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NORTH AMERICAN SECTION

International Society for the Study of Social Insects

North American Section Colloquium

Rosen Plaza Conference Center, Orlando, FL
7:30 am to 6:00 pm, September 24, 2016

Organizing Committee: Colin Brent, Karen Kapheim, Sean O'Donnell, Olav Rueppell, Amy Toth

ORAL PRESENTATIONS

Keynote Speaker: Robin Moritz (Martin Luther Universität of Halle-Wittenberg, Germany) - The dark side of the hive: Social parasitism in the honeybee

Talk 1. Guy Bloch (Hebrew University of Jerusalem, Israel), Esther Hazan, Hagit Porath, Eli Eisenbeg, Erez Levanon - *RNA editing and its possible contribution to the social organization of bumblebee colonies*. Bumblebees are important for pollination and basic research, but little is known on molecular and physiological mechanisms regulating their behavior. We tested the hypothesis that Adenosine Deaminase Acting on RNA (ADAR) mediated RNA editing ("A-to-I RNA editing") regulates social behavior in the bumblebee *Bombus terrestris*. Many coding and non-coding brain transcripts were edited, including recoding of ion channels, transporters, and receptors that are predicted to affect brain function and behavior. Editing levels were influenced by task performance, but not by dominance or juvenile hormone. ADAR expression was significantly enriched in the brain, and was not regulated by queen presence, task performance, or dominance. The ADAR transcript includes three auto-editing sites, in one of which editing levels were correlated with task performance. Our results show that A-to-I RNA editing is ubiquitous in bumblebees and may contribute to socially-regulated behavioral plasticity.

Talk 2. Brock A. Harpur (York University, Canada), Amro Zayed - *Elucidating the genetic and evolutionary basis of social immunity in honey bees*. In a eusocial society defense against pathogens can come through the response of single individuals defending themselves or through the altruistic responses nest mates. The latter is termed "social immunity" and forms of it have evolved in all eusocial species. Using artificially selected populations and a population genomics approach, we identify the sources of genetic variation underpinning hygienic behavior, a form of social immunity in honey bees, and quantify how these loci evolve. Our results provide strong support for hygienic behavior resulting from differential developmental canalization brought about by variation in the regulation of highly conserved neuronal developmental genes - a "hygienic genetic toolkit".

Talk 3. Arian Avalos (University of Illinois - Urbana Champaign, USA), Hailin Pan, Guojie Zhang, Matthew Hudson, Gene E. Robinson - *Genomic analyses of gentle africanized honey bees in Puerto Rico*. Africanized honey bees (AHB) were introduced to Puerto Rico in 1994; within 10 years the population exhibited reduced aggression while retaining other known AHB traits. The genetic basis and adaptive significance of this remarkably rapid change are unknown. We sequenced the genomes of 90 haploid males from gAHB (Puerto Rico), AHB (from a region of

Mexico ancestral to gAHB), and EHB (Illinois). A genome wide analysis identified 505 SNPs similar in gAHB and EHB but distinct in AHB. They correspond to 241 genes, many previously functionally implicated with aggression; 29 have previously determined signatures of positive selection, and 24 have copy number variation (CNV). Results suggest that differential selection favoring EHB alleles and structural genomic variation tied to specific chromosomal events appears to underlie this remarkable evolutionary change.

Talk 4. Tian Wu (University of Western Ontario, Canada), Graham J. Thompson - *Genomic correlates to kin recognition and invasiveness in a subterranean termite*. Termites live in kin-based colonies headed by king/queen reproductive castes, and supported by numerous sterile workers and soldiers. Despite sterility, workers and soldiers gain indirect fitness by helping reproducing relatives and defending against unrelated intruders. For invasive populations of *Reticulitermes flavipes*, this kin-mediated behavior appears to break down, leading to the formation of mixed-kin supercolonies that occupy large areas and have many reproductives. One genetic explanation for the social structure shift is the loss of alleles necessary for kin recognition. If so, invasive populations should have fewer alleles per locus relative to native populations. In this talk, we report the allelic and expression profiles of *R. flavipes* transcriptomes from Canada and the US. Our on-going analysis of these transcriptomes will provide a framework for testing genetic hypotheses of supercolony formation and potentially identify candidate genes for kin recognition in termites.

Talk 5. Amir B. Cohanim, Rana Saad, Etya Amsalem, Eyal Privman (University of Haifa, Israel) - *Molecular adaptation in olfactory functions in the fire ant social chromosome*. Monogyne or polygyne social structure in the fire ant *Solenopsis invicta* is determined by a "social chromosome": a non-recombining region containing 527 genes with two distinct haplotypes, SB and Sb. Workers discriminate monogyne (SB/SB) and polygyne (SB/Sb) queens based on cuticular pheromones. We searched for candidate genes that could be responsible for this olfactory discrimination. We annotated 472 putative olfactory receptors (ORs) in the *S. invicta* genome. The OR gene tree shows many S. invicta-specific expansions, and multiple branches show evidence for positive selection. Notably, a cluster of 23 ORs resides in the social chromosome. Nine genes in this cluster are the result of recent duplications in the *S. invicta* lineage. We identified significant differences in these genes between SB and Sb, the most dramatic difference being the complete deletion of two genes in Sb. Thus, these ORs are prime candidates for involvement in queen discrimination.

Talk 6. Cassondra Vernier (Washington University in St. Louis, USA), Joshua Krupp, Joel Levine, Yehuda Ben-Shahar - *Age- and social environment-dependent modulation of the cuticular hydrocarbon profile in the honey bee*. Nestmate recognition, a mechanism of nest defense in eusocial insects, relies upon colony-specific sensory cues, usually in the form of cuticular hydrocarbon (CHC) blends. Although much effort has focused on identifying specific CHCs that serve as colony-specific cues, little effort has focused on understanding how these cues develop in individual colony members. Using colony manipulations, we are assessing the role of age and behavioral development in the maturation of CHC signatures in individual worker honey bees. Our data show that for individual workers: CHC profile increases in complexity with age; colony-specific CHC signatures do not fully develop until shortly before the onset of foraging; and the social environment plays a key role in defining forager CHC profiles. This suggests that chemical signatures used in honey bee nestmate recognition are not defined by population-level genetic variations, but by species-level developmental processes and colony-level social factors.

Talk 7. Anja Buttstedt (Martin Luther Universität of Halle-Wittenberg, Germany), Robin F.A. Moritz - *All the royal makings of a queen: Royalactin does not a honey bee queen make*. Queen determination in honeybees is nutritionally regulated and only larvae that exclusively receive royal jelly (RJ) emerge as queen bees. In spite of an intensive search over many decades for the actual compounds in RJ triggering queen development, no specific determinator could be singled out. Based on a large body of research testing various compounds of RJ, sugars and the fatty acid 10-HDA, had been suggested to affect caste development. In the end it seemed clear that queen

determination is not the result of the absence or the presence of a single determinator but rather the consequence of a discrete feeding regime throughout larval development. Hence claims that a single protein (Royalactin) in RJ induces queen differentiation came to a surprise in light of previous research. Because the issue of caste determination is arguably the most central paradigm for social insect research in general, we here show that this claim is incorrect and exclude Royalactin as queen determinator.

Talk 8. Beryl M. Jones (University of Illinois, Urbana-Champaign, USA), Callum J. Kingwell, William T. Wcislo, Gene E. Robinson - *Molecular determinants of behavioral plasticity in a facultatively eusocial bee*, Megalopta genalis. One remarkable feature of eusociality is a reproductive division of labor. While there is good understanding of the mechanisms of queen-worker differentiation in highly eusocial insects, we know less about its evolution. Some species, such as *Megalopta genalis*, are facultatively eusocial and may represent transition points in the evolution of eusociality. We removed queens from social nests of *M. genalis*, stimulating workers to become reproductively active replacement queens. Here we present changes in brain and abdominal gene expression associated with this shift in behavior, and compare gene expression between solitary reproductives, queens, non-reproductive workers, and replacement queens. We find that abdominal gene expression differences are much more pronounced than brain gene expression differences across castes, and that replacement queens shift their gene expression profiles rapidly following queen removal.

Talk 9. Christina L. Kwapich (Arizona State University, USA), Jürgen Gadau, Bert Hölldobler - *The ecological and genetic basis of annual worker production in colonies of* Veromessor pergandei*.* The life history of an ant colony is revealed across multiple years, but emerges from the accumulated attributes of short-lived workers. To survive and grow colonies must balance forager mortality and worker production across each annual cycle. By tracking monthly forager turnover rates, we calculated total annual worker production in wild colonies of *Veromessor pergandei*. Microsatellite analysis revealed the relationship between the total number of worker births per annum, queen number and patriline number. Predictions of colony lifespan were inferred from forager turnover rates, estimated mating frequency and counts of stored sperm. The 16-fold variation in productivity assigned to individual queens was also considered with respect to intraspecific pressure, worker development rate and longevity. Our findings emphasize the importance of connecting worker characteristics to colony-level strategies on a longitudinal scale.

Talk 10. Hugo Darras (Université Libre de Bruxelles, Belgium), Alexandre Kuhn, Serge Aron - *Gene-environment interaction effects on caste determination in hybridogenetic ants*. Some species of *Cataglyphis* ants have evolved an unusual reproductive system where the female caste is genetically determined. Two divergent genetic lineages co-occur as a complementary pair. Queens typically mate with a male of the alternative lineage and use its sperm to produce F1 hybrid workers. By contrast, new reproductive individuals are produced asexually by parthenogenesis. The association between genotype and caste is maintained by a genetic caste determination system, whereby hybrid eggs develop into workers, whereas pure-lineage eggs develop into new reproductive individuals. Yet, contrary to what was previously thought, the system does not appear to be genetically "hardwired". We show that female brood totipotency has not been completely lost and can be restored by means of pharmacological treatments mimicking the effects of environment.

