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Foraging Behaviors of Mice and Voles: Relations Between Cover and Food Type

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Abstract. Risk-reward behavior and food selection of mice and voles were subjected to study. Sets of Foraging trays, in either the presence or absence of plant litter, and offering millet seeds and alfalfa pellets, were positioned in a prairie habitat in March of 2012. The foraging behaviors of these rodents were studied by measuring the giving-up densities (GUD's) at semi regular intervals. Foraging trays with plant litter as cover had a slight, yet statistically insignificant decrease in GUD's. The only statistically significant result was food selection, in which millet seeds were highly preferred to alfalfa pellets. Further study is needed to determine if a great contrast between protected and unprotected foraging trays is necessary for significant differentiation in risk-reward behavior. The selection of food may be attributed to diets of the species, seasonal shifts in diet, and the nutrition and energy the food provides.

Key words: behavior; cover; feeding; foraging; GUD's; mice; nutrition; predator; reward; risk; voles

INTRODUCTION

The foraging behaviors of animals are known not only by the availability and nutritional value of food, but are also heavily influenced by risk-reward behavior (Batzli 1986, Begon and Mortimer 1986). The risk-reward behavior of foragers is a balance between meeting the demand for food and avoiding predators, ultimately allowing natural selection to favor individuals whose foraging strategies produce maximum nutrition intake relative to predator avoidance (Trussell et al. 2011). Keeping true to its namesake, this equilibrium between risk and reward is known as optimal foraging (Begon and Mortimer 1986). In this experiment, the foraging behavior of prairie rodents is subjected to study.

Three species were studied: the meadow vole (*Microtus pennsylvanicus*), the prairie vole (*Microtus ochragater*), and the white-footed mouse (Permyscus *leucopus*). Like most small rodents, these are inconspicuous animals that have little means of defense against potential predators (Kurta 1995). Voles will even go so far as to create tunnels through the plant litter as a means of avoiding predators (Hoffmeister 1989). Due to this exhibited behavior, these species were thought to make excellent candidates for this type of research. Their feeding behavior was assessed by laying out foraging trays in a prairie and measuring the giving up-densities (GUD's), the mass of food left behind in each foraging tray (Kotler et al. 1991). The independent variable in this experiment is the sense of security given to foraging animals. This is done by either having naturally occurring plant litter surround the foraging trays, creating cover, or by having bare ground in lieu of such protection, potentially leaving foragers venerable to predators. Two hypotheses will be tested from the data.

The first hypothesis is that the GUD's would be lower in foraging trays with plant litter cover, and those that didn't provide any cover would have higher GUD's. This supposes that these species will follow an optimal foraging model: seeking foraging trays with cover will allow them to maximize their food intake while minimizing their exposure to predators. A study of risk-reward behavior between wood mice and genets supports this hypothesis. Wood mice were found to be more active foragers when the presence of genets, a common predator, was found to be in found to be lower (Diaz et al. 2005). Trussell et al. (2011) also note that even the mere fear and possibility of predation will have similar effects, had the predators actually removed individuals from the prey

population.

In order to ensure the food in the foraging trays would be fed upon, the types of food used had to match the diets of the species studied. Voles primarily feed on green plant shoots and grasses, but may also feed on seeds as well (Kurta 1995). Mice are more granivorous, feeding mainly on seeds, and are omnivores (Hoffmeister 1989). Alfalfa was selected as a representation of the vole's diet of grasses and green plants; and grass seed was selected to match the herbivory potion of the mouse's diet (Hoffmeister 1989). The feeding behavior of each individual species was not subjected to study, but they may be used to form conclusions from the data. The second hypothesis states that there will be no statistically significant difference in the two types of food used in the foraging trays. It is assumed that both species will feed regularly on their respective diets, and that populations remain stable.

METHODS

Each food type sample was measured to a mass of 3.0-g. The alfalfa pellets required the additional task of being cut into roughly 0.5-cm pieces for easier consumption. Each measured sample of a particular food was placed into a foraging tray, a green bowl averaging 30-cm in diameter and 4-cm in depth. The sample-filled foraging trays were then filled three-fourths of the way with 1.0-L of sand and mixed thoroughly. This was done to replicate the conditions experienced by rodents when acquiring food.

The foraging trays were paired, each pair having a tray of alfalfa and a tray of seeds set about 50-cm apart. A shelter consisted of four, 20-cm, camouflaged columns that supported a pane of transparent polycarbonate, measuring 30 x 30-cm, which was set over each individual tray. The shelter was not meant to provide protection for the animals, rather to protect the trays from the elements. Each of the 20 sheltered pairs of foraging trays was set 10-m apart in a grid of four by five. Additionally, half of the pairs had the surrounding plant matter completely raked away, leaving them with a 1.8-m radius of bare ground. This was done on alternating pairs, creating a checker-patterned grid of raked and unraked foraging stations.

The experiment procedures were conducted in the Russell R. Kirt Prairie on the College of DuPage campus. The prairie was the product of a restoration effort in 1990. It was built upon a mixture of clay and rubble that provides only a thin level of topsoil. Now covering an area of 7.30-h, it consists of native prairie grasses and forbs, a marshland, as well as trees and bushes scattered throughout. Prior maintenance had it burned about every 1-3 years, but the prairie hadn't been burned in the past three years. Because of this, the plant litter was compact and low to the ground, averaging about 4-cm deep. Conditions were relatively mild: temperatures tended to range from about 8ºC to 17ºC for the duration of the experiment. The exact site for the foraging trays was atop a hill, one with a relatively uniform topography and containing several small trees and shrubs lightly dispersed.

