Ecology & Evolutionary Biology
UNIVERSITY OF TORONTO

Undergraduate Research Fair 2024

Program Guide

Welcome

Thank you for joining us for the 2024 EEB Undergraduate Research Fair! We are so excited that you will be joining us for a showcase that highlights the incredible fourth-year research projects students have worked on during the Fall/Winter 2023-24 term. The fair is a great way to experience the diversity of exciting undergraduate research in EEB, to hear about new scientific discoveries made by students, and interact with undergraduates and peers.

The students participating in the fair are competing for the *Corey A. Goldman Prize for Best Research Poster in Ecology and Evolutionary Biology*. The prize is named after former EEB Undergraduate Associate Chair Corey A. Goldman, and recognizes the top students within the department for excellence in their fourth-year independent research projects. Cash prizes will be awarded to the best research poster in each category.

Check out our website at https://eebuoft.weebly.com.

Event Details

Date: Friday, April 5, 2024
Time: 2:00PM – 4:00PM EST
Location: Hallway outside ESC2050

Event Schedule

2pm-3:45pm	The Research Fair is open! Student researchers will be available to answer questions about their research.
3:45pm-4pm	Brief closing remarks by Shelby Riskin and announcement of winners and honourable mentions

Research Categories

Student	Supervisor	Title
Category: Effects of Global Change on Organisms & Ecosystems		
Judges: Luna Taguchi & Mathieu Videlier		
Nadine Hamie	Asher Cutter	Cold vs Worm: Hatching and Mating Success of Caenorhabditis nigoni in Cold Temperature
Eleanor Hector	Megan Bontrager	Assessing the impact of winter temperature and duration on early development and flowering time in Clarkia pulchella
Justice King	Shelby Riskin	The Influence of Rising Temperatures in Canada on Fall Migration Timing in Passerines
Ashlyn Nance	Chelsea Rochman	Accumulation of Microplastics in the Littoral-Shoreline: Analysis of Rock Rings, Shoreline Surface Water and Macrophytes
Category: Urban Ecology & Ecotoxicology		
Judges: Amanda Peake & Bianca Sacchi		
Kieran Guimond	Shelby Riskin	Bird diversity and tolerance across urban ponds
Elli Hung	Cutter & Rochman	Understanding the impacts of multiple road-related contaminants on Daphnia magna gene expression
Kezia Wei	Santiago Claramunt	Using Wing-loading, Aspect Ratio, Tail Morphology, and Phylogeny as Predicters for Building Collision Vulnerability
Catherine Yan	Shelby Riskin	The diversity and viability of a seedbank from centuries-old wetland soils
Category: Ecophysiology		
Judges: Zoie Diana & Athmaja Viswanath		
Noah Cazabon	Santiago Claramunt	Getting the Leg Up - an Exploration of Unipedal Roosting in Columba liva domestica
Yara Ghabra	Celina Baines	Investigating the Effects of Moisture and Body Size on the Dispersal Probability of Folsomia candida
Freyja Moser	Rowan Sage	Does Chloroplast Arrangement Change with CAM Strength?
Charlie Olsen	Rowan Sage	Responses of obligate and facultative CAM plants to high and low ambient CO2 concentrations
Category: Evolution, Phylogenetics & Systematics		
Judges: Puneeth Deraje & Mark Hibbins		
Yuechen Hao	Tomo Parins-Fukuchi	Clade Shape and Evolutionary Dynamics in Epidemiological and Paleontological Phylogenies
Michaela Riley	Jacqueline Sztepanacz	Investigating Sexual Selection and Assortative Mating in Drosophila suzukii
Jaden Tran	Santiago Claramunt	Estimating flight performance from morphology to understand selection for hunting ability in birds of prey
Chelsea Wong	Asher Cutter	Exploring Conserved Transcription Factor Binding Site Motifs in the Caenorhabditis Genus

Poster Abstracts

Category: Effects of Global Change on Organisms & Ecosystems

Judges: Luna Taguchi & Mathieu Videlier

Nadine Hamie (Supervisor: Cutter)

Cold vs Worm: Hatching and Mating Success of *Caenorhabditis nigoni* in Cold Temperatures