Talk 11. Sean O'Donnell (Drexel University, USA), Susan Bulova, Elisabeth Sulger - *Brains vs Brawn?: Comparing worker subcaste differences in brain investment among* Eciton *army ant species*. Neotropical army ants are among the most strongly worker polymorphic ants. Most species in the genus Eciton have a large bodied, specialized soldier caste. Soldiers may have reduced task/behavioral repertoires relative to other workers, leading us to ask whether soldiers have reduced brain investment relative to body size. We found significant species differences in the degree of soldier brain reduction. We will explore possible behavioral/ecological patterns associated with these species differences.

Talk 12. Natalia S. Araujo (Universidade de São Paulo, Brazil), Yannick Wurm, Maria Cristina Arias - *Worker subcastes: What makes bees nurses?* In eusocial bees colonies the females responsible for reproduction are the queens and the ones in charge for other colony activities are the workers. Within the worker caste there are specialized sub-castes: nurses, mainly responsible for brood care and colony maintenance; and foragers, involved in foraging and nest-guarding. Differences between subcastes are subtle and not always a clear polymorphism exists, especially in highly eusocial taxa. Previous studies about sub-caste differentiation in *Apis* suggests that specific genes networks are involved in worker behavior but it is still an open question if these networks are similar in other eusocial bees. To address this question we have analyzed transcriptomic differences between nurse and forager subcastes in two bee species, the highly eusocial *Tetragonisca angustula* and the primitively eusocial *Bombus terrestris*. Our results suggest a set of similarities but also lineage specific genes involved in subcaste division of work.

Talk 13. Barbara Thorne (University of Maryland, USA) - *Differentiation and longevity of replacement reproductives, including reproductive soldiers, in a primitive termite*. Prototermite ancestors co-inhabited single decaying tree trunks or logs, therefore met neighboring conspecific families. Dynamics of extant species in which colonies occupy the same resource may thus offer fundamental clues to explain origins of eusociality in Isoptera. We use entire colonies of *Zootermopsis nevadensis* (Archotermopsidae) as a model to examine social, reproductive, and survival consequences of unrelated families meeting under bark. Contiguous colonies merge, non-relatives cooperate, and new reproductives may differentiate from helper offspring of both original families. We present data on ecological contexts and timing resulting in development of replacement reproductives of both genders, including reproductive soldiers, as well as longevity of those reproductives. We discuss implications of our findings for understanding the evolution of eusociality in termites, highlighting the importance of ecological circumstances impacting direct, indirect, and colony-level fitness.

Talk 14. Tali Reiner Brodetzki (Tel Aviv University, Israel), Ofer Feinerman, Abraham Hefetz - *Game of Thrones: polygyny in the desert ant*. Ants show a remarkable diversity in social organization from the ancestral colony that was presumably composed of a monogyny, and monoandrous queen and her daughter workers to more derived states of polyandrous queens and polygyne colonies. Polygyny poses two problems: queens are predicted to compete for monopoly in reproduction; workers are predicted to favor their own matriline in rearing gynes. Using a QR-coding system that allows us to indicate the proximity between queens and workers, along with polymorphic DNA microsatellite markers indicating the matriline and patriline of each worker in the nest, we demonstrate the complex social interactions in polygyne nests of *Cataglyphis niger*. Our data suggest that although all queens are fertile there is a functional monogyny, where workers attend to mainly one queen, regardless of their own matriline. This is probably due to the high level of relatedness between queens.

Talk 15. Brian R. Haney (Arizona State University, USA), Jennifer H. Fewell - *Evidence of cheating in cooperative groups of harvester ant queens*. Primary polygyny, the cooperation of multiple unrelated queens in a social insect colony, creates a multi-family group, often composed of unrelated queens and their offspring. This form of non-kin cooperation has been documented in multiple taxa but little is known about the resulting costs and benefits to the individual queens. A population of the harvester ant *Pogonomyrmex californicus* is dominated by multi-queen colonies that were formed through primary polygyny. Over three years, we captured and quantified the reproductive flights of polygynous *P. californicus* colonies. Microsatellite markers were used to determine the relative reproductive and workforce investment by each queen in these colonies. We found evidence of a cheater phenotype in this population, with some colonies containing one queen that disproportionately contributes to reproductive output over worker production.

Talk 16. Sarah Bengston (University of Rochester, USA), Christian Rabeling - *A new case of social parasitism in four western* Temnothorax *ant species drives colony interactions*. Social parasites are unlike the conventional parasite in that they consist of members of a social species that exploit the resources of another social group. In social insects, types of social parasitism are remarkably

widespread and diverse. Here, we present the first evidence of and characterize the nature of a newly discovered host- parasite system that involves four western *Temnothorax* ant species. We investigate the interactions between the hosts and parasites from both an inter- and intraspecific perspective. We show (i) behavioral variation between distinct populations, (ii) that populations with evidence of social parasitism show decreased congeneric colony tolerance and differential patterns of interspecific queen tolerance, and that (iii) this is likely mediated by ecological conditions. Additionally, we test for biased production of sexuals, which may provide evidence for intraspecific cheating and allows for insights into the evolution of socially parasitic life histories.

Talk 17. Qian Sun (University of Kentucky, USA), Jordan Hampton, Kenneth Haynes, Xuguo Zhou - *The social regulation of worker-reproductive transition in the eastern subterranean termite*. In many termites, totipotent workers can molt into ergatoid reproductives, but colony fitness requires a balance between reproductives and workers. To understand the regulation of worker-reproductive transition, we studied the social cues and behavior that mediate ergatoid reproduction in the eastern subterranean termite, *Reticulitermes flavipes*. Our results showed that reproductives inhibit workers of the same sex from differentiating into ergatoids, but stimulate the opposite sex to undergo this transition. Excessive ergatoids are killed through policing behavior, and we demonstrated that the policing behavior is age-dependent and carried out by both reproductives and workers. Older ergatoids attack younger ones, and workers then cannibalize the injured ergatoids. Our findings suggest that reproductive efficiency in *R. flavipes* is maintained by pheromones that suppress ergatoid differentiation, as well as policing behavior that eliminates additional ergatoids.

Talk 18. Jon Andreja Nuotclà (University of Bern, Switzerland), Michael Taborsky - *Should I stay or should I go? Conditional dispersal decisions in cooperatively breeding beetles*. Field and laboratory studies on fungus farming ambrosia beetles showed that delayed dispersal of sexually mature females is a fundamental component of cooperative breeding. While beetles stay in their natal gallery, they groom other colony members, remove waste and tend the mutualistic fungus garden serving as food. Hygienic behaviors constitute an important part of the social immune response, by which the virulence of experimentally introduced parasitic fungi can be significantly reduced. Theory predicts that dispersal decisions should be based on information about the relative fitness effects expected when dispersing or staying at home. Our data show that the state of the fungus garden, the number of dependent offspring, and ecological parameters such as humidity, grade of wood decay and barometric pressure critically influence dispersal decisions. We shall outline how internal and external information is integrated by these beetles to optimize life history trajectories.

Talk 19. Michael L. Smith (Cornell University, USA), Phoebe A. Koenig, Jacob M. Peters - *Cueing in on colony size: How do honey bees detect that their colony has enough workers to invest in reproduction?* When to begin to invest in reproduction depends on each organism's life-history, environment, and condition. Superorganisms, such as honey bee colonies, first invest resources in survival and growth, and later commit resources to reproduction. When the number of workers in a colony surpasses a reproductive threshold, the bees begin to build comb with large cells for rearing males (drones). How do the workers detect that their colony is large enough to invest in reproduction? To address this question, we used both experimental and observational approaches. We experimentally increased three possible cues of colony size: worker density, volatile pheromone concentration, and nest temperature. We then monitored and quantified cues in small and large colonies, to determine how cues changed with colony size.

Talk 20. Deby Lee Cassill (University of South Florida St. Petersburg, USA), Alexander Casella, Jaeson Clayborn, Matthew Perry, Michael Lagarde - *What can ants tell us about collective behavior during a natural catastrophe?* The fire ant, *Solenipsis invicta*, has successfully invaded and colonized ecosystems worldwide. One of the more striking behaviors of fire ants is their ability to form a living raft when springtime rains flood their domiciles. What are the survival benefits, if any, to collective behavior during a flood? We quantified the survival of individuals as solitary swimmers compared to cooperative rafters. We found that large workers and matriarchs survived

equally well as solitary swimmers or rafters. In contrast, small workers drowned whether they were solitary swimmers or rafters. However, when rafting with large workers or matriarchs, the mortality of small workers declined three-fold. Although the ultimate goal of rafting behavior by fire ant workers is to protect their matriarch, the proximate goal for the vast majority of fire ants is to save themselves first and to save others if the opportunity arises.

Talk 21. Adrian A. Smith (North Carolina Museum of Natural Sciences, USA) - *Fertility signal evolution in* Odontomachus *trap-jaw ants*. The cuticular chemical profile of insects is a primary means of communication. Mate choice for many solitary insects is based on sex-dimorphism, while for eusocial insects this profile provides information through which colonies members are identified and individual fertility status is assessed. Profiles of queens and workers have been described for many species, however comparisons of fertility signals between closely related species are rare. The cuticular chemical profiles of four species of *Odontomachus* ants, *O. brunneus*, *O. ruginodis*, *O. relictus*, and *O. haematodus*, and focus on identifying the fertility signals. Also presented are experimental data from two of these species that show that fertility signals are interpreted as such by workers only when they are within the context of a complete profile. These results provide unique insights into how these eusocial chemical signals are interpreted and evolve.

Talk 22. Jess Vickruck (Brock University, Canada), Miriam H. Richards - *A test of kin and nestmate recognition in the eastern carpenter bee (*Xylocopa virginica*): Familiarity matters more than family*. Insects living in social groups must constantly decide whether the conspecifics they encounter are part of their group, as allowing outsiders access can have negative fitness consequences for the entire nest. Using observation nests and relatedness analyses we asked whether eastern carpenter bee females use nestmate or kin recognition when encountering conspecifics. Eastern carpenter bees live primarily in small social groups of 2-8 females. In early spring, bees interact frequently with conspecifics while dispersing and joining new nests. We found increased levels of feeding and decreased levels of aggression among familiar interactants, but no behavioral difference in related or unrelated pairs, showing that eastern carpenter bees use nestmate recognition when interacting with conspecifics. This is logical for eastern carpenter bees, where summer reproductive nests are comprised largely of unrelated females.

