May 6 – 8th 2011

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CONTENTS

Biological Sciences
UNIVERSITY OF TORONTO
SCARBOROUGH

Dear conference attendees:

Welcome to the University of Toronto Scarborough (UTSC) and the Department of Biological Sciences. The interests and expertise of our faculty ranges the full breadth of biology, from the molecular and cellular details of development or disease to the ecology of populations and biodiversity of ecosystems. Our faculty currently supervise approximately 65 graduate students, both M.Sc. and Ph.D. candidates, as well as being a centre for postdoctoral and research associate training and supervision. Individuals from our faculty are also members of several University of Toronto tri-campus graduate programs and maintain a tri-campus network of resources and expertise to draw upon.

The research, teaching and administrative facilities of the department are housed in the architecturally-renown *Andrews* S-wing as well as the new Science Research Building opened in 2008. Both these buildings reside directly along the picturesque Highland Creek Valley that is a beautiful and dominant feature of the campus' park-like environment.

I wish you the best for this weekend's OE3C conference and hope that you have an interesting and productive visit to UTSC.

Greg C. Vanlerberghe
Professor and Chair
Biological Sciences

THE ORGANIZING COMMITTEE

There were many challenges along the way to organize the 2011 OE3C, but with the wonderful dedication and hard work from the volunteers we were able to organize a conference we are all proud of. We obviously could not have done it without them. Thank you.

Janice Ting & Tiffany Schriever
Co-chairs, OE3C 2011 Organizing Committee

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SPONSORS

Without the support from our sponsors, this year's OE3C would not have been possible. The financial donations allowed us to hold the conference at UTSC, reduce the registration costs, and to subsidize the travel costs of the plenary lecturers.

Thank you to all of our supporters for their generosity,

The OE3C 2011 Organizing Committee

Financial

UTSC Office of the Vice-Principal, Research
UTSC Biological Sciences Department
UTSC Office of the Vice-Dean, Graduate Education and Program Development
UofT Ecology and Evolutionary Biology Department
UTSC Department of Physical and Environmental Sciences
UTM Biology Department
UTSC Council on Student Services Student Enhancement Fund
UTSC Graduate Student Association at Scarborough (GSAS)
UofT Ecology & Evolutionary Biology Graduate Students Association (EGSA)
OEEC 2010 at Laurentian University

Prizes

General INFORMATION

Registration

Fri, May 6: Registration at Social Mixer,
Fossil & Haggis Pub, 5 - 9pm

Sat, May 7: SY110 Foyer, 7:30 - 9am
Management Foyer, 10 am - 5pm

Sun, May 8: SY110 Foyer, 7:30 - 9am
Management Foyer, 10am – 2:15pm

Registration fees include the conference program, breakfasts, lunches, coffee breaks, and three drink tickets for use during the poster session and banquet.

Please be sure to bring your own water bottle, pen, and notebook.
Complimentary reusable mugs will be included in your registration package.

Please support our efforts to make this conference as green as possible.

Notice to Session Moderators

Please report to the designated room a few minutes prior to the start of the session. Use this time to confirm that the speakers are present. Since there are multiple concurrent sessions it is very important that we adhere to the scheduled times. Speakers are allotted 15 min in total. Please signal the speakers at 10 min, and at 11 min. At 14 min please ask the speaker to leave the podium.

Notice to Oral Presenters

Please hand in your presentation on USB or CD when you register. This will be returned to you. We recommend that you bring a backup CD of your presentation. Presentations must be compatible with Microsoft Office 2007. Please verify your presentation on this platform (especially Mac users) using a different computer than the one that you burned it on. Please use your last name as the file name for your talk (e.g. Darwin.ppt).

Please report to the room where you will be speaking 15 min prior to the start of your session. Each speaker will be allotted 15 min (12 min talk + 3 min questions). You will be asked to leave the podium if you exceed this time limit. You will not be permitted to use your own computer. Slide and overhead projectors will not be available.

Notice to Poster Presenters

You may put up your posters anytime on May 7th and ideally have it up prior to the start of the poster session. You are only required to stand by your poster during the poster session that will be held on Saturday, May 7 from 5:30-7:00pm in the Management building foyer. Poster boards are 1 m x 1 m. Please only use the velcro tape that will be provided.

Computer Access

Wireless internet will be available during the conference; we will provide guests with wireless access information during the weekend. The library will unfortunately be closed during the conference.

T-Shirts

T-shirts ordered on the web prior to the conference will be available at the OE3C registration desk. There will be a limited number of t-shirts available for purchase for $15.

Parking

After 4:30pm weekdays and all day weekends, parking for visitors is available in Inner Lots Pa, Pb, Pc, Pd with payment at meters required. Outer Lots P3, P4, or P5 are also available (P4 and P5 entrance gates accept coins only, P3 accepts coins or credit cards). Parking costs $2 to $5 a day. Please see the map at the end of the program for the location of the lots.

Meals

Breakfasts will be provided consisting of various baked goods such as bagels, muffins, and breads in the SY110 foyer. Lunches will be provided on Saturday, May 7 and Sunday, May 8 and held in the H-wing cafeteria (HW305). All coffee breaks will take place inside Management building. The banquet will take place in the H-wing cafeteria (HW305). Vegetarian options will be available during coffee breaks, lunches, and the banquet.

During the weekend on campus food services are limited to vending machines. These are located throughout the campus.

Banquet dinner

The banquet will be held in H-wing upper level dining room on Saturday May 7th at 7pm following the poster session. Drinks will be available for purchase or you may use one of your complimentary drink tickets.

Prize Draw

This will take place during the closing remarks on May 8. There will be an opportunity to see the prizes during the dinner.

Local Restaurants

Scarborough boasts a wide variety of ethnic restaurants within a 10 min drive from the UTSC campus. Highland Fish and Chips (3357 Ellesmere Road), Fratelli Pizza (384 Old Kingston Road), Sugarbuds Village Bakery and Cafe (360 Old Kingston Road), Shamrock burgers & Fish & Chips (6109 Kingston Road), Amigos (6091 Kingston Rd) and others are within a 10-15 min. walking distance.

On-Campus Housing

You will be staying in **Joan Foley Hall** (see map on back of program or on OEEC website). Please check in at the **Residence Centre**. Each unit consists of four lockable bedrooms. When you check in at the Residence Centre, your parking pass will be provided. You may check in at any time.

Nature Walks

The UTSC campus is fortunately located near the beautiful Morningside and Colonel Danforth Parks which contains a number of walking trails and Highland creek. Access to Morningside Park is available at the Morningside Ave. or via the walking trail leading down from the H-wing. It is not uncommon to see deer, foxes and various other wildlife near the campus.

Emergency

911:	911
Campus Police:	416-287-7398
Campus Police Emergency:	416-287-7333
Scarborough Police:	416-883-6361

MEETING SCHEDULE

Time	Fri May 6, 2011	Sat May 7, 2011	Sun May 8, 2011
7:30 AM		7:30am Registration SY110 foyer	
8:00 AM		**Breakfast**	**Breakfast**
8:30 AM		SY110 foyer 8:00-8:45am	SY110 foyer 8:00-9am
9:00 AM		Welcome & Plenary #1: **Philip Gingerich**	Plenary #3: **Antónia Monteiro**
9:30 AM		SY110 8:45-10am	SY110 9-10am
10:00 AM		Coffee break: Management foyer 10-10:30am	Coffee break: Management foyer 10-10:30am
10:30 AM		**Sessions 1A, 1B, 1C**	**Sessions 4A, 4B**
11:00 AM		MW140, 160, 170	MW160, 170
11:30 AM		10:30-noon	10:30-noon
12:00 PM		**Lunch**	**Lunch**
12:30 PM		HW305 12-1pm	HW305 12-1pm
1:00 PM		Plenary #2: **Bridget Stutchbury**	Plenary #4: **Darryl Gwynne**
1:30 PM		SY110 1-2pm	SY110 1-2pm
2:00 PM		Coffee break: Management foyer 2-2:15pm	Coffee break: Management foyer 2-2:15pm
2:30 PM		**Sessions 2A, 2B, 2C**	**Sessions 5A, 5B**
3:00 PM		MW140, 160, 170 - 2:15-3:30	MW160, 170
3:30 PM		Coffee break: Management foyer 3:30-3:45	2:15-3:45pm
4:00 PM		**Sessions 3A, 3B**	**Closing remarks/prizes** MW 170 - 3:45 - 4:15pm
4:30 PM		MW160, 170 - 3:45-5pm	
5:00 PM		break	
5:30 PM	5pm-9pm	**Poster Session**	
6:00 PM	**Registration & Social**	Management Atrium	
6:30 PM	**Fossil & Haggis**	(5:30-7pm)	
7:00 PM	790 Military Trail		
7:30 PM	Scarborough, ON	**Dinner**	
8:00 PM	M1E 4P7	HW305	
8:30 PM		(7:00pm -)	
9:00 PM			
9:30 PM			
10:00 PM			
10:30 PM			
11:00 PM			

ORAL PRESENTATIONS

Saturday May 7, 2011: 10:30-noon

Session 1A	Plant biology	Room: MW 140	moderator: Caroline Tucker
10:30	First report of seed parasitism on common reed (Phragmites australis) by insects Jordan Ahee	Trent University	
10:45	Maintenance of an Ecologically Significant Polymorphism in the Coastal Dune Plant Camissoniopsis cheiranthifolia Danielle Denley	Queen's University	
11:00	Experimental tests of pollen theft: an under-appreciated feature of plant-animal interactions Anna Hargreaves	Queen's University	
11:15	Population-genetic analysis of extreme mating system differentiation in a costal dune plant. Adriana Lopez	Queen's University	
11:30	Gene level resource trade-offs between sexual and vegetative reproduction in Sagittaria latifolia, a clonal aquatic plant. Wendy Van Drunen	Trent University	
11:45	The functional relationship between herkogamy and seed production in the Red Columbine - a phenotypic selection approach to estimating reproductive assurance Andy Wong	Queen's University	

Session 1B	Paleobiology	Room: MW 160	moderators: Kirstin Brink/Nicolas Campione
10:30	A juvenile sphenacodontid with implications for ontogeny and evolutionary history of non-mammalian synapsids Kirstin Brink	University of Toronto Mississauga	
10:45	Comparison of Missing Data Estimation Techniques in Morphometric Analyses: A Case Study for Quantitative Palaeobiology Caleb Brown	University of Toronto	
11:00	Interspecific limb scaling in non-avian amniotes and the estimation of body mass in extinct terrestrial vertebrates Nicolas Campione	University of Toronto	
11:15	Cranial anatomy and the evolution of skull elongation in Ophiacodontidae (Synapsida) Jessica Hawthorn	University of Toronto Mississauga	
11:30	Theropods through time: Identifying speices turnover in small Theropod dinosaurs Derek Larson	University of Toronto	
11:45	A new problematic taxon from the Burgess Shale Lorna O'Brien	University of Toronto	

Session 1C	Mating behaviour	Room: MW 170	moderator: Maydianne Andrade
10:30	Female-controlled timing of remating alters paternity & costs of polyandry Maydianne Andrade	University of Toronto Scarborough	
10:45	Teneral matings in fruit flies: Male coercion and female response. Corrine Seeley	McMaster University	
11:00	Lolita's web: juvenile female matings in the brown widow spider Iara Sandomirsky	Ben Gurion University of the Negev	
11:15	Who's Your Daddy? Paternity Analyses in Plainfin Midshipman Fish Karen Cogliati	McMaster University	
11:30	Reproductive Skew, Natal Philopatry, and Sexual Dimorphism in a Secondary Sexual Trait Cody Dey	McMaster University	
11:45	Pheromone-Based Assessment of Female Reproductive Value in Phidippus clarus Sanjiv Kandiah	University of Toronto Scarborough	

Saturday May 7, 2011: 2:15-3:15pm

Session 2A	Landscape Ecology	Room: MW 140	moderator: Tiffany Schriever
2:15	Spatial variability in granivory determines the strength of stochastic community assembly Rachel Germain University of Toronto		
2:30	Quantifying size and shape of lakes: comparisons of approaches and implications of islands Jaewoo Kim University of Toronto		
2:45	Prescribed burning after clearcut harvesting in boreal forests does not emulate wildfire effects on post-disturbance plant communities Azim Mallik Lakehead University		
3:00	Previously undocumented male combat and territoriality in the Emei Moustache Toad (Leptobrachium boringii; Sichuan Province, China) Cameron Hudson University of Guelph		

Session 2B	Behavioural genetics	Room: MW 160	moderator: Saira Meese-Tamuri
2:15	The nature of epistasis between foraging gene and wupA gene and its role in the maintenance of the rover/sitter balanced polymorphism. Saira Meese-Tamuri University of Toronto Scarborough		
2:30	Plasticity of Drosophila larval learning ability based on early-life environment Zachary Durisko McMaster University		
2:45	A genetic link between foraging strategy and dispersal Allan Edelsparre University of Toronto Scarborough		
3:00	Genetics and nature of condition dependence in a multi-component sexual display. Matthieu Delcourt University of Ottawa		

Session 2C	Communication	Room: MW 170	moderator: Norman Lee
2:15	Molecular phylogenetics of the Neotropical electric knifefish genus Gymnotus (Gymnotidae, Teleostei): Biogeography and signal evolution of the trans-Andean species Kristen Brochu University of Toronto		
2:30	The role of temporal characteristics in song recognition as measured through phonotaxis in the parasitoid fly, Ormia ochracea Dean Koucoulas University of Toronto Scarborough		
2:45	Acoustic communication in a bark beetle, Ips pini (Say) (Coleoptera: Scolytinae) Senthurran Sivalinghem Carleton University		
3:00	Selective Attention by Noise Avoidance in the Acoustic Parasitoid Fly Ormia ochracea Norman Lee University of Toronto Scarborough		

Saturday May 7, 2011: 3:45-5:00pm

Session 3A	Invasion Biology	Room: MW 160	moderator: Ilona Naujokaitis-Lewis
3:45	The influence of the proportion of introduced species on the organization of forest communities		
	Ashley Clingen	Algoma University	
4:00	Simulated herbivory reduces seed production in Vincetoxicum rossicum: implications for the biological control of an exotic invasive plant		
	Laura Doubleday	Queen's University	
4:15	Biotic interactions at invader's range limits		
	Dasvinder Kambo	University of Toronto	
4:30	Ecological Differentiation and Hybridization between Typha spp. in the Peterborough Ontario Area		
	Andrew McKenzie-Gopsill	Trent University	
4:45	Population demographics of Giant Hogweed (Heracleum mantegazzianum) in southern Ontario.		
	David Staples	York University	

