Seasonal Changes in the Reproductive Organs and Body Condition of Northern Redbacked Voles (*Clethrionomys rutilus*)

Arvicoline rodents (voles and lemmings) are small, non-hibernating mammals that play important ecological roles in high-latitude environments. Vole reproduction can be species-specific and generally occurs in spring and summer, but almost all arvicolines are known to occasionally breed in winter. Our aim was to determine whether seasonal change occurs in the relative reproductive organ masses of the northern redbacked vole (*Clethrionomys rutilus*) in coastal, south central Alaska (61°N), and, if so, to test whether these masses were correlated with the rodents' body condition. We measured seasonal change in the masses of three male organs (seminal vesicle, testis, and epididymis) and two female organs (ovary and uterus) for adult and adolescent voles, used histological methods to define male reproductive state, and measured body condition (percentage body fat) using dual-energy X-ray absorptiometry (DXA). The relative masses of all male and female organs showed significant seasonal change ($P<.05$), but body condition did not change significantly with season ($P>.05$) and there was no correlation between any of the relative organ masses and the vole's body fat percentage ($P>.05$, r^2 0.0 to 0.1). All male and female organ masses were significantly heavier in the spring and early summer seasons. Reproductive condition was linked to season but not to body condition. The reproductive condition of Northern red-backed voles is likely to continue to follow season, by responding to increased or decreased light, regardless of any changes in the energetic demands placed on the animal due to climate change.

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Introduction

Arvicoline rodents are small, non-hibernating mammals that inhabit arctic, sub-arctic, and northern temperate regions. Voles and lemmings are an important food source for many predatory birds and carnivorous mammals[1] and also widely affect the growth of vegetation[2] in high-latitude environments. Although winter breeding has been documented in most species, arvicoline reproduction is typically seasonal because the need for additional energy to maintain body temperature in winter makes it harder for small mammals to successfully reproduce. The reproductive organs of small mammals are often affected by the changes in day length (photoperiod) associated with changes of season.[3] They may also be affected by changes in the energy intake or energetic requirements of the voles. If the current warming trend in Alaska continues, the amount of energy required by the voles to survive will change. Our aim was to determine whether the reproductive structures of Northern red-backed voles would be likely to continue to conform with photoperiod or to change with changes in energy availability if such a change occurred. To determine this, we addressed three questions: Did the masses of vole reproductive organs change seasonally? Did vole body condition change seasonally? And were the relative masses of the reproductive organs correlated with body condition?

Materials and Methods

Northern red-backed voles, *Clethrionomys rutilus*, were collected in Chugach State Park, Alaska (61°N) between November 2004 and May 2006. We divided these voles into six groups based on season (spring: April–May, early summer: June–July, late summer: August–September, fall: October–November, early winter: December–January, and late winter: February–March) and measured the masses of reproductive structures of the adults (total body mass >17 g) and adolescents (body mass >13 g). The structures measured were the seminal vesicles, testes, and epididymidis in the males and the uterus and ovaries in the females. We used dual-energy x-ray absorptiometry, DXA, to measure body condition, which we defined as the percentage of soft tissue composed of body fat (PixiMus2 with a corrective algorithm for C. rutilus[4]). We used paired t tests to test for differences between the left and right structures of complimentary organs. As we found no significant differences ($P>.05$) between any of these pairs, subsequent analyses were carried out on paired structure masses. We used one-way analyses of variance to test for the presence of seasonal differences and least significant difference, LSD, tests to identify the seasons that differed. We used regression analysis to test for correlations between the mass of each of the five reproductive structures and body condition.

Results

The mean mass of the male reproductive structures – testes, epididymides, and seminal vesicles – were all significantly higher in spring and early summer than at other times of the year ($P<.05$) (Figure 1) The mean mass of