It is crucial to decipher how temperature tolerances impact the ecological niche and fitness of organisms. Thermal tolerance may also influence physiological responses to environmental change and acclimation which can influence mating behaviours and reproductive success of organisms as well as gene flow between populations. If populations acclimate to divergent environmental conditions, this provides one method by which they can adapt to different ecological niches, potentially leading to genetic divergence and reduced gene flow. This project investigates how changes in rearing temperature may impact reproductive success, induce physiological changes that protect the body from cold stimuli, and may result in change to an ecological niche over evolutionary time. Specifically, we investigate the effect of temperature on reproduction using egg-hatching and mating assays in the nematode *Caenorhabditis nigoni.* Additionally, by quantifying egg-laying and mating success, we assess the potential consequences of altered temperature regimes using temperature shift assays. These experiments aimed to establish the thermal tolerance of *C. nigoni* and observe physiological acclimation in nematodes. By subjecting *C. nigoni* to temperatures below its thermal optimum, we assess its lower thermal tolerance profile. We show that egg-hatching success decreases at low temperatures across a gradient, while mating success is largely unaffected by thermal conditions, suggesting that temperature shifts may disproportionately impact embryonic development relative to adult reproductive behaviours. This research provides insights into the selective and ecological pressures on nematode populations facing environmental variability and underscores the utility of laboratory assays in studying the physiological and demographic implications of temperature tolerance. Elucidation of organismal acclimation to changing temperatures through hatching and mating assays increases *Caenorhabditis* species knowledge, so researchers can better assess population phenotypes in the face of climate change.

Eleanor Hector (Supervisor: Bontrager)

Assessing the impact of winter temperature and duration on early development and flowering time in Clarkia pulchella

Climate change is altering the temperature of most environments, and some recent work suggests that winter warming may be more ecologically relevant than summer warming. Despite this, the specific implications of stronger winter warming, characterized as asymmetrical warming, remain poorly understood. While most studies have focused on summer warming due to its alignment with the growing season, it is crucial to acknowledge that, depending on life history, certain plants likely undergo important developmental steps during cool winters. Particularly, for plant species germinating in the fall and overwintering, the interplay of temperature and duration of winter may become vital for accumulating necessary resources and influencing the onset of flowering. This study aims to assess the importance of both the temperature and duration of this cool period on the growth and early development, flowering time and size and biomass allocation at the time of first flower for a winter annual wildflower *Clarkia pulchella*. Prior greenhouse experiments have indicated that temperature during early-developmental stages of *C. pulchella* may impact flowering time and size at time of

flowering. In this study, we manipulate the duration and temperature of winter during early development of six populations of *C. pulchella* to examine their potential impact on resource allocation during early development and subsequent changes in the timing of the first flower. Our methodology includes repeated measurements of growth and developmental traits throughout the early growth stages, on the day of first flower, and the drying and weighing of the above- and below-ground biomass of each plant. We found that longer and cooler winters slowed the growth of aboveground biomass, but may allow for the development of more belowground biomass and a later day of first flower. Based on what we observed in the four treatment groups, we expect to see *C. pulchella* flowering earlier in nature if winter gets shorter and warmer.

Justice King (Supervisor: Riskin)

The Influence of Rising Temperatures in Canada on Fall Migration Timing in Passerines

Recent shifts in avian migratory patterns, often attributed to global climate change, raise questions about how these changes impact the timing of fall migration in passerine birds, a critical period for their survival and reproductive success. This study examines fall migration trends at four key Canadian Bird Banding Stations (BBO, LMBO, LSLBO, OOT) and their correlation with local temperature variations. Using regression analysis, we investigated the relationships between departure dates and mean temperatures over time. Our findings revealed a range of responses across stations: BBO and LSLBO displayed significant trends in departure dates, with the latter showing earlier departures rather than delayed departures correlated with increasing temperatures. By analyzing both broad temperature trends across 19 weather stations and all passerine species at 19 corresponding banding stations, and detailed trends using a subset of four stations that represent a full record from 1994 to 2022, this research provides insights into the adaptability of these birds to changing climatic conditions prior to their fall migration. The study contributes to the understanding of avian migration in the context of climate change, highlighting the complex and varied nature of migratory responses to temperature changes. These insights are crucial for biodiversity conservation strategies in a rapidly changing global climate.