Session 3B	Physiology	Room: MW 170	moderator: Chris Chen
3:45	Measuring Metabolic Fuel Use and Metabolic Rate During Flight in Archilochus colubris		
	Chris Chen	University of Toronto	
4:00	Aquatic Rockets: Variation in anti-predator jetting performance in larval dragonflies (Odonata: Anisoptera)		
	Morgan Edwards	University of Guelph	
4:15	Variation within and Selection on the Honey Bee Immune System		
	Brock Harpur	York University	
4:30	Neuromuscular Control of Hummingbird Flight Kinematics		
	Sajeni Mahalingam	University of Toronto Scarborough	
4:45	Does sex, weight, temperature, and feeding affect respiratory motor output from the in vitro brainstem-spinal cord preparation of the Cane Toad?		
	Andrew Peters	University of Toronto Scarborough	

Sunday May 8, 2011: 10:30-noon

Session 4A	Conservation	Room: MW 160	moderator: Tiffany Schriever
10:30	Down to the ground: attracting Double-crested Cormorants to nest in deforested areas at Tommy Thompson Park, Lake Ontario, Canada		
	Ilona Feldmann	York University	
10:45	Evaluating the success of outplanting hatchery-raised larval and juvenile Northern Abalone (Haliotis kamtschatkana) using microsatellite markers		
	Kaitlyn Read	University of Guelph	
11:00	European fire ants at Tommy Thompson Park: Abundance, distribution and impact on native ant biodiversity		
	Kristi Rudmik	York University	
11:15	Human-disturbance and caterpillars in managed forest fragments.		
	Peter White	McGill University	
11:30	A health assessment of Acacia xanthophloea woodlands in Lake Naivasha, Kenya.		
	Rachel White	University of Western Ontario	
11:45	Factors affecting Canada Goose (Branta canadensis interior) nest defence behaviour on Akimiski Island, Nunavut		
	Valerie Miller	Trent University	

Sunday May 8, 2011: 10:30-noon

Session 4B	Behaviour	Room: MW 170	moderator: Lucia Kwan
10:30	Fear kills: anti-predator behaviour reduces the number of offspring songbirds produce per year Marek Allen University of Western Ontario		
10:45	Larval dragonfly predation selects for more efficient lamellar autotomy in Enallagma and Lestes damselfly larvae Aneesh Bose University of Guelph		
11:00	Does disruptive coloration hinder object classification Richard Webster Carleton University		
11:15	Sex differences in group joining decisions in social fish Adam Reddon McMaster University		
11:30	Foraging Habits of Southern Flying Squirrels (Glaucomys volans) Meghan Murrant Trent University		
11:45	How do subtle cues of social presence influence human cooperation? Adam Sparks University of Guelph		

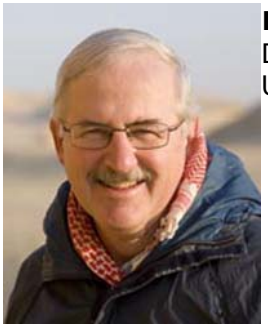
Sunday May 8, 2011: 2:15-3:45pm

Session 5A	Molecular evolution	Room: MW 160	moderator: Kristen Brochu
2:15	Are predators eating away at genetic diversity in song sparrow populations? Michelle Bondy University of Western Ontario		
2:30	An Empirical Test of Adaptive Bet Hedging in Neurospora crassa Jeffrey (Jake) Graham Carleton University		
2:45	Molecular evolution and its genomic correlates in the honeybee Shermineh Minaei York University		
3:00	The effect of genetic quality on the mutation rate in Drosophila melanogaster Nathaniel Sharp University of Toronto		
3:15	Condition-dependent usage of alternative double-strand DNA break repair pathways in Drosophila melanogaster Alethea Wang University of Toronto		
3:30	Adaptation and positive selection in rhodopsin: the dN/dS debate David Yu University of Toronto		

Session 5B	Development & life history	Room: MW 170	moderator: Aiswarya Baskaran
2:15	Fecundity selection drives developmental plasticity Aiswarya Baskaran University of Toronto Scarborough		
2:30	Variation in sperm load unrelated to male morphology or developmental challenges in black widow spiders Luciana Baruffaldi University of Toronto Scarborough		
2:45	Developmental environment affects risk-acceptance in the hissing cockroach, Gromphadorhina portentosa Sandeep Mishra University of Guelph		
3:00	Effect of temperature on development in the Australian Redback Spider Nizanthan Rathitharan University of Toronto Scarborough		
3:15	Temperature-Dependent Behaviours in the Nematode *C. briggsae* Gregory Stegeman University of Toronto		
3:30	The role of hydrodynamic habitat in the feeding ecology of freshwater mussels (Bivalvia: Unionidae) Julie Vanden Byllaardt University of Guelph		

PLENARY LECTURERS

We are very honoured to have four exceptional researchers at this year's OE3C. The plenary sessions are sponsored by **UTSC Office of the Vice-Principal, Research**.



Dr. Philip Gingerich
Departments of Geological Sciences, Biology, and Anthropology
University of Michigan

How Fast is Evolution?

Darwin thought evolution is slow. Evolution is slow on long time scales, but the fundamental process works on a generation-to-generation scale, not long time scales. Phenotypic variation is geometric normal, with normality reflecting its underlying polygenic source; ln transformation is part of the measurement process. The natural rate unit is the haldane, particularly H0, representing change in standard deviations per generation on a timescale of one generation. When appropriately sampled, rates calculated on longer scales can be projected to a generational timescale. Empirical studies are reviewed concerning: (a) rates of polygenic mutation, (b) rates of response to human versus natural disturbance; and (c) rates of change in a classic study of punctuated equilibrium. Rate studies commonly find phenotypic change on the order of H0 = 0.1 to 0.3 standard deviations per generation. This is fast by any standard. Darwin was wrong on rates, but more right than we knew on natural selection.

Dr. Darryl Gwynne
Department of Biology
University of Toronto Mississauga

Female Ornaments

Sexual selection on females is more widespread than previously thought and can be due to mechanisms such as mate choice by males. More rare are reversals in the mating roles: where mate choice by males co-occurs with direct sexual competition among females. Although sexual selection on females is widespread, examples of sexual dimorphism with sexually-selected female-specific ornaments or devices are rare compared to the ubiquity of male-specific ornamentation. I will focus on apparent female ornaments in insect systems in which males feed their mates. For a local species of dance fly I will discuss sexual selection and viability selection in the wild on some particularly elaborate ornaments displayed by females.

PLENARY LECTURERS

Dr. Antónia Monteiro
Department of Ecology and Evolutionary Biology
Yale University

The Origin, Evolution, and Function of Butterfly Eyespots

How does a complex visual signal, such as an eyespot, originate? And what selective factors lead to its maintenance and evolution? Complex gene networks underlie the development of complex morphologies and, thus, its is important to investigate the origin of these networks. I will present our lab's empirical framework for addressing the origin of complex novelties and illustrate them with examples surrounding the evolution of butterfly eyespots. In addition, I will show how butterfly eyespot number evolves at different rates on distinct surfaces of the wings of closely related species, and at different rates in males and females. I will relate this evolutionary pattern to the eyespots' role in natural and sexual selection. Finally, I will address how sexual monomorphism in eyespot number can result from developmental plasticity in the sexual roles of males and females.

Dr. Bridget Stutchbury
Department of Biology
York University

Frequent Fliers: New Discoveries in Bird Migration

Miniaturization of tracking technology has made it possible to track the start-to-finish migration of small songbirds for the first time. Since 2007, my lab has used light level archival "geolocators" to track two species of migrants, purple martins that over-winter in South America and wood thrushes that migrate to Central America. Both species exhibit very rapid spring migration, typically returning to their breeding site within 2-3 weeks of departure from the tropics. In wood thrushes, we have found a remarkably high level of breeding-wintering ground connectivity whereas purple martins breeding thousands of kilometers apart nevertheless use a similar wintering region. Migration schedules are highly flexible in wood thrushes and departure dates do not predict arrival dates, owing to prolonged stopovers especially in fall migration. My lab's research raises intriguing questions about plasticity in migration schedules and the extent to which climate change, and tropical deforestation, will impact migratory bird populations.

ORAL PRESENTATION ABSTRACTS

(Listed alphabetically by presenter*)

First Report of Seed Parasitism on Common Reed (*Phragmites australis*) by Insects

Jordan Ahee* and Marcel Dorken
Trent University

Because they are often host-specific, parasites have received considerable attention in recent decades for their utility in the control of invasive plants. We report for the first time two parasitic insects that attack the seeds of common reed (*Phragmites australis*) and evaluate associations between rates of seed parasitism with plant and stand characteristics (stand density, stand area, and average inflorescence mass per stand). The seed parasite is a gall midge (Cecidomyiidae: *Stenodiplosis sp*.), which is itself parasitized by a chalcid wasp (Eulophidae: *Aprostocetus sp.*). On average, 9.5% of ovaries sampled from 2400 flowers in 12 stands of *P. australis* around Peterborough, Ontario had been consumed by the midge (range = 0% - 50%). There was a negative association between inflorescence mass and the proportion of ovaries parasitized by the midge (GLMM: Wald's $Z = -3.77$, $P < 0.001$). There were no statistically significant associations between rates of parasitism per ovary and stand characteristics. Recent genetic evidence indicates that seedling recruitment is a key factor in the spread of invasive *P. australis*. Because up to 50% of seeds per site were consumed by the midge, these insects might play an important role in reducing the spread of *P. australis* in the study region.

Fear Kills: Anti-predator Behaviour Reduces the Number of Offspring Songbirds Produced per Year

Marek C. Allen*, Aija F. White, Liana Y. Zanette, and Michael Clinchy
University of Western Ontario

Though theory suggests that predator-induced changes in prey behaviour may affect prey demography there have been almost no experimental studies on birds examining all of the steps in the pathway from predation risk to behavioural responses to changes in demography. We tested the effects of predation risk on parental anti-predator behaviours and demography in song sparrows. We protected nests to eliminate predation events and manipulated perceived predation risk by broadcasting either predator- or non-threatening- calls and sounds, every few minutes, throughout the 130 day breeding season. Predator playback females built their nests in denser, thornier vegetation; were more skittish; and spent shorter on- and longer times off- the nest during incubation; and predator playback parents made fewer feeding visits per hour during brood-rearing. Greater skittishness, and shorter on- and longer off- bouts during incubation, were associated with poorer hatching success; and nesting in denser, thornier vegetation, greater skittishness, and fewer feeding visits, were associated with increased nestling mortality. The cumulative consequence being that predator playback parents fledged 40% fewer offspring over the breeding season.

Female-controlled timing of remating alters paternity & costs of polyandry

Jeffrey Stoltz and Maydianne C. B. Andrade*
University of Toronto Scarborough

Understanding the evolution of polyandry requires quantification of costs for females, and paternity of males with polyandrous mates. Such effects may depend on variation in female inter-mating intervals, but since many studies of polyandry are manipulative, natural remating intervals and their consquences are often unclear. Here we use the timing of production of sex pheromones by female redback spiders (*Latrodectus hasselti*) to create naturalistic remating intervals in the laboratory, then measure costs of polyandry and paternity. Female redbacks advertise their receptivity at adulthood, cease pheromone production immediately after mating, then re-advertise receptivity after several months. We paired once-mated females with a second male immediately or after a delay to mirror these 2 natural widows of receptivity. We show that polyandry reduces female longevity and reproductive output, but these costs are significantly less severe when remating is delayed. Moreover, whereas paternity is equal for males that mate within 24 hours, paternity of the second male increases to 70% if there is delayed remating. We suggest the female's timing of pheromone production minimizes costs of polyandry in nature. We discuss paternity patterns in terms of female tactics for producing diverse offspring, and male tactics for seeking reproductively valuable females.

Variation in sperm load unrelated to male morphology or developmental challenges in black widow spiders

Luciana Baruffaldi*, Maria Modanu, and Maydianne C. B. Andrade
University of Toronto Scarborough

Current theories predict that male body condition and the risk of sperm competition may be responsible for the evolution of ejaculate size. In this study we analyze the variation in the number of sperm produced by male *Latrodectus hesperus* spiders in relation to body size after experimental injuries that simulate developmental challenges that occur in nature during the male's last

molt. Males of varied body size were randomly split into 2 groups. In group A, we amputated one of the male's two copulatory organs (palps) the first day after the adult molt, while in group B we amputated one foreleg to compare the effect of losing a reproductive or non-reproductive appendage on sperm allocation. On the seventh day after maturity, males were sacrificed and their sperm counted to compare sperm load between groups and to determine any correlations between sperm number and male morphology. We did not find any significant relationship between sperm load and male morphological traits, nor differences in the amount of sperm carried by males from either group. Hence the variation in sperm observed in this species seems to be unrelated to male morphology and independent of the type of injury incurred during molting.

Fecundity Selection Drives Developmental Plasticity

Aiswarya Baskaran*, Maria Modanu, and Maydianne C. B. Andrade
University of Toronto Scarborough

Some organisms have the capacity to alter their development to produce a variety of phenotypes under different environmental conditions. In this study, we examine the developmental response of female redback spiders (*Latrodectus hasselti*) to variation in resource and mate availability. We predicted strong negative effects of diet on female development time and positive effects on body condition, as has been found in other invertebrates. We also predicted interactive effects with male availability since females reared in low male densities might shift resources to mate attraction at the expense of development or size. We measured the effect of two different diet and mate density treatments on female body size at maturity and development. Our results show that diet influenced development time and female body condition, with females in the high-diet treatment maturing faster and growing larger by maturity. Differences in mate density did not alter female development or body size. Comparison of our results to previous work on plasticity in male redback spiders suggests sexual dimorphism in the growth pattern of this species. Female developmental strategies may be primarily fecundity selected while male growth is determined by mate availability.

Are Predators Eating Away at Genetic Diversity in Song Sparrow Populations?

Michelle Bondy*, Liana Zanette, and Michael Clinchy
University of Western Ontario

Island populations are typically less genetically diverse than their mainland counterparts, primarily due to increased isolation leading to decreased dispersal. However, in the Gulf Islands of British Columbia, physical dispersal barriers alone are not able to explain the variation in genetic diversity amongst song sparrow (*Melospiza melodia*) populations. These island populations range from highly inbred to highly heterozygous, though they are only a few kilometres apart. We used 17 microsatellite loci to determine the genetic structure of the sparrow populations, and to test the hypothesis that patterns in genetic diversity may be driven by variation in predation pressure. We found that genetic structure exists at a relatively small scale (10 km or less). We also report the surprising result that Gulf Island sparrow populations are more genetically diverse than those inhabiting the Vancouver Island 'mainland' and find a relationship between genetic diversity and predation pressure. Lower heterozygosity on the mainland occurred despite clear evidence of immigration into these populations, which lends further support to the idea that ecological factors rather than physical barriers are at play. Our current focus is on determining the mechanism(s) that may be mediating this relationship between predation pressure and genetic diversity.

