UNIVERSITY of WASHINGTON

Undergraduate Research Symposium May 18, 2012 Mary Gates Hall

Online Proceedings

POSTER SESSION 1

MGH 241, Easel 159

12:00 PM to 1:30 PM

Analyzing Metabolic Reactions of Microbial Communities of Various Prairie Restoration Plots

Korena K (Korena) Mafune, Junior, Environmental Science & Resource Management (Restoration Ecology & Environmental Horticulture)
Mentor: Jonathan Bakker, Environmental and Forest Sciences
Mentor: Rachel Mitchell

Washington State is home to unique prairie ecosystems that have been invaded and degraded over the last several decades. A habitat restoration study is underway at 4 research sites in Western Washington. Areas at each site were prepared with solarization, burning, or herbicide, and plots were seeded with a diverse mixture of native species following site preparation. I am researching the effect of these treatments on the physiological profile of soil microbial communities and on available nitrogen (N) mineralization. Soil samples were collected from 5 locations at each site: the site preparation treatments, an unseeded herbicide area, and an untreated area. The samples were either inoculated into a Biolog EcoPlateTM containing 31 carbon sources and 3 water well controls, or used to extract a KCl solution for N mineralization amounts. The wells of the EcoPlatesTM contain tetrazolium, which changes color in response to microbial activity. The color development was recorded when plates were first inoculated using a micro-plate reader at a wavelength of 590nm, and were then incubated for 24 hours. Readings were then taken every 12 hours for 96 hours. The normalized data are analyzed using PCA and PERMANOVA.N Mineralization rates are obtained by subtracting the results of time 0 from time 1. PVC tubes were inserted into the 5 treatment plots on day 1 and removed to collect samples for mineralization. To obtain the second sample PVC tubes were left in the 5 treatments plots and collected after 40 days. Samples were mixed with a 2M KCl solution to extract NO3 and NH4 amounts. The resulting amounts of NO3 and NO4 from day 1 will be subtracted from day 40 to obtain mineralization rates. This research is important to the larger restoration project because it is examining how strongly the restoration treatments affect the soil microbial community.

POSTER SESSION 1

Commons East, Easel 62

12:00 PM to 1:30 PM

Psychological Predictors of Male Smokeless Tobacco Use Acquisition and Cessation: A 15-Year Longitudinal Study

Leela Rebecca Holman, Senior, Psychology, Sociology
Mentor: Jonathan Bricker, Psychology

Smokeless tobacco use, 90% of which occurs among males, typically begins in adolescence and significantly ceases by the end of young adulthood. This study tested the hypothesis that psychological factors consistent with the Theory of Triadic Influence (TTI) longitudinally predict male SLT acquisition and cessation. This is the first known study to test these predictions. TTI psychological risk factors (parental noncompliance, friend compliance, rebelliousness, and thrill-seeking) were assessed in a cohort of Washington State males participating in a 40 school district tobacco study. To predict acquisition of daily use, never SLT users had their risk factors assessed at age 12. Their SLT use was assessed at age 18 (N = 2,468; 94.8% 5-year retention). To predict cessation, all daily SLT users had their risk factors assessed at age 18. Their SLT cessation status was assessed at ages 20 and 28 (N = 182; 86.9% 10-year retention). All models were tested with logistic regressions adjusting for experimental condition, team sport participation, parental education, and clustering among participants in the same school district. Scoring high on the following psychological factors at age 12 increased the odds of daily SLT use at age 18: 156% increased odds for friend compliance (OR = 2.56; $p < .001$), 116% for rebelliousness (OR = 2.16; $p < .001$), and 133% for thrill seeking (OR = 2.33; $p < .001$). Parent noncompliance was not a significant predictor ($p = .33$) of SLT acquisition. None of the psychological factors at age 18 predicted SLT cessation at ages 20 or 28 (p value range: .13 to .94). This study provides the first evidence that friend compliance, rebelliousness, and thrill-seeking strongly predict SLT acquisition among males. However, there was no evidence that the psychological factors predicted SLT cessation. Targeting these psychological predictors early may help prevent SLT use among males.

SESSION 1T

MOLECULAR AND CELLULAR BIOLOGY

Session Moderator: Hannele Ruohola-Baker, Biochemistry
Johnson Hall 175
1:00 PM to 2:30 PM
* Note: Titles in order of presentation.