Talk 23. Juergen Gadau (Arizona State University, USA) – *GAGA initiative*.

Talk 24. Brendon E. Boudinot (University of California - Davis, USA), Itanna O. Fernandes, Rodolfo S. Probst, Julio M. Chaul, Jorge L.P. Souza, Marcio L. Oliveira - *Insights into the biology of an isolated lineage: first natural history data of the ant from Mars,* Martialis heureka*.* Known from one complete worker, sclerite fragments, and a few dozen males, the Amazonian endemic Martian ant (*Martialis heureka*) is a mysterious isolated lineage, potentially sister to the remaining Formicidae. Two populations are known one near Manaus, and the other about 50 km North, at the Biodynamics of Forest Fragments Research Project (BDFFP) plots. Our objective is to discover and document the natural history of these ants at the BDFFP research station. Specifically, we intend to document nesting, colony demography, social structure (including trophallaxis and larval hemolymph feeding), queen and brood morphology, functional morphology, diet, and predatory behavior. Field work is to take place in August, 2016.

Talk 25. Thomas Chouvenc (University of Florida, USA), Nan-Yao Su - *Using hybrid colonies to test the role of cuticular hydrocarbon profiles on intercolonial agonism in subterranean termites*. Agonism usually results from the interaction of con-specific non-nestmate individuals in subterranean termite colonies, and it was previously hypothesized that the cuticular hydrocarbon profile of individuals had a major role in nestmate or kin recognition. The role of cuticular hydrocarbons was tested on intercolonial agonism in *Coptotermes formosanus*, *C. gestroi* and their hybrid (Rhinotermitidae) by controlling for all other environmental variables. Our results showed that the cuticular hydrocarbon profile is not a major component for colony recognition in subterranean termites, as the two hybrid mating types that shared a similar profile initiated strong agonism, while one of the hybrids mating type predominantly merged with *C. formosanus*, despite a dissimilar cuticular profile.

Talk 26. Elinor M. Lichtenberg (University of Arizona, USA), Chase D. Mendenhall, Berry Brosi - *Diet breadth impacts tropical eusocial bee species' sensitivity to forest lost*. Anthropogenic land use change can substantially impact biological communities and the ecosystem services they provide, including pollination. We know relatively little about bee community composition changes in the tropics in response to ongoing land use changes, despite animal pollination's importance there. We used a traits-based approach to study how communities of Costa Rican, eusocial stingless bees (Apidae:Meliponini) disassemble under forest loss. In contrast to theory and temperate bee communities, stingless bee species with the widest diet breadths were less likely to persist with less forest. Wide-diet-breadth species tend to be solitary-foraging, and subordinate to group-foraging stingless bee species. Species with broader diets may tolerate disturbance poorly if they require the larger or more diversified resource pool in natural habitats. Functional traits may thus affect the degree to which community processes, such as competition, modify effects of land use change.

Talk 27. Nathan Smith (Arizona State University, USA), Jennifer Fewell - *Macronutrient regulation by the desert leafcutter ant* Acromyrmex versicolor*.* Leafcutter ants live in an obligate mutualism with a fungal food source. The leaves the ants harvest are provided to their fungal symbiont, which the ants in turn consume. As a result, leafcutter ants must make foraging decisions based not directly on their own nutritional needs, but on those of the ant/fungus colony system. A large body of nutritional research suggests that animals forage to obtain nutrients in specific relative amounts based on physiological needs. This investigation focused on how colonies of the desert leafcutter ant *Acromyrmex versicolor* balance collection of two important macronutrients: protein and carbohydrates. The results indicate that *A. versicolor* colonies forage to a specific target ratio of protein:carbohydrate. This ratio is carbohydrate-biased; foragers collect approximately 1 gram of protein for every 6.5 grams of carbohydrates. We discuss how the ability of colonies to regulate nutrient intake may emerge from variation in individual foraging choices.

Talk 28. Jonathan Z. Shik (University of Copenhagen, Denmark), William T. Wcislo, Jacobus J. Boomsma - *Nutrition mediates the expression of cultivar-farmer conflict in a fungus-growing ant*. Early subsistence farming implied significant physiological challenges for Neolithic farmers until they genetically isolated their crops through artificial selection and polyploidization. The attine ants faced analogous challenges when they adopted fungus farming 50 MYA. While evolutionarily derived attine lineages irreversibly domesticated cultivars 20 MYA and ultimately realized industrial-scale farming, basal lineages retained small-scale farming, diversified, and now coexist with advanced fungus-farmers in most (sub)tropical ecosystems. We show that management of independent sexual reproduction in cultivars constrained farming productivity echoing early human farming of unspecialized, low-productivity crops. Loss of cultivar gene exchange with non-domesticated relatives likely reduced host-symbiont conflict over reproduction, fostering the rise of ecologically dominant ant-agriculture and broadening our understanding of the general principles by which farming practices evolve.

Talk 29. Yi Hu (Drexel University, USA), Jon Sanders, Piotr Lukasik, John T. Wertz, Corrie S. Moreau, Jacob A. Russell - *Nitrogen metabolism in an ancient nutritional symbiosis between* Cephalotes *ants and core gut bacteria*. Symbiosis is a common strategy used by herbivorous animals to overcome N-limitation. While the mechanisms behind these partnerships are understood for simple symbioses, N-provisioning by complex gut bacterial communities is currently less characterized. In this study, we assess roles of ancient and specialized gut bacteria in N-provisioning for turtle ants of the genus *Cephalotes*. We find that a few bacterial groups can recycle N from ant- or diet-derived nitrogenous wastes, producing substances that nearly all symbionts can use to make amino acids. Our findings of amino acid provisioning by gut symbionts suggest that nutritional symbiosis has been key to the evolution of several arboreal ant clades, helping to resolve a long-standing paradox of abundant ant biomass in tropical rainforest canopies.

Talk 30. Jacob Russell (Drexel University, USA), Jon Sanders, Yi Hu, Corrie Moreau - *Hotspots for bacterial symbionts across the ants*. With an impressive degree of niche diversification across the

ants' history, evolution has performed a range of natural experiments, allowing studies of symbiosis through a lens of comparative biology. Through this lens it is gradually becoming clear that specialized symbioses can be gained or lost in association with important shifts in dietary ecology. But viewing symbiosis across the ant phylogeny has also lent an additional insight—that the presence of specialized and ancient bacterial symbionts is a patchily distributed attribute of ant biology. In fact, recent evidence suggests that several groups of ants harbor very few microbial symbionts—at least those of a eubacterial nature. These combined findings raise the possibility that the importance of symbiosis has fluctuated throughout the evolutionary history of the ants, making "hotspot" lineages stand out amongst potential symbiotic coldspots.

Talk 31. Aniek Ivens (Rockefeller University, USA), Daniel Kronauer, Toby Kiers - *A mutualistic network of ants, aphids, mealybugs and their microbiomes*. Subterranean ant-symbiont interactions are classic examples of mutualism: ants protect their symbionts, which in turn provide them with honeydew. We study mutualism evolutionary stability by mapping a North American community of ants that tend several species of root-feeding aphids and mealybugs inside their nests. Using both genetic barcoding and morphology, we characterize all species interactions and their specificity in this multi-level ecological network. We show that most symbionts have their own host plant and all insects harbor a specialized internal microbiome that facilitates these nutritional interactions. The prime commodity of these mutualisms, honeydew, may thus not only be influenced directly its producers, but also indirectly by their endosymbionts and host plants. Extending our view from the central species interaction towards including those organisms that indirectly influence this interaction may thus greatly contribute to our understanding of mutualism.

Talk 32. Benjamin E.R. Rubin (Princeton University, USA), Jon G. Sanders, Sarah D. Kocher - *Nascent bacterial endosymbionts compete for sweat bee hosts*. We identify a bacterial endosymbiont widespread across the bee family Halictidae with a degenerating genome, a characteristic suggestive of a soon to be obligate association. This bacterium is closely related to a variety of species in the genus *Sodalis* that also appear to be in the early stages of symbiosis with a diversity of insects. Similar to *Wolbachia*, *Sodalis* may specialize in establishing tight relationships with insect hosts. Remarkably, we find two strains of *Sodalis* within a single species of bee, though they never appear together in the same individual suggesting competition for host occupancy. Notably, the bacterium with the more highly degraded genome is consistently present at higher levels and may be more specialized for intra-host existence. We have yet to determine what functional role, if any, these bacteria play for their bee hosts, but it is possible that *Sodalis* substantially influences halictid ecology.

Talk 33. Amy Geffre (Iowa State University, USA), Adam Dolezal, Bryony Bonning, Amy L. Toth - *Host-Pathogen interactions in the Hive: a study of honey bee behavior during IAPV-infection*. Despite their importance to honey bee health, host-pathogen interactions of many honey bee viruses are poorly described, outside of basic pathology. Such host-pathogen relationships may be complex, involving host-adaptive responses to infection, as well as host-manipulation by pathogens. This study uses controlled infection of adult honey bees with Israeli Acute Paralysis Virus (IAPV) to detail infection-effects on honey bee social behavior. We tested two hypotheses: 1) "host-manipulation hypothesis": viruses manipulate hosts to increase social interactions, enhancing viral transmission, and 2) "social-immunity hypothesis": antiviral immune response in honey bees induces reduced social interactions to minimize viral transmission. We examined infection effects on general activity, social behavior, brood care, and quantified virus transmission. The results of this study raise questions about sub-pathological effects of viral infection honey bees and how they affect transmission dynamics.

