BeeCon 2012

November 23rd, 2012

Southern Ontario Bee Researchers Symposium

Welcome to the second BeeCon hosted at York University! BeeCon was organized in an effort to bring together graduate students in the area conducting research on the Apoidea. It is a **free event** and a great place to present current research in a friendly environment.

This year's BeeCon was organized by:

Dr. Clement Kent – York University
Scott MacIvor – York University
Jess Vickruck – Brock University
Brock Harpur – York University

With the help of:

Dr. Amro Zayed– York University
Dr. Laurence Packer– York University
Dr. Miriam Richards – Brock University

We hope to have BeeCon become an annual event hosted at campuses around Ontario by graduate students. If you'd like to help organize BeeCon next year, please email any of this year's organizers.

Sponsors:

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Speaker's List and Schedule

9:45	10:00	Welcome and Coffee – TEL Building 0007	
		Speaker	**Title**
10:00	10:15	Dave Awde	From solitary to eusocial: Testing the reproductive ground plan hypothesis in the primitively eusocial sweat bee *Lasioglossum laevissimum*
10:30	10:45	James Thomson	Novel artificial flowers for experiments with captive bees.
10:45	11:00	Emma Mullen	A provisional gene network for worker sterility in the honey bee (*Apis mellifera)*
11:00	11:15	Vern Lewis	Alloparental care in a sub-social bee
11:15	11:30	Sheila Colla	Applied Conservation of At-risk Pollinators in Canada
11:30	**12:30**	**Lunch**	
12:30	12:45	Rola Rutby	Bee Communities in Restored Landfills of the Niagara Region
12:45	1:00	James Postlethwaite	Changes in relative abundance of the Bumble Bee (Hymenoptera: Apidae: *Bombus*) fauna of Cape Breton Island, Nova Scotia
1:00	1:15	Jess Vickruck	Dominance heirarchies and reproductive strategies in the large carpenter bee, *Xylocopa virginica*
1:15	1:30	Laurence Packer	Barcoding the bees of the world
1:30	1:45	Clement Kent	How eusocial hymenopteran genomes are shaped by neutral and selective processes.
1:45	2:00	Pegah Valizadeh	Natural immunity and resistance of honey bees to *Nosema* disease
2:00	2:15	Jen Albert	Sociogenetic organization of the bee *Halictus farinosus* in northern Utah
2:15	2:30	Scott MacIvor	Cavity-nesting bee and wasp assemblages in cities: Landscape determinants of diversity and colonization
2:30	**2:45**	**Coffee Break**	
2:45	3:00	Sheila Dumesh	Taxonomic methods, identification keys and the importance of imaging
3:00	3:15	Tom Onuferko	Temporal variation in pollinator abundance and diversity: The restoration ecology of a Niagara Bee Community
3:15	3:30	Kimberly Caswell	Three new *Lasioglossum* from Mexico, and phylogenetic analyses of *Lasioglossum* sensu stricto of the New World based on morphology and DNA barcoding.
3:30	3:45	Miriam Richards	Traits that define the pattern and process of social evolution in sweat bees
3:45	4:00	Spencer Moncton	Systematics and biogeography of a subgenus of Chilean bees, *Chilicola (Heteroediscelis)*
4:00	4:15	Amro Zayed	The awesomeness of honey bee genomes!
4:15	4:30	Erika Nardone	The bees of Algonquin Park: a study of their distribution, their community guild structure, and the use of various sampling techniques in logged and unlogged hardwood stands
6:30pm		**Closing at Dr. Laurence Packer's House – Address provided at meeting**	

Abstracts

Sociogenetic organization of the bee *Halictus farinosus* in northern Utah

Jennifer Albert

Species of bee in the family Halictidae exhibit a variety of social behaviours from solitary nesting, to various types of social and communal nesting including eusociality. Nests of the primitively eusocial bee *Halictus farinosus* were excavated within a large aggregation of the bee in Green Canyon, North Logan, Utah. By comparing microsatellite alleles between nestmates in this species we have revealed kin relationships and determined that first brood females (workers) were producing many of the reproductive offspring in the population. In addition allelic data indicated that this population was predominately monandrous. This study aimed to improve our understanding of social interactions and social organization in the eusocial halictids and allow us to examine the predictions of inclusive fitness theory in a primitively eusocial bee species.

