IGRAD
Interdisciplinary Graduate
Research & Discovery Conference

UNIVERSITY OF TORONTO SCARBOROUGH

Abstract Book

Session 1 | Long Talks

You take the high road and I'll take the silk road: male widow spiders find females faster by following silk trails of rivals

Catherine Scott, Sean McCann, Maydianne CB Andrade

Social information can allow individuals to bypass the costs and risks of exploration, but may also intensify competition. Here we show that mate-searching males can exploit inadvertent social information produced by rivals to find females faster, increasing their mating success in spite of heightened competition. In western black widows (*Latrodectus hesperus*), first-male sperm precedence leads to intense scramble competition for access to sedentary females. Unmated females signal to males via silk-bound pheromones, but cease signaling shortly after copulation. Through field- and lab-based studies we demonstrate that females mature asynchronously in nature, creating brief windows of detectability. Larger males are more successful at localizing females, but smaller males achieve higher average search speeds. Critically, all males improve their mate-searching success by following silk draglines (byproducts of locomotion in spiders) produced by rivals to arrive at receptive females' webs faster. Silk-following males enter webs in which rivals are already courting, but pre-copulatory courtship lasts several hours, so the first male to arrive is not necessarily first to mate. Moreover, we show that mate-searching males vastly outnumber signaling females on any given night. We conclude that social information use by males increases their fitness because patterns of female receptivity necessitate competition.

Neural and Behavioural Patterns of Within-Task and Between-Task Mental Fatigue

Zoë Francis, Akina Umemoto, & Michael Inzlicht

Mental fatigue within one continuous, effortful task is reliably characterized by worsening performance and reduced neural reactions to errors as the task continues. Ego depletion effects – where fatigue originates in one task and negatively affects performance on a subsequent second task – occurs less reliably. Fatigue may not simply cross between tasks, especially if task-switching restores or temporarily recovers motivation or attention. This study examined patterns of performance and neural engagement (measured using EEG), for both within-task fatigue and between-task depletion. Participants (N = 72) completed a 40-minute Stroop task immediately followed by a 10-minute Go/No-Go. Both cognitive tasks were strongly affected by within-task fatigue, with performance and neural engagement decreasing across the course of each task. Between-task fatigue effects (depletion) were not apparent at the beginning of the second task; neither performance nor neural indicators of engagement significantly differed when comparing baseline Go/No-Go to the post-fatigue Go/No-Go. Instead, switching tasks resulted in re-engagement of cognitive monitoring processes, with increased neural engagement from the end of the Stroop to the beginning of the Go/No-Go. Self-reported measures of engagement also decreased within each task, and partially recovered when the task changed. These results suggest that potential between-task depletion effects may be weakened by initial reengagement that occurs when one difficult cognitive task ends, and another begins.

Understanding invasiveness: an integrated assessment of traits leading to invasion success in widow spiders

M.A. Mowery, A. Dorison, A.C. Mason, M.C.B. Andrade

Understanding invasiveness is an ongoing challenge. There are debates about which types of behavioural and phenotypic traits facilitate establishment in novel environments. We predicted that spiders from invasive (Japanese) populations of redback spiders *Latrodectus hasselti* would perform better than native (Australian) spiders under temperatures typical of the invasive range, even after 'common garden' rearing. Here we report differential effects of temperature on behavioural, morphological, and life history traits and trade-offs that are likely to underlie invasive success. Spiders from invasive populations were more cannibalistic towards siblings and more tolerant of temperature challenges. When held under Australia-typical and Japan-typical temperatures, egg sacs from the invasive population experienced less of a delay in development and had higher hatching success in cool, Japan-typical temperatures than did Australian sacs. As juveniles, invasives showed more behavioural plasticity in response to temperature differences. As adults, invasive females had higher fecundity. Nevertheless, spiders from the invasive population were larger and took longer to develop. Invasive populations may be able to thrive in novel environmental conditions because of increased behavioural plasticity, tolerance of temperature fluctuations, and higher fecundity. We speculate that species-level differences in these traits may explain variable patterns of invasion success across the widow spider genus.

Parasite transmission between wild and domestic carnivores around protected areas

Juan Sebastián Vargas Soto, Péter K. Molnár

Parasite transmission between wild and domestic species (livestock and pets) creates a major risk of emerging diseases and epidemics. To properly address these threats and prevent disease outbreaks, we need to understand how different host species contribute to the persistence of the parasite. I analyzed this issue with *Ancylostoma caninum*, an intestinal parasite that affects domestic dogs and wild felines in Southern Costa Rica, to determine if dogs or ocelots are acting as reservoir hosts. I collected and analyzed scat samples from these two species to estimate the parasite prevalence. I used camera-traps to estimate host abundance and spatio-temporal overlap. With these data, I used an epidemiological model for multiple hosts with environmentally transmitted parasites to quantify the relative contributions of each host species. My results show that dogs would be acting as reservoir hosts, and the parasite spills over to wild ocelots. Sensitivity analyses show that only for a few combinations of parameter values the parasite could be sustained by both hosts independently. This information can be used to design management strategies to prevent negative effects of these and other similar parasites on wild species. My results should be updated to include other potential hosts, and with more accurate estimates of prevalence and abundance.

Session 2 | Long Talks

Can RFMOs Manage Fisheries During Climate Change?