Talk 34. Vincent Doublet (University of Exeter, United Kingdom), BeeDoc Consortium - *Changes in viral community dynamics following the invasion of the Varroa mite in the Western honey bee*. *Varroa destructor* is a parasite of the Western honeybee, *Apis mellifera*, feeding on its haemolymph and vectoring viral diseases. Since its worldwide spread from Asia to *A. mellifera* colonies during the second half of the last century, the Varroa mite provided a new transmission route to viruses. We collected honeybee workers across several continents and countries, from

infested and non-infested colonies, and compared the prevalence and loads per bee of 12 viruses. We demonstrate that 6 viruses have increased prevalence when the Varroa mite is present in the host population, with deformed wing viruses and Black queen cell virus also showing increased load. Conversely, Big Sioux River virus shows lower prevalence in infested populations, a possible consequence of within host virus competition. Overall, this work reveals how the honeybee viral landscape has been altered since the invasion of the Varroa mite and how the new transmission route offered by Varroa modifies virus epidemiology.

Talk 35. Kaitlin M. Baudier (Drexel University, USA), Sean O'Donnell - *Microhabitat, elevation and body size effects on thermal tolerance among Neotropical army ants*. Tropical species face high climate change impacts because seasonally stable temperatures select for thermal specialization. Our previous study showed that soil microhabitat (above vs. belowground) and size predict heat tolerance of army ants. High elevation causes wide thermal tolerance breadths and lower minimum and maximum thermal tolerance (CTmin & CTmax) across taxa. We predicted low CTmin & CTmax at high elevation, and asked whether microhabitat and size effects differ across elevations. Army ants (Formicidae: Dorylinae) have wide elevation ranges, different sizes, and species with above and belowground activity. We assayed thermal tolerance of army ants from 50-1700m elevations. CTmax decreased with elevation. Larger ants had greater heat and cold tolerance. Soil microhabitat use was a stronger predictor of thermal tolerance than size or elevation. In some sites ambient temperatures were close to CTmax of local ants. Microhabitat is important to predicting climate change impacts.

Talk 36. Sarah Lawson (University of New Hampshire, USA), Sandra M. Rehan - *Maternal manipulation of pollen provisions affects worker production in a carpenter bee*. Mothers play a key role in determining the body size, behavior and fitness of offspring. Mothers of the small carpenter bee, *Ceratina calcarata*, provide less food to their first female offspring resulting in the development of a dwarf eldest daughter (DED). The DED serves as a worker for the nest and is coerced to forage and feed siblings. In order to better understand how this maternal manipulation leads to the physiological and behavioral differences observed in DEDs, we characterized the quality of the pollen balls fed to theses females versus other offspring. We found that, in addition to the smaller quantities of pollen provisioned, late brood cells receive pollen balls with significantly less floral diversity than early brood cells. These differences in floral diversity result in differential protein content of pollen balls. These results reveal that mothers manipulate not only the quantity, but also the quality of the provision provided to her first offspring.

Talk 37. Lucas P. Carnohan (University of Florida, USA), Rudolf H. Scheffrahn - *Description of a new soldierless termite genus from Peru*. For termites, the greatest amount of species diversity is found in the family Termitidae. New World termitid species found in the subfamily Apicotermitinae are easily distinguished from other termites by the lack of a soldier caste. However, soldier morphology is usually an important tool used for classification. Therefore, for genus and species differentiation of Apicotermitinae, the characteristics of the enteric valve armature, a cuticular structure found in the hindgut, is often used due to its diverse characteristics among different species. Presented here is a unique apicotermitine termite collected in Peru that represents a new genus and species. Unlike the majority of soldierless termite species, the workers of this new species have a unique external morphological character. They possess a fontanelle with an exceptionally large diameter. The workers are also dimorphic, with a smaller and a larger fontanelle size.

Talk 38. Daniel Charbonneau (University of Arizona, USA), Anna Dornhaus - *Who needs 'lazy' ants? Investigating potential functions of inactive workers*. Social insect colonies are commonly thought of as highly efficient complex systems. Yet they contain workers that effectively 'specialize' on inactivity. Though inactivity has been linked to age-related constraints and reproductive conflict, little is known about potential adaptive functions that inactive workers may play. Here we investigate whether inactive workers act as food stores (repletes) that can be used by the colony when external resources are unpredictable or scarce. We show that inactives are more corpulent than their nestmates, have limited task repertoires and slower walking speeds which is consistent

with repletism in other social insect species. We also test the hypothesis that inactive workers act as a 'reserve' labor force that can mitigate the effects of worker loss or fluctuating workloads. We show that inactive workers compensate for the loss of experimentally removed highly active workers by increasing their activity levels to match those of the removed workers.

Talk 39. Ken Tan, Shihao Dong, Xinyu, Li, Xiwen Liu, Chao Wang, Jianjun Li, James C. Nieh (University of California - San Diego, USA) - *Honey bee inhibitory signaling can act as a colony alarm signal and is tuned to threat severity*. Alarm communication is an adaptation that helps social groups rally defenses and resist predation. In Asia, the world's largest hornet, *Vespa mandarinia*, and the smaller hornet, *Vespa velutina*, prey upon nests and foragers of the Asian honey bee, *Apis cerana*. We attacked foragers and colony nest entrances with these predators and provide the first evidence, in social insects, of an alarm signal that encodes graded danger and attack context. The honey bee waggle dance, sophisticated recruitment communication that encodes food location, is therefore matched with an inhibitory/alarm signal that encodes information about the context of danger and its threat level.

Talk 40. Floria Mora-Kepfer Uy (University of Miami, USA), Rita Cervo, Stefano Turillazzi, Alessandro Cini, Federico Cappa, Irene Pepiciello, Mark Hauber - *Defense behaviors in animal societies: Tinkering or de novo evolution?* In animal societies, group formation and composition are essential to maintain the benefits of cooperation. Particularly, nest-building groups need to discriminate group members from intruders that create substantial fitness costs, including conspecific intruders and heterospecific social parasites. Thus, in many taxa, defensive behavior is mediated by recognition mechanisms. Here, we focus on behavioral responses towards conspecific intruders versus social parasites. We compare behavior in two different taxa exposed to non-nestmates/flock-mates and social/brood parasites: social Polistes wasps and colonial Agelaius birds. Our results show that residents exhibit different behavioral responses towards conspecific intruders and social parasites. Currently, we are comparing the neural mechanisms underlying these behavioral decisions. Our work will provide novel insights to determine if defense behavior across distantly-related taxa are the result of de novo or conserved neural mechanisms.

Talk 41. Erin Cole (Northeastern University, USA), Jeremy McDavid, Rebeca B. Rosengaus - *Termite embryos are no sitting ducks: embryonic immune-competency in a social insect*. In social insects, vulnerability of embryos to nest pathogens can negatively impact the successful establishment of the colony. Termites can employ various strategies to protect their embryos from infection, including the deposition of antimicrobial compounds on the exterior surface of the chorion, the addition of antimicrobial peptides inside the chorion, and/or the evolution of innate immunological responses by the developing embryos themselves. Here we investigate the antimicrobial properties of embryos of the termite, *Zootermopsis angusticollis*. After incubating homogenized termite embryos at different developmental stages with a common soil bacteria and fungus, we compared the microbe's growth to that of controls lacking homogenates. Our data indicate that recently oviposited embryos have inhibitory properties of bacteria while older embryos inhibit fungal pathogens. Our work is the first to address whether termite embryos have a constitutive defense against pathogenic microbes.

Talk 42. Christopher Mayack (Swarthmore College, USA), Frank Hirche, Ying Wang, Gabriele I. Stangl, Gro V. Amdam - *Physiological constraints of coping with energetic stress in the eusocial honey bee*. Honey bees (*Apis mellifera*) can communally build up food stores to buffer against energetic stress. I hypothesize that social insects have lost the highly conserved Adipkinetic hormone to mobilize fat stores and instead only rely on octopamine to increase search activity for food, out away from their centralized buildup of food stores. To test this hypothesis, I starved forager honey bees and infected them with *Nosema ceranae*, with a combination of treatments. I measured each hormone using High Performance Liquid Chromatography and gene expression of their corresponding receptors. While there was an increase in octopamine in response to energetic stress, Adipokinetic hormone was present in small quantities and did not respond to any treatment. This finding supports the notion that highly conserved regulatory pathways retained

from a solitary ancestral state might be constrained such that social insects are less able to buffer against energetic stress at an individual level.

POSTER PRESENTATIONS

Poster 1. Alexandria M. DeMilto, Stefanie Neupert, Falko Drijfhout, Simon Speller, David Nash, Rachelle M.M. Adams (The Ohio State University, USA) - *Trojan horse or helpful ally? How fungus growing ants perceive their social parasite.* Like a Trojan horse, ant parasites are disguised when invading another ant species fortress. Social parasites evolve strategies to extract resources and hosts evolve counter-strategies to resist. Attracted by abundant fungus gardens, *Megalomyrmex symmetochus* infiltrate *Sericomyrmex amabilis* nests and establish their colonies. Farmer-ant hosts respond with either submission or aggression. Behaviors of host and non-host *S. amabilis* ants were experimentally assayed with a conspecific or parasitic nestmate or non-nestmate. We established that host ants can differentiate between nestmates and non-nestmates and that *S. amabilis* can recognize ants from parasitized and non-parasitized colonies. Finally, we compared the reactions of host and non-host colonies to nestmate or non-nestmate parasites. This work elucidates parasitic infiltration strategies and determines if parasites are being treated as a Trojan horse threat or as a harmless nestmate ally.

Poster 2. Ioulia Bespalova (Arizona State University, USA), Jennifer Fewell - *Development of seed preference in the bearded desert seed harvester ant* Pogonomyrmex californicus. Despite the variety of seed species available, *Pogonomyrmex* harvester ant colonies show clear preferences and can be thorough in their exploitation of favorite seed and rejection of others. In this study we ask, how does preference develop though colony experiences with seeds? We monitored the ontogeny of seed selection by field colonies of *P. californicus* (including a few colonies with marked foragers) while offering varying amounts of two seed species: niger (high quality) and ryegrass (low quality). Preferences were not influenced by seed abundance, but colonies developed stronger preference for niger over ryegrass across days, and showed a similar pattern across months. Individuals switching to favoring niger may explain this change. Collection rate was additive across seeds, not absolute – colonies collecting similar amounts of niger and ryegrass, had seed return rates that were twice as fast as colonies preferring niger. Thus there may be costs to specializing in mixed patches.

