AN ABSTRACT OF THE THESIS OF

Chris D. Hase for the Master of Science

in Biology presented on 29 June 1998

Title: The Effects of Body Size, Season, and Food Type on Food Selection of Eastern Woodrats

Abstract approved: Elmer J. Finck

Experimental evidence shows that food selection of eastern woodrats might be affected by food type, season, and body size. Most studies of the eastern woodrat (*Neotoma floridana*) have involved translocating animals to more unnatural conditions. The purpose of my study was to find if body size, season, and food type affected food selection of eastern woodrats under more natural conditions. To accomplish this, I conducted two experiments concurrently, one using novel foods and the other using natural foods. The study was conducted from 10 November 1997 to 12 March 1998. In the first experiment, I tested the hypothesis that novel food selection among eastern woodrats would differ relative to body size, season, and food type (i.e., energy content and perishability). In the second experiment, I tested the hypothesis that natural food selection among eastern woodrats would differ relative to body size, season, and food type (i.e., perishability). I used a general linear model repeated measures procedure to test the effect of body size, season, and food type on food selection of eastern woodrats. There was a significant difference ($P = 0.008$) for food type and a significant interaction ($P < 0.0005$) between body size and food type in the novel food experiment. A significant difference ($P = 0.024$) for food type and a significant interaction ($P = 0.009$) among body size, season, and food type was found in the natural food experiment. Detectable trends

support the results and predictions of other food studies on the eastern woodrat. Because of the similar results for food type and interactions between and among factors for both experiments, I suggest my results support the hypothesis of an effect of body size, season, and food type on food selection of eastern woodrats under more natural conditions, but these effects and interactions cannot be separated by the methods I used.

THE EFFECTS OF BODY SIZE, SEASON, AND FOOD TYPE ON FOOD SELECTION OF EASTERN WOODRATS

A Thesis

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the Division of Biological Sciences

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PREFACE

My thesis has been prepared in the style appropriate for the journal *Animal Behaviour*. The journal style includes British spelling and grammar conventions.

Running Headline: Hase: Food selection of eastern woodrats

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Caching describes the behaviour, exhibited by certain animals, of manipulating and deferring consumption of food to preserve it for future use (Vander Wall 1990). Caching by some animals imparts advantages over other animals who do not cache (Sherry 1985), such as avoidance of unfavourable environmental conditions and risk of predation. Caching might allow individuals to redirect time normally spent in foraging to other activities, including reproduction and other life history traits (Vander Wall 1990). Larder-hoarding species cache most of their food in essentially one or a few places in a small portion of their home range (Smith & Reichman 1984).

The eastern woodrat, *Neotoma floridana* Say and Ord, is a medium-sized murid rodent in the subfamily Sigmodontinae (Wiley 1980; Wilson & Reeder 1993). Two subspecies occur in Kansas; the eastern woodrat of east-central Kansas is the subspecies *N. f. attwateri* Mearns (Bee et al. 1981). Eastern woodrats construct stick dens and cache a variety of food items inside the dens (Fitch & Rainey 1956; Rainey 1956). The eastern woodrat caches food for long periods (Rainey 1956; Wiley 1980) as a mechanism for surviving times of resource scarcity and unpredictability. Although eastern woodrats remain active and forage when the winter is mild (Fitch & Rainey 1956; Rainey 1956; Reichman 1988), the cache can comprise a large portion of their winter diet (Post 1991).

One important decision faced by eastern woodrats, related to the cache, is the order of consumption of foods because eastern woodrats remain active during the winter months (Fitch & Rainey 1956; Rainey 1956). Reichman & Fay (1983) suggested a caching species should eat small portions of a variety of cached foods rather than eating all of the high-quality (energy- and nutrient-rich) foods first. By consuming a variety of food items, an individual thus avoids having only poor-quality food items available late in the winter. Four species of Sonoran Desert rodents studied by Reichman (1977) chose seeds high in energy content, but also consumed seeds low in energy content, apparently to satisfy other needs, such as nutrition or moisture.

The dietary quality of eastern woodrat caches in east-central Kansas has great implications because the length of time eastern woodrats might have to rely on caches is indeterminate and can vary considerably from year to year. Post (1993) showed eastern woodrats could determine small lipid and protein differences in experimental diets within 24 h. She proposed eastern woodrats might possess the ability to detect differences in food nutritional values with greater acuity than that exhibited by the animals in her study. She suggested the eastern woodrat's ability to detect small differences in food lipids and proteins would benefit it in food selection. By identifying the most energy- and nutrient-rich foods, eastern woodrats should be very efficient at selecting the most beneficial foods in their environment.

Optimal foraging theory predicts eastern woodrats should maximize their energy intake (Pyke et al. 1977). Theoretically, eastern woodrats should consume a variety of food items ranging in energy value, thereby eliminating the possibility of having only energy-poor, stored foods available during periods in which foraging opportunities outside the den are limited or not possible (Reichman & Fay 1983). In addition, Reichman & Fay (1983) showed a caching species, *Chaetodipus intermedius*, had a more diverse diet than a noncaching species, *Peromyscus maniculatus*. If eastern woodrats manage caches efficiently, one would expect individuals to consume more perishable items than persistent items, thus reducing the loss of cache value relative to energy content and decomposition

(Post 1991).

Post (1992) showed that the nutrient content of foods in eastern woodrat caches varies through winter and in some foods declines by early spring. She suggested the decrease in energy content might negatively affect eastern woodrats having a limited cache. Post et al. (1993) showed that larger eastern woodrats store more energy per gram of body mass in caches than smaller individuals. They proposed smaller eastern woodrats probably spend more time foraging outside the den. This size discrepancy might cause smaller eastern woodrats to adopt a different strategy when consuming cached food. Assuming smaller eastern woodrats are restricted to foods contained within their caches and home ranges, those individuals should take advantage of any high energy food when encountered, despite its degree of perishability.

Food perishability also appears to play a role in food chosen for consumption by other small mammals who cache. The short-tailed shrew, *Blarina brevicauda*, consumes cached foods in rank order of their apparent degree of perishability (Martin 1984). The banner-tailed kangaroo rat, *Dipodomys spectabilis*, prefers mouldy seeds to very mouldy or non-mouldy seeds (Reichman & Rebar 1985). Likewise, food perishability does affect which types of food items eastern woodrats cache or consume (Reichman 1988; Wooster 1990; Post & Reichman 1991). Experimental evidence seems to show the foods an eastern woodrat consumes from its cache affect its probability of winter survival because of the eastern woodrat's reliance on stored food. Furthermore, results appear to show that food selection of eastern woodrats might be affected by varying environmental conditions during cache use (i.e., season), food energy and perishability (i.e., food type), and the body size of individual eastern woodrats.