Brian Penntz

This study evaluates the frameworks of 12 Regional Fisheries Management Organizations (RFMOs) against 28 criteria to assess whether these organizations can effectively respond to resource fluctuations brought about by climate change. RFMOs are assessed on breadth of management frameworks and inclusion of best available science in policy frameworks. The assessment method builds upon a previously published framework, but is expanded to capture organizational attributes associated with an effective response to climate change. The results of the RFMO assessment suggest that generally, RFMO policy frameworks are comprehensive, and seem to possess most elements required to achieve resource management goals under climate change. The study hypothesizes that the legal (i.e. issues of compliance and enforcement, sovereignty, decision-making rules) and political factors (i.e. factors intrinsic to common-pool resources) characterising the management of transboundary and high seas fisheries, rather than framework comprehensiveness, are predominately responsible for resource outcomes in RFMOs. To further promote effective resource management and desired outcomes during climate change, the study makes four recommendations: (1) prioritize performance evaluation from a climate change perspective, (2) continue enhancement of enforcement and monitoring strategies, (3) increase the designation of marine protected areas (MPAs) and (4) include political analysis of decision-making processes in RFMOs. The complex governance and political factors affecting high seas and transboundary fisheries management under climate change underscores the importance of the upcoming Biodiversity Beyond National Jurisdictions (BBNJ) treaty for its potential to support the conservation of high seas marine living resources in parallel with RFMOs.

Investigation of *Daphnia magna* sub-lethal exposure to organophosphate esters in the presence of dissolved organic matter using ^{1}H NMR-based metabolomics

Vera Kovacevic, André J. Simpson and Myrna J. Simpson

Organophosphate esters (OPEs) are frequently detected in aquatic environments. Hydrophobic OPEs with high octanol-water partition coefficients (Log K_{OW}) will likely sorb to dissolved organic matter (DOM) and consequently alter OPE bioavailability and sub-lethal toxicity. ^{1}H nuclear magnetic resonance (NMR)-based metabolomics was used to evaluate how DOM (5 mg organic carbon/L) alters the metabolic response of *Daphnia magna* exposed to sub-lethal concentrations of three individual OPEs with varying hydrophobicity. *D. magna* exposed to the hydrophilic contaminant (Log K_{OW} = 1.43) tris(2-chloroethyl) phosphate (TCEP) did not have substantial metabolic changes and DOM did not alter the metabolic response. There were significant increases in amino acids and a decrease in glucose from exposure to the hydrophobic contaminant (Log K_{OW} = 3.65) tris(2-butoxyethyl) phosphate (TBOEP) which DOM did not mitigate, likely due to the high sub-lethal toxicity of TBOEP. Exposure to DOM and the hydrophobic contaminant (Log K_{OW} = 4.76) triphenyl phosphate (TPhP) resulted in a unique metabolic response which was unlike TPhP only exposure, perhaps because DOM may be an additional stressor with TPhP exposure. Therefore, Log K_{OW} values may not always predict how sub-lethal contaminant toxicity will change with DOM and there should be more consideration to incorporate DOM in sub-lethal ecotoxicology testing.

An efficient method for choosing the best sub-ensemble of climate models for *ΔT* Projections

Conor I. Anderson · Ken Butler · William A. Gough

Climate scientists produce projections of future climate using Global Climate Models (GCMs), however, for a regional climate study, it is sometimes inconvenient or otherwise impractical to analyze each of the available models individually. Often, scientists will instead perform an `ensemble` study, by averaging the output of all available models. Recent studies have shown, however, that representative sub-ensembles may outperform individual models and full ensembles alike. We propose an efficient method for the selection of representative sub-ensemble members for *ΔT* projections based on the sub-ensemble's ability to reproduce an observed climate baseline. We used our method to validate GCM reproduction of long-term baseline temperature averages at Toronto and Montreal, and found that sub-ensembles consistently outperformed individual models and total model ensembles when tested for individual variables and stations. Furthermore, sub-ensembles were more effective at reproducing the baseline average across combinations of variables and stations. Our method, derived and developed in the R programming language for statistical computing, provides a fast, computationally efficient solution to the selection of model members of selective, representative sub-ensembles.

Session 2 | Short Talks

Detecting evidence of positive selection in key osmoregulatory genes in freshwater and marine Beloniformes

Katherine Balasingham

Physiochemical barriers, such as differences in salinity, is a challenge for aquatic organisms to overcome. Evolutionary shifts between marine and freshwater habitats requires evolutionary changes in osmoregulation. Marine fish regulate to increase water uptake and remove intracellular ions to avoid dehydration, whereas freshwater fish need to excrete water and retain ions. Genes involved in regulating intracellular ion concentration and movement of water work to maintain internal ion and water balance. Evolutionary changes in these genes are likely associated with marine to freshwater habitat transitions, allowing freshwater adaption and speciation. Selective pressures will be analyzed on several osmoregulatory genes in the Beloniformes (e.g. needlefishes, medakas, flyingfishes, and halfbeaks), an order that includes multiple marine and freshwater lineages. Phylogenetic approaches such as testing nucleotide substitution rates will be implemented to detect evidence of positive selection in candidate genes associated with osmoregulation.

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A New Family of Small Manganese(III) Porphyrin Based MRI Contrast Agents and the Analyses of the Binding to Human Serum Albumin

Piryanka Sasidharan, Hanlin Liu, Dr. Xiao-an Zhang

Introduction. Magnetic resonance imaging (MRI) relies on the ^{1}H-NMR signal of water existing *in vivo*. Variable proton densities and relaxation properties produce variable signal intensity. In cases of no significant signal difference, a contrast agent (CA) is often employed to allow tissue contrast enhancement. The effectiveness of a CA is referred to as relaxivity (r_1) and is given in $mM^{-1}s^{-1}$. Currently, gadolinium based CAs (GBCA) dominates clinic use but unfortunately GBCAs are associated with Gd-toxicity, such as nephrogenic systemic fibrosis (NSF) in patients with renal dysfunction. Additionally, relaxivity is seen to decrease at magnetic fields of 1-3T, limiting its future application where high field clinical scanners will dominate.[1] To overcome these limitations, we have developed a number of manganese(III) porphyrin (MnP) alternatives to conventional GBCAs. MnPs have been found to display high relaxivity, contains a biocompatible manganese at its core and the porphyrin backbone allows for versatile structural modifications.[2] Here we report a novel family of small, asymmetric MnPs for magnetic resonance angiography (MRA) with high relaxivity and display affinity to human serum albumin (HSA), a prominent protein within the blood plasma.

