Squirrel Foraging Preferences: Gone Nuts?

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Abstract: This field exercise examines the feeding preferences of Gray Squirrels (*Sciurus carolinensis*). Students present squirrels with a variety of food types in a cafeteria-style arrangement in order to test hypotheses about foraging preferences. This exercise, which is appropriate for introductory biology, ecology, and animal behavior classes, is designed to allow students to be involved in the entire scientific process. Students design the experiment, collect the data, and analyze and interpret the results.

Keywords: Foraging, foraging preference, feeding preference, diet choice, squirrels

Introduction

Animals often prefer specific food types. Many reasons may be responsible. Particular food resources may provide more energy, or they may be more profitable (provide more energy per time spent foraging). Certain prey may be more conspicuous, easier to find, open, capture or handle, or provide essential nutrients. Some studies have found that animals prefer larger, more profitable prey (Werner and Hall,1974; Krebs,1978). Other studies have found that when prey have hard cases or shells, foragers may avoid prey that are tough or difficult to open, even if they are large (Meire and Ervynck,1986). Foragers may also avoid prey that are spiny or difficult to handle (Barnhise, 1991), or prey that is evasive (Vinyard, 1982). Additionally, prey choice may be influenced by prey that provide predators with essential nutrients (Belovsky, 1978).

The foraging preferences for a particular species can be examined by designing experiments in which individuals are presented with a range of different resources to measure prey selection. In this experiment, students examine the food resource preference of Gray Squirrels (*Sciurus carolinensis*) by presenting them with a "cafeteria-style" selection: squirrels are given a selection of several different food items presented in equal amounts (FIG 1). This laboratory works well for testing the feeding preferences of Gray Squirrels, but can be adapted to work with any field rodent that forages on nuts and seeds. Gray Squirrels can be found in forests, parks, cities, and suburbs. Like many animals, they are particularly active in the morning and evening. They feed on a wide range of nuts, seeds, fruit, and bark (Whitaker, 1996). They nest in cavities in trees, or in large nests they build in the tops of trees. Gray Squirrels are scatter-hoarders. In the fall, they are especially active and run about gathering nuts and seeds that they store in a many different small holes that they dig in the ground. During the winter and spring, they rely on these cached nuts and seeds (Whitaker, 1996).

FIG 1. A cafeteria-style arrangement of various food types. Students can examine squirrel foraging preferences by placing out equal quantities of various food types and measuring food selection. Note: the term "shelled nuts" refers to nuts that have had the shell removed. Students often use this term to mean the opposite. Therefore, to avoid confusion, I prefer to say "nuts with shells" and "nuts without shells."

Methods

In my class, rather than give the students the methods, I encourage the class to think about the issues involved in designing an experiment and allow students to design their own field experiment. Below, I have outlined the issues that the class should discuss.

Food

The class should first discuss how various factors, such as the size of food items (energy consumed), type of food (nuts, seeds, fruits, "natural" food items versus novel food items), and ease of opening (nuts in shells versus nuts without shells), influence prey selection. Students should consider what food items they could use in their experiment (some could be field collected such as acorns, others could be purchased). For example, they could use raisins, peanuts, walnuts, sunflower seeds, pecans, etc. (nuts can be in shells or without shells).

After discussing factors that might influence squirrel foraging preferences, students should decide on a hypothesis to test. I ask students to generate a list of possible hypotheses they could test, then we discuss the alternatives and the class chooses one. For example, the class could test the hypothesis that squirrels will prefer nuts without shells to nuts in shells because nuts without shells take less time to handle. Or, students might want to test the hypothesis that squirrels will prefer large nuts to small nuts. Many different possible hypotheses are available.

Based on the hypothesis that the class decides to test, the class should then choose several (e.g. two to six) different types of seeds and/or nuts of varying sizes or differing in ease of opening. Students need to decide what food types will be appropriate to test their hypothesis, and whether the food items will be field-collected or purchased. When I conduct this lab, the class discusses the hypothesis to test and works out the details of the experimental design during one week, and provides me with a list of items that I need to purchase. Then, the investigation is implemented during a following week. I like to schedule the field lab for two weeks after the experimental design lab to provide time to purchase items. If students decide to use any field-collected prey, they have this time period to gather the necessary items.

Experimental Design and Procedures

Students should discuss all of the details of the experimental design before conducting the experiment. The class needs to decide how many of each type of food type will be set out, where the food will be placed, at what time of day the experiment will be conducted, how the experiment will be observed, for how long the investigation will continue, and how many replicates will be presented. I have conducted this experiment over several years and have explored a number of different permutations. Below, I outline some suggestions that I have found to be helpful based upon the results we have generated.

Students need to decide when and where the experiment will be conducted. We have found that foraging activity varies at different times of day and across different habitat types (e.g. open park areas, forested habitat). Students will get the best results if all students select similar habitats and conduct their experiment during the same time of day. Suitable sites include wooded areas near campus and forested habitats. I have had students conduct this experiment in the afternoon during lab period (1200–1500 h) and that works, but I have found that squirrel foraging activity tends to be highest in the morning. Therefore, in recent years, I have changed to having students conduct the field portion of this laboratory independently. After being supplied with all of the necessities, students prepare the food items. I give students one week to independently conduct their experiment during a morning that fits their schedule. The class usually decides on a time when everyone should conduct their experiment (for example, any morning from 0800–1200 h). Having students conduct the field data collection independently also avoids the potential of bad weather during a scheduled laboratory day, and I find students like working independently.