From solitary to eusocial: Testing the reproductive ground plan hypothesis in the primitively eusocial sweat bee *Lasioglossum laevissimum*

David Awde

The reproductive ground plan hypothesis (RGPH) states that eusocial divisions of labour evolved through the uncoupling of reproductive and non-reproductive phases of an ancestral solitary life cycle. If this were the case, homologous genes associated with reproductive and non-reproductive phenotypes in solitary taxa should show the same differential expression between queens and workers of a primitively eusocial bee. To test this hypothesis I will compare gene expression within *Lasioglossum laevissimum* (Smith) of candidate genes originally described in highly eusocial *Apis melifera* and associated with reproductive and non-reproductive phenotypes. Gene expression that agrees with *Apis mellifera* work will lend support to the RPGH and highlight potential genes whose expression has become uncoupled. On the other hand, gene expression that does not agree with *Apis mellifera* work will suggest that these genes are not appropriate RGPH candidates.

Three new *Lasioglossum* from Mexico, and phylogenetic analyses of *Lasioglossum* sensu stricto of the New World based on morphology and DNA barcoding.

Kimberly Caswell

Three new species of *Lasioglossum* sensu stricto from Mexico were described and keys to their identification are provided. The *Lasioglossum* sensu stricto of the New World were analyzed phylogenetically based on morphological characteristics, DNA barcodes, and a combination of these data. Strict consensus trees support an Eickworti species group. The geographical data was found to broadly be in agreement with the strict consensus tree of the combined data sets.

Taxonomic methods, identification keys and the importance of imaging.

Sheila Dumesh

Biological specimen identification, although often a difficult and time consuming task, is a vital part of many ecological studies. To facilitate the identification process, we are striving towards producing dichotomous keys which include high quality images representing all characters mentioned in each couplet. Having these images available greatly aids in the identification process, allowing the user to see all diagnostic characters mentioned in the key, thereby making correct identifications more likely. In addition, images can be posted on the web, making them extremely valuable for researchers and museums, and can often serve as surrogates for actual specimens when full synoptic collections are not available. Also important, especially in cases where the specimen(s) are of very rare species, are type specimens, and/or other fragile material, imaging can be used to capture the whole animal or any diagnostic character(s). As such, high quality images can also be used to avoid shipping such delicate material, and thus serve many important roles in taxonomy, ecology, and museum function.

How eusocial hymenopteran genomes are shaped by neutral and selective processes.

Clement Kent

We have detected large-scale patterns in the genomes of eusocial hymenoptera due to both neutral processes (mutation and gene conversion) and selection. In this talk I will briefly review patterns described in our recent PNAS paper (Kent et al, Recombination is associated with the evolution of genome structure and worker behavior in honey bees), then describe the model we propose to explain these patterns, and show some new data from ants, bees, and wasps which supports the model.

Applied Conservation of At-risk Pollinators in Canada

Sheila Colla

Several bee species are currently or are in the process of being listed federally and provincially as at-risk species in Canada. Additionally, the newly formed IUCN Species Specialist Group chaired by Dr. Paul Williams will be assessing the status of the global bumblebee fauna within two years. This talk with introduce the bee species known to be in decline in Canada and talk about next steps in conservation management for these native bees. Working with several partners, Wildlife Preservation Canada has recently launched a pollinator program. This hands-on, science-based program will be outlined and opportunities for collaboration discussed.

