



**Ontario Ecology and Ethology
Colloquium
2006**



**May 5-7
St. Catharines, Ontario**

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The Organizing Committee Welcomes You!

Welcome!! On behalf of the OEEC 2006 organizing committee, we wish you an enjoyable and informative stay at Brock and in the Niagara Region. We hope our time here serves both as a forum and celebration of our work and the natural world.

The organizing committee has worked hard for many months to make the best possible OEEC. In many instances we have attempted to keep with the traditions of this colloquium. In other instances we have made arrangements that best represent us, the organizers of this meeting. In particular, we have strived to reduce waste and keep costs low. This is apparent in numerous ways. We have kept the materials we will distribute to the essentials, such as name tags and this program. Also, in lieu of the book/prize raffle that has become custom for the OEEC, we have chosen to give every participant a mug designed specifically for OEEC 2006 at Brock.

Wishing you a fantastic weekend at Brock,

Sincerely,

The OEEC 2006 Organizing Committee

Candice Kerling

Sean Prager

Marianne Peso

Aynsley Thielman

Amy Sharp

Curtis Russell

Roger Kroeker

Sandra Rehan

Dimitri Skandalis



Brock University



Introductory Note

On behalf of the Department of Biological Sciences at Brock University, I extend a warm welcome to all participants in this year's OEEC meeting! Brock University is proud to host the meeting, and the Department of Biological Sciences is very happy to act as a sponsor. Ecology and evolution are emphasized heavily as core topics in our undergraduate programs in Biological Sciences, and they are active areas of research for many of our M.Sc. and Ph.D. students and faculty as well. Ultimately, these key areas influence all members of our department and all levels of our curriculum. Thus, we are very excited about having OEEC at Brock this year!

I congratulate the local organizing committee on their hard work in putting everything together for you. I hope you all enjoy the campus and its facilities, and I encourage you to take some time to see a bit of the Niagara escarpment and the Niagara region.

I hope you all find this meeting fun and informative!

Joffre Mercier, Chair
Department of Biological Sciences
Brock University

General Information

Registration:

Registration will take place after 4pm on May 5th at the Arnie Lowenberger Residence, which is also the site of the registration mixer (see campus map item 1).

On May 6th, registration will take place outside of Thistle 325 prior to the first plenary session at 9:00am.

Instructions for oral presenters:

Total length of each oral presentation is 20 mins (15 mins for the talk and 5 mins for questions). We request that all computer presentations be in PowerPoint (.ppt, .pps) and optimized to run on Windows. You can generate a .pps version of your presentation by using Save As... and selecting PowerPoint Show as the format. We also recommend that you use the pack and go feature to prepare a copy of your presentation.

Presentation rooms contain Windows computers. All machines are equipped with internet access and Powerpoint. If you require other arrangements please email the organizers at oeec@brocku.ca.

Please bring your presentation on a CD or a flash drive (USB memory key), and present it to us when you register. Please provide your files with clearly recognizable names (include your initials). Please be sure to label your CD or flash drive with your name so we can return it to you. If you are presenting in the afternoons, please get your presentation to us at the registration table 9am of the day you are presenting.

Slide and overhead projectors MAY BE available, but you must let us know in advance that you'll need this equipment. We will NOT have one dedicated to each room and need time to get them where they are needed.

Instructions for poster presenters:

Posters may be as large as 4 feet by 5 feet and will be directly affixed to the wall. Power outlets will not be available, but wireless internet access may be possible if arrangements are made in advance.

The poster session will take place on Saturday the 6th prior to the Banquet in the Pond Inlet balcony. Setup for the session will begin at 4:15.

Instructions session moderators:

Please arrive at the scheduled room a few minutes before the session is to begin. Please be sure that you check with speakers in your session about proper pronunciation of names. Each talk should last 15 minutes with 5 minutes of questions, try to keep to this schedule as we are running concurrent sessions. All talks should be preloaded onto the computer in your session's room. If a speaker is going over, ask them to leave the lectern. Thank you for agreeing to moderate at this year's OEEC.

Parking:

Pay parking is available in Zone 1 (item 4 on campus map). For those staying in residence, parking passes to S-Lot will be provided that are valid for the duration of your stay. Those staying at the Sheraton Four Points may find it easier to leave their cars there and walk to campus.

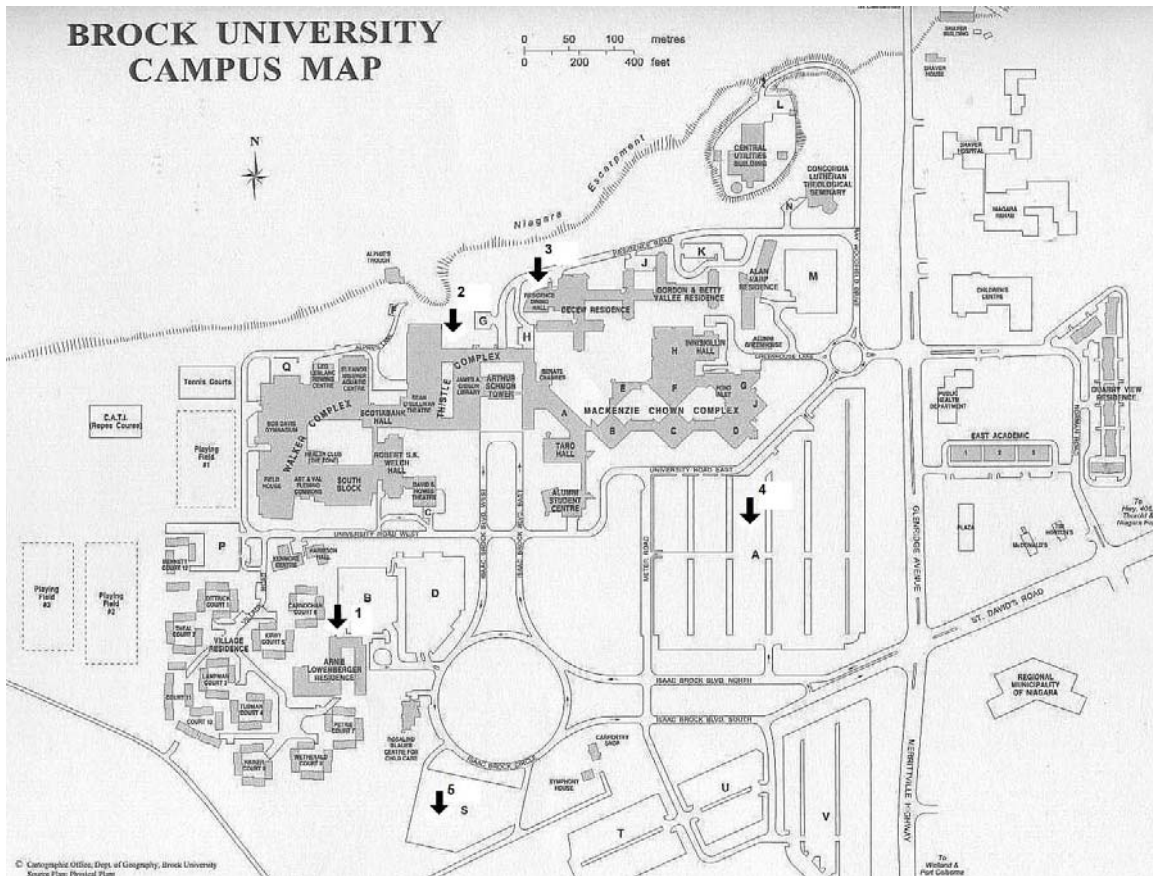
T-shirts:

T-shirts will be available for purchase at the registration desk. Each shirt will be \$13.00 and will be available in small, medium, large and extra-large sizes.

Phone Numbers:

Emergency Police/Fire/Ambulance	911
Campus Security Services	x4300 (non-emergency) x3200 (emergency)
First Aid Services	x3200
Brock U. Biology Department	x3388

Campus Map:



- 1) Arnie Lowenberger Residence
- 2) Thistle Complex
- 3) Decew Residence Dining Hall
- 4) Zone 1 pay parking
- 5) S-Lot pay parking

Meal and Banquet Information:

Breakfast:

Those staying in residence will have complimentary breakfast available at the Decew Residence dining hall (item 3 on campus map). Breakfast will be available there for anyone else who wishes it at their regular prices.

Lunch:

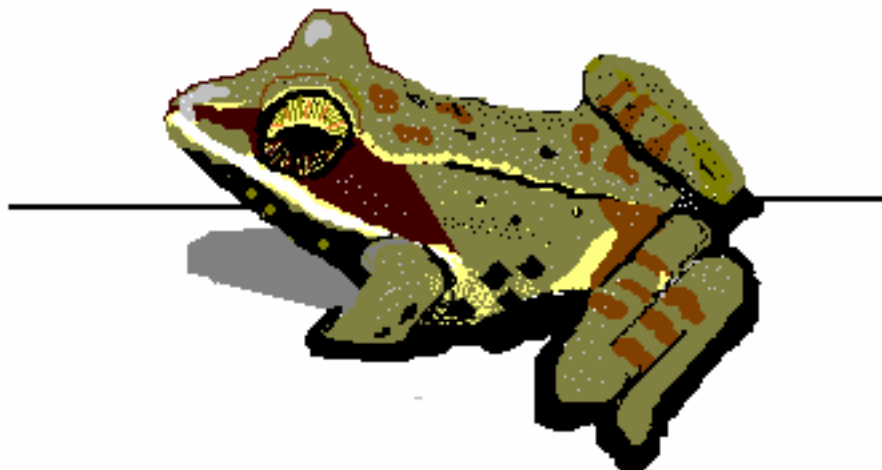
Lunch will be provided on Saturday, May 6th and Sunday, May 7th in the Thistle complex outside of room 325. Weather permitting, lunch will be eaten outside.

Refreshments:

Refreshment breaks will be held outside Thistle complex room 325.

Banquet:

The banquet will take place on Saturday, May 6th at 6:30pm in the same room as the poster sessions.



