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FEATURE: Kluane squirrels

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DEK: Two decades of studying Yukon's red squirrels yields surprising insights into adaptation and climate change.

Story and photographs by Philippe Henry.

Sunlight pours down through the boreal forest after three long days of rain. Millions of bothersome mosquitoes seem to have a rendezvous here. In the distance we have a picturesque view of the 3,400-metre peaks of the Kluane range.

I'm talking to graduate student Ryan Hodges when his colleague, Sara Hanner points at a treetop. "She's in the nest," says Hanner as she gets closer to the spruce.

She's picked up a signal from the antenna on the collared squirrel, who is indeed still in the nest with her babies. "But we don't want her to stay in the nest," says Hanner. "It's better to not have the mama squirrel inside when you want to take her babies outside."

Squirrels are not particularly aggressive, but they have sharp teeth and can give a painful bite when defending themselves and their young, so Hanner kicks the base of the spruce tree. Immediately the mother squirrel jumps out of the nest, flicking her tail and hurling squeaking barks. The mother stops for a while and then disappears when Sara starts climbing high into the tree to reach the nest.

Hanner and Hodges are researchers involved in the Kluane Red Squirrel Project taking place near Kluane National Park in southwestern Yukon. Since University of Alberta biology professor Stan Boutin started the project in 1987, over 7000 squirrels have

been tagged and in any given year biologists monitor over 500 individuals.

They are the perfect experimental animal to study,” says Boutin. “They are long-lived and numerous, and they have small territories where you can study them from birth to death. You can also manipulate their world in many different ways without doing them serious harm or driving them off.”

He and his colleagues work with researchers in the United States and the United Kingdom to pool their findings. “We use a combination of long-term field studies of individuals and experimental manipulation of their environment to learn how organisms living in the north adapt to changing food and climate. My research investigates how resource availability affects maternal investment, development of offspring, and lifetime reproductive success in boreal mammals.”

The wide-scale project has attracted other scientists such as Murray Humphries from McGill University, who focuses on the behavior and physiology of red squirrels, especially how they acquire energy through feeding and food hoarding and how they expend energy through activity, regulation of their body temperature, and reproduction.

In Andrew McAdam's lab, in the University of Guelph, one of the main research directions investigates the importance of spruce cone abundance to life history adaptations in a natural population of red squirrels.

After her climb, Hanner is back to terra firma, shirt torn in places by the sharp branches she had to traverse to get at the nest. “Climbing a spruce tree is not without drawbacks,” she says, but at least she has all four juvenile squirrels in her bag.

She and Hodges calculate the little squirrels’ age as 25 days. “We took them out of the nest to tag and weigh them to calculate growth rates. We already counted, sexed, weighed them and obtained tissue samples soon after the birth. We will weigh them again within a week of weaning,” he says, which takes place around 70 days of age.

A few juveniles receive radio collars to track how far they disperse from their home nest.

It used to be that when the environment underwent major long-term changes, animals could adapt, move or go extinct. Now, as suitable habitats vanish, many species can only adapt or become extinct — moving is no longer an option.

Red squirrels seem to be able to adapt to a warming world not only through physical and behavioral adjustments but also through genetic changes. This startling discovery, made by Boutin and his colleagues, supports the hypothesis at the basis of evolutionary theory, which posits that living organisms adapt to change in their environment as a result of natural selection.

“Red squirrels in Kluane are breeding earlier than they did ten years ago,” says Boutin. Over the first 10 years he and his colleagues have been studying the southern Yukon red squirrel population, the climate has warmed and spring has arrived earlier, he says. The result? Females give birth to their young two to three weeks earlier than they did a decade ago.

“Our work is unique, however, in that, by using some pretty sophisticated analytical techniques, we figured out how much of this advancement in breeding was due to behavioral changes within generations and how much was due to genetic changes across generations,” says Boutin. “The easy part was to document that the squirrels are in fact breeding earlier. The hard part was to separate effects of individual behaviors from genetic changes. It is a great discovery even if we don’t know yet the specific genes responsible for the timing of breeding in red squirrels.”

It is these genetic changes that signal evolution is taking place. They also demonstrate an aspect of evolution that’s surprising to many: Evolution is not necessarily a long-term process but can occur over a very short period of time. “The changes we observed took place in four generations of red squirrels,” Boutin says.