Ashlyn Nance (Supervisor: Rochman)

Accumulation of Microplastics in the Littoral-Shoreline: Analysis of Rock Rings, Shoreline Surface Water and Macrophytes

Microplastic pollution is ubiquitous in lakes and rivers. Most studies look at contamination in the pelagic waters and biota. Exploring the interaction between macrophytes and plastic pollution represents a novel and emerging field of investigation. Moreover, researchers are trying to understand how shorelines are reservoirs for microplastics. The primary objective of this study is to examine the entrainment and accumulation of microplastics on shorelines, including in macrophytes and other matrices. My research is part of the pELAstic project – a multiyear whole ecosystem experiment assessing the fate, transport and effects of microplastics. In Summer 2023, we sampled microplastics from rock rings, the surface water surrounding macrophytes, and the macrophytes themselves along the littoral shoreline of L378 at the Experimental Lakes Area (ELA). Our investigation focuses on two distinct types of macrophytes, lily pads and grasses. In each matrix, I quantified and characterized polyethylene (PE), polystyrene (PS) and polyethylene terephthalate (PET) microplastics in each matrix at six stations across the lake. By observing the amount accumulated at each station within each matrix we can understand the fate of microplastics on the littoral shoreline and how they may accumulate in each matrix. We see relatively large amounts of microplastics on the shoreline, with more in locations where the wind blows into the shore. This study will contribute valuable insights into the dynamics of

microplastic fate and their interaction with macrophytes and other littoral shoreline matrices in aquatic ecosystems.

Category: Urban Ecology & Ecotoxicology

Judges: Amanda Peake & Bianca Sacchi

Kieran Guimond (Supervisor: Riskin)

Bird diversity and tolerance across urban ponds

Urbanisation is a pressing issue, and the creation and maintenance of urban ponds could be used to combat the negative effects on biodiversity that urbanisation causes. Stormwater ponds (SWPs) are a type of urban pond linked to the sewer system that have been previously proven to be a host for various species, but there has been little previous research specifically focusing on the interaction of birds with these ponds. A study was conducted over the 2023 summer which compared nine SWPs to two non-SWPs and observed them over a period of 11 weeks. The species richness and the urban tolerance of observed bird species for each pond was measured. A follow up experiment was conducted from September to November—during fall migration—where recorders were set up at one SWP and two non-SWPs. The recordings were run through a machine learning program which identified which birds were present at the ponds during this time. Using these data, information can be found on the species richness of the ponds, how the species composition of the ponds changed over the fall migration period, as well as how migrants and endangered species used the pond. This is a start to deepening our understanding of how urban ponds are essential habitats for birds in urban landscapes. Due to the decrease of suitable urban habitats—particularly wetlands—it is important for these spaces to be treated as the biodiversity hotspots they have the potential to become. Birds experience less impact from habitat loss compared to other species but understanding how urbanisation impacts them is essential for knowing our larger ecosystem.

Elli Hung (Supervisor: Cutter & Rochman)

Understanding the impacts of multiple road-related contaminants on Daphnia magna gene expression

Anthropogenic contaminants such as salt, polycyclic aromatic hydrocarbons (PAHs), tire wear particles, and heavy metals enter aquatic ecosystems as runoff during rainfall or snow melt events. These contaminants can interfere with physiological processes of organisms, including gene expression, to impact higher levels of biological organization (i.e., ecosystems). Although a significant amount of research has investigated the ecotoxicological effects of individual contaminants, the impacts of combinations of contaminants remains unresolved, especially at a transcriptomic level. This project aims to investigate the effects of a combination of road-related contaminants on the survival and gene expression of *Daphnia magna*. The gene expression analysis examines *Daphnia*'s transcriptomic patterns in response to pyrene, tire wear particle leachate, and their combination at five environmentally relevant concentrations. We exposed *Daphnia* to these treatments in a two-day, acute toxicity test, performed RNA-sequencing, and employed Weighted Gene Correlation Network Analysis (WGCNA). Over 20,000 genes were identified and clustered into 20 eigengene modules. Preliminary analysis does not show any obvious correlation patterns of gene expression to contaminant or concentration level. Gene Ontology (GO) terms associated with each contaminant show tire wear particle leachate to be correlated with the most diverse and unique biological processes. Altogether, this project helps to better characterize how multiple stressors interact to impact aquatic biota, brings environmental

relevance into toxicity tests, and ultimately may help to inform protection and monitoring of aquatic systems.