The Electrostatics of Ubiquitin and its Role in Ubiquitin Ligase Activity
Matthew Steven Novack, Senior, Biochemistry
Mentor: Rachel Klevit, Biochemistry
Mentor: Jonathan Pruneda, Biochemistry

Ubiquitin is a small post-translational signaling molecule. Its roles in repairing damaged DNA, apoptosis and protein degradation make it critical for tumor suppression. Genetic mutations affecting proteins in the ubiquitination pathway have been implicated in multiple inherited human cancers. The ubiquitination pathway attaches the protein ubiquitin (Ub) onto a substrate molecule with the help of three enzymes, ubiquitin activating enzyme (E1), ubiquitin conjugating enzyme (E2), and ubiquitin ligase (E3). Transfer of Ub onto the substrate requires the formation of a thioester bond between Ub and E2, denoted as E2. A catalytically active E3 ligase which can bind E2, but never directly binds Ub, is also necessary. E3's catalytic mechanism is not fully understood. One function of E3 is to bring E2and substrate in close enough proximity to facilitate a reaction. However, E3 enhances the release of Ub from E2in the absence of substrate molecules. This suggests E3 plays a role in priming E2for transfer of Ub. Using site directed mutagenesis and protein-protein interaction assays visualized through western blotting, I have investigated what electrostatic properties of Ub are important for E3's catalytic activity. Informative Ub mutations don't stop formation of E2, but disrupt the catalytic activity of E3. I propose that polar/charged Ub residues in the contact region between Ub and E2 affect E2binding modes, promoting inhabitance of E2conformations favorable to Ub transfer upon binding of E3.

POSTER SESSION 2

Commons East, Easel 49
2:00 PM to 3:30 PM

Characterization of Gene Expression Changes in White Matter Following Ischemic Preconditioning
Samuel Wroe (Sam) Sussman, Senior, Neurobiology
Mentor: Jonathan Weinstein, Neurology

Ischemic preconditioning (IPC) is a robust neuroprotective phenomenon in which a brief period of ischemia leads to tolerance to subsequent ischemic attacks. Characterizing the mechanisms of IPC is a major focus in stroke basic research. Prior IPC investigations focused primarily on gray matter – infarct volume reduction in rodents following a surgical stroke model, middle cerebral artery occlusion (MCAO). IPC reduces infarct volume by greater than 50%. This effect has been shown to be dependent on immune cell receptor Toll-like receptor 4 (TLR4). However, human brains have a far greater percentage of WM than rodents and WM injury is a major component in human stroke. Preliminary studies from our laboratory have shown that IPC in vivo can protect optic nerve (a pure WM structure) from subsequent prolonged ischemic injury in vitro. This effect is also TLR4-dependent. We hypothesize here that specific IPC-induced changes in optic nerve gene and protein expression are responsible for WM protection. Based on prior work from our laboratory, we hypothesize that two sets of genes in particular: (i) AMPA class glutamate receptors and (ii) Interferon stimulated genes play a role in IPC-induced WM protection. To test this hypothesis, we are using our standard model of WM IPC (15 minute common carotid artery ligation) to generate preconditioned (ipsilateral) and control (contralateral) optic nerves. Three days later, the optic nerves are dissected out and homogenized. We then isolate either total RNA or total protein. We then use targeted PCR arrays and immune- (Western) blotting techniques to quantify expression of the AMPA glutamate receptors and interferon-stimulated genes. We anticipate that IPC will induce selective down regulation of the former and broad-based, TLR4-dependent up-regulation of the latter. Based on our results we hope to identify novel molecular pathways for therapeutic intervention in WM injury following either stroke or ischemic optic neuropathy.