Larval dragonfly predation selects for more efficient lamellar autotomy in *Enallagma* and *Lestes* damselfly larvae

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Damselfly larvae possess three caudal lamellae that may autotomize when grasped by a predatory dragonfly larva. This study tested two hypotheses related to lamellar autotomy in damselfly larvae: (1) that predation by dragonfly larvae is largely responsible for incidences of lamellar loss (autotomy), and (2) that dragonfly predation selects for lamellae that are easier to autotomize. These hypotheses were tested by comparing traits among larval populations of *Enallagma* and *Lestes* damselflies. I used indirect estimations of pond predation-risk, via the frequency of lamellar regrowth. A positive association was found between lamellar regrowth frequencies and the proportion of dragonfly larvae within the Odonate population. Additionally, as risk of dragonfly predation increased, a decrease in the allometric growth of the lamellar joint diameter was observed at the across-genera level. The lamellar joints of *Lestes* were consistently wider than those of *Enallagma*. The decrease in the allometric growth rate of the joints in response to increasing dragonfly predation-risk was nearly significant in *Lestes* and insignificant in *Enallagma*. Lamellar autotomy in damselfly larvae may have evolved under selection imposed by dragonfly larva predation but it remains to be tested whether any within-genus variation in lamellar joint diameter reflects genetic change or plastic developmental responses.

A Juvenile Sphenacodontid with Implications for Ontogeny and Evolutionary History of Non-Mammalian Synapsids

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The first terrestrial apex predator to evolve, *Dimetrodon*, is also the most speciose and abundant sphenacodontid synapsid from the Early Permian, known from hundreds of specimens at varying growth stages. However, the ontogeny of sphenacodontids remains poorly understood and morphologic variation as a result of growth may confound the delineation of discrete characters useful for taxonomic and phylogenetic identification. Here, we describe a small skull and vertebral column of *Dimetrodon* and use it to examine potential ontogenetic patterns within Sphenacodontidae. Morphologically, the cranium is typically sphenacodontid, with a well-developed supracanine buttress and maxillary precaniniform step. Postcranially, the vertebrae possess elongate dorsal neural spines with ventrally keeled centra. Initial comparisons of this specimen to closely related taxa suggest that ontogeny-dependent characters include tooth counts and ratios of skull length to orbit width. Characters that are taxonomically informative include the shape and height of the neural spines and the morphology of the temporal region of the skull. This study illustrates the importance of recognizing that variation in proportions may be ontogenetic rather than taxonomic, and this distinction will be considered for future alpha-taxonomic and phylogenetic analyses of Sphenacodontidae.

Molecular phylogenetics of the Neotropical electric knifefish genus Gymnotus (Gymnotidae, Teleostei): Biogeography and signal evolution of the trans-Andean species.

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Gymnotus, the banded electric knifefish, is a diverse genus including species distributed both east (cis-Andean) and west (trans-Andean) of the Andes. Seven species of *Gymnotus* exhibit exclusively trans-Andean distributions; however, only one has been included in molecular studies. Each *Gymnotus* species exhibits a distinctive electric organ discharge (EOD), used for communication and navigation. The two trans-Andean species with a known EOD, *Gymnotus cylindricus* and *Gymnotus maculosus*, have monophasic (i.e. composed of a single phase) EODs. In contrast, adults of all but one of the 22 species of cis-Andean *Gymnotus* with known EODs, exhibit triphasic or tetraphasic EODs. We collected five trans-Andean *Gymnotus* species and recorded their EODs. We sequenced multiple nuclear and mitochondrial genes to incorporate these new taxa into a molecular phylogenetic hypothesis for *Gymnotus*. Our results suggest that the trans-Andean species are distributed in three separate clades, each with a cis-Andean sister group. We considered the evolution of EOD phase number in a phylogenetic context. Each trans-Andean clade exhibits reduced phase number relative to its cis-Andean sister group, with three trans-Andean species possessing monophasic signals. We provide hypotheses to account for the unusually high proportion of trans-Andean taxa with reductions in EOD phase number.

Comparison of Missing Data Estimation Techniques in Morphometric Analyses: A Case Study for Quantitative Palaeobiology

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Multivariate methods are widely used in palaeobiological analyses, but issues of small sample size and incomplete datasets inherent in the fossil record confound these methods, which require complete datasets. Missing data in extant datasets can be addressed by additional collection, or deletion of incomplete observations, approaches not practical for fossils. Analyses of fossil datasets must either estimate missing data or work around missing observation/variable pairs. When effects of missing data are tested, they input missing data randomly, a non-biological phenomenon. To test these effects, an extant crocodilian sample was measured and analyzed using principal components analysis. Multiple percentages of missing data were introduced into the dataset following three distributions (random, anatomic bias, and taxonomic bias), re-estimated, analyzed, and compared to the original result using Procrustes analysis. Simple substitution methods have a high error rates that increase linearly with missing data, whereas multivariate methods show low error rates and exponential or power functions. Taxonomically biased samples perform similar to random, but with higher error. Anatomical biases show greater deviation from random, more complex patterns, and high error for non-estimation methods. This study highlights estimation methods that input the least error, and illustrates that random missing data is not a good proxy for biological missing data.

Interspecific limb scaling in non-avian amniotes and the estimation of body mass in extinct terrestrial vertebrates

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Body mass is among the most important properties of an organism because it correlates with several biological variables. Body mass in extinct taxa cannot be measured directly and therefore biological insights can only be provided via estimation. Current estimation methods rely on volumetric reconstructions, based on numerous subjective interpretations. An alternate method uses scaling relationships of limb circumference to body mass in extant vertebrates. However, this method is criticized because limb proportions differ between vertebrates as a result of size, life-style, and limb posture. Given these proportional differences we test that: 1) the relationship of limb circumference to body mass will be distinct between major terrestrial vertebrate clades, and 2) differences in loading regimes as a result of limb posture will result in distinct relationships between limb circumference and mass. Our results, based on a sample of 202 mammals and 51 reptiles, indicate that scaling patterns of limb circumference with body mass do not significantly differ among mammals or between mammals and reptiles, despite major differences in limb proportions. This suggests that limb circumference might be constrained by body mass in quadrupedal terrestrial vertebrates, and is independent of other factors associated with lifestyle and limb posture. This measure likely provides a robust proxy to predict body mass in extinct taxa.

Measuring metabolic fuel use and metabolic rate during flight in *Archilochus colubris*

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Powered flight is one of the most energetically expensive forms of locomotion for vertebrates. However, the quantification of energy expenditure during flight is challenging due to the difficulty of effectively focusing equipment on a bird moving through air. 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 have one of the highest mass-specific metabolic rates of any vertebrate. This provides an opportunity to examine animal energetics on the extreme end of the performance spectrum. I will be adapting novel techniques to examine metabolic rate during hovering flight as well as examine the use of specific metabolic fuels during flight in the ruby-throated hummingbird, *Archilochus colubris*.

The influence of the proportion of introduced species on the organization of forest communities

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Introduced species can be new and strong competitors that reduce diversity by competitively excluding native species. However, they may also capture previously unused resources, adding to a community's species richness. Consequently, introduced species may alter organization, another element of community structure. Community organization was quantified using species co-occurrence patterns, specifically C-Score; an index of how checkerboarded a community's presence-absence matrix is. From a generated distribution of C-Scores possible by chance for each matrix, the standard effect size of the C-Score is determined. For 19 natural North American forest communities, the native status of each species was determined at the provincial or state level. All communities were found to be organized significantly more than expected by chance, however standard effect size was unaffected by changes in both the proportion and relative abundance of introduced species.

Who's Your Daddy? Paternity Analyses in Plainfin Midshipman Fish

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In many species, males may adopt alternative reproductive tactics: guarding and cuckolding. Guarding males invest more energy into courting females, defending nests, and providing paternal care. Cuckolder males steal fertilizations by simply releasing their sperm in the nest of a guarding male. These tactics are in the plainfin midshipman fish (*Porichthys notatus*); however, the reproductive success of each tactic is still unknown. The aim of our research was to quantify the overall reproductive success (using both egg counts and paternity assays) for guarding males in a population of plainfin midshipman from Southwestern British Columbia. We investigated how paternity rates in the field varied temporally and ecologically by collecting and genotyping fin tissues from the supposed dads and 20-50 putative offspring from 30 nests. In the lab, DNA was extracted from all the tissues, amplified and then paternity analyses conducted based on six microsatellite primers. Paternity rates for guarding males was relatively low early in the breeding season, but rates increased temporally. Also, larger males (attractive to females) had more egg numbers in their nest, but did not have significantly higher paternity rates. Our findings provide an important contribution for understanding the ultimate factors underlying alternative reproductive tactics in this species.

Genetics and Nature of Condition Dependence in a Multi-Component Sexual Display.

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The handicap theory predicts that males in better condition should signal their genetic quality to females through heightened condition-dependent expression of sexual ornaments. Despite the considerable number studies, very few have determined the genetic basis of condition-dependence. Furthermore, the interpretations are often complicated by the fact that selection acts rarely on traits in isolation and that the evolution of condition-dependence of a suite of trait depends on the amount of genetic variation in condition that lies in the direction of the multivariate female preference. In this study, using a paternal half-sib breeding design and a standard diet manipulation of male condition in a fruit fly, Drosophila serrata, we investigated the genetic basis of condition-dependence in contact pheromones (cuticular-hydrocarbons, CHC), a multi-component sexually selected trait. We detected a significant G×E interaction indicating that male condition varies genetically. In addition, we found that condition dependence increases with the strength of selection on CHCs and that the preferred combination of CHCs is highly condition-dependent. This has important evolutionary implications regarding the resolution of the lek paradox, the evolution of mate preference, the rate of adaptation into novel environments and the purge of genetic load.

Maintenance of an Ecologically Significant Polymorphism in the Coastal Dune Plant *Camissoniopsis cheiranthifolia*

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We exploited the exceptional genetic variation in a population of *Camissoniopsis cheiranthifolia* polymorphic for leaf trichomes to examine the relative importance of genetic drift and natural selection in maintaining this polymorphism. The frequency of alternate phenotypes was stable over a 5-year interval and within one growing season. Pubescent plants were significantly larger and reached reproductive maturity at a higher frequency than glabrous plants. However, the phenotypes that did reproduce did not differ in total flower or fruit production or fruit set. While plants tended to occur with higher than expected frequencies of like phenotypes, fitness did not correlate with the frequency of like phenotype among neighbours, as would be expected if the polymorphism was maintained by spatial heterogeneity in the relative fitness of alternate phenotypes. Moreover, the frequency of the glabrous phenotype did not correlate with local temperature across microsites. Stable phenotype frequencies suggests that drift is not responsible for the high frequency of glabrous plants in this population. However, we found no evidence for spatial variation in selection pressures maintaining this polymorphism. Instead it appears that pubescent individuals have higher average fitness, suggesting the polymorphism in this population is a transient phenomenon.

Reproductive Skew, Natal Philopatry, and Sexual Dimorphism in a Secondary Sexual Trait

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Despite a comprehensive understanding of secondary sexual traits in males, the mechanisms underlying elaborate trait evolution and maintenance in females remain elusive. Recent studies have suggested that degree of reproductive skew (i.e., reproductive sharing) can influence the intensity of intrasexual competition and select for female elaboration. However, high reproductive skew is often associated with natal philopatry, and long-standing associations between related females may decrease the importance of secondary sexual characteristics in determining reproductive success. Using two New Zealand populations of cooperatively breeding pukeko (*Porphyrio porphyrio melanotus*) that differ in the degree of female reproductive skew and philopatry, we test these competing hypotheses. Our results show that females have more elaborate ornaments, and that sexual dimorphism is decreased, under conditions of low reproductive skew. We discuss why reproductive skew may not provide an accurate estimator of the degree of intrasexual competition and highlight the importance of life-history in defining the evolution of female traits.

Simulated Herbivory Reduces Seed Production in *Vincetoxicum rossicum*: Implications for the Biological Control of an Exotic Invasive Plant

Laura Doubleday* and Naomi Cappuccino
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Vincetoxicum rossicum (Apocynaceae) is an exotic invasive perennial vine that is spreading rapidly throughout northeastern North America and threatening native plant communities and the animals that depend on them. While *V. rossicum* is known to have specialist insect herbivores in its native range, it has escaped herbivory in its introduced range. A biological control program is currently being developed to identify an insect agent that could be released in North America to control *V. rossicum*. To estimate the impact of different herbivore feeding guilds and damage levels on seed production, we simulated varying intensities of leaf and root herbivory on individual plants in naturally occurring populations of *V. rossicum* in its introduced range. Damage intensity had a greater impact on seed output than damage type, although root damage was slightly more effective than leaf damage. We consider the implications for biological control programs targeting this exotic invasive plant.

Plasticity of *Drosophila* Larval Learning Ability Based on Early-Life Environment

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The brain tissue required for learning may be metabolically expensive and in some environments may not be necessary or beneficial to an individual. In such cases, investing in increased learning ability can be considered a waste of resources, which may reduce fitness. For many species, brain tissue develops throughout early life, and environmental cues at early stages may indicate the likely later-life environment. Thus it would be adaptive to sense this early environment and adjust brain development and Aquatic Rockets: Variation in anti-predator jetting performance in larval dragonflies (Odonata: Anisoptera) the future cognitive phenotype accordingly. We tested whether *Drosophila* larvae modify their later-life learning ability depending on the degree of variation in their early-life food experience. Larvae were reared with identical nutrients, but in either an 'easy' environment, consisting of one large patch of one food flavour, or a 'difficult' environment, consisting of many small patches of different flavours and varying bitterness. All larvae developed normally and there were no differences in larval mortality across treatments. We found that larvae reared in a 'difficult' environment exhibited greater learning abilities than those reared in an 'easy' environment. This behavioural difference may reflect changes of investment in learning ability as the larvae use this early experience to adaptively inform their future cognitive phenotype.

A genetic link between foraging strategy and dispersal

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Populations often partition into short and long distance dispersers. Theoretical models suggest these differences may evolve from daily activities, such as sociability and foraging. We hypothesized that genes influencing foraging behaviour may also underlie dispersal. Using the fruit fly *Drosophila melanogaster*, we assessed adult dispersal in genotypes that display distinct polymorphic foraging strategies as larvae: "rovers" cover larger areas than "sitters" whilst foraging within and between patches. This polymorphism is largely attributed to allelic variation in foraging (for), which encodes a cGMP-dependent protein kinase (PKG). Rovers (forR) have higher levels of for-mRNA and PKG activity than sitters (fors). We marked and recaptured adult rovers and sitters in the field over four days and, concomitant with their foraging behaviour, rovers dispersed longer distances than sitters. The sitter mutant strain (fors2) is a rover carrying a mutation in for leading to sitter-like RNA expression, PKG activity, and behaviour. As expected, the dispersal tendency of fors2 flies was similar to sitters providing a direct implication of for. We offer a novel genetic association between foraging and dispersal that validates theoretical models and hypothesize a role of PKG as a molecular function underlying dispersal rates in populations.