Methods. MnTPPS has been previously shown to display long *in vivo* retention. This is likely due to the diffused hydrophobicity along the perimeter of the molecule.[3] Additionally, MnTCP has been previously synthesized by our group as an alternate to MnTPPS whereby the four $PhSO_3^-$ arms were replaced with carboxylates as a means of increasing water solubility and polarity. A series of MnPs have been designed herein based upon these two molecules (**Fig 1**) and contain one unique substitution for binding to HSA.

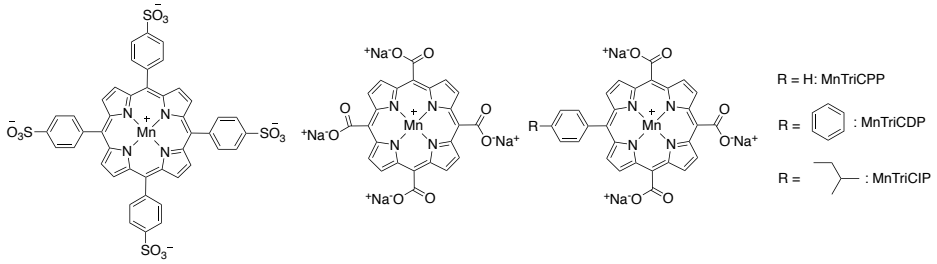

Fig 1. Chemical structure of molecules left: MnTPPS, middle: MnTCP, right: novel MnPs designed herein

The novel MnPs have been synthesized and a series of spectroscopy techniques have been used to confirm its identity and purity. Nuclear magnetic resonance dispersion (NMRD) profiles were acquired with a SMARTracer™ Fast Field Cycling NMR Relaxometer in combination with a variable high field relaxometer (10–120 MHz) HSA binding was followed by relaxivity change.

Results. All novel MnPs were synthesized, purified and characterized by use of NMR, UV-VIS, ESI-MS and HPLC. NMRD profile of MnTriCPP was obtained (**Fig 2**). MnTriCPP was found to display a drastic relaxivity increase upon HSA binding. Moreover, the maximum r_1 was found to be 21.0 $mM^{-1}s^{-1}$ at 31.6 MHz and at high clinical fields an r_1 of 14.8 $mM^{-1}s^{-1}$ was obtained.

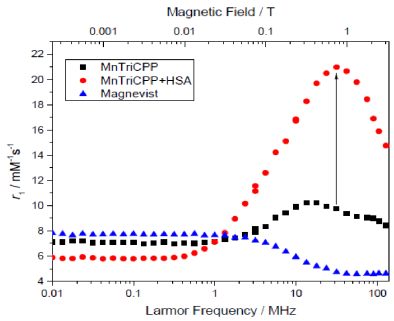

Fig 2. NMRD profile

Conclusion. The new family of MnTriCPP analogs exhibit significant improvement to previously synthesized MnPs and GBCAs, with high sensitivity upon HSA binding, and displays potential for future *in vivo* MRA applications.

References. [1] *J Med Chem*. 2014;57(2):516-520. [2] *J Biol Inorg Chem*. 2014;19(2):229-235. [3] *Magn Reson Med*. 1987;33:24-33.

Kissing Cousins: Population Density Predicts Effects of Kinship on Mating Outcomes in Widow Spider Populations

Nishant Singh

Population density affects selection on traits that shape reproductive fitness, thus linking ecology and evolution. We studied how density affects mating behaviour, response to kin, and inbreeding in black widows (*Latrodectus hesperus*). We used two focal populations—British Columbia (BC) and California (CA)—that differ in average density and spatial variation in density across their active season. High densities intensify male-male competition given first-male sperm precedence in *Latrodectus*, and increase the likelihood of inbreeding. We predicted inbreeding tolerance and adaptations to intensify mating competition in the high density, facultatively group-living BC population, and conversely, discrimination of kin and inbreeding depression in the variable, yet lower, density, solitary CA population. We paired females with kin or non-kin males within each population. High density lineages from CA showed slow mating progress in kin pairs, compared to low density lineages, or when pairs were non-kin. Moreover, these kin-matings were costly, with fewer eggs hatching and lower offspring survivorship. Comparing between populations, BC pairs progress through mating faster, and this relationship is intensified in kin pairs, opposite to kin in CA. This result suggests local adaptation to distinct ecologies and competitive environments linked to sustained differences in density.

Influences on quantity and quality of dissolved organic matter by land-use differences

Huan Tong

Dissolved organic matter (DOM) is a heterogenous and complex mixture of molecules primarily derived from plants and microbes. It is found ubiquitously in terrestrial, aquatic and atmospheric systems. As a major pool of actively cycling organic carbon in soils, terrestrial-derived DOM can also be a major carbon flux to other environments. DOM chemistry can also vary, depending on the type of terrestrial ecosystem. For example, DOM derived from forests is chemically distinct from DOM derived from agricultural lands. The amount of carbon exported is also dependent on ecosystem type and environmental properties. In addition, land-use changes likely alter the amount and composition of DOM exported to aquatic systems, but rarely has this aspect studied with other environmental factors. To address this, the molecular composition and quantity of extractable DOM from both native and cultivated North and South American soils along a mean annual temperature gradient were analyzed. Water-extractable organic matter (WEOM) samples were isolated and analyzed with solution-state nuclear magnetic resonance (NMR) spectroscopy and total organic carbon analysis for composition and concentration determination, respectively. With land-use changes, the variations of concentration of WEOM showed a decrease (r^2 = 0.6033) with increasing mean annual precipitate. NMR analysis showed that the dominant component of cropland WEOM was from carbohydrates and peptides. The aromaticity of native forest-derived WEOM decreased faster per year after land-use changes to pasture land. Based on the study, land-use, including vegetation, and other environmental factors changed the quantity and quality of DOM. Further study will be performed with long-term crop rotation to better understand the relation between vegetation and quality and quantity of DOM.

