Keynote Speaker:

Dr. Shalene Jha,

Associate Professor
Department of Integrative Biology
University of Texas, Austin

presenting...

Plant-pollinator Interactions and Ecosystem Services in the Face of Global Change

BeeCon 2021

October 15-16, 2021

(a free, virtual event)

Virtually Hosted by: Centre for Bee Ecology, Evolution & Conservation

York University, Toronto, Canada

The mission of the Centre for Bee Ecology, Evolution & Conservation (BEEc) is to foster interdisciplinary, innovative, collaborative, & cutting-edge research to be used for the advancement of knowledge and implementation of policy changes, to help sustain pollinators globally.

For more information about BEEc, please visit https://www.yorku.ca/bees/

About BeeCon

Fostering an inclusive, barrier-free, and safe space to host BeeCon is paramount. We aim and are committed to ensuring that every person feels safe, respected and free from harassment and discrimination, while attending this event. All event participants, speakers and guests are expected to uphold these values and York's commitment to being a "welcoming and approachable campus, embracing global perspectives and differences in cultures, people and thinking, by engaging communities in collegial dialogue" (York University Free Speech Statement of Policy 2018, s.3(1)).

BeeCon is an annual free symposium for local and international melittologists (bee biologists) to present & discuss their work on a wide range of bee-related topics, including behaviour, genetics & genomics, ecology, and conservation. The inaugural BeeCon meeting took place in 2011 & has since been organized & hosted annually by YorkU researchers.

Support for this event has been provided by York University's Vice-President Research & Innovation, the Faculty of Science and the Faculty of Environmental & Urban Change.

BeeCon logo by: Spencer Monckton.

BeeCon 2021 Program Schedule

Friday, October 15, 2021 (eastern time)

9:00 am	Welcome & land acknowledgement
9:15 am	Introduced honey bees are no honeys for native bees & pollination networks in an urbanised biodiversity hotspot - Kit Prendergast
9:30 am	Can green roofs compensate for the loss of (Hymenopteran) biodiversity in cities? - Jeffrey Jacobs
9:45 am	Phylogeny & rapid diversification of the mining bee family (Andrenidae) - Silas Bossert
10:00 am	Studying the backyard bee-cosystem: using community science to investigate cavity nesting bees across Canada - Sage Handler
10:15 am	Beekeeping livelihood development in Nepal: value-added opportunities & professional support needs - Kedar Devkota

Morning Break (10:30-11:00 am)

11:00 am	KEYNOTE PRESENTATION: Plant-pollinator Interactions & Ecosystem Services in the Face of Global Change - Shalene Jha
12:00 pm	Assessing the impacts of urban beehives on wild bees using individual, population-level, & community level metrics - Hadil Elsayed
12:15 pm	Assessing pollen nutrition impacts on bumblebee health & reproduction - Sarah MacKell & Mathilde Tissier

Lunch Break (12:30-1:30 pm)

1:30 pm	Quantifying the impact of neonicotinoids & new-generation insecticides on bee health - Harry Siviter
1:45 pm	Development of diagnostic tools for neonicotinoid exposure in the western honey bee (*Apis mellifera*) using transcriptomics - Aidan Jamieson
2:00 pm	Sublethal effects of single & combined realistic exposure to pesticides used on squash crops on a ground-nesting solitary squash bee (*Eucera pruinosa*) - Sabrina Rondeau
2:15 pm	The role of nicotinic acetylcholine receptors in learning & memory - Nadia Tsvetkov
2:30 pm	The molecular basis of altruistic & selfish aggression in honey bees - Kathryn Galang
2:45 pm	Effects of social status on aggression in a facultatively social bee species (*Xylocopa virginica*) - James Mesich

Afternoon Break (3:00-3:30 pm)

3:30 pm	Maternal investment patterns in a facultatively social bee showing that socially dominant females forage more than solitary females - Lyndon Duff
3:45 pm	Social environment & sibling cooperation in a small carpenter bee - Jesse Huisken
4:00 pm	A large-scale field-test of beneficial bacteria as a practical in-hive supplement - Brendan Daisley
4:15 pm	The effect of elevation on tropical bee species abundance & crop visitor assemblage turnover within a narrow elevational gradient - Kristin Conrad
4:30 pm	Forest landscapes increase diversity of honey bee diets in the tropics - Chris Cannizzaro
4:45 pm	Closing Remarks

BeeCon 2021 continued...

Saturday, October 16, 2021 (eastern time)

8:45 am	Land acknowledgement
9:00 am	Holocene population expansion of a tropical bee coincides with early human colonisation of Fiji rather than climate change - James Dorey
9:15 am	The effects of human-driven landscape disturbance on wild bee communities & plant bee networks across southern Manitoba, Canada - Emily Hanuschuk
9:30 am	The risks of crop exposure to honey bee colonies - Sarah French
9:45 am	The blueberries & the bees: assessing honey bee health stressors using proteomics - Rhonda Thygesen
10:00 am	How large colony sizes can select for higher meiotic recombination - Clement Kent
10:15 am	Corpse management in bumblebee colonies - Victoria Blanchard
10:30 am	A comparison of *Bombus* collection methods for detecting trends in species abundance - Jocelyn Armistead

Morning Break *(10:45-11:00 am)*

11:00 am	Disturbance type, landscape, groundcover, & trap type affect wild bee captures in the endangered tallgrass prairie ecosystem - Reid Miller
11:15 am	Assessment of habitat use & ecology of native bee communities in tallgrass prairie & oak savanna in Southern Ontario - Janean Sharkey
11:30 am	Bees & aculeate wasps in disappearing Canadian prairie sandhill environments - Thomas Onuferko
11:45 am	Preliminary morphological phylogeny of *Liphanthus* (Andrenidae: Panurginae) - Nora Romero
12:00 pm	Down the bee-burrow, unexpected diversity in the *Lasioglossum gemmatum* species complex - Joel Gardner
12:30 pm	Native Perennial Plantings for Pollinators in Eastern Tennessee - Laura Russo
12:45 pm	Closing Remarks

LAND ACKNOWLEDGEMENT

We recognize that many Indigenous nations have longstanding relationships with the territories upon which York University campuses are located that precede the establishment of York University. York University acknowledges its presence on the traditional territory of many Indigenous Nations. The area known as Tkaronto has been care taken by the Anishinabek Nation, the Haudenosaunee Confederacy, the Wendat, and the Métis. It is now home to many Indigenous Peoples. We acknowledge the current treaty holders and the Mississaugas of the Credit First Nation. This territory is subject of the Dish With One Spoon Wampum Belt Covenant, an agreement to peaceably share and care for the Great Lakes region.