Schedule of Events

Day	Time	Event	Location	Notes
Friday, May 6th	4:00pm	Registration	Lowenberger	
	7:00pm	Registration Mixer	Lowenberger Lounge	
Saturday, May 7th	9:00-10:00	Plenary: B. Rosemary Grant	Thistle 325	-Sat. registration takes place in Thistle
	10:00-10:20	Break		
	10:20-12:00pm	Session One: Behavioural Ecology, Evolution and Aquatic	Thistle 245, 244 and 246	
	12:00-1:00	Lunch		
	1:00-2:00	Plenary: Lynda Corkum	Thistle 325	
	2:00-2:20	Break		
	2:20-4:00	Session Two: Behavioural Ecology, Evolution and Conservation Biology	Thistle 245, 244 and 246	
	4:15	Poster set-up		
	5:00-6:30	Poster Session	Pond Inlet	
	6:30-10:00	Banquet	Pond Inlet	
Sunday, May 8th	9:00-10:00	Plenary: Ellie Prepas	Thistle 325	
	10:00-10:20	Break		
	10:20-12:00pm	Session Three: Behavioural Ecology, Evolution and Neuroscience/Other	Thistle 245, 244 and 246	
	12:00	Lunch		
	1:00	Plenary: Marie-Josée Fortin	Thistle 325	
	2:00	Closing Remarks General Meeting		

Schedule of Oral Presentations

Time	<i>Behavioural Ecology</i>	<i>Evolution</i>	<i>Aquatic, Conservation, and more...</i>
Saturday AM	Thistle 245	Thistle 246	Thistle 244 <i>Aquatic Behav. Ecology</i>
10:20-10:40	M. Kasumovic	M. Johnson	A. Drake
10:40-11:00	M. Boisvert	S. Stewart-Williams	C. Kerling
11:00-11:20	S. Vijayan	M. Mallett	D. Linley
11:20-11:40	J. Gorrell	M. Peso	A. Valois
11:40-12:00	M. Moscicki		J. Richardson
	Moderator: C. Russell	Moderator: M. Peso	Moderator: J. Richardson
Saturday PM	Thistle 245	Thistle 246	Thistle 244 <i>Conservation Biology</i>
2:20-2:40	Y. Brandt	D. Punzalan	V. St. Amour
2:40-3:00	M. Andrade	A. Pischedda	K. Duncan
3:00-3:20	J.L. Fitzpatrick	J. Lindell	H. Kharouba
3:20-3:40	G. Burness	G. Dingle	J. Norghauer
3:40-4:00	A. Schulte-Hostedde		K. Marshall
	Moderator: A. Sharp	Moderator: S. Prager	Moderator: R. Kroeker
Sunday AM	Thistle 245	Thistle 246	Thistle 244 <i>Neuroscience/Other</i>
10:20-10:40	M.D. Biaggio	T. Kiyonari	N. Lee
10:40-11:00	K. Stiver	F. Chain	A. Mason
11:00-11:20	M. Sudan	J. Gibbs	M. Pereira
11:20-11:40	K. Judge	M.J. Fitzpatrick	V. Redwing
11:40-12:00	S. Matchett		H. May
	Moderator: K. Judge	Moderator: M.J. Fitzpatrick	Moderator: H. May

Plenary Speakers

Dr. Barbara Rosemary Grant-Princeton University

Dr. Grant is interested in the diversity of individuals produced by the interaction between genetics, ecology and behavior. How natural selection acts on this variation; the evolutionary response to natural selection and the bearing this has on the process of speciation.

A fundamental problem in the study of evolution is to understand the steps involved in the process of speciation, because the question of how one species splits into two addresses the foundation of the biodiversity we see around us today. Yet there is much controversy about the process of speciation. Debates center around, the extent of the role of genetic variation, past history and geography in lineage divergence and the role of genetic variation, behavior and learning as factors in the formation of reproductive barriers to gene flow between closely related sympatric species, and whether or not speciation can occur in sympatry.

Dr. Lynda Corkum—University of Windsor

Potential Control of an Invasive Fish, the Round Goby, using Pheromones

The success of the invasive fish, the round goby (*Neogobius melanostomus*) may be due to its pheromonal communication between males and females during reproduction. We hypothesize that reproductive males (RM) release pheromones into the water that attract females to nests and deter males. Histological and biochemical studies showed that specialized glandular tissue in the male reproductive system produce androgen steroids, two of which (11-oxo-etiocholanolone (ETIO) and 11-oxo-ETIO-sulfate) are novel compounds in teleosts. Lab experiments showed that males do not respond (positively or negatively) to conspecific male odours (washings). In contrast, ripe females exposed to RM washings spent more time near the odour source, swam faster, and swam directly to the odour source when compared with responses to control water. When responses of females were tested against blends of synthesized steroids found in male round goby gonads, there was an overall significant difference between treatment and control, but no difference in response between reproductive and non-reproductive females. Different blends of steroids did not elicit differences in behavioural responses by females. Although females are attracted to the total blend of steroids, responses by females to male washings are more dramatic. Thus, the blend of identified steroids is likely missing an active ingredient.

Dr. Ellie Prepas-Lakehead University

Canada Research Chair in Sustainable Water Management and the Boreal Forest

Dr. Ellie Prepas is an internationally recognized expert on cyanobacterial toxins, their occurrence and treatment options in lakes. Federal and provincial governments are using her earlier work as a basis for developing guidelines for use of water containing toxic phytoplankton blooms for recreation and drinking.

Dr. Prepas focuses on the collection and organization of an appropriate database on fresh water in the Boreal (northern) Forest and the development of tools to link those data with current modelling efforts for sustainable landscape or watershed management. The intent is to develop strong linkages between surface water quality, bioindicators and landscape management models.

The modelling approach to be used in the research will be integrated into detailed forest management plans of forest companies over the next five years.

Dr. Marie-Josée Fortin-University of Toronto

Management decisions regarding conservation reserve design are dependent on our ability to characterize landscape spatial heterogeneity and its effects on species biodiversity and persistence. Understanding species spatial habitat requirements in fragmented forested landscapes can increase our ability to maintain species biodiversity at the landscape scale. Here, I present a method of using spatial graph theory to identify a network of patches that maximizes habitat connectivity in multi-use forested landscapes with a fixed conservation area budget. A case study in a forest management unit in Québec is presented to illustrate the utility of combining spatial graph measures with geomatic approaches to prioritize patches for inclusion in a spatial reserve network.

Oral Presentation Abstracts (Alphabetical by Presenter's last name)

Adaptationist lessons from the edge: sacrificial redback spiders dismantle spandrels

Maydianne CB Andrade*

University of Toronto at Scarborough

Gould and Lewontin's influential paper (1979) emphasizes errors in the adaptationist program. Loose interpretation of this paper has led to frequent invocations of constraints in explanations of behavioural evolution. I use empirical research on self-sacrificial male redback spiders (*Latrodectus hasselti*) to question whether this is the most productive approach to understanding behaviour. I consider two contexts in which redback males are faced with situations that strongly favour solutions that might be considered impossible to a constraint-focused researcher. Male redback spiders facilitate sexual cannibalism by females during mating by moving the posterior portion of their abdomen over the female's mouthparts. The female begins to eat the male during sperm transfer. However, a complete mating requires two copulations; one with each of the female's paired, independent sperm storage organs, and males must achieve that second copulation despite the significant injury inflicted during the first copulation. I show that males have a unique trait that allows them to survive partial cannibalism by their voracious mates and thus achieve complete copulations. Second, I show males are able to detect and preferentially inseminate previously-unused female reproductive tracts despite the absence of any known sense organs or cues with which such discrimination might be accomplished. I conclude by supporting Alcock's (1998) argument that the constraint-based approach to studying behaviour may severely restrict the range of hypotheses considered plausible, and thus may unnecessarily retard development of understanding. **(Behavioral Ecology)**

Experienced females leave their options open: evidence for cryptic choice in redbacks

M. Daniela Biaggio* & Maydianne C. B. Andrade

University of Toronto at Scarborough

Factors controlling female mating decisions are poorly understood, but recent work suggests information gathered by juveniles might affect adult mating behaviors. Female Australian redback spiders (*Latrodectus hasselti*) encounter 0-8 males in nature, yet sometimes remain unmated. Choosiness should be affected by this risk. Adult males often cohabit in webs with sub-adult females, so females may use male presence to gauge the future availability of mates. We predicted females that cohabit with males as sub-adults would be choosier than those who cohabit with younger juvenile females or who were reared in isolation (controls). We measured adult choosiness as the number of copulations obtained by a separate set of males in staged matings following cohabitation. Females have paired reproductive tracts, in each of which the first male to mate deposits a sperm plug and achieves sperm precedence. Thus males achieve 100% paternity only if they copulate twice. In our study, as predicted, females that had cohabitated with males manipulated paternity by frequently restricting males to 1 or 0 copulations, while females in both control treatments usually permitted 2 copulations (cryptic choice). Females controlled mating through aggression or fatal cannibalism of males after a single copulation. Thus females may use sub-adult experience to increase the possibility of polyandry (by preventing sperm

precedence) when males are common. In contrast, females are less choosy and reduce the risk of remaining unmated when males are rare. This study indicates that laboratory research on mating behavior should consider potential mating bias introduced by isolating females, particularly in species where juvenile social interactions are common. **(Behavioral Ecology)**

Bumble bees (*Bombus impatiens*) can estimate multiple durations in concurrent fashion

Michael J. Boisvert* and David F. Sherry
University of Western Ontario

All environmental events can be defined temporally by their location in time, their position in a sequence, and their duration. It is therefore expected that temporal sensitivity and the ability to adjust behavior to the temporal structure of the environment should be phylogenetically widespread. Little is known, however, about invertebrates' ability to time durations. Bumble bees responded to the time elapsed between successive food rewards with proboscis extension responses that were reinforced after either a fixed interval of time or on a schedule in which time intervals of different durations were mixed. Behavior varied as a function of time under both simple and mixed timing conditions. In simple interval conditions, maximal proboscis extension rates occurred near the end of the interval while in mixed interval conditions, maximal rates were clustered around short and long interval values. Bumble bees learned rapidly to time interval durations and flexibly timed multiple durations simultaneously. **(Behavioral Ecology)**