Understanding the role of sediment diagenesis and how it's captured by mechanistic models applied to Lake Erie

Meghan Brady, Yuko Shimoda, George Arhonditsis

The use of mechanistic ecological models has allowed for the identification and understanding of important in-lake process that are known affect the trophic state and water quality of Lake Erie. Specifically, they are commonly applied to Lake Erie as an environmental management tool to predict eutrophication, harmful algal blooms (HAB), and hypoxic events. These models attempt to capture critical in-lake processes, such as sediment diagenesis, which may cause internal loading and influence eutrophication, HABs, and hypoxia. Our research focuses on identifying the role of sediments diagenesis and how these processes are described by mechanistic models applied to Lake Erie. We will examine how well these models have properly reproduced the influence of sediment processes on the internal loading of the system and also evaluate the mathematical equations used, methodological practices followed, and lessons learned from these mechanistic models.

Session 3 | Long Talks

HSP90C functions in the thylakoid targeting of PsbO1 through interaction with the thylakoid targeting peptide

Tim Jiang

The plastid heat shock protein 90 (HSP90C) has been shown to serve as an essential component of the plastid protein quality control system. Previously, we found that HSP90C interacts with the PSII subunit, PsbO1, enroute to the thylakoid. While the steady-state level of *i*PsbO1 (stromal form) and *m*PsbO1 (lumen form) was modified in the presence of differential HSP90C activity, the exact cause of this alteration was unknown. Using seedlings which only expressed the chloroplast targeting peptide (cTP) and thylakoid targeting peptide (tTP) of PsbO1 fused to GFP ($PsbO1^{1-85}$GFP), we studied the dynamic trafficking of the tTP fusion protein by using isolated chloroplasts. Our thylakoid transport chase assays showed that the HSP90 ATPase inhibitor geldanamycin could cause a reversible inhibition of tTP transport across the thylakoid membrane. Analyses of fractionated stroma and thylakoid samples post-chase suggested that HSP90C activity is necessary for stroma-to-thylakoid movement of SEC translocon substrates. Based on our observations, we propose that HSP90C regulate lumen transport of PsbO1 by the selective stromal targeting of the TPP towards the thylakoid membrane.

The SnRK1 interaction network plays a role in salt stress response in *Arabidopsis thaliana*

Carina Carianopol

Yearly, abiotic stress is responsible for 70% of crop yield loss. 50% of agricultural land is affected by high soil salinity, and with the expected increase in food demand over the next few decades, it is important to study mechanisms of plant abiotic stress response to engineer better stress-adapted crops. Plants have developed intricate mechanisms to enable survival under abiotic stress. Once the stress is severe enough, the plant reaches a status of energy deprivation. The plant SnRK1 (Sucrose non-fermenting Related Kinase 1), yeast Snf1 and mammalian AMPK are conserved energy sensors activated under metabolic stress to achieve energy homeostasis. The SnRK1 heterotrimeric kinase complex comprises 2 catalytic (SnRK1a), 3 regulatory beta and 2 gamma subunits, one of which is plant-specific (by). SnRK1 has been proposed to link stress, sugar and developmental signals to regulate plant metabolism and energy balance and therefore survival of the plant under stress. Important during abiotic stress response, is the hormone abscisic acid (ABA). Recent work indicates that the SnRK1 and ABA signaling pathways share common transcriptional targets during stress response, although the mechanism of this crosstalk is unclear. The aim of this project is to investigate how SnRK1 and ABA interact to regulate abiotic stress responses in *Arabidopsis thaliana*. A high-throughput yeast two-hybrid (Y2H) screen using all SnRK1 subunits against a library of 258 ABA-regulated genes was performed, resulting in 47 putative SnRK1 substrates identified in the ABA-SnRK1 interaction network. Bioinformatics analysis suggests that a core subset of 10 novel SnRK1-PP2C-ABA partners may orchestrate the plant response to salt and osmotic stress. Several of these interactions have been confirmed *in planta*. Their possible role in mediating the response to salt and osmotic stress will be discussed.

Predicting the likelihood of a regime shift in Cootes Paradise with statistical & mathematical models

Cindy Yang, Dong-Kyun Kim, George Arhonditsis

Despite extensive restoration efforts, Cootes Paradise continues to be degraded and seemingly unable to revert back to its former clear state. Previous work has failed to address the spatial heterogeneity in the system when characterizing its ecological functioning. Our modelling study will evaluate the spatially-explicit ecosystem response in Cootes Paradise to: (1) nutrient reductions in wastewater treatment plant discharge and (2) the presence of submergent vegetation communities. The present modelling exercise combines our best ecological understanding of Cootes Paradise and observed data to draw predictions about the ecosystem response to nutrient loading reductions and re-establishment of submergent vegetation. We evaluated the combined effects of submergent vegetation and nutrient loading reductions, as projected by a calibrated eutrophication model. We then developed a Bayesian statistical model to analyze the spatial distribution of reduced nutrient loading impact and delineate areas in Cootes Paradise where the greater water quality improvements will likely occur. We conclude by discussing the various sources of uncertainty and additional remedial actions required in Cootes Paradise marsh to realize a shift from the current turbid-phytoplankton dominated state to its former clear-macrophyte dominated state.

Session 3 | Short Talks

Temperature and tactile stimulation alter stress-related gene expression in the neonatal rat brain

Samantha C. Lauby & Dr. Patrick O. McGowan

Early life experiences can affect stress response in later life. In rat pups, maternal licking/grooming in the first week of life can regulate adult stress reactivity. However, we do not know whether the temperature drop pups experience during the mother's absence facilitate the effects of licking/grooming when the mother returns. To study this potential interaction, we briefly separated pups in the first week of life at room temperature (19-21° C) or nest temperature (33-35° C) and provided half the animals in a litter with supplemental tactile stimulation (a proxy for licking/grooming). Results indicate that temperature conditions affected corticotrophin-releasing factor and oxytocin gene expression in the week-old rat paraventricular nucleus of the hypothalamus. In addition, tactile stimulation decreased paraventricular corticotrophin-releasing factor, oxytocin, and arginine vasopressin gene expression. These findings suggest that both temperature and tactile stimulation affect gene expression related to the stress response early in life. We are currently investigating thyroid hormone, implicated in both temperature and tactile stimulation, as a mechanism for these differences.