POSTER SESSION 2

Commons West, Easel 31
2:00 PM to 3:30 PM

Taxonomic Diversity of Oligo-Miocene Gophers (Mammalia: Rodentia: Geomyidae: Entoptychinae) using Geometric Morphometrics
Jennifer W Glusman, Senior, Biology (Physiology)
Mentor: Gregory Wilson Mantilla, Biology
Mentor: Jonathan Calede

The fossil record in western Montana and central Oregon of the late Oligocene-early Miocene period, about 20-30 million years ago, presents a rich fauna of gophers (Geomyidae) of the subfamily Entoptychinae. These burrowing creatures may represent up to 25% of the mammalian fauna of certain fossil assemblages. Understanding the ecology of this large population is thus important for interpreting community-wide ecological changes. Prior to investigating their ecology, it is necessary to understand the taxonomic and morphological di-

versity of these fossil gophers. Previous attempts have been made to differentiate these gophers by using cranial and dental material. However, skulls and dentaries of such small rodents are rarely preserved. Isolated teeth are sometimes the only material available for identification. As a consequence of their abrasive diet, geomyids wear down their teeth over time, erasing potentially diagnostic features of the occlusal surface of the tooth. Therefore, several authors have suggested that differences in the shape of the teeth could be used as a means of species differentiation. This hypothesis has yet to be quantitatively tested. Geometric morphometrics allows such analysis of shape independently of size. This method involves the statistical comparison of geometric coordinates of landmarks placed on an object of interest. I will apply this method to the enamel band of the last premolar and last molar of 140 fossil geomyids. The goal of this study is to test the hypothesis that the shape of Entoptychine teeth can be used as a tool for species differentiation. Preliminary results of the analysis of M3s reveal statistically significant differences between genera. More specifically, the angles of the tooth (tilted anteriorly or posteriorly), its shape (rectangular versus square), and the proximity of its two lophs, appear taxonomically diagnostic. This analysis will allow me to distinguish between gopher taxa, and allow the investigation of their ecology and potential roles in the community.

POSTER SESSION 2

Commons East, Easel 48

2:00 PM to 3:30 PM

The Association Between Functional Human Polymorphisms and Outcome Following Acute Ischemic Stroke

Hunter Phillips, Senior, Neurobiology
Mary Gates Scholar
Mentor: Jonathan Weinstein, Neurology

Toll-like receptor 4 (TLR4) is an important modulator in the pathophysiology of acute ischemic stroke (AIS). Specific Single Nucleotide Polymorphisms (SNPs) in TLR4 alter the immune cell responsiveness to bacterial lipopolysaccharide and various endogenous activators, such as heat shock protein (HSP), tumor necrosis factor (TNF) and nitric oxide (NO). This project utilized data generated from patients presenting with AIS to University of Washington Medical Center (UWMC) and Harborview Medical Center (HMC) between September 2005 and May 2009. DNA was first extracted from patient serum samples collected at regular intervals following AIS. The DNA was then analyzed using Direct-PCR for the presence of various TLR4 SNPs, such as 1063 A/G (Asp299Gly) and 1363 C/T (Thr399Ile). In an analysis adjusted for both initial stroke severity and age, the presence of either TLR4 SNP was associated with an increased rate of infection and a decreased likelihood of favorable outcome at 3 months following stroke. In addition to pointing to a functionally and clinically significant genetic variation in TLR4 SNPs for AIS patients, these results suggest a direct connection between TLR4 function and stroke pathophysiology.

POSTER SESSION 2

MGH 241, Easel 158

2:00 PM to 3:30 PM

Integrity of Steel Gravity Framing Systems

Scott Martin Tetzlaff, Senior, Civil Engineering
Mary Gates Scholar
Mentor: Jeffrey Berman, Civil & Environmental Engineering
Mentor: Jonathan Weigand, Civil and Environmental Engineering

Disproportionate collapse is a phenomenon in which the localized failure of a small portion of a structure triggers the failure of adjoining members, resulting in damage disproportionate to the original cause. In Steel Gravity Framing Systems (SGFSs), connections between members are designed solely to support nominal gravity loading in shear, exemplifying a system which may be particularly vulnerable to collapse if subjected to unanticipated loading. If unanticipated loading compromises a column's ability to resist gravity loading in a SGFS, demands on the shear connections become significantly more complex. Under this scenario, gravity loading initially induces primarily shear and bending moment on the connections, which are resisted through friction and clamping forces and later through horizontal bearing forces at the bolt holes when the friction is overcome. As the beams rotate, the gravity loading becomes resolvable into components perpendicular and parallel to the beam axes, generating large tension forces in the connections. Thus, connections originally designed only to resist shear are subjected to a complex combination of bending moment, shear, and tension forces. This research experimentally investigates the behavior of steel gravity framing connection subassemblages under loading consistent with a column losing its load carrying capacity in order to evaluate connection performance and system-level integrity of existing SGFSs. Furthermore, once the demands on the connections are adequately characterized, practical solutions to improve connection robustness and SGFS integrity can be developed.

