



May 11 – 13, 2012

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McMaster
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2012 Organizing Committee

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Introduction and Welcome

Welcome to the 42nd Annual Ontario Ecology, Ethology and Evolution Colloquium!

Each year for the past four decades, researchers across Ontario and beyond have come together to present their work at the Ontario Ecology & Ethology Colloquium (OEEC). Last year, the organizers broadened the scope of our conference by adding a third E – *Evolution*. We have continued this new tradition with OE3C 2012, jointly hosted by the McMaster University Departments of Biology and Psychology, Neuroscience & Behaviour.

We are happy to welcome top graduate and undergraduate students, post-docs and faculty to share their exciting findings in a series of several dozen talks and posters covering such diverse topics as genetics, botany, psychology, conservation, behaviour, and environmental science. We are especially honored to have three distinguished plenary speakers who are sure to present some very fascinating work. We are also excited this year to introduce a special talk session for Evolutionary Psychology that has not been included in previous years.

We hope to continue the legacy of this conference as a great place both for young researchers to present their work in a constructive and collegial environment and for faculty to recruit promising new students. We also hope that this conference serves to further integrate the community of Ontario biologists, encouraging our social network and the cross-pollination of ideas.

As has been typical for the past few years, this conference has been entirely organized by a few dedicated graduate student volunteers. We have worked hard to make this conference interesting, productive and fun. Please enjoy your time here at McMaster, and welcome to OE3C 2012!

Sincerely,

Zachary Durisko and Joelle Thorpe
OE3C 2012 Organizing Committee Members

OE3C 2012 Organizing Committee

The hard work and dedication
of the following volunteers made
this conference possible:

Karen Cogliati
Cody Dey
Zachary Durisko
Erin McCallum
Constance O'Connor
Matthew Pachai
Kasia Pisanski
Adam Reddon
Joelle Thorpe
Cara Tigue

Acknowledgements

This year's OE3C conference would not have been possible without the generous help of many sponsors. We greatly appreciate the financial and gift donations from the following:

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We would also like to acknowledge last year's OE3C organizing committee.

We thank Lanna Jin & Janice Ting of University of Toronto at Scarborough for the OE3C logo design.

Thank you to Sigal Balshine for guidance and support.

Finally, we thank Adam Guzzo of McMaster University for website design and maintenance.

Plenary Speakers



Dr. Martin Daly

Department of Psychology, Neuroscience & Behaviour
McMaster University

Lethal Competition in Homo sapiens

This talk will focus on interpersonal competition culminating in homicides rather than lethal coalitional competition (warfare). The majority of homicides are the dénouements of competitive confrontations between young men, and variation in homicide rates is primarily due to the variable incidence of such contests. The best predictor of homicide rates is the intensity of economic competition, as indexed by income inequality. The particular men who are at risk are mainly those whose lives are going nowhere unless they escalate their competitive tactics. Thinking about homicide in this way has led to a number of discoveries about its demography and epidemiology, which I will review.

I will also address some recent challenges to the claim that income inequality is a precipitator of violence, as well as why homicide rates declined in much of the developed world in recent decades even though income inequality was on the rise.



Dr. Hans Hofmann

Section of Integrative Biology
University of Texas at Austin

Genes, Neurons, and Circuits: Mechanisms and Evolution of Social Decision Making

We respond to the actions of others by making decisions and executing them. The research in my laboratory aims to elucidate the mechanisms underlying the decisions that prove to be most consequential in our lives: social status, mate selection, parental care, and escaping from danger. Using cichlid fishes – famous for their amazing diversity, social complexity and ease of experimentation – as my model system of choice, I will show how certain fore- and midbrain regions along with nonapeptide pathways regulate paternal care in a manner that appears conserved across vertebrates. Using comparative gene expression profiling across 12 brain regions in 88 vertebrate species I will then discuss the evolution of a vertebrate social decision making circuit, which provides a powerful framework for bridging the molecular and behavioral levels of sociality.



Dr. Dustin Rubenstein

Department of Ecology, Evolution and Environmental Biology, Columbia University

Environmental Uncertainty and the Evolution of Complex Social Behavior: Patterns, Processes, and Mechanisms

Although the inclusive fitness benefits of helping relatives ultimately set the stage for the evolution of cooperative breeding behavior, environmental factors have long been thought to influence the reproductive costs and benefits of helping relatives, as well as the incidence of this behavior across species and regions. Cooperatively breeding birds typically live in heterogeneous environments where spatial variation in territory quality and resource availability can influence reproductive decisions and behaviors. However, temporal environmental variability may also play an important and under-appreciated role in the evolution and maintenance of complex sociality. I will discuss the diversity of cooperatively breeding species in birds and then examine how both resource heterogeneity and environmental uncertainty influence the evolution of this complex social behavior. I will demonstrate that environmental variability in time and space not only influences individual behavioral decisions, but also broad-scale patterns of social diversity across species and regions. Finally, I will discuss some of the hormonal mechanisms that animals living in unpredictable environments use to cope with climatic uncertainty.

Important Information

Registration

Includes a conference package, meals, coffee, and two drink tickets (one each for the Friday night mixer and the Saturday night wine & cheese)

Saturday May 12

8am to 4pm Burke Science Building B138

Sunday, May 13

8am to 3:30pm Burke Science Building B138

Oral Presentations

Please report to your scheduled room in the Burke Science Building 15 minutes *before* your session begins so a moderator can help you load your presentation onto the audio-visual equipment.

Oral presentations are 15 minutes maximum (we suggest 12 minutes + 3 minutes for questions). Moderators in your session will signal to you at 10 minutes, and will ask you to wrap up at 14 minutes.

Please be prompt and respectful to help us stay on schedule!

Poster Presentations

Poster boards will be set up on the mezzanine overlooking the East Meets West Bistro in the Mary Keyes building. Please feel free to hang your poster any time after 5pm on Saturday using the pins provided.

A wine and cheese reception will take place from 5:30 to 7pm during the poster session. The banquet will begin at 7pm in the East Meets West Bistro in the Mary Keyes building.

Be sure to remove your poster by 10pm on Saturday. Any posters remaining at the end of the banquet will be discarded.

T-shirts

Pre-ordered t-shirts will be handed out with your registration package.

Extra t-shirts will be available for purchase (\$12 each) at the registration desk. First come, first served!

Parking

Parking is available on campus for \$6/day (highlighted on the campus map provided).

Meals

Breakfast and coffee will be served in the Burke Science Building room B139 (highlighted on the campus map provided).

The Friday night mixer and all lunches will be at The Phoenix on campus (highlighted on the campus map provided).

The Saturday night banquet will be served at the East Meets West Bistro in the Mary Keyes building on campus (highlighted on the campus map provided).

Accommodation

On campus housing will be in the Mary Keyes residence building (highlighted on the campus map provided).

Check in time is 4pm and check out time is 10am.

If you have bags or posters that you would like stored during the day, bring them to the registration desk (Burke Science Building B138).

Schedule at a Glance

Time	Friday May 11
6:00	Welcome Social Phoenix Bar & Grill – Wentworth House

Time	Saturday May 12
8:00	Registration & Breakfast BSB B138
9:00	Dr. Martin Daly “Lethal Competition in <i>Homo sapiens</i> ” BSB B135
10:15	Coffee Break BSB B139
10:30	<div>Talk Session 1A “Social Behaviour” BSB B135</div> <div>Talk Session 1B “Plasticity” BSB B136</div>
12:15	Lunch Phoenix Bar & Grill – Wentworth House
1:45	<div>Talk Session 2A “Cognition & Learning” BSB B135</div> <div>Talk Session 2B “Mating” BSB B136</div>
3:30	Coffee Break BSB B139
4:00	Dr. Hans Hofmann “Genes, Neurons, and Circuits: Mechanisms and Evolution of Social Decision Making” BSB B135
5:30	Poster Session Wine & Cheese Reception East Meets West Bistro - Mary Keyes Residence
7:00	Banquet East Meets West Bistro - Mary Keyes Residence

Time		Sunday May 13	
8:00		Registration & Breakfast BSB B138	
9:00		Dr. Dustin Rubenstein “Environmental Uncertainty and the Evolution of Complex Social Behavior: Patterns, Processes, and Mechanisms” BSB B135	
10:00		Coffee Break BSB B139	
10:15		Talk Session 3A “Evolutionary Psychology” BSB B135	Talk Session 3B “Genetics” BSB B136
12:00		Lunch Phoenix Bar & Grill – Wentworth House	
1:30		Talk Session 4A “Conservation” BSB B135	Talk Session 4B “Environmental Ecology” BSB B136
3:30		Coffee Break BSB B139	
4:00		Talk Session 5A “Stress & Physiology” BSB B135	Talk Session 5B “Ecology & Evolution” BSB B136
5:30		Closing Remarks BSB B135	

Saturday May 12 - Morning

Time	Talk Session 1A: Social Behaviour	BSB B135
10:30	Effects of isotocin on social responses in a cooperatively breeding fish Adam Reddon, McMaster University	
10:45	Safety and sociability: A tale of two cichlids Rachel Charney, McMaster University	
11:00	Social organization in the primitively eusocial sweat bee <i>Halictus farinosus</i> Jennifer Albert, York University	
11:15	Hostile takeover! The battle for nest ownership in a species with alternative reproductive tactics Karen Cogliati, McMaster University	
11:30	Long-term effect of incubation temperature on dominance and neophobia in zebra finches Tara Farrell, The University of Western Ontario	
11:45	Quantifying individual variability in aggressive behaviour in <i>Apteronotus leptorhynchus</i> : A behavioural syndrome approach Isabelle Shank, University of Ottawa	
12:00	Do dominant competitors reduce predation risk of subordinates? William Halliday, Lakehead University	

Time	Talk Session 1B: Plasticity	BSB B136
10:30	Adaptation in <i>Drosophila melanogaster</i> and <i>D. simulans</i> Christopher Austin, The University of Western Ontario	
10:45	Behavioural flexibility in bumblebee (<i>Bombus impatiens</i>): Reversal learning and the mushroom bodies Caroline Strang, The University of Western Ontario	
11:00	The plasticity of alternate reproductive strategies in the large carpenter bee, <i>Xylocopa virginica</i> Jess Vickruck, Brock University	
11:15	Plasticity in developmental responses to cold temperature shocks in the Western Black Widow and Australian Redback Spider Nizanthan Rathitharan, University of Toronto Scarborough	
11:30	Variation in anti-predator behavioural flexibility in larval <i>Enallagma</i> damselflies Allison Brown, University of Guelph	
11:45	Effects of dietary restriction shaped by sex and mating system Dr. Maydianne Andrade, University of Toronto Scarborough	
12:00	Long-term effects of developmental stress on song complexity, stress physiology, and immune function in song sparrows Kim Schmidt, Western University	

Saturday May 12 - Afternoon

Time	Talk Session 2A: Cognition & Learning	BSB B135
1:45	Local enhancement and social learning in <i>Drosophila</i> larvae Zachary Durisko, McMaster University	
2:00	Effects of experience on courtship behaviour in male fruit flies Lisa Klotz, McMaster University	
2:15	Cognitive consequences of living in a contaminated environment in round goby (<i>Neogobius melanostomus</i>) Dominika Tomczyk, McMaster University	
2:30	Pigeons make errors due to interval timing in a visual, but not visual-spatial mid-session reversal task Neil McMillan, The University of Western Ontario	
2:45	The nature of play and its relation to sexual behaviour in farmed mink, <i>Neovison vison</i> Jamie Ahloy Dallaire, University of Guelph	
3:00	Information seeking in the rat Chelsea Kirk, The University of Western Ontario	
3:15	Role of chemosensory and auditory communication on the outcome of female mating decisions in <i>Drosophila melanogaster</i> L. Kathryn Deeming, Wilfred Laurier University	

Time	Talk Session 2B: Mating	BSB B136
1:45	Discrimination of chemical sexual signals in closely related spiders Julian D'Cruz, University of Toronto Scarborough	
2:00	Female value or risk: What fuels male mate choice in black widows? Luciana Baruffaldi, University of Toronto Scarborough	
2:15	Fitness consequences of forced copulation in fruit flies Katherine Jongsma, McMaster University	
2:30	Contemporary adaptation of offspring sex ratio: Are alterations to masculinity an adaptive mode to sex ratio manipulation? Frances Stewart, University of Guelph	
2:45	Complex communication through simple plumage: multiple ornaments and multiple receivers in an achromatic passerine Sarah Guindre-Parker, University of Windsor	
3:00	What's scent got to do with it? Floral fragrance and reproductive strategies of a Pacific coast dune plant Laura Doubleday, Queen's University	
3:15	Can variation in breeding ground territory quality explain the increased reproductive success of early-arriving male American redstarts? Mitchel Daniel, Queen's University	

Sunday May 13 - Morning

Time	Talk Session 3A: Evolutionary Psychology	BSB B135
10:15	Cues to different aspects of mate quality provide similar information about fitness: Women's voice pitch is positively related to 3D facial symmetry Cara Tigue, McMaster University	
10:30	Menstrual cycle shifts in women's voice preferences are associated with the fundamental but not formant frequencies of male voices Katarzyna Pisanski, McMaster University	
10:45	Uninformative social cues increase cooperation, but not for long Adam Sparks, University of Guelph	
11:00	The evolution of superstition through optimal use of incomplete information Dr. Kevin Abbott, Carleton University	
11:15	The varying relationship between helping and individual quality Dr. Pat Barclay, University of Guelph	
11:30	Framing effects and risk-sensitive decision-making Dr. Sandeep Mishra, University of Guelph	
11:45	Enhanced kin recognition through population estimation Dr. Daniel Krupp, Queen's University & McMaster University	

Time	Talk Session 3B: Genetics	BSB B136
10:15	The evolutionary implications of genome rearrangements on the genetic architecture of salinity tolerance in Atlantic salmon (<i>Salmo salar</i>) Joseph Norman, University of Guelph	
10:30	Evidence for concurrent decline in inbreeding coefficients and mortality rates across life history stages in <i>Aquilegia canadensis</i> Andy Wong, Queen's University	
10:45	Evolutionary analysis and genetic mapping of neuropeptide Y (NPY) receptors in Rainbow Trout (<i>Oncorhynchus mykiss</i>) and Arctic Char (<i>Salvelinus alpinus</i>). Aaron Goldt, University of Guelph	
11:00	Detection of QTLs associated with age of smoltification and maturation in F1 transAtlantic backcrosses of aquaculture strains of salmon (<i>Salmo salar</i>) Stephanie Pedersen, University of Guelph	
11:15	Candidate genes for growth in rainbow trout, <i>Oncorhynchus mykiss</i> Andrea Kocmarek, University of Guelph	
11:30	Life history predicts genome structure in bees and ants Dr. Clement Kent, York University	
11:45	Population-genetic analysis of extreme mating system differentiation in the coastal dune endemic plant <i>Camissoniopsis cheiranthifolia</i> (<i>Onagraceae</i>) Adriana Lopez-Villalobos, Queen's University	

Sunday May 13 - Afternoon

Time	Talk Session 4A: Conservation	BSB B135
1:30	The role of pollination in influencing the altitudinal range limits of the plant <i>Rhinanthus minor</i> Jennifer Weiner, Queens University	
1:45	Effects of climate change on the ecology and evolution of aphids Micheline Khan, University of Toronto Mississauga	
2:00	Temporal variation in pollinator diversity: A study of the Niagara bee community Thomas Onuferko, Brock University	
2:15	Management increases genetic diversity of honey bees via admixture Brock Harpur, York University	
2:30	Determining population genetic variation of the Cassin's auklet: Are multiple conservation units needed? Sarah Wallace, Queen's University	
2:45	Sources of ebullition and methane emissions in Alaskan peatlands following permafrost degradation Sara Klapstein, University of Guelph	
3:00	Increasing atmospheric nitrogen deposition: implications for tallgrass prairie and forest restoration Jennifer McPhee, Western University	
3:15	Unintended outcomes and trade-offs of fish passage Eric Smyth, University of Guelph	