Food studies of small mammals often involve translocating experimental organisms into climate-controlled, semi-natural, or otherwise unnatural conditions for extended periods; such examples include food studies of eastern woodrats (Reichman 1988; Wooster 1990; Post & Reichman 1991; Post 1993). Martin (1984) showed a difference in caching behaviour between short-tailed shrews held in simulated, natural conditions and those held in climate-controlled, captive conditions. Studies to understand food choice or preference of eastern woodrats over a short duration under natural conditions seem lacking.

The purpose of my study was to find if body size, season, and food type affected food selection of eastern woodrats under more natural environmental conditions. To test this, I conducted two experiments, one using novel foods and the other using natural foods. The experiments were conducted concurrently from late fall through early spring.

In the first experiment, I tested the null hypothesis that selection of novel foods amongst eastern woodrats does not differ relative to body size, season, and food type (i.e., energy content and perishability). In the second experiment, I tested the null hypothesis that selection of natural foods amongst eastern woodrats does not differ relative to body size, season, and food type (i.e., perishability). For both experiments, I predicted eastern woodrats would selectively consume foods and that selection of foods would be affected by body size, season, and food type and would be commensurate with the findings and predictions of previous food studies of eastern woodrats and other caching species. Ideally, I expected my study to provide an option for testing various aspects of food selection under more natural environmental conditions than previous studies.

METHODS

Study Site

I conducted my study on the Ross Natural History Reservation (RNHR), 23 km northwest of Emporia, in Lyon County, Kansas. The RNHR is an 80 ha tract located on the eastern edge of the Flint Hills physiographic region. The RNHR is comprised mainly of tallgrass prairie interspersed with many tree rows, woody ravines, and woody patches. The most abundant tree and shrub species on the study site include red cedar, *Juniperus virginiana*; Osage orange, *Maclura pomifera*; honey locust, *Gleditsia triacanthos*; rough-leaved dogwood, *Cornus drummondii*. Other abundant tree species found on the RNHR include cottonwood, *Populus deltoides*; American elm, *Ulmus americana*; hackberry, *Celtis occidentalis*; green ash, *Fraxinus pennsylvanica*. Other abundant shrub species include fragrant sumac, *Rhus aromatica*; wild plum, *Prunus americana*; Missouri gooseberry, *Ribes missouriense*; buckbrush, *Symphoricarpos orbiculatus*; (Conrad 1995). Plant nomenclature follows that of the Great Plains Flora Association (1986).

Study Period and Trapping Considerations

I conducted my study from 10 November 1997 to 12 March 1998. The study period was divided into three sampling seasons of 41 days each as follows: 10 November 1997 to 20 December 1997, late fall; 21 December 1997 to 30 January 1998, winter; 31 January 1998 to 12 March 1998, early spring. By using forty-one-day sampling seasons, the beginning of the winter sampling season coincided with the Winter Solstice on 21 December and a complete cycling of moon phases occurred during each sampling season.

Trapping commenced in late fall to increase the probability that individuals would have occupancy of a den, would have most of their caches filled, and would be unlikely to change occupancy given the relatively few unoccupied dens within the area (Fitch & Rainey 1956; Rainey 1956; personal observation). I anticipated the study period would encompass times when eastern woodrats were not relying heavily on caches, continuing into times when they were relying more heavily on caches.

The feasibility of trapping eastern woodrats was based on consideration of weather conditions (Johnson 1967) and moon phases (Wolfe & Summerlin 1989). Those days in a sampling season closest to the full moon were largely avoided (Wiley 1971; Wolfe & Summerlin 1989) after the first sampling season because of apparent reduced eastern woodrat activity (personal observation). Traps were placed on areas of the RNHR where eastern woodrat dens are highly concentrated (personal observation). Observations included eastern woodrats residing in natural dens and individuals residing in artificial dens constructed and placed in August and September 1996.

Novel Foods

I used four novel foods in the first experiment including two perishable and two persistent foods. Each category consisted of a high and low energy food. Novel foods were selected to control for any natural food bias individual eastern woodrats might have (Wooster 1990). Additionally, by using novel foods I was able to select persistent and perishable high and low energy foods with proportionally similar protein, fat, and carbohydrate constituents (Souci et al. 1986). The classification of novel foods as either perishable or persistent was based on a qualitative, relative assessment. Peanut butter balls and grapes were selected as the perishable foods. Peanut butter balls consisted of peanut butter and rolled oats formed into balls and wrapped in weighing paper (Kaufman et al. 1988). Peanut butter balls were frozen until use. Grapes were washed in a biodegradable soap solution and rinsed before use to eliminate potential pesticide and preservative residues. Peanut butter balls represented the high energy food and grapes represented the low energy food. Peanuts and raisins were selected as the persistent foods. Peanuts represented the high energy food and raisins represented the low energy food. Peanut butter balls, with approximately a three fourths to one ratio of rolled oats to peanut butter, provide 7.90 kcal/g and grapes provide 0.69 kcal/g (Souci et al. 1986). The caloric value of peanuts is 5.27 kcal/g and for raisins is 2.78 kcal/g (Souci et al. 1986). Caloric values of the novel foods were based on the digestible fraction of the edible portion on a dry weight basis (Souci et al. 1986).

Natural Foods

The natural foods in the second experiment consisted of a perishable and persistent food. Rough-leaved dogwood fruits represented the perishable food, whereas red cedar leaves represented the persistent food. Rough-leaved dogwood fruits and red cedar leaves were selected as the natural foods because both were found to comprise much of the eastern woodrat's winter diet (Post 1991). Approximately 28 l of rough-leaved dogwood fruits, including stem parts, were collected during September 1997 and frozen until used. Red cedar leaves (stem tips) were freshly collected before use. Only leaves from red cedar trees not bearing fruit were collected because Post (1991) found that eastern woodrats in her study did not consume red cedar fruits.

General Methods

Foods were placed in glass containers wired to the rear of Tomahawk live-traps (407 x 127 x 127 mm). Fiberfill batting for nest material was placed in each trap. Approximately 35 g of each novel food were measured with a triple-beam balance. The mass of two peanut butter balls constituted the mass of all the other novel foods. Approximately 30 g of each natural food were measured with a triple-beam balance. Thirty grams of each natural food were used because of the container volume occupied by the red cedar leaves. Stem parts were removed from the rough-leaved dogwood fruits before being weighed. Mass of both novel and natural foods was recorded to the nearest tenth of a gram. The perishable novel foods and both natural foods were replaced with fresh foods on a regular basis. Traps were set at least one hour before sunset and checked at sunrise. I recorded the mass of the remaining amount of novel and natural foods in each trap, despite the presence or absence of an eastern woodrat, to account for any desiccation incurred by the perishable foods. The number of individuals trapped with each food type in late fall established the number to be trapped in winter and early spring.