Introduced honey bees are no honeys for native bees and pollination networks in an urbanised biodiversity hotspot

Kit Prendergast, Curtin University, Australia

Authors: Prendergast, K.S., Ollerton, J., Dixon, K., & Bateman, P.W.

The European honey bee *Apis mellifera* is a widespread, eusocial domesticated species, and having been introduced across the globe, including Australia, there are concerns that it may harm native bee fauna and disrupt pollination networks. In the southwest Western Australian biodiversity hotspot we investigated the relationship between honey bee abundance and native bee diversity, and honey bees' role in bee-plant networks in seven residential gardens and seven bushland remnants over two years. Honey bees on average dominated assemblages and were found to differ significantly from native bee taxa in species-level roles in interaction networks, visiting more plants, especially non-natives. Greater honey bee abundance disrupted network properties, increasing generalisation, niche overlap and functional complementarity, whilst decreasing connectance. Honey bee abundance had no overall correlation with native bee abundance. However, impacts of honey bees were evident on larger native bees and on taxa that had high resource overlap with honey bees. Relationships between honey bees and native bee species richness varied from positive to negative between years. Greater floral resource levels exacerbated negative impacts, likely by favouring honey bees. We conclude that honey bees can negatively impact pollination networks, and their impacts on native bees will vary by ecological context and native bee life-history traits.

Can Green Roofs Compensate for the Loss of (Hymenopteran) Biodiversity in Cities?

Jeffrey Jacobs, Hasselt University, Belgium

Authors: Jacobs, J. & Artois, T.

Green roofs are often promoted to counter the negative environmental effects of urbanization on nature and to increase the amount of green space in cities. However, how they can support biodiversity and more specifically what is driving the species richness and community composition of Hymenopteran on green roofs is rarely studied.

We have sampled invertebrate communities on eighteen extensive green roofs over a half year period from march until September (2020), in the city of Antwerp, Belgium. Our assumption was that the more isolated (from e.g. green spaces) the roof was the less biodiversity we would find there, as it becomes more and more difficult for species to colonize these isolated habitats.

We compiled overall abundance of the Hymenoptera as well as the total abundances of these species from the different traps on all green roofs. However, we were unable to support our hypothesis that we would find significantly less biodiversity in more isolated roofs compared to roofs closer to green spaces. We are currently repeating our sampling period (March-September 2021) on the same extensive green roofs.

Phylogeny and Rapid Diversification of the Mining Bee Family (Andrenidae)

Silas Bossert, Washington State University, USA

Author: Bossert, S.

The mining bees (Andrenidae) are a major bee family of over 3,000 described species with a nearly global distribution. Despite their ecological and evolutionary significance, our knowledge on the evolutionary history of Andrenidae is sparse. My talk focuses on the phylogeny of Andrenidae and their extraordinary diversification in the Neogene. I show that diversification rates of Andrenidae steeply increased

over the past 15 million years, particularly in the genera *Andrena* and *Perdita*. My results suggest that these two groups and the brood parasites of the genus *Nomada* (Apidae), which are the primary parasitic counterparts of Andrena, are similar in age and may represent the fastest-diversifying lineages of all bees.

Studying the backyard bee-cosystem: using community science to investigate cavity nesting bees across Canada Sage Handler, University of Guelph, Canada

Authors: Handler, S.F., Steinke, D. & Raine, N.E.

Ecological interactions are often very challenging to study as they are complex and difficult to observe. Many interactions provide essential services to the environment and to humans. For instance, solitary bees are essential pollinators of many fruit, vegetable, nut, and animal feedstock crops and sustain the diversity of terrestrial plant ecosystems. However, habitat loss and fragmentation threaten their populations across Canada. Bees@Schools is a community science program aimed at educating students about the importance and diversity of Canada's bees while collecting data on cavity-nesting bee distributions. Each year, nest boxes are distributed to elementary and high schools across Canada and installed on school grounds in May. In September, nest boxes are returned to the University of Guelph, and all occupants and their food sources are identified using DNA metabarcoding. Bees@Schools is in its 3rd year, and so far, nest boxes have been distributed to over 250 schools allowing us to better understand the distribution of cavity-nesting hymenopterans and their interactions with the environment and other species. These results will aid management decisions in supporting their populations and the essential ecosystem services they provide.

Beekeeping Livelihood Development in Nepal: Value-added Opportunities and Professional Support Needs Kedar Devkota, Agricultural and Forestry University, Nepal

Authors: Devkota, K., Egan, P.A., dos Santos, C.F. & Blochtein, B.

Beekeeping contributes to poverty reduction in many developing countries. In Nepal, management practices associated with beekeeping are poorly characterised, and so the potential contribution of this sector to rural livelihoods remains unclear. This study sought to identify factors associated with production efficiency and financial profitability of beekeeping, with the aim of enhancing economic gains for Nepalese beekeepers. Profitability of beekeeping with the European honey bee (Apis mellifera) and the Asian honey bee (*Apis cerana*) was assessed from a sample of 150 respondents from 22 commercial beekeeping districts The results showed that different types of management practices (such as number of beehives kept, colony multiplication, supplementary feeding, marketing strategy, time of harvesting) and professional supports (such as the availability of subsidies and training) were key factors to enhance beekeeping productivity and profitability. As a whole, this work can help guide policymakers and practitioners to expand commercial beekeeping for sustainable livelihood development in Nepal.

