TEA Student Symposium Abstracts

Talks

Jessica Browne, University of Toronto
Sexual selection on female ground weta leads to female ornaments and post-copulatory sexual selection in males

Sexual ornaments are rare in females, likely due to their potential costs to fecundity or survival. The presence of ornaments indicates strong sexual selection on females, resulting from competition to mate frequently (polyandry) and thus acquire critical goods and services that males provide. This study focuses on the evolution of female ornaments by exploring the conditions that lead to selection for these unusual traits. In addition, I investigate the seemingly paradoxical co-occurrence of strong sexual selection on females with the post-copulatory sexual selection on males that is expected with increased polyandry and thus, sperm competition. I test for sexual selection on females (ornamentation) and males (paternity) using New Zealand ground weta, a group with several species that exhibit valuable male mating gifts and female ornaments, which apparently result from intense sexual selection. Using novel molecular methods to measure female mating success and paternity patterns, I will increase understanding of this exceptional system, which functions a as valuable tool to test theories of sexual selection and sex differences.

Mohammad Arshad Imrit, York University
Mohammad Arshad Imrit, Katie Dogantzis, Amro Zayed.
What is the extent of negative selection in social insects?

Solitary insects evolved and gave rise to eusocial insects showing complex social behaviours, such as kin selection and cooperative brood care. These eusocial insects include honey bees, bumble bees, wasps, and ants among others, with the honey bee being arguably the most recognizable due to its importance as a pollinator and honey production. The honey bee's social behaviour and genome has been studied arduously, making it the model organism to understand the evolution of sociality and how this in turn influence genome evolution. To understand evolution in honey bees, scientists have investigated positive selection to study the genes and traits being affected and how these played a role in adaptive evolution. These genomic studies provided evidence of multiple worker traits being shaped through positive selection and how honey bees became such important pollinators. However, *no studies have yet quantified negative selection on social insects*, and its impact on levels of genetic diversity. To address this gap in knowledge of social insects, my research will determine the extent of negative selection in honey bees, bumble bees, and wasps, through genomic analysis of allele frequencies. This study will address the following questions: 1) Do genes with caste-specific patterns (such as drones, workers, and queens) of dispersal differ in their extent of negative selection, as they do in rates of adaptive evolution? 2) Do worker-biased genes experience a relaxation of selective constraint as previously hypothesized? and 3) How does negative selection correlate with the level of eusociality in insects?

Matt Muzzatti
M.Sc. Candidate, School of Environmental Sciences, University of Guelph
Entomophagy – An exploration of the world's oldest sustainable superfood

Approximately 2 billion people worldwide regularly consume insects, however the practice of entomophagy has been slow to gain popularity among Western culture. The Food and Agriculture Organization of the United Nations (FAO) claims that there are roughly 1900 documented edible insect species. Insects are sustainable superfoods; they are extremely high in protein and vitamin B12, and they require considerably lower amounts of resources than other sources of protein, such as beef or chicken. As well, insects emit much lower greenhouse gas emissions than conventional livestock. Agriculture is one of the leading causes of climate change, and as the planet continues to warm, humans must integrate alternative sources of protein into their diets to help mitigate these changes. The nutritional and environmental benefits of entomophagy are undeniable – so why have Western societies been so slow to integrate insects back into their diets? This presentation will explore the health, environmental, and cultural implications of entomophagy, and will briefly highlight the diversity of insects consumed across the globe.