Poster 3. Jon A. Nuotclà, Michael Taborsky, Peter H. W. Biedermann (Max-Planck Institute for Chemical Ecology, Germany) - *Is pathogen defense a driver of social evolution in fungus-farming ambrosia beetles?* Social immunity is a crucial for the survival of insect colonies. Here we investigated the presence, plasticity and effectiveness of the social pathogen defense by artificially infecting nests of a facultatively eusocial ambrosia beetle, with pathogenic fungi. After an Aspergillus-spore-buffer solution or a sterile buffer solution had been injected in laboratory nests, totipotent adult female workers increased activity and hygienic behaviors like allo-grooming, self-grooming and cannibalism. Such social immune responses had been unknown in beetles and are reported here for the first time. Most remarkably, in response to Aspergillus injections adult females also delayed dispersal and thus prolonged their cooperative phase within their mother´s nests. This is interesting because, social immunity has been always regarded as a prerequisite for the evolution of higher sociality in arthropods, but these results suggest that pathogen defense may also be a key driver of social evolution.

Poster 4. Vanessa Bonatti (Universidade de São Paulo, Brazil), Sónia C. S. Andrade, Maria Cristina Arias, Tiago M. Francoy - *Population genomics and mitochondrial diversity of* Melipona subnitida *in dry forests of Brazil*. *Melipona subnitida* is a stingless bee endemic from Northeastern Brazil currently threatened due to the destruction of its habitat. Populational studies with this bee are still very scarce, as well as the need to understand the structure and dynamics of its populations. In order to investigate its genetic structure, the variability of *M. subnitida* was characterized by SNPs and mitochondrial gene Cytochrome c oxidase I. 219 workers were sampled from 27 locations within its natural distribution. The COI data indicated low genetic variability ($\pi = 0.00357$) and high

structuration among sampled locations (pairwise FST = 0.14 to 1). The dendrogram of genetic distance identified three main clades. The 10,882 recovered SNPs showed high variability and the existence of three evolutionary lineages. When combined, there is an apparent congruence of the distribution of the evolutionary lineages and groups of maternal haplotypes. Our study may help future efforts to preserve *M. subnitida* specie.

Poster 5. Andrew T. Burchill (Arizona State University, USA), Wataru Toyokawa, Takao Sasaki, Zachary Shaffer, Keigo Inukai, Tatsuya Kameda, Stephen C. Pratt - *Ants vs humans: exploration, exploitation, and social information in a dynamic environment*. Ants and humans have independently evolved complex cooperative societies adept at making adaptive collective decisions. However, the ecology of these organisms and the evolutionary selection pressures that have shaped their behavior are fundamentally different. Paired studies of humans and ants have the potential to illuminate commonalities and differences in their collective processing of information. In this study we compare how humans and *Temnothorax rugatulus* ants, both individually and in groups, maintain a balance between exploring and exploiting resources in similar environments. We hypothesize that human groups, due to their conformity bias, would be less flexible to environmental changes. However, our initial assumptions and expectations were not met: human subjects did not show a strong reliance on social information. Our results indicate that the mechanisms underlying this exploration-exploitation balance operate on different levels in humans and *Temnothorax*. While humans relied mostly on individual exploration, the ants instead used social information to reallocate non-exploratory foragers. These results are consistent with a greater reliance on collective mechanisms in the ants, perhaps reflecting stronger selection on group-level phenotypes.

Poster 6. Jason R. Carbaugh (Texas A&M University, USA), Robert D. Renthal, Raul F. Medina, S. Bradleigh Vinson - *Color discrimination and preference in the red imported fire ant* Solenopsis invicta *Buren*. Color vision has been extensively studied in bees. However, color vision has not been studied as much in other Hymenopteran, such as ants. In this study, color vision was explored in the red imported fire ant *Solenopsis invicta* Buren, an invasive ant species. The experiments tested whether *S. invicta* workers can discriminate colors. Workers from ten colonies were randomly selected to dig in colored glass beads in paired choice tests for one hour. Five colors were used: blue, green, yellow, orange, and red. The number of colored glass beads brought to the surface was determined. In the experimental group, workers dug in light conditions, while in the control group, workers dug in the dark. Overall, workers were able to discriminate colors and showed preference for some colors. In the control group, workers could not discriminate any colors, except orange from yellow. Results of this study can be used to improve the attractiveness of fire ant baits.

Poster 7. Erika Cevallos Dupuis (Arizona State University, USA), Jon F. Harrison - *Trunk trail maintenance in leafcutter ants: Caste involvement and effects of obstacle type and size on path clearing in* Atta cephalotes*.* The role of morphological castes in task partitioning and colony success remains controversial. We studied the role of *Atta cephalotes* castes in the maintenance of trunk trails by recording their involvement in the removal of leaves and testing the effect of removal of majors on task performance. Ants treated live and dead leaves identically. Removal of larger leaves required more ants and took longer. We hypothesized size matching between ants and the obstacle removed, but found no correlation. As leaf size increased, the number of majors and mediae increased for cutting and pulling, but numbers of minors only increased for cutting. Major removal did not affect removal time of any obstacles, but their removal influenced the behavior of the remaining castes, with greater numbers of mediae pulling and an increased number minors cutting. Thus, task partitioning differs among minors and mediae, but we found no evidence that castes improve capacities for trail-clearing.

Poster 8. Linh Chau (Georgia Institute of Technology, USA), Michael A.D. Goodisman - *Gene duplication in the evolution of sex and caste biased gene expression*. The success of social insects arises from the caste system, whereby different individuals, which often exhibit different phenotypes, are each responsible for certain tasks within the colony. Gene duplication is

important for evolution because it can provide novel genetic material. We hypothesize that genetic redundancy provided by gene duplication could be used to facilitate differential gene expression which promotes the evolution of different phenotypes. We approached this hypothesis by investigating the genome of the honey bee, *Apis mellifera*, using biased gene expression as a proxy for phenotype specific gene function. We found that duplicate genes have a higher level of biased expression compared to singletons. Also, gene expression patterns amongst duplicate pairs diverge over time. By studying the interaction between gene duplication and gene expression, we can further our understanding of the factors involved in evolution of social insect castes.

Poster 9. John Cho (Arizona State University, USA), Stephen C. Pratt - *Does hunger state affect recruitment levels in* Temnothorax rugatulus *ants*? Social animals often share information about food sources to their group members. In *Temnothorax* ants, a model ant group in collective decision-making, there is evidence that their foraging process is affected by hunger state. But it is not known in detail how recruitment is affected for these ants. I hypothesize that hunger state affects recruitment due to higher motivation to forage. To test, I am starving 15 ant colonies for 1 week, and 2 weeks or more (these ants can endure 8 months of starvation). I will then offer a sucrose solution to each of the colonies and measure the number of tandem runs for recruitment. I predict that higher hunger state will result in higher tandem run numbers.

Poster 10. Rebecca Clark (University of California - Berkeley, USA), Jennifer H. Fewell - *Protein, carbohydrates, and phosphorus differentially affect growth across the leafcutter ant-fungus trophic system*. Nutrient balances have interactive, distinct effects on growth across trophic levels. Despite awareness of this, there are few tests of how nutrient regulation occurs across complex, dynamical systems. We examined how ratios of digestible protein, carbohydrate, and phosphorus affected food intake and growth within the leafcutter ant-fungus symbiosis, by adding nutrients to a standard diet given to *Acromyrmex versicolor* colonies for four months. Colonies on carbohydrate-biased food foraged more, grew larger fungus gardens, showed indicators of enhanced worker growth, and tended to produce more waste. Adding phosphorus resulted in larger brood and a higher ratio of brood to workers, with no effect on foraging or fungus garden size. Protein addition caused decreased foraging and reduced fungus growth, including garden death in some cases. These findings suggest the balance and concentration of all three nutrients affects colony growth via differential effects on colony trophic levels.

Poster 11. Chelsea N. Cook (University of Colorado - Boulder; Arizona State University, USA), Colin S. Brent, Michael D. Breed - *Octopamine and tyramine regulate the group thermoregulatory fanning response in honey bees*. Biogenic amines regulate the proximate mechanisms underlying most behavior. While the role of biogenic amines is relatively known in individuals, how biogenic amine-mediated individual responses can influence group behavior is not fully understood. Here, we examined how changes in biogenic amines can modulate group-performed thermoregulatory fanning behavior in honey bees. We found that the concentrations of two biogenic amines, octopamine and tyramine, are significantly lower in active fanners than in non-fanners. Direct feeding of these biogenic amines induced a decrease in fanning responses, but only when both amines were included in the treatment. This is the first evidence that fanning behavior is influenced by these two biogenic amines, which is consistent with their role in regulating activity in other insects. Observed individual variation in amine expression also provides a mechanistic link to explain how this group behavior might be coordinated within a hive.

Poster 12. Pingli Dai (China Academy of Agricultural Sciences; University of Florida, USA), Huiru Jia - *Bt Cry1Ie toxin has no harmful effects on the survival, pollen consumption and midgut bacterial diversity of Chinese honey bees* (Apis cerana cerana). The cry1Ie gene may be a good candidate for the development of Bt maize because of highly toxic to Lepidopteran pests such as *Heliothis armigera* and *Ostrinia furnacalis*. Chinese honey bees (*Apis cerana cerana*) are potentially exposed to transgenic crops expressing Cry1Ie toxin via pollen. This study tested whether worker bees are negatively affected by sugar syrup containing 20, 200 or 20,000 ng/ml Cry1Ie toxin and 48 ng/ml imidacloprid under controlled laboratory. The results demonstrated that Cry1Ie toxin has

no adverse effects on survival and pollen consumption. Furthermore, the midgut bacterial structure and compositions were determined using high-throughput sequencing targeting the V3-V4 regions of the 16S rDNA. All core honey bee intestinal bacterial genera were detected, and no significant changes were found in any bacterial taxa among treatments. These results suggested that Cry1Ie toxin may not exhibit harmful impacts on gut bacterial communities of Chinese honey bees.