Time	Talk Session 4B: Environmental Ecology	BSB B136
1:30	The role of sustained water table drawdown on carbon cycling in boreal peatlands Agnieszka Kotowska, University of Guelph	
1:45	Interactive effects of warming and N addition on seedling establishment in a temperate old field Bryana McWhirter, The University of Western Ontario	
2:00	Freshwater macroinvertebrate communities across Nunavut, Canada: The effects of habitat and ecoregion scale environmental controls on species distribution and community function Christopher Luszczek, York University	
2:15	Optimal subsampling of arctic benthic macroinvertebrates Ray Biastoch, York University	
2:30	Do plants allocate more to seeds when grown with siblings or strangers? A test for kin selection in field grown ragweed Amanda File, McMaster University	
2:45	Do geographic range limits reflect niche limits? A meta-analysis of experimental studies Christopher Eckert, Queen's University	
3:00	Interactive effects of soil freezing and nitrogen deposition on nitrogen retention over winter and the following growing season Mathew Vankoughnett, Western University	
3:15	Post-Pleistocene dispersal in a freshwater amphipod: A biogeographical approach to the <i>Hyalella azteca</i> cryptic species complex Matthew Hrycyshyn, University of Waterloo	

Time	Talk Session 5A: Evolution & Ecology	BSB B135
4:00	Is bigger always better? An investigation of egg quality and egg number in plainfin midshipman Michael Barone, McMaster University	
4:15	Allometry and phenotypic variation of the baculum in the wolverine (<i>Gulo gulo</i>) Albrecht Schulte-Hostedde, Laurentian University	
4:30	Ecological correlates of parental care in <i>Porichthys notatus</i> Amanda Pereira, McMaster University	
4:45	Non-indigenous species: Ecological bane or experiential learning opportunity? James Boudreau, McMaster University	
5:00	Potential mechanisms to maintain additive genetic variance in fitness in a red squirrel (<i>Tamiasciurus hudsonicus</i>) population Eryn McFarlane, University of Guelph	
5:15	The invasive round goby, <i>Neogobius melanostomus</i> , a potential host for Unionid species at risk Maude Tremblay, University of Guelph	

Time	Talk Session 5B: Stress & Physiology	BSB B136
4:00	Consequences of intense stress: Are the maternal effects of high predator risk mediated by epigenetic changes in snowshoe hare offspring? Sophia Lavergne, University of Toronto Scarborough	
4:15	Persistent effects of prenatal stress on offspring physiology in wild red squirrels Amy Newman, University of Guelph	
4:30	Effects of chronic corticosterone administration on vocal learning Jackie Day, The University of Western Ontario	
4:45	Neuromuscular control of aerodynamic power output via changes in wingbeat kinematics in ruby-throated hummingbirds (<i>Archilochus colubris</i>) Sajeni Mahalingam, University of Toronto Scarborough	
5:00	Flying high on sugar: Carbohydrate oxidation kinetics in the ruby-throated hummingbird (<i>Archilochus colubris</i>) Chris Chen, University of Toronto Scarborough	
5:15	A bioinformatic analysis of the evolution of the macrophage scavenger receptors Fiona Whelan, McMaster University	

#	POSTERS
1	Landscape genetics of the eastern hog-nosed snake (<i>Heterodon platirhinos</i>) in Ontario Amanda Xuereb , Queen's University
2	The rapid effects of the G protein-coupled estrogen receptor on social learning Chris Gabor , University of Guelph
3	Changes in oxytocin and vasopressin following sexual and parental experience in Mongolian gerbils Anna Phan , University of Guelph
4	Female fruit flies prefer foods occupied by conspecific larvae for oviposition Blake Anderson , McMaster University
5	Assessing body size of human adult speakers through modal, whispered, and sinewave speech Kristin Taylor , McMaster University
6	Video games and attractiveness: will playing competitively or cooperatively make me sexier? A correlational study examining the effects of game play and mating strategies on attractiveness Justin Michel , McMaster University
7	The role of striatal cholinergic neurons for social recognition in VAcT Knockout mice Daniel Palmer , University of Guelph
8	Does phenological assortative mating cause S-alleles to be structured by flowering time? Zoryana Gorin , University of Toronto
9	Local adaptation throughout the range of <i>C. rubella</i> Adriana Salcedo , University of Toronto
10	Kin recognition response in <i>Cakile edentula</i> seedlings? Mudra Bhatt , McMaster University
11	Behavioural and endocrine profile of naked mole-rats following social pairing Melissa Holmes , University of Toronto Mississauga
12	Detecting family differences associated with resistance to the salmon louse (<i>Lepeophtheirus salmonis</i>) in Atlantic salmon Christina Rochus , University of Guelph
13	The effect of social experience on female mate preference and mating dynamics Hannah Tennant , Wilfrid Laurier University
14	Habitat influences on white-tailed deer behaviour at the University of Toronto Mississauga Teresa Didiano , University of Toronto Mississauga
15	Systematic spatial foraging patterns in Rufous hummingbirds (<i>Selasphorus rufus</i>) Christine Mishra , University of Lethbridge
16	Effect of habitat quality on benthic macroinvertebrate communities and colonization Sarah Steele
17	I (used to) hate R! Shidan Murphy
18	Estrogens rapidly facilitate learning of a socially acquired food preference in female mice Kelsy Ervin , University of Guelph
19	Deer as drivers of ecosystem change: a look to the future Alexandra Djorjevic , Queen's University
20	Generosity as a costly signal: Female act- and context-specific preferences Sara Kafashan , University of Guelph
21	A novel ancestor-descendent population approach to finding DNA markers for economically important traits to use in Atlantic salmon breeding programs Elizabeth Boulding , University of Guelph
22	No population structure in <i>Littorina plena</i> (<i>Gastropoda</i>) around the coast of Vancouver Island, Canada, and the cross-species amplification of microsatellite primers in other <i>Littorina</i> species Melissa Holborn , University of Guelph
23	The role of hydrodynamics in determining the habitat selection of juvenile unionid mussels Sarah Glover , University of Guelph
24	Role of absolute and relative male and female body size variation in <i>Drosophila melanogaster</i> mating behaviours Adam Lounsbury , Wilfrid Laurier University

Oral Presentation Abstracts

(By scheduled session, *presenter*)

Session 1A: Social Behaviour

Effects of isotocin on social responses in a cooperatively breeding fish

***Adam R. Reddon*, Constance M. O'Connor, Susan E. Marsh-Rollo and Sigal Balshine**
McMaster University

Oxytocin and its non-mammalian homologues play an important role in modulating a diverse array of social behaviours. Recently, it has been suggested that one of the key functions of oxytocin is to direct attention towards socially relevant stimuli, increase social motivation and guide social decision-making. Here, we test whether an exogenous increase in isotocin (the teleost homologue of oxytocin) increases the response to social information in a cooperative breeder, the highly social cichlid fish, *Neolamprologus pulcher*. In our first experiment (a simulated territorial contest), we found that *N. pulcher* injected with isotocin were more sensitive to the size of their opponent regardless of whether their opponent was a live rival or a mirror image. Isotocin-treated fish fought in accordance with the size of their opponent while control fish fought according to their intrinsic aggressive propensity. In our second experiment (a social group context), we found that isotocin treated *N. pulcher* were more responsive to aggressive feedback and produced more submissive displays (an important social signal in this species). These experiments provide evidence that isotocin increases responsiveness to social information and further support the function of the oxytocin family of nonapeptides as a highly conserved regulator of social behaviour across vertebrates.

Safety and sociability: A tale of two cichlids

**Constance O'Connor, *Rachel Charney*, Lindsay Bruer,
Sigal Balshine and Susan Marsh-Rollo**
McMaster University

This study explores differences in social behaviour between two cichlid species with different social systems. *Neolamprologus pulcher* is a highly social, cooperatively breeding species of cichlid that lives in groups, whereas *Telmatochromis temporalis* is a monogamous species of cichlid that lives in simple breeding pairs. The type of anti-predator strategies adopted by these species will vary with life history and depend on

both costs and benefits. In both species of cichlid we investigated anti-predator strategies by comparing the time individuals spent with a conspecific (a “safety in numbers” strategy) to the time individuals spent hiding (a “sheltering strategy”) while in the presence of a predator (*Lamprologus lemairii*). We predicted that in the presence of *L. lemairii*, *N. pulcher* (the social species) would spend more time with a conspecific whereas *T. temporalis* (the non-social species) would spend more time hiding. This research will better help us understand the building blocks of social behaviour, and how social systems evolve.

Social organization in the primitively eusocial sweat bee *Halictus farinosus*

***Jennifer Albert* and Laurence Packer**
York University

Species of bee in the family *Halictidae* exhibit a variety of social behaviours from solitary nesting, to various types of social and communal nesting as well as eusociality. Nests of the primitively eusocial bee *Halictus farinosus* were excavated in the summer of 2010 within a large aggregation of the bee in Green Canyon, North Logan, Utah. By comparing alleles at a set of microsatellite loci between nestmates we have revealed kin relationships and determined that first brood females (workers) were producing many of the reproductive offspring in the *H. farinosus* population. In addition, allelic data indicated that this population was predominately monandrous. This study aimed to improve our understanding of social interactions and social organization in the eusocial halictids and to examine the predictions of inclusive fitness theory in a primitively eusocial bee species.

Hostile takeover! The battle for nest ownership in a species with alternative reproductive tactics

***Karen M. Cogliati*, Bryan D. Neff and Sigal Balshine**
McMaster University

In many mating systems, males adopt alternative reproductive tactics (ARTs) to maximize reproductive success. In fishes, guarding males often invest more energy into courtship, defense, and paternal care, while cuckolding males forego such costs and steal fertilizations by releasing their sperm in the nest of a guarding male. These two tactics have been well documented in the plainfin midshipman fish (*Porichthys notatus*). We have documented the lowest rates of paternity yet in a species with obligate male parental care. In this study, we used microsatellite markers to explore the role of male nest takeovers that may contribute to the low observed rates of paternity. Furthermore, we explored how male size and condition contribute to the occurrence of nest takeovers.

We found that nest takeovers were more common early in the breeding season, and after incorporating paternity values from the previous nest owner, paternity remained consistently lower than reports in other species with ARTs and male obligate care. Our findings provide an important contribution for understanding alternative factors that may lead to paternity loss in species with ARTs, and highlight the importance of investigating genetic reproductive success across the entire breeding season.

Long-term effects of incubation temperature on dominance and neophobia in zebra finches

***Tara Farrell*, Haruka Wada, Buddhamas Kriengwatana and
Scott MacDougall-Shackleton**
Western University

During development, parental effects are a source of environmental variation that can shape offspring phenotype. In birds, differences in parental incubation behaviour can lead to variability in the temperature at which eggs are incubated, and is one manner by which parental effects could influence development *in ovo*. Experiments on songbirds and waterfowl have studied the effects of incubation temperature largely during the nestling stage, while much less is known about the long-term effects in adulthood. Here we present data from two behavioural measures, dominance and neophobia, collected from adult zebra finches that were artificially incubated in one of three temperature conditions: control (37.4°C), low (36.2°C), or high (38.4°C) temperatures. Immediately after hatch, birds were assigned to a foster nest wherein developmental conditions were held constant across all groups. We found minimal effects of incubation treatment on dominance. Males incubated in the high condition supplanted a partner bird more often than control males, but there was no effect on any of the additional measures. Incubation temperature had no effect on the measures of the neophobia task. These results suggest the systems regulating these behaviours likely develop post-hatch and were thus largely unaffected during incubation when the manipulation was enforced.

Quantifying individual variability in aggressive behaviour in *Apteronotus leptorhynchus*: a behavioural syndrome approach

***Isabelle Shank* and John Lewis**
University of Ottawa

Apteronotus leptorhynchus, an Amazonian weakly electric fish species, produce a quasi-sinusoidal electric signal that sets up an electric field surrounding their bodies. Electroreceptors distributed on the skin can detect distortions in the field, permitting complex behaviours. Transient increases in frequency of the electric signal called chirps are believed to act as aggressive communication signals in males as their incidence

increases with the presence of a conspecific or a synthetic playback signal. However, pronounced inter-individual variation in chirp and aggressive responses to playback intruders has been found. Behavioural syndromes, defined as suites of correlated behaviours across behavioural contexts, are often used to quantify individual variation in behaviours. A behavioural syndrome approach was therefore taken to quantify individual variation in aggressive behaviour, in *A. leptorhynchus*, in order to shed light on the relationship between aggression and chirping behaviours. The behavioural contexts in which aggression was observed are: Anti-predation, environmental novelty, feeding, territorial intrusion and exploration. Preliminary data suggest the presence of an aggression behavioural syndrome in *A. leptorhynchus*: The aggression rankings of the fish are generally consistent across trials. Physiological parameters usually associated with social status, length and mass, show no apparent relationship with aggression rankings.

Do dominant competitors reduce predation risk of subordinates?

***William Halliday* and Douglas Morris**
Lakehead University

Predation risk tends to cause prey to forage in safe over risky patches. Yet prey forage in patches co-occupied by competitors, and must deal with the negative effects of competition. The prey foraging game lacks the effects of dominant competitors, therefore we developed a model for subordinate individuals foraging in safe and risky patches co-occupied by dominants. The model predicts that dominants will spend more time in safe than risky patches, which will cause subordinates to forage less in safe patches. We assumed that dominance depends on the weight of competitors. We tested this model using sympatric meadow voles and southern red-backed voles. We first allowed voles to compete one-on-one to confirm that dominance depends upon the weight difference between competitors. We then allowed voles to forage in safe and risky sites within a set of experimental enclosures to determine how competition affects their use of foraging patches. Dominance increased with the weight ratio between competitors. Large voles foraged more in safe than risky patches. Small voles foraged indifferently in safe and risky patches. These combined results demonstrate that interference from dominants can be as risky as predation; therefore subordinates must base their patch use on competitors and predators.

Session 1B: Plasticity

Adaptation in *Drosophila melanogaster* and *D. simulans*

Christopher Austin* and Amanda Moehring
Western University

With the current shifts in global climate, it is critical for us to understand how organisms historically have adapted to local climate and their potential future ability to respond to changes, particularly in temperature. While *Drosophila simulans* is thought to be a more genetically variable species, its sister species, *D. melanogaster*, is thought to be more genetically adapted to its local environment. I used collections of these two species from around the world as a model to determine whether a species that has less genetic variation can adapt to its local environment through phenotypic plasticity. I tested the hypothesis that *D. simulans* is more plastic than *D. melanogaster*, which is thought to be more a more genetically adapted species. To do this, I determined whether populations of *D. simulans* and *D. melanogaster* have adapted to their local environment by comparing their optimum temperatures range at a variety of life stages. This study determined there was a difference in optimum temperatures, and compared this difference to determine the degree of genetic variability versus plasticity. Preliminary results indicate that *D. simulans* has equal levels of fitness in a very wide range of temperatures, whereas, *D. melanogaster* is more sensitive to changes in temperature.

Behavioural flexibility in Bumblebee (*Bombus impatiens*): Reversal learning and the mushroom bodies

Caroline Strang* and David F. Sherry
The University of Western Ontario

Foraging bumblebees engage in impressive discrimination learning when locating nectar and pollen in the wild. We used a serial reversal task to test the flexibility of bumblebees' discrimination learning. In a serial reversal task animals are trained on an initial discrimination and then required to repeatedly change their response pattern when reward contingencies are changed. Serial reversal tests animals' ability to change their behaviour in response to changes in the environment, making it a measure of behavioural flexibility. Free flying bumblebees were trained on a simultaneous colour discrimination and completed nine reversals. Bees successfully improved performance with repeated reversals. A possible mechanism for the improvement is proactive interference. The mushroom bodies are an invertebrate brain structure necessary for associative learning. Mushroom bodies of tested bees were compared to reversal performance. A non-significant negative relationship was found between mushroom body volume and reversal performance.

The plasticity of alternate reproductive strategies in the large carpenter bee, *Xylocopa virginica*

Jess Vickruck* and Miriam Richards
Brock University

Large carpenter bees can nest solitarily or in small social groups of two to five females per nest. Three reproductive strategies have been observed among females in social nests. Primary females monopolize oviposition, but are also responsible for all foraging. Secondary females forage and lay eggs at a reduced rate, and often attempt to relocate to other nests where reproductive opportunities are higher. Tertiary females neither forage nor lay eggs but do guard nest entrances, and may overwinter twice in an attempt to become primaries in their second summer. Removal and reintroduction experiments in the summer of 2011 showed that some reproductive strategies are more flexible than others. Primary females were either (a) permanently removed from their nest, or (b) removed then reintroduced after a secondary female had succeeded to the position of dominant female. Primary and secondary females were flexible in their reproductive strategies: reintroduced primaries sometimes regained the dominant position, and secondary females readily changed strategies to become dominant females. The tertiary strategy was far less flexible, and these females almost never became dominant or secondary females, even if they were the only bees in the nest.