The mass and sex of each eastern woodrat were recorded in both the novel and natural food experiments. Mass of trapped eastern woodrats was recorded with a Pesola spring scale (500 g x 5 g) to the nearest five grams. Using the standards established by the American Society of Mammalogists (*ad hoc* 1987), I toe-clipped individual eastern woodrats to record recaptures.

I categorized the body size of individual eastern woodrats as either small or large based on the mass and sex of each individual. I combined sex with mass because eastern woodrats are sexually dimorphic. I assumed that any differences in food consumption related to mass might also be related to sex. Categorization was based on the mass means reported by Rainey (1956) for males and non-pregnant females. The mean for males was 299 g and for non-pregnant females was 216 g (Rainey 1956). Those individuals with a mass below their respective mean were considered small, whereas those individuals with a mass above their respective mean were considered large.

Analysis and Data Considerations

I used a general linear model (GLM) repeated measures procedure (SPSS 1997), by blocking subjects, to test the effect of body size, season, and food type on food selection of eastern woodrats. A chi-square test was used to compare the sex ratios of individuals captured throughout the study. For all analyses, the level to reject was 0.05.

Some observations were not considered in the analysis because a trap had been moved and tipped over, an individual had escaped before it could be weighed and identified, or food was spilled before being reweighed. The final mass of eight novel food observations from late fall, in which no individuals were captured, was not recorded.

RESULTS

Trapping Success

One hundred five eastern woodrat captures were made during 192 trap nights. Trapping success was 54.7%. Twenty individuals were captured during each of the three sampling seasons with novel foods. Eleven individuals were captured during late fall and winter and 10 during early spring with natural foods. Five individuals were recaptured in late fall with novel foods and two were recaptured in winter with novel foods. The mean of the two observations for each individual within a sampling season was reported as one observation.

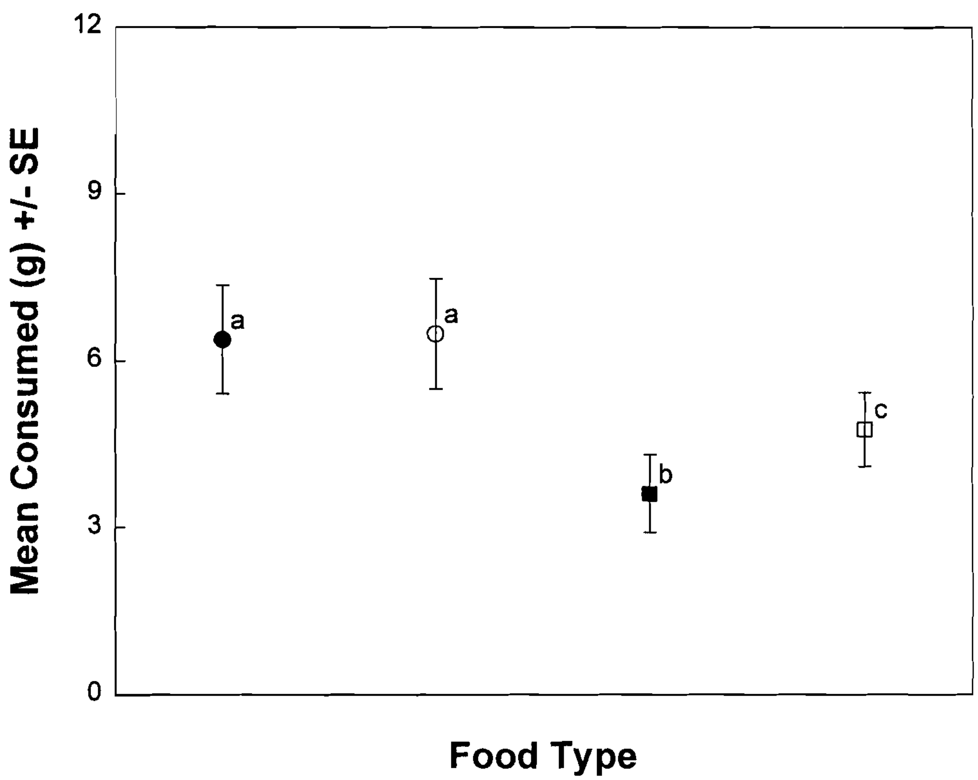
Desiccation of Perishable Foods

Desiccation of novel and natural foods was not considered in the analysis because differences between initial and final mass, in which no individual eastern woodrats were trapped, were relatively small. The mean difference for peanut butter balls and grapes was less than 1%, and for dogwood fruits was approximately 4% of the total mass.

Novel Food Experiment

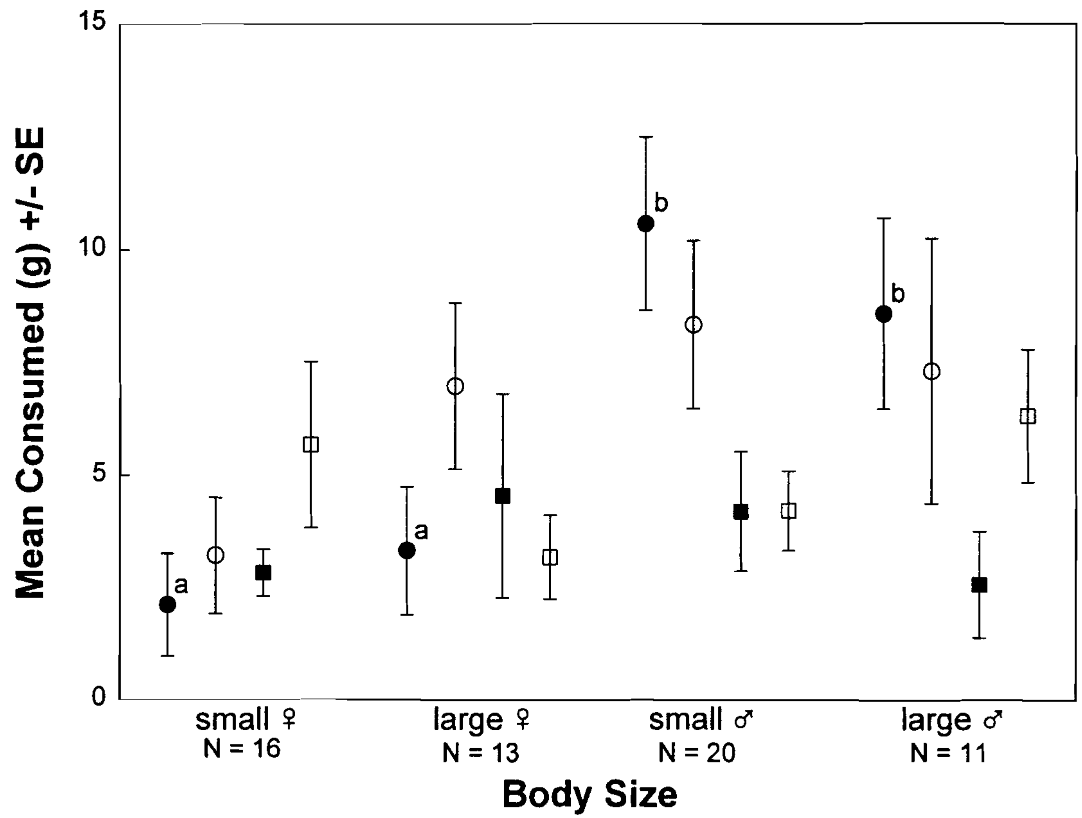
Observations of the quantity of novel foods consumed were log transformed to meet the assumption of normality. The GLM univariate analysis of the novel food experiment revealed a significant difference (GLM repeated measures: $F_{2,3}$=4.047, P=0.008) for food type (Fig. 1). A significant interaction (GLM repeated measures: $F_{2,9}$=4.116, P<0.0005) between body size and food type was found (Fig. 2). A Tukey