Poster 13. Katie D'Amelio (Drexel University, USA), Yi Hu, Jacob A. Russell - *Dietary effects on bacterial gut symbiont transcriptome of turtle ants*. Ants of the genus *Cephalotes* harbor a core set of gut bacteria that show strong evidence for codiversification with host species. *Cephalotes* consume a variety of food sources including pollen, lichen and bird droppings. In controlled experiments, different dietary sources do not appear to substantially alter microbiome composition; the aim of this study is to examine whether diet impacts symbiont gene expression using metatranscriptomics. Subcolonies of workers were fed one of four diets for 3 weeks before RNA from guts was extracted and sequenced. After de novo transcriptome assembly, differential expression of gene classes between treatments was evaluated. This study helps elucidate mechanistic underpinnings of a nutritional symbiosis, building upon prior studies on the identities and genomic content of long-standing symbionts of the *Cephalotes* genus. Implications for *Cephalotes* evolution are discussed, as are similarities of our results to those in other host-symbiont systems.

Poster 14. Adam Dolezal (Iowa State University, USA), Stephen Hendrix, Nicole A. Scavo, Mary A Harris, M. Joseph Wheelock, Matthew O'Neal, Amy L. Toth - *Wild bees commonly harbor, but are not affected by honey bee viruses*. Pathogen spillover from managed to wild bees has sparked concern that emerging diseases could be causing or exacerbating population declines. We tested 169 bees for five honey bee viruses, finding that more than 80% of wild bees harbored at least one, and that virus incidence was associated with honey bee presence. We also quantified virus levels: although detection was common, virus levels were minimal compared to healthy honey bee hives. Further, when we experimentally inoculated two different solitary bees with a lethal mixture of honey bee viruses, we saw no effect on survival or evidence of viral replication. Overall, there is frequent but low-intensity spillover of RNA viruses into wild bee species, likely caused by direct or indirect interactions with honey bees. However, despite frequent exposure, these viruses appear incapable of causing harmful infections in some solitary bees, suggesting that these viruses currently pose a minimal threat to the health of wild bees.

Poster 15. Anna Dornhaus (University of Arizona, USA) - *What to learn? Information that is and isn't used in individual decision-making by bumble bee foragers*. Bumble bees are generalist foragers, who have to select which types of flowers to visit when and where. These decisions carry consequences: the mortality, energetic and time costs of foraging are considerable. Unsurprisingly, bees can learn to distinguish rewarding from unrewarding flowers. Bees can also use both information acquired by trial-and-error learning and information acquired socially. We have demonstrated that bees weigh the reliability of personally or socially acquired information, and make their choices accordingly. However, we present several costs and constraints on individual decision-making by bees, and discuss their consequences for behavioral innovation. For example, naive bees are terrible at even landing on flowers, and may miss rewarding flowers entirely if rewards are not obtained immediately. Learning may also amplify stochastic initial choices, particularly in groups. Innate biases thus impact learning outcomes, and may be used by plants to manipulate bees.

Poster 16. Ti Eriksson (Arizona State University, USA), Bert Hoelldobler, Juergen Gadau - *Founding strategy variation in* Myrmecocystus mendax. Independent colony founding in ants can be accomplished via haplometrosis or pleometrosis. Here I present behavioral evidence of variation in founding strategies and its effects on colony fitness components in the honey ant *Myrmecocystus mendax*. I tracked the development of lab colonies reared from queens collected from two populations that differ in the frequency of the observed founding strategies. In the population exhibiting both strategies, foundress number does not affect queen mortality during

colony founding but positively correlates with total minim number and rate of replete formation. During laboratory raiding assays, queens from colonies with more workers relative to the opponent colony are more likely to survive. In colonies of the haplometrotic population, foundress number negatively correlates with queen mortality during founding, but has a positive effect on total minim number. Natural variation in colony density may explain the evolution of pleometrosis in *M. mendax*.

Poster 17. Joshua Gibson (Purdue University, USA), Miguel E. Arechavaleta-Velasco, Jennifer M. Tsuruda, Greg J. Hunt - *The epigenetic basis of aggression in hybrid honey bees*. Hybrid honey bees with a European mother (*Apis mellifera carnica*) and an Africanized father (primarily *A. m. scutellata*) display asymmetrically high levels of aggression relative to hybrids with the inverse parental relationship. Aggressive hybrids show a strong maternal allelic expression bias for over 200 genes that are clustered in loci associated with defensive traits, while the less aggressive reciprocal hybrids show no such bias. The asymmetric pattern of aggression and allelic bias point to epigenetic regulation of these traits that differs between the parents. The biased gene set implicates small RNAs in the regulation of this expression. Small RNAs are known to be loaded into mature eggs and sperm and therefore represent a potential epigenetic mechanism of regulation. We have sequenced small RNAs in both eggs and sperm and have identified pathways that may contribute to the asymmetry in these hybrids and which may underlie the epigenetic inheritance of aggression in honey bees.

Poster 18. Patricia D.G. Pinhal (Universidade de São Paulo, Brazil), Claudinéia P. Costa, Vanessa Bonatti, Clycie A.S. Machado, Francisco G. Hernandez, Tiago M. Francoy - *Two decades after the arrival of Africanized bees in central region of Mexico, Guanajuato*. Africanized bee (AHB) arrived in Mexico and impacted on the local European honey bee (EHB) populations previously established. Here, analyzed current populations and the consequences of constant introduction of EHB matrices. For this, geometric morphometric analysis of bees from four Guanajuato state locations was performed (León, Irapuato, Abasolo and Romita), comparing them with individuals of four EHB and one African subspecies and Brazilian AHB. The Mahalanobis distance identified that Mexican bees were closer to AHB (3.44) and A. m. mellifera (3.70), values of the same magnitude of subspecies taxonomically well established and closely related (A. m. ligustica and A. m. carnica). The results showed group structures with significant separation ($p<0.0001$). Our data showed that Mexican bees are distinct from EHB, African and Brazilian AHB, probably, indicating that containment management, as well as environmental factors, contribute for variations found.

Poster 19. Xiaohui Guo (Arizona State University, USA), Michael R. Lin, Jennifer Fewell, Yun Kang - *Does individual variation matter in spreading alarm signals in seed harvester ant social networks?* Social communication plays an important role in the task organization of ant colonies. Colony behavior relies on the decisions of workers locally, and share information via physical antennations and/or releasing pheromones. However, not much is known about how information actually propagates in these worker interaction networks. In seed harvester ant colonies (*Pogonomyrmex californicus*), workers propagate alarm signals between individuals via characterized by rapid non-directional movement and focal antennal interactions. The transmission of alarm can be measured as an information-transfer network. We provided alarm stimuli to individual ants and used tracking programs to track colony alarm response,to collect data about movement patterns, spatial factors and antennation rates. We use these data to generate algorithms for information transmission rate, which allow us to understand how variation in individual alarm response affect the escalation and decay of colony alarm behavior.

Poster 20. Xianbing Xie, Shudong Luo, Zachary Huang (Michigan State University, USA) - *Cost of relocating honey bee colonies*. Honey bee colonies are often used for pollination of various crops. To accomplish this, colonies have to be transported and relocated. We are interested to determine the cost of relocation in terms of colony labor. Our premise is that honey bees will lose their familiar patch of food sources (both nectar and pollen) when relocated, but the exact loss has never been quantified. We compared colony weight gain between bees that were stationary and those that were relocated and found that relocated colonies showed a significantly smaller weight

increase compared to stationary ones, but only for one day. Relocated colonies quickly recovered to the same level as the stationary colonies, even if these colonies were also transported (transported but not relocated). Both nectar foraging and pollen foraging were negatively impacted during the first few hours after relocation.

Poster 21. Greg Hunt (Purdue University, USA), J Krispn Given, Jennifer M. Tsuruda and Gladys K. Andino - *Breeding mite-biting bees to control varroa mites*. We are breeding for bees that have a high proportion of chewed *Varroa* mites falling in the hive. The average proportion of chewed mites in our population increased from 3% in 2007 to nearly 50%. We worked with beekeepers to conduct a blind study that compared Indiana “mite-biter” queens to commercial sources (23 beekeepers, 27 side-by-side comparisons). Beekeepers received queens marked different colors but did not know which was the mite-biter. After de-queening and splitting a hive, they introduced the queens and observed them for a full year. IN mite-biter colonies had about as third as many mites and more than twice the survival rate of the commercial-source colonies (55% versus 22%). Beekeepers preferred the IN mite-biters ten to one. We are distributing the stocks through the Heartland Honey Bee Breeders Coop to make instrumentally inseminated breeder queens available.

Poster 22. Jonathan Jackson (Arizona State University, USA), Stephen Pratt - *Friend or foe: testing the optimal acceptance model in honey bees*. How honeybees guard their nests against other honeybees is a topic of both theoretical and practical concern, given the role of kin recognition in the evolution of eusociality and the costs of robbing in crowded apiaries. The optimal acceptance model posits a tradeoff between thorough exclusion of non-nestmates and rejection of nestmates, as a result of the overlap in recognition cues between kin and non-kin. The model's prediction that acceptance thresholds should be condition dependent is supported by past research showing that guard bees become more accepting when food availability increases. However, this finding could also be explained by gradual habituation of guards to the introduction of chilled bees used to probe their acceptance. We are testing these two explanations by tracking guarding behavior while food availability decreases. We will report whether acceptance decreases (as predicted by the optimal acceptance model) or increases (as predicted by the habituation model).