Jaws of life: allometry and function of spider chelicerae

Yoni Brandt* & Maydianne Andrade
University of Toronto

The chelicerae (jaws) of spiders in the genus *Tetragnatha* serve an unusual function and are conspicuously elongated, often exceeding the carapace in length. In addition to the ubiquitous functions of subduing prey and fighting with rivals, the chelicerae are employed for clasping and securing the partner in copulation. The degree of jaw elongation within *Tetragnatha* varies considerably between age classes, size classes, sexes and species. In many animal taxa, copulatory appendages show negative allometry (relative appendage size decreases as body size increases) whereas appendages used in fighting and display are positively allometric (relative appendage size increases with body size). Herein we describe patterns of variation in adults, as a step toward elucidating the selective pressures and constraints that shape the length of chelicerae in *Tetragnatha*. Jaw elongation is absent in juvenile instars, detectable in the penultimate instar, and highly developed in the adults. Females are moderately larger than males in body length, yet in all species, the chelicerae of males are longer than female chelicerae. Among species, male jaws are moderately positively allometric, whereas female jaws are highly positively allometric. Hawaiian species are smaller than North American species, and the allometric coefficients in both sexes are lower in the Hawaiian species than in the North-American species. Male and female body length and jaw length are significantly correlated. In *T. guatemalensis*, a North American species, male and female allometric coefficients are similar in magnitude to inter-specific allometric coefficients. We discuss the potential of size- assortative mating and patterns of intra-specific body size variation to account for patterns of Tetragnathid jaw elongation. **(Behavioral Ecology)**

Energetics and individual quality in tree swallows

Gary Burness*
Trent University

Within any population, some individuals consistently achieve higher reproductive success than others of similar age and breeding experience. Using tree swallows as a model, I have tried to understand some of the factors that help to define individual “quality”. In tree swallows, adults rearing naturally large broods of nestlings are presumed to be of higher quality than individuals with smaller broods. I have shown that adults rearing large broods spend less energy per nestling than adults rearing small broods. Despite this, the growth rate of individual nestlings does not vary with brood size. I hypothesize that adults rearing large broods have higher foraging efficiency, possibly due to differences in foraging strategy or skill levels. Among swallows rearing broods of the same size, females (but not males) with higher daily energy expenditure have faster growing nestlings, a presumed correlate of fitness. The ability to attain high energy expenditure seems dependent on a high digestive capacity, which may entail elevated costs of self-maintenance. To explore the potential trade-off between adult self-maintenance and offspring quality, I have immunochallenged adults and nestlings at two breeding sites differing in food availability. Adults at the low food site did not have a depressed cell-mediated immune response or elevated basal levels of corticosterone. Nestlings at the low food site grew more slowly however, suggesting adults were unwilling to sacrifice their own self-maintenance for the benefit of increased offspring quality. **(Behavioral Ecology)**

Multiple Mechanisms Promote the Retained Expression of Duplicate Genes

Frederic Chain* and B. Evans
McMaster University

Gene duplications can facilitate genetic innovation and catalyze reproductive incompatibilities and adaptive radiation. The mechanisms that maintain the expression of both gene copies can exhibit coding region changes that might add, compromise, or not affect protein function. We tested the applicability of three types of mechanisms for promoting the retained expression of duplicated genes in 290 expressed paralogs of the tetraploid clawed frog, *Xenopus laevis*. Tests were based on explicit expectations concerning the k_a/k_s ratio, and the number and location of substitutions after duplication. Results provide evidence for multiple mechanisms acting within the same genome, within the same functional classes of genes, within the same period of time following duplication, and even on the same set of duplicated genes. Each copy of a duplicate gene may be subject to distinct evolutionary constraints, and this could be associated with degradation or enhancement of function. The evolution of most *X.laevis* paralogs is consistent with retained expression via mechanisms that do not radically alter functional constraints, such as selection to preserve post-duplication stoichiometry or temporal, quantitative, or spatial subfunctionalization. **(Evolution)**

The reproductive success of war heroes

Greg Dingle*

McMaster University

Non-kin based altruism is difficult for evolutionists to explain. Yet people across the world are known to perform acts of extreme altruism that appear to clash with their fitness interests. Individuals who perform these acts are typically praised by their communities. Their actions are deemed "heroic". This public reaction suggests possible benefits to these individuals, such as increased attention prestige and attractiveness. If heroic acts conferred increased reproductive success among our ancestors, then heritable traits that underlie heroism could have been selected for. Alternatively, heroic acts may garner only momentary gratefulness and fleeting praise. To test whether heroism can affect reproductive success, I investigated 57 male US Medal of Honor recipients from WWI. I found that the Medal of Honor recipients were more likely to have married and had more children than other comparable groups of veterans, independent of age, socioeconomic status and geographic factors.

Environmental factors affecting growth of Eastern sand darter, *Ammocrypta pellucida*, in the lower Thames River, Ontario

A. Drake*, M. Power, M. Koops, S. Doka, and N. Mandrak

University of Waterloo

Environmental factors affecting growth of Eastern sand darter, *Ammocrypta pellucida*, in the lower Thames River, Ontario. Environmental factors affecting growth of the threatened eastern sand darter, *Ammocrypta pellucida*, were analyzed from specimens ($n = 395$) sampled in the lower Thames River, Ontario, in July 2005. Length-at-age and corresponding growth increments were back-calculated from scale samples using the Fraser-Lee method. During the first of three years of life 86.03% ($\pm 0.81\%$ at $\alpha = 0.05$) of total length is attained, suggesting considerable energetic partitioning towards reproduction following age 1. Growth history analysis was segregated given the significance between young-of-the-year and age 1+ length increments. Stepwise multiple regression between length-at-age and environmental factors identified positive relationships between mean 2005 young-of-the-year growth increments and sand substrates and between mean seasonal 2001, 2002, 2003, and 2004 young-of-the-year growth increments and mean annual channel discharge. Negative relationships were present between mean 2005 young-of-the-year growth increments and silt substrates. Seasonal young-of-the-year and age 1+ growth increments correlated negatively with mean ambient air temperature, but lacked significance. The combined effects of environmental factors posit critical habitat features (substrate, channel discharge) as largely influencing mean seasonal growth increments. **(Aquatic Ecology)**

How increasing the number of protected areas impacts species at risk

K. Duncan*, H. Kharouba and J.T. Kerr

University of Ottawa

Rates of species endangerment in Canada are comparable to those of developing countries, primarily due to habitat conversions to agriculture. One way to stem further losses and to promote recovery of species at risk is to set aside new protected areas or expand existing ones.

In Canada, the Mixed Wood Plains ecozone, the smallest and most pervasively altered region of Canada, has the highest number of species at risk ($n=98$). Recently, two new protected areas (St Williams Forest and the Oak Ridges Moraine) were added to the reserve system, both in areas where there are many species at risk. This study tests the prediction that these new reserves will improve the performance of the existing reserve network with respect to including additional species at risk within their boundaries. Mean number of species per reserve and the mean species redundancy (i.e. the average number of parks that intersect species' ranges) were compared for protected areas before and after the new reserves were added. Also, the number of species at risk included within the boundary of the actual reserve network was compared to randomly generated reserve networks. This comparison was conducted both before and after the addition of the new reserves. While the results from this study indicate that the new reserves enhance endangered species protection, the increase is not significant ($p>0.05$). Although these reserves improve the outlook for endangered wildlife, species outside any protected area are distributed idiosyncratically, underscoring the urgent need to integrate conservation into day-to-day land uses. **(Conservation Biology)**

Rapid increases in reproductive investment in a cooperatively breeding fish

J.L. Fitzpatrick*, J. K. Desjardins, K. A. Stiver, R. Montgomerie, S. Balshine
McMaster University

One of the outstanding puzzles in cooperative breeding lies in understanding how reproduction is partitioned among group members. While dominant individuals may attempt to suppress the reproduction of subordinates to maintain reproductive primacy, subordinates may attempt to steal reproductive opportunities, potentially leading to intense and pervasive sperm competition between dominant and subordinate individuals. If behavioural subordinates are suppressed, then subordinate investment in reproduction should be less than dominant individuals, but if sperm competition occurs widely then behaviourally subordinate individuals are expected to invest substantially more in reproduction. To examine these predictions we compared reproductive investment in dominant male breeders and subordinate male helpers of the cooperatively breeding cichlid *Neolamprologus pulcher* from Lake Tanganyika, Africa. Reproductive investment followed patterns consistent with reproductive suppression, not sperm competition, with male breeders investing considerably more in reproduction than helpers. We then experimentally removed male breeders from different social groups, allowing large male helpers the opportunity to ascend in social status. Changes in social status, from helper to breeder, elicited a rapid behavioural response, with ascending males performing more dominant behaviours than control males. Ascending male helpers showed a dramatic increase in gonadal investment, having relatively greater investment in testes than male helpers that remained in subordinate social positions. There was also a trend towards greater sperm swimming speed in ascending males. These findings demonstrate that social status strongly influences male reproduction investment patterns in *N. pulcher*. **(Behavioral Ecology)**

Maintenance of polymorphic foraging strategies by frequency-dependent selection

M.J. Fitzpatrick*, E. Feder, L. Rowe and M.B. Sokolowski
University of Toronto at Mississauga

Negative frequency-dependent selection is believed to be a powerful and prevalent evolutionary force that maintains polymorphisms in nature. If the relative fitness of each of a pair of alleles increases when it is rare in the population, then each allele can only achieve its highest fitness when the other is present in the population at high frequencies. We explored whether the rover/sitter behavioural polymorphism found in larvae of the fruit fly *D. melanogaster* can be maintained by negative frequency-dependent selection. This has become a model system for behaviour genetics since it directly links allelic variation within a gene to variation in behaviour and orthologs have been recently found to influence similar behaviours in additional organisms. In fruit fly larvae, rovers and sitters arise mainly from allelic variation in the foraging gene. Rovers feed less but move more than sitters when foraging on a food patch. Rovers are also more likely to explore new food patches than sitters. We find that when raised under a constant density and in conditions known to impose a stress on survival, rovers attain their highest relative fitness when rare in the population (outnumbered 3 to 1 by sitters). Likewise, sitters attain their highest fitness when they are similarly rare in the population. Moreover, the involvement of the foraging gene was further confirmed using a mutant (a sitter generated on a rover genetic background) in place of the natural sitter strain. These results imply that rovers and sitters can be stably maintained in nature by negative frequency-dependent selection. Our study is important since we provide a rare example of negative frequency-dependent selection maintaining naturally occurring allelic variation at a single locus.