Kezia Wei (Supervisor: Claramunt)

Using Wing-loading, Aspect Ratio, Tail Morphology, and Phylogeny as Predicters for Building Collision Vulnerability

Birds are one of the most negatively impacted species by urbanization. Studies estimate that there are between 365 to 988 million bird deaths due to building collisions annually in just the United States, making building collisions one of the leading anthropogenic causes of avian mortality (Loss et al., 2014). Due to its pressing nature, researchers have sought to seek out and understand the reasons for this issue. Lots of research has been done on various aspects of birds such as bird age, sex, condition, and timing of migration (Klem, 1989; Nicholes et al., 2018; Winger et al, 2019). My research will focus on finding out whether aspect ratio, wing-loading, tail morphology, and phylogeny can be used as predictors for the vulnerability of each species to window collisions. This is because these characteristics affect flight dynamics in birds and may provide either an advantage or disadvantage when it comes to avoiding buildings during flight (Norberg, 1995). I am conducting my study on birds found in Toronto because Toronto is along a major migratory route for spring and fall migratory birds. Migratory bird collisions are also the main group of birds that is seen to have window collisions (Weninger, 2009). My data is being gathered at the ROM and through FLAP and calculations will be performed on R version 4.3.2 (2023-10-31 ucrt)

Yuhui (Catherine) Yan (Supervisor: Riskin)

The diversity and viability of a seedbank from centuries-old wetland soils

Industrialization and urbanization in the past two centuries have significantly altered wetlands in North America, critical habitats for biodiversity and ecological interactions. This study focuses on the seedbank from centuries-old soils that have been recently excavated and revealed in an urban environment. Our research focuses on exploring the age of the soil, the ancient wetland community composition, and the viability of the seedbank. We extracted seeds from the soil, conducted radiocarbon dating, identified seeds, and assessed viability using tetrazolium and germination tests. The seeds likely date to before the 1750s, prior to urban development. We identified 14 families and 20 genera of seeds, mostly from the Cyperaceae family, including *Carex*, *Schoenoplectus*, and *Sparganium*, and both terrestrial and aquatic species indicative of a historically seasonal wetland. The viability tests, while showing no germination success, may reflect a sampling bias rather than actual seed viability. Overall, the diversity and viability analyses of the seedbank offer a representation of the vegetation in a native wetland over 200 years ago, providing critical insights for the wetland's natural restoration.

Category: Ecophysiology

Judges: Zoie Diana & Athmaja Viswanath

Noah Cazabon (Supervisor: Claramunt)

Getting the Leg Up - an Exploration of Unipedal Roosting in *Columba liva domestica*

Endothermy is a highly advantageous trait ubiquitous across mammals and avians. Avians exhibit a variety of physiological and behavioural adaptions to improve the efficiency of their thermoregulation. A rather infamous trait in avians is the tendency to stand on one leg, referred to in literature commonly as

unipedal roosting (UR). While most evidence points towards this behaviour arising as a means of thermoregulation, many studies have produced mixed results, and the trait does not have a clear phylogenic pattern. Other theories explain UR as a means of improved evasion from predators, as a part of unihemispheric sleep, or as a way of relieving muscle fatigue. An outlier in presenting this behaviour is found in *Columba livia domestica* (the feral pigeon). This study utilizes observational data collected with a mobile thermal camera in Toronto over the course of February and March 2024, to compare the ground surface temperature and body temperature of pigeons that are observed UR and not UR. The goals of this study are to 1. investigate whether UR occurs more frequently at extreme temperatures, and 2. investigate whether UR results in a difference in body temperature.