Figure 1. Significant (P=0.008) affect of food type [peanut butter balls (●), grapes (○), peanuts (■), and raisins (□)] on food selection of eastern woodrats (N=60 for each food type). Lower case letters indicate significant differences. Those values with the same letter are not significantly different.



Mean Consumed (g) +/- SE
12
9
6
3
0
a
a
b
c
Food Type

Figure 2. Effect of body size and food type [peanut butter balls (●), grapes (○), peanuts (■), and raisins (□)] on food selection of eastern woodrats. Interaction between body size and food type is significant ($P<0.0005$). Lower case letters indicate significant differences. Those values with the same letter are not significantly different.


Mean Consumed (g) +/- SE
15
10
5
0
a
a
b
b
small ♀
N = 16
large ♀
N = 13
small ♂
N = 20
large ♂
N = 11
Body Size

multiple comparisons test revealed small males consumed significantly more (Tukey test: $q_{9,12}$=3.739, P=0.003) peanut butter balls than large females and significantly more (Tukey test: $q_{9,12}$=5.278, P<0.0005) than small females (Fig. 2). Large males consumed significantly more (Tukey test: $q_{9,12}$=2.734, P=0.042) peanut butter balls than large females and significantly more (Tukey test: $q_{9,12}$=3.980, P=0.001) than small females. There was no significant interaction (GLM repeated measures: $F_{2,6}$=1.605, P=0.150) between season and food type (Fig. 3) and no significant interaction (GLM repeated measures: $F_{2,18}$=1.268, P=0.217) amongst body size, season, and food type (Fig. 4).

Natural Food Experiment

Observations of the quantity of natural foods consumed were square root transformed to meet the assumption of normality. The GLM univariate analysis of the natural food experiment revealed a significant difference (GLM repeated measures: $F_{2,1}$=5.972, P=0.024) for food type (Fig. 5). A significant interaction (GLM repeated measures: $F_{2,6}$=3.939, P=0.009) amongst body size, season and food type was found (Fig. 6). A Tukey multiple comparisons test revealed no significant differences between food type with body size or food type with season. There was no significant interaction (GLM repeated measures: $F_{2,3}$=0.568, P=0.643) between body size and food type (Fig. 7) and no significant interaction (GLM repeated measures: $F_{2,2}$=1.782, P=0.194) between season and food type (Fig. 8).

Figure 3. Effect of season and food type [peanut butter balls (●), grapes (○), peanuts (■), and raisins (□)] on food selection of eastern woodrats. Interaction between season and food type is not significant (P=0.150).