The next morning I meet Ryan at the research camp, which is actually just a few trailers and rustic buildings in the woods near the

Alaska Highway, south of Haines Lake. It looks a bit rough, but I feel some comfort after I jump over the electric bear fence and open the door of the main structure to find a wood stove and propane heaters, cozy old sofas and armchairs, shelves staggering under the weight of books. There are shoes and clothes everywhere and a pleasant smell of fresh coffee and toasted bread. (The buildings were winterized recently to allow researchers to use the camp during the winter. Red squirrels don't hibernate, meaning the team can do field work even in the coldest conditions, when temperatures are below -20 C for weeks at a time.)

Most of the crew is already outside checking on the live traps, handling squirrels in specially designed bags, weighing the squirrels, drawing blood, collecting scat and putting uniquely coloured wires in the animals' ear-tags so they can be recognized from a distance. Hodges is heading to a stand of spruce trees near Squirrel Camp to set new live traps baited with peanut butter.

Red squirrels eat all kind of things: seeds, nuts, mushrooms, insects, birds' eggs, baby hares and mushrooms. They also collect several thousand green spruce cones during the summer and stash them in food caches called middens: huge mounds of scales from cones and located at the base of spruce trees, where they stay moist and cool. Researchers have discovered that some females can allow one of their offspring to take over their territory, including their middens, when it is time for the young to be independent. She moves to another midden she took over before she had young, improving the youngsters' chance for survival.

"Lots of animals time their reproduction to match predictable increases in resources like the new growth of plants every spring," says Boutin. "But the interesting twist here is that the squirrels have figured out a way to produce a second litter of pups at a time when they have little food and months before an unpredictable boom in seed production."

How can red squirrels predict trees' future yields? Researchers speculate it might be related to buds which turn into cones and are eaten by the squirrels every summer.

McAdam says the team speculates that the buds the spruce trees put out the summer before cones develop may hold the clues to a masting event, when all of the trees produce a very large cone crop.

The buds differentiate in the summer — some become branches, some develop into cones. The squirrels eat the buds, and may be able to detect which destiny they will follow, in the process getting tipped off to an upcoming masting event.

What will the forest look like for these resourceful little creatures in the future? Mild winters and springs provide good breeding conditions for the spruce bark beetle, which bores into trees to lay its eggs. By 1999, this voracious insect had killed almost all of the mature white spruce over some 200,000 hectares in the Alsek corridor in Kluane National Park and in the Shakwak Valley, northwest of Haines Junction. There are already beetle-infested trees in the squirrel study area.

But despite their reliance on spruces for food and shelter, red squirrels are once again proving their adaptability. It seems they already have started to resolve the problem by feeding on the beetle larvae.

Philippe Henry is a writer and photographer based in St. Leonard, Quebec. He spent a few weeks at Squirrel Camp to learn about the busy, noisy little red squirrel. Visit www.philippe-henry.com to see more of his photography.

SIDEBAR 1

SUBHED: Fact File

Red Squirrel

Scientific name: *Tamiasciurus hudsonicus*

Also known as: pine squirrel, chickaree

Length: 25 to 35 centimetres from nose to tip of tail

Weight: 200 to 300 grams

Appearance: reddish-brown to reddish-grey fur with white underbelly

Diet: conifer seeds make up more than 80 per cent of diet; also eats buds, flowers, berries, insects, larvae, birds' eggs, young mice or rabbits, mushrooms, etc.

Predators: lynx, coyotes, great horned owls, goshawks, red-tailed hawks, marten, foxes, wolves, weasels

Reproduction: after gestation averaging 33 days, females give birth to litters of one to five blind, hairless pups

Habitat: coniferous, deciduous and mixed forests across North America; also found in suburban settings with large stands of mature trees

Range: one of the widest distributions of all North American squirrels; found from Alaska continuously across Canada to the northeast United States

Status: Canadian population is secure

-PH

SIDEBAR 2

SUBHED: The European Connection

Canada isn't the only place where scientists are studying red squirrels. In the forests of Italy, England and Belgium, biologists are focusing on another creature also known as a red squirrel, *Sciurus vulgaris*. Despite their similar common names, the two species are not closely related, their evolutionary paths having diverged about 13 millions years ago In a strange twist, one of the biggest threats facing European red squirrels is actually the invasive North

American eastern gray squirrel, which was first released in southern England in the 1870s by a misguided animal lover. About 60 per cent of gray squirrels carry the squirrelpox virus, which doesn't harm the big grey squirrels, but kills the smaller red ones, or leaves them too sick to compete for food against the North American invaders.

But just as the Yukon's red squirrels have proved resilient in the face of changing conditions, some European red squirrels are already showing up with antibodies to the disease. The change suggests the immune systems of some squirrels have already adapted to recognize and fight the virus.

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