Plasticity in developmental responses to cold temperature shocks in the Western Black Widow and Australian Redback Spider

Nizanthan Rathitharan*, Maria Modanu and Maydianne C.B. Andrade
University of Toronto at Scarborough

Developmental plasticity may play a critical role in an organism's ability to cope with sudden environmental stressors. Low temperatures have been associated with inhibited growth and development in a variety of taxa. However, some organisms survive temporary cold shocks and resume development when temperatures are more favorable. We investigated the developmental response of Black Widow and Australian Redback spider eggs when exposed to cold shocks of 15°C. A 15°C cold shock for two weeks suspended development, but spiderlings from egg sacs exposed to the shock were larger than those that were incubated at 25°C. Redback egg sacs that underwent a two week cold shock at different stages of development showed a suspension of development during the shock. However, only spiderlings exposed to the cold shock in earlier stages showed accelerated growth, while later stages appeared to be unaffected. These data illustrate a potential overwintering strategy by spiderlings to delay development until spring and emerge when conditions are more favorable, with varying

effects on spiderling growth depending on which developmental stage the cold shock occurs.

Variation in anti-predator behavioural flexibility in larval *Enallagma* damselflies

***Allison Brown* and Beren Robinson**
University of Guelph

Predation favours the evolution of anti-predator traits in prey when these traits increase survival and different predators often select for different anti-predator traits. In larval *Enallagma* damselflies, selection has favoured the evolution of divergent species specialized either to resist predatory dragonfly larvae or fish by exhibiting respectively high or low levels of activity. However, no work has addressed, 1) whether predator generalist larval *Enallagma* damselfly species exist, and 2) whether these damselfly larvae express adaptive flexible behaviour. I found *E. ebrium* and *E. hageni* in ponds both with and without fish predators, suggesting that these are predator generalists. I then assayed an individual's behaviour in the presence of fish, dragonfly larvae, and no predators in order to test if behaviour depends on predator context. Four behavioural phenotypes were found: inflexible low or high activity types and two flexible types with contrasting responses to predator type. I discuss the evolution of anti-predator traits in the context of taxa that are predator specialists or generalists in *Enallagma*. Behavioural flexibility may interact with heterogeneity in predation environment to influence the composition of natural odonate communities.

Effects of dietary restriction shaped by sex and mating system

**Michael Kasumovic, Jeffrey Stoltz, Rob Brooks, Ramez Hanna
and *Maydianne Andrade***
University of Toronto at Scarborough

Dietary restriction (DR) increases longevity across taxa. Life history hypotheses for this phenomenon rest on the proposal that dietary restriction alters trade-offs in resource allocation to reproduction and self-maintenance. If this is the case, then differences in the importance of self-maintenance for reproductive success should affect the relationship between DR and longevity. We compare responses of male and female redback spiders to ecologically relevant periods of DR. Males are monogynous, short lived, and semelparous whereas females are polyandrous, longer lived, and iteroparous. We show that DR does not increase male longevity. In fact, increased longevity is evident only when well-fed males are reared under conditions in which longer-lived males could increase their mate-searching success. In contrast, DR increases female longevity, but only after mating. Unmated females show depressed longevity regardless of DR. These results support accumulating evidence that links between DR and

longevity may be complex and depend on the natural history of the organism under study.

Long-term effects of developmental stress on song complexity, stress physiology, and immune function in song sparrows

***Kim L. Schmidt*, Elizabeth A. MacDougall-Shackleton and
Scott A. MacDougall-Shackleton**
Western University

In many songbird species, females prefer males that sing more complex song. Songbirds learn song early in life, and exposure to stressors during this time can decrease song complexity. In addition, because early-life stress has widespread effects on many physiological systems, males who experience developmental stress may be of poorer phenotypic quality in general. We determined the long-term effects of experimentally induced early-life stress (food restriction or corticosterone treatment) on song complexity, immune function, endocrine regulation, body size, and metabolic rates in male song sparrows (*Melospiza melodia*). Neither treatment affected adult body size or metabolic rates. However, males exposed to either stressor during development had fewer song types and syllables in their repertoires as adults relative to males raised in control conditions. Moreover, males exposed to corticosterone treatment had larger increases in plasma corticosterone in response to exogenous adrenocorticotrophic hormone (ACTH) and exhibited less cutaneous inflammation in response to phytohaemagglutinin (PHA), suggesting alterations in stress physiology and immune responses. Therefore, exposure to stressors during development decreases song complexity in song sparrows and may permanently affect immune function and endocrine regulation. By choosing mates based on song complexity, females may obtain direct benefits for their offspring, because males experiencing less developmental stress are of higher phenotypic quality.

Session 2A: Cognition & Learning

Local enhancement and social learning in fruit fly larvae

***Zachary Durisko* and Reuven Dukas**
McMaster University

Social learning, defined as learning from others, allows fast spread of novel behaviors within and between generations. Although social learning may have played an important role in the ecology and evolution of insects, neither its evolution nor its neural mechanisms have been closely studied. We examined socially influenced behavior and social learning in fruit fly (*Drosophila melanogaster*) larvae. Focal larvae preferred food disks containing larvae that had fed on that food for 24 hours over similar larvae-free food disks. Focals also preferred food that had recently contained larvae but was currently larvae-free over food without larvae. Focals were indifferent when given a choice between fresh food containing larvae and larvae-free food. This suggests that the social cue is a larvae-generated odor emanated from the food and not directly from larvae. Focals that experienced a novel odor paired with a food source containing larvae later preferred this odor over an odor paired with food alone, indicating social learning. Fruit fly larvae are an excellent model system for further work on the ecology, evolution and neurogenetic mechanisms of social learning.

Effects of experience on courtship behaviour in male fruit flies

***Lisa Klotz* and Reuven Dukas**
McMaster University

In order to determine how male fruit flies (*Drosophila melanogaster*) respond to experiences with different types of females with respect to their future courtship efforts, we provided males with experience with either rejection or acceptance, which corresponded with mating, by a variety of types of females and subsequently tested them with rejecting females. We found, for the first time in any *Drosophila* species, that the males reduce their courtship of rejecting females following experience with acceptance. Males experienced with any one of a variety of types of rejecting females showed both specific and non-specific reductions of courtship of these types of females in subsequent encounters. We interpreted courtship reductions as an ability of these males to learn which females to avoid courting in the future. Our results indicate that a variety of adaptive learning mechanisms are in place in this species to allow males to court effectively.

Cognitive consequences of living in a contaminated environment in round goby (*Neogobius melanostomus*)

***Dominika Tomczyk*, Erin McCallum and Sigal Balshine**
McMaster University

The ability to learn associations between location and reliable food availability can be a survival advantage for many organisms. However, exposure to contaminants in the environment may impair such cognitive behaviours as associative learning. To test this hypothesis, we collected round goby (*Neogobius melanostomus*) from two sites within Hamilton Harbour: one highly contaminated, Sherman Inlet (N= 24); and one relatively clean, La Salle Park (N= 24). Our study employed a conditioned place preference paradigm, to condition fish to associate a particular tank compartment with a positive stimulus (food). An overall increase in preference for and decrease in latency to move to the conditioned compartment, were considered supportive of learning. Brain mass measures were also taken. Contaminated site fish had lower brain masses; however, contrary to predictions appeared to learn better than clean site fish. Further research is required to understand the impact of real world contaminant exposure on learning.

Pigeons make errors due to interval timing in a visual, but not visual-spatial, mid-session reversal task

***Neil McMillan* and William A. Roberts**
The University of Western Ontario

It has been previously shown that pigeons make surprising errors on a visually-based mid-session reversal task. We trained birds with red and green sidekeys, with one color rewarded in the first 40 sessions (S1) and the other color rewarded in the latter 40 sessions (S2). Importantly, in Experiments 1 and 3, red and green were always presented on the same side, while in Experiment 2 sidekeys were presented on either side equally often. In Experiments 2 and 3, probe sessions with inter-trial intervals (ITIs) longer or shorter than the training ITI were interjected among baseline sessions. Results showed that pigeons presented with visual-only cues used interval duration since the beginning of the session to predict when the reversal of reward contingency would occur, but pigeons presented with color and spatial dimensions confounded for predicting reward tended to use a more optimal reward-following strategy of choice based on local reinforcement.

The nature of play and its relation to sexual behaviour in farmed mink, *Neovison vison*

***Jamie Ahloy Dallaire*, Kaela E. Shaw, Rebecca K. Meagher,
and Georgia Mason**
University of Guelph

We tested the hypothesis that play, in American mink, prepares males for adult sexual behaviour. We studied fur-farmed animals, semi-domesticated but still experiencing some aspects of sexual selection. We observed 93 sister-brother pairs of juveniles in standard farm cages (non-enriched), and their 93 sibling pairs in cages that we “enriched” with golf/wiffle balls and chewable hoses. Social play and solitary object play have different motivational bases: though enriched mink could play with objects, they engaged in as much social play as non-enriched mink. Furthermore, time spent performing both types was uncorrelated. During the two-week breeding season, six months later, 60 males had different females placed inside their cages daily. Juvenile social play was positively correlated to copulation duration, and tended to predict a high number of successful copulations. The latter relationship was significant among non-enriched males, in whom social play also tended to correlate with shorter latency to initiate copulation. Among enriched mink, solitary object play tended to correlate positively with copulation duration and number of successful copulations. We now plan to experimentally manipulate opportunities for juvenile play to determine whether it has a causal role and to test competing hypotheses about the mechanisms mediating its relationship to sexual behaviour.

Information seeking in the rat

***Chelsea R. Kirk* and William A. Roberts**
University of Western Ontario

Metacognition is awareness of what one does and does not know. Students given a choice between studying material they have learned well and material they have learned poorly prefer to study the less mastered material (Metcalfe, 2009). Recent studies suggest that primates also know about the state of their own knowledge and will seek unknown information to complete a task (Call & Carpenter, 2001; Hampton et al., 2004). We used a radial arm maze to look for metacognition-like behavior in rats. Each maze arm had a bulb mounted on it to serve as a signal light. Rats were trained to go to whichever arm was lit on a trial for reward. They then were trained to press a bar in the maze hub that led to immediate food reward and turned on a light in one randomly chosen arm of the maze. Once the rats learned to press the bar, the reward for bar pressing was discontinued. We report on the rats’ readiness to press the bar for information about the location of reward under conditions that varied the degree of information and the motivation to obtain information.

Role of chemosensory and auditory communication on the outcome of female mating decisions in *Drosophila melanogaster*

***Kathryn L. Deeming* and Tristan A.F. Long**
Wilfrid Laurier University

The information transmitted and received during inter-sexual communication is central to the decision making processes involved in mate choice. This information can be transmitted through a variety of different signal modalities (eg. auditory, chemosensory, visual, mechanosensory, etc.), which may (or may not) convey the same information about the “quality” of the signaller (often a male) to the receiver (often a female). In this project, we examined the presence/absence of two signal modalities, auditory and chemosensory, in male *Drosophila melanogaster* to determine how these signal modalities affect the outcome of female mating decisions. The initial assay was done at the population level to determine the overall importance of these signals. It was found that both chemosensory and auditory signalling had significant effects on the outcome of female mate choice and that the two modalities had an interaction effect. A second assay was run using hemiclone analysis, looking at auditory signalling, to determine whether there is genetic variation in the “weight” placed on this form of communication.

Session 2B: Mating

Discrimination of chemical sexual signals in closely related spiders

***Julian D'Cruz*, Maydianne C.B. Andrade and Luciana Baruffaldi**
University of Toronto at Scarborough

The success of an invasive species in a novel environment heavily depends on the ability of individuals to locate mates over large distances. Sexual signaling over long distances in spiders requires chemical signals providing species-specific information about reproductive status. These sexual signaling chemicals, termed pheromones, have been the focus of research for several decades. We study the discriminatory ability of three species of the Widow family to distinguish between these closely related spiders using web-based contact pheromones. Our study shows that the Black Widow and the Redback male spiders appear unable to discriminate between web-silk based pheromone extracts of conspecifics and heterospecifics. However, the more invasive Brown Widow spiders appear capable of distinguishing conspecific web-based contact pheromones from the closely related heterospecifics we tested. The allopatric speciation experienced by this Genus suggests that the pheromones produced by these spiders may not have diverged to a great enough extent to be detected by all the *Latrodectii* just yet. However, the Brown Widow spider may have recently adapted the ability to exhibit this discriminatory behavior due to its rapid global spread in the last half century and the need to locate suitable conspecific mating partners in novel environments.

Female value or risk: What fuels male mate choice in black widows?

***Luciana Baruffaldi* and Maydianne C.B. Andrade**
University of Toronto at Scarborough

Male mate choice may be common, particularly with (1) extensive variation in female reproductive value and (2) a significant cost of finding and mating with multiple females. Recent work shows that male black widows (*Latrodectus hesperus*) avoid hungry females in favour of well-fed females, reducing the risk of pre-copulatory sexual cannibalism. However, these results are also consistent with a preference for more fecund females. Here, we show male choice can occur based solely on diet-based variation in females' sex pheromones. We then use pheromone bioassays to test these two alternative hypotheses for male choice. Our comparative study measures response of males to sex pheromones as a function of the female's diet in two species: *L. hesperus* (polygynous, pre-copulatory sexual cannibalism) and *L. hasselti* (monogynous, post-copulatory sexual cannibalism does not prevent paternity). If male choice of well-

fed females is primarily a way of avoiding cannibalism, we expected this preference in *L. hesperus*, but not *L. hasselti*. If, however, male choice is a preference for fecund females, we expected to find the preference in both species. We discuss our results in terms of the importance of male mate choice in species where mate searching, or mating itself is costly.

Fitness consequences of forced copulation in fruit flies

***Katherine Jongsma* and Reuven Dukas**
McMaster University

Typically female fruit flies choose their mate, however young females, recently emerged from the pupae, can undergo forced copulation by mature males. This study quantified the fitness consequences of forced copulation in fruit flies. To measure female fitness, we compared the average offspring of females who were forcibly or consensually mated. Forcibly copulated females had fewer offspring than consensually copulated females, and therefore there is a female fitness cost for forced copulation compared to consensual mating. Male fitness was measured by comparing the average offspring of males who forcibly or consensually copulated. Males that forced copulated had fewer offspring than males that consensually copulated. There is a male fitness benefit from forced copulation, which is not as high as the fitness benefit from consensual copulation. These results provide clear empirical evidence that forced copulation in fruit flies is a form of sexual conflict as it increases male fitness and decreases female fitness.

Contemporary adaptation of offspring sex ratio: are alterations to masculinity an adaptive mode to sex ratio manipulation?

***Frances E.C. Stewart* and Andrew G. McAdam,**
University of Guelph

Fisher (1930) stated that natural selection favours equal parental investment towards both sexes, however, we repeatedly see skews in sex ratio when looking at wild populations. Several adaptive theories of sex ratio manipulation have been proposed, involving behavioural, physiological, or frequency dependent mechanisms, but the ultimate goal is to maximize fitness through producing the sex with the greatest reproductive success in their given environment. Detailed rodent laboratory studies have noted that the masculinity (measured as ano-genital distance) of offspring can be affected by litter sex ratio, percent of the litter that is male, and maternal androgens. As adults, masculinity can affect individual behaviour and reproductive success through frequency and willingness to engage in copulations. Here we propose that litter sex ratio manipulation is not the only mechanism to adaptively modify sex ratio. Alterations to offspring masculinity may represent a fine scale adjustment to the phenotype of the two sexes that would also influence parental fitness. We present data from a laboratory

study and a long-term study on wild *Peromyscus* and generate hypotheses as to why masculinity may change with environmental variation. We present this idea to generate discussion as to whether considering masculinity is important to sex ratio theory.

