UNIVERSITY OF TORONTO
FACULTY OF ARTS & SCIENCE

Office of the Dean

Project Code: EEB 1

RESEARCH OPPORTUNITY PROGRAM
299Y/399Y PROJECT DESCRIPTIONS 2018-2019
FALL/WINTER

Name and Title: Asher Cutter (Professor)
Department: Ecology & Evolutionary Biology

TITLE OF RESEARCH PROJECT: Genetic and Developmental Control of Gamete Cell Interactions and Evolution

Number of 299Y Spots: 1 **Number of 399Y Spots:** 1

OBJECTIVES AND METHODOLOGY:

Evolution by sexual selection can drive rapid divergence in features of organisms that are important in reproduction. Current research in our laboratory is investigating how different species form and are maintained as genetically distinct populations of organisms, and how interactions between gamete cells provides an important point at which this can happen. Our work focuses on nematodes related to the classic model organism *C. elegans*. Despite the wealth of information on development and genetics in this species, relatively little is known about how it evolves. This study will investigate some of these issues surrounding the role of sexual selection using lab experiments, transgenic manipulation and genetic editing, genetic crosses, high resolution microscopy, competition assays, and other approaches to study features of how *Caenorhabditis* gamete cells develop, interact and evolve.

DESCRIPTION OF STUDENT PARTICIPATION:

The student will be responsible for carrying out experimental treatments and genetic crosses with species of *Caenorhabditis* bacteria-feeding nematodes, collecting data, and writing up and interpreting the results of the experiments. The experiments will involve transferring and quantifying nematodes using white-light and fluorescent microscopy with sterile technique under a range of treatment conditions. The student should be able to work successfully as part of a team, be highly organized with close attention to detail, and have a flexible work schedule to accommodate the life cycle of the organisms under study. The student must also be self-motivated, capable of trouble-shooting and problem solving to be able to work independently. The student will also be expected to participate in lab meetings (including a presentation), to make a final oral presentation or poster for the ROP poster fair, and to write a final paper.

MARKING SCHEME (assignments with weight and due date**):**

Project proposal / Interim report (Nov. 1): 20%
Poster for ROP poster fair (Mar. 1): 20%
Final report (Apr. 4): 40%
Weekly lab meeting attendance, participation & presentation (ongoing): 10%
Lab notebook detail, organization, and neatness (ongoing): 10%

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Project Code: EEB 2

RESEARCH OPPORTUNITY PROGRAM
299Y/399Y PROJECT DESCRIPTIONS 2018-2019
FALL/WINTER

Name and Title: Megan Frederickson, Associate Professor
Department: Ecology & Evolutionary Biology

TITLE OF RESEARCH PROJECT: Evolution of Mutualism

Number of 299Y Spots: 1 **Number of 399Y Spots:** 1

OBJECTIVES AND METHODOLOGY:

The Frederickson lab studies the ecology and evolution of plant-animal and host-microbe mutualisms. Over the fall and winter semesters, ROP students will study plants and their microbiomes in lab experiments, as we work towards developing a high-throughput experimental model of host-microbiota interactions. Students will experimentally manipulate the number and identity of microbes and host genotypes, in combination with various abiotic factors such as nutrients and pollutants. Data collection typically depends on measuring plant growth and culturing bacteria, but may also involve some microscopy or basic molecular or chemical analyses.

DESCRIPTION OF STUDENT PARTICIPATION:

ROP students will be involved in the design and execution of lab experiments, first under the supervision of the PI or a graduate student or postdoc and then more independently. Students may assume primary responsibility for data collection and care of growth chamber or greenhouse plants. Students will be expected to participate in lab meetings (including giving a presentation), carry out experiments in a meticulous and timely manner, to make a poster for the ROP poster fair, and to write a final report.