Changes in soil organic matter composition with long-term forest soil warming and nitrogen addition

Lori vandenEnden and Myrna J. Simpson

Soil organic matter (SOM) is the largest pool of actively cycling organic matter and two-thirds of this SOM is stored in forest soils. As global temperatures and atmospheric concentrations of greenhouse gases continue to rise, it is important to maximize the carbon (C) storage capacity of SOM. At the same time, it is unclear how forests will respond to future environmental conditions, including warmer temperatures and greater rates of nitrogen (N) deposition. To better understand the relationships between long-term warming, N addition and SOM composition, a study site was established at Harvard Forest, MA in 2007. At this site four treatments were applied continuously: Control, Warming (soil temperature was increased by 5°C using heating cables), N-Addition (N applied annually as NH_4NO_3) and Warming+N (a combination of the Warming and N-Addition treatments). After ten years, the O and A horizons were sampled and analysed at the molecular level using biomarker methods and nuclear magnetic resonance (NMR) spectroscopy to measure SOM composition and degradation state. Results of NMR spectroscopy show that in all treatments, the SOM in the A horizon is more degraded than in the O horizon, which is receiving continuous fresh inputs from above-ground litter. The Warming treatments appear to have accelerated degradation, particularly in the A horizon. In contrast, the N-Addition may have suppressed degradation. The response of the Warming+N treatment is most similar to the Warming treatment, which suggests that after ten years, soil warming controls degradation more strongly than N-Addition. Molecular-level data will provide detailed information about SOM composition and biogeochemistry, which will improve understanding of the relationship between future climate change and C storage and cycling in temperate forests.

The Influence of Atmospheric Halogenated Ozone Depleting Substances on Arctic Amplification

John Virgin, Karen Smith

The globally warming climate, as depicted through all potential Radiative Concentration Pathway (RCP) scenarios from the Intergovernmental Panel on Climate Change (IPCC), stands to have an exacerbated effect at polar latitudes. This process, known as Arctic Amplification, has forecasted warmer average Arctic temperatures than the global average through various climatological mechanisms. One such potential mechanism is the influence of halogenated ozone depleting substances (ODS) on the natural cycle of ozone destruction and production, as well their direct impact on climatic warming as potent greenhouse gases. Elucidation of the precise relationship between ODS's and Arctic Amplification has not yet been ascertained in past research efforts due to the complex nature of processes shaping the Arctic Climate. Here, we use output from three completed simulations of a fully coupled General Circulation Model (GCM) with atmospheric chemistry, known as the Whole Atmosphere Community Climate Model (WACCM), to investigate the relationship between ODS's and Arctic temperatures throughout the stratosphere and troposphere. The control simulation includes three runs from 2005 to 2065, which impose greenhouse gas emissions equivalent to the IPCC RCP4.5 scenario. The "World Avoided" simulation includes three runs from the same timeframe and with the same inputs as the control simulation, save for a prescribed 3.5% emission increase of ODS's per annum. Lastly, the "fixODS" simulation includes three runs from the same time frame, and is identical to the control simulation, except for a fixed level of ODS's for the entire time frame equivalent to historical levels from the year 2000. Preliminary spatial comparisons of decadal surface temperature changes across all three simulations, as well as vertical temperature profiles for each season, have shown elevated levels of warming and altered lapse rates. Key findings for such research indicate the importance of the still lingering trace amounts of halogenated ozone depleting substances in Earth's atmosphere, as well as the past and potential future influence of ozone depletion on Arctic Amplification.

Effects of early life stress on offspring HPA axis development and behaviour.

Mouly Rahman

Nutrients play a key role in regulating prenatal and early postnatal neurodevelopment. At these stages, offspring exhibit the highest degree of neuroplasticity, and thus, are vulnerable to maternal nutrient imbalance. By creating an inflammatory environment for developing offspring, maternal high-fat diet (mHFD) acts as a prenatal stressor. Epigenetic modifications, chemical tags which activate or silence gene expression, are sensitive to prenatal stressors. Influenced by epigenetic changes, the hypothalamic-pituitary-adrenal (HPA) axis is a neural system that responds to stress through signaling of glucocorticoids (GCs) onto GC receptors (GRs). Inflammation caused by mHFD imbalances GC-GR dynamics, since the HPA axis and immune system are linked. Modulating cognition and stress, limbic brain regions express GRs, thus, disrupted GC-GR dynamics due to immune interference from mHFD can lead to long-term effects on offspring behaviour. As altered immunity has been shown in offspring exposed to mHFD, it remains to be studied whether a post-natal immune stressor interacts with high-fat diet induced neural remodeling. To investigate this interaction, the proposed study will deliver an immune stressor to offspring exposed to mHFD. Stress behaviour and the epigenetic profile of HPA axis markers in limbic brain regions will be assessed.

Defining the influence of channel complexity on the distribution of trace metals in suspended sediments in salt impacted urban streams

Aimé Kayembe, Carl P.J. Mitchell,

Widespread urbanization has led to increased trace metal and salt levels in urban streams. In addition to its impact on water quality, changes to channel geomorphology are pervasive in urbanizing landscapes resulting from dramatic alterations in the stream hydrograph.
Trace metals distribution in salt impacted systems has been widely covered primarily at the interface between the aquatic and terrestrial boundary and during salting season. However, the role of channel geomorphic structure on mechanisms controlling trace metal mobilization and transport in urban streams under baseflow conditions remain poorly resolved. In this study we aimed at providing a space-resolved analysis of trace metal (Cu, Cd, Pb and Zn) distribution between predominantly “mobilizable” and “non-mobilizable” fractions in suspended sediments. We investigated the possible association between concentration variability in these fractions and stream reach geomorphological attributes such as sinuosity and hydraulic conductivity, in 12 reaches in three urban watersheds. Initial results indicate that highly complex reaches (highly meandered with greater riparian connectivity) are associated with the highest concentrations of salt cations, total recoverable and mobile fractions of metal elements.
This study allows for a meaningful discourse on the role of stream geomorphology on trace metal distribution in suspended sediment in salt impact stream of highly urbanized watersheds and their subcatchments.

