibit the target enzyme, however, these securinine compounds were actually

found to increase *Pf*dUTPase activity. While it is unusual to pursue compounds that do not inhibit target enzymes, these compounds might still prove to be possible drug candidates by over activating *Pf*dUTPase and killing the parasite in this manner. Whether this is a viable method of utilizing these compounds remains to be tested.

SESSION 2R

EVOLVING SYSTEMS IN BIOLOGY: FROM MOLECULES TO MARSUPIALS

Session Moderator: Billie J. Swalla, Biology

022 JHN

3:45 PM to 5:15 PM

* Note: Titles in order of presentation.

Convergent Evolution of Blade-Like Teeth in Mammals

Abby Renee Vander Linden, Senior, Biology (Ecology, Evolution & Conservation)
Mentor: Gregory Wilson Mantilla, Biology

In evolutionary history, distantly related taxa have often independently evolved the same or similar complex structure as a solution to a common problem presented by their environment. One such example is the plagiaulacoid tooth—a laterally compressed shearing blade that convergently evolved in four clades of mammals, some extant and others extinct. To better understand the selective forces that led to the convergent evolution of this specialized trait in multiple lineages, I investigated how this tooth form correlates with diet in a sample of extant taxa. Specifically, I measured complexity of lower cheek tooth rows of 15 species from five families of extant marsupials with plagiaulacoid teeth. To quantify dental complexity I created digital 3-D models from microCT scans of these specimens and used GIS software to generate orientation maps of the tooth surfaces. Contiguous pixels with the same orientation are considered a patch on the tooth surface, and the number of patches approximates the number of shearing surfaces available to mechanically process food. Previous studies of placental mammals have shown that increases in Orientation Patch Count(OPC) (i.e., increases in tooth surface complexity) correlate with increased consumption of plant material. However, I found no correlation between OPC value and diet as recorded in the literature for these taxa. I then compared complexity of the blade to complexity of the molars to investigate the functional contribution of the plagiaulacoid tooth and again found no correlation with diet. Broader sampling will help determine the pattern of tooth complexity and diet in marsupials, but the range of OPC values generated in this study suggests that the convergent evolution of the plagiaulacoid phenotype is not a simple case of one morphological adaptation to a particular environmental problem.

POSTER SESSION 3

Balcony, Easel 104

2:30 PM to 4:00 PM

Foliar Uptake of Toxic Metals and Stress Responses of Pine Seedlings from Biosolids-Treated Sites at Pack Forest, WA

Jennifer Lynn (Jen) Vittetoe, Senior, Environmental Science, UW Tacoma
Mentor: Erica Cline, Sciences and Mathematics, Interdisciplinary Arts & Sciences
Mentor: Jim Gawel, Environmental Science, University of Washington Tacoma
Mentor: Gregory Ettl, Forest Resources

Biosolids applications can increase heavy metals in soils, which may impact seedling survival in managed forests. Western white pine (*Pinus monticola*) seedlings, planted in a biosolids-treated site at Pack Forest in the lower foothills of the Washington Cascades, have experienced heavy mortality which has prevented reforestation of the site even after 30 years of replanting. The purpose of this study was to determine whether these seedlings are exhibiting metals stress. Soil and foliar metal content was measured using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Phytochelatins and glutathione, compounds that are induced by metals stress and serve as bioindicators of metals stress, were measured in freshly emerged needles using high performance liquid chromatography (HPLC). Soil metals, at 16 ppm for cadmium, 293.5 ppm for copper, 585 ppm for zinc, and 509.5 ppm for lead, were substantially elevated at this site compared to comparable untreated sites, and furthermore, these were significantly higher than at other biosolids-treated sites. Foliar cadmium was 2.6 ppm, copper was 10 ppm, zinc was 177 ppm, and lead was undetectable; of these, all but lead was significantly elevated in seedlings growing in the biosolids-treated site compared to control seedlings. While phytochelatins and glutathione measurements are not yet complete, based on preliminary results it appears that seedlings are producing elevated levels of these compounds. The elevated foliar metals, in particular the highly toxic cadmium, suggest that these seedlings are experiencing metals stress. Further analysis of phytochelatins levels in seedlings in this biosolids-treated site may help to explain why these seedlings are experiencing such high mortality rates.

POSTER SESSION 4

Commons East, Easel 78

4:15 PM to 5:45 PM

Variation in the Shape of the Molars of Modern Gophers as a Basis for Differentiating Taxa in the Fossil Record: A Geometric Morphometrics Investigation

Jennifer W Glusman, Senior, Biology (Physiology)
Mentor: Gregory Wilson Mantilla, Biology
Mentor: Jonathan Calede, Department of Biology

The late Oligocene-early Miocene fossil record (30-18.8 million years ago) of North America includes an abundant fauna of entoptychine gophers (Rodentia: Geomyidae: Entoptychinae). These burrowers make up as much as 20% of the mammalian individuals of the faunas they are part of, and can be involved in habitat partitioning or competition with other burrowing herbivores. The wide geographic range of these animals and their use in constraining the age of the fossil assemblages of the Cabbage Patch beds (western Montana) and John Day Formation (eastern Oregon) makes them critical to understanding the biogeographic relationships among these fossil faunas. To understand these spatiotemporal patterns, I am evaluating the taxonomic richness of entoptychine gophers. Previous studies have discriminated among these gopher species by using morphological features of skulls and dentaries. However, anatomical elements are rarely preserved in fossil assemblages, and isolated teeth are commonly the only material available for identification. Since the occlusal surfaces of the cheek teeth are usually worn down as a consequence of feeding, they lack discrete features for species identification. Instead, some researchers have hypothesized that the more continuous variation in the enamel outline of select cheek teeth could be used for discrimination. Here, I use semi landmark-based geometric morphometrics (an arithmetical comparison of geometric coordinates) on the upper last premolar and molar. Applying this method to 98 modern geomyine gopher specimens (Geomyidae: Geomyinae), representing 10 taxa, helps quantify intra- and interspecific tooth shape variation and offers guidelines for recognizing fossil gopher species. Preliminary analyses indicate that tooth shape is species-specific in modern gophers, supporting the use of this method to differentiate fossil gopher taxa. Applied to 96 specimens of fossil gophers, I found a strong overlap of fossil taxa in the morphospace, suggesting that previous researchers may have overestimated the species diversity of some fossil gophers.