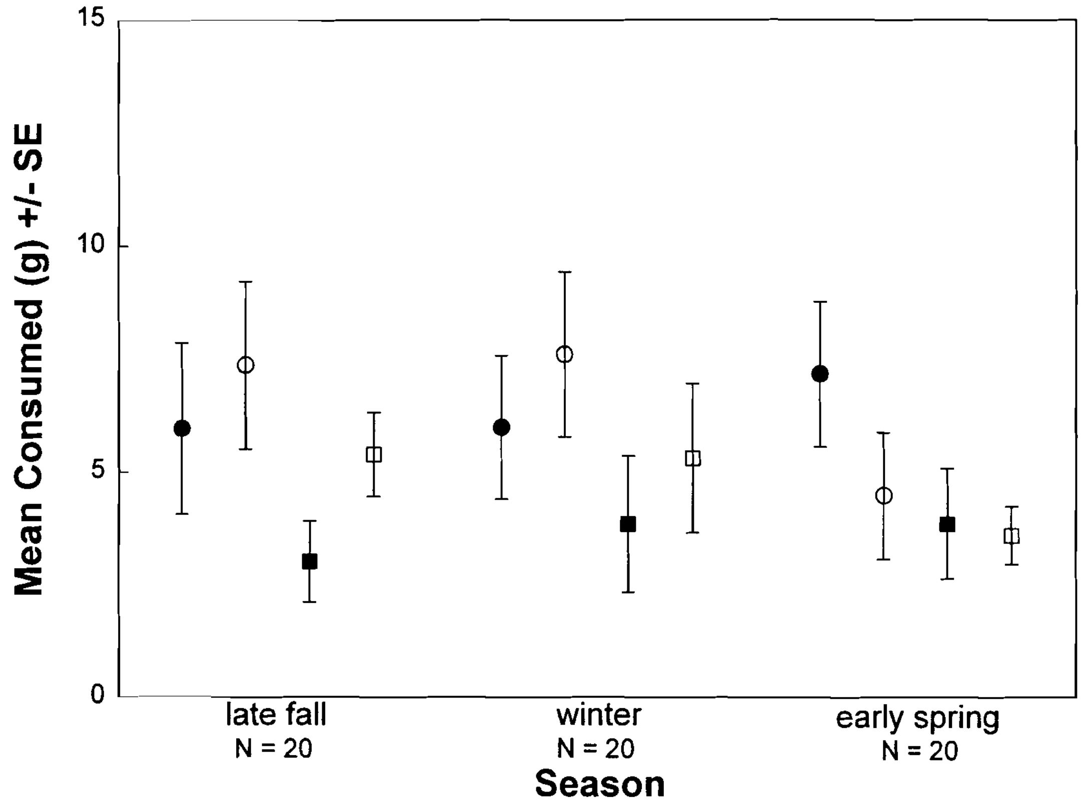
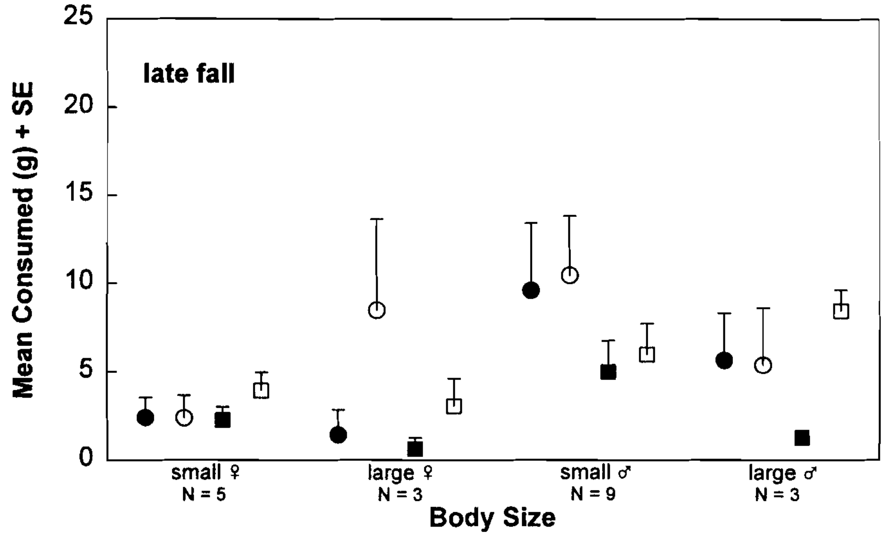
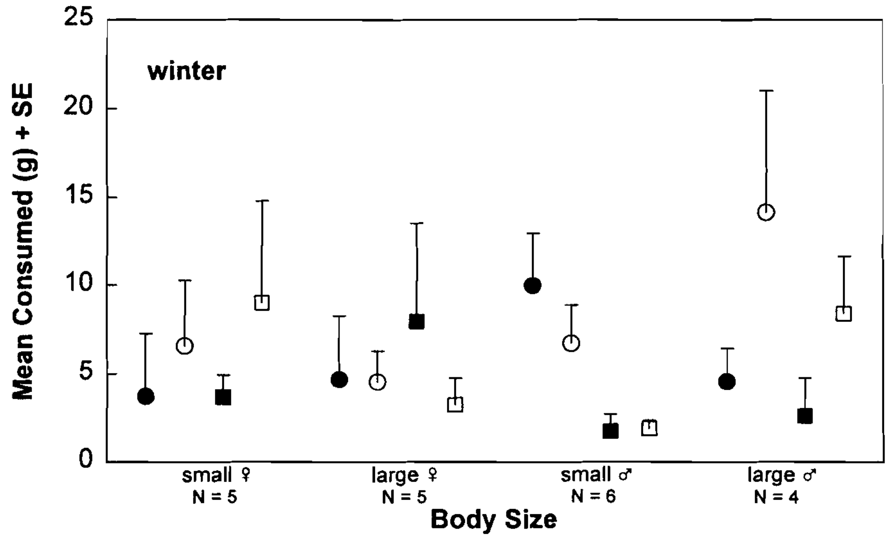

Mean Consumed (g) +/- SE
15
10
5
0
late fall
N = 20
winter
N = 20
early spring
N = 20
Season

Figure 4. Effect of body size, season, and food type [peanut butter balls (●), grapes (○), peanuts (■), and raisins (□)] on food selection of eastern woodrats. Interaction amongst body size, season, and food type is not significant (P=0.217).


late fall
Mean Consumed (g) + SE
25
20
15
10
5
0
small ♀
N = 5
large ♀
N = 3
small ♂
N = 9
large ♂
N = 3
Body Size


winter
Mean Consumed (g) + SE
25
20
15
10
5
0
small ♀
N = 5
large ♀
N = 5
small ♂
N = 6
large ♂
N = 4
Body Size

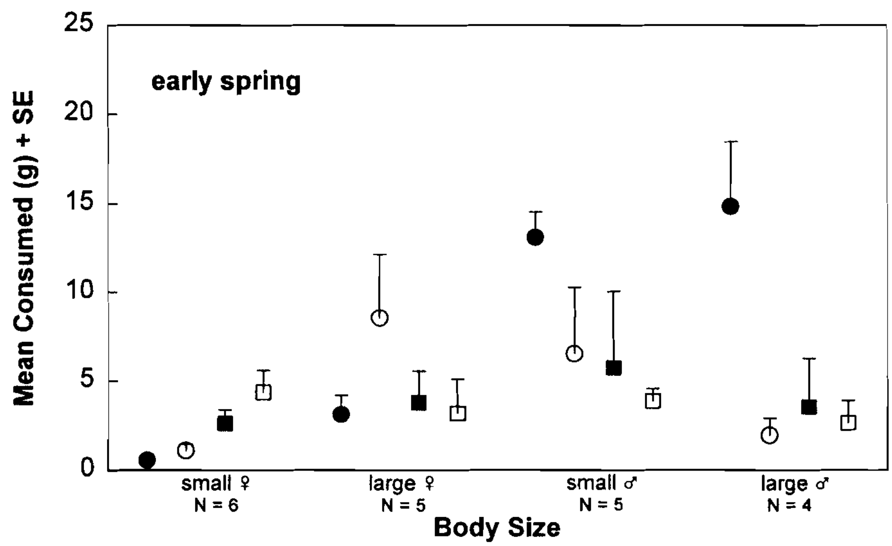

early spring
Mean Consumed (g) + SE
25
20
15
10
5
0
small ♀
N = 6
large ♀
N = 5
small ♂
N = 5
large ♂
N = 4
Body Size

Figure 5. Significant (P=0.024) effect of food type [rough-leaved dogwood fruits (●) and red cedar leaves (□)] on food selection of eastern woodrats (N=32 for each food type).