Aquatic Rockets: Variation in anti-predator jetting performance in larval dragonflies (Odonata: Anisoptera)

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Although highly skilled and efficient hunters in their adult form, juvenile dragonflies are entirely aquatic and are often subject to heavy predation by fish. To avoid capture, they possess a means of escape entirely unique within the insects; jet propulsion. Despite this anti-predator function, neither the variation in jet ability nor its underlying causes are well studied. I used video analysis of sprints induced in the lab to quantify variation in various parameters of jetting performance. These included average and maximum velocity and acceleration in individual jets and averaged across three jets, as well as distance and time per jet. I illustrate up to 5-fold variation in jet performance and relate it to abdominal morphology and body size. I also discuss preliminary work examining the large-scale implications with respect to the fitness consequences of variation in this complex predator-avoidance trait.

Down to the ground: attracting Double-crested Cormorants to nest in deforested areas at Tommy Thompson Park, Lake Ontario, Canada

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The expansion of a double-crested cormorant (*Phalacrocorax auritus*) colony in Tommy Thompson Park (TTP), Toronto, has led to increasing concerns regarding deforestation from nesting activities. As a result, management was in urgent need of scientifically-based research to explore ways to establish a new ground-nesting colony with a ground-nesting colony already existing elsewhere in the park. In 2009 and 2010, I conducted a conspecific attraction experiment on cormorants to understand key features which attract them to nest on the ground, and ultimately to move cormorants within TTP from tree nesting to a ground-nesting site. For the experiment I used a randomized design consisting of plots with different densities of decoys and nesting substrates. While the cormorant visitation rate was higher in year two (2010, 1.10 ± 0.14 visits/hr; 2009, 0.63 ± 0.12 visits/hr; p=0.01), nesting was not observed. In both seasons, cormorants were more likely to visit tires than stakes (2009, tires=63%, stakes=37%; 2010, tires=70%, stakes=30%) and plots with low-decoy densities (2009, low density=39%, high density=35%, control=26%; 2010, low density=40%, high density=28%, control=32%). Understanding the proximate factors which attract cormorants to ground-nesting sites could assist in situations where culling is not possible, or desirable and provide alternative management solutions.

Spatial Variability in Granivory Determines the Strength of Stochastic Community Assembly

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High diversity in many biological communities is not well explained by trait-based deterministic models, in part because stochastic processes also influence community assembly. Testing how deterministic and stochastic processes combine to regulate diversity, however, has been limited by the spatial complexity of these interactions. Here, we demonstrate how spatial variability in the impacts of granivory results in fine-scale switching between deterministically and stochastically regulated plant community assembly in an otherwise environmentally homogeneous 18-hectare tallgrass prairie. In field edges where granivory is most intense, traits reducing seed palatability deterministically create homogeneous subsets of less palatable plant species (low α- and β-diversity). As granivory impacts decline in more open areas in association with perceived predator risk, assembly unfolds stochastically based on which species happen to land in a given location (high α- and β-diversity). The net effect across the study area is a heterogeneous and species-rich array of co-occurring species that includes a positive relationship between diversity and environmental suitability, which is explained by cryptic but predictable fine-scale differences in the strength of limiting factors.

An Empirical Test of Adaptive Bet Hedging in *Neurospora crassa*

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Under temporally varying environments, selection is expected to maximize the geometric-mean fitness over generations, which results in the evolution of "bet-hedging" traits such as dormancy. Empirical evidence has been circumstantial and limited to some insects and plants. In our study, we use the ascomycete, *Neurospora crassa*, as an ideal model system for an empirical test. Cohen's classic 1966 model of the evolution of dormancy is used to ask if selection maximizes the geometric-mean fitness. Populations derived from eleven parental strains were subjected to selection treatments differing in the degree of environmental variance. At the termination of the experiment, we found that dormancy increased with increasing frequency of "bad years," which is consistent with the predictions of Cohen's model. The results provide empirical evidence consistent with the geometric-mean principle, and highlight the need for further work on evolution in variable environments.

Experimental Tests of Pollen Theft: an Under-Appreciated Feature of Plant-Animal Interactions

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Pollen is unique among floral rewards in functioning as both a carrier of plant gametes and as an attractant and nutritious resource for potential pollinators. Floral visitors that collect pollen without pollinating (pollen thieves) could reduce siring success of thieved plants and cause pollen limitation of seed set at the population level; however, such impacts on plant reproduction have not been demonstrated experimentally. To test these effects we added hives of native honey bees to populations of a primarily bird-pollinated plant, *Aloe maculata*, in South Africa. In

field and aviary trials, bee addition increased pollen removal but decreased pollen deposition, reducing both male and female pollination components. Further, seed production decreased with hive addition in the aviary experiment and in three of four field populations, indicating that population-level pollen theft can also compromise reproductive success. Our results highlight the importance of social bees as pollen thieves, even for plants that have evolved in their presence, and suggest that pollen theft is a much more common influence on floral ecology and evolution than generally appreciated.

Variation within and Selection on the Honey Bee Immune System

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Invertebrates have an innate immune system, and unlike the adaptive immune system of vertebrates it does not make use of antibodies to target specific pathogens. Instead, the innate immune system—composed of the IMD pathway, the JAK/STAT pathway, and the Toll pathway—recognizes and responds to broad classes of pathogens. The pathways of invertebrate innate immunity are all highly conserved within and across insect taxa, with the potential exception of social insects. The honey bee, for example, has the three innate immune pathways but each is composed of substantially fewer genes relative to other insect taxa. This is surprising considering both that as a social species and as a species that has been transported globally, honey bees should face a greater pressure from pathogens than solitary species. The question then arises as to how honey bees respond and adapt to pathogens. Here, I explore the variation and search for signs of selection within the honey bee's Toll pathway.

Cranial Anatomy and the Evolution of Skull Elongation in Ophiacodontidae (Synapsida)

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Representatives of the synapsid family Ophiacodontidae comprise the earliest record of amniote diversification, and are known from the Middle Pennsylvanian to Early Permian of North America and Europe. An exquisitely preserved three-dimensional specimen of *Ophiacodon uniformis* (USNM PAL 487098) from the Lower Permian of Texas, the most complete known skull of *Ophiacodon*, allows for an improved, detailed description of cranial morphology aided by CT imaging. Increasing skull length relative to trunk length through time has been reported within Ophiacodontidae, with the latest and largest species having proportionally larger heads. Large heads are unusual among Palaeozoic amniotes; however, the apparent emergence of this highly atypical morphological feature has not previously been tested to determine if it is truly an evolutionary trend within the family, or merely a factor of increasing body size. The trend of antorbital skull elongation has also not previously been tested. Here, only specimens with measureable skull lengths and associated postcrania are used in the analyses. USNM PAL 487098 and a new small ophiacodontid from the Upper Pennsylvanian of Kansas provide important additional data points for this study. The results do not support the trends of increased relative skull length or antorbital elongation through time.

Previously Undocumented Male Combat and Territoriality in the Emei Moustache Toad (*Leptobrachium boringii*; Sichuan Province, China)

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Herein we present video and photographic evidence for previously undocumented cases of intense male combat during the breeding season of the Emei Moustache Toad (Sichuan Province, PRC). Males develop temporary keratinized nuptial spines on their upper lip which are used for the purpose of competing for nests. The breeding season is rapid (approximately 2 weeks) and there is a high rate of nest turnover with corresponding intense competition. Future work regarding multiple paternity and male parental care will also be discussed.

Biotic Interactions at Invader's Range Limits

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Latitudinal range limits of plant species potentially may be influenced by interactions with their natural enemies. For instance, if herbivores are scarce in marginal populations, performance of their host plants may benefit relative to core-range populations. In this study, we looked at populations of burdock, *Arctium minus*, at different latitudes, representing a gradient from core to marginal populations. We took samples of capitula and leaves to determine whether interactions with herbivores differed between sites. Results show that there is a higher amount of leaf damage by specialist herbivores in core populations. Core populations also had more holes and more chlorophyll stripped than marginal populations. Finally, core populations had more seeds destroyed by pre-dispersal seed predators compared to marginal populations. These results suggest that marginal populations may benefit from a partial release from their natural enemies.

Pheromone-Based Assessment of Female Reproductive Value in *Phidippus clarus*

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Numerous studies from the past have scrutinized the importance of female mate choice in the context of sexual selection, however relatively few studies have focused on male preference. In this study, we investigated male mate choice through a pheromone-based web assessment of female reproductive value in a jumping spider, *Phiddipus clarus*. We presented males with webs of female spiders and observed male seismic signaling and web contact duration. We predicted that males should show a preference for virgin females and an increased courtship activity towards larger females. Consistent with our predictions, our study suggests that males are inclined to choose virgin females as opposed to mated females and they made contact with those webs for a longer duration. However, males who invested in courtship through seismic signaling did not show a significant difference in the number of vibrations they produced based on the female mating status. This could have resulted because mated females are choosier and require intense courtship in this species. In addition, those males who vibrated to virgin web stimulus did not show a preference for larger females possibly due to size threshold effect or female body size may be assessed visually rather than through web-borne cues.

Quantifying Size and Shape of Lakes: Comparisons of Approaches and Implications of Islands

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Lake morphology is important for function and structure of community within lakes. It may influence primary and secondary productivity, mixing depth and surface-water temperature which are associated with thermal habitat, winterkill, and hypolimnetic suitability of a lake. To quantify lake morphology, studies relied on metrics such as surface area, mean depth, and shoreline development index. Given increasing interest in landscape ecology, our objectives were to (1) compare approaches used in limnology and landscape ecology to quantify size and shape of Ontario lakes, and (2) examine how islands within lakes influence comparisons of lake morphology. We selected a series of lakes varying shape complexity which we scaled to five size classes and compared morphological measures on these lakes using principal component analysis to classify the various measures into groups of metrics. Principal component analysis revealed that most underlying variation was summarized by the first two axes. Principal component 1 was strongly associated with size related indices, whereas principal component 2 was strongly associated with shape related indices. Moreover, incorporating island perimeter into lake morphology greatly influenced the relationship among indices of lake morphology. Our study suggests that approaches in landscape ecology may complement approaches in aquatic ecology and limnology.

The Role of Temporal Characteristics in Song Recognition as Measured Through Phonotaxis in the Parasitoid Fly, *Ormia ochracea*

Dean Koucoulas*, Norman Lee and Andrew C. Mason
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Reproductive success in *Ormia* depends on their ability to recognize and localize the calling song of suitable host crickets. The dominant frequency of the sound pulses within the call song of field crickets are generally at 5 kHz, and species-specific differences largely occur in the temporal organization of these sound pulses. Previous measurements of *Ormia* walking phonotaxis (movement in response to auditory stimuli) have demonstrated their accuracy in localizing synthetically produced songs modeled after *Gryllus rubens* (preferred host cricket), but have been incomplete in specifying what temporal organization of these pulses are necessary for recognition. I will discuss work in our lab that has described temporal features in the call song important to song recognition such that walking responses occur to pulse durations and interpulse interval combinations that make up a range of acceptable pulse rates. In addition, I will present early results that demonstrate *Ormia*'s ability to respond to changes in call temporal properties that occur during an ongoing bout of phonotaxis, and suggest future directions for elucidating the role of temporal cues in host song recognition and localization.

Theropods Through Time: Identifying Species Turnover in Small Theropod Dinosaurs

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Isolated teeth of small theropod dinosaurs are often abundant in vertebrate microfossil assemblages, with large sample sizes that make them ideal for palaeoecological studies. However, the taxonomic affinities of these teeth are often problematic due to the absence of associated diagnostic skeletal material. In morphological descriptions of theropod teeth, previous workers have referred specimens (often

separated by up to 18 million years) to taxa known from more complete skeletal remains found only in tightly constrained stratigraphic units. Here, we compared measurements of small theropod teeth from several North American formations ranging from 85.5 to 65.5 Ma in age using discriminant function analyses. The results indicate that teeth from formations of different ages previously referred to the same taxon are quantitatively distinct from each other. In contrast, similar isolated teeth from equivalently aged formations are indistinguishable. This method provides a means of assessing minimum small theropod diversity and faunal turnover in the absence of more diagnostic material. These results support the hypothesis that small theropod taxa, like other dinosaurs in these assemblages, change through time, with species having known stratigraphic ranges no longer than three million years. This illustrates the importance of time in dealing with diversity in the fossil record.

Selective Attention by Noise Avoidance in the Acoustic Parasitoid Fly Ormia ochracea

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Localizing sound sources of interest in noisy environments is a sensory challenge encountered by all organisms that depend on hearing for behavioural decisions. Reproduction in the acoustic parasitoid fly *Ormia ochracea* (Diptera: Tachinidae) requires successful localization of species-specific calling songs from singing field crickets that serve as hosts for the flies' developing larvae. Both song recognition and sound localization require that the auditory system precisely measure, and segregate temporal information that corresponds to individual sources and these tasks may be compromised by masking noise. In walking phonotaxis experiments with tethered females, we examined the ability of *O. ochracea* to detect and localize song in the presence of random noise at different signal-to-noise ratios (SNR) and when song and noise were spatially grouped or separated. Our results indicate no support for spatially-mediated release from masking in *O. ochracea*. Flies walked significantly less in the presence of noise. Greater SNR resulted in improved signal detection that modulated walking velocity to the cricket song and resulted in greater walking distances. Noise caused flies to divert walking responses away from noise source locations and thereby biased orientation to song sources. Responses were diverted even further with greater song and noise separation. Diverted walking responses were mainly attributed to changes in steering velocity that depended on the location of the noise source. Our results show a form of selective attention expressed as directional noise avoidance behaviour that may be a feature of hyperacute directional hearing in *Ormia ochracea*.

Population-Genetic Analysis of Extreme Mating System Differentiation in a Costal Dune Plant

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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 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 25 populations for variation at six 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.

Neuromuscular Control of Hummingbird Flight Kinematics

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Hummingbirds have the highest wingbeat frequencies of any flying vertebrate and they have to modulate mechanical power output via changes in neuromuscular control. A closer inspection of the neuromuscular control of hummingbird flight provides insight on mechanisms of power output modulation in locomotor muscles. Electromyogram recordings (EMGs) of the pectoralis muscle are interesting because some species of hummingbirds display EMGs that are simple and thus readily interpretable. The relationship between neuromuscular activation patterns and power output can be examined by challenging hummingbirds to hover under a range of conditions which demand variable aerodynamic power output while EMGs are recorded. Specifically, I will simultaneously characterize wingbeat kinematics, using high speed videography,

and obtain EMG recordings from the pectoralis and supracoracoideus of ruby-throated hummingbirds while hovering under each of the following conditions: 1) Variable density gas mixtures: ambient air, Argon-oxygen-air (hyperdense), and heliox-air (hypodense) mixtures. 2) Transient maximal load lifting. 3) Sustained, sub-maximal load lifting. Examining the relationship between neuromuscular control patterning and flight performance in hovering hummingbirds provides a powerful system in which to better understand limits to control of locomotion in motor systems producing large mechanical power at extremely high operating frequencies.