Friday Morning Break

4 Bees (Sarah Peebles. July, 2017, 7 min, video with 2-channel audio)

An observable bee nesting plank is inhabited by several solitary native bees actively constructing nests in adjacent tunnels. These bees and visible tunnel nests created earlier in the season reflect a variety of solitaries. Their quiet sounds are amplified by an embedded vibrational sensor. Bees include 3 species of leafcutter bee,

one of which uses resin (all *Megachile* genus); a small resin-using bee, banded sweat bee *Heriades carinata* and a grass-carrying wasp (*Isodontia* genus). This nest plank is situated in a cabinet accessible to the public as a sensory experience for viewing with loupe and headphones in tandem.

Filmed at Sonic Solitaries sensory bee cabinet, Rooftop Garden - Access Alliance Multicultural Health and Community Services, Toronto. Peter Gmelling, camera. Sarah Peebles, amplified nest plank, bee observation cabinet. Rob Cruickshank, audio electronics.

Sarah Peebles is a Toronto-based artist and music improviser. Her project, "Resonating Bodies", is a long-term series of integrated media installations, community outreach projects and educational initiatives which focuses on biodiversity of pollinators indigenous to the natural and urban ecosystems of Canada and beyond. Special thanks to Packer Lab (YorkU), MacIvor Lab (UT Scarborough) and Richards Lab (Brock U) for occasional consultation and assistance.

KEYNOTE: Plant-Pollinator Interactions & Ecosystem Services in the Face of Global Change Shalene Jha, University of Texas, Austin, USA

Ecosystem function and resulting services are essential for human well-being and are often the product of species interactions, such as the interaction between plants and animal pollinators. More than 80% of all flowering plant species benefit from pollination services, including the majority of global crop species; despite this fact, we know little about how changes in local and landscape management and regional climate impact ecosystem function. In this talk, I will evaluate ecological and evolutionary processes from genes to landscapes to quantify global change impacts on plant-animal interactions, movement ecology, and the provisioning of ecosystem services. Specifically, this will cover the local and landscape drivers of pollinator diversity, the complex and dynamic nature of wild pollinator foraging, and the critical impacts of urbanization and climate change on gene flow processes across historic and contemporary time periods.

Assessing the Impacts of Urban Beehives on Wild Bees Using Individual, Population-level, and Community Level Metrics Hadil Elsayed, York University, Canada

Authors: MacKell, S.E., Elsayed, H.L. & Colla, S.R.

Several species of wild bees are in decline globally and the presence of managed honey bees is one of many proposed stressors on wild bee populations. However, there is limited knowledge of the impacts of honey bee hives on wild bees, especially in urban landscapes. We performed a field study to assess the associations between honey bees and wild bees within the Greater Toronto Area in Ontario, Canada. We measured relative abundance of honey bees, wild bee metrics (abundance, community composition, and functional diversity), and floral resources (floral density and richness); we also calculated impervious surface at 500m and 1km for each of our sites. Our main findings were that increasing honey bee abundance was associated with decreases in the abundance of certain

bee species, as well as reduced species richness and functional diversity. This research adds to the growing body of literature aiming to evaluate whether honey bees are a stressor on wild bees in urban landscapes, which will be valuable for informing conservation management practices and future research.

Assessing Pollen Nutrition Impacts on Bumblebee Health and Reproduction

Sarah MacKell, Wildlife Preservation Canada & Mathilde Tissier, Bishop's University & Université Laval, Canada

Authors: Tissier, M. & MacKell, S.

To provide adequate nutrition to bumble bees in managed landscapes and lab environments, we need a better understanding of how different pollen sources impact bumble bee health and reproduction. We assessed the impact of multiple pollen sources on bees' reproduction success and disease prevalence. We installed 40 wild caught *Bombus impatiens* and *Bombus griseocollis* queens. Half were fed commercially available mix pollen (control group) and the other half were fed 75% red maple pollen (*Acer rubrum*) and 25% mix pollen. Preliminary results of their reproductive success highlight that red maple fed queens had a 2-4 times higher initiation success (80% for *B. impatiens* and 60% for *B. griseocollis*) than mix fed queens (20% for *B. impatiens* and 30% for *B. griseocollis*). We then formed 45 micro-colonies of 5 workers from the main B. impatiens colonies, fed either: 1) mix pollen (N=15), 2) mix pollen and hawthorn (*Crataegus canadensis*, N=15), or 3) mix pollen and sumac (*Rhus typhina*, N=15). We monitored their pollen preferences and reproductive success. All ejected larvae and dead specimen were stored for disease screening. Sub-samples of pollen were collected for assessment of their nutritional composition. This study will help inform land managers and captive breeding programs on the ideal pollen sources for bumble bees to ensure healthy and reproductively successful populations.

Friday Lunch Break

Join us between 1:00-1:30pm!

We will be hosting a speed networking event in a separate zoom meeting.

Get to know your bee colleagues better!

Quantifying the Impact of Neonicotinoids and New-generation Insecticides on Bee Health

Harry Siviter, University of Texas, Austin, USA

Authors: Siviter, H. & Muth, F.

