TORONTO ENTOMOLOGISTS' ASSOCIATION STUDENT SYMPOSIUM 2023 ABSTRACTS

Stephanie Allen. Nicholas Mandrak lab, University of Toronto

Imperfect Detection of an Endangered Riverine Dragonfly, Rapids Clubtail (*Phanogomphus quadricolor*): Implications for Monitoring

Ontario is home to four endangered riverine dragonflies in the family Gomphidae. Despite listing and recovery strategy development for each species, there has been little effort to monitor the species, determine specific threats, and, to date, no specific recovery efforts have been reported for any of the species. To determine how and when to monitor Rapids Clubtail, *Phanogomphus quadricolor*, field surveys were conducted at known sites for the species. Surveys were conducted in southern Ontario for exuviae in the Grand and Nith rivers, followed by adult surveys in the Grand, Nith and Humber rivers. Occupancy modelling using PRESENCE software resulted in a detection probability (p) at known sites of 0.1282 for exuviae and 0.5334 for adults during previously known emergence periods. Adult detectability was significantly and negatively affected by cloud cover. *Phanogomphus quadricolor* emergence occurred over a period of one week in the Nith River and was found on just one day in the Grand River. Based on this study, adult flight time in 2021 in the Grand River was May 23 – June 19 and in the Nith River was May 31 – June 19, a substantially shorter flight time than in previously published reports. Implications for Insect Conservation: this study demonstrates that survey methods for rare dragonflies need to consider imperfect detection. Results also indicate that ongoing monitoring of *Phanogomphus quadricolor* at known sites using multiple life history stages is needed.

Alice Carvalho Assmar. Supervisor: Jessica Gillung, McGill University

Past, present, and future of freshwater insects: evolution and diversification of Osmyloidea (Insecta: Neuroptera)

Freshwater insects inhabit freshwater environments in at least one stage of their lifecycle and represent ~60% of all freshwater biodiversity. They play important ecological roles, such as in the food web and controlling invasive species. However, their populations are sharply declining, mostly due to climate change and human-mediated pollution. Major life strategy transitions, such as aquatic-terrestrial lifestyles, require a series of adaptations, and by deciphering these transitions we can better understand the macroevolution, diversification, and conservation needs of these organisms. Neuropterans are an excellent model for investigating life strategy transitions. They are predominantly terrestrial, except for Osmyloidea. Osmyloidea comprises three families, two truly aquatic (Sisyridae and Nevrorthidae) and one terrestrial and semi-aquatic (Osmylidae). The ancestral larval habitat of Osmyloidea has yet to be deciphered, and both aquatic and terrestrial origins have been proposed. The specialized feeding on freshwater sponges and worldwide distribution of Sisyridae, and the generalist feeding behaviour and restricted distribution of Nevrorthidae makes Osmyloidea an interesting model for testing biogeographic hypotheses of freshwater insects. My research comprises a macroevolutionary study of Osmyloidea based on extensive phylogenomic dataset. By combining statistical comparative analysis with distributional and climatic data, I aim to reconstruct the ancestral life history and historical biogeography of Osmyloidea to understand when the transition happened and how these organisms have distributed on Earth. Understanding insects' life strategy transitions and diversification can help us understand how they responded to climate change in the past. This knowledge can contribute to our understanding of the major drivers of species diversification.

Heloísa Fernandes Flores. Supervisors: Dr. Jessica Gillung / Dr. Dalton Amorim, Universidade de São Paulo / McGill University

Evolution of kleptoparasitism in jackal flies (Diptera, Milichiidae)

Stealing or taking advantage of another organism is a well-known strategy of resource gathering in the tree of life, and it is used by some of the key components of natural, urban, and agricultural environments: parasites. Among parasites, several animal groups evolved a type of interaction known as kleptoparasitism. Jackal flies (Milichiidae, Diptera) are a diverse group of kleptoparasites of other arthropods with approximately 420 species distributed worldwide. These flies also display other resource exploitation strategies, including coprophagy, saprophagy and even herbivory. Kleptoparasitism has likely influenced the morphological diversity and geographical distribution of jackal flies, further demonstrating that these insects provide an outstanding model for investigating the coevolutionary hypothesis across time and space. In addition, kleptoparasitic lineages vary in their level of specialization. Therefore, Milichiidae represents a great study system to broaden our understanding of the consequences of kleptoparasitism to diversification dynamics, and investigate how niche breadth affects speciation. Using jackal flies as model and genomic and statistical comparative tools, my research explores the historical associations between kleptoparasitic jackal flies and their hosts, and their significance to the group's diversification dynamics. This research project will advance our knowledge of the evolutionary origins and adaptations of this specialized life-history, and it will bring new insights on the ecosystem functions delivered by kleptoparasites in natural environments. In addition, it also expands what we know about the diversity, evolution, diversification, and natural history of jackal flies.

