

TEA Student Symposium Abstracts
Mar 26, 2022, 1-3:15pm

Kelly Murray-Stoker, Shannon J. McCauley, University of Toronto

Assessing effects of urbanization on caddisfly assemblages within a regional context using community science

Historical processes, landscape characteristics, and the distribution of biodiversity form the context in which local community interactions occur. Using caddisflies in lotic ecosystems, we are studying the influence of regional context on urban stream communities. We have characterized regional species pools in terms of taxonomic diversity and, in future work, will assess whether the variation in diversity across regions and can be predicted by landscape-level environmental and historical patterns. Additionally, with a community-science approach, we have sampled urban streams in various North American regions in order to evaluate whether caddisfly communities in certain areas are better equipped to tolerate the effects of urbanization because of the historical distribution of taxonomic, ecological, and phylogenetic diversity. Participants have collected adult caddisflies at more than 120 sites across the US and Canada. Studying this question will help researchers understand how much to consider the region-specific characteristics of a community to mitigate detrimental effects of urbanization and preserve the integrity of freshwater ecosystems.

Britney Picinic, Andrew Donini and Jean-Paul Paluzzi, Department of Biology, York University
Neuroendocrine Control of Aquaporin Expression in the Adult Disease Vector Mosquito, *Aedes aegypti*

The mosquito, *Aedes aegypti*, is found in subtropical and tropical regions around the globe and is responsible for the spread of several diseases, including yellow fever, Zika virus, Dengue, and Chikungunya. Adult female *A. aegypti* take a blood meal from vertebrate hosts to acquire the protein and nutrients needed to produce mature and viable eggs. Immediately following the initiation of feeding, the mosquito rapidly excretes urine to remove excess fluid volume associated with the plasma portion of the bloodmeal. This is made possible by the release of diuretic neuroendocrine factors, whose release is triggered by a bloodmeal. Diuresis is the process of increased urine output stimulated by hormones such as calcitonin-like diuretic hormone 31 (DH₃₁), corticotropin-releasing factor (CRF)-related diuretic hormone, and serotonin (5-HT) that are released from the nervous system and target excretory organs such as the Malpighian tubules (MTs). The MTs are responsible for the production of primary urine by active transport of ions. It has been established that the abovementioned diuretic factors bind to receptors at the cell surface of MTs, activating second messenger pathways to increase production of primary urine. In addition to an increase in ion secretion, there is also an increase in water secretion by the MTs due to the resulting osmotic gradient. Aquaporins (AQPs) are transmembrane domain proteins that allow for the transport of water from one side of the membrane to the other. Previous studies demonstrated that a bloodmeal taken by female *A. aegypti* causes a significant increase in expression of AQPs. However, the influence of specific diuretics on the expression and abundance of AQPs in the MTs of *A. aegypti* remains unknown. Therefore, the objective this study is to determine if diuretic factors affect the abundance and localization of AQPs in the MTs of adult female *A. aegypti*. We hypothesized that diuretic factors, such as DH₃₁, CRF and 5-HT will increase the abundance of AQPs in the MTs of adult female *A. aegypti*. Immunohistochemistry was completed to determine the cellular and sub-cellular localization of AQP 1, 4, and 5 in the MTs of

female mosquitoes following incubation with distinct diuretic factors. Further, western blot analysis was used to determine if the MTs incubated in each diuretic factor had any change in protein abundance of AQPs (1, 4, and 5). Our results indicate that AQPs 1 and 4 are localized to the apical membrane of female *A. aegypti* MTs under control conditions, as well as in DH₃₁ and CRF treated MTs. Immunohistochemical staining reveals that AQP4 abundance in MTs may increase following exposure to DH₃₁. Indeed, western blot analysis indicates that an increase of AQP4 protein abundance is evident when MTs have been incubated in DH₃₁. In addition, we studied the effects of the anti-diuretic hormone, CAPA. Anti-diuretic factors work to decrease secretion by the MTs or promote greater reabsorption in the hindgut, which is critical to sustain homeostatic conditions. Intriguingly, MTs incubated in both DH₃₁ and CAPA had a decrease in AQP4 protein abundance, indicating that both diuretic and anti-diuretic hormones can influence expression of AQPs in the *A. aegypti* MTs.