Domesticated honey bees are a flagship species for insect conservation, but wild bees are also vital to both food production and wild ecosystems. Wild bee declines are driven by a multitude of anthropogenic stressors such as intensive agriculture, which is highly reliant on pesticides for controlling unwanted pest species. Neonicotinoid pesticides are the most commonly used insecticides globally, yet assessment of their use has typically been based around their effects on honey bees. In addition, with the restriction of these pesticides in the EU and increasing pest resistance, novel insecticides such as sulfoxaflor are replacing them in many areas, with a similar lack of assessment of their sub-lethal effects on non-target beneficial insects. In two meta-analyses, we quantified the impacts of neonicotinoids and novel insecticides on bee health. We found robust evidence that both neonicotinoids and novel insecticides have significant negative sub-lethal effects on bees at field-realistic levels. Our analysis also highlights key gaps in the

literature, confirming the dearth of data on solitary bees. More broadly our research demonstrates that environmental risk assessments are failing to protect bees from the unwanted consequences of agrochemical use.

Development of diagnostic tools for neonicotinoid exposure in the western honey bees (*Apis mellifera*) using transcriptomics

Aidan Jamieson, BeeCSI Consortium, York University, Canada

Authors: Aidan Jamieson, A. & Zayed, A.

Pollination is vital in agriculture as it is a key process in the reproduction of flowering plants. The eusocial western honey bee, *Apis mellifera*, is the only honey bee in North America and is the most commonly used managed pollinator in the world. In Canada, honey bees contribute $3.97 to $5.5 billion to the national economy each year via their pollination services. Unfortunately, honey bees are susceptible to a wide range of interacting stressors, including insecticides used in agriculture. This has resulted in increasing rates of overwintering mortality worldwide. In particular, Canadian beekeepers have been losing more than a quarter of their colonies annually since 2006. Neonicotinoids are a specific class of insecticides that have been linked to decline in pollinator health. Exposure results in neural dysfunction leading to changes in behaviour, altered development, or death. It can be difficult to disentangle and identify specific stressors that affect a particular colony. Our research aims to solve this problem by conducting field and laboratory studies to develop biomarkers specific to two common neonicotinoids based on differential gene expression in response to exposure.

Sublethal effects of single and combined realistic exposure to pesticides used on squash crops on a ground-nesting solitary squash bee (*Eucera pruinosa*)

Sabrina Rondeau, University of Guelph, Canada

Authors: Rondeau, S. & Raine, N.E.

Mounting evidence supporting the negative impacts of neonicotinoids on bees has led to the registration of novel "bee-friendly" insecticides for agricultural use. Flupyradifurone (FPF) is a butenolide insecticide that shares the same mode of action as neonicotinoids. FPF has been assessed to be "practically non-toxic to adult honey bees" using current risk assessment procedures. However, these risk assessments do not consider the many different routes of exposure specific to wild bees. For instance, solitary ground-nesting bees could be exposed to FPF residues in soil when nesting on farmlands. Combined exposure with other pesticides may also lead to detrimental synergistic effects. We used the hoary squash bee (*Eucera pruinosa*) as a model species to assess the possible effects of realistic exposure to FPF (Sivanto Prime, soil application) and the fungicide Quadris Top (azoxystrobin + difenoconazole, foliar spray application), alone or in combination, on the survival, foraging and motor activity, and reproductive output of ground-nesting bees. Squash bees exposed to squash plants sprayed with Quadris Top collected less pollen per single flower visit while those exposed to both pesticides in combination, but not individually, showed increased motor activity. The potential ecological implications of these effects will be discussed.

The role of nicotinic acetylcholine receptors in learning and memory

Nadia Tsvetkov, University of British Columbia, Canada

Author: Tsvetkov, N.

Nicotinic acetylcholine receptors (nAChRs) are ligand-gated ion channels, which are involved in many

behaviors, including learning and memory. They are modular, with five subunits making a single receptor. Different combinations of subunits produce receptors with different physiological properties, however we still don't know the composition of insect nAChRs, despite the fact that they are the targets of neonicotinoids, the most commonly used insecticide in the world. In our study, we plan to expose honey bee workers to a chronic dose of clothianidin, a neonicotinoid, and test their learning and memory. We then plan to perform a proteomic analysis on the brain in order to determine the subunit composition of nAChR after neonicotinoid exposure and whether it correlates with learning and memory performance.

The Molecular Basis of Altruistic and Selfish Aggression in Honey Bees Kathryn Galang, York University, Canada

Authors: Galang, K. & Zayed, A.

The aggressive behaviour of the Western honey bee, *Apis mellifera*, is prototypically characterized by stinging. A worker bee will sting intruders to defend her hive. This behaviour is frequently categorized as altruistic as workers sacrifice themselves to protect their sisters and queen. In sharp contrast, a virgin queen bee selfishly stings to obtain reproductive control of the colony. A newly emerged virgin queen will seek out and kill her sister queens to ensure she is the sole egg layer in the colony. The genetic and molecular bases of altruistic worker aggression in honey bees have been extensively studied on its own, or via comparisons with aggression in other solitary insects. The molecular bases of queen aggression has never been studied, and we think it provides a more appropriate control for understanding the molecular biology of altruistic aggression in worker bees. Here, we test the hypothesis that altruistic aggression is transcriptionally different from that of selfish aggression by comparing the brain gene expression profiles of aggressive worker bees against that of aggressive queen bees. Our study provides a more in-depth understanding of how situational context (altruistic vs selfish) affects aggression in insects.

Effects of Social Status on Aggression in a Facultatively Social Bee Species (*Xylocopa virginica*) James Mesich, Brock University, Canada

Authors: Mesich, J. & Richards, M.

The eastern carpenter bee (*Xylocopa virginica*) is a facultatively social species that can live either solitarily or in small groups, with dominance hierarchies that display heavy reproductive and ergonomic skew towards dominant individuals. Therefore, there is an increase in reproductive success for those at higher social positions. Dominant females will usually partake in nestmate provisioning while solitary females remain safe in their nests before both begin provisioning brood. Why some females incur this extra cost of sociality is unclear, but lower levels of aggression in social females could prevent them from excluding other females from their nest as well as make them more tolerant to other females generally. To test whether this was the case, I used circle tube assays to compare the levels of aggressive behaviours in dyads of unfamiliar solitary and social females. I found that aggressive behaviours such as biting and pushing were the lowest in social-social dyads, compared to solitary-solitary and mixed solitary-social dyads. In mixed dyads, social individuals were less likely to display aggressive behaviours. These findings are important as they show that behavioural tendencies towards decreased aggression could result in a social life history and reduced reproductive success in a facultatively social species.