Yara Ghabra (Supervisor: Baines)

Investigating the Effects of Moisture and Body Size on the Dispersal Probability of Folsomia candida

A core interest in ecology has been to discern the effects of environmental conditions and phenotype on the dispersal probability of organisms. However, previous findings show inconsistency in the behavioural response of organisms to varied environmental conditions. This study aims to investigate the effects of moisture on the dispersal probability of the springtail Folsomia candida, and whether body size plays a role in this context. Springtails are ecologically significant soil-dwelling arthropods that are highly sensitive to drought; however, drought resistance increases with body size. To elucidate the effects of moisture in driving dispersal decisions, springtails of various sizes were subjected to low, medium, and high moisture treatments. Using two-habitat networks linked by inhabitable corridors, dispersal from variable moisture conditions to constant high moisture habitats was analyzed. Additionally, body length measurements were taken to evaluate the effects of body size on dispersal within moisture treatments. I hypothesized that moisture and body size play significant roles in the dispersal probability of springtails, with smaller individuals experiencing lower moisture conditions exhibiting a greater propensity to disperse. Through this investigation, I aim to shed light on the intricate mechanisms driving dispersal strategies and their implications for species persistence in dynamic environments.

Freyja Moser (Supervisor: Sage, R)

Does Chloroplast Arrangement Change with CAM Strength?

Crassulacean Acid Metabolism (CAM) photosynthesis is a carbon-concentrating mechanism with advantages for water conservation. Although certain anatomical traits, such as increased succulence and reduced intercellular air space (IAS), are suggested to be important for CAM expression, there is more to be learned about what other anatomical traits are important, particularly regarding traits which might enable flexibility in CAM expression (i.e., traits that enable plants to change the strength of CAM they express). Thus, this study investigates a more fluid trait, chloroplast arrangement, across a range of CAM families, representing a range of CAM strengths and modes (including species that express weak and strong CAM as well as species that are obligate — CAM is always expressed — and facultative — CAM is induced environmentally). Specifically, I compare the relationship between chloroplast coverage of mesophyll cell walls adjacent to IAS with CAM strength, as determined by leaf titratable acidity. The results will indicate whether chloroplast coverage of IAS is associated with CAM expression and suggest whether chloroplast arrangement might be important for enabling the fluidity in CAM expression.

Charlie Olsen (Supervisor: Sage, R)

Responses of obligate and facultative CAM plants to high and low ambient CO2 concentrations

Crassulacean acid metabolism (CAM) photosynthetic plants are a functional group that is hypothesised to have evolved after atmospheric CO_2 declined to near-current levels about 23 million years ago. Here, we investigate the impact of three atmospheric CO_2 concentrations on the strength of CAM expression in the obligate CAM species *Phalaenopsis* "Edessa" and the drought-inducible facultative CAM species *Kalanchoë blossfeldiana*. Leaf gas exchange was measured in successive 24-hour profiles under modern ambient (400 ppm), low (200 ppm), and high (800 ppm) CO_2 conditions. CAM strength was quantified by percent nocturnal CO_2 assimilation and dawn vs. dusk titratable acidity measurements. In *Kalanchoë blossfeldiana* low CO_2 conditions increased percent nocturnal CO_2 assimilation and thus the strength of CAM expression; the opposite was true under high CO_2 conditions. These responses were elevated under drought. High CO_2 conditions increased net CO_2 uptake during both the day and the dark period for both species. These results demonstrate a large potential for enhanced nocturnal CO_2 assimilation in obligate CAM species while the largest enhancement of CO_2 assimilation occurs in the day for facultative CAM species. As the atmospheric CO_2 concentration increases under anthropogenic global change, the relative performance of C_3 and CAM plants in warm and arid environments will not change as dramatically as previously thought.

Category: Evolution, Phylogenetics & Systematics

Judges: Puneeth Deraje & Mark Hibbins

Yuechen Hao (Supervisor: Parins-Fukuchi)

Clade Shape and Evolutionary Dynamics in Epidemiological and Paleontological Phylogenies

Understanding evolution is essential to the study of biological processes in living beings, and the fossil record is currently one of the only ways to study the evolutionary past of most species. However, the fossil record is often inconsistent and incomplete, leading to skewed reconstruction of phylogenies, and how we understand the diversification of extinct and extant species. On the other hand, viruses are biological entities that are extremely rapidly evolving and constantly undergoing speciation. Their genetic information and evolutionary history is extremely well sampled, and it is readily available, in many online studies and databases. Therefore, this study attempts to use viral phylogenies to better understand tree shapes, and the effects that specific events can have on tree shape, then extrapolating this data onto paleontological phylogenies to see if any ambiguities can be resolved. We collected 25 trees of viruses and 25 paleontological trees from various databases and articles online, and using 11 tree summary metrices adapted from Colijn et al. (2016), characterized each of the trees with the metrices to determine their shape. The results are still currently in progress.