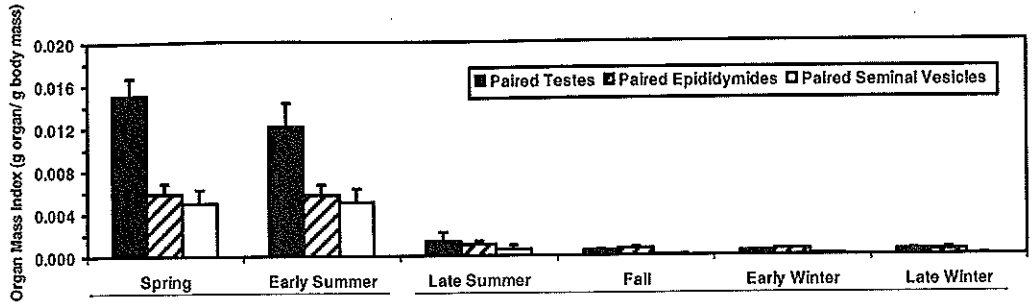

Fig 1. The effect of season on male organ masses

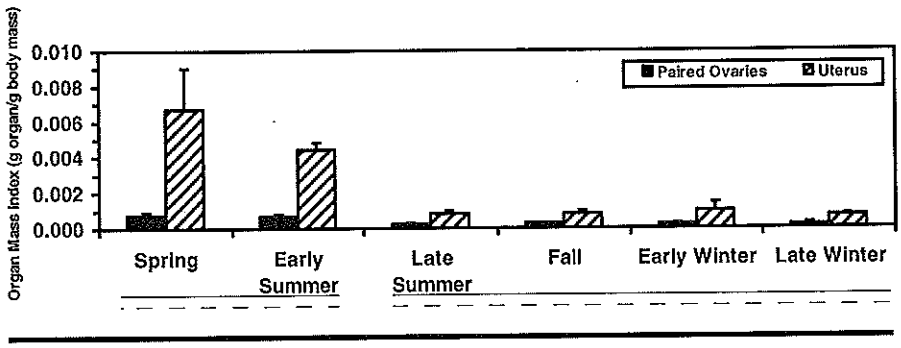

Fig 2. The effect of season on female organ masses

the female reproductive structures – ovaries and uterus – followed the same pattern, with the uterus being significantly larger ($P<.05$) in spring than early summer and both structures being significantly larger in spring and early summer than at other times of the year ($P<.05$) (Figure 2). We found no significant effect of season on body condition (ANOVA, $P=.16$, $F=2.3$). There was no correlation between any of the reproductive organ masses and body fat percentage ($P>.05$ for all five regressions, r^2 values ranged from 0.0 to 0.1).

In all three figures, bars represent means, error bars represent standard errors, Sample sizes included: spring, 13 males, 7 females; early summer, 5 males, 9 females; late summer, 20 males, 18 females; fall, 13 males, 15 females; early winter, 7 males, 6 females; late winter, 5 males, 2 females. Shared under-linings indicate means that did not differ significantly ($P>.05$).

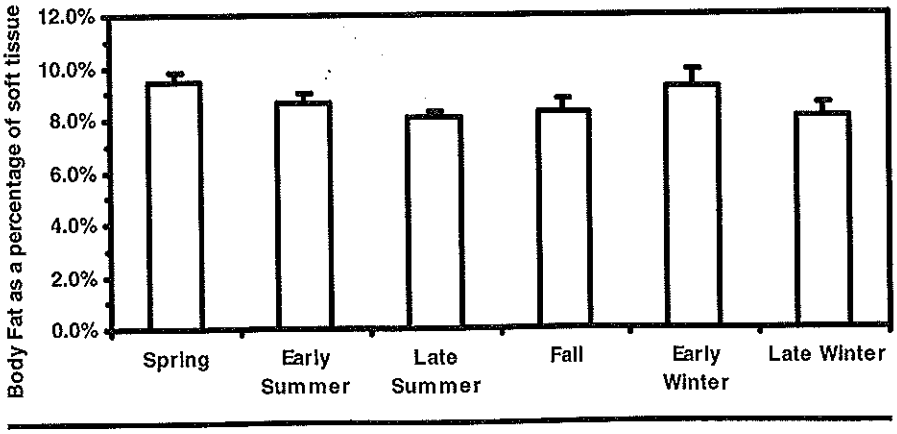

Fig 3. The effect of season on body condition

DISCUSSION

The masses of vole reproductive organs did change seasonally. Both male and female reproductive organ masses were much higher in spring and early summer. However, the body condition of the voles did not and the percentage of the soft tissue composed of body fat was not correlated with the mass of any of the reproductive structures measured. As the reproductive condition of Northern red-backed voles is linked to season, but not to body condition, their reproductive condition is likely to continue to follow season, by responding to increased or decreased light, regardless of any change in the energetic demands placed on this species as a result of climate change.

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