Friday Afternoon Break

Planting Together: Finding Flowers' First Years

Headed by artist, cook, and curator Lisa Myers and conservation biologist Dr. Sheila Colla, Finding Flowers' biocultural approach to native pollinator conservation aims to merge disciplines, inquiries, and methods from ecology, art, and education. The conceptual and physical ground of study has been the more-than-thirty pollinator garden artworks of the late Mi'kmaw/Beothuk artist Mike MacDonald.

Slideshow presentation by Kennedy Halvorson, Research Assistant, Finding Flowers Project

Find out more about this inspirational project:

@Finding_Flowers_Project | www.findingflowers.com

Maternal Investment Patterns in a Facultatively Social Bee Showing that Socially Dominant Females Forage More than Solitary Females Lyndon Duff, Brock University, Canada

Authors: Duff, L. & Richards, M.

Xylocopa virginica is facultatively social, which facilitates comparisons between individuals that nest solitarily or in groups. In social nests, there is high ergonomic skew such that dominant, primary females, provision their own brood without help from subordinate secondaries that wait to replace or usurp the primary. We aimed to measure the costs and benefits to solitary versus social nesting by examining females' brood provisioning behaviour. We hypothesized that solitary females and social primaries would have similarly high lifetime rates of brood provisioning, whereas social secondaries would have significantly lower rates. Thus, we should see similar numbers of pollen trips by solitary and social primaries, while social secondaries should make very few pollen trips. Based on observations from 2016-2019, we observed that social primaries did the most pollen flights, but both primaries and solitaries did far more pollen flights than secondaries. This suggests that social primaries either produce more brood than solitaries, or that they feed their secondary nestmates in addition to provisioning brood. Although secondaries high in the reproductive queue likely produce some brood, these are probably far fewer than those produced by solitaries and primaries.

Social Environment and Sibling Cooperation in a small carpenter Bee Jesse Huisken, York University, Canada

Authors: Huisken, J. & Rehan, S.

Sibling care is found in diverse taxa, including invertebrates, birds, mammals and primates. Understanding why siblings cooperate is critical to unraveling the evolution of social behaviour. In the small carpenter bee, *Ceratina calcarata*, one daughter will often forage with her mother on behalf of siblings. This under-provisioned worker-like daughter is smaller, suggesting maternal manipulation and malnutrition, and possibly physical coercion plays a role in her behaviour. To test the effect of mothers and worker-like daughters on social group cohesion, individuals were recorded in observation nests to determine frequencies of foraging and interactive behaviours across control colonies, and mother and worker-like daughter removal nests. Activity within the nest increased with removals. Aggression peaked in the absence of mother and worker-like daughters, suggesting these females retain social order. In the absence of mothers foraging behaviour declined. Worker-like daughters provide an important insurance mechanism for assured fitness returns through cooperation and sibling care.

A large-scale field-test of beneficial bacteria as a practical in-hive supplement Brendan Daisley, University of Western Ontario, Canada

Authors: Daisley, B.A., Pitek, A.P., Chernyshova, A.M., Reid, G., & Thompson, G.J.

Infectious disease is a major threat affecting the health status of managed Western honey bees (*Apis mellifera*). In our previous work, we demonstrated that prophylactic use of antibiotics (e.g. oxytetracycline) to prevent disease outbreaks can have several side effects, including diminished innate immune function and reduced hive productivity. Here, we assess the ability of three strains of beneficial bacteria (*Lactiplantibacillus plantarum* Lp39, *Lacticaseibacillus rhamnosus* GR-1, and *Apilactobacillus kunkeei* BR-1) to mitigate these side effects, as well as their potential as a stand-alone therapy to prevent two common bacterial diseases – American foulbrood (AFB) and

European foulbrood (EFB). Preliminary assessment of multi-year field trial data from Ontario and California suggest the trio of beneficial bacteria can favourably influence overall bacterial disease (AFB/EFB based on qPCR-based detection), *Varroa destructor* mite loads (alcohol-wash), queen egg-laying activity (brood frame counts), and immune gene expression (RT-qPCR). Collectively, the results indicate that the tested strains of beneficial bacteria can offer multifaceted health benefits across vastly different habitats, with or without antibiotic usage. While confirmatory studies are warranted to further support reproducibility, the combined use of the three strains as a practical in-hive supplement holds great promise as an adjunct to current apicultural disease prevention and management strategies.

The effect of elevation on tropical bee species abundance and crop visitor assemblage turnover within a narrow elevational gradient.

Kristin Conrad, Eastern Kentucky University, USA

Authors: Conrad, K.M. & Peters, V.E.

There is an urgent need to document the bee assemblage distribution along tropical mountains to understand how important pollinators may respond to climate change and other global change impacts. We quantified bee abundance at 100m elevation intervals across a narrow elevation gradient in the seasonally-dry forests of Costa Rica. The study area is characteristic of the tropical countryside, including smallholder farms, pastures, and forest patches. We focused on the honey bee, *Apis mellifera*, and 25 Ceratinine and Meliponine species.

We found that 15 of 26 bee species showed abundance differences by elevation, suggesting that many species in these tribes exhibit elevational range specialization. Differences in the relative abundance of bees by elevation was evaluated using a CCA ordination. Elevation and site together explained ~42% of the variation in bee community composition (Fpseudo(3,8) = 1.91, p = 0.002).

Mountain-dwelling species are expected to shift ranges to higher elevations and cooler temperatures in response to global temperature increases. Our results indicate that tropical montane bee species could be at high-risk to warming temperatures or changing patterns of precipitation, as elevation is a strong factor in shaping bee communities, and species with narrow elevational ranges are predicted to be more vulnerable to range shifts.