Alex Proulx, Brock University
Eusocial Behaviours of the Solitary Sweat Bee *Lasioglossum zonulum* in the Niagara Region

Of the ~20,000 species of extant bees, sweat bees (subfamily Halictinae) exhibit substantial diversity in social behaviour, making them prime candidates for research on social evolution. Previous studies indicate that *Lasioglossum zonulum* exhibits solitary behaviour in Europe, however pan trap collections in the Niagara region over the last 15 years suggest that *L. zonulum* displays two periods of foraging activity, a trait consistent with eusocial species. I plan to identify both the number of *L. zonulum* broods and generations produced per year (demographic and genetic voltinism respectively) to test the following three hypotheses: **1.** If *L. zonulum* is demographically univoltine, then it must be solitary. **2.** If *L. zonulum* is demographically bivoltine, and females from the first brood possess a similar degree of ovarian development to foundresses (i.e. are reproductive), then *L. zonulum* is solitary. **3.** If *L. zonulum* is demographically bivoltine, and females from the first brood possess a significantly lower degree of ovarian development than foundresses (i.e. are workers), then *L. zonulum* is eusocial. New specimens will be collected using pan traps and will be used alongside specimens collected over the previous 15 years to determine demographic voltinism via foraging activity periods, and will be dissected to determine genetic voltinism via ovarian development. Phylogenetically, *L. zonulum* exists in a clade of primarily solitary sweat bees, therefore if *L. zonulum* is eusocial or exhibits eusocial behaviours, it could represent an evolutionary transition and independent origin of eusociality in sweat bees.

Catherine Scott, Sean McCann, and Maydianne CB Andrade
Department of Biological Sciences, University of Toronto Scarborough
The amazing race: how male black widows find females faster

Detecting and localizing a potential mate can impose strong sexual selection on males, particularly in species that are otherwise solitary. We examined mate detection and localization by male western widow spiders (*Latrodectus hesperus*) at a field site where there is intense scramble competition among males for access to females. First we assessed how male size and distance from pheromone-emitting females affected mate-searching success and speed. Depending on wind speed and direction, males were able to find females from up to 60 m away, and larger males were more likely to find females, although smaller males achieved higher average speeds. Intriguingly, males that traveled farther were faster on average. We hypothesized that this effect arose because males that had access to social information from silk draglines of other mate-searching males (a byproduct of locomotion) were at an advantage. We then tested this hypothesis with choice tests in the laboratory

that showed males do follow the draglines of conspecific males over controls and draglines of closely related, heterospecific males (*Steatoda grossa*). This result reveals that males use inadvertent social information to improve their mate-searching success in a system where competition over access to mates is fierce.

Lydia Wong, University of Toronto
The earlier the better? Reproductive timing and individual fitness in a solitary bee

The timing of reproduction in a given season can have important effects on reproductive output and offspring success, which ultimately contribute to an individual's overall fitness. These effects may be especially pronounced in highly seasonal environments where growing seasons are short, and favourable periods for reproduction are limited. In such environments, organisms must synchronize reproductive activity with periods of food abundance, but also leave enough time for offspring to undergo sufficient ontogenetic development before winter. Over a five-year period, we tested the effects of nesting timing on individual reproductive output and offspring success in subalpine populations of the solitary bee *Hoplitis fulgida*. We also explored the role of floral abundance and time required for offspring development as factors that potentially impose selection on nesting timing. Rates of nest construction and offspring production decreased as the season progressed. Nest construction rate and offspring production generally increased with floral resource abundance, although this effect was inconsistent among different sites and years. Offspring born later in the season were less likely to have completed cocoon development by late August. Overall, our results suggest that nesting early in the season is advantageous for *H. fulgida* in maximizing both individual reproductive output and offspring success. Although we do yet not have proximate explanations for the patterns we observed, our study highlights the fitness consequences of nesting timing in *H. fulgida* and raises questions about the substantial variation in nesting timing maintained in this species.