Thomas Hall, University of Toronto. Michael McTavish, Sandy Smith lab

First record of *Mordellina ancilla* as an inhabitant of garlic mustard stems in Southern Ontario

Preliminary research of the biological control of the biennial invasive plant garlic mustard (*Alliaria petiolata*) using the weevil *Ceutorhynchus scrobicollis* detected an unknown stem-boring larvae in host plants. DNA barcoding identified the species as *Mordellina ancilla*. There is currently relatively little research about the species, and its life history remains largely unknown. To address these gaps, we conducted field collections of 2nd year garlic mustard stems from late August 2021 to mid-January 2022 to study the prevalence of this species and to better describe its relationship with garlic mustard. Stem collections included a longitudinal survey at Koffler Scientific Reserve in King City, Ontario, as well as a geographical survey across Southern Ontario to assess the prevalence of this association throughout the region. Morphological measurements were taken of both dissected stems and larvae. The larvae of *M. ancilla* were found at every site we surveyed, though at greatly varying frequencies (1.8% to 72.3% of stems occupied). Larvae were found from August through January, indicating that they may undergo brumal diapause. Larvae were found more often in stems with wider diameters. The feeding habits of *M. ancilla* larvae on garlic mustard do not seem likely to interact negatively with the anticipated feeding action of biocontrol agents. In sum, this research has identified a previously unknown association between a widespread insect and an invasive plant, and will provide important supporting data to evaluate ongoing biological control efforts.

Zach S. Balzer, Graham J. Thompson Biology Department, Western University, London, ON, Canada

Emergence delirium in a social insect: Eastern subterranean termites respond to a concentrated dose of carbon dioxide

CO₂ is commonly used as a form of anaesthesia in insect science, notably to immobilize motile insects to allow for handling, examination and identification of specimens. Despite the routine use of CO₂ as a general anaesthetic, exposure to concentrated doses of this gas can affect insects in strange ways. Here we note that Eastern subterranean termites (*Reticulitermes flavipes*) recovering from a concentrated dose of carbon dioxide appear to express anti-social behaviour towards their colony mates, as if the threshold response that normally regulates aggression towards non-kin was tripped. Groups of recovering workers and soldiers noticeably bit and lunged at each other and otherwise changed the nature of their interactions, as evidenced by social network analysis, relative to untreated groups. We suggest that the apparently agitated response from a termite is comparable to anaesthesia

recovery effects in humans and other animals, and thus may involve effects to the central nervous system. Regardless of the mechanism, we present a putative case of ‘emergence delirium’ in Eastern subterranean termites and discuss how our assay presents a new tool to study kin recognition in termites and possibly other social insects.

Sisley Irwin and Scott MacIvor Department of Biological Sciences, University of Toronto
Restoration age increases plant-pollinator interactions and presence of specialists in urban meadows

Implementing restoration and management practices that aim to replicate natural areas within urban green spaces have been demonstrated to promote native species success and combat negative effects of urbanization, such as habitat loss. In my thesis, I set out to determine the impacts of urban green space restoration on wild bee communities to understand how plant richness, surrounding urbanization level, and restoration age support these critically important species. To do this, I evaluate wild bee-plant interaction networks, and wild bee diversity across a multi-year, early-successional meadow restoration project in the City of Toronto in Canada. Bee abundance and richness were positively correlated with restoration year, and bee community evenness was negatively correlated with restoration year. Plant-pollinator networks were specialized, but consisted of several dominant plant species, suggesting that future conservation efforts should focus on supporting the rare and underrepresented bee genera present in this study which may be more susceptible to disturbance.