Forest landscapes increase diversity of honey bee diets in the tropics

Chris Cannizzaro, Griffith University, Australia

Authors: Cannizzaro, C., Keller, A., Wilson, R.S., Elliott, B., Newis, R., Ovah, R., Inae, K., Kerlin, D.H., Bar, I., Kämper, W., Shapcott, A. &Wallace, H.M.

Honey bee diets in temperate areas have been well studied, and there is increasing evidence that floral diversity is critical for honey bee health. Tropical forests often contain high floral diversity, but honey bee diets have been rarely studied in the tropics. Here we compare the botanical sources in bee bread between landscapes with and without surrounding forest cover in the eastern highlands of Papua New Guinea by collecting bee bread from 24 hives across 8 sites over two years and examining floral sources, diversity measures and major plant groups using DNA metabarcoding. Bee bread from hives in sites with surrounding forest contained significantly greater species diversity (*H'*) and species evenness (*J*). Trees were the most abundant source of bee bread, regardless of landscape, and constituted 52% of total abundance. Herbaceous plants, mostly introduced species, were the second most abundant floral sources at ~26% of total bee bread. Our work suggests that bees are seeking out floral tree resources even in landscapes where trees are scarce and that beekeeping in tropical environments would benefit

from preserving remaining forest cover and incorporating more trees to existing, open landscapes to optimize the diversity in honey bee diets.

Saturday, October 16, 2021

Holocene population expansion of a tropical bee coincides with early human colonisation of Fiji rather than climate change

James Dorey, Yale University, USA & Flinders University, Australia

Authors: Dorey, J.B., Groom, S.V.C., Velasco-Castrillón, A., Stevens, M.I., Lee, M.S.Y., & Schwarz, M.P.

There is substantial debate about the relative roles of climate change and human activities on biodiversity and species demographies over the Holocene. The bee genus *Homalictus* is developing into a tractable model system for understanding how native bee populations in tropical islands responded to past climate change. We used sequences of the mitochondrial gene COI from 474 specimens and between 171 and 3,928 autosomal (DArTSeq) SNP loci from 19 specimens of the native Fijian bee, *Homalictus fijiensis*, to explore its historical demography using coalescent and mismatch analyses. We asked whether past changes in demography were human- or climate-driven. We show that inferred changes in population sizes are too recent to be explained by past climate change. We found that a dramatic increase in population size for the island of Viti Levu coincides with increasing occupation by humans and their modification of the environment. We found no corresponding change in bee population size for another major island, Kadavu, where human populations and agricultural activities have been historically low. We show that molecular approaches can disentangle the impacts of humans and climate change on a tropical pollinator and that stringent analytical approaches are required for reliable interpretation of results.

The effects of human-driven landscape disturbance on wild bee communities and plant bee networks across southern Manitoba, Canada

Emily Hanuschuk, University of Manitoba, Canada

Author: Hanuschuk, E.

Human-driven habitat loss caused by activities such as large-scale cropping is one of the main drivers of wild bee declines and changes to plant-pollinator networks worldwide. Factors such as land cover diversity and fragmentation can also influence bee communities and networks, but published effects are mixed and often depend on location, community composition, and scale of disturbance. I investigated the effects of landscape level disturbance on bee communities and plant-bee networks across southern Manitoba, Canada, with the goal of informing policies aimed at conserving wild bee populations and network functionality. Over two years at 64 sites, I collected 21,000 bees using coloured pan traps and blue vane traps and 2,189 using targeted aerial netting. Using linear modelling, I found that areas with diverse land cover types and high amounts of edge habitat supported bee communities and enhanced network size and stability, while simple landscapes dominated by crop cover decreased bee abundance and richness and reduced network stability. Land management policies that promote diverse landscapes with high amounts of edge are needed to maintain an abundant and diverse assemblage of bees and to enhance plant-bee network size and stability.

The Risks of Crop Exposure to Honey Bee Colonies

Sarah French, BeeCSI Consortium, York University, Canada

Author: French, S.

Managed honey bees are invaluable pollinators but are susceptible to multiple stressors that originate from surrounding landscapes. Determining how these stressors co-occur is vital for predicting how agricultural landscapes impact honey bee health. In order to assess crop-specific risks to honey bees, we exposed 122 experimental apiaries to six focal crops, which were located across five provinces in Canada. The apiaries were sampled before, during, and after seasonal exposure to crops, for stressors known to impair honey bees. In general, apiaries located in regions with soybeans accumulated the least risky levels of pesticides ($P < 0.002$), mites were less abundant in canola oil regions ($P < 0.03$), and European foulbrood disease was less likely to occur in canola oil, corn, and soybean regions ($P < 0.02$), whereas parasites were not affected by crop type. Our results, coupled with ongoing experimental manipulations of these stressors, will inform beekeepers and policymakers on how best to monitor and regulate environmental stressors to sustain healthy honey bee colonies for Canadian agricultural production.

The Blueberries and the Bees: Assessing Honey Bee Health Stressors Using Proteomics

Rhonda Thygesen, University of British Columbia, Canada

Authors: Thygesen, R. & Foster, L.

Honey bee (*Apis mellifera*) pollination is essential for British Columbia's (B.C.) top fruit export, highbush blueberry (HBB, *Vaccinium* sect. *Cyanococcus*), to ensure high fruit sets. Recently, B.C. beekeepers have noticed a decrease in health and strength of their colonies after HBB pollination, however, the risk factors affecting honey bee health are not yet well defined. Pesticides, pathogens, pests and parasites are all possible effectors of decreased bee health in HBB. The proteome is central to health, and its composition is likely to vary with health status. Proteomics allows for the comparative study of an organism's proteome in healthy versus diseased state so diagnosis and treatment is feasible. This study combines field and lab work to deduce what the major determinants of bee health in HBB are by observing protein signature change in bees. Two field seasons (2020 and 2021) were used to correlate differences in the proteome of nurse bees before, during, and after HBB pollination, as well as outside of HBB areas as a control. Cage trials of individual xenobiotic or pathogen stressors were subsequently performed to validate proteomic changes in order to define the main causes of stress in HBB pollination.