Prescribed Burning After Clearcut Harvesting in Boreal Forests Does Not Emulate Wildfire Effects on Post-Disturbance Plant Communities

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Prescribed burning (PB) is often suggested as a means to emulating natural disturbance after forest harvesting. Since boreal forests have evolved under natural fire regime we hypothesised that plant community originating after clearcut followed by PB would be more similar to that originating after wildfire than those formed after clearcut only. We determined species composition, species diversity and trait diversity in 18 clearcut, 17 clearcut + PB and 15 wildfire sites in NW Ontario aged between15-37 years. In total we surveyed 600 1 x 1 m plots. Using taxonomic and categorical trait data, we compared understory communities among the three post-disturbance forests. Contrary to our hypothesis we found that clearcut + PB formed communities less similar to those developed after wildfire and clearcut only, the latter two being similar. Clearcut + PB sites harboured more early successional species and were associated with seedbank, wind dispersed, deciduous and alien species than those in wildfire and clearcut sites, which showed no specific trait associations. Analysis of taxonomic and trait compositions of clearcut + PB sites exhibited the effects of compound disturbances as observed after short interval fires. We attribute this community divergence after clearcut + PB from wildfire and clearcutting to the compounding effects of multiple disturbances.

Ecological Differentiation and Hybridization between Typha spp. in the Peterborough Ontario Area

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Hybridization between invasive and native species has important implications for the maintenance of native lineages. Native cattails (*Typha latifolia*) in the Great Lakes region of North America form hybrids with the invasive cattail (*T. angustifolia*) forming the hybrid *T.* × *glauca*. A recent study has demonstrated that hybrids are fertile and backcross with the parental species. This and other studies have suggested that the parental species subdivide habitats by occupying sites with contrasting water depths, leading to the prediction that niche segregation contributes to the maintenance of *T. latifolia*. However, niche segregation in sympatric sites, and in particular sites that also include hybrids has not been demonstrated. A challenge to testing niche segregation between these phenotypically similar plants is in species assignment. We evaluated niche overlap between the two species and their hybrids by genotyping plants for species-specific alleles and measuring rooting elevations at sites containing all three groups. We found limited evidence for niche segregation between species. Moreover, our data strongly suggest that the hybrid occupies a limited range of elevations and may be competitively excluded by the parental species in sympatric sites, a finding that runs counter to previous inferences about the competitive ability of *T.* × *glauca*.

The nature of epistasis between foraging gene and wupA gene and its role in the maintenance of the rover/sitter balanced polymorphism.

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Continuous variation in quantitative traits account for much of the observable variation between individuals. Behaviour is an intriguing quantitative trait since it is the product of multiple genes and is regulated by a complex interplay between an organism's internal and external environment. In particular, foraging behaviour is an important determinant of larval development in *Drosophila melanogaster* and is likely to dictate differential success at exploiting food in the environment. Natural allelic variation in the foraging (for) gene underlies a foraging behaviour polymorphism, where rovers (forR) exhibit greater within and between patch foraging behaviour than sitters (fors). This rover/sitter polymorphism is maintained by negative frequency dependent selection (NFDS) on for, where the fitness of a genotype increases as it becomes rarer in the population. Recent studies showed that the expression of foraging behaviour is also affected by natural allelic variation in the wings up A (wupA) gene located on the X-chromosomes, where the wuplow allele suppresses the dominance of the forR allele. I propose to study the role of wupA in the maintenance of rovers/sitter balanced polymorphism and hypothesize that NFDS will be observed whenever one competitor is phenotypically a rover and the other is a sitter.

Factors affecting Canada Goose (*Branta canadensis interior*) nest defence behaviour on Akimiski Island, Nunavut

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Parental investment, such as nest defence in birds, plays a major role in the behaviour of adults towards their offspring. I studied the nest defence behaviour of female Canada Geese on Akimiski Island, Nunavut. My objectives were to determine how reproductive value, nest site characteristics, weather and human visitation influence nest defence. Flushing distance and return times were used as measures of defence and clutch size, nest age, egg volume, lateral vegetation density at 10m and temperature were the independent variables. The frequency of researcher visits had no significant effect on female nest defence. Model selection results suggest that female flushing distance was significantly inversely related to vegetation density and nest age. Females on well concealed nests and on older nests flushed at closer distances. Additionally, females flushed at significantly greater distances when temperatures were lower, though nest age may interfere. Return time was significantly negatively related to clutch size, as females with more eggs returned faster. Using model selection procedures, the best model to explain flushing distance included both vegetation density at 10m and nest age and for return time included clutch size. Significant differences in both flushing distance and return time were found among females. Thus, vegetation cover, nest age, temperature, clutch size and parental differences appear to influence the nest defence and parental investment in Canada Geese.

Molecular Evolution and its Genomic Correlates in the Honeybee

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The honeybee's genome provides us with the tools to study the genomic correlates of molecular evolution in social insects. One unique feature of the honeybee's genome is an extremely low GC content compared to other insect genomes. Honeybees also have the highest recombination rate when compared to other insects (eg. 10x higher than the fruit fly, *Drosophila melanogaster*). We are interested in studying the effects of GC content on molecular evolution. We sequenced 21 randomly chosen honeybee genes in addition to 20 other candidate genes. We estimated two measures of genetic diversity: nucleotide diversity and haplotype diversity. The preliminary results based on 15 random genes indicate that there is a highly significant positive correlation between nucleotide diversity, haplotype diversity and GC content. This can be explained by the high mutation rate in GC rich genes due to a higher recombination rate, or the fact that AT rich genes experience stronger positive or negative selection. We plan to further examine the joint effects of GC and recombination rate on the molecular evolution of honeybees.

Developmental Environment Affects Risk-Acceptance in the Hissing Cockroach, *Gromphadorhina portentosa*

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Consistent individual differences in the tendency to accept risk have been demonstrated in invertebrates, fish, birds, and mammals, including humans. These individual differences have been associated with size, growth rate, survival, and reproductive success. Little research, however, has investigated the effect of developmental environment on individual differences in risk-acceptance. Competing hypotheses offer different explanations of how variation in the quality of the developmental environment affects risk- acceptance in adults. The first hypothesis states that individuals developing in poor quality environments take risks because such behavior is their only means of obtaining adequate fitness returns. The second hypothesis states that individuals developing in poor environments avoid risk because their poor physical condition makes them especially vulnerable to injury or death. We measured several forms of risk- accepting behavior (exploration, foraging, and recovery after disturbance) in male hissing cockroaches (*Gromphadorhina portentosa*) that had developed in nutritional and social environments of varying quality. Individuals raised on poor nutrition diets exhibited lower levels of risk-acceptance than those raised on high nutrition diets. Risk-acceptance among individuals that developed on poor nutrition diets was negatively correlated with body size. We conclude that quality of developmental environment affects risk-acceptance across behavioral contexts in male hissing cockroaches. Our findings are consistent with the hypothesis that condition-dependent vulnerability mediates the relationship between developmental environment and risk-acceptance.

Foraging Habits of Southern Flying Squirrels (*Glaucomys volans*)

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Optimal foraging theory is based on maximizing intake rate while eating and minimizing search interval between prey. This foraging theory is influenced by whether individuals decide to forage alone (solitary foraging) or in groups (social foraging). Southern flying squirrels (*Glaucomys volans*) are social thermoregulators that create large nest group sizes in the winter (groups of 4-6) yet in the summer these

groups disperse and form smaller groups of 2-3 as there is no longer a need for thermoregulation. We examined the foraging behaviours of southern flying squirrels to determine if their nesting behaviours are reflected in their foraging behaviours. We studied flying squirrels on a 405m2 woodlot in central Ontario over 18 months to determine any social or seasonal foraging patterns. All squirrels in the study area were injected with passive integrated transponder (PIT) tags and nest cavity entrances were monitored with PIT-tag readers. Eight feeders were set up in natural cavities throughout the study area. These feeders were baited and monitored with PIT-tag readers to monitor foraging activity. We hypothesized that there would be no fitness benefit to social foraging. Preliminary results support this hypothesis, as the majority of read at feeding stations were from squirrels foraging independently.

A New Problematic Taxon from the Burgess Shale

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The 505 million year-old Burgess Shale (Yoho National Park, BC) is the best known site of exceptional soft tissue preservation and provides key biological and ecological information on the appearance of most modern phyla in the aftermath of the Cambrian explosion. More than 150 species have been described from Burgess Shale localities, and while many can be confidently placed within lineages of extant forms, many are unique, representing enigmatic life forms. Among these forms is a large stalked filter feeder, found at one of the stratigraphically oldest localities (Tulip Beds), on Mount Stephen. Known from almost 1000 specimens, it is a stalked, gregarious, filter feeding animal, characterized by a large calyx connected to a long, narrow stem terminating in a flattened holdfast. Specimens range from 50-230mm in length and 16-49mm in calyx width. Internally, the calyx contains a sac-like stomach followed by an intestinal tract that extends to the top of the calyx with a central opening interpreted as the anus. Surrounding the stomach is a hexaradial filter-feeding apparatus with six ventral pores presumably for water intake. While stalked organisms with a roughly similar shape are present in several unrelated extant forms (e.g., Cnidaria, Entoprocta, Ectoprocta) and other Burgess Shale animals (e.g. *Dinomischus*), the internal morphology is incomparable, and this animal remains an enigma.

Does sex, weight, temperature, and feeding affect respiratory motor output from the in vitro brainstem-spinal cord preparation of the Cane Toad?

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In vitro brainstem-spinal cord preparations from the Cane Toad, *Bufo marinus* display a great deal of variation in respiratory-related motor output (i.e., fictive breathing) between preparations. We investigated whether differences in sex, weight, ambient temperature, and feeding may have led to these differences in fictive breathing. Preparations from females had a greater fictive breathing frequency (fR) and a larger total fictive ventilation (TFV) than preparations from males. Preparations were divided into four weight groups; <100g, 100-199g, 200-299g, and >300g. The two larger groups, had similar fR but higher fR in comparison to the two smaller groups, which had similar values of fR. Only the >300g group had a larger TFV in comparison to the other groups, although this was not significant. Experiments performed in warmer temperatures showed a trend toward an increased fR compared to cooler temperatures, but this was not significant. There was also a trend for fR and TFV to decrease as the days after feeding increased. The results indicate that the sex and weight of toads may affect central respiratory motor output. The work also suggests that the respiratory requirements of the individual can be endogenously programmed in the CNS to modulate respiratory motor output and persists in the absence of peripheral input.

Effect of Temperature on Development in the Australian Redback Spider

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Developmental plasticity, the ability of an organism to detect changes in the environment and alter its developmental pathway accordingly, may play a key role in the organism's ability to cope with sudden environmental stressors. Temperature is known to affect development in a variety of taxa, with lower temperatures slowing or suspending growth. However, some organisms survive temporary cold shocks and resume development when temperatures are favorable again. We investigated the effects of exposing Australian redback spider egg sacs to a cold shock of 15 C. The duration of the cold shock varied between 14 and 31 days but did not affect emergence time, though spiderlings from egg sacs exposed to a cold shock were larger than those that were incubated at 28 C. The duration of the cold shock did not determine size, suggesting that development was totally suspended at 15 C. However, incubation duration at 26 C following the cold shock was found to correlate with spiderling size. This suggests a possible overwintering strategy by spiderlings that delays development until spring when temperatures are higher. The larger emergence size may be an adaptation to low levels of prey as larger spiderlings will be able to survive longer without food.

Evaluating the Success of Outplanting Hatchery-Raised Larval and Juvenile Northern Abalone (*Haliotis kamtschatkana*) Using Microsatellite Markers

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The restoration of abalone (*Haliotis* spp.) populations through supplementation with hatchery-raised individuals has been attempted in several species, with variable results. Between 2002 and 2005, the Bamfield Huu-ay-aht Community Abalone Project released 4.5 million larval and 152,000 juvenile Nothern Abalone (*H. kamtschatkana*) into Barkley Sound, BC. The purpose of this study was to assess the long-term survival of outplanted abalone in the wild and to determine their contribution to local population densities. We genotyped abalone from the three outplanting sites 3-7 years after the release of hatchery offspring, and assigned them to either wild or hatchery origin using both Pedigree 2.2 and Cervus 3.0. Based on these results, we determined that 30% of the individuals found at the outplanting sites were hatchery-outplanted individuals. Despite the relatively high survival rate of outplanted individuals, local population densities remain below minimum levels required for successful fertilization and recruitment. Further outplanting efforts may help to increase population densities to sustainable levels, however, factors impeding outplant survival, including habitat quality, predation and reduced genetic diversity may also need to be mitigated

Sex Differences in Group Joining Decisions in Social Fish

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In social animals, group-joining decisions can have important fitness consequences especially when individuals exist in a dominance hierarchy that relates to reproductive success. Choosing to join a large group may maximize safety but a small group can minimize the delay to dominant status. We explored this trade-off using Neolamprologus pulcher, a cooperatively breeding cichlid fish in which individuals conform to a rigid dominance hierarchy and females are philopatric. We predicted that because females have less opportunity to switch groups, they would place higher value on social rank than safety. We found that males prefer larger groups regardless of the rank they must assume when they join while females preferred larger groups only when joining did not compromise social rank. Our results help to elucidate factors underlying social decision-making and suggest that females value both rank and safety while males are primarily concerned with safety.

European fire ants at Tommy Thompson Park: Abundance, distribution and impact on native ant biodiversity

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Invasive species frequently disrupt the structure and function of ecosystems and constitute the second leading cause of global biodiversity loss (Vitousek et al., 1997). The European fire ant (*Myrmica rubra*) has recently invaded areas of Toronto, being particularly prominent at Tommy Thompson Park. The abundance and distribution of *M. rubra* was investigated to understand their impact on native ant species diversity as well as habitat preference. The results on *M. rubra*'s impact on native ant biodiversity proved inconclusive although some trends were observed which suggest multiple factors are at play. A predictive model revealed that *M. rubra* abundance is primarily influenced by sandy loam and loamy sand soil type and 0.77- 0.94% soil moisture. The presence of *M. rubra* in urban Toronto raises immediate concerns, as these stinging ants are not only affecting the human inhabitants of the city, but they may potentially be negatively impacting native ecological communities that are under active restoration efforts. Understanding the habitat characteristics that drive high *M. rubra* abundance is a step towards predicting patterns of future spread.