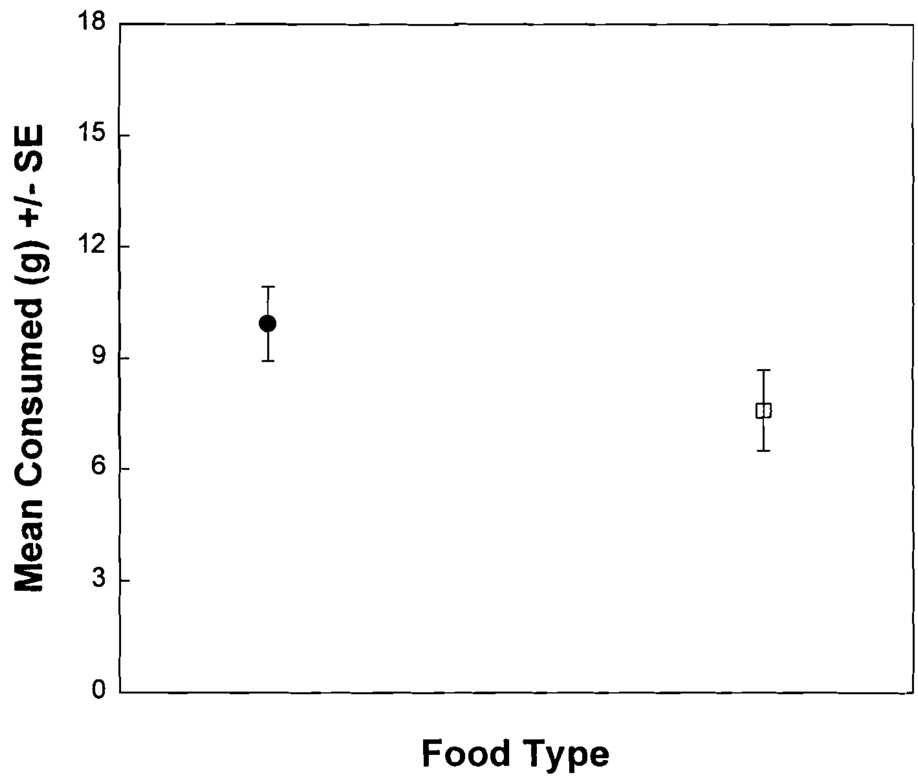
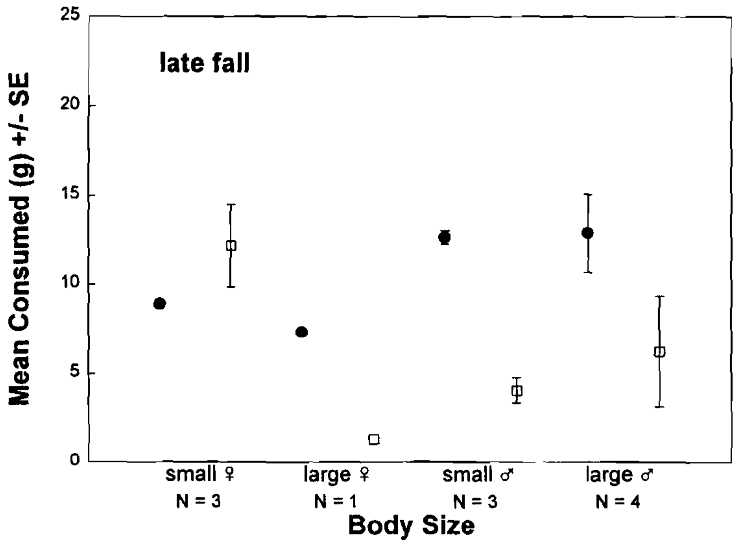
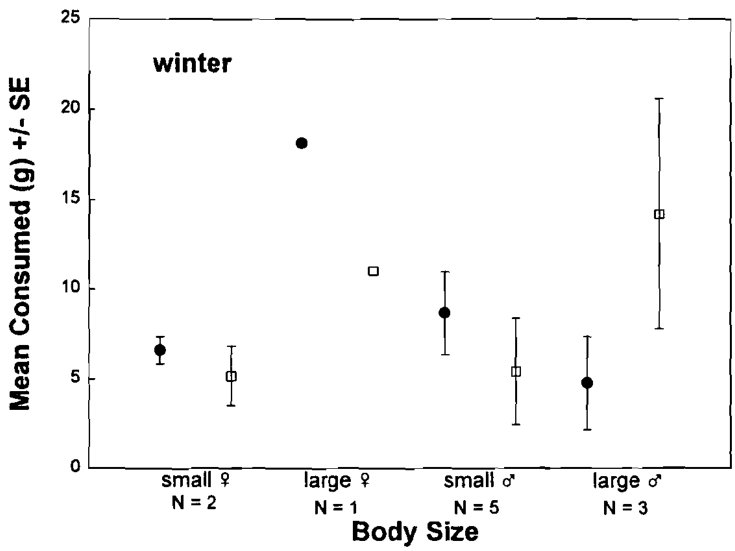

Mean Consumed (g) +/- SE
18
15
12
9
6
3
0
Food Type

Figure 6. Effect of body size, season, and food type [rough-leaved dogwood fruits (●) and red cedar leaves (□)] on food selection of eastern woodrats. Interaction amongst body size, season, and food type is significant (P=0.009).


late fall
Mean Consumed (g) +/- SE
25
20
15
10
5
0
small ♀
N = 3
large ♀
N = 1
small ♂
N = 3
large ♂
N = 4
Body Size


winter
Mean Consumed (g) +/- SE
25
20
15
10
5
0
small ♀
N = 2
large ♀
N = 1
small ♂
N = 5
large ♂
N = 3
Body Size

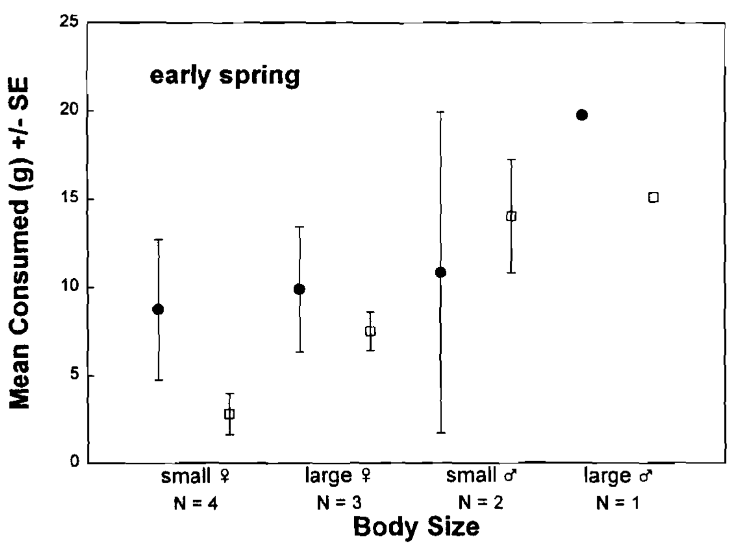

early spring
Mean Consumed (g) +/- SE
25
20
15
10
5
0
small ♀
N = 4
large ♀
N = 3
small ♂
N = 2
large ♂
N = 1
Body Size

Figure 7. Effect of body size and food type [rough-leaved dogwood fruits (●) and red cedar leaves (□)] on food selection of eastern woodrats. Interaction between body size and food type is not significant (P=0.643).