Wei Han Lau. Supervisors: Lock Rowe & Rowan French, University of Toronto

Do broader heads make for a stronger bite? A biomechanical analysis of a putatively ecologically dimorphic trait in the northeastern pine sawyer beetle (Cerambycidae: *Monochamus notatus*)

The diverse array of sexually dimorphic traits in nature can be shaped by different forces of selection. Although many sexual dimorphisms result from sexual selection, some instead arise as a result of divergent patterns of natural selection on homologous traits in ecologically differentiated males and females. Biomechanical studies of such ecological dimorphisms can clarify how differences in performance between the sexes can be shaped by variation in ecologically relevant modes of behaviour and their associated patterns of morphological divergence. Here, I quantitatively link morphology to performance to study the function of a putative ecological dimorphism. In this study, I examine the trait of bite force in *Monochamus notatus*, a species of longhorn beetles in which the capacity to chew oviposition slits is a distinctive aspect of female reproductive behaviour. Female *M. notatus* have wider heads than males, and I hypothesize that this represents an ecological dimorphism resulting from the different ways in which the different sexes utilize their mandibles. Through an analysis of external morphology and microtomographic scans of specimen heads, I test whether morphological differences are associated with bite force divergence between males and females. I measure the mechanical advantage of the mandibular lever system, muscle fibre length, and muscle volume to approximate the trait of bite force from ethanol-preserved specimens. Linear measurements of the size and shape of the morphology of *M. notatus* were also taken to examine the scaler relationship of various traits between the sexes.

Cailyn Rose McKay. Jeremy McNeil lab, Western University

Heat stress experienced during metamorphosis: impacts on pheromone-mediated mating in the true armyworm (*Mythimna unipuncta*)

While larval and adult stages of insects can move to more suitable habitats to avoid extreme temperature conditions, this is not an option for the sedentary egg and pupal stages. Thus, the increase in extreme weather events, such as heatwaves, could have a greater impact on these immobile stages. The true armyworm (*Mythimna unipuncta*) was used as a model to examine the effects of short-term heat stress during several stages during pupal development on the lifetime fecundity of females, and the fertility of eggs produced. While the data obtained showed there were direct effects of the heat stress, they also indicated that there was a reduction in the incidence of mating, regardless of which sex experienced heat stress. This could suggest that pheromone-mediated communication was impacted by pupal heat stress in both sexes. Repeating the heat stress experiments, pupal heat stress will this time be examined for potential effects on female calling behaviours, as well as the titers of both female and male sex pheromones. In addition, the responsivity of male and female antennae to sex pheromone of the opposite sex will be tested to determine if pupal heat stress affected pheromone perception. If results show that short-term heat stress experienced during metamorphosis alters pheromone-mediated communication, this could be of considerable importance within the context of climate change as pheromones are used in many pest management programs and other species may experience similar outcomes.

Campbell Allan McKay. Jeremy McNeil lab, Western University

Could the use of different species of milkweed as larval hostplants influence the fall migration of Monarchs?

In insects, the quality of the larval diet can significantly affect adult parameters, including mass, morphology, and fecundity. In addition, it can influence development time, shifting adult flight periods. For migratory species, this is particularly important, as earlier emerging fall adults may experience environmental cues that stimulate reproduction instead of migratory behaviour, resulting in an evolutionary dead end. The monarch butterfly (*Danaus plexxipus*) exclusively exploits milkweeds (*Asclepias* spp.) as their larval host plant. While studies have examined the effects of different species of larval host plants on summer generations, little attention has been given to the migratory fall generation. To study how larval host plant species may affect traits which can influence a timely departure and the capacity to undertake a long-distance migratory flight, I reared monarch butterflies in 2022 on three species of milkweed: common milkweed (*A. syriaca*), swamp milkweed (*A. incarnata*), and butterfly milkweed (*A. tuberosa*), using both measured leaf cuttings and whole plants outdoors under summer and fall conditions. I compared the effect of larval host plant on food consumption and assimilation, as well as on development time, adult body mass, wing surface area, and wing loading. While initial results indicate that larval host plant species may influence important traits such as development time and wing size, small sample sizes due to a smaller than usual immigrant population and high mortality in the field prevent me from drawing any strong conclusions. I will be repeating the experiment in 2023, increasing the number of individuals used.