Bee Communities in Restored Landfills of the Niagara Region

Rola Kutby

This study examined the impact of restoration time on bee fauna (Hymenoptera: Apoidea) of the Niagara Region, Ontario, Canada. I studied bee abundance and diversity in restored landfills Glenridge Quarry Naturalization Site (GQNS) in St. Catharines, Elm Street Naturalization Site in Port Colborne, and Station Road Naturalization Site in Wainfleet, Ontario. GQNS presents control sites that were restored from 2001-2003. Elm and Station represented landfills newly restored in 2011. I compared these to control sites at Brock University where bees have always been present compared to other landfills where no stable habitat was available. A total of 3186 bee was collected using two methods, pan traps and flower collections, from May to October 2011. Bees were classified to five families (Halictidae, Megachilidae, Apidae, Colletidae, and Andrenidae), 21 genera and sub-genera, and at least 78 species. The bee abundance was higher in some restored site than the control site and restored control site which proves that restoration increased bee abundance. For bee species richness I expect that the pattern will follow the Intermediate Disturbance Hypothesis (IDH), which states that species richness will be highest in the restored control sites followed by the control site then newly restored sites as the habitat of the disturbed landfill is recovered. The current study will relate the bee diversity and abundance to restoration time.

Alloparental care in a sub-social bee

Vern Lewis

Research into the evolutionary origins of sociality in insect colonies has, in recent years, changed emphasis from understanding how eusociality is maintained to how insects transition from solitary to social lifestyles. Popular model systems for investigating social behavior such as the Hymenoptera and Isoptera focus on highly derived species such as *Apis mellifera*. However such model systems can only tell us about the maintenance of social structure, and can say very little about the biotic and abiotic constraints and benefits of social evolution. The pygmy carpenter bees (*Ceratina* spp.) offer an excellent model for investigating such factors as they are

subsocial but possess some eusocial characteristics, which may indicate they are currently in a transitive phase. In order to show that members of the genus *Ceratina* may be transitioning from subsociality to a higher form of sociality, a primitive form of cooperative brood care must be present. By utilizing behavioural observation and experimental removal protocols, I attempted to show whether sibling care played a role in offspring development. I found, upon removal of the mother, that female offspring take up foraging and maintenance roles in the nest. Not only does evidence show that female offspring forage at the same frequency as the mothers, but secondary individuals were found to guard the nest entrance and eject nest debris while the foraging female was away. These preliminary results suggest that although *Ceratina* spp. are classified as subsocial bees, they possess the prerequisite behavioral repertoire for eusociality.

Cavity-nesting bee and wasp assemblages in cities: Landscape determinants of diversity and colonization

J. Scott MacIvor and Laurence Packer

A growing local food market is increasing the capacity and interest for agriculture in cities. Bees, by way of pollination, are integral components of fruit, vegetable, nut, bean, fiber, flower, and seed yield and thus their persistence is an essential component of any city planning targeted to support urban agriculture. Occupying a similar niche are solitary wasps, many of which collect pest or hyper-abundant insects to provision brood. Unfortunately, what limits these species in increasingly fragmented urban areas is complex and generally not known. In this study, cavity-nesting bees, wasps, and their parasites from nest boxes set up at 200 community and private gardens, parks and green roofs in Toronto were evaluated to examine landscape factors determining their presence and diversity. Thirty-five species of cavity-nesting bees, wasps, and parasites were identified. Only 12 of 193 nest boxes retrieved were not colonized, and this first year of data provides further evidence that these groups of bees and wasps are widespread in cities. The proportion of impervious surface surrounding a nesting site had no effect on the abundance of bees or wasps; however, total colonization generally decreased towards the centre of the city, and wasps were most abundant in urban parks. Colonization in community gardens was no different from that in parks and private gardens, although assemblages varied. Implications for the micro-management of solitary cavity-nesting bees in urban gardens will be discussed.