Complex communication through simple plumage: multiple ornaments and multiple receivers in an achromatic passerine

***Sarah Guindre-Parker*, Grant H. Gilchrist, Stephanie M. Doucet, Sarah Baldo and Oliver P. Love**
University of Windsor

Males display multiple elaborate ornaments indicative of quality, but the evolution of multiple ornaments are not well understood. Furthermore, studies of multiple ornaments have focused primarily on species with several highly exaggerated traits. We investigated whether simple achromatic plumage traits can act as multiple ornaments in an Arctic-breeding passerine, the snow bunting (*Plectrophenax nivalis*). Specifically, we examined whether multiple ornaments are providing different types of information, are redundant, or are unreliable signals of male quality. Using a breeding population of snow buntings (Nunavut, Canada), we measured plumage reflectance and pigmentation traits made conspicuous during male inter- and intra-specific displays. We also assessed male quality through a variety of condition-dependent measures. Our results indicate that several aspects of male plumage may have redundant messages but broadly, different body regions may be aimed at different receivers. The wings of males, displayed primarily towards females during courtship, can indicate male health and territory quality. Conversely, tail reflectance provides information on territory size and testosterone levels. We suggest that the different information provided by different aspects of plumage may have differential importance in inter- versus intra-specific communication. This study demonstrates that simple plumage may serve in complex communication similarly to highly exaggerated traits.

What's scent got to do with it? Floral fragrance and reproductive strategies of a Pacific coast dune plant

***Laura Doubleday*, Robert Raguso and Christopher Eckert**
Queen's University

One of the most significant evolutionary trends in flowering plants is the transition from self-incompatibility, where plants outcross obligately, to self-compatibility, where self-fertilization is possible. Such a mating system shift might cause selection to act to reduce expensive, formerly fitness-enhancing traits in populations where they are no longer crucial to reproductive success. In outcrossing populations of animal-pollinated plants, plants and pollinators may exert selection on each other to develop visual and

olfactory communication channels that enhance the likelihood of successful pollination, but can be costly to maintain when they do not confer a fitness advantage. The dune plant *Abronia umbellata* (*Nyctaginaceae*) provides an excellent opportunity to study the reduction of attractive floral traits across a transition to self-compatibility. Where *A. umbellata* outcrosses, it possesses traits associated with pollination by moths: tubular flowers and a sweet floral fragrance emitted in the evening. In self-compatible populations, flowers are smaller, with shorter floral tubes, and have extremely low scent emission rates. We characterize and compare the floral fragrances of outcrossers and selfers both in the field and in a common garden setting and discuss our findings in the context of pollination ecology.

Can variation in breeding ground territory quality explain the increased reproductive success of early-arriving male American redstarts?

***Mitchel Daniel*, Ann McKellar, Peter Marra and Laurene Ratcliffe**
Queen's University

In American redstarts, as with many other migratory songbird species, early arriving males typically breed earlier and achieve greater reproductive success. Variation in territory quality may mediate the relationship between arrival date and reproductive success in two ways. According to the quality hypothesis, early arrival allows males to acquire higher quality territories, which causes their increased reproductive success. Alternatively, the timing hypothesis states that early arriving males are more successful because seasonal declines in territory quality confer timing-specific advantages to earlier reproduction. In this study, territory quality was assessed in terms of size, food availability, and nest site characteristics. These measures did not vary between early arriving, late arriving, and experimentally delayed males; thus, support for the quality hypothesis was not found. Of the territory features examined, only food availability exhibited seasonal declines. Additionally, parental feeding rate was anecdotally found to be higher early in the season. These results support the timing hypothesis by suggesting early arriving males are more successful because they are able to breed earlier in the season, when food is most available. This seasonal food decline also indicates potential vulnerability to advancing spring onset due to climate change, which could create mistiming between redstart reproduction and peak food availability.

Session 3A: Evolutionary Psychology

Cues to different aspects of mate quality provide similar information about fitness: Women's voice pitch is positively related to 3D facial symmetry

***Cara C. Tigue*, Bernard P. Tiddeman, Katarzyna Pisanski,
Jillian J.M. O'Connor, Paul J. Fraccaro, David I. Perrett,
Benedict C. Jones, Anthony C. Little and David R. Feinberg**
McMaster University

Across animal species, individuals possess many traits that could indicate mate quality. These sexually-selected cues may evolve as multiple messages that combine to advertise overall mate quality. In humans, facial symmetry is a cue to developmental stability and voice pitch is a cue to sex hormone levels. More symmetric faces are more attractive than are less symmetric faces and higher-pitched women's voices are more attractive than are lower-pitched women's voices. A previous study found that people with more symmetric bodies had more attractive voices, but the biological basis for this relationship is unknown. Given that more symmetric people have more attractive voices and that higher-pitched women's voices are more attractive than are lower-pitched women's voices, we investigated whether women with more symmetric faces have higher-pitched voices. We used a novel method to measure women's facial symmetry in three dimensions and also measured their voice pitch. Analyses indicated that women with more symmetric faces had higher-pitched voices. Our data identifies voice pitch as a potentially important factor in the relationship between symmetry and voice attractiveness and provides evidence that cues to different aspects of women's mate quality co-vary and can indicate similar information about their fitness, complementing findings from non-human animals.

Menstrual cycle shifts in women's voice preferences are associated with the fundamental but not formant frequencies of male voices

***Katarzyna Pisanski*, Cara C. Tigue, Jillian J.M. O'Connor,
Paul J. Fraccaro, and David R. Feinberg**
McMaster University

Women demonstrate cyclic and contextual shifts in their preferences for androgen-dependent male traits, such as facial masculinity. Masculine traits are preferred most during the fertile phase of the menstrual cycle and in the context of a short-term relationship, when the benefits associated with male masculinity are maximized. Women

also demonstrate analogous shifts in their preferences for male voices; however, it is unclear from previous work whether shifts are driven by preferences for fundamental frequency (i.e., pitch, a cue to testosterone) or formant frequencies (a cue to stature). To test this, naturally ovulating women rated the attractiveness of male voice pairs, raised versus lowered in each voice feature independently, over six consecutive weeks. In separate manipulations, women generally preferred lowered pitch or formants to raised pitch or formants; however, lowered pitch was preferred to raised pitch more in the fertile (late-follicular) compared to the non fertile (luteal) phase of the menstrual cycle and only in the context of a short-term relationship. Comparable cyclic shifts were not found in women's preferences for male formant frequencies. This work provides further support for systematic variation in women's preferences for androgen-dependent male traits, and suggests that preferences for absolute male stature may be less variable.

Uninformative social cues increase cooperation, but not for long

***Adam Sparks* and Pat Barclay**
University of Guelph

Social scientists from a variety of fields use experimental economic games to study cooperative decision making. Outcomes of economic games can be influenced by the formal parameters of the game; humans make more cooperative decisions when games are structured to provide them information about the reputation of other players. Decisions can also be influenced by contextual cues; some studies have shown elevated levels of cooperation by people exposed to images of eyes or faces, i.e. cues of observation, though others have failed to replicate this effect. An effort to reconcile the body of findings about the "eyes effect" can usefully inform theoretical debates about the evolution of cooperation and practical efforts to maintain cooperation in real world systems. I report the results of an experiment in which participants showed the effect after a brief exposure to eyes, but not after a longer exposure. Habituation to uninformative cues may account for some of the discrepancies in eyes effect findings.

The evolution of superstition through optimal use of incomplete information

***Kevin Abbott* and Thomas Sherratt**
Carleton University

While superstitions seem maladaptive, they may be an inevitable result of adaptive causal learning mechanisms that optimally tradeoff the risks of falsely 'detecting' non-existent causal relationships (superstition) and of failing to detect real relationships. An individual's exploration-exploitation strategy helps manage this tradeoff. On any given trial an individual must decide whether to act so as to maximise its expected fitness based on current information (exploit) or so as to provide the most information about the

true nature of the causal relationship (explore). We present a two-armed bandit model of a simple causal learning scenario that allows us to identify the optimal learning strategy and to determine how various parameters affect the probability that an individual will develop a superstition. We find that superstitions are more likely when the cost of the superstition is low relative to the potential benefits, and when the individual's prior beliefs suggest that the superstition is true. We also find that both the number of learning trials available and the nature of the individual's uncertainty affect the probability of superstition, but that these effects depend on the individual's prior beliefs.

The varying relationship between helping and individual quality

***Pat Barclay* and Kern H. Reeve**
University of Guelph

Individuals of different quality often differ in their helping behaviour, but sometimes it is the high quality individuals who help most (e.g. human meat-sharing, vigilance) and other times it is the low quality individuals (e.g. reproductive queues, primate grooming). We argue that these differences depend on individual differences in the performance costs of actually helping, the opportunity costs from forsaking alternative activities, and the fitness benefits for engaging the help. If helping is more difficult for some individuals to do (quality-dependent help), it will usually be done by high quality individuals, whereas help that all individuals could do equally well (quality-independent help) will be done by whoever pays lower opportunity costs. Our model makes novel predictions about many kinds of helping, allows us to categorize different types of helping by their relationship with individual quality, and is general enough to apply to many situations. Furthermore, it can be generalized to any other type of (non-helping) behaviour where there are individual differences in benefits, performance costs, or opportunity costs.

Framing effects and risk-sensitive decision-making

***Sandeep Mishra*, Margaux Gregson and Martin Lalumière**
University of Guelph

Prospect theory suggests that people are risk-averse when facing gains, but risk-prone when facing losses, a pattern known as the framing effect. Although framing effects have been widely demonstrated, few studies have investigated framing effects under conditions of need. Risk-sensitivity theory predicts that decision-makers should prefer high-risk options in situations of high need, when lower risk options are unlikely to meet those needs. In two experiments, we examined (1) whether framing effects occurred in behavioral tasks involving risky decision-making from description and decision-making from experience, (2) whether participants' risky decision-making conformed to the predictions of risk-sensitivity theory, and (3) whether decision framing interacted with conditions of need to influence decision-making under risk. The results suggest that

under all circumstances, risky decision-making conformed to the predictions of risk-sensitivity theory. Framing effects were at least partially demonstrable under all experimental conditions. Finally, negative frames interacted with situations of high need to produce particularly elevated levels of risky choice. Together, the results suggest that framing interacts with conditions of need to affect risky choice.

Enhanced kin recognition through population estimation

Daniel B. Krupp

Queen's University and McMaster University

Kin recognition systems enable organisms to determine the genetic relatedness of others to themselves. In so doing, they help to maximize the fitness consequences of social actions, such as altruism and spite. In many instances, kin recognition will depend upon the assessment of the similarity between an individual's information about its own phenotype and the phenotypes of others. To assess similarity, however, I argue that individuals additionally require estimates of (1) the expected phenotype and (2) the variation among phenotypes in the population. This expanded concept of similarity assessment brings relatedness judgments closer in line with the concept of relatedness as it is currently understood, and provides a mechanism by which individuals can discriminate positive from negative relatives, thereby increasing opportunities for the evolution of altruism and spite. I propose ways in which organisms might acquire population estimates and identify research that supports their use in similarity assessment.

Session 3B: Genetics

The evolutionary implications of genome rearrangements on the genetic architecture of salinity tolerance in Atlantic salmon (*Salmo salar*)

***Joseph Norman*, Mike Robinson, Moira Ferguson, Brian Glebe, and Roy Danzmann**
University of Guelph

Quantitative trait locus (QTL) studies show that variation in salinity tolerance in Arctic charr and rainbow trout has a genetic basis. We compared salinity tolerance QTL in rainbow trout and Arctic charr to those detected in a higher salinity tolerant species, Atlantic salmon. The highly derived karyotype of Atlantic salmon allows for the assessment of whether disparity in salinity tolerance in salmonids could be related to differences in genetic architecture. To facilitate these comparisons, we examined the genomic synteny patterns of key candidate genes with the genome of three-spined stickleback. Comparisons reveal that salinity tolerance in salmonids is to some extent controlled by the same loci. Synteny between these QTL and candidate genes in stickleback suggests that genetic variation at these loci could be important. Three Atlantic salmon linkage groups contained larger syntenic combinations of candidate genes that were not evident in any of the other 2R, 3R, or 4R genomes examined. These larger synteny tracts appear to have resulted from the ancestral arm fusions in Atlantic salmon. We postulate that the superior hypo-osmoregulatory efficiency of Atlantic salmon could be related to these clusters. This suggests that ancestral arm fusions have formed co-adapted gene complexes for salinity tolerance in this species.

Evidence for concurrent decline in inbreeding coefficients and mortality rates across life history stages in *Aquilegia canadensis*

***Andy Wong* and Christopher Eckert**
Queen's University

Previous evidence of inbreeding depression in the eastern red columbine (*Aquilegia canadensis*) were inferred from a decline in inbreeding coefficient from offspring to adult. However, it is unknown when inbreeding depression is expressed in the columbine's life history. We assayed columbine plants in four life history stages in three populations over two years for eight microsatellite markers to estimate inbreeding coefficients at each stage where a decline in inbreeding coefficients over life history stages would be evidence for inbreeding depression. We also estimated life-history stage specific mortality rates to understand whether the decline in inbreeding coefficient is reflected

through demographic processes. We found that indeed inbreeding depression appears to be strong, early acting and coincides with high early stage mortality.

Evolutionary analysis and genetic mapping of Neuropeptide Y (NPY) receptors in Rainbow Trout (*Oncorhynchus mykiss*) and Arctic Char (*Salvelinus alpinus*)

***Aaron Goldt*, Moira Ferguson and Roy Danzmann**
University of Guelph

Whole genome duplications (WGDs) have important implications for evolution. The neuropeptide Y (NPY) family of receptors shows a complex evolutionary history of duplication events which is reflected in its diversity of functions, including control of: food intake, various neuroendocrine axes, vasoconstriction, and cardiovascular remodeling. The repertoire of NPY receptors found in major vertebrate groups has been well characterized, showing a dynamicity between duplication events and differential loss of receptor types. The objective of my research is to examine the fate of duplicated copies of the neuropeptide Y (NPY) receptors following the WGD leading to Salmonidae; with focus on rainbow trout (*Oncorhynchus mykiss*) and Arctic char (*Salvelinus aplinus*). Of the receptor subtypes found in vertebrates, receptors Y1, Y2, Y4, Y7, and the teleost duplicates Y8a and Y8b are predicted to be in the Salmonid genome based on teleost repertoires. Sequencing and genetic mapping using single-strand-conformational-polymorphism has identified single copies of Y2, Y7 and Y8b and two copies of Y8a within the rainbow trout and Arctic char genomes. The gain of a duplicate (Y8a) and the potential loss of two receptor subtypes (Y1 and Y4) shows a restriction on the number of receptors but also the adaptability of this family to losses.

Detection of QTLs associated with age of smoltification and maturation in F1 trans-Atlantic backcrosses of aquaculture strains of salmon (*Salmo salar*)

***Stephanie Pedersen*, B. Glebe B, M. Culling, S. Leadbeater,
W. Vandersteen, E.G. Boulding**
University of Guelph

Age of smoltification and maturation in Atlantic salmon are complex traits heavily influenced by both biotic and abiotic factors. Genetic improvement of economically-important complex traits in aquacultural Atlantic salmon has become a prominent topic for research. The purpose of this study to detect quantitative trait loci (QTL) associated with age of smoltification and sexual maturation. F1 trans-Atlantic salmon were created through the crossing of Norwegian Mowi and Canadian St. John aquacultural strains which represent different subspecies. Four large trans-Atlantic double backcross families

were raised to maturity, and data on gender, age of smoltification, and age at sexual maturity were collected. One family was genotyped for 320 Single Nucleotide Polymorphisms (SNPs) and three families were genotyped for 129 SNPs. This data was analyzed with GridQTL online mapping software to identify significant QTLs associated with threshold traits smolt and maturity. Preliminary results show a highly significant QTL that accounted for 15% of the variance in early smoltification on chromosome 23 and three smaller suggestive QTLs on chromosomes 5, 8 and 13. Mapping the genome regions associated with the age by size reaction norms for smoltification and maturation could help increase the rate of gain for these traits in salmon breeding programs.

Candidate genes for growth in rainbow trout, *Oncorhynchus mykiss*

***Andrea Kocmarek*, Moira Ferguson and Roy Danzmann**
University of Guelph

Growth in fishes is a complex trait controlled by many genes. To date no microarray study has directly compared the gene expression in large and small fish of the same species. To identify growth candidate genes we compared the gene expression profiles in white muscle and liver derived from small and large rainbow trout. Fish were produced at two spawning periods (Sept. and Dec., 2008), and sampled at 15 months of age. A significant size difference was observed between the Sept. and Dec. offspring. In the livers, genes related to cell growth, transcription/translation, energy production, the blood, and the immune system were up-regulated in the small fish compared to the large fish in both lots which suggests small fish require more energy for immune function and liver cell turnover. Gene expression in the muscle of both the Sept. and Dec. fish provided evidence of increased muscle growth in the large fish compared to the small fish. Genes related to protein turnover/synthesis, cell division, energy utilization, the blood, and muscle/cytoskeleton components showed decreased expression in the small fish compared to the large fish.