Session 4 | Long Talks

The Effect of Dog Strangling Vine on Invaded Communities

Darwin Sodhi

Increased globalization has led to the movement and spread of species around the world, and these species have the potential to profoundly alter ecosystems. These invasions often result in negative ecological, economic, and human health impacts. *Vincetoxicum. rossicum* is found in several ecosystems such as open meadows and understory, however very little is known about how it impacts communities. I hypothesized that *V.rossicum* would occupy similar niche space to that of the resident species and, due to both fitness and niche differences, impact community structure. In an observational field study conducted in the Rouge National Urban Park; Canada’s first national urban park, I found that in the meadow ecosystem *V.rossicum* has high niche overlap and is selecting for species to become more abundant. However, in the understory ecosystem niche overlap couldn’t be confirmed however, resident species are becoming increasingly specialized in order to avoid direct competition with *V.rossicum*.

The influence of curvature on convection in a temperature-dependent viscosity fluid: implications for the 2D and 3D modeling of moons

Joshua Guerrero

Convection in terrestrial bodies occurs within spherical shells described by the ratio, *f*, of their bounding radii. Previous studies that have modeled convection with a temperature-dependent viscosity noted the strong effect of *f* on transition to the stagnant-lid regime. Here, we analyze stagnant-lid convection (SLC) in 2D and 3D systems with curvatures including relatively small-core shells (*f* as small as 0.2) as well as in thin shell and plane-layer cases. Several peculiarities of convection in a strongly temperature-dependent viscosity fluid are identified for both high and low curvature systems. We demonstrate that effective Rayleigh numbers may differ by orders of magnitude in systems with different curvatures, when all other parameters are maintained at fixed values. Furthermore, as *f* is decreased, the nature of SLC in small-core bodies shows a divergence in the temperature and velocity fields found for 2D annulus and 3D spherical shell systems. In addition, substantial differences in the behavior of thin shell (*f*=0.9) and plane-layer (Cartesian geometry) models occur in both 2D and 3D, indicating that the latter (emulating a toroidal topology rather than spherical) may be inappropriate approximations for modeling variable viscosity convection in thin spherical shells. Our findings are especially relevant to understanding and accurately modeling the thermal structure that may exist in bodies characterized by thin shells (e.g., *f*=0.9) or relatively small cores, such as shells comprising the Galilean satellites and other moons.

Positive selection and red-shifting substitutions in the rhodopsin gene of a globally distributed family of fishes making evolutionary transitions into freshwater.

Alexander Van Nynatten

Rhodopsin, the light-sensitive visual pigment expressed in rod photoreceptors, is exquisitely well adapted for vision in dimly-lit environments. However, rhodopsin's ability to detect light diminishes underwater where the visible spectrum narrows with depth, unless its sensitivity coincides with the wavelengths of light available. In deep-sea fishes, specific amino acid substitutions in the opsin protein component of rhodopsin blue-shift its peak spectral sensitivity to match the wavelengths of light penetrating deepest in off-shore marine waters. In contrast, coastal regions and large rivers are more turbid and tannin stained; red-shifting the underwater light environment. The molecular mechanisms involved in adaptation to red-shifted waters has not yet been well established. We compared rates of molecular evolution in rhodopsin sequences of a globally distributed family of fishes inhabiting off-shore, coastal and freshwater habitats. We find positive selection in rhodopsin, consistent with the diverse array of visual environments these fishes inhabit. Models comparing phylogenetic partitions, separating marine and freshwater lineages, indicate dN/dS is highest along the transitional branch from marine to freshwater in South America. This branch represents the most substantial red-shift in environmental light conditions and included among the positively selected sites are red-shifting substitutions F261Y and S124A. Recreating these and other substitutions on the branch in vitro indicates the freshwater lineages have a red-shifted rhodopsin pigment compared to the most recent marine ancestor. This red-shifted rhodopsin pigment is more sensitive to the wavelengths of light penetrating deepest in Amazonian rivers, providing a clear adaptive advantage to this ancestrally marine clade of freshwater fishes.

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Selling Success: Portrayals of invasive species management and the potential to underestimate risk

Noelle Stratton, Nicholas Mandrak, Nicole Klenk

The Great Lakes are of enormous ecological and economic importance to Canada and the United States. Unfortunately, the region is currently threatened by at least 188 non-native species. The Sea Lamprey, is an ectoparasite that has been long established throughout the Great Lakes and had tremendous negative impacts. Sea Lamprey management is currently estimated to cost $20 million per year, and this is only one of the 188 non-native species. Despite the inability to date to eradicate the Sea Lamprey threat, the Great Lakes Fishery Commission has declared these efforts to be a “remarkable success”. Their goal was clearly to demonstrate to stakeholders that management efforts are having clear impacts on Sea Lamprey abundance and movement in the interest of continuing this highly effective management program. However, does this type of phrasing give a false sense of our ability to control the impacts of other invaders? Do we risk implying that the threat is over? Are we giving the impression that if we simply had the resources, we could manage anything? And, how might this influence the sense of urgency toward future invaders? Given the importance of early detection and rapid response to efficient and cost-effective invasive species management, any minimization of the threat of invasive species in the minds of stakeholders could be disastrous. By overselling our successes, are we underselling the risks? In this talk, I will explore these questions in order to frame my current PhD research objectives, and the questions I intend to explore going forward.

Posters Session

Locomotor agility and hearing sensitivity reconstruction from the inner ear of *Cantius sp*.