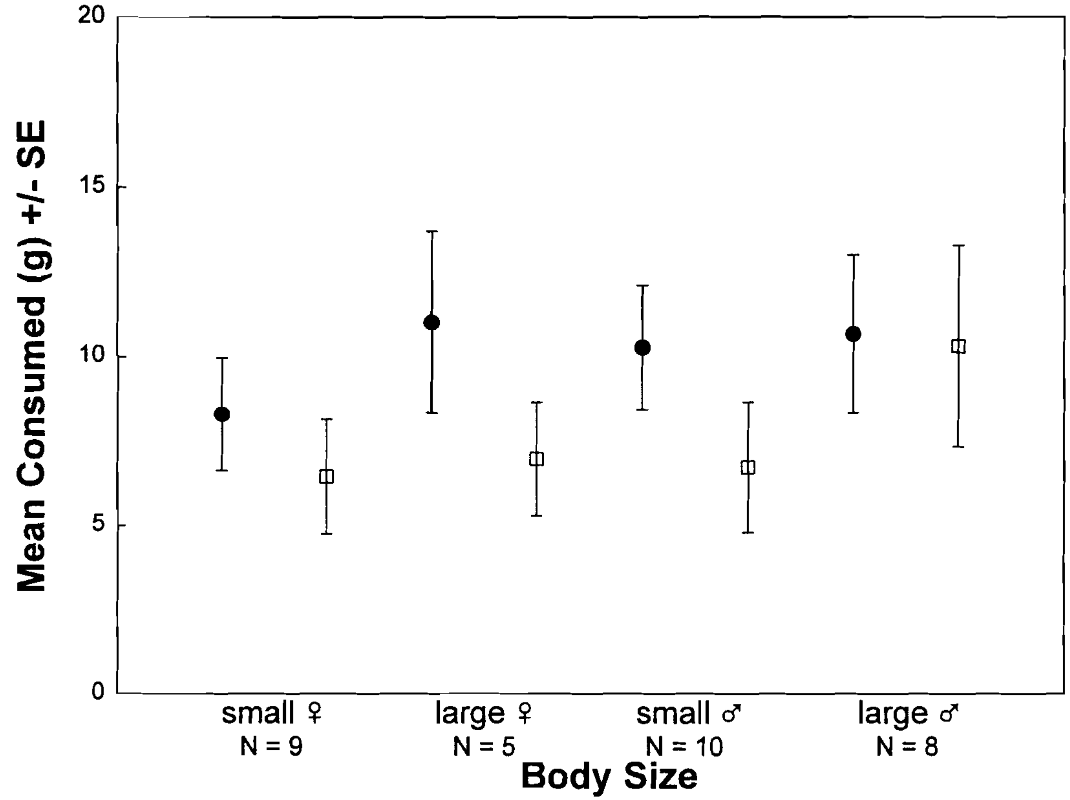
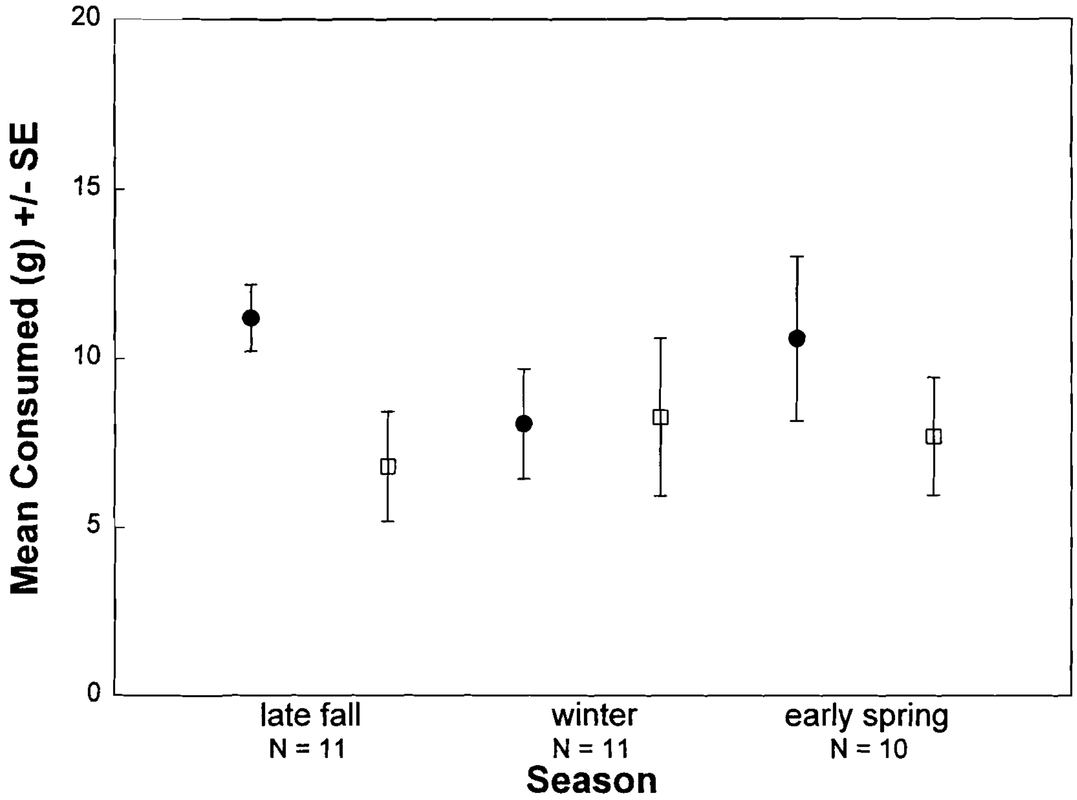

Mean Consumed (g) +/- SE
20
15
10
5
0
small ♀
N = 9
large ♀
N = 5
small ♂
N = 10
large ♂
N = 8
Body Size

Figure 8. Effect of season and food type [rough-leaved dogwood fruits (●) and red cedar leaves (□)] on food selection of eastern woodrats. Interaction between season and food type is not significant (P=0.194).


Mean Consumed (g) +/- SE
20
15
10
5
0
late fall
N = 11
winter
N = 11
early spring
N = 10
Season

Sex Ratios

A total of 33 individual eastern woodrats were captured during the study. Of those individuals captured, 16 were females and 16 were males. The sex of one individual was not recorded. The chi-square test revealed no significant difference (Chi-square test: $\chi^2_2 < 0.0005$, NS) between expected sex ratios.