Posters

Korrawat Attasaopa, H. Bänziger, T. Disayathanoowat, & L. Packer (Presenter: K. Attasopa, Chiang Mai University)
Resolving a problematic group of stingless bees in the *Lepidotrigona ventralis* species group in Thailand (Hymenoptera: Apidae) with the help of DNA barcoding

Stingless bees are advanced eusocial insects. As important pollinators they are a keystone species of tropical and subtropical forests. The genus *Lepidotrigona* is one of the most economically important bee genera in Thailand. Despite this, the *L. ventralis* species group is unresolved and in need of revision. The taxonomy of this species group is problematic mainly because the workers are cryptic and known males have been erroneously associated with described females. This study involved detailed examination of the genitalia and sterna of previously unknown males, association of males with workers, and analysis of DNA barcodes of sequenced specimens to help distinguish between inter- and intraspecific variation. The results reveal many distinct barcode clusters and some undescribed cryptic species. These results could help resolve problematic taxa in the *L. ventralis* complex, for instance by confirming the validity of *L. doipaensis* and *L. flavibasis* as separate species (both were formerly considered synonyms of *L. ventralis*).

Sumaya Dano*, Ajay David*, Nimra Javaid*, Dilakshan Srikanthan*, Amanda Yee*, N. Singh, C. Scott, & M.C.B. Andrade
University of Toronto

Eaten out of house and home? Effects of cohabiting offspring on fitness of female black widow spiders

Understanding the costs and benefits of group living is important for explaining the evolution of sociality. In spiders, permanent group living has evolved several times independently, likely via extended maternal care and tolerance in sub-social ancestors. Here we studied a population of western widows (*Latrodectus hesperus*) that live at high densities in nature and show facultative group living. Spiderlings can remain on their natal web for days to weeks after emergence, and have been observed feeding on prey captured by their mother. We examined fitness effects of this behavior by investigating how body mass of groups of spiders fed a single prey item changed as a function of relatedness (mother–offspring vs. mother–non-offspring) and spiderling number (zero, one, or ten). We predicted that females would share prey more readily with their own offspring than unrelated spiderlings, and that single spiderlings would benefit more than groups from one shared meal. However, we expected females to incur greater costs from sharing prey with groups of spiderlings. We interpret our data in terms of whether prey-sharing represents a form of passive maternal care or costly kleptoparasitism.

Aleksandra Dolezal
MSc candidate, Integrative Biology, College of Biological Science, University of Guelph
Farming with nature: using restored prairie grasslands to enhance beneficial insect abundance and richness in agricultural landscapes

Intensive agriculture has resulted in dramatic transformations of the landscape; with natural areas reduced to fragments or eliminated by large in a matrix of crop, livestock, and pasture areas. The expansion of monocultures has been a key driver of biodiversity loss, including insect abundance and richness. This has created a management paradox on conventional farms – a need for insect services, yet conducting farm practices that reduce their presence and benefits. One model that has been proposed to help tackle this farm management paradox is so-called “precision agriculture”; a multi-faceted strategy that includes conversion of marginal lands on farms to native species-rich tall-grass prairie, which may provide beneficial services such as insect habitat and critical food resources. This management strategy has been adopted by ALUS Canada with farms around Southern Ontario and is the basis of my study. The objective of this study was to provide a comprehensive arthropod survey on these farms which has not been attempted and therefore lacks information regarding recent prairie restoration efforts. The main questions my study addresses:
1) How does management strategy (ALUS vs conventional) affect beneficial species richness and abundance?
2) What local and landscape factors contribute to greater beneficial insect functional groups (pollinators, predators, parasitoids) that deliver vital ecosystem services?
Although the potential benefits of non-crop management practices are well recognized, the quantification of such services on farms is largely lacking, and are often tested independently and under experimental conditions. Studies under real-world scenarios, which include a gradient of land-use intensities and consider a wide range of arthropod groups, are missing. My study fills these gaps and provides a clear demonstration that precision agriculture which supports ecosystem services, is compatible with, and even increase beneficial insect taxa to agricultural landscapes.