An integrative taxonomic approach to the problematic bee subgenus *Dialictus*

Jason Gibbs*
York University

Bees play a vital role as pollinators of both wildflowers and agricultural crops worldwide. But pollination services worldwide are in decline. Evidence also suggests that bees may be excellent predictors of ecosystem health, because they are more extinction prone than almost all other organisms. Despite their importance, our knowledge of bee species richness is poor. Identification and classification of species is integral for the understanding of biology and so an efficient taxonomy is a prerequisite for the development of sustainable use of natural and anthropogenically altered systems. **(Other)**

Are individuals in good condition “healthy”? A test using American red squirrels.

J. Gorrell* and A. Schulte-Hostedde
Laurentian University

Body condition, determined by the residuals from a regression of body mass on structural size, is presumed to reflect individual energy reserves. A major assumption is that individuals in good condition are better able to withstand ecological stressors (e.g. disease) and are thus healthier than individuals in poor condition. Aspects of health, including hormone levels and the immune function may play a major role with respect to individual quality. The idea that animals in good condition are healthy has never been tested. A wild population of American red squirrel (*Tamiasciurus hudsonicus*) from Algonquin Provincial Park, Ontario, Canada, was used to determine whether body condition reflects physiological health. Ectoparasite load, hematocrit and testosterone levels were used to test the prediction that individuals in good condition are

healthier than those in poor condition. Hematocrit and parasite load were not related to body condition, but body condition was positively related to testosterone at the beginning of the second breeding cycle. These results reveal that body condition is not a reliable estimator of parasite load or hematocrit but support the suggestion that high levels of testosterone are energetically expensive and can only be maintained by individuals in good condition. **(Behavioral Ecology)**

GxE causes variable selection on life-history strategy in Common Evening Primrose

Marc Johnson*

University of Toronto

Monocarpic plants, where reproduction is fatal, frequently exhibit variation in the length of their pre-reproductive period prior to flowering. If this life-history variation in flowering strategy has a genetic basis, genotype- by-environment interactions (GxE) may maintain phenotypic diversity in flowering strategy. The native monocarpic plant Common Evening Primrose (*Oenothera biennis* L., Onagraceae) exhibits variation for annual versus biennial flowering strategies. I tested whether there was genetic variation for flowering strategy in *O. biennis*, and whether environmental variation causes GxE that imposes variable selection on flowering strategy. In a field experiment, I randomized >900 plants from 14 clonal families (genotypes) into five distinct habitats that represented a natural productivity gradient. GxE strongly affected the lifetime fruit production of *O. biennis*, with the rank-order in relative fitness of genotypes changing substantially between habitats. I detected genetic variation in annual versus biennial strategies in most habitats, as well as a GxE effect on flowering strategy. This variation in flowering strategy was correlated with genetic variation in relative fitness, and phenotypic and genotypic selection analyses revealed that environmental variation resulted in variable directional selection on annual versus biennial strategies. Specifically, a biennial strategy was favoured in moderately productive environments, while an annual strategy was favoured in low productivity environments. These results highlight the importance of variable selection for the maintenance of genetic variation in the life-history strategy of a monocarpic plant. **(Evolution)**

Condition-dependence of male lifetime reproductive effort in a field cricket.

Kevin Judge* and Janice Ting

University of Toronto at Mississauga

Darwin suggested that males with extreme sexual ornaments suffer a survival cost due to their increased conspicuousness to predators and/or increased energetic cost. However, a recent meta-analysis found that the predominant trend was for males with the most elaborate sexual ornaments to survive longest. This result suggests that there is usually no trade-off between male reproductive effort and survival, and is consistent with the oft-reported observation that females prefer older males. In crickets, males call to attract females, but increased calling effort is costly in terms of predation and energy expenditure. Females of the fall field cricket, *Gryllus pennsylvanicus*, are more likely to mate with older rather than younger males. If there is no trade-off between male reproductive effort (time spent calling) and survival in this species, then high-quality male *G. pennsylvanicus* should: 1) survive longer than low-quality males and 2) invest more in calling effort throughout their lives than low-quality males. To test these predictions, we individually-reared field crickets from hatching to death on three diets: high-, medium- and low-quality. We found no evidence of a trade-off between male reproductive effort and survival as there was a highly significant positive relationship between average nightly calling

effort and lifespan that did not differ among the three diet treatments. These results are in stark contrast to work on another species of field cricket, and highlight the possibility that differences in ecology may explain why individuals of different species allocate resources differently to competing life history traits. **(Behavioural Ecology)**

Male development tracks rapidly shifting sexual versus natural selection pressures

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It is a central tenant of evolutionary biology that natural and sexual selection often work in opposition to shape phenotypic distributions. Australian redback spiders (*Latrodectus hasselti*) show large variation in male quantitative traits. We show redback males have tactical, condition-dependant developmental shifts tracking fluctuations in the relative importance of competition and mate searching survival. Juvenile males exposed to pheromonal cues of different conspecific densities rapidly shifted development time and adult size to match the selective context likely to be faced upon maturity. We demonstrate shifted phenotypes are optimum for the conditions in which they arise. Males matured smaller and more rapidly at high females densities. In these conditions, mate searching mortality is minimal, but first male sperm precedence imposes strong selection for finding virgin females. As predicted, small males outcompeted larger males in scramble competitions. At low female densities, males matured larger and outcompeted smaller males in the direct competitions more likely under these conditions. Larger males are also more likely to survive arduous mate searching. Thus continuous variation in male traits critical to competitive success arose from adaptive, context-dependent plasticity. This contradicts the common emphasis on heritable variation in the ability to acquire sufficient resources to reach some optimum trait value (e.g., large size). Moreover, this highlights the importance of context-specific tests of fitness. We propose that male phenotypes alone are not good indicators of fitness, and quality should instead be measured as the ability to develop tactically in response to cues of environmental and selective heterogeneity. **(Behavioural Ecology)**

Efficacy of anti-predator behaviour in wood frog tadpoles (*Rana sylvatica*)

Candice L. Kerling* and Jean M.L. Richardson
Brock University

Tadpoles are vulnerable to predation, but they can reduce risk by lowering their activity. To test the efficacy of reduced activity level in wood frog tadpoles (*Rana sylvatica*), tadpoles from three populations were subject to three predator treatments (uncaged predator, caged predator, and no predator) for two natural predators (Notonectidae and *Anax junius*). The number of tadpoles active was surveyed both at the start and end of a 24 hour test period, and mortality examined in the uncaged predator treatment. Proportion of tadpoles active decreased as predation risk increased. Predator type did not affect tadpole behavioural response or mortality rates. Predation rates did differ among the three populations studied. These results combined suggest tadpoles respond to predation risk in a complex and population-specific manner. Future work will look for non-additive effects of multiple predators and examine neighbour effects on survivorship. **(Behavioral Ecology)**

The effectiveness of protected areas in Canada given recent global changes

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There is increasing evidence that global changes (i.e. climate and land use) have affected the distribution of several taxa. This redistribution is expected to alter the species assemblages of parks as ranges shift relative to these areas. Here, we studied the impacts of recent global changes on the distribution of Canadian butterfly species within protected areas. We measured change in species richness and turnover for 187 butterfly species in long- established protected areas networks across two epochs (1880-1949 and 1950-2000) using recently established distribution modelling techniques. To determine the effectiveness of these reserve networks, we compared richness change in the networks within each ecozone to randomly selected areas using a null model. Butterfly species richness has generally increased throughout Canada in the past century. Richness change in the random reserve network was the same as the actual network in all ecozones. Species composition remained similar in long- established reserves in most ecozones. Although species ranges have shifted relative to reserve boundaries, these results suggest there has been minimal species turnover. Since protected areas were not particularly effective at buffering species against recent global changes, it is unlikely that they will be successful at conserving diversity into the future given that environmental changes are expected to accelerate. **(Conservation Biology)**

Punishing doesn't yield a solution to the problem of cooperation but rewarding does

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Cooperation within non-kin groups presents an evolutionary puzzle. Punishment can sustain cooperation, but the provision of such "altruistic punishment" suffers from a second-order free-riding problem since non- punishers can free-ride on the costly punishment provided by others. A possible solution to this problem is "second-order punishment" of non- punishers; more generally, the threat or promise of higher-order sanctions might be what maintains the lower-order sanctions that enforce cooperation in collective action problems. In a previous study, we found that voluntary second- order punishment was very rare, but second-order rewarding was common enough to cover the costs of first-order rewarding. The present study extended these findings by showing that people typically didn't reward those who "altruistically" punished non-cooperators, but did punish those who failed to reward cooperators. This suggests that people are more inclined to reward those who deliver altruistic benefits than those who deliver altruistic punishment, and thus that rewards may have played a more important role than punishment in the emergence of human non-kin cooperation. **(Evolution)**