DISCUSSION

Desiccation of Perishable Foods

I did not consider the desiccation rates of the perishable foods to be sufficiently great to warrant consideration in analysis. The mean difference between initial and final mass for peanut butter balls was negative, indicating the final mass of peanut butter balls tended to be greater than initial mass. The final mass of grapes was less than initial mass, but the mean difference constituted less than 1% of the total mass. The mean difference for rough-leaved dogwood fruits was approximately 4% less than initial mass. However, the mean difference for red cedar leaves was only 1% less than rough-leaved dogwood fruits. Because of the relatively small differences between initial and final mass for all perishable foods, and the relatively small differences between perishable and persistent foods, I attributed the differences to the inherent variability between measurements.

Novel Food Experiment

For the novel food experiment, there was a significant difference for food type (Fig. 1) and a significant interaction between body size and food type (Fig. 2), thus supporting, in part, the hypothesis that body size, season, and food type affect food selection of eastern woodrats. Small and large males consumed significantly more peanut butter balls than small and large females. The disparity between the quantity of peanut butter balls consumed by small and large females and males might be attributable to the metabolic requirements of individuals within each body size category because males are generally larger than females. Therefore, males, especially large males, would have a higher average daily energy requirement than females (French et al. 1976).

Though not significant, small females and males tended to consume more peanuts and raisins in proportion to peanut butter balls and grapes than large females and males (Fig. 2). This trend of smaller individuals consuming proportionally more of the high energy, persistent foods supports the prediction proposed by Post et al. (1993) that smaller eastern woodrats might have a different foraging strategy than larger individuals. They found that smaller eastern woodrats have less energy stored in caches than larger individuals. Therefore, one might expect smaller individuals to consider energy content before perishability. Other studies have shown that eastern woodrats consume perishable foods over persistent foods (Reichman 1988; Wooster 1990; Post & Reichman 1991).

No significant interaction was found between season and food type (Fig. 3) or amongst body size, season, and food type (Fig. 4). Eastern woodrats consumed all of the food types across seasons (Fig. 3). Reichman & Fay (1983) predicted a caching species should eat a variety of foods to ensure it has high-quality foods available late in the cache dependent period. My results support, in part, their prediction.

I cannot discount the possibility that the nature of the novel foods affected the outcome of the experiment. However, novel foods have been used in other food studies of eastern woodrats (Reichman 1988; Wooster 1990; Post & Reichman 1991; Post 1993; Post et al. 1998). The energy and nutritional values of the novel foods, especially the persistent foods, probably remained constant and did not decline over time because these foods were replaced with fresh foods regularly. The lack of change in energy and nutritional values would not mimic the change shown for natural foods (Post 1992).

Novel foods were selected to control for any natural food bias and for their similar nutritional properties. Post et al. (1998) found that maternal diet affected food consumption and caching behaviour of juvenile eastern woodrats. Their findings support the hypothesis that eastern woodrats might posses natural food biases and those biases are dependent on maternal food preferences or might involve experience with food items in their environment.

Natural Food Experiment

In the natural food experiment, there was a significant difference for food type (Fig. 5) and a significant interaction amongst body size, season, and food type (Fig. 6), thus supporting the hypothesis that body size, season, and food type affect food selection of eastern woodrats. Food type was not significantly different with body size or season. A trend is evident for large females and small and large males. Large females and small and large males consumed more rough-leaved dogwood fruits than red cedar leaves during late fall (Fig. 6). This disparity lends support to the concept of efficient use of limited resources proposed by Post (1991) because the disparity decreases in winter and reaches its lowest point by early spring. Post (1991) found that eastern woodrats consumed more rough-leaved dogwood fruits early in cache use than in middle or late cache use. Post (1991) suggested that consuming more rough-leaved dogwood fruits during early cache use had an adaptive significance for eastern woodrats because rough-leaved dogwood fruits are prone to loss of nutritional and energy content by late cache use. She also found that the loss of nutritional and energy content in rough-leaved dogwood fruits is chemically mediated and not due to microbial infestation. Therefore, she concluded that the best defence eastern woodrats have against loss of cache value, relative to rough-leaved dogwood fruits, is consumption.

No significant interaction was found between body size and food type (Fig. 7) or season and food type (Fig. 8). Individuals of all body sizes tended to consume rough-leaved dogwood fruits over red cedar leaves (Fig. 7). During late fall, eastern woodrats consumed more rough-leaved dogwood fruits than red cedar leaves (Fig. 8). The disparity decreased by winter and into early spring. Both trends support the efficient use of a limited resource concept proposed by Post (1991). Rough-leaved dogwood fruits were not consumed significantly more than red cedar leaves, thus supporting the prediction by Reichman & Fay (1983) that a caching species should eat a variety of foods to increase the probability of having adequate foods, in terms of energy and nutritional content, through an unproductive time. Only two types of food were presented in the natural food experiment. Therefore, eastern woodrats might have consumed more red cedar leaves than expected, possibly to satisfy nutritional needs (Reichman 1977), rather than exhibiting efficient use of a limited resource. Additionally, rough-leaved dogwood fruits were frozen until use and replaced with freshly thawed fruits regularly. Freezing the fruits might have slowed or stopped the nutritional and energy degradation characteristic of rough-leaved dogwood fruits found in eastern woodrat caches by Post (1992). Rough-leaved dogwood fruits having the same or similar nutritional and energy content in early spring as those in late fall might have caused eastern woodrats to consume more rough-leaved dogwood fruits in winter and early spring than expected.

I cannot discount the possibility that sample size affected the outcome of the natural food experiment. Eleven individuals were captured during late fall and winter and only 10 were captured during early spring. Subdividing the animals into body size categories further reduced sample size, thus increasing the margin for error. The statistical tests might have detected differences that do or do not exist simply as an artifact of sample size.

Conclusions

Results of my study support the hypothesis that body size, season, and food type affect food selection of eastern woodrats under more natural conditions. Detectable trends support some of the predictions and results of previous food selection studies of eastern woodrats. I must acknowledge the fact that the use of live-traps precluded the study of eastern woodrats under totally natural conditions. Live-traps might have affected the behaviour of eastern woodrats, especially in terms of food selection. Further investigation into the food preferences of eastern woodrats under more natural conditions is warranted. Future studies might be accomplished with the use of food stations rather than live-traps by using remotely triggered cameras or night-vision optical equipment. The novel food experiment revealed a significant difference for food type and a significant interaction between body size and food type. The natural food experiment revealed a significant difference for food type and a significant interaction amongst body size, season, and food type. Because of the similar results for food type and interactions between and amongst factors in both experiments, I suggest the results support the hypothesis of an effect of body size, season, and food type on food selection of eastern woodrats under more natural conditions, but these effects and interactions cannot be separated by the methods I used.

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