MARKING SCHEME (assignments with weight and due date**):**

Attendance and participation in lab meetings (ongoing)	15%
Two-page description of proposed project (November 15, 2018)	15%
Completion of proposed experiment(s), following protocols and collecting data with attention to detail (ongoing)	40%
Poster for ROP fair (early March, 2019)	10%
Final report, including a detailed explanation of all methods and all data and meta-data in spreadsheet format (March 31, 2019)	20%

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Project Code: EEB 3

RESEARCH OPPORTUNITY PROGRAM
299Y/399Y PROJECT DESCRIPTIONS 2018-2019
FALL/WINTER

Name and Title: Martin Krkosek, Assistant Professor and Canada Research Chair
Department: Ecology and Evolutionary Biology

TITLE OF RESEARCH PROJECT: Experimental Epidemiology of Environmentally Transmitted Disease

Number of 299Y Spots: 1 **Number of 399Y Spots:** 1

OBJECTIVES AND METHODOLOGY:

The research aims to test basic models for the population dynamics and evolution of environmentally transmitted infectious diseases. The research uses experimental populations of freshwater zooplankton (Daphnia magna) and their microsporidian gut parasite Ordospora colligata that we maintain in the laboratory. The experimental system provides an ideal model system for parameterizing and testing basic models for environmentally transmitted disease. The experiments involve measuring the intensity of infection within individual hosts through time, the rate of spread of infection through a host population, responses of within- and among host disease dynamics to environmental change (e.g. climate), and evolutionary changes in traits such as virulence and transmissibility in response to the ecology of the host or environmental change. The methods involve maintaining the host and parasite populations in microcosms (i.e. jam jars) by raising algal cultures to feed the host and replenishing growth medium that provides trace elements needed by the Daphnia and removes waste metabolites. Parasite abundance is determined by dissecting the gut of a host and then counting spores under 400x phase contrast microscopy. Spores can also be visualized with fourescent dyes specific to microsporidians. Host abundance is monitored by subsampling, counting, and measuring body size under a dissecting microscope, but we are also developing an automated census procedure that uses digital image analysis. The data generated are analyzed and interpreted using mathematical models for disease dynamics**.**

DESCRIPTION OF STUDENT PARTICIPATION:

Students will participate in the research by helping to support the experimental work by helping to maintain algal cultures and growth medium, handling and counting zooplankton and parasites, and cleaning and sterilizing glassware. Students will also be given a small research project to lead themselves, and this will typically involve a small subcomponent of an experiment being done in the lab or address a methodological need of the lab such as comparing measurement error of different counting techniques.

MARKING SCHEME (assignments with weight and due date**):**

Project proposal (20%, due Oct 31)
Final project report (40%, due Apr 30)
Final project presentation to lab group (20%, due Apr 15)
Lab notebook (20%, due Apr 30)

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Project Code: EEB 4

RESEARCH OPPORTUNITY PROGRAM
299Y/399Y PROJECT DESCRIPTIONS 2018-2019
FALL/WINTER

Name and Title: Chelsea M. Rochman, Assistant Professor
Department: Ecology and Evolutionary Biology

TITLE OF RESEARCH PROJECT: Sources and Fate of Microplastics in Marine and Freshwater Ecosystems

Number of 299Y Spots: 2 Number of 399Y Spots: 1

OBJECTIVES AND METHODOLOGY:
The Rochman lab researches the sources, fate and impacts of microplastics in aquatic habitats. We receive and collect samples of fish, plankton, sediments and water from the Great Lakes, San Francisco Bay and the Canadian Arctic. These samples all need to be analyzed for microplastics. This entails extracting the microplastic from the matrix, identifying it as plastic via Raman spectroscopy, measuring each particle of microplastic found in each sample and recording the data (# of particles, plastic type and size).

DESCRIPTION OF STUDENT PARTICIPATION:
Each student will have an opportunity to lead their own part of the project by independently taking on one sample set. ROP students will be involved in the design and execution of analyses, first under the supervision of the PI or a graduate student or postdoc and then more independently. Students may assume primary responsibility for data collection and care of lab equipment. Students will be expected to participate in lab meetings (including giving a presentation), carry out analyses in a meticulous and timely manner, to make a poster for the ROP poster fair, and to write a final report.