Systematics and biogeography of a subgenus of Chilean bees, *Chilicola* (*Heteroediscelis*)

Spencer Monkton

Chilicola (*Heteroediscelis*) Toro & Moldenke (1979) is a diverse subgenus of colletid bees endemic to Chile. It includes 10 described species and at least 5 awaiting description. My project will consist of a taxonomic revision of *Heteroediscelis*, using morphological and molecular data to describe all species in this subgenus. To this end, I will examine previously collected

specimens and available DNA barcode data (COI gene), as well as additional specimens collected in Chile between January and April 2013 during an intensive field season. As a result of this work, I will produce a revised phylogeny and a user-friendly key to species of the subgenus *Heteroediscelis*. I will also conduct biogeographic analyses in hopes of providing additional insight into the origin and diversification of these interesting bees, and bee evolution in general.

A provisional gene network for worker sterility in the honey bee (*Apis mellifera)*

Emma Mullen, Mark Daley and Graham Thompson

The theory of kin selection explains how complex social behaviour can evolve at the gene level, yet the theory in itself does not identify which genes are involved in the expression of altruism. Previous comparative genomic analyses have revealed hundreds of genes implicated in reproductive regulation, but there has not yet been an attempt to link the genes from different studies into functional networks that explain the conditional expression of worker sterility. We use a knowledge-based modeling program to reconstruct networks that describe this form of reproductive altruism as a function of ovary activation. Network analysis reveals strong linkages between genes into different networks, and also identifies 'hub' genes that appear central to honey bee reproductive biology. These networks are the first of their kind and potentially describe how the coordinated expression of genes can control worker sterility, a quintessential trait at the core of social gene theory.

The bees of Algonquin Park: a study of their distribution, their community guild structure, and the use of various sampling techniques in logged and unlogged hardwood stands

Erika Nardone and Peter G. Kevan

This study investigates the bee community dynamics in hardwood stands of Algonquin Provincial Park under different logging regimes. The distribution of bee individuals and species was most dependent on the abundance of raspberry (*Rubus strigosus*), an important floral and nesting resource. Also of importance were total floral resources, microclimate, and habitat heterogeneity. The guild structure of bees was relatively resilient to habitat variation and was related to several factors. Malaise traps, pan traps and nets varied in their effectiveness at collecting different bee genera and a high percentage of species were collected only with one trap type. Malaise traps performed relatively poorly in forested environments, though very well in more open habitats. Pan traps and nets performed better in forested environments. Findings underline the importance of raspberry for bee communities of northern hardwood forests, and of heterogeneity, both of habitat types and sampling techniques, to maximize bee species richness.

Temporal variation in pollinator abundance and diversity: The restoration ecology of a Niagara Bee Community

Thomas M. Onuferko, Rodrigo León Cordero and Miriam H. Richards

Bee communities are potentially good indicators of habitat change because both abundance and species richness vary in response to environmental stresses and disturbance. In low disturbance or undisturbed habitats, there is considerable temporal variation in abundance because of population dynamics and small-scale disturbances such as local weather conditions, whereas species richness is expected to be more stable. Conversely, in disturbed habitats or those undergoing succession, species richness is predicted to vary according to patterns proposed by either the Increased Disturbance Hypothesis (diversity increases with time) or the Intermediate Disturbance Hypothesis (diversity levels increase then decrease). A 9-year study in the Niagara region yielded >40,000 specimens comprising at least 130 bee species collected in undisturbed grassy meadows and several former landfill sites currently undergoing habitat restoration. In both low and high disturbance sites, there were significant fluctuations in total bee abundance from 2003-2011. Preliminary data indicate that there were also significant fluctuations in bee diversity. Some variation in bee species richness was directly due to variation in bee abundance, but long term patterns suggest that in restored landfill sites, bee succession may be resulting in increased bee diversity.

Barcoding the bees of the world

Laurence Packer

The campaign to barcode the bees of the world was initiated in 2008, although work had started before then primarily on the Canadian fauna. I will outline the progress that has been made, discuss some interesting examples and mention some of the problems that have been encountered.