How a fly knows what's what and where it is

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Ormia ochracea are acoustic parasitoids of singing crickets that possess a specialised auditory system capable of accurate sound source localisation. Directional hearing functions solely in the

context of localising the 5 KHz tone pulses of host cricket calling songs. Correct phonotaxis involves both recognition and accurate localisation of a sound source, and both of these tasks require precise measurements of time intervals between sound pulses originating from the same source. However, the natural auditory scene is often complex as multiple signalers may produce sound pulses that overlap in time, therefore masking temporal cues used in these auditory processing tasks. Indeed, behavioural experiments have previously shown that flies misdirect their phonotaxis behaviour under certain stimulus conditions. We use stimulus conditions with known behavioural responses and simultaneous summed nerve recordings from the left and right auditory tract to describe neural response parameters that correspond with correct and incorrect phonotaxis behaviour. Results indicate that summed nerve response amplitudes are dependent on the duration of the time interval between arriving sound pulses. Responses from the left and right auditory tract are equal in amplitude to the first set of competing pulses for all stimulus conditions. Response amplitude to subsequent pulses decrease when competing sources overlap in time, with most prominent amplitude decreases observed in response to a contralateral sound source. This study is the first step to describing auditory processing of multiple sound sources in *Ormia* and neural response parameters are found to be consistent and can predict correct and incorrect phonotactic responses. **(Behavioral Ecology)**

Sharp mtDNA contact zones contradict ongoing gene flow in Baja Californian lizards

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Contact zones have been described as “natural laboratories for evolutionary studies” where evolutionary processes such as natural selection, development of isolation mechanisms, and speciation can be studied. Contact zones have historically been viewed as evolutionary intermediate stages of relative short time span, terminated either by resumed gene flow leading to reunion of differentiated populations or by the development of isolating mechanisms leading to speciation. We present an old and remarkably sharp contact zone in mitochondrial DNA in the black-tailed brush lizard (*Urosaurus nigricaudus*) of Baja California, as evaluated by cline analysis of more than 150 specimens. A deep genealogical pattern and genetic divergence estimates of approximately 11% along with geological evidence suggest that the opposing lineages are of late Miocene age and were reunited approximately 5 million years ago. However, allozyme variation strongly contrasts this pattern of deep mitochondrial divergence by suggesting little or no population differentiation across the contact zone. Similar patterns have been found in other lizard species. The conflicting patterns require that an undiscovered mechanism must maintain the sharpness of the mtDNA cline and yet allow nuclear gene flow that prevents speciation. We discuss the differences in maternal and biparental histories across the contact zone and suggest plausible mechanisms for the highly discordant patterns. **(Evolution)**

The maintenance of genetic variation for fitness in an unchanging environment

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Queen's University

The occurrence of substantial genetic variation for fitness, even in laboratory populations maintained under constant conditions, presents a question that is central to evolutionary genetics. The forces maintaining this variation in large outbred sexual populations have received little direct

empirical study, despite much theoretical work. Part of the problem is that net fitness is a slippery measure; its components may be negatively correlated and it is sensitive to the genetic and environmental context in which it is measured. We can use laboratory-adapted populations to overcome these difficulties because their well-defined lifecycles make total fitness directly measurable. Using a population of *D. melanogaster* isolated in 1975 and maintained at large population sizes under relatively constant conditions, we propose to quantify the factors which contribute to the maintenance of genetic variation for total fitness in an unchanging environment. Genetic variation for net fitness will be measured using hemiclone analysis, which allows us to isolate haploid genomes from the base population and measure their average fitness effects. Fitness of these haploid genomes will be assessed both when expressed as males and as females, giving us an estimate of their sex-dependent fitness effects. Using this system, we will also assess the impact of mutation on the entire genome without the artefacts associated with inbreeding as well as examine the contribution of interactions between whole genomes in determining individual fitness. Together, these experiments will yield insights into the genetic structure of fitness in *D. melanogaster*, and the forces which create and maintain genetic variation in the ultimate currency of selection. **(Evolution)**

Seismic signal production in a wolf spider: parallel vs multicomponent signals

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Animal signals can consist of multiple parts within or across sensory modalities (multi-component signals or multimodal signals). While recent work has focused on multimodal signals, the production, processing and evolution of multi-component signals has received considerably less attention. Here, using synchronous highspeed video and laser vibrometer recordings followed by experimental manipulations of putative sound-producing structures, we explored the mechanisms of seismic signal production in the courtship display of *Schizocosa stridulans* Stratton. Two types of seismic courtship signals were observed. Revs consist of a high-frequency component produced by flexions of the male pedipalp (stridulation) simultaneous with a low-frequency component produced by movements of the abdomen (tremulation). This multi-component signal is produced by independent structures and represents a parallel multi-component display. By contrast, idle displays consist of a high-intensity component produced by drumming of the forelegs on the substrate (percussion) followed by a high-frequency component produced by flexions of the male pedipalp (stridulation). While the components of the idle display are also produced by independent structures, the leg drumming and palp flexions occur serially and do not overlap in time. We discuss the selective pressures that may drive the evolution of multiple sound-producing structures as well as the selective pressures that drive the evolution of parallel versus serial multi-component signals. **(Ethology/Neuroscience)**

Does scent reinforcement affect spatial learning in a nocturnal gecko?

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In their natural environment, animals must navigate around their home range in order to find the optimum shelter, food source and mate selection. In animals with a known affinity for a discrete

home range, individuals use a variety of indicators to identify the most advantageous choice available. Discerning how reptiles negotiate their way through life has been extensively studied but rarely in the context of chemosensory cues. Also, maze-learning and orientation studies have been confined to typically only the specific task at hand and not relative to condition of the reward (be it food, heat, shelter, mate, etc.). Velvet geckos (*Oedura lesueurii*) are highly selective in habitat choice and suitable retreat-sites are chosen based primarily on thermal preferences, social interactions and predator avoidance. Previous experiments have shown avoidance of predators to be of higher priority than thermoregulation, yet in other trials, social interaction (presence of a larger male) took precedence over predator avoidance. Based results of an extensive, long-term field study, laboratory experiments were carried out to gauge the extent to which chemosensory navigation and memory are involved in retreat-site selection. We tested the hypothesis that location and condition of a favourable retreat-site can be learned, and whether a non-threatening scent cue reinforces that learning. The results of the learning trials and implications for further field studies will be discussed. **(Behavioral Ecology)**

Responses of Crayfish to a Reflective Environment Depend on Dominance Status

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Previous research has shown that several aspects of behaviour exhibited by socialized crayfish are modified by mirrors or by the reflection in a glass aquarium. Socialization of crayfish is known to generate a dominance hierarchy composed of dominant and subordinate animals. The present study tested the hypothesis that responses to a reflective environment depend on dominance status. 50 crayfish were maintained in pairs for two weeks to establish stable dominance ranks. 25 crayfish were isolated for two weeks and used as a control group. All crayfish were observed in an aquarium in which half of the walls were lined with mirrors and the other half were lined with non-reflective plastic. Dominant crayfish spent significantly more time on the reflective side of the aquarium than on the non-reflective side, while subordinate and isolated crayfish showed no preference. Dominant crayfish spent more time in reflective corners, turned more frequently toward reflective corners and crossed more frequently toward reflective walls. Such differences were not observed for subordinate or isolated crayfish. Subordinate crayfish exhibited more reverse walking on the reflective side of the aquarium than on the non-reflective side, but other groups did not. Thus, responses to a reflection depend on dominance status. Future research will use heart rate recordings to examine the physiological state of crayfish while exploring a reflective environment. Research supported by NSERC. **(Ethology/Neuroscience)**

Performance and herbivory of tropical tree seedlings after experimental defoliation: effect

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Despite the posited importance of insect herbivory in affecting tropical tree populations and the vulnerability of seedlings, herbivory of juvenile plants and interactions with biotic and abiotic factors have rarely been examined in concert. Here, we tested predictions of several key hypotheses, including the Limiting Resource Model (LRM), the Plant Vigour Hypothesis (PVH), and the Janzen-Connell Mechanism (JCM). We outplanted mahogany (*Swietenia macrophylla*

King) juveniles into canopy gaps and understorey and compared their performance under simulated attack by a specialist caterpillar (*Steniscadia poliophaea*) by clipping 0%, 10%, 50%, or 90% of leaf area. Seedling performance and natural herbivory were measured over the subsequent 8 mo. Predictions from the hypotheses were supported in all cases. As predicted by the LRM, juveniles in gaps tolerated simulated herbivory very well (3% died), whereas 79% of severely damaged (90% clipped) understorey juveniles died. However, moderate to severe simulated herbivory (50% and 90%) reduced gap juveniles' above-ground growth by 36% and 56% respectively and resulted in smaller-sized leaves being produced (irrespective of canopy cover). As predicted by the PVH, gap juveniles consistently produced more and larger leaves than understorey juveniles, but also suffered greater percent post-clipping herbivory (up to 100% leaf area lost) than in the understorey. All gaps were discovered by the specialist folivore, whereas it caused damage at only ~30% of understorey locations. Support for JCM was limited to the wet months and was influenced by canopy cover. Early-wet season herbivory to gap juveniles increased with total conspecific adult numbers and dbh within a 125-m radius, but not in the mid-wet months; whereas more understorey juveniles were attacked near (<50 m) reproductive adults in both early- and mid-wet months. Collectively, our results suggest that *S. poliophaea* can function as both a distant- and density-responsive enemy; and hence is capable of generating strong Janzen-Connell effects on juvenile growth and limiting recruitment of *S. macrophylla* in this forest. We conclude that a richer, more comprehensive picture of Janzen-Connell type plant-insect dynamics can emerge by integrating light availability in tropical forests and its consequences for host-plant tolerance, vigour, and susceptibility to natural enemy attacks. **(Conservation Biology)**

Usefulness and the Picturesque: An Experiment in Ecocriticism

Michael Pereira*
Brock University

Deep ecologists Bill Devall and George Sessions once remarked that the environmental crisis resultant of technocratic-industrial societies is increasingly "coming to be understood as a crisis of character and of culture". This paper is an experiment in a kind of cultural criticism which centres on just such a point of view. Through a brief overview of ecocritical methodology followed by a detailed case study this paper explores the potential for an ecologically informed criticism to begin unearthing the historical and cultural roots of the contemporary environmental crisis. The paper begins with an examination of what "ecocriticism" is and a brief profile the field's evolution. Following this is a detailed case study comparing Christopher Columbus' "Journal from the First Voyage to America" to Ralph Waldo Emerson's essay "Nature", which endeavours to demonstrate how the ecocritical method can be applied textually, and the possibilities it opens for deeper reconsideration of cultural history. In conclusion, I suggest that while science and technology have served as manifestations of a deep cultural pathos, it is ultimately our culture, indeed our very attitudes and perceptions of nature that must evolve if we are to survive. **(Other)**