MARKING SCHEME (assignments with weight and due date**):**
Attendance and participation in lab meetings 10%
Biweekly meeting with PI 10%
Three-page description of proposed project (November 15, 2017) 15%
Completion of proposed experiment(s), following protocols and
collecting data with attention to detail (ongoing) 35%
Poster for ROP forum (early March, 2019) 10%
Final report, including a detailed explanation of all methods and all data in spreadsheet format (March 31, 2018) 20%

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Project Code: EEB 5

RESEARCH OPPORTUNITY PROGRAM
299Y/399Y PROJECT DESCRIPTIONS 2018-2019
FALL/WINTER

Name and Title: Arthur E. Weis
Department: Ecology and Evolutionary Biology

TITLE OF RESEARCH PROJECT: Ecological Genetics of Plants: Evolutionary Response to Selection by Pollinators, Herbivores and Climate Change

Number of 299Y Spots: 2 **Number of 399Y Spots: 1**

OBJECTIVES AND METHODOLOGY:

Environmental perturbation, trough time and across geographic space, can shift selection pressures on plants. Under this overarching theme, the Weis Lab engaged in several projects that evaluate the nature of selection on ecologically important traits, and the genetic capacity to mount an evolutionary response. From these data we hope to understand the pace of adaptive evolution, and its limitations. Anticipated Projects in 2018-2019 include:

What maintains flower color variation in a roadside wild flower?: Every spring Ontario Roadsides burst with color as Dames Rocket comes into bloom. Nearly every patch of this species will have purple, pink, blush and white flowered individuals. Why doesn't natural selection narrow down the range of colors? In small patches, why aren't some colors lost via genetic drift? We are using both tradition crossing experiments and genomic tools to understand the genetics of flower color in this system.

Does climate warming nor only impose selection pressure on plants, but also increase the evolvability?: Using the Experimental Climate Warming Array at the Koffler Scientific Reserve, we are asking how quickly plants can evolve in response to the changing climate. Experiments with the field mustard (*Brassica rapa*) model system, we will determine how key quantitative genetic parameters (heritability, genetic correlations, selection gradients, etc.) for vital rates, differ when expressed under current versus 'future' thermal regimes. Plants will be grown in the array over the summer of 2018, and the harvested plants processed over the 2018-19 academic year.

DESCRIPTION OF STUDENT PARTICIPATION:

ROP students will help Prof. Weis and his graduate students set up several larger experiments, collect/enter data on growth, developmental rate, mortality and seed production, and, perform preliminary data analysis. In addition, students will develop side projects that either piggy-back onto the main experiments, or that take advantage of the UofT plant growth facilities.

By working side by side with the PI and graduate students through all stages of the project, and through the weekly lab meetings and tutorials, ROP participants will come away from the year with a number of basic and advanced research skills essential to environmental and evolutionary biology. Among these are: basic horticultural practices, including plant propagation and cultivation, and, pest identification; fundamentals of experimental design and statistical analysis; familiarity with the fundamental conceptual framework of quantitative genetics

MARKING SCHEME (assignments with weight and due date**):**

Participation in research	35	(evaluation at end of semester)
Oral Presentations	20	(Fall-October 30; Winter-31 March)
Field Note Book	10	(evaluation at end of semester)
Written Report	30	(5 April 2019)
Total	100	

Participation: Students will be evaluated for the quality of work they contribute on the day-to-day operation of the main research project. This includes: Reliable and prompt attendance at appointed times; attention to detail; rapid notification of problems or ambiguities operating procedures; consistency in executing procedures and logging of data; anticipation in discussion during lab meetings and tutorials.

Oral Presentation: Students will make two oral presentations at lab meetings. The first will concern the background and planned procedures for the independent project (5 marks). The second will be a presentation of independent project results (15 marks).

Lab Note Book: A daily log of research progress is required. The notebook should record observations made about both the main and the independent projects, the data collected, and thoughts on interpretation of results. The notebook will be reviewed several times over the summer and feedback given.

Written Report: This will be concern the independent project. It should be prepared in the format of a scientific paper, with sections entitled Abstract, Introduction, Methods, Results, Discussion, and References. It should also include figures and tables that summarize the findings. The report will be due at the end of the winter semester.