Pooja Nathan. Megan Fredrickson lab, University of Toronto
Understanding latitudinal variation in mutualistic interactions: a case study using the castor bean plant, *Ricinus communis*, in the Indian subcontinent

The Biotic Interactions Hypothesis posits that interactions with other species, rather than environmental variables, and the primary agents of selection on living organisms as we move closer to the equator. Mutualism has recently begun to gain traction as an important factor in structuring and maintaining biodiversity, but there is mixed evidence in the literature on how the degree of generalization, intensity and diversity of partners in mutualism vary across latitude. In this study, we surveyed the mutualistic interactions of the castor plant (*Ricinus communis*) with ants across a 20° latitudinal range across the Indian subcontinent to understand how mutualism with ants varies with latitude. In addition to being cultivated extensively for oil in India, castor plants are widespread close to human settlements. These plants produce different kinds of extrafloral nectaries (EFNs) and their seeds have fat-rich structures called elaiosomes, both of which are consumed by ants which may in turn protect the plant from herbivores and disperse its seeds. We measured mutualistic traits (EFN volume, size and number, elaiosome size) and interactions in castor populations in ten sites across India. We found that investment in mutualism by castor plants and the species richness of ant partners increases from temperate to tropical latitudes. We also found that herbivory decreased from temperate to tropical latitudes suggesting that recruiting ants as bodyguards is an effective anti-herbivore strategy. Taken together, our results lend support to the Biotic Interactions Hypothesis and contribute to a deeper understanding of the biogeography of species interactions.

Janean Sharkey. Nigel Raine lab. University of Guelph
Bee communities in tallgrass prairie and oak savanna in Southern Ontario
Restoring rarities: the impact of habitat management and restoration on wild bee communities in tallgrass prairie and oak savanna in southern Ontario
Understanding how restoration and land management practices may impact the structure of wild bee communities is important especially considering reported global bee declines. I assessed bee community composition in tallgrass prairie and oak savanna, one of the most endangered and biodiverse habitats in Canada. I found distinct differences in bee abundance and diversity among land management types, with remnant sites in most cases having comparably low bee diversity. This was driven by differences in floral abundance, canopy cover, and presence of woody debris. Bee community composition was unique at each locality, and I documented several bee species for the first time in Canada. Linking landscape structure with use will improve habitat management and bee conservation in this rare habitat.

Lydia Wong. Jessica Forest lab. University of Ottawa
It's getting hot and dry: what does this mean for subalpine cavity-nesting bees?
In recent decades, rapid warming has altered the environmental conditions experienced by many organisms. Bees play critical ecological roles as the primary pollinators of many wild plants and food crops, yet the consequences of climate change for their populations remain unclear. My work uses observational field methods to explore the relationships between temperature and population success in wild bees in the Colorado Rockies:
Firstly, I use a six-year dataset to characterize relationships between bee egg production (reproductive output) and daily temperature condition. I show that female bees produced eggs at a faster rate given warmer temperature conditions (more eggs produced per day), but that this ultimately does not result in higher total egg production per individual (reproductive output). This decrease in individual reproductive output is mediated by a decrease in female bee longevity given warmer temperature conditions.
Secondly, I explore the potential for upslope range shifts in cavity-nesting bees. I focus on species that nest in pre-existing holes in dead wood left behind by wood-boring insects. Cavity-nesting species may experience nest-site limitation if thermally suitable habitats shift beyond local treelines—a conceivable mismatch given that the rate at which bees can disperse and potentially expand their ranges likely outpaces the rate at which tree populations shift and subsequently age to serve as suitable nesting habitat. I ask whether upward range shifts in cavity-nesting bee populations are limited by the lack of nesting cavities at high elevations. I present preliminary results showing decreased nesting activity with increasing distance from local treelines.

Ruishen Zhang. Supervisors: Jessica Gillung, Morgan Jackson. McGill University
A taxonomic review of Canadian Oestridae
Family Oestridae is known as bot flies or warble flies. They are a family of obligate mammal parasites. While they have been well-researched as agriculture pests, but rarely known as a part of insect fauna in Canada. My research is to investigate the Canadian fauna of Oestridae based on adult morphology. To approach this goal, I examined over 1800 Canadian specimens and identified them to species level. I have developed the identification keys for genera-level and species-level Canadian Oestridae with high-definition illustrations. Currently, I am databasing all the specimens I have examined, dissecting the genitalia for both males and females, for each Canadian oestrid species. Genitalia morphology will be used to verify two potentially new species of *Cephenemyia* and attempt to discriminate *Cuterebra grisea* Coquillett 1904, as an individual species or a subspecies of *Cuterebra fontinella* Clark 1827. In the century of gene and molecular biology, we are still missing much basic morphology knowledge in many taxa. My research will fulfil this gap in Canadian oestrid fauna.