Ilia Maria Ferzoco
MSc student, Dept. of EEB, McCauley lab, UTM, University of Toronto

Co-occurring insect congeners respond differently to cues of predation risk: an experiment in semi-aquatic adult backswimmers (Heteroptera: Notonectidae)

Predators affect prey through direct consumption as well as by inducing prey to defensively alter their phenotypes, including behavioural phenotypes, to maximize survival. Prey commonly adjust activity to avoid predators, but this has negative effects on their ability to acquire resources. Co-occurring prey that share resources and predators may resolve the trade-off between predator avoidance and resource acquisition in different ways which may facilitate the ability of these species to persist in the same environment (i.e. permit competitor coexistence). Here, we experimentally assessed whether two congeneric, co-occurring species of semi-aquatic notonectids (Heteroptera: Notonectidae) detect and respond to visual and chemical cues of a heteropteran top predator commonly encountered in fishless ponds (Heteroptera: Belostomatidae). One species, *Notonecta undulata*, significantly reduced activity in response to chemical cues from the predator, whereas, the other species, *Notonecta irrorata*, did not exhibit behavioural plasticity in response to predator cues. Chemical cues appear to be more important in conveying information on predation risk than visual cues. These backswimmer congeners respond differentially to predators, which may correspond with differential vulnerabilities to the predator, and may affect their ability to coexist as competitors. Ultimately, knowledge of species-specific trade-offs related to predator avoidance will improve our understanding of how competitors coexist.

Nuria Morfin[1], Goodwin PH[1], Hunt G[2], Raine N[1] and Guzman-Novoa E[1]
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Effect of stressors on social immunity in the honey bee (*Apis mellifera*)

Honey bees *(Apis mellifera* L.*)* are exposed to a number of stressors, including insecticides and pathogens, such as the ectoparasitic mite *Varroa destructor*. Honey bees have developed social immunity, including grooming behavior, to defend themselves against diseases. Little is known about the effect of biotic and abiotic stressors on social immunity and the impact on honey bee health. To evaluate the effect of biotic and abiotic stressors and their combined effects, honey bees were exposed to three different sublethal doses of the insecticide clothianidin and/or *V. destructo*r for seven consecutive days. Through an evaluation of individual grooming behavior, this study found that sublethal doses of clothianidin, *V. destructor*, and their combination significantly reduced the proportion of bees that groomed intensively. Also, an interaction between the stressors was found in the expression of the gene neuroligin (*AmNlg-1*), which codes for a postsynaptic protein that interacts with the protein neurexin during synapse. Neurexin, coded by *AmNrx-1*, has been associated with grooming behavior in bees. Thus, these results suggest that the stressors, alone and combined, affect cognitive processes and the ability of the bees to remove pathogens from their bodies, which could have an impact on honey bee health and consequently contribute to colony mortality.

Negar Mir Sharifi
PCYU, York University
Phylogenetic Analysis and Description of Nine New Species of the Bee Genus *Liphanthus* Reed with Two Submarginal Cells

The panurgine genus *Liphanthus* has been thought to have only a single species with two, as opposed to three, submarginal cells. However, I discovered nine *Liphanthus* species with only two

submarginal cells and consequently I have been describing them. I verified that none of these are merely two submarginal celled variants of species with three submarginal cells by comparing each of the new species with all keys, figures and descriptions of all *Liphanthus* species and comparisons of most species with paratypes of Chilean species. Here, the genus is recorded from Bolivia for the first time. In addition, I performed a phylogenetic analysis for 38 taxa (24 described *Liphanthus* species, 9 undescribed *Liphanthus* species, and five outgroups) by scoring 52 morphological characters. Based on the results of equally weighted character, implied weighting and successive approximation character weighting analysis, *L. toroi* was assigned to the subgenus *L. (Xenoliphanthus)*. In addition, it was suggested that *L. bicellularis* belongs to the subgenus *Leptophanthus*. Species group 1 (sp. Bolivia, sp. Peru and sp. Argentina), species group 2 (sp. R II, sp. R III and sp. R IV) and species group 3 (sp. R V and sp. R metro) are monophyletic and each should also be given its own subgenus.