Life history predicts genome structure in bees and ants

***Clement F. Kent* and Amro Zayed**
York University

Genome GC content varies widely both within a species, forming regions called isochores, and between species. The honeybee genome has an unusually wide range of GC in isochores and a low mean GC, while the genome of the non-social wasp *Nasonia* has normal GC content and spread. This suggested low GC content might associate with sociality, but a recent review of ant genomes concludes that eusociality is not necessarily correlated with GC-poor genomes and high spread. Here we show that both

mean genome GC content and the spread of GC are well predicted by aspects of the life history of ants and bees.

Population-genetic analysis of extreme mating system differentiation in the costal dune endemic plant *Camissoniopsis cheiranthifolia* (Onagraceae)

***Adriana Lopez-Villalobos* and Christopher G. Eckert**
Queen's University

Transition from outcrossing to selfing has happened thousands of times in flowering plants. Self-fertilization has profound effects on population-genetic parameters: it reduces effective population size and pollen-mediated gene flow. It may also involve strong genetic bottlenecks and reproductive isolation from related outcrossing populations, resulting in a dramatic reorganization of population-genetic structure. *Camissoniopsis cheiranthifolia* exhibits striking variation in floral traits and mating system across its geographic distribution allowing investigation of the population-genetic consequences associated with shifts in the mating system. Large-flowered self-incompatible (LF-SI) and large-flowered self-compatible (LF-SC) populations are found in the south-central portion of the range. Small-flowered self-compatible (SF-SC) populations are distributed towards the northern and southern limits of the range and on the Channel Islands. We assayed individuals from 20 populations for variation at 15 microsatellite loci. Using Bayesian analyses we tested for genetic subdivisions across the species range and where these coincide with shifts in the mating system. Preliminary analyses show higher genetic diversity in LF-SI than in SF-SC populations. Interestingly, LF-SC populations are similarly diverse as SF-SC populations from northern California, but not from Baja or the Channel Islands. SF-SC Baja populations are highly differentiated from other populations. Finer analyses are discussed in this study.

Session 4A: Conservation

The role of pollination in influencing the altitudinal range limits of the plant *Rhinanthus minor*

***Jennifer Weiner*, Anna Hargreaves and Christopher G. Eckert**
Queen's University

Most plants require interactions with animals to facilitate pollination and successful sexual reproduction. However, the role of pollination in the formation and maintenance of geographical range limits is largely unexplored. I tested the hypothesis that pollination service declines with increasing elevation using *Rhinanthus minor*, a self-compatible annual pollinated by bumble bees (*Bombus spp.*), along two altitudinal transects in the Rocky Mountains of Alberta. Contrary to predictions, *Bombus* abundance estimated by pan-trapping and direct observations increased toward the upper range limit of *R. minor* and visitation rate to *R. minor* did not vary with elevation. Pollen deposition on stigmas declined with increasing elevation, though almost all flowers received more than enough pollen to fertilize all ovules. Accordingly, the seed set of pollen-supplemented flowers was not higher than that of open-pollinated flowers. The seed set of flowers isolated from pollinators was uniformly high, suggesting that autonomous self-pollination may buffer seed production from any altitudinal variation in outcross pollination. Given that pollinators were abundant and foraging on *R. minor* at high altitudes, it is unlikely that the upper range limit of *R. minor* can be attributed to a decline in *Bombus*-mediated pollination.

Effects of climate change on the ecology and evolution of aphids

Micheline Khan
University of Toronto at Mississauga

Climate change is increasing global temperatures and altering precipitation patterns which are having large impacts on natural populations and agricultural systems. Scientists are beginning to recognize that populations might not only react ecologically but also might evolve in response to these changes. Most empirical evidence of adaptation to climate change however remains observational and experimental evolution studies remain rare. I conducted an evolution experiment that tested how the green peach aphid (*Myzus persicae*) evolves in response to changes in temperature and drought. I created asexual aphid populations with different clonal compositions growing on Chinese cabbage to address a series of questions. First, I found that abiotic factors had large effects on aphid population growth. Second, I tested for an evolutionary response by creating populations composed of two clones with genetically-based colour

morphs. I found that the frequency of the red morphed increased in all conditions but the rate of change depended on the climactic conditions. Because evolution occurs in the same direction in most or all treatments, it suggests that evolution is adaptive. The implications of these results are especially important in agricultural systems, where securing resources to feed an ever-increasing global population is a major challenge facing our time.

Temporal variation in pollinator diversity: A study of the Niagara bee community

***Thomas Onuferko*, Rodrigo Leon Cordero and Miriam Richards**
Brock University

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

Management increases genetic diversity of honey bees via admixture

***Brock A. Harpur*, Shermineh Minaei, Clement F. Kent and Amro Zayed**
York University

Domestication often brings about profound changes in levels of genetic variation in animals and plants. *Apis mellifera* has been managed by humans for centuries for both honey and wax production and crop pollination. Management and selective breeding are believed to have caused reductions in genetic diversity in honey bee populations, thereby contributing to the global declines threatening this ecologically and economically

important insect. However, previous studies supporting this claim mostly relied on population genetic comparisons of European and African (or Africanized) honey bee races; such conclusions require reassessment given recent evidence demonstrating that the honey bee originated in African and colonized Europe via two independent expansions. We sampled honey bee workers from two managed populations in North America and Europe as well as several old-world progenitor populations in Africa, East and West Europe. Managed bees had highly introgressed genomes representing admixture between East and West European progenitor populations. We found that managed honey bees actually have higher levels of genetic diversity compared to their progenitors in East and West Europe, providing an unusual example whereby human management increases genetic diversity by promoting admixture. The relationship between genetic diversity and honey bee declines is tenuous given that managed bees have more genetic diversity than their progenitors and many viable domesticated animals.

Determining population genetic variation of the Cassin's auklet: are multiple conservation units needed?

***Sarah Wallace*, Shaye Wolf, Russell Bradley and Vicki Friesen**
Queen's University

Describing a species' genetic variation and determining historical and contemporary gene flow between populations can provide insight into appropriate conservation units as well as characterizing biodiversity. The Cassin's auklet (*Ptychoramphus aleuticus*) breeds in colonies along the Pacific coast of North America. One subspecies, *P. a. australe*, is described from Baja California, Mexico and another, *P. a. aleuticus*, is described from the rest of its range to the Aleutian Islands, Alaska. Many of the colonies throughout its range have been declining in numbers. Using computer programs based on coalescent and Bayesian theory, I investigated mitochondrial control region (mCR) and microsatellite variation to (1) characterize genetic variation within populations, (2) determine how the two subspecies compare genetically, and (3) describe the overall population genetic structure and gene flow. With 157 individuals, the AMOVA analysis, pairwise F_{ST} and pairwise F_{ST} values indicated that some genetic differentiation exists among populations. Moreover, individuals were mainly clustered by subspecies in the mCR haplotype network, as well as in the STRUCTURE plot suggesting that *P. a. aleuticus* and *P. a. australe* differ genetically. Further analysis will include using an isolation with migration model in IMA to estimate contemporary gene flow.

Sources of ebullition and methane emissions in Alaskan peatlands following permafrost degradation

***Sara J. Klapstein*, Merritt R. Turetsky, David A. McGuire,
Jennifer W. Harden, Claudia I. Czimczik, Xiaomei Xu, and
James M. Waddington**
University of Guelph

In boreal and subarctic regions, permafrost is often associated with peatlands due to the insulating properties of saturated peat. Recent studies however, have identified widespread degradation of permafrost in these regions that results in deeper active layers and warmer soil temperatures but also vegetation shifts that may impact the carbon budget of these ecosystems. The influence of permafrost thaw on methane production and its transport pathways, in particular ebullition, is poorly understood. The objective of this study was to examine the release of methane through ebullition from both surface and deep peat layers to tackle whether ebullition is dominated by new or old carbon. Our measurements were conducted at three thermokarst sites associated with the Alaskan Peatland Experiment (APEX). Results show that almost 95% of ebullition was captured in the shallow subsurface gas traps and that ebullition was controlled primarily by seasonal ice thaw and soil temperature. Initial radiocarbon results suggest that mid-season ebullition was dominated by young carbon and may be related to vascular stem density, suggesting a tradeoff between ebullition and plant-mediated release. Results from this study will be used to improve the methane component of the Terrestrial Ecosystem Model (TEM).

Increasing atmospheric nitrogen deposition: implications for tallgrass prairie and forest restoration

Jennifer McPhee
Western University

As the use of fossil fuels and synthetic fertilizers continue to increase, so does the emission of nitrogen pollution into the atmosphere, resulting in increased nitrogen deposition across the landscape. Typically, terrestrial ecosystems are nitrogen limited, and increased nitrogen deposition has a strong effect on plant biomass and species composition, in that it favors fast-growing, nitrogen-demanding species. Therefore, increasing nitrogen deposition has important implications for plant community restoration. I will use a field experiment to assess the effects of nitrogen addition on tallgrass prairie restoration, and the ability of native trees to establish in the restored prairie. I will also use a common garden experiment to examine the success of transplanted tree seedlings in response to competition from tallgrass versus non-tallgrass species in the context of nitrogen addition. Overall, I predict that competition

from fast-growing non-tallgrass species under high nitrogen addition will impede tree growth and establishment.

Unintended outcomes and trade-offs of fish passage

***Eric Smyth*, Robert McLaughlin, Theodore Castro-Santos,
Michael Jones, Marten Koops, Thomas Pratt and Luis Antonio
Vélez-Espino**

University of Guelph

We review evidence for unintended consequences and trade-offs associated with the passage of fishes. Provisioning of fish passageways at dams and dam removals are being carried out increasingly as resource managers seek ways to reduce fragmentation of migratory fish populations and restore biodiversity and nature-like ecosystem services in tributaries altered by dams. The benefits of provisioning upstream passage are highlighted widely. Possible unwanted consequences and trade-offs of upstream passage are coming to light, but remain poorly examined and underappreciated. Unintended consequences arise when passage of native and desirable introduced fishes is delayed, undone (fallback), results in patterns of movement and habitat use that reduce Darwinian fitness (e.g. ecological traps), or is highly selective taxonomically and numerically. Trade-offs arise when passage decisions intended to benefit native species interfere with management decisions intended to control the unwanted spread of non-native fishes and aquatic invertebrates, or genes, diseases, and contaminants carried by hatchery and wild fishes. Decisions about how to manage fish passage therefore involve substantial risks, and could benefit from use of a formal, structured process that allows transparent, objective, and, where possible, quantitative evaluation of these risks.

Session 4B: Environmental Ecology

The role of sustained water table drawdown on carbon cycling in boreal peatlands

***Agnieszka Kotowska*, Merritt Turetsky and Brian Benscoter**
University of Guelph

Northern peatlands store up to 370 Pg C, or ~80% of boreal soil carbon. Warmer, drier conditions under future climate change are predicted to decrease water table (WT) levels in boreal peatlands. The objective of this study was to examine the net effects of long-term WT drawdown in peatlands on fluxes of two greenhouse gases, carbon dioxide (CO₂) and methane (CH₄). We utilized a rich fen in northern Alberta to examine the response of plant and C cycling to drier conditions. We found that 20 years of sustained WT drawdown reduced the CO₂ sink strength of the fen by increasing rates of ecosystem respiration (CO₂ release) but having no impact on plant productivity (CO₂ uptake). Drier conditions also resulted in lower CH₄ emissions from the site and altered the functional response of CH₄ flux to temporal and spatial WT variation. The results of this study suggest that drier conditions associated with future climate change may lower the ability of western boreal peatlands, which have historically acted as carbon sinks, to sequester CO₂. However, the reduction in emissions of CH₄, a powerful greenhouse gas, may attenuate the potential of peatland drying to act as a positive feedback to global climate change.

Interactive effects of warming and N addition on seedling establishment in a temperate old field

Bryana McWhirter
The University of Western Ontario

Abandoned agricultural fields follow a typical pattern of succession from temperate old fields to secondary forest if there is a lack of disturbance. However, climate warming and increased atmospheric nitrogen deposition over the next century may alter plant community successional trajectories. Changes to growing season length and timing as well as nitrogen availability may affect the establishment of woody seedlings in grass-dominated communities. I will investigate the effects of warming and nitrogen addition on the germination, establishment, and productivity of six early successional woody species in the context of a field experiment, and assess the direct responses of these species to the treatments in a greenhouse experiment. This study will help to increase our understanding of how plant community dynamics and the early stages of succession in temperate old fields will be affected by predicted global changes.

Freshwater macroinvertebrate communities across Nunavut, Canada: the effects of habitat and ecoregion scale environmental controls on species distribution and community function

***Christopher Luszczek* and Roberto Quinlan**
York University

Larval insects, known collectively as macroinvertebrates, dominate freshwater systems in the Canadian Arctic where they form an important part of aquatic food webs and are often top predators in fishless systems. Understanding the composition and function of these ecosystems cannot be accomplished without detailed examination of invertebrate diversity. Littoral kick and sweep samples were taken from the shorelines of lakes and ponds across the Kivalliq and Baffin regions of Nunavut, Canada during the summers of 2008 & 2011, as well as a suite of limnological, habitat, and regional variables. Dominant taxa including chironomids, amphipods, and *Chaoborus* were identified to the species level in order to examine their diversity and distributions. Ordination analysis was used to determine environmental variables responsible for structuring communities. The purpose of this study was to use high taxonomic resolution to elucidate patterns in species distributions and to make predictions for species responses to potential habitat and environment alterations. While chironomids are used as indicators in many paleo-environmental studies, the examination of current populations has implications for environmental management and is important to our understanding of past, present and future biogeographic patterns in Arctic regions.

Optimal subsampling of Arctic benthic macroinvertebrates

***Raymond Biastoch* and Roberto Quinlan**
York University

The benthic macroinvertebrate communities of streams from two aquatic systems near Iqaluit, NU, were used to determine an optimal subsample size. Optimal subsample size is the minimum number of individuals required to represent the statistical difference in community structure between the two systems equivalent to that of the original samples. Stream samples obtained from minimally-disturbed sites outside Iqaluit were considered reference sites and samples from anthropogenically-disturbed Airport Creek in Iqaluit were considered urban sites. Analysis of similarity (ANOSIM) was performed on the original samples from the two systems. Simulated subsampling strategies of 100, 150, 200, 300, 500, and 1000 individuals were performed 1000 times on the original dataset. For each iteration of every subsampling strategy, ANOSIM was performed, and the median statistic was calculated over the 1000 iterations. The subsampling strategy that produced a median statistic no less than that which resulted from the original samples, with minimum counting effort, and minimal variation, was considered the optimal

subsample size. Developing community analysis methods based on multivariate analyses is critical for research in an under researched and low diversity region, and this work is part of a larger study investigating patterns of community structure in Arctic streams.

Do plants allocate more to seeds when grown with siblings or strangers? A test for kin selection in field grown ragweed

***Amanda File* and Susan Dudley**
McMaster University

The ability for plants to recognize and respond to the identity of their neighbours has recently been demonstrated in several species with the specific responses dependent upon the ecology of the species. Plants grown in a nutrient and water poor environment produce a more competitive root phenotype with strangers than with siblings. Plants that naturally compete for light produce phenotypes that shade their neighbours more when grown with strangers compared to siblings. Ragweed, a species that forms mycorrhizae, has been shown to increase mycorrhizal associations when grown in sibling groups, leading to increased nutrient uptake. However, evidence of a fitness benefit to these responses is lacking. We grew pairs of ragweed plants in the field at low and high density and measured biomass allocation to seeds relative to stems. Sibling pairs allocated significantly more biomass to seeds compared to pairs of strangers, suggesting that plants can benefit from growing next to their relatives. This study provides the first evidence of kin selection acting on field grown ragweed and suggests that there is a benefit for plants that can recognize and respond to neighbour relatedness.