Poster 23. Jennifer Jandt (University of Otago, New Zealand) - *Studying collective decision-making with ant farms*. *Monomorium antarcticum* excavate and nest ~5-10cm below ground. Therefore, if conditions shift, colonies may need to abandon their nest (else drown or desiccate) and excavate a new nest in a more optimal location. Here, we ask: Do *M. antarcticum* show a nesting preference for soil moisture? Will colonies emigrate when conditions become suboptimal? We provided colonies with 3 soil-filled ant-farms, each assigned a treatment: control (no water added), damp (5mL added regularly) and wet (10mL added regularly). We found that as the soil dried, colonies relocated brood to farms with added water, ultimately showing a preference for wet soil. Moreover, individual activity on top of farms shifted over time, and more individuals were observed on wetter farms before colony emigrations. These data suggest that *M. antarcticum* may be used to test hypotheses on collective decision making, and that, with our ant-farm design, we can explore how natural factors influence those decisions.

Poster 24. Bahram Kheradmand (University of California - San Diego, USA), James C. Nieh - *The waggle dance: memory dynamics and the role of reward*. The waggle dance of honey bees is a classic example of functionally referential communication. It has been described in detail on a behavioral level, but not much is known about the neuronal mechanisms behind this complex behavior. Since foragers must measure directions and distances to and from the foraging site in order to dance accurately, we asked how often do foragers update their dance information, and when do they start and stop measuring distance? We tested how fast the dance changes by training bees to a feeder, and then forcing them to forage at a different feeder at a different apparent distance. It is also unclear how the dance takes real food source patches, which vary in reward and spatial location, into account. To test the relation between reward and the dance, we tested which food source the bees advertise in their dance when their foraging bout consists of

multiple feeders of various sweetness at different locations. Results from these experiments will be presented.

Poster 25. Lori Lach (James Cook University, Australia) - *Using trophic ecology to inform control of an invasive ant in World Heritage rainforest*. Yellow crazy ants (*Anoplolepis gracilipes*) have invaded over 200 hectares of Australia's World Heritage and adjacent rainforest. Five aerial treatments have been applied to date with mixed success, and questions have been raised about bait uptake. Both currently permitted baits are in a fishmeal (protein) matrix and have been effective against yellow crazy ants elsewhere. Comparison of ant counts on lures revealed that the ants rarely prefer protein over carbohydrate, and preference does not appear to be associated with production of new queens. Laboratory colonies all preferred bait with sugar over baits without regardless of whether their diet in the previous 30 days included sugar, protein, or a mixture. The most successful treatment to date followed a period when protein was favored slightly more than carbohydrate. Although I have not found evidence to link food preference to colony needs or resource availability, it may be key to maximizing efficacy of current control options.

Poster 26. Natalie J. Lemanski (Rutgers University, USA), Nina H. Fefferman - *A game of drones: coordination between the sexes constrains the timing of reproduction in honey bees*. Honey bee (*Apis mellifera*) colonies reproduce in two ways: by producing a queen and swarming or by producing drones. The timing of swarm and drone production are crucial because food resources are seasonal and there is limited time for colonies to grow enough to reproduce. In addition, while drones contribute directly to fitness, workers contribute both indirectly as part of colony growth and directly as part of the swarm. Using a linear programming model, we ask when a honey bee colony should produce drones and swarms to maximize its reproductive success. We find that the optimal behavior for a colony is to produce all drones prior to producing swarms, an impossible solution on a population scale because of the need for queens and drones to co-occur. The timing of drone production and swarming are therefore not solely driven by the timing of resource availability but by the game theoretic problem of coordinating the production of reproductives with other colonies.

Poster 27. Hongmei Li-Byarlay (North Carolina State University, USA), Ming Hua Huang, Michael Simone-Finstrom, Micheline K. Strand, David R. Tarpy, Olav Rueppell - *Honey bee drones survive oxidative stress due to increased tolerance instead of avoidance or repair of oxidative damage*. Oxidative stress can lead to premature aging symptoms and cause acute mortality at higher doses in a range of organisms. Oxidative stress resistance and longevity are mechanistically and phenotypically linked; considerable variation in oxidative stress resistance exists among and within species and typically covaries with life expectancy. However, it is unclear how stress-resistant individuals deal with molecular damage to survive longer than others. We develop a protocol for inducing oxidative stress in honey bee males (drones) via Paraquat injection. Oxidative stress was measured in susceptible and resistant individuals. Paraquat drastically reduced survival but individuals varied in their resistance to treatment within and among colony sources. This first study of oxidative stress in male honey bees suggests that survival of an acute oxidative stressor is due to tolerance, not prevention or repair, of oxidative damage to lipids.

Poster 28. Tyler Murdock (Arizona State University, USA), Juergen Liebig, Bill Wcislo - *Variation in cuticular hydrocarbons in* Camponotus *ants*. Cuticular hydrocarbons (CHCs) function as both signals and cues in ants. As cues, they allow for nestmate recognition and therefore allow the colony to function as a distinct unit. As a signal, a suite of CHCs or perhaps single CHC can function as a fertility signal that designates the queen with in a colony, thus resulting in the reproductive division of labor that seems largely responsible for the success of social insects. The identities and roles of various CHCs have been described for a handful of ant species, one of the best studied of which being *Camponotus floridanus*. With its sequenced genome and well-understood social dynamics, *C. floridanus* is a model for investigating the eusocial lifestyle, yet, we do not know how well this single species represents ants or other members of its extremely diverse genus. Here I report how CHCs vary across the genus Camponotus and how this variation in composition is correlated with phylogeny, environment, and life history.

Poster 29. Scott Nacko (Louisiana State University, USA), Gregg Henderson - *Nesting biology: preferences, productivity and polyethism of polistine Wasps in southern Louisiana*. Nesting biology of polistine wasps in southern Louisiana is of scientific interest. Warm temperatures for 8 months provide a large window for reproduction in temperate species while a 4 month cold period limits reproduction in tropical species. We investigate nesting preferences, productivity and growth rates for each species found at 4 study sites. Six species of *Polistes* and one species of *Mischocyttarus* were recorded. Overall 75% of nests were established during March and April. Wasps had a failure rate of 57% by June; abandonment or foundress death caused 52% of failures, the remaining 47% due to nest disappearance. Most frequently used nest site was palmetto leaves, and a preference was shown by *M. mexicanus* with 88% of nests built on palmetto. Nests were found at an average height of 199 cm. From March - June, *P. bellicosus* had the highest average growth rate of 53%.These data suggest niche partitioning due to nest site selection and growth rates.

Poster 30. Isobel Ronai, Vanina Vergoz, Ben Oldroyd (University of Sydney, Australia) - *The mechanistic, genetic and evolutionary basis of worker sterility in the social Hymenoptera*. Extreme reproductive skew towards particular females is a defining feature of the social Hymenoptera and workers are completely sterile in at least thirteen genera. The evolution of worker sterility is problematic because an individual that has decreased fertility has reduced direct fitness. In order to understand how worker sterility evolved it is essential to identify the mechanistic basis of worker sterility. We show that the developmental mechanisms that underlie worker sterility are 'reproductive control points' that reduce reproductive capacity in workers. We propose that environmental cues (nutritional and social) interact with particular signalling pathways in the worker and regulate worker fertility through reproductive control points both pre- and post-eclosion. There are eight gene signalling pathways that are likely to be involved in regulating worker fertility in honey bees: insulin/insulin-like growth factor 1 signalling (IIS); juvenile hormone; ecdysteroid; mechanistic target of rapamycin (mTOR); dopamine; mitogen-activated protein kinases (MAPK); epidermal growth factor receptor (Egfr) and wingless-related MMTV integration site (Wnt). We suggest that the common mechanism underlying all the reproductive control points is programmed cell death, an active process that causes the worker's reproductive organs to degenerate. These reproductive control points are likely to have been involved in the ancestral emergence of worker sterility from a solitary insect.

Poster 31. Gard Otis (University of Guelph, Canada), Sarah J. Dolson, Hanh Duc Pham, Lien Thi Phuong Nguyen, Tatiana Petukhova, Patrice Bouchard - Platybolium alvearium*, a highly integrated associate of Apis cerana colonies in North Vietnam*. *Platybolium alvearium* beetles occur in hives occupied by colonies of *Apis cerana* in Asia. We quantified beetle abundance and made behavioral observations in 180 *A. cerana* and 30 *A. mellifera* hives in northern Vietnam. Overall, beetles were uncommon in *A. cerana* hives and were not seen in *A. mellifera* hives. *A. cerana* did not react to adult beetles upon contact. Beetle prevalence and abundance were low in May/June. Beetle abundance was greater in more populous *A. cerana* colonies, a pattern atypical for *Aethina tumida*. In bioassays, individual *P. alvearium* preferred (i) comb of endemic *A. cerana* over comb of introduced *A. mellifera*, and (ii) *A. cerana* beeswax over paraffin. Our results suggest that *P. alvearium* beetles are highly integrated commensals of *A. cerana* in Vietnam: they occur regularly in their colonies and are attracted to their products. In contrast to other integrated associates of honeybees, *P. alvearium* does not harm its host colonies in Vietnam.

Poster 32. Ted Bledsoe, Kiran Gangwani, Omar Halawani, Michael Jones, Adrian Smith, Robert Dunn, Margarita López-Uribe, Clint Penick (North Carolina State University, USA) - *Body sculpturing and pathogen defense in ants*. The functions of animal patterns have puzzled scientists since Darwin and Wallace debated the purpose of Zebra stripes in the late 1800's. While the patterns of large animals have received the greatest attention, the highest diversity is found in insects. Here we studied how cuticle patterns relate to pathogen defense in ants. We investigated differences in cleaning efficiency between rough and smooth-bodied ants, developed an assay to

test relative investment in antimicrobial compounds, and compared differences in nesting ecology between smooth and rough-bodied ants in the genus *Polyrhachis*.

