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Dispersal in Adult Arctic Ground Squirrels: Why Do Males Do What They Do?

by Elizabeth Gillis

INTRODUCTION

LIKE MOST OTHER CHILDREN, when I was young I could spend hours watching ants, beetles, and other insects move through their environment. Where are they going, I would wonder. How do they know when to stop? Are they following a particular route? As I grew older, this fascination with how and why animals move also grew, and animal movement ultimately became the focus of my developing career. These interests led me north in 1995, when I headed to the Kluane Lake area in southwestern Yukon to study snowshoe hares as part of my MSc. Once there, I became captivated by the apparent simplicity but actual complexity of northern ecosystems. I knew I would continue studying these systems for a long time to come.

I have been fortunate to be able to combine my interest in animal movement and my love of northern research. My research with hares evolved into research on the causes and consequences of breeding dispersal in arctic ground squirrels. Dispersal occurs when animals permanently relocate from one area to a new area that is entirely separate from the area of origin. Dispersal before animals become reproductively mature (called *natal dispersal*) is quite common. Sometimes, mature individuals also disperse between breeding attempts, resulting in *breeding dispersal*. Reproductively mature individuals and juveniles may disperse for very different reasons; however, breeding dispersal is rarely studied in mammals because it usually occurs at very low rates and only in some species. Nevertheless, in species where it occurs often, breeding dispersal can help prevent inbreeding and facilitate the establishment of populations in suitable vacant habitat. Arctic ground squirrels (*Spermophilus parryii*), more commonly known as "gophers" or "sik-siks," provide a unique opportunity to study the causes and consequences of breeding dispersal. Found throughout northern North America, they are peculiar among small mammals in that most adult males (85 to 100%) disappear between one breeding season and the next. Although some of the disappearing individuals undoubtedly die, past evidence from live trapping studies indicate that many of the disappearing males actually disperse.

Ground squirrels are both fascinating and practical animals to study. They hibernate eight months of the year, so their short active season follows a concise, predictable pattern. Adults emerge from their individual hibernation sites in late April and early May, while the ground is still snow covered, and they mate within a few days of emerging. Young are born after a 25-day gestation period and then continue to develop in underground nests for an additional 25 days. In late June and early July, the young first poke their noses above ground and begin foraging. Adult females enter into hibernation starting in late July, followed a couple of weeks later by adult males. Juveniles go into hibernation in September and October, after they have accumulated enough fat reserves to have hopes of surviving the winter. If juveniles do survive, they breed the following spring, and although some may live to see eight years old, most die in their first or second year. Fortunately, ground squirrels' love of peanut butter makes them easy to live-trap and ear-tag, allowing long-term population and behavioral studies to be feasible.

Female arctic ground squirrel with pups. (Photo: T. Karels.)

GOALS, METHODS, AND STUDY SITE

The primary goal of my research on ground squirrels is to determine why adult males disperse. I use this system to understand the ecology of mating behaviour and the

Elizabeth Gillis (left) and Alistair Blachford (right) trapping arctic ground squirrels. (Photo: L. Warman.)

Spring camp and study area. (Photo: E. Gillis.)

evolutionary implications of different mating strategies. Two hypotheses I am investigating are (1) that adult males disperse to avoid mating with their daughters, who breed very close to where they were born, and (2) that adult males disperse to increase their access to females for mating. I also quantify survival and reproductive costs and benefits associated with dispersal for adult males in order to identify potential explanations for the different mating strategies used by individuals within a population.

To address these objectives, I study a population of arctic ground squirrels in the Ruby Ranges, located along the eastern shore of Kluane Lake, Yukon Territory. The study site is above the tree line and ranges in elevation from 1600 to 2200 m. The site is home to a long-term project, the Kluane Alpine Ecosystem Project, run by D. Hik at the University of Alberta, and he and I have monitored ground squirrel numbers yearly since 1998. During the time of my field studies, 2000–2002, concurrent research projects were being conducted on hoary marmots (groundhogs, *Marmota caligata*) and collared pikas (rock rabbits, *Ochotona collaris*), as well as on vegetation-climate and plant-herbivore interactions.