Do geographic range limits reflect niche limits? A meta-analysis of experimental studies

Anna L. Hargreaves, Karen E. Samis and *Christopher G. Eckert*
Queen's University

All species are restricted in their geographic distributions, and how range limits are generated and maintained touches on fundamental questions in ecology, evolution and conservation. It is widely held that distributions are limited by abiotic and biotic factors that reduce individual fitness below that required for populations to be self-sustaining. That is, range limits are niche limits writ large. We analysed results from all studies that tested this hypothesis using transplant experiments. We found 42 studies that included 101 tests of range limits involving 84 species (79 plants, 5 invertebrates). Although 73% of tests revealed a decline in fitness or some component thereof when individuals were transplanted to sites beyond the species' range limit compared to within-range transplants, studies varied widely in the number and distribution of source populations

and planting sites. Only experiments that include source material from and planting sites at the range limit provide a test of the concordance between range and niche limits experiments. Of the suitable 23 tests, only 56% yielded evidence that range and niche limits coincide. Weak support for niche limitation suggests that alternative and largely untested hypotheses for why range limits exist, involving dispersal limitation, deserve more serious attention.

Interactive effects of soil freezing and nitrogen deposition on nitrogen retention over winter and the following growing season

***Mathew Vankoughnett* and Hugh Henry**
Western University

Warmer winter air temperatures over the next century may decrease snow depth and increase the frequency and intensity of soil freezing. Soil freezing can increase microbial lysis, disruption of soil aggregates, and damage to roots, leading to decreased N retention. Coupled with increased atmospheric N deposition, an increased quantity of N may be transferred from terrestrial to aquatic systems. The objective of this study was to investigate the interactive effects of soil freezing and N deposition on N retention. We added 15N to plots treated with combinations of snow removal and N addition, then sampled the plots in fall, the end of winter, and the next fall to assess cumulative N losses. In addition, we added 15N to separate plots after snow melt and at peak biomass to assess short-term uptake of simulated N deposition. Soil freezing decreased the retention of added 15N over the winter and the growing season. While 15N retention was similar among all treatments just after snow melt, soil freezing effects were significant at peak biomass. N addition had no effect on 15N retention. Our data confirm that severe soil freezing can reduce N retention in the winter and these effects carry over to the growing season.

Post-Pleistocene dispersal in a freshwater amphipod: a biogeographical approach to the *Hyaella azteca* cryptic species complex

Matthew Hrycyshyn

University of Waterloo

Charles Darwin suggested that widely distributed freshwater invertebrates were cosmopolitan species maintained by long-distance dispersal. Taxonomic revisions stimulated by advancements in molecular techniques have led to the reclassification of such invertebrates as cryptic species complexes with much more limited distributions. Genetic analyses allow us to test hypotheses concerning patterns of genetic variation to discover the salient biogeographical forces that have shaped contemporary population structures and distributions. The amphipod *Hyaella azteca* is a continentally distributed cryptic species complex that inhabits freshwater lakes, rivers and ponds throughout North America. Hyaellids provide an excellent opportunity to test the effects of Pleistocene glaciations on the freshwater biota. Over the last glacial period, species in glaciated regions experienced significant declines in habitat and population sizes. We tested the hypothesis that *Hyaella* populations that colonized historically glaciated regions from refugia would have lower divergences among populations as compared to unglaciated regions. Freshwater sites from Alaska to Florida were sampled and sequenced for the mitochondrial cytochrome c oxidase I and the first nuclear internal transcribed spacer. The patterning of genetic variation among *Hyaella* populations is complex and indicative of historical roles for both vicariance and dispersal.

Session 5A: Evolution & Ecology

Is bigger always better? An investigation of egg quality and egg number in Plainfin Midshipman

Karen Cogliati, Sigal Balshine and *Michael Barone*
McMaster University

The Plainfin Midshipman (*Porichthys notatus*), from the Pacific Northwest is a well-studied marine species with which exhibits male alternative reproductive tactics. Although larger eggs may increase likelihood of survival, it may reduce the amount of eggs a female is able to produce. One of the advantages of studying plainfin midshipman is that it nests in rocky intertidal zones which are accessible at low tide. Photos of nests were taken with a digital during the 2010 and 2011 May to late-July breeding seasons in British Columbia and Washington. Using the software ImageJ, the size of individual egg diameter and egg area was taken, as was the entire clutch area. Clutch area, egg diameter, egg area and egg number were compared among several different and distinct ecological environments where pressures such as density of conspecifics and predators, and number of high quality nests can impact egg quality. Variation in female egg size and clutch size will be explored. This research will provide further insight into the relationship between egg number and egg size, and increase our understanding of the effects of environment on egg quality.

Allometry and phenotypic variation of the baculum in the wolverine (*Gulo gulo*)

***Albrecht Schulte-Hostedde* and Markus Dyck**
Laurentian University

The genitalia are among the most variable of traits, and the mammalian baculum is of particular interest. The wolverine has a typical structurally-simple baculum except for a trifid tip, which is a unique feature of this species. Allometric patterns of the baculum have been of much recent interest, as some species have steep slopes, indicative of traits under sexual selection. Using baculum and body size, we tested whether the wolverine baculum has patterns of allometry and variation consistent with traits under sexual selection. Our results indicate that there is a strong age effect on wolverine baculum size, and that allometric slopes for all bacular features were shallow. In addition, patterns of variation indicated that the traits associated with the trifid tip were very high relative to other bacular and body traits, suggesting that either the trifid tip is condition dependent or selection on this trait is relaxed.

Ecological correlates of parental care in *Porichthys notatus*

***Amanda Pereira*, Karen Cogliati and Sigal Balshine**
McMaster University

Parental care is a widely spread phenomenon in the animal kingdom. Certain species of fish exhibit paternal care, whereby males show care for offspring. Guarding males typically incur a cost, in the form of decreased survival and mating opportunities. This might have lead to the evolution of alternative male types that avoid care by parasitic reproduction. Plainfin midshipman (*P. notatus*) are a well known example of this phenomenon. However, little is known about how parental care affects guarding males in this species. This study aims to document the costs of paternal care in these males using three measures. First, gut samples were analyzed to determine diet contents and fullness of gut. The second is overall body condition, which was calculated using body and liver masses. Thirdly, density of species found on the nests was analyzed to identify the extent of care by male midshipman. These findings add to the existing knowledge of paternal care and help quantify the costs of parental behaviour.

Non-indigenous species: Ecological bane or experiential learning opportunity?

***James Boudreau* and Chad Harvey**
McMaster University

Non-indigenous species are a highly studied area of ecology and are associated with significant environmental, ecological and financial impacts. Following the experiential approach to learning present in the McMaster Integrated Science program, a field-lab was designed to educate students enrolled in ISCI 1A24 about non-indigenous species. The field-lab has two main focuses: the invasive species garlic mustard and the buffering effects of a riparian ecosystem on human impacts. The field-lab location will be the riparian environment that separates Parking Lot M on the West side of the McMaster Campus from Ancaster Creek, which flows into Cootes Paradise. The field lab will span five years. In each year, a new class of students will monitor soil plots for the success rate of native plants versus garlic mustard, and will excavate and seed other plots with native Ontario plants. Students will be able to study the plots planted during previous years, and will plant plots for the year to follow. Soil and water salinity and pH will be monitored to investigate human impacts from the parking lot on the plant community. The results of these field-labs will be incorporated into a long-term study.

Potential mechanisms to maintain additive genetic variance in fitness in a red squirrel (*Tamiasciurus hudsonicus*) population

***Eryn S. McFarlane*, Jamieson C. Gorrell, David W. Coltman,
Murray M. Humphries, Stan Boutin and Andrew G. McAdam**
University of Guelph

A trait must both increase fitness and be heritable to evolve. However, theory has suggested that as fitness is under constant, strong directional selection, there should be no additive genetic variance available. Mechanisms, including balancing selection and mutation-selection balance, have been invoked to try and account for available additive genetic variance of fitness. We hypothesized that any additive genetic variance in fitness in a North American red squirrel population (*Tamiasciurus hudsonicus*) was maintained by either a) temporal fluctuations in selection and/or b) sexual antagonism. We predicted higher additive genetic variances when these categories were split (for example, higher male or female V_a when compared to total V_a) and negative genetic correlations between categories, indicative of trade offs. We estimated the additive genetic variance of sex-specific fitness and of fitness in different environments, as estimated genetic correlations between traits. We found no evidence of maintenance of additive genetic variance, as we generally found low levels of additive genetic variance in both separated categories and in the total population. We also found no evidence of negative genetic correlations between traits. Our future direction will be to look into maternal genetic variance in fitness, which may allow for microevolution in this system.

The invasive Round Goby, *Neogobius melanostomus*, a potential host for unionid species at risk

***Maude Tremblay*, Todd Morris and Josef Ackerman**
University of Guelph

Neogobius melanostomus is a threat to declining unionid mussel populations in Ontario, because it out-competes or preys on unionid's native fish hosts, is a molluscivore, and has recently invaded several species at risk (SAR) "hot spots". If *N. melanostomus* could serve as reproductive hosts for unionid glochidia (larvae), this may lead to a more complex interaction than anticipated. Laboratory experiments were conducted with four mussel SAR (*Epioblasma torulosa rangiana*, *E. triquetra*, *Villosa iris* and *Lampsillus fasciola*) and one common species (*Actinonaias ligamentina*). Specifically, infestation and metamorphosis rates on *N. melanostomus* were compared to those on known primary and marginal hosts of the aforementioned unionid species. Field studies were also conducted to examine body burden of encysted glochidia on *N. melanostomus* collected from areas of unionid occurrence. *E. triquetra*, *V. iris*, and *A. ligamentina* were observed to successfully infest and metamorphose on *N. melanostomus*, but rates were much lower than on their known hosts. Encysted glochidia were found on 0-87% of field *N. melanostomus* examined, depending on site. The results of this study have important

implications for understanding the potential impacts of *N. melanostomus* on unionid SAR and may suggest ways to mitigate the negative effects of their invasion.

Session 5B: Stress & Physiology

Consequences of intense stress: Are the maternal effects of high predator risk mediated by epigenetic changes in snowshoe hare offspring?

***Sophia Lavergne*, Patrick McGowan and Rudy Boonstra**
University of Toronto at Scarborough

The 8-10 year snowshoe hare (*Lepus americanus*) population cycle is caused by predation via both direct mortality and through indirect effects caused by chronic stress. Mothers experiencing high predation risk produce offspring that inherit an altered stress response that can have deleterious effects on their health and survival. We are investigating the role of epigenetic changes in this maternal programming as a potential mechanism by which maternal adversity influences offspring brain organization and the expression of different traits and behaviours. We have performed microarray hybridizations to compare gene expression patterns between wild-caught hares born in years of high versus low predation, and we will use this data to direct our future epigenetic analyses. To our knowledge this is the first study to investigate developmental programming of the fetus and neonate as a result of maternal adversity in a wild mammal species, and could represent a major advance in understanding the role that adversity at the individual level can play in shaping the dynamics of entire populations.

Persistent effects of prenatal stress on offspring physiology in wild red squirrels

***Amy Newman*, Ben Dantzer and Andrew McAdam**
University of Guelph

Stress and glucocorticoids have well-known and important effects on the development and function of the nervous system and the hypothalamic-pituitary-adrenal (HPA) axis. Laboratory studies indicate that prenatal stress and/or glucocorticoid treatment affect the brain, behaviour and HPA axis in adult offspring. However, it is not clear how natural prenatal stress in free-living wild organisms influences offspring development and the function of the HPA axis. Red squirrels (*Tamiasciurus hudsonicus*) are territorial and local conspecific density is positively related to fecal cortisol levels. We experimentally increased cortisol levels in pregnant, wild, red squirrels by increasing their perceived local density. We examined the effects of increased prenatal glucocorticoids on offspring growth rate, HPA axis sensitivity and glucocorticoid receptor (GR) expression in the hippocampus. Offspring born to stressed females grew faster and, as adults, had a reduced HPA axis sensitivity compared to offspring born to non-manipulated (control)

females. Interestingly, exposure to prenatal stress was related to an increase in GR expression for males and a decrease in GR expression for females. Understanding the mechanisms by which prenatal stress affects HPA axis development and function is critical as wild populations are being exposed to anthropogenic factors that may affect HPA function and influence fitness.

Effects of chronic corticosterone administration on vocal learning and vocal performance in adult black-capped chickadees (*Poecile atricapillus*)

***Jackie Day* and Scott MacDougall-Shackleton**
The University of Western Ontario

Chronically elevated corticosterone reduces the volume of HVC, a brain region that controls song learning and production, in adult songbirds. Thus, stress-induced corticosterone may affect vocal learning, vocal performance, or both. Effects of glucocorticoids on vocal learning and performance were tested in black-capped chickadees (*Poecile atricapillus*), a species for which HVC may control both year-round production of learned calls and song. Experimental birds were treated with corticosterone then introduced to flocks. Vocal learning was assessed by ability to converge on the fundamental frequency difference (FFD) of the chickadee call during flock formation. Corticosterone was re-administered, and birds were photostimulated, to assess vocal performance as the ability to produce stereotyped song. Call convergence was not apparent, regardless of treatment group. However, experimental birds' FFD changed more during flock formation than controls. Song stereotypy was not disrupted by corticosterone. Therefore, HVC may be more important for calls than song in black-capped chickadees.

Neuromuscular control of aerodynamic power output via changes in wingbeat kinematics in ruby-throated hummingbirds (*Archilochus colubris*)

***Sajeni Mahalingam* and Kenneth Welch**
University of Toronto at Scarborough

Hummingbirds have one of the highest wingbeat frequencies of any flying vertebrate, yet they are still able to modulate aerodynamic power output precisely. Hummingbirds are unique because simultaneous electromyogram (EMG) recordings of both major flight muscles (pectoralis: powering the downstroke; supracoracoideus: powering the upstroke) are simple; they consist of one to four spikes for each stroke. By examining how EMGs and wingbeat kinematics of hummingbirds change as aerodynamic power

requirements are altered, by the addition of weights or by varying the density of the air, we can better understand how aerodynamic power output is modulated via neuromuscular control. Results from load lifting trials in ruby-throated hummingbirds (*Archilochus colubris*) indicate that they increase aerodynamic power output by progressively increasing both wingbeat frequency and stroke amplitude, correlating with increases in number of spikes per wingbeat, spike amplitude, and rectified EMG area in the pectoralis muscle. This suggests that hummingbirds increase aerodynamic power output via progressive temporal and spatial recruitment of motor units. These results are in contrast to variation in wingbeat kinematics and EMG patterning in Anna's hummingbirds (*Calypte anna*) flown in comparable air densities, in which increases in lift performance was largely accomplished by increasing stroke amplitude alone, correlating with increases in spike amplitude. EMG patterns in the ruby-throated hummingbird pectoralis and supracoracoideus vary similarly as additional weights are added, suggesting the relative symmetry in lift production between half wingbeats is driven by similar recruitment patterns.

Flying high on sugar: Carbohydrate oxidation kinetics in the ruby-throated hummingbird (*Archilochus colubris*)

***Chris Chen* and Kenneth Welch**

University of Toronto at Scarborough

Powered flight is one of the most energetically expensive forms of locomotion for vertebrates. Use of non-invasive feeder-mask respirometric techniques in our lab (in which hummingbirds voluntarily “wear” a mask in order to reach a nectar reward inside) has revealed hovering hummingbirds to have one of the highest mass-specific metabolic rates of any vertebrate. Due to their nectarivorous diets, most of the calories they ingest come from monosaccharides (glucose and fructose) found in floral nectar. To examine the use of glucose and fructose, ¹³C enriched solutions of glucose and fructose were administered separately. ¹³C/¹²C ratios in expired CO₂ were measured via capture of exhaled breath samples using feeder-mask respirometry and subsequent mass spectrometric analysis. I found hovering ruby-throated hummingbirds initially oxidizing endogenous fatty acids, when fasted, to oxidizing exclusively exogenous glucose or fructose over a time period of 40 to 60 minutes. Furthermore, rate of nectar intake, fractional rate of isotope incorporation and time energy budgets were all higher in the fructose conditions than in the glucose conditions. Altogether these results support the notion that dietary sugars are a premium fuel for hovering hummingbirds but suggest there are inherent differences in how hummingbirds assimilate and metabolize fructose and glucose.