How Large Colony Sizes Can Select for Higher Meiotic Recombination

Clement Kent, York University, Canada

Author: Kent, C.

Some large colony bees and ants have high meiotic recombination rates. However, theoretical work by Nick Barton, Sally Otto, Aneil Agrawal, and others suggest selection for alleles that increase recombination is likely to be rare. Kent & Zayed 2013 proposed a model for high crossover in bees, but this model has been disputed. Recent experimental and theoretical work provides deeper insights at the molecular and cellular level on how meiotic crossover works and on what the benefits to eusocial bees of greater colony genetic diversity may be. I integrate these into a revised model and describe laboratory tests which could test the model.

Corpse Management in Bumblebee Colonies

Victoria Blanchard, Royal Holloway, University of London, England

Author: Blanchard, V.

Corpses can threaten group living by proliferating harmful microbiota, transmitting dangerous chemicals, and attracting scavengers to the nest area. Highly social (eusocial) species are thought to have evolved corpse management strategies (CMS) to mitigate the cost of corpses to colonies. Undertaking behaviours in perennial, eusocial insects are well studied but little is known of CMS in annual species. Here I attempt to summarise the knowledge to date on corpse management in eusocial insects generally, paying particular attention to gaps in the literature. I then used *Bombus terrestris* as a study system to begin to assess CMS in annual eusocial species. I established a novel protocol for introducing larval corpses into the brood and demonstrated corpse-specific removal (necrophoresis) in-situ in bumblebee colonies for the first time. I also assessed changes in CMS with regards to larval developmental stage and life stage of the colony, neither of which have been studied before. I found a linear relationship between larval size and time taken for it to be removed from the nest, and that final stage instars are removed more slowly than any other developmental stage. I also discovered no difference in CMS between growth and reproductive colony life stages, although a trend towards differential rejection does warrant further investigation. The development of our novel protocol allows for more realistic investigations into CMS across social systems.

A comparison of *Bombus* collection methods for detecting trends in species abundance Jocelyn Armistead, Brock University, Canada

Authors: Armistead, J., Sheffield, C., & Richards, M.

In order to accurately track changes in *Bombus* species abundance due to climate change, habitat destruction and intensive agricultural practices, we need to be sure we are using the most effective sampling methods. I compared three commonly used collection methods to assess their strengths and weaknesses; netting, photographs, and blue vane traps. Surveys targeting *Bombus* workers were conducted in the Niagara Region from late June to September. Traps were placed at survey sites in the morning, left for 1 week, and checked periodically in the evenings. Netting and photographic surveys (30 min) were conducted at the sites on the same days traps were checked. Netting and photographic methods collected a greater abundance of Bombus specimens compared to trapping. Due to the fewer specimens collected by traps, I expect the *Bombus* community composition produced by that method to be different compared to the photographic and netting surveys. Understanding the differences between survey methods will better help us to decide which methods are the most effective in a particular region and how they can complement each other. Ultimately the methods that produce the most accurate data, at the lowest cost, will be the best choice for future surveys targeting *Bombus* species.

Saturday Morning Break

Disturbance Type, Landscape, Groundcover, and Trap Type Affect Wild Bee Captures in the Endangered Tallgrass Prairie Ecosystem Reid Miller, University of Manitoba, Canada

Authors: Miller, R. & Gibbs, J.

Southern Manitoba represents the northern limit of the tallgrass prairie ecosystem. Current management practices aim to mimic the historical disturbances that created these grasslands. While managers often consider the effects of disturbance on prairie floral communities, the effects on invertebrate communities, whose health and stability are codependent with prairie plants, are often assumed. To test the effect of disturbance type (burning vs. grazing) on prairie

pollinators, we conducted an experiment where we collected wild bees using several different colour/height combinations of bee bowls as well as blue vane traps on tallgrass prairie sites that differed in the type of disturbance most recently experienced, their surrounding landscape, and local groundcover. Our results imply that cattle grazing should be minimized, or contained, on the prairie, while burning shows largely positive effects on bee communities, though often not as positive as lack of recent disturbance. Increasing landscape diversity, as well as increasing amounts of bare ground and forb cover locally positively affected our measures of bee community health. Traps differed in their ability to detect significant effects of the considered variables on bee abundance and diversity. Here we summarize our results and discuss implications for prairie management going forward.

Assessment of Habitat Use and Ecology of Native Bee Communities in Tallgrass Prairie and Oak Savanna and Southern Ontario

Janean Sharkey, University of Guelph, Canada

Authors: Sharkey, J. & Raine, N.E.

Tallgrass prairie and oak savanna communities are some of the most endangered and biodiverse habitats in Canada. Changes in land use and management have reduced this habitat to a fraction of its original range in Ontario. Our goals were to understand how restoration and land management practices might influence the structure of native bee communities. To achieve these goals, we assessed bee community composition using a combination of passive and active sampling techniques and characterized vegetation in four different management scenarios at three localities in tallgrass prairie and oak savanna habitats in southern Ontario. In total, we collected 153 bee species from 25 genera and five families, including one genus new to Canada, as well as more potentially new Ontario or Canada wide occurrence records. We will discuss trends in bee community composition, abundance, species richness and diversity between localities, and management types sampled. Research outcomes have implications for the restoration ecology, land management, and bee conservation of tallgrass prairie and oak savanna habitats.