SESSION 2Q

ORGANISMS IN THE OCEAN

Session Moderator: Rick Keil, Oceanography

Johnson Hall 022

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Effects of Ocean pH on Early Larval Survivorship and Behavioral Development of Lingcod (*Ophiodon elongates*)

Erin Nicole (Erin) Tomaras, Senior, Environmental Studies
Alyson Elisabeth Edholm Rae, Senior, Business Administration (Finance), Environmental Studies
Mentor: Jonathan Reum, NOAA
Mentor: P. Sean McDonald, Program on the Environment
Mentor: Terrie Klinger, Marine and Environmental Affairs

Beginning with the industrial revolution, levels of pCO_2 in the oceans have increased which in turn decreases the pH of waters and creates a chemical change known as ocean acidification. There are many potential impacts that ocean acidification may have on marine ecosystems and biodiversity, yet little research has been conducted on the effects of low pH levels on fish, particularly temperate species. In this study, we evaluated how different pCO_2 levels affect the survivorship and behavior of larval lingcod (*Ophiodon elongates*) under starvation conditions. To accomplish this task, we reared lingcod eggs that we obtained from the Manchester NOAA hatchery and the resulting larvae under three different pCO_2 levels that correspond to mean present day (˜550 ppm) and possible moderate and high future pCO_2 levels (1050 and 2159 ppm, respectively) in Puget Sound. For the survivorship experiments, we recorded daily mortalities, which allowed comparisons of the cumulative mortality curves and mean survival times among treatments. For the behavioral experiments, we scored several different behaviors to assess activity levels and group cohesion. Five fish were taken from each container in each treatment and placed in a 4cm tall enclosure where they were filmed for ten minutes. Initial results indicate that mortalities were highest under present day conditions (550 ppm) and lowest under predicted high future pCO_2 levels (2159 ppm). These findings suggest that low pH, high pCO_2 levels benefit some species of fish larvae, which is the opposite effect demonstrated in most published larval fish studies to date. We discuss our findings in the context of Puget Sound's dynamic pH environment and highlight areas of future research on this important yet understudied topic.

Importance of Visually Mediated Abdominal Motion for Flight Stability in *Manduca sexta*

David Julio Colmenares, Senior, Computer Engineering, Bioengineering
Mary Gates Scholar
Mentor: Tom Daniel, Biology
Mentor: Jonathan Dyhr, Biology

Flight control in dynamic environments is a complicated task that many animals accomplish with ease. It requires rapid integration of sensory input as well as balancing long-term planning with reflexive behaviors. The giant hawk moth *Manduca sexta* is a useful model organism for studying flight control because its physiology is well understood and it is easy to rear in captivity and work with experimentally. In order to make flight control adjustments, *Manduca* constantly integrates information from slow-sensing visual sensors and fast-sensing mechanosensory organs. Both visual motion and mechanical rotation elicit strong abdominal reflexes in *Manduca* during tethered flight, however the exact role of the abdomen in flight is unclear. Previous work has suggested that abdominal reflexes help maintain flight stability, but it has not been shown that the abdomen is actively used for control. The goal of my research is to determine if *Manduca* can actively use their abdomen to stabilize the visual field. To answer this question, I have created a virtual flight arena composed of a projection system, magnetic tether, and IR sensor. The visual stimulus is projected onto an acrylic dome within which the moth is suspended by the tether. The experiment consists of a system where the moth controls the velocity of a horizontal bar displayed on the dome with its abdominal position. The bar has an initial velocity that the moth counteracts by moving its abdomen in order to stabilize the visual field. The precision of the moth's abdominal control capabilities can then be tested by differing the initial velocities of the bar and varying the way that abdominal position controls the bar's velocity. In addition to answering my research question, this project provides a framework to study the general multi-input multi-output problem in neural control.

SESSION 2S

COMPLEXITY AND EVOLUTION OF BIOLOGICAL SYSTEMS

Session Moderator: Billie J. Swalla, Biology

Johnson Hall 111

3:30 PM to 5:00 PM

* Note: Titles in order of presentation.