Lolita's web: juvenile female matings in the brown widow spider

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Alternative mating tactics may arise when individuals modify behavioral responses as a function of variable social and ecological conditions. Anecdotal observations suggest that males of the brown widow spider *Latrodectus geometricus* sometimes mate with sub-adult (final instar) females in nature by opening through their exoskeleton to inseminate their newly-developed spermathecae. Here we document the occurrence of sub-adult matings, and examine whether this behaviour develops as a male or a female tactic by analyzing how the reproductive success of each sex is affected. In laboratory trials we compared the outcome of pairings between adult males and adult or sub-adult females. Males paired with sub-adults had higher initial mating success, were more likely to be polygynous, and mated with reduced investment in courtship relative to males mating with adults. Although sub-adult matings might also benefit females (possibly as a mating insurance in unpredictable male densities), our data suggest it can evolve as an alternative male mating tactic.

Teneral Matings in Fruit Flies: Male Coercion and Female Response

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Extensive research indicates that sexually mature female fruit flies typically choose with whom to mate, a process that is crucial for the operation of sexual selection and population divergence via female choice. We followed up on field data suggesting that male fruit flies (*Drosophila melanogaster*) force copulate with teneral females, which are recently eclosed females characterized by their folded wings and soft, light coloured bodies. Our results indicated that males succeeded in mating with about 20% of the teneral females from our Canton-S population and 15% of the teneral females from a local, wild-caught *D. melanogaster* population. Close behavioural observations indicated coercion by the males and resistance by the teneral females, during both courtship and mating, which probably contributed to the shorter mating duration of teneral females relative to that of mature females. Teneral females failed to foil some forced copulation attempts, they could reduce the impact of such copulations by subsequently remating with a male of their choosing. Indeed, tenerally mated females were six times more likely to remate than were control females that had mated when mature. Our results substantiate a novel aspect of sexual conflict in fruit flies, which could counteract processes driven by female mate choice.

The Effect of Genetic Quality on the Mutation Rate in *Drosophila melanogaster*

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Mutation is a force that affects all populations. Despite the importance of the deleterious mutation rate in evolutionary biology, estimates of this parameter remain contentious. There is suggestive evidence that genetic background and stress may influence the mutation rate, but the possibility that genetic quality (the presence or absence of deleterious mutations) may affect the mutation rate has not yet been examined. We have conducted a modified mutation accumulation experiment in *Drosophila melanogaster*, where new mutations accumulate on one chromosome and the genetic quality of another chromosome is manipulated. One set of lines accumulated mutations in the presence of a wild-type chromosome, and 10 other sets in the presence of chromosomes carrying one or two deleterious mutations. Following 46 generations of mutation accumulation, we then replaced the manipulated chromosome in each line, using standard crossing techniques, to assess the fitness effects of the new mutations on a common genetic background. We found that the mean and variance in fitness changed more rapidly in lines that accumulated mutations in the presence of deleterious mutations, indicating that poor genetic quality can significantly increase the mutation rate. This finding has important implications for our understanding of mutational parameters.

Acoustic Communication in a Bark Beetle, *Ips pini* (Say) (Coleoptera: Scolytinae)

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Bark beetles impose significant threats to North American forests, and management strategists rely upon knowledge of their sensory ecology. Most bark beetle species produce acoustic signals during distress, courtship, and aggression. However, there is a surprising dearth of information on signal transmission and reception for any bark beetle species. An understanding of signal characteristics allows for developing hypotheses regarding signal function and reception. Using the pine engravers, *Ips pini*, we recorded and characterized their acoustic signals during pre-mating interactions and tactile disturbance, and compared signal characteristics between conditions. At 1 cm, females produced low intensity (69 dB SPL) multi-impulse chirps with peak frequencies between 12-25 kHz. Distress chirps had significantly higher peak frequency (24 kHz) and impulse rates than pre-mating chirps (13 kHz), implying possible differences in signal function. Only stridulating females entered male nuptial chambers, and chirp rates significantly decreased after entrance. However, chirps produced four minutes after entrance had significantly slower tooth-strike rates. Pre-mating signals may serve different functions depending on the stage of the encounter. Female stridulation also elicited substrate-borne vibrations. Our results contribute novel information on the physical characteristics of sound and vibration signals, and elucidate possible functions of signaling, and acoustic reception in bark beetles.

How do Subtle Cues of Social Presence Influence Human Cooperation?

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Recent studies have reported more helping behaviour by humans exposed to images of eyespots or faces than those exposed to control images. These results are commonly interpreted as evidence for (1) the role of reputation in the evolution and maintenance of human cooperation, and (2) the influence of subtle social cues on the outcomes of economic games experiments. I report the results of three economic

games experiments in which participants exposed to images of eyes were no more generous (and in one case were significantly less generous) than those exposed to images of landscapes. I discuss how these results may have been affected by subtle aspects of experimental stimuli and game structure, and the relationship between involved parties.

Population demographics of Giant Hogweed (*Heracleum mantegazzianum*) in southern Ontario

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Although it has been the subject of many studies conducted in Europe, Giant Hogweed has received little attention in the North American portion of its invaded range. A large monocarpic perennial forb originally from the western Caucuses, this noxious weed has overrun large areas across of Europe and North America. The population growth patterns of Giant Hogweed were studied by identifying mature stands around the GTA and establishing 6 transacts with 6 1-m2 quadrats placed evenly along each transect. Of the 5 sites identified as suitable for the study only 3 provided any adequate results and only 2 of these managed to survive long enough to be re-sampled later in the season. Population density was determined for seedlings as well as returning plants which were further separated into size cohorts. Stand structure was compared between the two sites with no significant differences found between the number of seedlings or the number of returning plants. Repeated sampling demonstrated a massive mortality between the first observation in May and the second in June. This is consistent with studies conducted on several European populations, although the documented densities overlapped with only the lowest range of densities observed in Europe.

Temperature-Dependent Behaviours in the Nematode *C. briggsae*

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Natural genetic variation allows the discovery of new gene functions and novel alleles for genes already known to act in biologically important processes. We are applying this approach to temperature-dependent behaviours in nematode worms in order to better understand the genetics behind behaviour. We focus on *Caenorhabditis briggsae* because most wild caught individuals fall into two genetically distinct clades that correspond approximately with northern temperate or with tropical latitiudes. Movement through its thermal landscape is the main way for nematodes like *C. briggsae* to regulate body temperature, so we also expect to see heritable differences in temperature-dependent behaviours. Here we quantify for the first time classic thermal-response behaviours among several *C. briggsae* wild strains from different haplotype groups using assays like accumulation on a linear thermal gradient, isothermal tracking, and a new droplet based thermal gradient assay. We demonstrate that *C. briggsae* shows thermotaxis and isothermal tracking similar to *C. elegans* but with some differences. We also identify heritable differences among strains from wild genetic backgrounds within *C. briggsae*. We will continue to develop higher throughput assays for temperature-dependent behaviour in order to carry out a quantitative trait loci mapping project using recombinant inbred lines derived from tropical and temperate parental lines.

Genet Level Resource Trade-Offs and the Cost of Reproduction in *Sagittaria latifolia* (Alismataceae)

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Trade-offs play a central role in the evolution of organismal life histories. We investigated two resource trade-offs predicted to influence reproductive strategies in plants. First, many plants combine sexual reproduction with vegetative propagation. Both should involve resource costs, and previous studies have found trade-offs between reproductive modes for single shoots. However, those studies failed to demonstrate that these costs scale up to entire clones. Second, investment in reproduction can be divided into allocations to male or female function. It is usually predicted, but less often directly evaluated, that female function is more costly than male function. Evaluating trade-offs is complicated by the currency used to measure costs. In *Sagittaria latifolia*, corms are the only vegetative biomass remaining at the end of the growing season. We used corms as a common currency to evaluate trade-offs between sexual and clonal propagation and between female and male function for whole clones. In a common garden experiment involving 418 plants we found evidence for a substantial trade-off between reproductive modes, particularly for female function. This is the first study demonstrating that trade-offs between sexual and vegetative propagation are apparent at the level of entire clones.

The role of hydrodynamic habitat in the feeding ecology of freshwater mussels (Bivalvia: Unionidae)

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North America has the most diverse assemblage of freshwater unionid mussels. By studying their suspension feeding we may gain insight into how multiple species (> 30/ river in SW Ontario) can coexist, as well as much needed information on their basic biology. In this study, we examined whether hydrodynamic habitat affected the suspension feeding (clearance rate, CR) of unionids in a recirculating flow chamber. CR was found to vary with the flux (J = UC, where U is the velocity and C is the seston concentration) of suspended material for the 4 species examined. The lotic species (*Elliptio dilatata*) cleared up to four times more water than lentic species (*Elliptio complanata*). Differences in CR were not found among four species (*E. dilatata*, *Fusconaia flava*, *Strophitus undulatus*) from the same hydrodynamic habitat, however the CR of *E. dilatata* varied with the hydrodynamics of its native river. These results provide important and new insight into how material flux influences unionid suspension feeding, which may help to explain niche breadth and competitive abilities in this group.

Condition-Dependent Usage of Alternative Double-Strand DNA Break Repair Pathways in *Drosophila melanogaster*

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Although both theoretical and empirical literature suggest that mutation rates are evolvable, a comprehensive understanding of the factors causing mutation rate variation is lacking. One possibility is that variation amongst individuals in condition, caused by either environmental or genetic differences, leads to differentiation in their mutation rates. A plausible mechanism by which differences in condition can lead to differences in DNA repair abilities is if condition effects an individual's usage of alternative DNA repair pathways. Multiple pathways exist for DNA damage repair that confer varying levels of risk for causing mutations. Some pathways are more conservative and can repair DNA without introducing mutations while others are more error prone. We have conducted an empirical study using a system in *Drosophila melanogaster* that measures how the relative usage of alternative DNA double-strand break repair pathways changes in response to condition. Male *D. melanogaster* were manipulated to be in either HIGH or LOW condition through manipulation of their larval diet. Individuals were then sampled at separate time points, for up to 5 weeks through their fertile lifetime, to measure the frequency of use of different DNA double-strand break repair pathways in their germ-line cells. Our results show that HIGH and LOW condition males differ not only in the overall relative frequencies at which they use alternative DNA repair pathways, but also in the rate and level of change in repair pathway use as they age.

Does disruptive coloration hinder object classification?

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Disruptive coloration is thought to be an important factor in animal camouflage. We address how patterning and object shape influence survivorship of moth targets in asking; do targets with disruptive coloration survive better; do targets with complex shapes survive better, do targets with stripes survive better; and does the benefit of disruptive coloration lessen for targets with complex shapes. Moth target treatments were designed in a 3-by-3 factorial design investigating coloration (plain, inside patterned and disruptive) and shape (straight edged, high frequency edged and low frequency edged). These artificial moth targets were pinned to trees along a woodland transect and their survival monitored over 92 hours. This experimental paradigm was extended by recording inter-pattern variability, allowing authors to control for pattern variability within each treatments replication. Results showed that disruptive coloration (as a discrete and continuous variable) had no affect on target survivorship, contrary to other empirical work. Shape complexity of target also had no affect on survivorship. Contrastingly, stripiness of target seemed to have an affect survival. As striping increases, background matching is enhanced by resembling trees distinctive vertical furrows. Such subtle patterning differences have been ignored. The potential of disruptive classification to artificially inflate camouflage gleaned indirectly from targets' stripes is discussed. We strongly suggest that future work in animal camouflage controls for pattern-to-pattern variation, when comparing treatments. To compliment this fieldwork, a human predator game was conducted. Here shape complexity, disruptive coloration and the interaction between shape complexity and disruption was found.

Human-Disturbance and Caterpillars in Managed Forest Fragments.

Peter White*, Brian McGill and Marty Lechowicz
McGill University

The impact of forest-edge habitat on Lepidoptera assemblages has been well-studied, but the impact of trailside habitat has rarely been considered. We surveyed caterpillar populations in relation to recreational trails at 72 quadrats in four forest fragments in southeastern, Quebec, Canada. We found a consistent negative relationship between trails in the

forest and both the abundance and species diversity of caterpillars within and among forest fragments. Conversely, caterpillar presence was not related to the presence of favorable host trees at a given quadrat. We suggest that the negative effect of trails may be due to increased predator pressure in trailside habitat and to conditions that make trailside habitat less preferable for oviposition. These results underscore the importance of managing trails to limit the amount of intra-forest disturbance experienced in important forest fragment remnants.

A Health Assessment of *Acacia xanthophloea* Woodlands in Lake Naivasha, Kenya.

Rachel White* and Jane Bowles
University of Western Ontario

Acacia xanthophloea woodlands fringe Lake Naivasha, the largest freshwater lake in Kenya's Rift Valley. These woodlands have been subjected to intense human pressure and land use changes over the last few decades. The aim of this study was to assess the health of these woodlands and how they are affected by local and adjacent land use. Field surveys were conducted in 26 woodlands around Lake Naivasha in 2010. Results show that these acacia trees grow and senesce in even-aged cohorts. Trees in sites with abundant wildlife were found to be least healthy. Small and mid-sized trees were subject to bark stripping by giraffes, and saplings were severely stunted by browsers. Regeneration was reduced in woodlands where the soil conductivity was high. We conclude that in addition to land use change, over browsing by livestock and wild animals, increased soil conductivity and invasion by non-native species may all contribute to a decline in health of the remaining acacia woodlands and threaten their long-term survival.

The Functional Relationship Between Herkogamy and Seed Production in the Red Columbine - a Phenotypic Selection Approach to Estimating Reproductive Assurance

Andy Wong* and Christopher Eckert
Queen's University

The Eastern Red Columbine (*Aquilegia canadensis L.*) exhibits remarkable variation in herkogamy (the spatial separation of male and female reproductive organs), yet this maintenance of phenotypic variation is difficult to explain.

Herkogamy is highly variable, heritable within populations and functions to reduce selfing in the Eastern Red Columbine. 75% of *A. canadensis* seed production is through selfing, yet one would expect directional selection favouring large herkogamy to reduce selfing because of strong inbreeding depression (~0.98).

One explanation for the maintenance of herkogamic variation is reproductive assurance (RA) - the increase in seed production via selfing. RA in the past were estimated by seed production differences between unmanipulated and emasculated flowers. The increase in seed production (~14%) however is confounded with experimental manipulation of a trait beyond its natural range and damaging floral parts. An alternative approach to find evidence for reproductive assurance is to study the natural correlation between seed production and herkogamy. Larger herkogamy (bigger separation, thus lower selfing) should lead to reduced seed production if reproductive assurance exists. Here we present a study of 6 Columbine aggregations in one year (N=534) where we found no evidence of reproductive assurance.