Poster 33. Theresa Pitts-Singer (USDA ARS Pollinating Insects Research Unit, USA), Natalie K. Boyle - *Interactions of solitary bees with social bees in crop pollination systems: consequences, concerns and complementarity*. Honey bees have been compromised by many biotic and abiotic stressors. Agricultural systems may be able to meet pollination demands by using a combination of honey bees and alternative bees, resulting in a functional synergy between species. The alfalfa leafcutting bee (*Megachile rotundata*) and the blue orchard bee (*Osmia lignaria*) (Megachilidae) are solitary bees used for commercial pollination of alfalfa and tree fruit, respectively. Because these bees nest in large aggregations and are used in commercial systems, they interact with each other and with other managed pollinators. The different lifestyles of solitary and social species demand consideration of not only crop-pollinator management, but also the consequences of inter- and intraspecific pollinator interactions. We will discuss pollinator strategies and their influence on pollinator services, spread of pathogens and pests, and response to nutrition and pesticides.

Poster 34. Sandra Rehan (University of New Hampshire, USA) - *Molecular evolution of early insect societies: genomics of the Australian small carpenter bee,* Ceratina australensis. Understanding the evolution of animal societies, considered to be a major transition in evolution, is a key topic in evolutionary biology. Recently, new gateways for understanding social evolution have opened up due to advances in genomics, allowing for unprecedented opportunities in studying social behavior on a molecular level. In particular, highly eusocial insect species (caste-containing societies with non-reproductives that care for siblings) have taken center stage in studies of the molecular evolution of sociality. Despite recent enormous advances in both ecological and genomic studies on eusocial insects, we still lack a broad model to explain how this major transition in evolution has come about. I highlight the importance of a comparative, phylogenetic context and hypothesis-driven genomic approaches for understanding the evolution of social phenotypes.

Poster 35. Corrie Moreau, Scott Powell, Jacob Russell (Drexel University, USA), John Wertz, Yi Hu, Shauna Price, Jon Sanders - *Dimensions of holobiont biodiversity across the* Cephalotes *genus*. Bacterial symbionts are enriched across several groups of ants, but only recently have we begun to understand the identities and functions of bacteria outside of the well-studied carpenter ants and fungus-growing attines. In this study we report on the phylogenetic, functional, and genetic components of holobiont biodiversity seen for a 46 million year old symbiosis between *Cephalotes* and specialized gut bacteria. Hosts of highly specialized, co-diversifying bacteria, these ants appear to have harnessed their symbionts' metabolic activities to persist on nitrogen poor diets. We discuss our collaborative findings from this system to date along with future directions in dissecting the multipartite interactions between turtle ants and their microbes. Through a broad study of microbial function, evolution, and diversity we aim to understand these symbioses across the full range of *Cephalotes* phylogenetic, ecological, and habitat diversity.

Poster 36. Madison Sankovitz (University of Colorado - Boulder, USA), Michael Breed - *Effects of the mound nests of the ant Formica podzolica on the surrounding vegetation.* Ants are regarded as 'ecosystem engineers' because they change the biological, chemical, and physical properties of the soil around their nests by means of nest construction and nutrient cycling. The hypothesis that *Formica podzolica* facilitates the increase of vegetation biomass and diversity through the enrichment of nutrients and alteration of soil properties around its nests was investigated. Through measurements of vegetation percent cover, biomass, species diversity and richness, and soil moisture and pH, along with utilizing a stable isotope analysis in the near future, the effects of *F. podzolica* on the soil structure and vegetation composition surrounding 24 nests in an alpine ecosystem of Colorado was quantified. Proximity to nest had a positive influence on plant abundance and soil moisture. In addition, biomass and plant cover were found to be greater downhill than uphill from nests, suggesting that slope may cause the flow of water and nutrients in

the downhill direction. This research shows how *F. podzolica* has relatively large-scale impacts on the alpine ecosystem of Colorado, and possibly farther-reaching effects.

Poster 37. Anne Shen (Wellesley College, USA), Anita Yau, Hailey Scofield, Heather Mattila - *Does developmental pollen stress affect the performance of inspector honey bees?* Environmental stress can limit the pollen resources that are available to pollinators such as the honey bee. Pollen provides colonies with most of their nutritional requirements, so a restricted supply can seriously undermine colony function. Our previous work showed that foraging and recruitment rates of adult workers are reduced if they are reared in pollen-stressed colonies. Here, we report the effect of developmental pollen stress on inspectors, foragers who visit known floral resources and reactivate nestmates to those that still yield food. Focal workers reared under conditions of pollen stress or abundance were introduced as adults into a host colony, where they could elect to participate in an inspection assay. Fewer adults reared under pollen-stressed conditions joined the assay, although those who did performed equivalently in many ways to unstressed workers. Our study reveals one way that pollen stress impairs the ability of honey bees to take up specialized foraging tasks.

Poster 38. Hagai Y. Shpigler (University of Illinois - Urbana Champaign, USA), Michael C. Saul, Emma E. Murdoch, Amy Cash-Ahmed, Christopher H. Seward, Laura Sloofman, Sriram Chandrasekaran, Saurabh Sinha, Lisa Stubbs, Gene E. Robinson - *Transcriptomic and epigenetic responses to social challenge and their association with future behavior in honey bees*. We studied behavioral, transcriptomic and epigenetic responses of honey bees to social challenge. Groups of bees were exposed to two intruders at 30, 60, and 120 minute intervals. Aggressively responding bees in the first trial were more likely to respond again with increased intensity at 60 minutes. Transcriptomic analysis of the mushroom bodies at the same time points showed dynamic differential gene expression (DEG), with two trends. The first was correlated with the changes in behavioral intensity, highlights by genes related to cytoskeleton remodeling. The second, related to behavioral persistence, highlights genes related to hormones, stress response and transcription factors. Histone profiling revealed very few changes in chromatin accessibility in response to social challenge; most DEGs were “ready” to be activated. These results suggest that biological embedding of social information involves changes in neurogenomic states, which influence future behavior.

Poster 39. Simone Tosi (University of California, San Diego, USA), James Nieh - *Toxicity of a new insecticide, flupyradifurone, on in-hive and forager honey bees across seasons*. Honey bee health is affected by multiple factors, including pesticides. Attention has focused on the neonicotinoids. However, their use has been restricted in the EU and new pesticides have entered the market. Flupyradifurone is a relatively novel insecticide, which was discovered in 2012 and first registered in 2014. Like the neonicotinoids, flupyradifurone is a systemic insecticide that acts as an anagonist of insect nicotinic acetylcholine receptors. We tested the toxicity (LD50 and behavioural effects) of flupyradifurone and dimethoate (reference standard in honey bee toxicity tests) in relation to bee age (in-hive vs. foragers) and season (early spring vs. summer). The preliminary results show that foragers were significantly more sensitive to both flupyradifurone (2.4-fold) and dimethoate (3.7-fold).

Poster 40. Nadejda Tsvetkov (York University, Canada), Olivier Samson-Robert, Keshna Sood, Harshillkumar S. Patel, Daniel A. Malena, Pratik H. Gajiwala, Philip Maciukiewicz, Valérie Fournier, Amro Zayed - *Honey bee exposure near corn crops, a season long study from Ontario and Quebec*. Experiments linking neonicotinoids and declining bee health have been criticized for not simulating ‘field-realistic’ exposure. Here we quantified the duration and magnitude of neonicotinoid exposure in Canada’s corn growing regions. We detected 26 different agrochemicals, of them neonicotinoids posed the highest risk to honey bee health. We also discovered that the acute toxicity of neonicotinoids to honey bees significantly increases in the presence of a commonly encountered fungicide. Our extensive field survey found that previous in-lab experimental often used 'field realistic' doses. Implications are discussed.

Poster 41. Carlos J. Vega Melendez (University of North Carolina - Greensboro, USA) - *Effects of early developmental exposure on* Apis mellifera. No single factor has been found to explain the ongoing honeybee health crisis but several acute stressors negatively influence honeybee health at high dosages. Many stressors act at sub-lethal concentrations and such potentially long-term effects have not been sufficiently studied. We characterize stress responses of the oxidative stressor paraquat and heat stress. Paraquat did not affect survivorship significantly and only lead to very minor changes behavior. However, RNAseq analysis showed long-lasting molecular consequences that might indicate phenotypically undetectable trade-offs. Several immune genes were down-regulated in adult workers as a result of paraquat exposure. 5th instar worker larvae can withstand acute exposure to high temperatures but the stress translates into phenotypic changes. We will discuss molecular and behavioral consequences of the heat stress in adults to better characterize this stressor due to its role in migratory beekeeping and Varroa treatments.

Poster 42. James Waters - *How the strobe ant strobes: locomotion of the peculiarly-gaited* Opisthopsis. The northern Australian ant *Opisthopsis* is known as the "strobe ant" for its peculiar pattern of locomotion, which appears to the casual observer as if the ants are walking underneath a strobe lamp. Are the ants jumping or are they taking individual steps, and is there any apparent function to this strobing gait? Using high speed video, we investigated the movements of two species of *Opisthopsis* in the lab and in the field, and report on the pattern and kinematics of this unique behavior.

Poster 43. Anne Shen, Anita Yau (Wellesley College, USA), Hailey Scofield, Heather Mattila - *Does developmental pollen stress affect the performance of inspector honey bees?* Environmental stress can limit the pollen resources that are available to pollinators such as the honey bee. Pollen provides colonies with most of their nutritional requirements, so a restricted supply can seriously undermine colony function. Our previous work showed that foraging and recruitment rates of adult workers are reduced if they are reared in pollen-stressed colonies. Here, we report the effect of developmental pollen stress on inspectors, foragers who visit known floral resources and reactivate nestmates to those that still yield food. Focal workers reared under conditions of pollen stress or abundance were introduced as adults into a host colony, where they could elect to participate in an inspection assay. Fewer adults reared under pollen-stressed conditions joined the assay, although those who did performed equivalently in many ways to unstressed workers. Our study reveals one way that pollen stress impairs the ability of honey bees to take up specialized foraging tasks.