Raj Bhagat, Mary T. Silcox

The morphology of the mammalian inner ear is functionally related to certain aspects of ecology such as an animal's type of locomotion and hearing capabilities. These patterns are useful in paleontology to reconstruct behavioural information from fossils. Here, we reconstruct locomotor agility and hearing sensitivity from the inner ear of the adapoid primate *Cantius sp*. (DMNS EVP 124767). *Cantius sp*. belongs to the infraorder Adapiformes, a group of euprimates that lived in the Eocene of North America, Europe, Asia and Africa starting about 56 Ma. DMNS EVP 124767 was found in the Bighorn Basin, Wyoming, during the 2017 field season of the Silcox Lab (UTSC) and field partners. It includes associated dental and neurocranial fragments. A high resolution micro CT scan revealed the preservation of the right inner ear including the lateral and posterior semicircular canals (SSCs) and the cochlea (Figure 1). The dimensions of the SSCs can be used to reconstruct agility and infer locomotor behaviour while cochlear dimensions can be used to estimate hearing sensitivity.

In terms of locomotor behaviour, North American adapoids (i.e., notharctids) are generally considered to be arboreal with some propensities for leaping. The agility score of DMNS EVP 124767 is calculated to be 2.9 (based on the lateral SSC), which suggests it had medium slow agility. Our results are in line with a previous study that reconstructed *Cantius nuniensis* as having the same agility score (2.9). Other notharctids were found to have higher scores, in the medium-medium fast range. This contrast is surprising considering the postcrania of *Cantius* displays some adaptations for leaping, which is generally considered an agile locomotor mode. Our results may support previous speculations that the genus had lesser propensities for leaping than other notharctids.

Few studies have looked at hearing sensitivities in adapoids. The European adapoid *Adapis sp.* is considered to have hearing sensitivities of 20.7 dB for high frequency sounds (32 kHz) and 35.5 dB for low frequency sounds (250 Hz). The hearing sensitivity of previously studied notharctids for low frequency sounds (250 Hz) is in the range of *Adapis sp*., although sensitivity for high frequency sounds is unknown. DMNS EVP 124767 provides the first estimate for hearing sensitivity at high frequencies in notharctids. *Cantius* sp. had a hearing sensitivity of 25.2 dB for high frequency sounds (32 kHz) and 38.8 dB for low frequency sounds (250 Hz). Its hearing frequency limits are in the range of other adapoids including its high frequency limit. These results are in line with the understanding that early euprimates started to develop better perception to high frequency sounds and a slight reduction in the perception of low frequency sounds relative to primitive stem primates. In sum, these results help to provide additional context to the early evolution of the group that includes all living primates.

Forest management practices alter soil organic matter degradation and composition in the Silviculture Treatments for Ecosystem Management in the Sayward (STEMS) experimental forest

B. F. Sultani

Forest management practices such as clear-cutting for the production of timber in forests are ecologically disruptive and may result in the loss of soil carbon. Green tree retention (GTR) is an emerging silviculture treatment that retains a portion of forest cover which includes dispersed and aggregate retention. However, molecular-level analysis of soil organic matter (SOM) of GTR methods is lacking. We studied the molecular-level root decomposition (in litter bags) and the SOM profiles of two different GTR forest practises as well as clear-cutting at the Snowden Demonstration Forest in Vancouver Island, BC. Soil samples were taken adjacent to the litter bags after 12 months of deployment. SOM biomarkers were subsequently analysed with gas chromatography- mass spectrometry which targets compounds derived from cutin, suberin, lignin as well as various lipids. In addition, soil and root samples were characterized using solid-state ^{13}C nuclear magnetic resonance (NMR). Results showed that among different treatments, similar plant-derived inputs were identified but varied in concentration. The input of plant-derived compounds significantly altered SOM composition and enhanced the turnover of soil C. Analysis of SOM composition will assist with the development of strategic and effective forest management practices as SOM is an important factor regulating carbon cycling.

Investigation into the post-translational regulation of proteasome complex assembly in *Arabidopsis thaliana* during abiotic stresses

Diana Bonea

Cellular proteins may undergo misfolding, denaturation, oxidation and aggregation in unfavorable environments. The buildup of dysfunctional proteins is mitigated, in part, by degradation and recycling via the ubiquitin-proteasome system. Under this system, substrates tagged with polyubiquitin chains (by enzymes E1, E2, E3) are targeted for hydrolytic breakdown by the 26S proteasome, which is canonically composed of a 19S regulatory particle (RP) and a 20S core particle (CP). While many studies highlight the importance of E3 ligases in targeting regulatory proteins for degradation during plant stress responses, little is known about the regulation of the 26S complex itself. In this study, we aim to investigate how the stoichiometry of proteasome assembly impacts the abiotic stress response. Using *A. thaliana* seedlings that were transiently exposed to high heat, oxidative, osmotic and salt stress, we found that the proteasome undergoes post-translational structural regulation that alters the ratio of RP_1-CP, RP_2-CP and CP alone in total lysates. Immunoprecipitation of PAG1-FLAG, a subunit of the CP that co-purifies RP, has verified our findings and also gives us a potential means of detecting novel interactors that assist in structural remodeling of the proteasome. Bioinformatics analysis has revealed putative *A. thaliana* orthologs of at least 10 yeast chaperones that are critical in proteasome assembly. We have obtained T-DNA insertions in the corresponding 10 genes and will test whether some of these assembly factors directly function to remodel the proteasome during stress adaptation.

Roles of infralimbic and prelimbic cortices in contextual biconditional discrimination memory retrieval.

Sadia Riaz, Pugaliya Puveendrakumaran, Dinat Khan, Sharon Yoon, Rutsuko Ito.