Influence of body size on egg size in solitary and eusocial bees

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Fully developed bee oocytes (eggs) are sausage-shaped, slightly curved and variable in size. Egg size varies across bee species in accordance with the level of sociality (Michener 1974), solitary bees laying the largest eggs and highly eusocial bees

laying the smallest eggs relative to their body sizes. I examined bees from different taxa exhibiting different levels of sociality. Since most solitary bees produce only one brood per season, they may be able to invest more resources into each egg than eusocial bees that have several broods per season. I recorded a number of body size measurements, including head width, subcostal vein length, intertegular width, abdomen width, and femur length as well as egg length and egg width measurements. Egg volume was approximated by using egg width and length measurements to calculate the volume of a cylinder. Preliminary results from *Augochlorella striata*, *Halictus ligatus* and *Osmia conjuncta*, *Ceratina calcarata* and *Xylocopa virginica* indicate that egg size varies with body size. According to both the principal components and the regression analyses, head width positively correlates with egg length, indicating that the larger the bee, the larger the egg. The regression analysis also shows a positive correlation between species and egg length. This suggests that the egg size and body size relationship remains consistent across bee species and does not vary with sociality. It is possible that full egg size is limited by body size in females who still need to fly while developing large eggs. More bee species representing other levels of sociality will be included in this analysis to see if the relationship still holds true. **(Behavioral Ecology)**

Hope for the shallow end of the gene pool: Sexual conflict opposes sexual selection

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Queen's University

Evolution based on the benefits of acquiring 'good genes' in sexual selection is only plausible with the reliable transmission of genetic quality across generations. Accumulating evidence suggests that sexually antagonistic (SA) genes with opposite effects on fitness when expressed in the two sexes may be common in animals and plants. These SA genes should weaken the potential indirect genetic benefits of sexual selection by reducing the fitness of opposite-sex progeny from high fitness parents. Here we use hemiclinal analysis in *Drosophila melanogaster* to directly measure the inheritance of fitness. We show that any potential genetic benefits of sexual selection are reversed because high fitness males produce low fitness daughters, and high fitness females produce low fitness sons. Moreover, male fitness was not inherited by sons, consistent with theory and evidence connecting SA genes with the X chromosome. This inheritance pattern may help explain how genetic variation for fitness persists in spite of strong sexual selection, and why the ZW sex-chromosome system in birds and butterflies fosters the evolution of extreme sexual display traits in males. **(Evolution)**

Condition dependence of sexually dimorphic colouration and longevity in the ambush bug

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Sexually selected traits are predicted to exhibit stronger condition dependence than non- sexually selected traits. We tested this prediction in the colour dimorphic ambush bug *Phymata americana*. We experimentally manipulated adult diet and compared the strength of condition dependence of two male traits (sexually selected versus non-sexually selected) as well as a sexually homologous trait in males and females (non-sexually selected in both sexes). We also evaluated the effects of condition on longevity in both sexes. We found that expression of colour pattern was strongly determined by both diet treatment and age. The strength of condition dependence was much more pronounced in the sexually selected, male- limited trait but the non- sexual trait (in both sexes) also exhibited significant condition dependence. The sexually selected trait also exhibited a higher coefficient of variation than the non-sexually selected traits. Diet had opposite effects on male and female longevity; increased food availability had a (statistically significant) positive effect on female survival but a (non-significant) negative effect on male lifespan. These results are consistent with the prediction that sexually selected traits are costly and that investment in such traits may come at the expense of other components of fitness. **(Evolution)**

Swimming Endurance in Tadpoles

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Brock University

Larval anurans (tadpoles) segregate into pond types that differ in predator regime and permanence. Different pond types favour different, incompatible, trait values in tadpoles inhabiting those ponds and this has resulted in a diversification of larval traits in anurans using different pond types for breeding. Burst swimming speed in response to a simulated predator attack is one such trait. However, little is known about sustained swimming ability in tadpoles, a second component of swimming performance that may be important to larval fitness in the presence of predators. In this study, I consider the swimming endurance of tadpoles from species of three different anuran families (*Pseudacris triseriata*, *Rana sylvatica*, *Bufo americanus*) and show that swimming endurance differs significantly among species, and in accordance with pond use and activity level. **(Behavioral Ecology)**

Does Sexual Selection Promote Adaptation to a Novel Environment?

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University of Ottawa

The net effect of sexual selection on nonsexual fitness is controversial. On one side, elaborate display traits and preferences for them can be costly, reducing the nonsexual fitness of individuals possessing them, as well as their offspring. In contrast, sexual selection may reinforce nonsexual fitness if an individual's attractiveness and quality are genetically correlated. According to recent models, such good-genes mate choice should increase both the extent and rate of adaptation. We evolved 12 replicate populations of the Australian fruit fly, *Drosophila serrata*, in a powerful two-way factorial experimental design to test the separate and combined contributions of natural and sexual selection to adaptation to a novel larval food-resource. After 16 generations of experimental evolution, mean nonsexual fitness had increased by 52% on average in populations experiencing natural selection. In contrast, and despite strong sexual selection on display traits, sexual selection provided no benefit to mean nonsexual fitness, nor was there any evidence for

an interaction between natural and sexual selection during adaptation. This suggests that sexual selection may not facilitate adaptation to novel environments, even when good-genes operates in the ancestral environment. How novel environments affect the operation of good-genes mate choice is therefore a fundamental question for future sexual selection research. **(Evolution)**

Geographic variation in ejaculate investment in walleye

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Walleye (*Sander vitreus*) are large, freshwater fish with a mating system under which sperm competition is likely to occur. Variation in the relative size of the testes is evident across populations, ranging from 1.73% to 4.32% of somatic body mass. Here, we use data from 60 lake populations of walleye spanning northern Ontario, Canada to examine ecological correlates of this variation in order to test the hypothesis that investment in ejaculates is energetically expensive, and an adaptation for sperm competition. Populations inhabiting nutrient- rich lakes had relatively large testes, whereas latitude did not relate to testis size. Interestingly, body condition was positively related to testis size within populations, but testis size was negatively related to body condition among populations. Populations with relatively more males than females had large testes, suggesting that testis size responded to the intensity of sperm competition. These results are consistent with the view that the production of ejaculates is energetically expensive, and that the response to increased intensity in sperm competition at the population level can include increased ejaculate investment. **(Behavioral Ecology)**

The Role the Ranavirus in Relation to Fluctuating Asymmetry in the Green Frog (*Rana clamitans*)

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Amphibian populations are facing rapid declines and recent discoveries have shown that Emergent Infectious Diseases (EIDs) such as Ranavirus and chytrid fungus are playing major roles. Although these diseases are involved in the decline of certain populations little is known about the effects of these EIDs in relation to development. Developmental stability can be measured using fluctuating asymmetry (FA) which is often used as a tool to measure stress and the overall fitness of organisms. The theory assumes that an organism presents mechanisms that control asymmetry during development. Such mechanisms may be costly to the individual and when faced with other stressors it is believed that these mechanisms will suffer resulting in fluctuating asymmetry. Using genetic tools several populations of green frogs (*Rana clamitans*) were analyzed for presence or absence of Ranavirus. Infected and non infected individuals were then measured to determine FA under the hypothesis that FA will be more likely to be observed in individuals infected by Ranavirus. Since secondary sexual traits are more costly than non-sexual traits we also expected to observe FA in the former rather than in the latter. Preliminary results show a trend of fluctuating asymmetry when comparing sexual traits among infected and non-infected individuals. This shows that not only are EIDs causing massive die offs they are also having a further reaching effect on the development of those individuals carrying the diseases. **(Conservation Biology)**

Altruistic behaviour among kin versus non-kin

Steve Stewart-Williams*

McMaster University

Evolutionary principles suggest that, although altruism need not be directed exclusively toward kin, there will be differences in the nature of altruism among kin vs. non-kin. The present study sought to explore these differences. Participants were 295 undergraduate students who each completed a questionnaire about help exchanged with siblings, cousins, acquaintances, or friends. For siblings, cousins, and acquaintances, greater relatedness was associated with higher levels of helping. Friends were an exception, however, receiving as much or more help than kin. Consistent with an evolutionary analysis, as the cost of helping increased, a higher proportion of help went to siblings and cousins, and a lower proportion to acquaintances and friends. For low-cost help, people helped friends more than kin. In contrast, for medium-cost help, they helped siblings and friends equally, and for high-cost help they expressed a greater willingness to help siblings than friends (despite being closer to friends). Partial support was found for the hypothesis that non-kin relationships involve higher levels of reciprocal exchange than do kin relationships. These findings are not readily explained in non-evolutionary terms, and therefore constitute good support for an evolutionary explanation of human altruism. **(Evolution)**

Relatedness estimates suggest male-biased dispersal in a cichlid fish

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McMaster University

Ecological constraints can lead to delayed dispersal, a hallmark of cooperative breeders. Limited dispersal may result in genetic isolation due to decreased gene flow between subpopulations. However, even in such philopatric species, sex differences in costs and benefits associated with dispersal may predispose one sex to disperse. Recent theory suggests that a critical factor determining sex-bias in dispersal is comparative risk of kin competition; for example, where males experience increased mating competition relative to females, they are expected to be the dispersing sex. To test this theory, we used calculations of genetic similarity to estimate sex-bias in dispersal using a cooperatively breeding cichlid fish from Lake Tanganyika. This fish lives in groups of 3-17 individuals clustered in spatially and genetically distinct subpopulations. Our results suggest that large males commonly dispersed between subpopulations, while movement of large females and smaller fish was largely confined to within a subpopulation. Within a subpopulation, males appeared to move (and breed) far from their male relatives. Thus, our results support the idea that dispersal between subpopulations is constrained, and avoidance of kin competition drives male-biased dispersal. Our study is among the first to examine dispersal patterns in a cooperative breeder on both a large and small spatial scale simultaneously. **(Behavioral Ecology)**