Adaptation and Positive Selection in Rhodopsin: the dN/dS Debate

David D. Yu* and Belinda S. W. Chang
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The relative contributions of positive selection and genetic drift during evolution is one of the central unresolved debates in molecular evolution. Positive selection at specific amino acid sites can be detected by comparing the ratio of nonsynonymous and synonymous substitutions (dN/dS) using likelihood codon models. Despite the widespread use of dN/dS-based methods, experimental validations have been lacking, with nearly all claims of positive selection based on statistical analyses alone.
Rhodopsin is the dim-light sensor in vertebrates whose wavelength of maximum absorbance (λmax) has been shown evolve adaptively to an organism's spectral environment. A recent study has cast doubt on the validity of dN/dS-based methods by finding no correspondence between dN/dS-based site predictions and amino acids known to adaptively shift λmax.
We have performed dN/dS-based analyses on two large rhodopsin datasets (>400 taxa total) and identified a number of sites that are robustly-predicted to be undergoing positive selection. These sites are non-randomly distributed in rhodopsin's tertiary structure, with a large subset located adjacent to the predicted exit-channel of rhodopsin's all-trans-retinal (ATR) ligand. We have introduced natural variants at positively-selected sites into a defined genetic background. Variants alter both λmax and the ATR release rate suggesting that positive selection may be modulating these two aspects of rhodopsin function.

POSTER ABSTRACTS

The poster session is sponsored by **UTSC Office of the Vice-Principal, Research**

(Listed alphabetically by presenter*)

Factors Affecting Lion (*Panthera leo*) Distributions within the Welgevonden Reserve, South Africa

Daniel Anstett* and Marie-Josée Fortin
University of Toronto St. George

Understanding predator-prey spatial interactions is critical for small reserve management. Lions have been hypothesized to seek habitats with higher prey abundances. Alternatively lions may prefer environments that allow for concealment and ambush strategies. Lions are territorial and should show little overlap between territories. We consider these hypotheses in Welgevonden, a small, actively managed reserve in South Africa. Vehicle transects were performed over a ten-week period, during which the GPS coordinates of herbivores were recorded. We analyzed herbivore GPS coordinates from ten years of helicopter transect data, and four years of lion GPS collar data. Lion distributions were compared to the positions of the seven most common prey and to eight habitat types using multiple regression. Overlap of lion homeranges was compared between prides. Abundances of the three most predated herbivores: wildebeest, warthog and hartebeest explained 30% of the variation northern pride distributions and 59% of the variation in southern pride distributions. Homeranges of lions in northern and southern prides had almost no overlap. Within each homerange, the results support the prey availability hypothesis and show that wildebeest and hartebeest are preferred and predated by lions. Management actions should ensure lion populations are kept low and at-risk herbivores are re-stocked.

Is Sheep Grazing Connectivity Influencing Genetic Structure and Diversity *in Anthyllis vulneraria*?

Antoinette Battaglia*, Yessica Rico and Helene Wagner
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Habitat fragmentation threatens the genetic diversity of various plant species of the Central European calcareous grasslands. Conservation efforts have included reinstating traditional shepherd routes in order to maintain the ecosystem. This study investigates how one species of the calcareous grasslands, *A. vulneraria*, has been affected by this conservation method. The investigation focuses on the genetic structure and relatedness of populations. In comparing groups based on grazing occurrence, One way ANOVA results indicated there was no significant difference in Shannon's Index I ($F = 0.07$, d.f.= 2, $p = 0.931$) nor in unbiased heterozygocity UHe ($F = 0.01$, d.f. = 2, $p = 0.989$). AMOVA testing of groups based on shepherd routes displayed a low genetic structure for the species, with genetic differentiation highest among individuals (77%). One way ANOVA results also indicated no significant difference of genetic diversity between populations based on age and population size ($F=0.93$, d.f.=4, $p=0.468$ for Shannon's Index)($F=0.52$, d.f.=4, $p=0.719$ for unbiased heterozygocity). These results indicate that *A. vulneraria* is benefiting under the current management strategies.

Effect of Developmental Mode on the Population Responses of Four Different Marine Snail Species to ENSO Events

Elizabeth Grace Boulding*
University of Guelph

Developmental mode has been hypothesized to strongly affect the responses of marine animal populations to climate change but datasets with sufficient temporal replication to test this are rare. I monitored the population dynamics of four ecologically similar northeastern Pacific gastropod species - two with and two without a free-swimming, planktotrophic larval phase - over an 18 year period on the west coast of Vancouver Island, Canada. Twice each year I counted and measured all individuals of four *Littorina* species inside 65 permanent quadrats at two intertidal sites. I then compared snail abundance with environmental variables such as sea surface temperature, wind speed, wave height, air temperature, rainfall and the El Nino Southern Oscillation (ENSO) index using multivariate general linear models. Environmental variables were often highly correlated with one another. Nevertheless, direct-developing species responded strongly to different environmental variables than did planktotrophic species. For example, the summer juvenile abundance of the most common direct-developing species was highly correlated with the rainfall during the previous January but the abundances of the two planktotrophic species were not. This suggests that populations of species with different developmental modes may respond differentially to long-term trends in environmental variables caused by global warming.

Social Pleiotropy and Adaptive Evolution in Bees

Alexandra Bunting*, Amer Issa, Clement Kent and Amro Zayed
York University

The vitellogenin egg-yolk precursor protein affects fecundity in queens and division of labour in workers of the honey bee *Apis mellifera*. We sequenced vitellogenin and seven other genes in a large population panel of *Apis mellifera* and several closely related species to investigate the role of social pleiotropy on adaptive protein evolution. We found a significant excess of non-synonymous fixed differences between *A. mellifera*, *A. cerana* and *A. florea* relative to synonymous sites indicating high rates of adaptive evolution at vitellogenin. Further, replacement polymorphisms in vitellogenin were significantly enriched in parts of the protein involved in binding lipid. Our study provides evidence of historical and ongoing bouts of adaptive evolution acting on a key socially pleiotropic gene in the honey bee, suggesting that social pleiotropy does not limit adaptive protein evolution.

The Information Content of *Acheta domesticus* Songs and the Evolution of Multiple Signals

Andrea Covey* and William D. Brown
SUNY Fredonia

Male field crickets (Orthoptera: Gryllidae) produce three qualitatively distinct song types that are used in different social contexts: the calling song, courtship song, and aggressive song. Calling song is produced to attract females, but it also plays a role in maintenance of male territories. Courtship song is vital to successful copulation. Aggressive song is involved in male-male competition for females.

The current body of literature has identified several parameters of male cricket song that are highly variable within populations yet highly repeatable within individuals. It has also linked certain "beneficial" male phenotypes (i.e., those that convey greater fitness advantages) to some of these song parameters. Because intraspecific variation within song type is great, and because certain male phenotypes have been found to be beneficial in both intersexual (aggressive) and intrasexual (mating) interactions, the possibility unfolds for potential similarities in information content to be present across both song type and social context. The aim of the current study is to determine the fitness-related information content of each distinct song of the male house cricket, *Acheta domesticus*, and to reveal potential similarities across social context. In doing so, I hope to elucidate the evolutionary significance of multiple signals in this system.

The effects of selection harvesting on Black-throated Blue Warbler reproduction

Melissa Creasey*, Erica Nol, and Dawn Burke
Trent University

We examined the possible short- and long-term impacts of selection harvesting on the reproduction of Black-throated Blue Warblers (Dendroica caerulescens) in Algonquin Provincial Park, Ontario, Canada. Black-throated Blue Warblers typically breed in undisturbed forests with thick understories suitable for nest placement. Few studies have examined this species in disturbed forests, and with eastern North America's most populous region overlapping Black-throated Blue Warbler breeding range, this research is a priority.

128 nests were monitored in stands ranging from 0 to 70 years post-harvest, resulting in an effective sample size of 507. The top-ranked models for logistic exposure included a term for nest age, nest age + date, and nest age + time since harvest. Nest age is the only significant variable indicating a decreasing daily survival rate as the nest ages (parameter estimate = -0.0695 [-0.1017,-0.0373]).

Significant differences in habitat variables across the treatment ages were observed for percentage of plot coverage for saplings, shrubs and seedlings, regeneration, hemlock saplings, hobblebush, and canopy cover. Nest site habitat variables significantly differed from territorial and random plots with respect to percentage of plot coverage for saplings, regeneration, hemlock saplings, and canopy cover.

Predatory Prawns Manipulate a Pre-Existing Sensory Bias of their Prey, the Trinidadian guppy

Alexandra De Serrano*, Cameron Weadick, Anna Price, and Helen Rodd
University of Toronto St. George

Sensory biases, an adaptive predisposition toward certain signals, have been implicated in the origin of mate preferences in some species. Female Trinidadian guppies prefer males with large orange body spots. However, a potential risk associated with the evolution of these biases is that these signals could be co-opted by predators as a sensory lure. Here we propose that a predatory species of prawn, which co-exists with some guppy populations, has evolved orange spots on its pincers to lure guppies based on their bias for orange. To test the sensory lure hypothesis, we exposed guppies from populations that are sympatric or allopatric with this prawn to a life-like model of this species with orange, green or no spots on the pincers. We found that sympatric guppies spent significantly less time than allopatric guppies in the dangerous head region of the prawn of the spotless models suggesting that the former recognized our model as a potential

'predator'. We also found that both sympatric and allopatric populations spent more time in the head region of the model prawn when orange, but not green, spots were added. These results suggest that the orange spots on prawn pincers are acting as a sensory lure.

Altitudinal Range Limits in a Hemiparasitic plant

Anna Hargreaves* and Chris Eckert
Queen's University

The maintenance of species' range limits (RL) involves fundamental questions in ecology, evolution, and conservation. Niche-based models assume that species' ranges overly an environmental gradient in habitat quality, such that fitness declines from the range centre outwards and RL occur when populations are no longer self-sustaining. Much attention is paid to gradients in abiotic variables (e.g. climate-envelope models), but niches are often substantially modified by interactions with other species. Further, the importance of biotic interactions, both in general and in limiting ranges, is predicted to increase in environmentally benign and species-rich environments (e.g. low vs. high elevation). We examine evidence for both declining fitness towards RL and increasing importance of biotic interactions with decreasing elevation using the altitudinal range of the annual, hemiparasitic plant *Rhinanthus minor*. We surveyed natural populations along replicated elevational gradients in Alberta's Rocky Mountains, from valley bottom to alpine (~1000m elevation change). Contrary to expectations, lifetime reproductive success did not always decline towards upper RL, nor did herbivory and disease consistently decrease with increasing elevation. We discuss the implications of these results for *Rhinanthus minor* and the evolution of altitudinal ranges in general.

Species Composition Within Nests of Plainfin Midshipman (*Porichthys notatus*) at Rocky Intertidal Sites of British Columbia, Canada

Ahdia Hassan* and Sigal Balshine
McMaster University

Little is known about the ecology of the plainfin midshipman fish (Porichthys notatus) during their reproductive season in late spring/early summer. This exploratory study aims to characterize the marine biodiversity found growing within midshipman nests at intertidal sites throughout British Columbia, Canada. Midshipman males adopt alternate growth trajectories early in development resulting in two reproductive morphs. Type 1 males build and maintain nests, produce acoustic courtship displays, and actively defend their territory. Type 2 males are significantly smaller in body mass, invest in larger testes, and rely on sneak or satellite spawning as their main reproductive strategy. During the reproductive season Type 1 males enter the intertidal zone and build nests under rocks from which they will court females. Females are transient figures, only entering the nest to deposit eggs, leaving the male to fertilize and care for the egg clutch until they are free swimming. It is hypothesized that nest biodiversity is indicative of better territory, thus positively correlated with increased nest size, water quality, and reproductive success. In addition, a survey of species abundance within actual vs potential nests will provide insight on species displacement through spatial competition and/or active defense by parental males.

'Thyonic' Semelparity: the paradox of secondary reproduction explained

William P. Hughes* and Andrew M. Simons
Carleton University

'Semelparity' is a life-history characterized by a single, terminal bout of reproduction followed by senescence and death, and is defined in opposition to iteroparity, a life-history characterized by repeated episodes of reproduction interspersed between periods of nutritive or somatic growth. Semelparous organisms (i.e. salmon, bamboo, annual plants, etc…) are thought to possess a demographic fitness advantage over iteroparous congenerics under various environmental circumstances (i.e. high adult mortality) and the evolution of semelparity has been explained as an adaptation for this reason.
This work examines imperfect semelparity, focusing on 'thyonic' (i.e. secondary – post-terminal senescence) reproductive episodes found in many semelparous organisms. Using clonal populations of the monocarpic biennial Lobelia inflata, we investigate the causes of these 'thyonic' episodes. We elicit such episodes through the manipulation of environmental cues, and find that their production is correlated with initial flowering phenology, indicating that semelparity in this system is phenotypically plastic. We also compare key reproductive characteristics of offspring from both 'thyonic' and 'primary' reproductive episodes, and find that they do not significantly differ. This result is an important step in understanding the continuity between semelparous and iteroparous life-histories, as well as establishing the basis for future examination of 'thyonic' reproduction.

Development and Use of Novel Microsatellite Primers in a Pacific Marine Gastropod, *Littorina plena*

David A. G. A. Hunt*, Stephanie Pedersen and Elizabeth G. Boulding
University of Guelph

We present the development of an enriched library of microsatellite loci for the Pacific marine gastropod *Littorina plena*. The library was enriched using biotin-tagged oligonucleotides complementary to microsatellites, before being cloned and sequenced. Preliminary data from three populations (British Columbia and Washington State) showing that some of these loci are in Hardy-Weinberg equilibrium is presented. We discuss work currently underway using these loci for the purposes of analyzing the potential effects of a high dispersal planktonic larval stage on population structure and associated special considerations when dealing with such organisms. The potential for "sweepstakes reproduction" where normal considerations of spatial and temporal structure have to be modified due to high dispersal is highlighted. This phenomenon raises the potential inapplicability of some normal meta-population dynamics to systems subject to sweepstakes reproduction.

Phylogeography of *Caenorhabditis remanei*: Population Structure and Incipient Species

Yong Suk Jeon*, Alivia Dey and Asher Cutter
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Nematodes in the genus *Caenorhabditis* is widely used model organisms with both gonochoristic (male-female) and androdioecious (male-hermaphroditic) species. *C. remanei* is gonochoristic species that inhabits around the globe, making it suitable species for phylogeographical study. Previously, only a single population of *Caenorhabditis remanei* has been investigated for distribution of nucleotide variation; showing approximately 20 fold greater genetic diversity than its hermaphroditic relatives (Cutter 2006). Here, we examine how migration between populations might affect the distribution of genetic diversity throughout the species. We first gathered approximately 59 strains of *C. remanei* from Asia, North America, and Europe. Then, we quantified nucleotide variation for 15 loci each ~700 bp long (linked to X chromosome). After DNA of individual strains was sequenced, numbers of statistical analysis were carried out to investigate neutrality of selection, level of nucleotide diversity, population structure, and linkage disequilibrium. Test of neutrality imply complex German has highly skewed allele frequency distribution. It suggests complex population demography: either population contraction or recent admixture of multi-population. In terms of population structure, there was strong level of correlation between genetic distance and geographical distance (Spearman's Correlation = 0.75). In fact, Chinese sample is strongly genetically differentiated: this may represent distinct species.