Michaela Riley (Supervisor: Sztepanacz)

Investigating Sexual Selection and Assortative Mating in Drosophila suzukii

Drosophila suzukii, an invasive fruit fly species native to Southeast Asia, exhibits notable adaptability to temperature and humidity conditions in novel habitats, in addition to a high reproductive rate and a short generation time of 10-21 days, facilitating its dispersal and survival across diverse environments. Assortative mating, where individuals select mates based on phenotypic similarity, is often considered a precursor to speciation. This often goes hand in hand with sexual selection, which can be a very strong factor in speciation. This study examines whether populations evolving under different sexual selection regimes exhibit assortative mating. To investigate this, we examined mate choice in female D. suzukii populations, which were previously evolved under differing sexual selection pressures. Two populations, one evolved under sexual selection (+SS) and one evolved under reduced sexual selection (-SS), were

used to do this. Virgin females from the +SS population were introduced to one +SS virgin male and one -SS virgin male in a vial, and mating behaviors were observed. Our findings revealed a high rate of mate rejection, with most females exhibiting rejection behaviors and remaining unmated for approximately 5 hours, or the observed mating time. The influence of sexual selection and assortative mating on adaptation to novel environments is discussed, offering insights into the success of D. suzukii in non-native conditions.

Jaden Tran (Supervisor: Claramunt)

Estimating flight performance from morphology to understand selection for hunting ability in birds of prey

Predator species are under strong selection for hunting success, as they must engage in high-risk predator-prey interactions to acquire food. The defensive traits of prey create conditions that predators must overcome, such as having the top speed to prevail in the chase. Here we investigate flight performance in diurnal predatory raptor species within the orders Falconiformes and Accipitriformes. Individual health and motivation make it difficult to study the upper limits of vertebrate flight with live specimens, so we use morphological measurements from museum collections. Wing morphology parameters and characteristic flight speeds are estimated for 101 raptor species, which are then categorized by diet and compared across the phylogeny. We predict species that share the same preferred prey types will possess flight performance characteristics more similar to each other than to related species that hunt different prey. We found that some models of prey type were able to explain variation in flight performance, but the majority did not. This leads to further questions that may be investigated regarding behavioural hunting strategies, the success of generalist species, and the intricate effects of predator-prey interactions on predator evolution.

Chelsea Wong (Supervisor: Cutter)

Exploring Conserved Transcription Factor Binding Site Motifs in the Caenorhabditis Genus

Transcription factor binding sites (TFBS) are cis-regulatory elements that often regulate specific biological processes by binding to transcription factors. Changes in cis-regulatory elements play a pivotal role in the evolution of morphological traits, leading to novel patterns of gene expression. In nematodes, Major Sperm Protein (MSP) functions in sperm locomotion and is central to fertilization. Despite the importance of MSP, we still lack a complete understanding of the evolution and conservation of gene regulation of the MSP genes in the Caenorhabditis genus. In this study, we identified transcription factor binding sites (TFBS) of 1227 MSP genes in 47 species within the Caenorhabditis genus to understand how TFBS binding sites of the MSP genes evolve. Our analysis revealed 265 TFBS motifs, with a range of 3-15 motifs per species. We then determined the similarities among all motifs, resulting in the identification of 108 motif clusters, 18 of which were composed of 3 or more individual motifs. Furthermore, to investigate whether the base composition of these TFBS motifs affects their evolutionary process, we studied the GC content and length of the motifs. We observed a negative correlation, indicating that lower GC content was associated with longer motifs, providing insights into the structural and compositional aspects of regulatory elements. These findings not only enhance our understanding of conserved TFBS motifs of MSP genes but also lay the groundwork for future investigations into the molecular mechanisms governing MSP expression and its evolutionary conservation in nematodes.