Male Mate Choice in the Guppy (*Poecilia reticulata*)

Meeta Sudan*

University of Toronto

Males generally maximize their reproductive success by mating as many times as possible. Nevertheless, when mating indiscriminately is costly for males and females vary in quality, males are expected to be selective. Research has shown that male guppies (*Poecilia reticulata*), favour larger females over smaller females, as female fecundity increases with body size. In addition, non-pregnant females tend to receive more courtship displays than pregnant females. However, these previous studies did not account for female response to males, as female behaviour might have affected males' mate preferences. Pregnant female guppies are markedly unreceptive to male courtship. Furthermore, pregnant females develop a distinct dark spot near their anal fins called a gravid spot. Males may use this to avoid wasting time and energy on courting or attempting to copulate with pregnant females. I used the guppy to examine male mate preference for female pregnancy status and size while strictly controlling for female response and based solely on visual cues. I predicted that, given a choice between females of varying size and mating status, males should choose virgin females over pregnant females regardless of size. I found that males did not display any significant mate preferences, which is in contrast to my previous study, which showed a significant preference for virgin females. Whereas the previous study only physically separated males and females for months during maturation, the present study separated them physically and visually. Therefore, male visual experience of females may have an important influence on male mate selection and deserves further investigation.

(Behavioral Ecology)

The effects of added landscape cover on foraging behaviour of gerbils

S.Vijayan*, B. P. Kotler and S.Mukherjee
Ben Gurion University, Israel, (previous)

The effects of added landscape cover on foraging behavior of two coexisting gerbils (*Gerbillus pyramidum* and *Gerbillus andersoni allenbyi*) were investigated by experimentally manipulating cover patches in an otherwise natural setting. The artificial cover manipulations were used to manipulate the predator lethality (mainly foxes) in the grids. Three types of cover manipulation were used in the experiment, i.e. No- Fox cover (low cover, 10 cm), Fox cover (high cover, 30 cm) and natural cover (control) with no addition. By providing additional artificial cover and food patches, we quantified how foraging decisions (like time allocation, apprehension) are affected by the risk of predation. I used manipulated seed resource patches (seed trays) with electronic readers ("smart" seed trays) to record the species foraging activity. The gerbils showed significantly lower GUDs (giving up density: the amount of seeds remaining in a food patch following a forager's visit) in the no-fox cover patches as compared to the other two cover types. Thus, no-fox cover provided low cost of foraging in terms of reduced predation risks. At no-fox cover stations, the dominant species *G. pyramidum* had significantly lower GUDs compared to *G. andersoni allenbyi*, suggesting it to be more efficient than the latter. The cover manipulation also had a significant effect on habitat quality as the numbers of gerbil burrows were significantly greater at no-fox cover stations than the other station types, suggesting a preference for habitats in which high quality refuges from foxes are abundant. Data from the electronic seed trays reveal that the average activity time in different cover types were significantly different. The gerbils in no-fox cover stations showed lesser activity, but had lower GUDs (higher harvest rates), suggesting that they can effectively use their activity time in foraging without worrying about their safety. In control stations (natural habitat), high activity time with higher GUDs suggest that the gerbils apparently have to devote more time in vigilance related activities, which is consistent with the results from previous studies on rodents. However, in fox cover stations the gerbils had the least activity with high GUDs suggesting less preference of habitats in which the covers merely acts as an obstruction instead of providing safety. Fox activity was significantly higher in control stations compared to other cover types and was with accordance to the gerbil's behavior of selectivity for the full tray (measure of apprehension).

(Behavioral Ecology)

Poster Presentation Abstracts
(Alphabetical by Presenter's last name)

Thermoregulatory responses of the bearded dragon, *Pogona vitticeps*, to hypoxia

Viviana Cadena Ruiz *
Brock University

It has been demonstrated that lizards significantly lower their preferred body temperature in response to low oxygen concentrations as a way of protecting vital organs from oxygen depletion. It has also been proposed that lizards will thermoregulate less precisely when the costs associated with it are high. We evaluated the effect of four levels of hypoxia (10%, 7%, 5% and 4%) on the precision and level of thermoregulation of the bearded dragon, *Pogona vitticeps*. The upper (UET) and lower (LET) ambient escape temperatures as well as the selected ambient (T_a) and internal body temperatures (T_b) of eight bearded dragons were tested in an electronic shuttle box. T_b was significantly lowered from 34.7 °C in normoxia to 33.1 °C at 4% O₂. Although hypoxia had no significant effect on UET, LET was significantly reduced from 25.7 °C at 21% O₂ to 21.4 °C at 4% O₂. The precision of thermoregulation was determined by the preferred T_b range (given by the central 68% of the distribution). The preferred T_b range was found to be progressively wider with exposure to lower O₂ concentrations and significantly different between normoxia and 4% O₂ (27.6 to 41.0 and 23.2 to 40.6 °C respectively). The present study indicates that, during profound hypoxia (4% O₂), the bearded dragon reduces O₂ demands by both, lowering its preferred T_b and minimizing locomotion at the expense of precise behavioural thermoregulation. **(Other)**

Allometry and sexual selection in the whirligig beetle *Dineutus nigrior*

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Sexually selected traits often exhibit positive allometry and the presence of positive allometry in a trait can be interpreted as evidence that larger trait size is favored by sexual selection. The "one-size fits all" hypothesis suggests that sexual selection favors an intermediate size in male genitalia and predicts that the allometric slope for male genitalia is lower than for other body parts. Mating behavior in whirligig beetles includes males attempting to grasp and hold the female using protarsal pads covered with adhesive setae. Females resist copulation attempts by swimming erratically. The male accessory gland produces components of the ejaculate that in some insects induce ovulation or a refractory period in females and therefore decrease the risk of sperm competition. We used allometry and a mating experiment to test the "one-size fits all" hypothesis and to determine if body size, protarsal pad size, and accessory gland size are sexually selected in the whirligig beetle *Dineutus nigrior*. The allometric slope for aedeagus length was the lowest of the traits we tested which is consistent with the prediction from the "one-size fits all" hypothesis. The length and width of the male accessory gland exhibited positive allometry suggesting that this trait is sexually selected. The size of the protarsal pad was isometric and was not correlated with any measure of mating success. Body size was associated with the probability of obtaining a copulation and was correlated with total reproductive effort suggesting body size may be sexually selected. **(Evolution)**

Maintenance of the rover-sitter polymorphism of *Drosophila melanogaster*

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One of the central problems in evolutionary biology is the question of what maintains non-neutral genetic variation. Yet empirically supported explanations for genetic variation in natural systems are rare. The naturally occurring rover-sitter polymorphism of *Drosophila melanogaster* presents us with an ideal system for exploring this problem. A recent study found that larval viability of rovers and sitters is negatively frequency- dependent when reared in low-quality food conditions. To assess the robustness of this phenomenon, I set up populations consisting of either rovers or sitters and introduced first instar larvae of either rover or sitter genotype at one of three times in population development: 24 hr (early), 48 hr (middle), 96 hr (late). Results from 3 runs of this experiment were variable, but suggested that the operation of negative frequency dependence is sensitive to the degree and quality of stress experienced in the environment, with frequency dependence only being detected when conditions were neither overly stressful nor benign. In addition, late treatments (96 hr) in all 3 runs exhibited average survivorship levels 20% or less with no detectable frequency dependence, suggesting that environmental conditions deteriorated rapidly and that negative frequency dependence may be important early in population development when the major stressors are competition for food rather than waste accumulation. (Evolution)

A comparison of ethanol and methanol for preserving bees (Hymenoptera: Apoidea).

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Several methods have been reported for preserving insect specimens for the purpose of maintaining collections. We have evaluated the use of different alcohol preservatives to determine which is preferable for maximizing DNA retrieval and PCR amplification. Three bee species, *Lasioglossum (Dialictus) admirandum*, *Lasioglossum marginatum* and *Augochlorella striata* were stored in either ethanol (50, 70 or 95%), methanol (50 or 95%) or in an ethanol-methanol solution (70:30 or 95:5). Extracted DNA was quantified both visually and spectrophotometrically. Polymerase chain reaction was performed on the *cytochrome c oxidase subunit I* gene. The quality of PCR amplification was determined visually using ethidium bromide staining and was scored based on the brightness of the bands. Preliminary results suggest that maximum DNA can be extracted from samples stored in 50% methanol and that maximum PCR amplification is obtained from specimens stored in ethanolic solutions of >70%. (Other)

Sperm longevity affects female remating rate: evidence from experimental evolution

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Queen's University

The post-copulatory survival of sperm, which can potentially affect sperm competition and remating rates, is highly variable across taxa. However, surprisingly little is known about genetic variation in the characters influencing sperm storage or longevity. In *Drosophila*, recent evidence suggests that (1) sperm cells experience either mass mortality within, or ejection from, the female reproductive tract over relatively short periods of time, (2) there is genetic variation in both male and female aspects of sperm competition, and (3) sperm size coevolves with the female storage organs. I attempted to experimentally evolve enhanced sperm longevity by depriving mated females of males for 10 days prior to founding a new generation. After over 20 generations of selection, females in selected lines were less likely to remate when exposed to new males and had increased numbers of offspring irrespective of the presence of males, compared to controls. These data point to a complex set of interactions between the sexes and reproductive strategies. (Evolution)

Population genetics and landscape ecology of muskrats (*Ondatra zibethicus*)

