Effect of Soil Texture on Burrow Site Selection by Ground Squirrels

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Abstract: The distribution and abundance of organisms is determined by a variety of physical and biological factors. The purpose of this field-based, ecologically oriented laboratory experiment is to determine if the abundance of ground squirrel burrow sites is influenced by soil texture. Students are involved in all aspects of the experiment from the design to the collection, analysis, and interpretation of data. This laboratory exercise is easy-to-do, requires minimal equipment, and illustrates well the many facets of experimental design and implementation.

Keywords: soil texture, ground squirrels, burrow sites, experimental design

Introduction
The physical environment plays a major role in determining the distribution of populations of plants and animals. Preferences for and tolerances of environmental factors such as temperature, precipitation, and soil conditions vary among species and serve to restrict populations to habitats within which they are best adapted. Habitat structure and soil properties are major factors influencing selection of burrow sites by semi-fossorial rodents such as ground squirrels (Owings and Borchert, 1975; Murray and Vestal, 1979; Laundre and Appel, 1986).

Richardson's ground squirrel (Spermophilus richardsonii) is a semi-fossorial species whose distribution is influenced, in part, by soil texture. These animals exhibit a preference for drier, well-drained soils (Laundre and Appel, 1986) that presumably facilitate easy burrowing. Laundre and Appel (1986), however, also found that short vegetation, which allows for increased visibility, is preferred by ground squirrels. This latter characteristic makes this field experiment particularly appealing because 1) ground squirrels are fairly common on many college campuses (to the chagrin of the maintenance staff) due to their preference for short, mowed grass and 2) students can locate burrows fairly easily without having to walk through tall, thick vegetation.

This paper describes an easy-to-do, ecologically oriented laboratory experiment that demonstrates use of the scientific method in a field setting. Students will actively participate in the design of the experiment, collection, analysis, and interpretation of data. The specific objective of this experiment is to determine if soil type influences the frequency of observed ground squirrel burrow sites.

Methods and Materials
The instructor should obtain a soil survey map of the experimental area(s) in order to become acquainted with the variety of soil types present. The local Soil and Water Conservation District or Natural Resource Conservation Service offices will usually provide one upon request. A soils map is also valuable because it allows the instructor to direct the students' efforts to sites with known soil differences. In addition to finding plots with different soil types, the instructor will need to have the students preview the intended experimental areas for the presence of ground squirrel burrows.

After the experimental areas have been determined, the instructor can engage students in a discussion of experimental design. Some of the questions regarding experimental design that the instructor may present for student discussion include: Will the entire experimental area be surveyed for ground squirrel burrows or should students sample randomly from each of the experimental areas? Sampling may be preferred if the experimental area is very large, laboratory time constraints won't allow for a complete survey, or if ground squirrel burrows are particularly dense. If sampling randomly, how many samples should be taken and what should be the size of each sample site? I have found that taking three 10 x 50 M samples within a particular experimental area works well for a laboratory of 2 hours.

When the experimental areas have been identified, students and the instructor can then discuss how to collect ground squirrel and soil data as well as

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design a data collection sheet for both variables. Burrow data may be obtained simply by walking through the experimental area and recording all ground squirrel burrows found within the boundaries of the area. Students should be cautioned not to confuse ground squirrel burrows with pocket gopher burrows. Ground squirrels generally leave the entrance to the burrow open (Quanstrom, 1971), whereas pocket gophers plug their burrow entrance with soil.

Within each experimental area, students may collect soil samples by inserting a soil corer approximately 30 cm into the ground, carefully withdrawing the corer and removing all vegetation from the top of the soil core, rolling off the top 20 cm into a plastic bag. They should label the bag with the name and/or number of the experimental area (or sampling site, if appropriate), date, and time. The instructor should have discussed with students the number of soil samples to take within each experimental area or each sampling site. I generally have students take three, randomly selected soil samples from each sample site.

When students return to the laboratory, they can determine soil texture for the areas sampled. Soil texture is determined by the proportion of clay, silt, and sand particles present (Smith, 1996). These particles are classified on the basis of size. Sand particles are largest (0.05-2.0 mm), followed by silt (0.002-0.05mm) and finally clay (less than 0.002 mm). The following procedure is relatively simple and based on the premise that different sized soil particles will settle at different rates.