I live-trap, ear-tag, and radio-collar adult male ground squirrels and follow them throughout the summers to determine dispersal distances and rates and adult male survival. To measure male reproductive success, I monitor the female population for signs of pregnancy and, after locating the pregnant females' natal nests, monitor them for the presence of juveniles. As the juveniles emerge, I trap them to determine litter sizes and take tissue samples. I am now analyzing the DNA of these tissue samples to determine which males sired which litters. Using the data I have collected over the last several years, I can test predictions (based on the two specific hypotheses outlined above) about which males should and should not disperse. I can also evaluate the costs and benefits of each male's "decision" to disperse in terms of whether he survived and how many offspring he produced.

Combining the yearly census data with the reproductive data, I am comparing the population dynamics of arctic ground squirrels at my site, in an alpine habitat, to published and unpublished data for a population living at the same latitude but at lower elevation, in the boreal forest. Such comparative work of population dynamics across elevation gradients provides essential information for predicting the effects of global warming on animal populations—particularly in northern regions, where climatic changes are expected to be great. Taking advantage of existing differences in climate by comparing different elevations gives us a glimpse of the effects that climate change might have on animal populations.

RESULTS

My data analysis is not yet complete, but preliminary results challenge many of the assumptions previously held about dispersal of adult arctic ground squirrels and male mating strategies in general. For the ground squirrels, it is commonly assumed that most breeding dispersal occurs shortly after juvenile emergence. Although I found some adult males that disperse at this time, the majority disperse earlier, in the spring, shortly after they emerge from hibernation, or just before the young are born. Since I use radio telemetry to locate males, I can determine the fate (alive and moved or dead) of each disappearing male. During the mating season, survival of adult males is lower than that of females and seems to be associated with an increase in movement rate that leads to an increase in predation. How far a male moves is associated with the distribution of females. Males living near "clumps" of females remain relatively close to home, while those in areas with few or no females nearby move large distances. Males also die during the mating season of causes not related to predation, such as injuries sustained in fights and drowning! In contrast, male survival during the non-mating portion of the active season is very high, even when males disperse. The high survival rate among dispersers contradicts the common assumption that dispersing animals are at high risk of death.

Interesting results are also emerging from the comparison of population dynamics of ground squirrels at the alpine and lower-elevation sites. The majority of mortality in the boreal forest population occurs because of predation during the active season, but overwinter mortality appears to contribute most to yearly death in the alpine population. Contrary to most species that inhabit a range of elevations, arctic ground squirrels at the higher-elevation site have significantly higher birth rates than those at the lower-elevation site. In addition, there is a trend toward larger litters and survival of more young to weaning age at the higher elevation. Usually, we expect high-elevation sites to have extreme conditions with lower food availability, resulting in reduced reproductive performance. Arctic ground squirrels at high elevation may experience reproductive success because they have evolved in open tundra areas and rely on sight for predator detection. Trees at low elevations obscure visibility, and this may be the reason why squirrels in the boreal forest are physiologically stressed. Chronic stress could be responsible for the apparent reproductive suppression in the forest. These results suggest that many factors predicted by global climate change, such as shifts in tree line and predator distribution, as well as changes in the winter climate that affect overwinter survival, have the potential to interact and affect ground squirrel population size.

THE BIGGER PICTURE

Causes and consequences of dispersal in naturally occurring populations are poorly understood. This is unfortunate, as dispersal is an important aspect of small mammal demography and has many conservation implications. For example, dispersal is required for recolonization in areas where populations have been extirpated, but as habitats become fragmented, dispersal may be disrupted. My detailed studies of dispersal processes provide information on the largely mysterious processes of animal movement.

My work is also important to understanding Canada's boreal and tundra ecosystems. Combining my research with that of others working at the same site allows us a better understanding of northern alpine communities. A variety of emerging pressures threaten these ecosystems—including global warming, habitat loss and fragmentation, and pollution. By understanding the ecosystem dynamics before they are substantially altered, we will be able to document changes as they occur, predict the damage they may cause, and (we hope) lessen their impact.

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