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Environmental factors such as physical barriers have been shown to affect gene flow and population genetic structure. Small species are expected to show more evidence of spatial structuring than large species which have greater potential to disperse and have large home ranges. In terms of dispersal and gene flow, genetic distances between populations may vary depending on habitat fragmentation and physical barriers resulting in potential geographic isolation. The muskrat, *Ondatra zibethicus*, will be used as a model to examine these issues. Because of the biology of this species, substantial genetic differentiation at small geographic scales is predicted as is significant isolation by distance. However, other characteristics of the species ecology may promote relatively high rates of gene flow. Moreover, populations may show genetic evidence for sex biased dispersal. Reduction in gene flow leading to population genetic structuring should ultimately lead to population divergence with respect to phenotype. These phenotypic differences may be the result of local adaptation or genetic drift. To examine this issue, we are examining skull morphology as a measure of phenotypic variation to determine whether genetically structured populations have diverged enough to result in phenotypic divergence. Comparisons among populations in the context of habitat will allow us to determine if these differences are the result of random drift or due to adaptations to local habitat condition. (Landscape Biology)

Geographic variation in the design of male threespine stickleback nuptial signals

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The threespine stickleback fish (*Gasterosteus aculeatus*) is an excellent model for studying the evolution of communication systems. Males of this species produce a nuptial signal that is comprised of a red chin, blue-green dorsum and bright blue iris. The signal has been studied extensively under laboratory conditions and shown to play a role in both inter- and intra- sexual

selection as well as in pre-mating reproductive isolation. Although much is known about the strategic design (function) of this signal, very little is known regarding its tactical design (structure). Signalling theory predicts that the tactical design of a signal will be shaped by the signalling environment to maintain effectiveness (i.e., the signal stimulates the receiver's sensory system). In the context of stickleback, male nuptial signals are expected to be correlated with variability in spectral characteristics among lakes in order to maintain signal effectiveness (contrast). Here, we report the first examination of stickleback nuptial signals in the wild, and show that chromatic and brightness contrast among spectrally divergent lakes is achieved by modifying signal design. **(Evolution)**

Mechanisms behind climate induced changes in Arctic aquatic ecosystems

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York University

While changes in chironomid and diatom community composition have been linked to climate change, the actual mechanisms in which climate warming has affected invertebrate populations have not been elucidated. If permafrost layers are decreasing in thickness, there could be greater interaction of pond, lake, and stream water with hyporheic environments and groundwater inputs. Since hyporheic zones are known to influence nitrate and phosphorus concentrations, a larger hyporheic influence could lead to greater abundances in algal and chironomid communities. These influences could cause the alteration and reorganization of arctic food-webs and community structure. It is therefore necessary to identify the influence of climate change on the active hydrological zones in arctic ponds, lakes, and streams, to evaluate their potential impacts on biological communities. **(Aquatic Ecology)**

Effects of veiling light on nuptial signal characteristics in threespine stickleback, *Gasterosteus aculeatus*

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Communication involves the generation, transmission, and reception of signals and is essential for a variety of functions including mating. Effective mating signals are those that are conspicuous with respect to the communicator's background and that transmit well through the signaling medium. Male threespine stickleback (*Gasterosteus aculeatus*) develop a nuptial signal (red chin) that is an effective signal in most coastal and freshwater habitats. Nevertheless, spectral properties of water vary among different environments and consequently variation in signals may arise among populations to maintain signal effectiveness. I investigated the relationship between the veiling effect (light between the observer and an object is scattered, decreasing the contrast between an object and its background) among several British Columbia lakes and the threespine stickleback nuptial signal variation. I found that peak reflectance of male nuptial signals shifted to longer wavelengths in lakes that had the poorest transmission of red light. I also developed and tested a mathematical model of signal contrast degradation based on the human visual system. This model can be applied to the threespine stickleback visual system to predict variability among lakes in male signal characteristics. **(Aquatic Ecology)**

The effects of weather variation and habitat alteration on Niagara Region bee population dynamics

Sandra Regan*, Amy Rutgers-Kelley, and Miriam Richards
Brock University

In 2001 the Glenridge Quarry landfill was closed and converted into a naturalization site of Carolinian grassland and meadow. From 2003 to 2005, bees were collected in six sites at the naturalization site and the adjacent Brock University campus using standardized collection methods. Bee specimens were identified, counted and measured to examine population dynamics and response to annual weather and disturbance changes.

In years with hot and dry weather, ideal foraging conditions, bee brood should be larger in terms of abundance or body size. In cold wet years, brood should experience reduced abundance or body size. I found a significant effect of annual variation on bee abundance but not body size.

In 2003 collection sites were established and classified by disturbance levels. Since 2003, two high disturbance landfill sites have decreased in disturbance accompanied by an increase in bee abundance. Two low disturbance old field sites have experienced an increase in surrounding disturbance leading to a decrease in bee abundance. Meanwhile, an intermediate disturbance meadow has maintained both interference level and relatively stable bee abundance through three years of collection with slight variation accounted for by annual weather conditions.

Annual abundance fluctuations show how rapidly bee populations respond to anthropogenic impacts changing their habitat through both restoration and degradation. Abundance does vary with annual weather change but patterns are noticeable only in relatively stable landscapes where the impacts of ongoing habitat alterations do not override.

Speciation in a bottle: Does intersexual coevolution drive evolutionary divergence

Mark Rogers*, Adam Chippindale
Queen's University

Theory suggests that a combination of genetic drift and intersexual coevolution may be a potent mechanism of speciation. We have been investigating the apparent rapid divergence of reproductive traits in a unique complex of laboratory-evolved *Drosophila* populations. A laboratory- adapted founder population was split into six sister populations which have now been evolving under identical conditions in allopatry for ~700 generations. Using genetically-marked replica populations of all six original populations we conducted a full-generation competitive fitness assay with all possible combinations of populations. Preliminary analysis has revealed that female (population) fitness was highest when two different populations were combined. This effect may derive from divergence in characters relating to resource competition or reproductive interaction between the sexes. If the latter, it suggests that foreign males are, on average, less

harmful to females than local males are, promoting gene flow if these populations came back into contact at a hybrid-zone. **(Evolution)**

Prospective Range Expansion Due to Global Warming in the Large Carpenter Bee, *Xylocopa virginica virginica*.

Dimitri A. Skandalis, Sean Prager, Glenn J. Tattersall, Joshua C. Shaw, Miriam H. Richards

Our group focuses on the life history of the large carpenter bee, *Xylocopa virginica virginica*, at the northern extent of its range, currently, Southern Ontario in Canada, and Maine in the United States. Unlike other overwintering insects, the large carpenter bees nest in exposed wood structures, which afford little or no protection against the winter climate. *X.v. virginica* is intolerant of freezing, but can maintain liquid tissues well below the equilibrium freezing point (supercooling to $\sim -30^{\circ}\text{C}$, equilibrium freezing at $\sim -4^{\circ}\text{C}$). The minimum extreme winter temperature thus likely represents the winter selection pressure. We also have extensive data concerning the periods of activity of this bee during the spring and summer, the foraging season. The length of the foraging season is dictated in part by the magnitude of degree-days in base 14°C , the threshold temperature of activity. Eleven potential sites where *X.v. virginica* populations are not currently known to exist were analysed for winter and summer temperature shifts using scenarios for the years 2050 and 2100 in the Canadian Global Climate Model. These sites were chosen for their representativeness of geographic distribution from the western extent of the Great Lakes, to the Maritimes. Overall, the increase in winter temperatures, already of import to Canadian ecology, was found to be more directly influential than spring temperatures. In the best case of global warming, the range of *X.v. virginica* may increase to two new locales out of the analysed eleven. However, in the worst case of warming, this species' range may increase to ten out of the eleven sites, from Duluth, Michigan (western Lake Superior) to Halifax, Nova Scotia (Maritimes).

Bees as Bio-Indicators for Oak Savannah Restoration

Alana Taylor* and Laurence Packer
York University

The purpose of my study is to examine the changes in bee communities since the restoration of various oak savannah habitats in southern Ontario over the past 20 years. As habitats become increasingly fragmented, ways of rapidly determining which habitats to conserve is becoming more and more essential. One method to approach this problem is the use of indicator taxa to determine biodiversity in an ecosystem. In theory, the diversity of the indicator taxa should reflect the diversity and state of other species within the given ecosystem (Kerr et al., 2000). Bees have been chosen as the indicator taxa for this study for two reasons: (1) they are highly prone to extinction (Zayed and Packer 2005) and (2) they are a vital part almost all terrestrial ecosystems as most habitat conservation depends on the presence of pollinators (Michener, 2000).

(Conservation Biology)

Interval Timing by Foraging Bumble Bees, *Bombus impatiens*

Anthea J. Veal*, Michael J. Boisvert and David F. Sherry

University of Western Ontario

Interval timing mechanisms are assumed to function in the foraging domain, however, they are usually examined in artificial operant contexts. In experiments with bumble bees, a high-quality floral reward became available after a fixed delay elapsed since the initiation of a foraging bout in another patch. Bees were trained to forage in a screened enclosure that contained 13 artificial flowers. At the start of a trial, twelve flowers contained a small volume of 25% sucrose reward, the remaining flower was empty. Either 60 s or 90 s after the first reward was taken, the HQ flower filled with a large volume of 50% sucrose reward. Bees scheduled visits to the HQ flower sooner when the delay was 60 s than when it was 90 s and the times of visits to the HQ flower corresponded closely to the delay. These findings extend earlier demonstrations of interval timing by bumble bees trained on fixed interval schedules, and suggest that bees can also time intervals in the minutes range while foraging. **(Behavioral Ecology)**

Size-dependent female mate copying in the guppy (*Poecilia reticulata*)

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Ryerson University

Previous work on guppies has shown that small females copy the mate choice decisions of larger females, but not vice versa. We extended this work to ask, when put in a situation where they have little information available to distinguish between males, whether large females will also copy large females, and small females will copy small ones. Using Dugatkin's (1992) criteria, we found that both small and large females will copy the mate choice decisions of large females, but that neither small nor large females copy small females. However, we did not find evidence of mate copying using criteria used by other researchers. We discuss possible explanations for our observations and we propose that the advantages of avoiding sexually transmitted parasites (e.g. *Gyrodactylus turnbulli*) could be maintaining this pattern of copying behaviour. **(Behavioral Ecology)**

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