A bioinformatic analysis of the evolution of the macrophage scavenger receptors

***¹Fiona J. Whelan*, ²Brendan J. McConkey and ¹Dawn M.E. Bowdish**

¹McMaster University, ²University of Waterloo

Macrophages are specialized white blood cells which are defined based on their ability to phagocytose. Phagocytosis (“big eating”) is used as a method of host defense against invading particles which was originally used by amoebae to acquire food, but has since evolved into a mechanism used by multi-cellular eukaryotes to clear pathogens. The immune system, in which macrophages play a prominent role, is charged with the task of protecting a host against infection brought on by exposure to bacteria, viruses, and parasites. Expressed on the surface of macrophages are scavenger receptors, which are responsible for the recognition of pathogens and further inducing phagocytosis. The evolutionary relationships between the various scavenger receptors are undefined. Thus, we identified and annotated novel mRNA and amino acid sequences of these receptors in vertebrate genomes to determine the evolutionary relatedness of these molecules. We discovered that there is a distinct evolutionary relationship shared amongst all scavenger receptors. Specifically, we postulate four distinct gene duplication events that allowed for the diversification of protein structure and function of this family. The further characterization of the evolution of this family will provide insight as to how the scavenger receptors function as part of an organism’s immune system.

Poster Presentation Abstracts

(in numerical order, *presenter*)

1. Landscape genetics of the eastern hog-nosed snake (*Heterodon platirhinos*) in Ontario

***Amanda Xuereb* and Stephen Loughheed**
Queen's University

Habitat fragmentation may impose barriers to dispersal and gene flow ultimately affecting the genetic structure of populations of species. Reptiles are especially vulnerable to anthropogenic features such as roads as they attempt to cross them while searching for food and mates often with little success. We aim to investigate the effects of landscape features on the genetic structure of a threatened snake species in Ontario. The Eastern hog-nosed snake (*Heterodon platirhinos*) is one of the most mobile snakes in Ontario making them particularly susceptible to barriers imposed by a heterogeneous landscape. We have so far optimized PCR conditions for 13 microsatellite markers and successfully genotyped 110 individuals at these loci. Preliminary Bayesian analyses revealed 3 genetic clusters. We will also incorporate GIS-based spatial maps and perform minimum resistance analyses to determine the relative “cost” of movement through various habitat types on a heterogeneous landscape. At present, there are no genetic data on eastern hog-nosed snakes available to assess fine-scale population structure of the species and little is known about factors that impinge on dispersal and gene flow in this species. Results obtained from this project will allow management authorities to make informed decisions concerning the conservation of this species.

2. The rapid effects of the G protein-coupled estrogen receptor on social learning

***Chris Gabor*, Jennifer Lymer, James Saunders and Elena Choleris**
University of Guelph

Estrogens have been shown to play a role in social learning processes. G protein-coupled estrogen receptor (GPER/GPR30) is a novel, membrane bound, estrogen receptor (ER) capable of mediating rapid signaling events in response to estrogen. GPER is expressed in areas of the mouse brain important for learning and memory such as the hippocampus and forebrain. Previously, our lab has demonstrated that the social transmission of food preference in mice can be rapidly affected by 17- β estradiol. Furthermore, we have shown that social recognition can be improved rapidly with systemic treatment of G-1, the GPER agonist. Thus, we used ovariectomized CD1 female mice to investigate whether G-1, at 0, 1, 6, 10 or 30ug/kg, can affect the social

transmission of food preference on a rapid timescale. We also investigated whether the hippocampus mediates the rapid effects of GPER on social recognition by infusing G-1 directly into the hippocampus 40min before a social recognition test. Preliminary results show that GPER at 6 and 10ug/kg blocked the social transmission of food preference on a rapid time scale. Intrahippocampal administration of G-1 at 200nM slightly improved social recognition within 40min of treatment. These preliminary results suggest that GPER is involved in rapid estrogen-mediated social learning.

3. Changes in oxytocin and vasopressin following sexual and parental experience in Mongolian gerbils

***Anna Phan*, Virginia Roberts, R. Abadilla, Jessica A. Mong,
Elena Choleris and Mertice M. Clark**
University of Guelph

Mongolian gerbils (*Meriones unguiculatus*) are a monogamous species where both males and females contribute to raising their pups. The neuropeptides oxytocin (OT) and arginine vasopressin (AVP) are involved in a variety of sexually dimorphic social and parental behaviours in other rodent species. Therefore we investigated sex differences and the effect of sexual and parental experience in the expression of these neuropeptides. 19 experienced males (which had mated and raised pups), 36 virgin males and 6 female gerbils were tested for various social behaviors. Separate sections of brain tissue were immunostained for OT or AVP and analyzed using ImageJ. Sex differences: There were no sex differences in OT staining, but females had higher levels of AVP than males. Differences between virgin and experienced males: OT and AVP staining was higher in experienced males compared to virgin males. OT and AVP in the paraventricular nucleus correlated positively with the time experienced males spent with their pups and negatively with time spent with their mate in a preference test. This suggests that higher levels of AVP and OT in the Mongolian gerbil may mediate paternal behaviours but not mate bonding. Funded by NSERC.

4. Female fruit flies prefer foods occupied by conspecific larvae for oviposition

***Blake Anderson*, Zachary Durisko and Reuven Dukas**
McMaster University

Female fruit flies rely on a variety of cues when deciding where to best lay their eggs, such as their familiarity with a food source or the presence of aggregation pheromones. Recent research suggests that they may respond to social cues as well. Naïve females have been shown to copy the oviposition choices of conspecifics and even learn from these observations. In nature, different females may utilize the same egg-laying site across several days, and the presence of healthy conspecific larvae may play a role in

both indicating and maintaining the quality of the site. We examined whether females would prefer to oviposit on a site occupied by other larvae. We found that given the choice between two equal quality sources of food, females showed a significant preference for food dishes that were occupied by conspecific larvae. This aggregated oviposition likely increases the density of larvae upon a substrate, and may be associated with higher fitness despite increases in larval competition.

5. Assessing body size of human adult speakers through modal, whispered, and sinewave speech

***Kristin A. Taylor*, Katarzyna Pisanski and David R. Feinberg**
McMaster University

People often assume a lower pitched voice (lower fundamental frequency) belongs to a larger person. Although these assumptions are consistent, they are incorrect when age and sex are controlled. Past research has failed to suggest a significant correlation between fundamental frequency and body size; however, studies have illustrated significant correlations between formant frequencies and body size. The current experiment sought to explore whether participants could accurately assess speakers' body size through listening to vowel sounds in modal, whispered, and 3-formant-sinewave speech. Although it was predicted that participants would have the highest accuracy of body size assessment in whispered speech, where the presence of fundamental frequency is eliminated, results revealed participants were most accurate when listening to male modal speech. These findings suggest that fundamental frequency may help to provide a more important cue to body size than originally believed, leading to further implications for the perception of body size through vocal cues.

6. Video games and attractiveness: will playing competitively or cooperatively make me sexier? A correlational study examining the effects of game play and mating strategies on attractiveness

***Justin Michel*, Paul Fraccaro and David Feinberg**
McMaster University

We examined females' ($n = 8$) attractiveness ratings of their male video game partners after playing Wii Tennis competitively and cooperatively. In accordance to Trivers' (1972) theory of differential parental investment and mating strategies, women who preferred masculine faces and voices were hypothesized to be more attracted to their male co-participants after playing competitively, as females preferring short-term mates are likely to prefer a mate that is successful in a competitive setting. Likewise, females preferring feminine faces and voices were hypothesized to give higher attractiveness rating after playing cooperatively, as women preferring long-term mates are likely to prefer a male

that they can successfully cooperate with. Results were non-significant. Alternate theories are explored. Further research is warranted.

7. The role of striatal cholinergic neurons for social recognition in VACHT Knockout mice

***Daniel Palmer*, Elena Choleris and Boyer Winters**
University of Guelph

The present research is one component on a large behavioural battery being used to phenotype the behaviour a novel transgenic mouse model. Animals in this model have had expression of the Vesicular Acetylcholine Transporter (VACHT) protein altered in the striatum. Disruption of VACHT results in the inability for acetylcholine to enter synaptic vesicles which prevents its release. One aspect of the present research is to characterize these knockout animals on tasks assessing social behaviour. One such task, the social recognition paradigm, assesses the ability of an animal to discriminate a familiar conspecific from a novel intruder. Previous work has shown that the cholinergic system is being recruited for this task. Animals were given four sample phases of 5 minutes where they were exposed to two conspecifics. Between each phase was a fifteen minute delay. In the choice phase, one of the familiar conspecifics is replaced with a novel intruder. Results of this study will provide a better understanding of how the cholinergic system modulates social behaviours.

8. Does phenological assortative mating cause S-alleles to be structured by flowering time?

***Zoryana Gori* Jennifer Ison, Emily Austen and Arthur Weis**
University of Toronto

In plant populations, individuals tend to mate more often with other individuals who share a similar flowering time. Because flowering time is heritable, this phenological assortative mating may lead to increased mating amongst relatives. However, the genetic self-incompatibility (SI) system may hinder this process. The SI system recognizes related individuals and prevents fertilization of self or closely related pollen by halting pollen tube growth. The goal of my project is to determine whether phenological assortative mating causes temporal structuring of S-alleles. I used the annual plant, *Brassica rapa*, to test this hypotheses. This species expresses a heritable flowering time, temporal assortative mating, and a sporophytic incompatibility system. I reciprocally hand crossed plants flowering at three different time periods (early, mid, and late), and observed stigmas under a fluorescent scope to determine if the crosses were compatible. Preliminary analyses indicate that there are differences in the incompatibility rates between the different crossing treatments. Specifically, late flowering plants with

late flowering pollen donors were less compatible than late flowering plants crossed with early or mid flowering pollen donors. These results may provide insight into temporal structuring of S-alleles through phenological assortative mating, and if S-alleles reduce the strength of phenological assortative mating.

9. Local adaptation throughout the range of *C. rubella*

***Adriana Salcedo*, Emily Josephs and John Stinchcombe**
University of Toronto

10. Kin recognition response in *Cakile edentula* seedlings?

***Mudra Bhatt* and Susan Dudley**
McMaster University

Plants can detect the presence of neighbouring plants and exhibit competitive behaviour in order to acquire limited resources. The competitive behaviour displayed by plants differs among different plant species depending on the ecology of their environment. Recently, many studies have shown that plants can recognize the identity of their neighboring individuals. Having the ability to discriminate between kin and stranger (non-related) neighbours and exhibiting competitive traits only with non-related neighbours is highly beneficial for plants as it reduces the cost of competition. *Cakile edentula*, a highly selfing annual beach plant, has shown a kin recognition response in juvenile plants with lower root allocation in pairs of siblings in comparison to pairs of strangers. There is evidence that soluble chemicals exuded by plant roots are the basis of this kin recognition response. Hence, we explore if *C. edentula* seedlings also react in a manner similar to the juvenile plants by responding to the root secretions of related seedlings.

11. Behavioural and endocrine profile of naked mole-rats following social pairing

***Sklyer J. Mooney*, Matthew B. Lovern and Melissa M. Holmes**
University of Toronto at Mississauga

Naked mole-rats are eusocial mammals, living in large subterranean colonies where reproduction is restricted to a single dominant breeding female (the queen) and 1-3 breeding males. All other colony members are subordinate, non-reproductive, and obtain reproductive success by participating in co-operative breeding and colony maintenance. The queen maintains status by behavioural intimidation. Removing subordinates from their natal colony and pairing them with an opposite sex animal can result in new colonies but only approximately 50% of the time. Here we created four different groups:

opposite-sex pairs, same-sex pairs, gonadectomized opposite-sex pairs, and opposite-sex pairs where the male was vasectomized. We next performed behavioural scans both 3 months and 6 months following social manipulation. Notably, females, regardless of the sex or endocrine status of their partner, were more aggressive than males. However, this effect was driven by a subset of females, indicating individual differences in predisposition to aggression. Removal from the colony also results in an increase in gonadal steroid hormones in males (testosterone) and females (progesterone). By better understanding variability in behavioural and endocrine responses following removal from the natal colony, we hope to better predict which subordinate animals are likely to successfully establish new colonies.

12. Detecting family differences associated with resistance to the salmon louse (*Lepeophtheirus salmonis*) in Atlantic salmon

***C.M. Rochus*, K.P. Ang, KP, B.D. Glebe, S. Leadbeater, L.R. Schaeffer, J.J. Tosh and E. Boulding**
University of Guelph

Development of a strain of Atlantic salmon that is resistant to the salmon louse (*Lepeophtheirus salmonis*) would economically benefit the aquaculture industry. We investigated differences in *L. salmonis* resistance among 41 families of the St. John River aquacultural strain. Fifteen recent smolts per family were challenged by releasing 30 *L. salmonis* copepodids per fish into each of two tanks. Four days later we challenged them again by releasing 60 copepodids per fish. We euthanized and froze all fish four days after the second infection and then quantified the *L. salmonis* on individual fish. Counts per fish were analyzed using a general linear model with the factors: body weight (covariate), interaction of tank by time of quantification (3 subclasses), and family. Family and weight were highly significant and the least squares mean counts per family ranged from 8.42 to 22.1 ($p < 0.0001$). Differences among families could be an indication of additive genetic effects. . Additional families will be challenged to estimate breeding values for their parents and grandparents to be associated with their genotypes at 6000 SNP loci to detect QTL for *L. salmonis* resistance.

13. The effect of social experience on female mate preference and mating dynamics

***Hannah Tennant* and Tristan A.F. Long**
Wilfrid Laurier University

As female preference for mates is an important source of variation in individual reproductive success, and thus sexual selection, it is important to understand the causes of variation in female preferences and mating. This study aimed to investigate how females' preferences for different male phenotypes are influenced by their social

experience and mating history using the model organism *Drosophila melanogaster*. Female preference for large bodied vs. small bodied males was tested using mate choice confinement chambers for females in three different treatment groups: nonvirgin females, virgin females, or “sham-mated” females. Observations on male associations showed no differences in female preference for male body size between the treatments. In subsequent studies where males and females were allowed to freely interact, virgin females had a quicker latency to copulation than sham-mated females and nonvirgin females, but copulation duration was similar across the three treatments. This study has shed light on how social experience can affect female preferences and the plasticity that exists in female mate choice. Evaluation on whether male preference or female preference is the major factor in mate choice is presented. Studying genotype-environment interactions should lead to a better understanding of female mate choice dynamics and how it evolves.

14. Habitat influences on white-tailed deer behaviour at the University of Toronto Mississauga

***Teresa Didiano* and Christine Palermo**
University of Toronto at Mississauga

White-tailed deer are an integral part of the University of Toronto Mississauga (UTM) ecosystem. With an expanding student population and many changes in the built environment, the response of deer to UTM's growth, development, and habitat fragmentation is largely unknown. The aim of the study was to examine the variation of deer behaviour at three UTM campus sites in response to four factors: human activity, vegetation, weather, and species interaction. Three sites were chosen: a forest fragment surrounded by highly populated buildings and pathways; a semi-secluded field-forest; and a secluded field surrounded by dense forest. Each site was visited for forty minutes, three times a week, with site alternation occurring on a weekly basis. Data for the four factors was collected through field observations, surveys of vegetation diversity and abundance, and the UTM Meteorological Station. The sex, age, on-site duration, type of movement, and foraging, grooming, and social behaviour were recorded for each deer observed. Our results show that the number, sex, and social organization of deer varied at each site. The four factors had no effect on deer presence; however human activity, vegetation, and species interaction affected deer behaviour differently at the three sites.

15. Systematic spatial foraging patterns in Rufous hummingbirds (*Selasphorus rufus*)

***Christine Mishra*, Ida Bailey, Sue Healy and T. Andrew Hurly**
University of Lethbridge

We examined systematic spatial foraging patterns of wild Rufous hummingbirds visiting experimental flowers. All birds demonstrated preference for outer flowers on the experimental array, and most preferred particular areas of the array. Some birds exhibited patterns in their movement across the board - moving in a particular direction, or visiting near-by flowers next. Birds with strong spatial preferences revisited emptied flowers less often, suggesting a function for systematic foraging patterns. Such abilities may interfere with experimental attempts to assess simple preferences in choice tests.