Changes in relative abundance of the Bumble Bee (Hymenoptera: Apidae: *Bombus*) fauna of Cape Breton Island, Nova Scotia

James Postlethwaite and David McCorquodale

Bumble bees, the large familiar furry bees, are attracting conservation interest because of declining populations and shrinking geographic ranges in North America and Europe. Recently the Committee on the Status of Endangered Wildlife in Canada listed *Bombus affinis* and is now considering *B. terricola* and *B. occidentalis*. At the same time, since 1990, other species, such as *B. impatiens*, have expanded their geographic range. Here I will document the changes in relative

abundance and phenology of the 13 bumble bees on Cape Breton Island using the Cape Breton University insect collection. Although *B. terricola* and *B. fervidus* have declined in relative abundance since the 1990's, *B. impatiens, B. vagans* and *B. citrinus* have increased in relative abundance in the same time period.

Traits that define the pattern and process of social evolution in sweat bees

Miriam Richards and Jason Gibbs

I compare traits commonly reported in studies of halictine sociality, and use principal components analysis to assess whether these traits define social categories in a way that justifies a typology that can then be mapped onto a phylogeny. This analysis suggests d find that increasing strength of eusociality is associated with increases in worker numbers, queen-worker size differences, nest guarding, bivoltinism, and foundress longevity; and decreases in pleometrosis, proportion of males in the early brood, and worker mating. A preliminary statistical analyses of the phylogenetically independent contrasts for each trait indicates that only four traits are truly crucial: the proportion of males in the early brood, the number of workers, worker matedness and worker ovarian development.

Novel artificial flowers for experiments with captive bees.

James Thomson, Jane Ogilvie and Marcus Guo-Rui Tan,
EEB Department, University of Toronto.

We developed artificial flowers that dispense and receive powdered food dyes as pollen analogs while their nectar is replenished by capillary action. Dye receipt, which can be measured colorimetrically, is a direct surrogate for pollen receipt or female reproductive success, but can also serve to compare pollen donation (male reproductive success) from flowers with different colors of dye. By allowing captive bumble bee colonies to visit large arrays of such flowers, we investigated whether total dye receipt depended on the sugar concentration of a flower's nectar. Flowers with richer nectar did receive more dye regardless of their spatial arrangement, but the effect was greatest when rich and poor flowers were segregated in large blocks, as opposed to being intermingled. Richer nectar also enhanced dye donation.

Natural immunity and resistance of honey bees to Nosema disease

Pegah Valizadeh

Honey bees are dying worldwide. The loss is caused by the synergistic action of a series of factors that could provoke immunosuppression in the bees. Nosema disease, which is one of the most damaging factors, is caused by microsporidia and shortens bee's life span. The current treatment is the antibiotic fumagillin. However, there is risk of antibiotic resistance, as well as honey contamination. An alternative approach to control Nosema disease could be through enhancing their natural immunity. Honey bees' immunity can be induced by applying PAMPs (pathogen associated molecular pattern). In order to explore the immune system activation, bees are exposed to PAMPs followed by analysis of immune gene expression. It is expected that the exposure of honey bees to potential immune inducers prior to challenge with *Nosema* will induce immune genes and this induction will result in higher resistance to subsequent challenge with the pathogen. Our preliminary results support this hypothesis.

Dominance hierarchies and reproductive strategies in the large carpenter bee, *Xylocopa virginica*

Jess Vickruck and Miriam Richards

Three reproductive strategies have been observed among females in social carpenter bee nests. Primary females monopolize oviposition, but are also responsible for all foraging, secondary females forage and lay eggs at a reduced rate and tertiary females do not forage or lay eggs but guard nest entrances. Tertiary females may overwinter twice in an attempt to become primaries in their second summer. Within nests, primary and secondary bees were significantly larger than tertiary females. Removal experiments showed that secondary females assumed primary positions when available. Tertiary females were inflexible, and these females almost never assumed dominant or secondary status, even when alone. Many tertiaries were successful at overwintering a second time. These former tertiaries had varied success at achieving primary status in their second summer, suggesting that if you are small waiting may be the best way to increase your fitness.