Jinghan Tan, Jean-Paul Paluzzi Department of Biology, York University
Characterization of the distribution of the neuropeptide CCHamide2 and deorphanization of its receptor in the yellow fever mosquito, *Aedes aegypti*

As a widely distributed anthropophilic mosquito species, *Aedes aegypti* is able to transmit various pathogens leading to human diseases. Studying the neuroendocrine system of mosquitoes allows us to better understand their biology. The neuropeptide CCHamide2 (CCHa2) and its associated G-protein coupled receptor (CCHa2R) were recently identified across insects. In the fruit fly *D. melanogaster*, CCHa2 is a sugar-responsive peptide hormone synthesized primarily in the fat body and gut that stimulates insulin-producing cells in the brain regulating growth. However, expression profiles and physiological roles of CCHa2 and CCHa2R in other insects, including *A. aegypti*, remain unclear. This research aims to examine, quantify and localize expression of CCHa2 and CCHa2R and elucidate its physiological functions in the yellow fever mosquito. To date, RT-qPCR demonstrates transcript abundance of CCHa2 and CCHa2R changes over development with the highest expression in one day old male adult and late-stage pupa, respectively. Differential expression of CCHa2 and CCHa2R transcript was also observed in tissues/organs of adult mosquito indicating the CCHa2 transcript is enriched in the midgut while CCHa2R highly expressed in the hindgut. Further, CCHa2 producing endocrine cells were immunolocalized in the posterior midgut adjacent to the midgut-hindgut junction corroborating the transcript expression profile. A heterologous expression system was used to confirm the specificity and sensitivity of the CCHa2 receptor by assessing the activity of diverse peptidergic ligands, which revealed CCHa2 exhibited the strongest response. Future research will employ various bioassays and reverse genetic approaches (i.e. RNAi) to elucidate the physiological roles of CCHa2 in this important human-disease vector.

Jocelyn Armistead, Cory Sheffield (Royal Saskatchewan Museum) & Miriam Richards Brock University
A comparison of three bumble bee collection methods for detecting trends in species abundance and distribution

Bumble bee (*Bombus*) populations across Canada are experiencing increases and decreases in both abundance and distribution. To better understand these changes, surveys must be conducted. However, currently many different collection methods are used, and improving our knowledge about how these methods compare would be valuable. The objective of my study is to evaluate three collection methods to determine if they provide the information needed to understand long-term trends in bumble bee population abundance and distribution. From summer until early autumn 2021, I conducted surveys for bumble bees using targeted netting, photographs, and blue vane traps (BVTs) at 8 sites across Niagara. Netting and photographic surveys were conducted for 30 minutes, 3 times, weekly, and BVT contents were collected on these same days. Comparisons among the three collection methods revealed differences in the number of individuals collected, species richness, and species composition. The greatest number of specimens were collected by photographic surveys, but this method produced the lowest species richness. In contrast, BVTs collected the fewest number of specimens, but had the highest species richness. Netting surveys fell in between. As well, species composition varied by collection method. This highlights both the differences between and the need for careful selection of collection methods. These results will help researchers to make informed decisions about which methods would work well for their study purpose. Using the most suitable methods will improve data quality and produce the most accurate representation of bumble bee population trends.

Jesse L. Huisken and Sandra M. Rehan, York University
Social environment, cooperation and conflict in an incipiently social bee, *Ceratina calcarata*

How mutual tolerance is produced, and the role of social environment in inducing cooperation in social groups, remains unstudied in many simple insect societies. Maternal and sibling care and conflict are challenging to manipulate experimentally for many species. Most bees are solitary, but the eastern small carpenter bee, *Ceratina calcarata*, are better defined as subsocial as they engage in prolonged maternal care of offspring. Females form social associations of mothers and a single generation of offspring, including a dwarf eldest daughter (DED) who forages and feeds her adult siblings. Adult assemblages of *C. calcarata* present a unique opportunity to study the effect of social environment on cooperation and sibling care. To study how social environment influences foraging and intranidal behaviours, observation nests were constructed, and unaltered as a control, or treated by removing either only mothers or both mothers and DEDs. Nests were video-recorded for 464 hours during summer (July–August) parent-adult offspring cohabitation. Individual and interactive behaviours were scored. In the absence of mothers, offspring were more avoidant, suggesting that a hierarchy between mother and offspring produces less tolerance between offspring. Aggression was significantly greater in the absence of both mother and DED. We found that foraging was the lowest in the absence of mothers, and persisted in the absence of both mother and DED. This study provides the first detailed account of the intranidal behaviours of this species and experimentally reveals how social environment influences cooperative behaviour.