Bees and Aculeate Wasps in Disappearing Canadian Prairie Sandhill Environments

Thomas Onuferko, Canadian Museum of Nature, Canada

Authors: Onuferko, T.M., Buck, M., Gibbs, J. & Sokoloff, P.

Active sand dunes in the Canadian Prairies represent a unique ecosystem wherein diverse plant and animal species specialized for life on sand can survive. In recent times, the extent of active dunes in the southern Canadian Prairies has declined dramatically due to stabilization (the vegetation of dunes by encroaching invasive plants). The remaining dunes are islands of biodiversity and home to a variety of organisms of conservation concern within Canada. Solitary bees and predatory wasps (Hymenoptera: Aculeata) are some of the most abundant and diverse organisms inhabiting the dunes, but the effects of stabilization on the resident aculeate fauna have not been formally investigated previously. In a cross-sectional study, 13 dunes at various stages of stabilization were surveyed in 2019 to document the species inhabiting these unique inland dune systems and measure patterns of taxonomic turnover as dunes change to grassland. Approximately 12,000 specimens representing >340 species/morphospecies were sampled. Findings include 50 species representing new provincial records, a new species of sweat bee, and several potentially undescribed species. Results indicate a decline in the abundance of sand specialists with increased vegetative cover, suggesting that such

species may be at risk of extirpation from areas where dune activity is in decline.

Preliminary Morphological Phylogeny of *Liphanthus* (Andrenidae: Panurginae)

Nora Romero, York University, Canada

Author: Romero, N.

Liphanthus Reed is a relatively poorly known genus of bees with a mostly Chilean distribution. Until 2014 the group contained 27 species in 7 subgenera, and 5 species not assigned to a subgenus. Recently, by means of DNA barcoding and morphological scrutiny of new collecting and earlier collected material, 49 new species have been discovered, 15 of which have been described but most still lack subgeneric status. A preliminary phylogeny based upon the morphology of exemplars from all subgenera and unassigned species groups will be presented.

Down the Bee-Burrow: Unexpected Diversity in the *Lasioglossum gemmatum* species complex (Halictidae: Halictini)

Joel Gardner, University of Manitoba, Canada

Authors: Gardner, J. & Gibbs, J.

Within the "nightmare taxon" *Lasioglossum* (Dialictus), the *L. gemmatum* species complex is a refreshingly distinctive lineage characterized by an enlarged tegula. Historically, identifying species in this group was a simple matter of geography and metasoma colour. Under this system, only three names were commonly used: *L. tegulare*, *L. tegulariforme*, and *L. hunteri*. But recent work paints a much more complicated picture. A previous revision of *L. tegulare* revealed that it actually included four "cryptic" species, and ongoing work in the western Nearctic region is revealing even higher diversity in both *L. tegulariforme* and *L. hunteri*. There are up to 23 western species, including 10 new ones.

Native Perennial Plantings for Pollinators in Eastern Tennessee

Laura Russo, University of Tennessee, USA

Authors: Russo, L. & Khalil, A.

Floral resource supplementation is a common way to support beneficial pollinating insects in a variety of landscapes, but determining which plant species will support the largest diversity and abundance of pollinators is often challenging. Eastern Tennessee is home both to the high regional biodiversity of the Smoky Mountains and is also an area of intense agricultural production. To conserve the natural pollinator diversity of the region, protecting and promoting natural habitat is essential. Thus, we designed floral resource provisioning habitat for pollinating insects in five land-use types across eastern Tennessee. Our objectives were: 1) to compare pollinator preferences among 18 perennial plant species native to Tennessee, and 2) to quantify the effects of land-use on pollinator abundance and diversity in this region. We provide recommendations for providing floral resource provisioning habitat and illustrate its utility and conservation potential, even in highly agricultural landscapes.

A special thanks to our conference moderators:

Taylor Kerekes (Native Pollinator Research Lab, York University), and Dr. Sheila Colla (York University), Cindy Nguyen (Rehan Lab, York University), Kathryn Galang (Zayed Lab, York University), Katherina Odanaka (Rehan Lab, York University), Anthony Ayers (Rehan Lab, York University)

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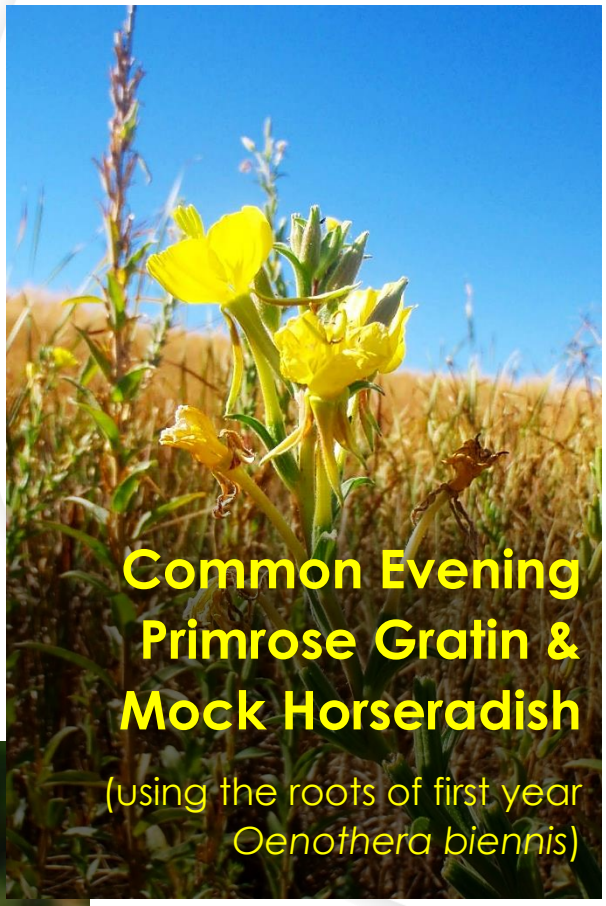

Thank you for joining us for BeeCon 2021!!