The structural covers for the trays were set out in the field a full week before the foraging trays were set out. This was done to allow the rodents to become accustomed to them and become less affected by their presence. The food was sifted from each of the foraging trays at 2-3 day intervals and then weighed. This process was performed in two rounds from March 8-15, 2012. All means were reported as mean ±1 SE. Data was analyzed with a 2-way analyses of variance. Significance was analyzed at $\alpha=0.05$ (Proc GLM SAS Institute, 2011).

RESULTS

The initial results show a stark contrast in the preference of alfalfa pellets in relation to millet seeds-- the millet seeds being the more preferred of the two. When the GUD's are averaged without the presence or absence of litter factored in, the millet was fed upon 88.2% more than the alfalfa. The presence of litter only increased the GUD's by an average of 13.5% for both food types (Fig.1).

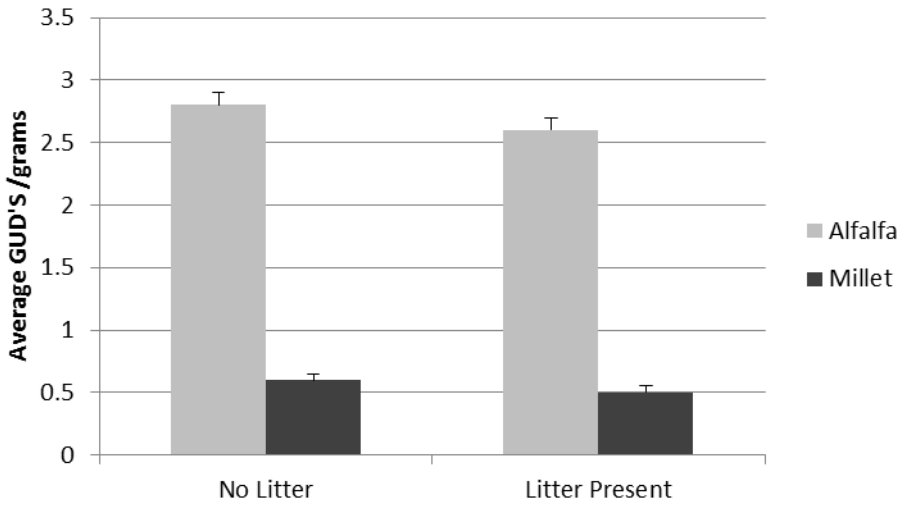

Fig. 1. The average GUD's of alfalfa and millet in relation to litter presence. Alfalfa GUD's were 2.8-g without litter and 2.6-g with litter. Millet GUD's were 0.6-g without litter and 0.5-g with litter.

There was a significant difference in the mean GUD's between alfalfa pellets and millet seeds ($F_{1, 73}$=35.79, P<0.005). There was no significant difference between the presence or absence of litter ($F_{1, 73}$=3.21, P=0.251). When the factors of food type and litter cover were combined for a statistical significance, the difference was not significant ($F_{1, 73}$=278, P=2.78).

DISCUSSION

The results don't support the first hypothesis that foraging rodents would prefer foraging trays surrounded by plant litter. However, past observations of these species would suggest this is an anomaly of normal behavior. Hoffmeister (1989) notes that meadow voles prefer tall, dense grass and litter layers as they provide far more protection from predators. Since mice and voles been documented to have similar preferences in habitat, this principle of tall, dense cover would likely apply to them as well (Hoffmeister 1989, Kurta 1995). The prairie, in which the experiment was conducted, only had a thin layer of dead plant litter approximately 4-cm thick. It is possible that the lack of proper vertical cover didn't provide enough contrast between the plant litter and bare ground to be considered an increase in vulnerability. A lack of predators could also condition the rodents to be less cautious in their foraging behaviors (Diaz et al. 2005)

The significant difference in the GUD's of alfalfa and millet don't support the second hypothesis as well. This is likely due to the nutritional values and seasonal feeding patterns within a species. As noted earlier, mice are highly granivorous and it should be expected that they feed primarily on seeds (Kurta 1995). Yet, the GUD's of alfalfa were lower than expected if it was to match the primary diet of voles, green plant matter and grasses (Hoffmesiter 1989). It could be possible that there were simply more mice than voles. However, if the assumption that the populations of mice and voles were the same held true, this deviation in the diet of voles must be explained. Lindroth and Batzli (1984) show that the diet of the meadow vole isn't always simple, and it actually changes the proportions of its diet throughout the year, expanding to include seeds, roots, and insects. Seeds make up approximately 35% of a meadow vole's diet in the winter and approximately 10% in the spring (Lindroth and Batzli 1984). While data was collected in March when seed consumption should have decreased, certain properties of seeds may have prolonged their winter dietary behaviors.

Grass seeds, in which millet is included, contain a higher digestibility energy in California voles, far more than chow or grass (Batzli 1986). Batzli (1986); it is also found grass seed lacked the amounts of calcium and sodium needed to maintain full reproductive abilities. Since seeds contain fewer nutrients, foragers must compensate for this lack of nutrition by consuming more (Batzli 1979). It may also be a necessity for voles to diversify their diet though seeds in order to maintain their health. Prairie voles fed a diet consisting completely of grass eventually lost weight and died (Batzli 1979).

It is recommended that further studies explore the possible threshold in the contrast of cover versus exposure that would dictate a more pronounced risk-reward behavior. If the lack of contrast in cover was responsible for insignificant results, then taller grasses would produce greater differentiated behavior. This should coincide with the presence and behavior of predators as well. The food selection of mice and voles could be determined with greater accuracy with the proper equipment and methods, although such methods can be rendered redundant if both mouse and vole population are known to be high.

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