The two subdomains within the medial prefrontal cortex (mPFC), infralimbic (IL) and prelimbic (PL), have been shown to differentially control context-dependent behaviour. While activity in the PL has been shown to promote the expression of conditioned fear and drug seeking, IL activation has been associated with the extinction and inhibition of these behaviours. Yet, the potential roles of the PL and IL in contextually driven natural reward seeking remain underexplored. The present study sought to further examine the functional dichotomy of the mPFC in contextual control over appetitively motivated behaviour, employing a contextual biconditional discrimination (CBD) task in combination with temporary pharmacological inactivation. To this end, adult male Long Evans rats received CBD training involving the sequential presentation of two distinct auditory stimuli (X,Y) in two different contexts (A,B; different size & odor). Rats were trained to nose poke in response to the presentation of one stimulus for the delivery of sucrose reward and to withhold a nose poke response to the presentation of the second stimulus in a context-specific manner (e.g. AX+, AY-; BX-, BY+). Following acquisition, rats received an intracerebral microinjection of a cocktail of GABAR agonists or saline into the PL or IL, prior to undergoing a CBD training session and an extinction test. Contrary to expectation, both IL and PL inactivation resulted in robust impairment in CBD memory, indicating that both regions are necessary for the processing of appetitively motivated contextual memories in natural reward seeking.

Dissociative effects of dorsomedial striatum D1 and D2 receptor antagonism in the regulation of innate and learned approach-avoidance conflict decision-making

David Nguyen, Erind Alushaj, Suzanne Erb, & Rutsuko Ito

The striatum is widely implicated in the translation of motivation into goal-directed behavioral output. We have recently shown that dopaminergic D1 (D1R) and D2 receptors (D2R) in the ventral aspect of the striatum exert dissociable control over cue-elicited approach-avoidance decision-making, in the presence of conflicting motivational forces. The dorsomedial striatum (DMS) has also been suggested to be involved in cost-benefit conflict processing, but the contribution of the region's dopaminergic receptors remains unexplored. To this end, we utilized a neuropharmacological approach to investigate the roles of DMS D1R and D2R in regulating cue-elicited and innate approach-avoidance decision-making. Using a conditioned mixed-valence conflict paradigm, we initially trained rats in a three-arm radial maze to associate visuotactile cues with appetitive, aversive, and neutral outcomes. Rats then received an intra-DMS micro-infusion of D1R antagonist, SCH23390, or D2R antagonist, sulpiride, and were then tested for the expression of approach-avoidance behavior in a conflict scenario, wherein the appetitive and aversive cues were superimposed within a single maze arm. The results revealed that DMS D1R antagonism suppressed approach towards the conflict arm while DMS D2R antagonism enhanced approach. Neither D1R nor D2R antagonism in the DLS had an effect on approach-avoidance conflict behavior. All rats also underwent testing in an elevated plus maze test, as a measure of innate approach-avoidance conflict (anxiety). DMS D1R antagonism decreased anxiety, while DMS D2R antagonism increased it. Both D1R and D2R antagonism in the DLS elicited an anxiogenic effect. Together, our findings suggest a dissociation in the role of DMS D1R and D2R in regulating learned approach-avoidance decision-making, and reveal a dorsal striatal dopaminergic mechanism in the expression of innate anxiety.

The Role of Ecological Differentiation in Accelerating Trait Evolution in Neotropical Birds

Vanessa Luzuriaga-Aveiga

The importance of ecological opportunity in promoting speciation has been stressed at high latitudes and island ecosystems, but our understanding of whether ecological-mediated divergent selection accelerates the process of speciation remains poorly studied in the tropics. I performed a macroevolutionary analysis of trait divergence across 135 closely related pairs of passerine bird species from the Amazon basin and adjacent Andean slopes to assess whether the difference in elevational range separating species pairs influences the speed of trait evolution. Trait divergence in elevation was used as a proxy for the degree of ecological divergence. My results demonstrate that the degree of elevational separation is associated with faster differentiation of song frequency – a trait important for premating isolation – and several morphological traits – which may contribute to extrinsic postmating isolation. These latter, suggest that ecological differentiation has played a pivotal role in accelerating rates of evolution in traits important for speciation in Andes.

The Functional Segregation of the Dentate Gyrus in Learned Approach-Avoidance Conflict Decision Making

Yeates, Dylan CM; Ussling, Alicia; Lee, Andy CH; Ito, Rutsuko

Approach-avoidance conflicts occur when organisms face situations that signal opposing affective outcomes, and must choose to either engage or disengage. It is increasingly acknowledged that the hippocampus, particularly its ventral aspect, is part of a critical network involved in recognizing and resolving approach-avoidance conflicts. Less is known about how the ventral hippocampus' subdivisions along its transverse axis mediate affective conflicts. Using transient pharmacological lesions in Long-Evans rats, the present study observed that temporary inactivation of the ventral dentate gyrus resulted in increased approaches towards affectively conflicting information despite also being associated with aversive outcomes, and without affecting spatial memory. In contrast, dorsal dentate gyrus inactivations did not result in changes to approach-avoidance conflict resolution but did impair spatial memory. These findings suggest that the dentate gyrus is functionally dissociable along its longitudinal axis, with its ventral part serving as a critical actor in resolving learned approach-avoidance conflicts.

Differential mechanisms of bacterial adhesion in response to substrate stiffness

Zayadi, Alexa; Hengge, Regine; Sullan, Ruby M.A.

Biofilms confer bacterial resistance to antimicrobial agents and host defenses and, once mature, are difficult to eradicate making prevention of biofilm formation the optimal mitigation strategy. Biofilms begin with bacterial adhesion to a substrate, mediated by sticky cell surface appendages including flagella and type 1 fimbriae. Recent evidence indicates bacteria can use surface appendages to sense and respond to the properties of an underlying substrate, including its stiffness. Understanding the molecular mechanisms of stiffness-dependent adhesion is an important part of informed materials design and selection for surfaces vulnerable to bacterial colonization. In this work, the extent of adhesion by isogenic Escherichia coli mutants, either lacking flagella or lacking type 1 fimbriae, is shown to differentially depend on the stiffness of the underlying substrate.