The more replicates students can implement, the better the class results will be, and the greater the chance of finding a significant foraging preference — if one exists. I generally have between twelve to sixteen students in my Animal Behavior class. To increase the number of replicates, each student sets out two replicates of their experiment (at the same time and day), giving a total of 24–36 replicates. Each replicate requires little time, so two per student is manageable. A student sets his or her replicates out near each other, but not too close together (no closer than the approximate length of a football field).

FIG 2. A squirrel foraging.

I have found that if students observe their study sites the entire time (from a distance with binoculars), they get few or no visitors to their study sites. Therefore, what I have found works better is a mixture of students observing their study sites (from a distance with binoculars) for short periods of time, and then leaving and giving squirrels a chance to forage without fear of human interference (FIG 2). What we have done in the past is set food out at a specific time (for example, 0800 h). Each student observes his or her two replicates from a distance with binoculars for 10 min, then leaves and returns at 0900 h to collect the one-hour data (records the number of each type of food type taken). The student then observes from a distance for 10 min, leaves, and returns at 1000 h to collect the two-hour data (recording cumulative numbers of each food type taken). The student then observes again for 10 min, leaves, and returns at 1100 h to collect the three-hour (and final) data.

Students need to decide how much of each food type to set out. They should set out equal amounts of each food type. Students want to set out enough of each food type so that when they leave their food stations for an hour, some of the food will still be there when they return. I suggest using at least twenty pieces of each type of food, more if possible.

Data Collection and Analysis

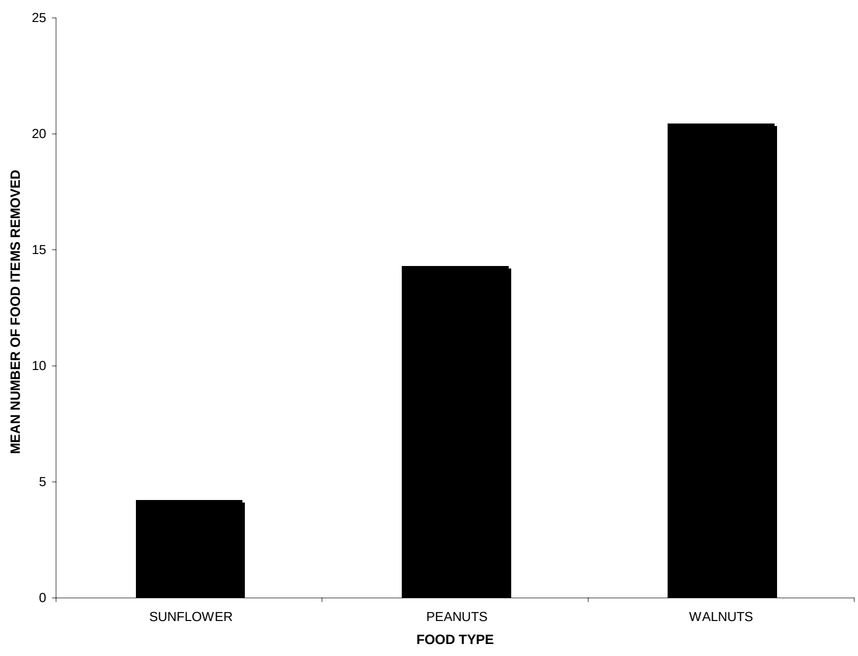
The instructor can lead students through a discussion of what data should be collected to test for food preferences. Students should record the cumulative number of each food type removed each hour (as discussed above) and should periodically look for visitors at the food patches. Students should design a data table to ensure that all students collect data in the same manner.

Results and Discussion

This laboratory gives students an opportunity to statistically analyze data. I have conducted this lab in my class after students have been introduced to statistical analyses. The instructor can lead the students through a discussion of what results are expected.

Graphing the data will let students visualize whether squirrels have feeding preferences as predicted by the students' hypothesis. Students can graph the results to examine if equal numbers of each food type were removed by animals. To test for food preferences, students can plot the mean number removed (on the y-axis) versus food type (on the x-axis; see FIG 3). Graphs can be generated for each data set (e.g., for each of the three hours during which data were collected).

FIG 3. Graphical analysis of feeding preferences. The mean number of food items removed for each food type is plotted for the second hour of observation. Equal numbers of the three food types were left for three hours and we recorded the cumulative number of each type of food that had been removed. All food types (sunflower seeds, peanuts and walnuts) were in shells.



Students can statistically analyze the data to determine whether animals removed equal numbers of each food type. For each data set (each hour), students can calculate the mean number of each food type removed by animals and then use appropriate statistical tests (e.g., t-tests, Mann-Whitney U tests, ANOVAs, or Kruskal-Wallis tests to compare means).

Students can present their results in written (laboratory reports in scientific format) or oral venues. For lower division courses, students could write a shorter report by answering a series of questions provided by the instructor. Questions students can address include: Did animals show food preferences? Was the hypothesis supported? If the class did not get the results that were expected, what biological factors might explain the observed results? What is the purpose of observing at one-, two-, and three-hour intervals? Which data set provided the best results? What animals were observed visiting the study sites, occasionally animals besides squirrels may visit the food patches (FIG 4). How might this influence the results?

FIG 4. Occasionally other animals such as chipmunks or birds will visit the food patches.

In conclusion, this field exercise provides students with an opportunity to design and conduct an experiment, and analyze and summarize their results. Finding field-based experiments that involve testing a hypothesis can be challenging, and this exercise provides means of reliably and quickly generating interesting results suitable for analyses.

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