16. Effect of habitat quality on benthic macroinvertebrate communities and colonization

***Sarah Steele*, Silvia D'Amelio and Don Jackson**
University of Toronto

Sustaining biodiversity has become an important consideration in current and future impacts on the environment, with restoration of cold water habitat developing as an important tool in the conservation of native aquatic biodiversity in Ontario. Biomonitoring surveys using benthic macroinvertebrate communities as indicators of ecosystem health were conducted in this study to assess the impact of restoration on community structuring in heavily altered streams. Ontario Benthic Biomonitoring Network (OBBN) protocol was used to collect benthic samples from three newly watered channels designed to improve cold water habitat. Conditions not only allowed for assessment of restoration methods, but for understanding successional patterns and rates of colonization events of benthic macroinvertebrates in temperate streams. Benthic communities from five test sites within the new channels were compared to reference conditions in their respective watersheds using species diversity and community similarity indices. Early results showed shifts toward less sensitive taxa within and downstream of the restoration site as compared to reference conditions. Greatest differences occurred during summer suggesting that community structure is influenced by several factors including hydrology and habitat quality. This bio-assessment approach can be used to predict and assess the effectiveness of restoration work in returning a community to a pre-disturbed state.

17. I (used to) hate R!

Shidan C. Murphy

Anyone who works with data can benefit from learning R, a powerful statistical, graphing and data manipulation software. Formerly an interesting hobby for scientists frustrated with the inflexibility of existing software, R is now being forced upon unwilling undergraduates everywhere and becoming the choice software for graduate students and beyond. Unfortunately, R is very hard to learn -- especially if you lack a local R-Guru in your lab that can show you the ropes. To fill the void between free but technical and difficult to understand help files and very expensive but authoritative reference books, I have created an interactive and online study guide to aid novice through intermediate users advance in R. This guide will be demonstrated.

18. Estrogens rapidly facilitate learning of a socially acquired food preference in female mice

***Kelsy Ervin*, Jeffrey Friesen, Nicola Gallagher, Veronique Roussel, Jonathan Zicherman, Amy Clipperton Allen, Anna Phan and Elena Choleris**
University of Guelph

The social transmission of food preferences (STFP) is an adaptive social learning in which an animal prefers a novel food using solely on olfactory cues provided through social interaction with a conspecific that has eaten that food, avoiding potential costs of trial-and-error individual learning. Estrogens modulate performance on this task, through activation of specific estrogen receptors (ERs). On a long-term scale, involving gene activation, ER-alpha agonists block and estradiol and ER-beta agonists improve performance on STFP. Estrogens can also affect social cognitive behaviour such as social recognition within minutes of treatment. We tested estrogenic effects on social learning on a similarly rapid time scale, by administering 17 beta-estradiol and specific ER-alpha and ER-beta agonists to female mice 15 minutes prior to brief social exposure to a recently fed conspecific. This paradigm examines effects of estrogens on learning with specific attention to the first hour of testing for possible rapid effects. 17 beta-estradiol rapidly facilitated learning, as did ER-beta, while ER-alpha had no effect. These results extend the rapid effects of estrogens to a social learning paradigm and shows that estrogenic effects on learning of socially acquired information can be much more rapid than previously thought.

19. Deer as drivers of ecosystem change: a look to the future

***Alexandra Djorjevic* and Paul Grogan**
Queen's University

The overabundance of white-tailed deer (*Odocoileus virginianus*) populations within North America has caused growing concern over the long-term consequences of their selective foraging. The direct effects of ungulate browsing are well documented at the plant species and population level, but extended research into how these changes are reflected at both the community and the whole systems scale is lacking. This latter perspective has become increasingly important in the past ten years as a growing body of evidence suggests that deer have the ability to destructively modify their forest habitats beyond the point of recovery, shifting their trajectory towards an alternate stable state. Ultimately these changes require decades to manifest, but identifying and understanding the factors that indicate that such a shift is likely to occur is essential. Using a five year old set of replicated exclosures, we aim to quantify not only the immediate effects of deer browsing on our mixed hardwood study site, but as well to identify the potential for changes in system parameters to generate feedback mechanisms that prevent the system from reverting to its original state even if deer are removed. Preliminary results indicate that the community is appreciably different after only five years; more importantly, it suggests that release from browsing pressure has not been enough to facilitate the regeneration of heavily browsed tree species. This has serious implications for forest management, and with future research I hope to identify the mechanisms through which deer can cause the initiation and persistence of alternate stable states.

20. Generosity as a costly signal: Female act- and context-specific preferences

***Sara Kafashan*, Pat Barclay and David Stanley**
University of Guelph

Females are expected to prefer qualities that maximize direct fitness benefits in a long-term mating context (e.g., resources, abilities, and cooperative intent), and indirect fitness benefits in a short-term mating context (e.g., abilities). Individuals can use generosity to signal underlying qualities, such as one's abilities, and/or resources, in addition to one's cooperative intent. The current research consisted of two studies that investigated female short-term and long-term mate preferences for acts that indicated abilities via generosity (Study 1), and resources via generosity (Study 2). Female university students ($n = 176$) were presented with vignettes that contained descriptions of individuals engaging in single acts that varied in the level of generosity and abilities (Study 1), and generosity and resources (Study 2). Participants rated the attractiveness of described individuals as short-term and long-term mates. We found evidence that generosity increased individuals' attractiveness in a short-term and long-term mating

context. Contrary to predictions, however, preferences for resources and abilities were similar across mating context.

21. A novel ancestor-descendent population approach to finding DNA markers for economically important traits to use in Atlantic salmon breeding programs

***¹Elizabeth G. Boulding*, ²Keng P. Ang, ²Allison Burton, ¹Leslie Damphousse, ²Jake A.K. Elliott, ³Matthew P. Kent, ³Sigbjørn Lien and ⁴Danielle Macdonald**

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Fisheries and Oceans Canada.

Selection for rapid growth rate and late sexual maturity in salmon is expected to cause heritable changes that can be observed at the DNA marker level. We searched for quantitative trait loci (QTLs) for growth and maturity by comparing DNA marker genotypes of wild founder populations with their aquacultural strain descendents. The ancestor population was reconstructed by genotyping 100 cultured-wild-exposed salmon from the Tobique River. The derived population comprised 434 aquacultural strain fish sampled from six different year classes of broodstock from a local commercial hatchery. We also sampled 100 adults from a non-ancestral cultured-wild population from the Stewiacke River in the inner Bay of Fundy to use as an outgroup. Each salmon was genotyped for 5,500 Single Nucleotide Polymorphisms (SNPs) using 6K V2 Illumina iSelect bead-arrays. SNP genotypes of the St. John aquacultural strain were very similar to those of its wild ancestral population ($F_{st} = 0.018$) but not to those of the non-ancestral wild Stewiacke population ($F_{st} = 0.091$). Thirty-six 'outlier' SNPs were more differentiated between the wild ancestral and aquacultural descendent populations than expected. Three outlier SNPs overlapped with the 50 outlier SNPs identified by comparing the aquacultural strain to the wild outgroup population supporting their proximity to important QTLs.

22. No population structure in *Littorina plena* (Gastropoda) around the coast of Vancouver Island, Canada, and the cross-species amplification of microsatellite primers in other *Littorina* species

***Melissa K. Holborn*, Madoka V. Krick, Stephanie L. Pedersen,
David A. G. A. Hunt and Elizabeth G. Boulding**
University of Guelph

Microsatellites are a powerful tool for estimating current population structure but designing, optimizing and screening primers is time-consuming and expensive. In this study microsatellite primers designed for the marine gastropod *Littorina plena* were tested for cross-species amplification in its sibling species *L. scutulata*, as well as in *L. subrotundata*, *L. saxatilis*, *L. obtusata*, *L. sitkana*, and *L. littorea*. Cross-species amplification was observed, but null alleles were present at two loci. Preliminary results show no significant differences in allele size frequencies for the four loci between *L. plena* and *L. scutulata*. We then used the four loci to test for metapopulation structure among four populations of *L. plena*, two from the east coast and two from the west coast of Vancouver Island, British Columbia, Canada. There was no statistically significant evidence of metapopulation structure ($F_{CT} = 0.01389$), indicating gene flow between the two coasts. This result supports the hypothesis that life history affects population connectivity because *L. plena* has floating egg capsules and free-swimming larvae that are planktonic for four to six weeks.

23. The role of hydrodynamics in determining the habitat selection of juvenile unionid mussels

***Sarah Glover* and Josef Ackerman**
University of Guelph

Several factors may determine habitat selection in juvenile unionid mussels between post-larval detachment from a fish host and burrowing into sediment. Bed shear stress, which has been proposed as a critical factor, was generated using a laboratory wall jet to assess the resuspension or burrowing of juvenile *Epioblasma triquetra*, *Ligumia nasuta*, and *Villosa iris*. The relationship between juvenile unionids and bed shear stress was also examined in the field in areas of high (stoss-side) and low (lee-side) bed shear stress measured around stream boulders. Similar and significant relationships were found among species and between the resuspension of the juvenile unionids and bed shear stress in the wall jet, respectively; resuspension occurred when bed shear stress > 0.26 Pa for mussels of shell height < 437 μm . Results from two field sites revealed that the number of sphaeriid clams (a proxy for juvenile unionids) was marginally significantly higher in areas of low bed shear stress. These results support the hypothesis that a critical bed shear stress exists, beyond which juvenile mussels may not be able to

establish themselves in river sediments. Hydrodynamics thus play an important role in unionid habitat selection and are relevant to the conservation of this imperiled taxon.

24. Role of absolute and relative male and female body size variation in *Drosophila melanogaster* mating behaviours

***Adam Lounsbury* and Tristan A.F. Long**
Wilfrid Laurier University

In many species, body size is a sexually dimorphic and phenotypic variation in this trait (and its correlates) is strongly correlated with individual reproductive success in one or both sexes. In *Drosophila melanogaster*, a model species for the study of sexual selection, previous studies have examined the role of variation in one sex on the behaviours and outcomes related to courtship and copulation, but there has been no research that has simultaneously ranked both male and female body size. In this project we experimentally paired flies from across the phenotypic spectrum of body sizes and quantified a number of traits: time to courtship initiation, intensity of courtship, length of courtship, incidence of successful courtship, and copulation duration. The effect of both absolute and relative body size on these variables was analysed. This study reveals how the outcomes of interactions between the sexes often depend on the specific phenotype of both sexes.

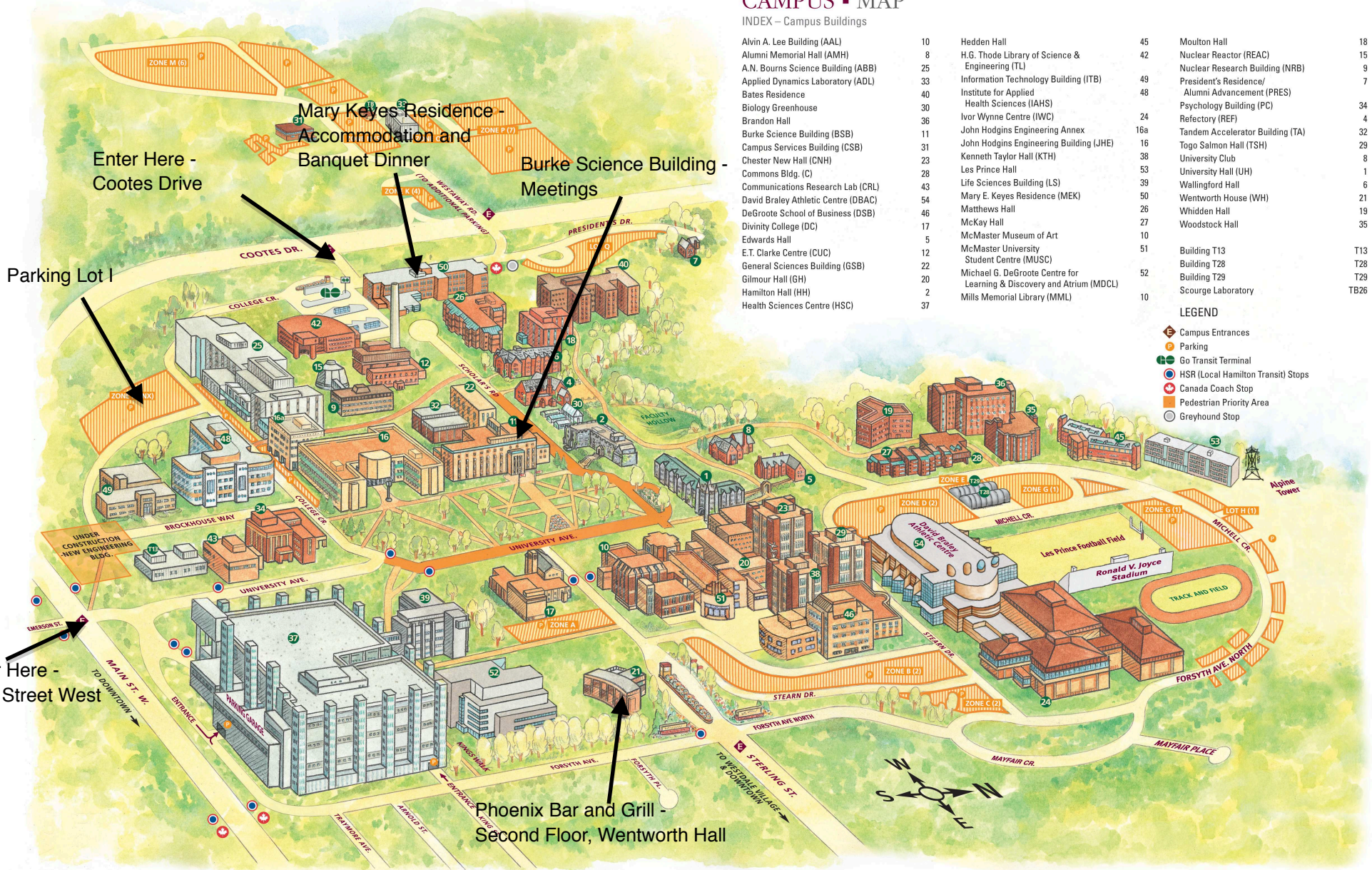
CAMPUS MAP

INDEX - Campus Buildings

Alvin A. Lee Building (AAL)	10	Headden Hall	45	Moulton Hall	18
Alumni Memorial Hall (AMH)	8	H.G. Thode Library of Science & Engineering (TL)	42	Nuclear Reactor (REAC)	15
A.N. Bourns Science Building (ABB)	25	Information Technology Building (ITB)	49	Nuclear Research Building (NRB)	9
Applied Dynamics Laboratory (ADL)	33	Institute for Applied Health Sciences (IAHS)	48	President's Residence/Alumni Advancement (PRES)	7
Bates Residence	40	Ivor Wynne Centre (IWC)	24	Psychology Building (PC)	34
Biology Greenhouse	30	John Hodgins Engineering Annex	16a	Refectory (REF)	4
Brandon Hall	36	John Hodgins Engineering Building (JHE)	16	Tandem Accelerator Building (TA)	32
Burke Science Building (BSB)	11	Kenneth Taylor Hall (KTH)	38	Togo Salmon Hall (TSH)	29
Campus Services Building (CSB)	31	Les Prince Hall	53	University Club	8
Chester New Hall (CNH)	23	University Hall (UH)	1	Wallingford Hall	6
Commons Bldg. (C)	28	Life Sciences Building (LS)	39	Wentworth House (WH)	21
Communications Research Lab (CRL)	43	Mary E. Keyes Residence (MEK)	50	Whidden Hall	19
David Braley Athletic Centre (DBAC)	54	Matthews Hall	26	Woodstock Hall	35
DeGroote School of Business (DSB)	46	McKay Hall	27		
Divinity College (DC)	17	McMaster Museum of Art	10		
Edwards Hall	5	McMaster University Student Centre (MUSC)	51	Building T13	T13
E.T. Clarke Centre (CUC)	12	Michael G. DeGroote Centre for Learning & Discovery and Atrium (MDCL)	52	Building T28	T28
General Sciences Building (GSB)	22	Mills Memorial Library (MML)	10	Building T29	T29
Gilmour Hall (GH)	20			Scourge Laboratory	TB26
Hamilton Hall (HH)	2				
Health Sciences Centre (HSC)	37				

LEGEND

- Campus Entrances
- Parking
- Go Transit Terminal
- HSR (Local Hamilton Transit) Stops
- Canada Coach Stop
- Pedestrian Priority Area
- Greyhound Stop



Sept-07 (PR)