Note from the director: One of the privileges of being the Director at KSR is seeing first-hand the fantastically creative science and teaching that our professors, researchers, and students do. KSR has many advantages to it—stunning beauty, diverse habitats, fantastic biodiversity, all less than an hour from North America’s fourth-largest city—but its greatest asset is the people who work here. Each year, I’m amazed at the fascinating biology our researchers are unravelling, their passion for science, and their love of studying ecological and evolutionary processes in the field where they occur. Each year we host close to 50 research projects, hundreds of undergraduate students and researchers, and courses from all three UofT campuses. By using the 350 hectares of KSR as a living laboratory for studies on the environment, in the environment, their collective efforts are helping us understand global change, biological invasions, and the fundamental workings of populations, species, and ecosystems in a changing world. To see our researchers’ enthusiasm, determination, energy, and passion is to be inspired by them. —John Stinchcombe

Kenneth Welch is learning how ruby-throated hummingbirds exquisitely balance energy intake and energy expenditure to survive and adapt to the dynamic world.

Shannon Meadley Dunphy is looking at the difference in seed dispersal between one native and one aggressive, invasive ant species and how it affects plant survival.

Stephen De Lisle dives into a fresh area of study, how sexual dimorphism evolves. He’s particularly fascinated with the red-spotted newt.

Most biologists find spring the exciting time to study wildlife. But Rosemary L. Martin is tackling winter ecology to understand the impact of global warming. Her focus: two species of dragonfly.

To find out more about the work being done at Koffler Scientific Reserve at Jokers Hill, go to ksr.utoronto.ca

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Koffler Scientific Reserve, 17000 Dufferin St., King City, Ont., L7B 1K5
The power of a 2.5-gram hummingbird: By Kenneth Welch

Each summer, thousands of cottage owners hang feeders on their porches and wait for the brilliant little hummingbirds to come. Each year they do. It’s easy to look at a 2.5-gram hummingbird and conclude that this delicate creature with a brightly burning flame could extinguish under the lightest of stresses. But in the past six years that I’ve been studying ruby-throated hummingbirds, or Archilochus colubris, at KSR, I’ve come to appreciate how resilient and strong they are. Just like cottage owners, I put up feeders – half a dozen each year across Jokers Hill. Mine are outfitted with small electronic antennae and precision digital scales.

I’m learning how these birds exquisitely balance energy intake and energy expenditure to survive and adapt to the dynamic world. In every hummingbird I catch I implant tiny electronic tags – just like the ones a vet implants in a pet dog or cat – except mine are the smallest. When tagged birds visit my feeders, they perch, are detected, and are weighed while they eat. Just like you and I, when a hummingbird takes in more calories than they expend, they gain weight, and vice versa. Unlike us, these changes occur very rapidly, painting a picture of hummingbird energy balance through the day and across seasons. These birds can eat 10% of their body weight in a single feeder visit; fluctuate in weight by 20% or more over a day.

Far from being fragile jewels, these birds are aggressive, cantankerous and hearty. Many of them will travel all the way to Central America and back each year.

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Invasive fire-ant is a game-changer: By Shannon Meadley Dunphy

Seed dispersal by ants is an important ecosystem service. Seeds have a fleshy nutrient-rich food body attached to them that ants eat after they have brought the seed back to their nest. This is called myrmecochory. North American deciduous forests are a hotspot of myrmecochory, with about 30% of forest herbaceous plants being dispersed by ants, including many violets, trilliums, lilies, bloodroot, and wild ginger. One abundant seed-dispersing ant in KSR’s forests, Aphaenogaster rudis, is responsible for 74% of seed-dispersal events in these ecosystems.

My work aims to understand how invasive species disrupt this mutualism. I am working on a project that focuses on the differences in seed-dispersal patterns between a native and an invasive ant species, and how these differences affect plant fitness and survival.

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As an eight-year-old, I would spend hours catching red-spotted newts (*Notophthalmus viridescens*), taking them home to watch swim around a tank in my living room. To me, even then, their biology was fascinating: The bright orange, toxic juvenile newts spend years wandering the forest, before eventually changing color to become a semi-aquatic adult. The adults spend their time feeding and breeding in ponds and small lakes.

At KSR, where I have worked for the past five years, I continue to study red-spotted newts, although I now have bigger scientific questions and bigger tanks. In particular, I study the evolution of differences between the sexes.

When I tell people that’s what I study, I get a giggle, or an eyebrow raise that suggests “and you’re getting a Ph.D. for this?” Sexual dimorphism, as it’s called, is often an obvious outcome of simply trying to attract a mate. Think of peacocks and their magnificent plumage. But males and females of many species diverge in body size and shape, diet, and habitat use: traits that play a major role in community ecology and the formation of new species. We know much less about how and why these types of sexual dimorphism evolve, so it’s a fresh area of study.

Newts are interesting because the sexes diverge subtly but significantly in habitat use, head shape and size, and diet. Males have narrow, long jaws and spend their time cruising in open water eating plankton. Females have wider, shallower heads and eat larger insect larvae on the bottom of the pond.

What are the ecological causes and consequences of this sexual dimorphism? To answer this I conduct experiments in artificial ponds (just big plastic tanks used for watering cattle), where I can manipulate density and sex ratio of newts.

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Hummingbirds: Picture of energy balance (cont.)

With the data I’ve gathered, we’ve begun to understand how hummingbirds prepare for their migration south for the winter, and how age and experience play into that process.

Older birds often fatten by 35% over just four days in preparation for longer, continuous flights south. The inexperienced young remain lean and seem to skip along, feeding frequently.