1. In the lab, combine all soil samples for a given experimental area.
2. Mix the soil together thoroughly and pick out all the organic material.
3. Dry the soil by placing it in a drying oven set at 30 degrees C for 24 hours.
4. Remove the soil from the drying oven and weigh out 50 g.
5. Grind the soil with a mortar and pestle until it is of uniform consistency.
6. Transfer the soil sample to a pint-sized jar that has a uniformly flat bottom and a tightly fitting lid.
7. Fill the jar with distilled water to about 0.5 cm from the top.
8. Add one tablespoon of dry Calgon (to prevent soil from clumping) to the jar and shake vigorously.
9. Set the jar down on a flat surface and do not move it. Allow the contents of the jar to settle for 40 seconds. Have students measure the amount of sand (the largest, heaviest particles) that settled using a metric ruler and record it on a data sheet. Mark the sand line on the glass jar with a wax pencil being careful not to disrupt the contents.
10. After approximately 2 hours measure the new band of particles, which represents the silt layer that has settled. Record the amount settled on the data sheet. Mark the silt line on the jar being careful not to disturb the contents.
11. After approximately 24 hours, measure the last band of clay particles that has settled and record on the data sheet.
12. When all the soil has settled, have students calculate the percentages of sand, silt, and clay in their sample. Using these percentages, have students determine the soil type of the experimental area by consulting a soil texture triangle (see Smith, 1996).

When soil type has been determined, students can summarize the burrow data for each experimental area. Burrow data can be compiled for all experimental areas with the same soil type. Students can then be instructed in the use of a chi-square goodness of fit test to compare burrow number with soil type. If experimental areas differed in size, or burrow data from two or more experimental areas were combined, the number of burrows observed for the chi-square test must be adjusted accordingly.

Results and Discussion

Do the results of the chi-square test support the hypothesis? In other words, is the frequency of ground squirrel burrows observed influenced significantly by soil type? This would be a good opportunity to discuss how the word "significant" differs among scientists and nonscientists. Nonscientists use the word "significant" if the results look intuitively different. To a scientist, however, the word significant implies that a statistical test has been done and the results obtained are not due to chance alone, but can be attributed to a specific factor. I have found that one of the most challenging aspects of this experiment, or for that matter any experiment, is helping students understand the use and meaning of statistical tests. Even students who have taken a statistics course still have difficulty understanding the importance of statistics in analyzing and interpreting data. However, I have found that a chi-square test is one of the easier statistical tests to explain to students.

If the results of the experiment are significant and soil type influences the frequency of ground squirrel burrows, does that mean that no other factors such as height of vegetation are important? Were all other factors, such as frequency of mowing the experimental areas, constant except for the one factor tested i.e., soil type? Was the test for soil testing appropriate and accurate? If more sophisticated laboratory equipment for determining soil type is available, such as a
hydrometer, more accurate soil data may be obtained. The method for determining soil type presented in this paper is simple, but may not be particularly accurate, especially if the soils in the area form a highly mosaic pattern. However, this exercise could be easily modified to incorporate more sophisticated soil analysis techniques. In this experiment, one assumes that ground squirrels exhibit a distinct preference for a certain soil type because it allows for easier burrowing. However, could there be another explanation? For example, soil texture has a great affect on the water- and oxygen-holding abilities of the soil, which in turn may have a considerable affect on the type of vegetation present. Do ground squirrels prefer certain soil types, or do they prefer certain vegetation as a food source, which is associated with specific soil types? How can data be collected differently to exclude this possibility?

I often have my upper division ecology students use this laboratory experiment as the topic of a scientific paper. The students are instructed to write the paper as if they plan to submit it to a respectable, ecologically oriented journal. For lower division courses, this laboratory experiment can be modified so students don't write a paper, but write answers to the questions posed above or give an oral presentation of the results to the rest of the class.

In conclusion, this field-based laboratory experiment is relatively easy-to-do and generally enjoyed by students, even those onto ecologically oriented, because of its out-of-doors focus. This experiment also presents an excellent opportunity for the instructor to discuss the many facets of experimental design as well as the inherent difficulties in controlling variables, with the exception of the one being tested, in a field setting.

Literature Cited