Why Risk It? Risky Behaviour as an Honest Signal

Sara Kafashan*
University of Guelph

Two models have guided the study of risky behaviour as an honest signal of quality. One suggests that high quality individuals (i.e., individuals with few perturbations) may engage in more positive or prosocial risky behaviours (e.g., adventure sports, heroic acts). A second model suggests that low quality individuals (i.e., individuals with more perturbations) may engage in more negative or antisocial forms of risk taking (e.g., delinquency, crime). This study tested these two models. Male university students (n = 50) were assessed on questionnaires and behavioural tasks to determine risk preference and behavior in various situations (e.g., Zuckerman's Sensation Seeking Scale; Choice Task). Participants were also assessed on several markers of developmental instability to indicate quality (e.g., fluctuating asymmetry of the face and body). Some evidence for low quality individuals engaging in more negative or antisocial risky behaviours was found: Antisocial risk takers, as opposed to prosocial risk takers, were shorter and more likely to be left handed. Antisocial risk takers, however, were also rated higher on attractiveness. Directions for future research are discussed.

Crickets exposed to spiders produce offspring with enhanced survival capabilities

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Science is finding that some behavioral phenomena are explained by epigenetics and maternal effects, rather than classical genetics. One of these is the epigenetic transmission of information from mother to offspring, when there is no direct interaction between the two such as maternal care. This transgenerational maternal effect on offspring behavior occurs in the fall field cricket, *Gryllus pennsylvanicus*. Offspring of mothers exposed to wolf spiders, *Hogna carolinesis*, behave in a way to decrease risk of predation. To test the stimuli that induced this transgenerational effect, gravid mothers were exposed to three different treatments: presence of a spider rendered non-lethal, spider pheromone cues, and a control treatment. The offspring's survival abilities of these treatment groups were then measured. The results supported previous research that shows that predator naïve offspring with the transgenerational maternal "warning? show greater survivability in the presence of Hogna spiders than other offspring that received no maternal "warning". I also found that pheromonal cues from the predator alone are not enough to produce the transgenerational "communication" of the risk of predation from mother to offspring.

The effects of reduced environmental calcium on behaviour and mortality in an invasive freshwater crayfish (*Orconectes rusticus*).

Vern Lewis and Brie Edwards
University of Toronto

Fresh water lakes depleted of dissolved cations represent an inhospitable environment to aquatic ecosystems because they are deficient in dissolved calcium, which is needed by many aquatic organisms. For example, dissolved calcium is an important functional component of mollusc and crustacean physiology, affecting both somatic strength and metabolic activity. However, some organisms are able to compensate for reduced structural integrity by modification of behaviour. In this study, I asked whether the invasive rusty crayfish, *Orconectes rusticus*, modifies its anti-predator behaviour in response to the physiological limitations imposed by low levels of ambient calcium. I subjected immature, wild-caught crayfish to one of three levels of dissolved calcium and measured their anti-predator responses to a natural predator cue. I found that under extreme calcium deprivation, *O. rusticus* increased the number of times it stopped during normal activity. Furthermore, compared to controls, calcium deprived individuals tended to spend more time being vigilant. I also found that some individuals in very low levels of calcium, unlike those in low and control levels, died during molting events. This study suggests that the northern expansion of *O. rusticus* onto the Canadian Shield may be slowed or halted.

Shoaling in the Trinidadian Guppy (Poecilia reticulata): Survival Costs, Benefits and Plasticity

Anna Li* and Helen Rodd
University of Toronto St. George

Trinidadian guppies (*Poecilia reticulata*) show inter-population variation in shoaling behaviour. One explanation for the reduced levels of shoaling in low predation populations is that shoaling increases salience to its natural predator, *Rivulus hartii*. First, we asked whether guppies exhibit plasticity in shoaling behaviour in response to the presence/absence of this predator. To do this, we raised guppies, from natural populations where *Rivulus* is the major predator, with both visual and olfactory predator cues. We were surprised to find that during predation trials with *Rivulus*, guppies raised with cues from this predator shoaled significantly more under extremely stressful situations than guppies that had never been exposed to predators. Preliminary analyses suggest that *Rivulus* was significantly more likely to direct attacks at individuals in the largest shoal present during the trial, suggesting an increased risk for guppies that shoal. However, preliminary data indicate that *Rivulus* were more likely to catch solo individuals than individuals in shoals. We are investigating the possibility that shoaling is only detrimental to guppy fitness at certain stages of the predatory behaviour of the *Rivulus*. Future studies will evaluate the overall risks and benefits of shoaling for guppies in the presence of *Rivulus*.

Patterns of prevalence and infection levels of fungal endophytes in native Mongolian grasses

Paul Marmer*, Mehwish Riaz and Dawn Bazely
York University

Symbiosis of fungal endophytes within grasses is widespread and capable of significantly affecting ecosystem dynamics. The ecology of this interaction has primarily been studied in heavily managed agricultural pastures. While relatively little is known about the ecological significance of the fungal endophyte-host grass relationship in natural ecosystems, the presence of endophytes may be affected by herbivory and abiotic factors. Native *Festuca* species and *Agropyron cristatum* in two regions of Mongolia were examined for the prevalence and infection level of *Neotyphodium* endophytes. Endophyte infection was determined with immunoblot kits and visual screening. Prevalence of endophytes ranged from 0 to 81.6 % and was significantly correlated with elevation, latitude and herbivory pressure, reflecting patterns found elsewhere. The intensity of immunoblot kit imprints was a reliable indicator of hyphal density in grass leaves in all native grasses examined, indicating that infected grasses vary with respect to the amount of fungal infection. The applicability of using commercial agricultural immunoblot kits for screening large samples of selected Pooid grass species for endophyte infection was demonstrated. This represents the first study to demonstrate the presence of endophytic fungi among grasses in Mongolia.

Predicting the Interaction Between Future Climate Changes and Habitat Loss at the Range Margins: a Population Dynamics Approach

Ilona Naujokaitis-Lewis* and Marie-Josée Fortin
University of Toronto St. George

Understanding the factors that limit population level responses to global environmental changes, such as habitat loss and climate change, is required to accurately predict responses and to identify effective conservation actions. Species distribution models (SDMs) are commonly applied to predict the effects of future global changes on species where species

occurrences are correlated with environmental variables. However, SDM predictions across space and time have been recently criticized because they do not explicitly account for processes that affect extinction risk, including demography and dispersal behaviours. Here we present a novel methodology to model and quantify predicted extinction for a long-distance migratory bird, the Hooded Warbler (*Wilsonia citrina*) by integrating metapopulation demographic models with climate change scenarios across the breeding and non-breeding ranges. Preliminary results compare predictions derived from static SDMs with process-based metapopulation dynamic models. We explore the sensitivity of predictions to alternative functional relationships between climate variables and demography, and varied parameters including dispersal rates, dispersal distance function, initial abundances, and demographic rates. We discuss methods for quantifying and partitioning uncertainty in predictions to model parameters, and present approaches to map spatial patterns in prediction uncertainty.

The Effects of Pollinators and Sex Ratios on the Evolution of Life-History Traits in *Aralia nudicaulis*

Emony Nicholls* and Marcel Dorken
Trent University

Aralia nudicaulis is a clonal dioecious herb common to forested ecosystems of eastern North America. Our study had two main objectives: (1) to understand the factors responsible for variation in female frequencies, and (2) to investigate interactions between *A. nudicaulis* and its pollinators. We investigated variation in female frequencies at 15 sites in Algonquin Park, Ontario. At each site we recorded the age and sex of each flowering ramet. We found striking variation in the frequency of females vs. males across the study sites, with the percentage of females ranging from 10% to 95%. Because fruit production involves greater resource costs than pollen production, we predicted that females should be less common where resources such as light are limiting. Consistent with this expectation, we found a negative association between canopy closure and female frequencies, with females more common in more open sites. We further predicted that variation in the ratio of females:males could have important implications for pollinator activity across sites because only males produce pollen, a key food source for insect pollinators. Using transects of pan traps in flowering patches of *A. nudicaulis* we found, contrary to our expectations, that pollinators were more abundant in sites with more females.

Family Effects on Sibling Cannibalism in redback spiders (*Latrodectus hasselti*)

Lucy Dong Xuan Li*, Nizanthan Rathitharan, Hosay Said*, Maria Modanu and Maydianne C. B. Andrade
University of Toronto Scarborough

Sibling cannibalism has been demonstrated across diverse taxa in response to factors such as competition, low prey availability, outbreeding opportunities, and density. In our study, we used the Australian redback spider, *Latrodectus hasselti*, to investigate the effects of sibling density on cannibalism and survivorship. We used a paired design in which we assigned newly hatched siblings from single family lines to a low density (LD) treatment (10 spiderlings) or a high density (HD) treatment (30 spiderlings) and left them unfed for a week. Our results showed that the number of spiderlings that survived did not vary with density, with equal rates of cannibalism in both density treatments. Our study also showed that when comparing the HD and LD treatments for spiderlings that came from the same egg sac, a strong positive correlation was found for both survivorship and number of spiderlings cannibalized, suggesting family effects play a role in sibling cannibalism. We discuss these results in reference to possible implications for female reproductive tactics in nature.

Cross Amplification of Microsatellite Primers Among Seven *Littorina* species.

Stephanie Pedersen*, David Hunt, and Elizabeth Boulding
University of Guelph

Enriched DNA libraries from the marine gastropod *Littorina plena* were used to isolate microsatellite sequences. Pairs of primers were designed for each locus then screened for polymorphism in *L. plena* using polyacrylamide electrophoresis and silver staining. The main objective was to isolate and design primers for 8 - 10 microsatellite loci which display high levels of variation. Polymorphic loci were also screened against six related *Littorina* species: *L. scutulata*, *L. subrotundata*, *L. sitkana*, *L. saxatilis*, *L. obtusata*, and *L. littorea*. It was hypothesized that many primers designed for *L. plena* would also amplify in its sister species, *L. scutulata*, and that a smaller number within conserved regions would amplify in more distantly related species. Amplification of some primers was seen across all species, most often in *L. scutulata* with 67% of primer sets amplifying, and least frequently in *L. subrotundata* with only one of the ten tested primer sets amplifying *L. plena* microsatellite loci. The potential for the study to determine genetic diversity in a population will be beneficial in conservation, as well as studies in gene flow of dispersing populations. Loci which amplified throughout the genus can be used for future microsatellite analyses in non *L. plena* species.

The Dynamics of Resource Allocation and Costs of Reproduction in a Sexually Dimorphic Wind-Pollinated Annual Plant

Zachary Teitel*, Melinda Pickup, David Field and Barrett Spencer
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Sexual dimorphism of resource allocation in dioecious plants is expected to change during the life cycle because of temporal differences between genders in reproductive allocation. Moreover, because of different gender-specific costs of reproduction we might expect contrasting allocation responses depending on whether plants reproduce or not. In two glasshouse experiments, using the dioecious, wind-pollinated annual, *Rumex hastatulus*, we tested whether sexual dimorphism varied with life history stage and fertilizer treatment, and, investigated allocation patterns in plants with contrasting reproductive commitments. Plants were harvested at three stages during the life cycle in the first experiment and plants in the second experiment were allowed to reproduce or not. Proportional allocation to roots, reproductive structures and vegetative growth differed temporally between the genders, but not with nutrient levels. Males prevented from reproducing compensated with increased above- and below-ground allocation to a much greater degree than females suggesting that reproduction in males is more costly in terms of reduced vegetative growth. Our study illustrates the importance of timing, with regard to sex-specific resource allocation strategies, and also indicates that the widespread assumption of greater resource costs for reproduction in females than males may not be warranted, at least in wind-pollinated annual plants.

Partner Benefits and Partner Choice in Seed Dispersal by Ants

Kyle Turner* and Megan Frederickson
University of Toronto

Myrmecochory, or seed dispersal by ants, is the dispersal syndrome of thousands of plant species, and myrmecochorous plant species make up a large minority of plants in some habitats. Seeds of myrmecochorous plants have elaiosomes, which are fleshy appendages thought to have evolved as a nutritional reward for ants. Although the benefits of myrmecochory to plants are quite well studied, little is known about whether and how ants
benefit from this partnership. We provisioned 48 laboratory colonies of the woodland ant *Aphaenogaster cf. rudis* with seeds of four sympatric understory herbs and tested whether eating elaiosomes yielded a measurable benefit to the ant colonies, and also tested whether ants' willingness to disperse seeds differed between plant species. *A. rudis* colonies were able to maintain larger clutches of brood when provisioned with elaiosomes of some species, yet the quality of dispersal service provided by ants was mismatched with the quality of elaiosome reward provided by different species. This suggests that some ant-dispersed plants may dishonestly signal reward quality, and instead invest in other cues to elicit seed dispersal.

"Love Potion 9": The Evolution of Male Attraction to Caenorhabditis sp. 9 Pheromone (*Caenorhabditis*)

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University of Toronto

Nematodes of the *Caenorhabditis* genus are widely used as model organisms, yet not much is understood about their sex pheromone and the evolution of its attractiveness to prospective mates. This sex pheromone is secreted by females and acts as the primary means of mate attraction of conspecific males. Previous studies have shown that *Caenorhabditis* sex pheromones attract not only conspecific males, but heterospecific males as well, and we confirm this result using the sex pheromone of C. sp. 9, a recently discovered species. Males more closely related to C. sp. 9 tend to have a stronger attraction to C. sp. 9 pheromone than do males of more distantly related species. By testing the effect of phylogenetic distance on male attraction, we aim to better understand the evolution of sex pheromone and the species-specificity of the males' response as prezygotic barriers to reproductive isolation among distinct *Caenorhabditis* species.

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A
B
C
D
1
2
3
4
5
TO HWY 401
Friday Social:
Fossil & Haggis pub
790 Military Trail
(Military trail & Morningside Ave)
P5
P2
P4
P4
MILITARY TRAIL
PG
PH
IC
Permit Holders
P3
Visitors
Outer Parking: $2/day
P3: coin & credit card
P4 & P5: coin only
ELLESMERE ROAD
ELLESMERE ROAD
To access inner lots
enter here
(other entrances are one way)
NR
NR
NR
NR
PF
CC
MILITARY TRAIL
TTC buses:
38 - to/from scarb. town centre
95 - to/from york mills station
Plenaries SY110
Breakfasts SY110 foyer
SY
PO
SW
SL
AA
BV
AC
RC
PA
PB
PD
Go bus stop
TTC bus: 116E stop
to/from Kennedy stn
Lunches & Dinner
HW 305
HW
Inner Parking: $5/day
PA, PB, PC, PD
PC
SRC
SR
SR
MW
Concurrent sessions
MW 140/160/170
Check in/out
on-campus housing
JF
SR
SR
SR
SR
PE
On-campus housing
Joan Foley Hall