Far from being fragile jewels, these birds are aggressive, cantankerous, and hearty. Many of them will travel all the way to Central America and back each year.

There are tagged birds in my study that have shown up like clockwork each of the last four years. And, next summer, when a cottage owner puts up a hummingbird feeder, many of the same birds will also return: to buzz, chirp, and battle over their sweet food.

Kenneth Welch, originally from Phoenix, Arizona, is associate professor in the Dept. of Biological Sciences at UTSc. He hopes to uncover the secrets of rapid hummingbird weight loss and promises to share them if he does.

Newts: How sexual dimorphism evolves (cont.)

Because each newt has a unique pattern of red spots on its back, like a fingerprint, I can track growth rates of each individual over the course of an experiment and see how growth is affected by individual “phenotype,” or trait: sex, density, and so on.

I have shown that female newts compete more strongly with some species of bottom-feeding fish than male newts, and females in general compete more strongly with other female newts. This suggests resource competition plays a key role in the evolution of sexual dimorphism in newts.

I have gone on to study other species and subspecies of newts, and found that ecologically important sexual dimorphism is pervasive and may be playing an important role in adaptation and the formation of new species.

Stephen De Lisle, from Gloucester, Virginia, is an evolutionary ecologist finishing up his Ph.D. in Locke Rowe’s lab at the University of Toronto. De Lisle is beginning a postdoc in Sweden this year, and hopes to continue in research.
Winter survival is crucial to a species’ ability to establish a stable population, so to dismiss winter ecology is foolish. Duration of cold, number of freeze-thaw events, amount of precipitation, and contact with ice are critical when studying an organism’s cold hardiness. Understanding what winter conditions restrict or allow a species’ presence in an area will be crucial in predicting what species will invade or be driven out with changing winter conditions caused by climate change.

For my studies, I chose two species of closely related dragonflies, the White-Faced Meadowhawk (Sympetrum obtrusum) and the Autumn Meadowhawk (Sympetrum vicinum), which have overlapping ranges in Ontario. The Autumn’s larvae possess fish-repelling spines and are found in fish ponds, while the White’s larvae, lacking spines, are excluded, but found in high abundance in fishless ponds. Relatively fewer Autumn are found there. What drives the relative proportions of these species in fishless ponds?

This dragonfly species overwinters as eggs before hatching in spring. I thought White eggs might be more resistant to drying and cold land temperatures during the winter than Autumn eggs, an adaptation to living in fishless ponds.

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The European fire ant, *Myrmica rubra*, is an introduced seed-disperser from Europe. It is a reddish-brown colour, 3.5-5.0 mm in length, and has an aggressive and painful sting (the most painful ant sting that you will likely encounter in Ontario). Many plants that are dispersed by this ant in its native range, such as greater celandine, have also been introduced in Ontario.

In 2012 we began an experiment in a red pine plantation at KSR in which we dug 42 kiddy pools into the ground and covered them with mesh—each a “mesocosm” (they contain their own communities). Colonies of the native ant, *A. rudis*, and invasive European fire ant, *M. rubra*, were added to these mesocosms along with three native species: sharp-lobed hepatica, wild ginger, and bloodroot; and the invasive plant: greater celandine.

Over the past four years we have been monitoring the growth of plants that germinated from seeds dispersed by both types of ants. Importantly, we've found that the native ant leaves seeds closer to its nest, whereas the invasive ant spread seeds further out around the entire mesocosm. The invasive plant grows best in the spread-out presence of the invasive ant, whereas the native plants can survive in the high density around native ant nests.

Changing the identity of a mutualistic partner, from a native to an invasive ant, can cause changes in plant community, with a shift to domination by invasive plants. This has important implications for local ant and plant communities, because the European fire ant has been quickly expanding its range across North America.

Invasive fire ant is a game-changer (cont.)

Shannon Meadley Dunphy of Toronto is finishing her M.Sc. degree in Ecology and Evolutionary Biology at UofT. Since 2013, she has worked at KSR, on various projects.

I collected *Sympetrum* eggs in late summer/early fall and stored them in a cool, dark, barn where they went into diapause (like hibernation).

In December I set out mesh-capped specimen cups containing either White or Autumn eggs at KSR’s fishless pond, in three micro habitats: 1) on shore 2) in shallow water at the pond’s edge, and 3) deep in the pond beyond the reach of ice. I retrieved the cups in March and hatched the eggs, removed and counted the larvae, recording hatch success and date.

Surprisingly, the White eggs had much a much lower hatch success rate than the Autumn eggs in all treatments. (Normal? or did the White females just have crummy eggs?).

The pattern I find most exciting, seen in both species, is the difference among microhabitats. Eggs that overwintered on dry land or deep in the water had high hatch success, and hatched quickly over the course of six days. The shallow water treatment had much lower hatch success, and hatching events were delayed and spread out.

More than three months later, hatchlings continue to emerge at a very low rate from the shallow treatment, much to the chagrin of my trusty research assistant Emile Sabeti-Mehr who must look through all 127 cups for the one or two that still hatch each week. These results suggest that winter habitat selection is important for the survival and life-stage timing of dragonflies.

While Emile holds down the fort at the lab in Mississauga I am up again at KSR, looking into aspects of *Sympetrum* summer life history.

Dragonflies in winter (cont.)

Rosemary L. Martin is a graduate student of biology at UofT Mississauga: My ultimate goal is to create a year-round picture of what conditions determine the survival and coexistence of the White and Autumn Meadowhawk dragonflies. In the end though, I’m just very clever; I’ve devised an excuse to come out to KSR all year round.