



Using Termites to Learn the Scientific Method

This is an inquiry based lesson plan used to teach students how to employ the scientific method.

Students will learn all steps of the scientific method and use them to explore the behavior of termites. A formal lab report will help ensure that students understand the scientific method.

Primary Learning Outcomes

Students will learn the steps of the scientific method. Students will be able to use the steps in the scientific method to explore the behavior of termites.

Assessed Georgia Performance Standards

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh7. Students analyze how scientific knowledge is developed.

SCSh8. Students will understand important features of the process of scientific inquiry.

SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.

Background

There is a chemical in ink from ball point pens that closely resembles pheromones secreted by termites. Thus the termites will follow the ink as if it were a trail left by one other members of the colony. This is quite remarkable—and your students will have fun!

Procedures/Activities

Step: 1 Duration: 20-30 minutes

Instructor should collect termites from a wooded area. Look for logs lying on the ground. Be careful! There may be spiders, insects, or reptiles present there as well. Store the termites in a container with moist soil, wood, and air holes. If stored properly, termites may be kept several months.

Step 2 Duration: 15-20 minutes

Provide students with handout containing background information on termites. Allow time for the students to read the handout. Discuss the handout with the students, emphasizing pheromones as the means of communication between individuals in the species.

Step 3: 5-10 minutes

Review scientific method using handout provided or notes provided by the instructor. A fresh review on the day of the experiment will help the students retain the information necessary for use during the lab.

Step 4: 60-90 minutes

Students should follow procedures in the lab handout. A group of 2-4 students will work best. Students will observe termites and use observations to develop testable hypotheses. The group will then choose one of these hypotheses to test and develop an experiment to test this hypothesis. They will gather data, draw conclusions, and provide a formal lab report to the instructor. Some example questions: 1) What color ink do the termites follow the longest? 2) What brand of ink do the termites follow the longest? 3) How many termites choose to follow blue ink over black ink?

Step 5: 40-60 minutes (Optional)

Students will present their experimental design to the class, data, and conclusions from their experiment. This step will help with scientific communication skills.

Materials and Equipment

For each group: 6 pens (red, blue, and black Papermate and Bic brand pens), white paper small brush, 10-20 termites in a petri dish

Total Duration

20-30 minutes teacher prep before class collecting termites

80-120 minutes in class (no presentation of results)

or

20-30 minutes teacher prep before class collecting termites

120-180 minutes in class (presentation of results)

Assessment

Students will be assessed based on their ability to work in a group setting and produce a formal lab report that demonstrates their understanding of the scientific method. Students may also be required to present experiment, data, and conclusions to the class; this would be used to assess their ability to effectively communicate scientific concepts.

Modification

Some students may choose to test how long the termites remain on the line of ink or how long it takes the termites to find the ink when placed in the middle of the paper, so you might want to have some stop watches on hand.

Biology of Subterranean Termites in the Eastern United States

Adapted from

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Subterranean termites are social insects that live in societies whose members are mostly immature individuals. Their colonies, which can contain thousands to millions of termites, are formidable, even though each individual termite is soft-bodied and delicate. In nature, subterranean termites are closely associated with the soil habitat where they tunnel to locate water and food (e.g., wood, fallen logs, and other cellulose-containing materials). Termites excavate galleries throughout their food as they consume it. Subterranean termites construct aboveground earthen runways (shelter tubes) that protect them from the drying effects of air as well as from natural enemies, such as ants. Termites are very susceptible to desiccation, and thus they are dependent on moisture sources.

Distribution and Economic Impact

In the United States, subterranean termites are found in every state except Alaska (Fig. 1). They are most abundant in warmer climates, where structural infestations are common. Subterranean termites are the most economically important wood-destroying pests in the United States. They are, however, important components of natural forest ecosystems, where they break down cellulose. Unfortunately, when land is cleared for human habitation the termites present may eventually pose a threat to the wood used in construction because their natural food resources have been removed. Nationwide, treatment and prevention of subterranean termite infestations costs approximately \$2 billion per year. In Georgia alone, residents spend over \$200–300 million per year for the remedial control of existing infestations and the repair of damage that subterranean termites cause to homes and other structures.

Subterranean Termite Biology

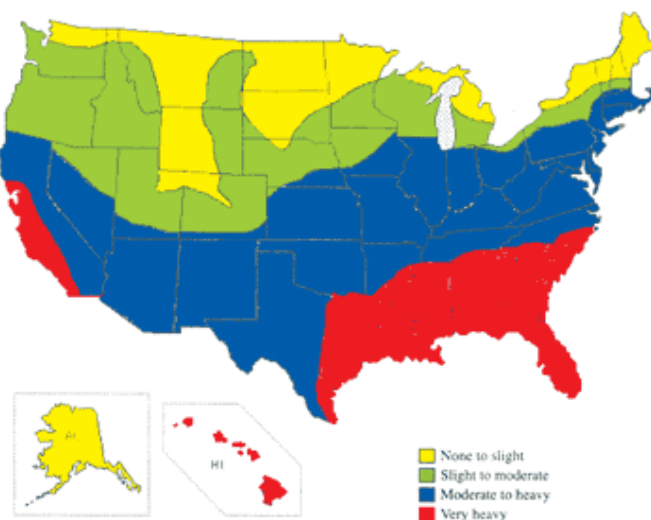


Figure 1. Subterranean termites are found in all states except Alaska and are most abundant in the south and southeastern United States.

Social Insects

Termites, like other social insects, are characterized by:

- cooperation in the rearing of young,
- sharing of resources (i.e., food, water and shelter),
- an overlapping of generations (i.e., eggs are laid year-round), and
- a division of labor, characterized by the presence of one or more castes, or life forms.

Eastern subterranean termites have a well ordered social system with amazing engineering capabilities and acute survival instinct; they obtain moisture from the soil and moist decaying timber, and communicate using pheromone signals. Termites are insects that live in loosely associated societies called colonies. A colony is a collection of individuals that cooperate in the rearing of young and that share resources (e.g., food and shelter). Termite colonies are comprised of a few adults (the king and queen) while the majority of the population are immature forms that are represented by approximately equal numbers of males and females.

What Subterranean Termites Need to Survive: Food, Water, and Warmth

Food of subterranean termites consists of anything made of or containing cellulose. Termites feed primarily on dead wood and wood by-products, and only under unusual circumstances will they feed on other living or dead plant tissue. However, in their search for food, termites can tunnel into and damage a variety of noncellulose materials (e.g., rigid foam-board insulation, sheetrock, etc.).

Moisture is the most important factor limiting subterranean termite activity and distribution in the environment. Termites are thin-skinned insects that quickly dry out when exposed to the desiccating effects of wind or dry air and they require a constant supply of moisture. In suburban areas where irrigation occurs regularly, and soil moisture is not limited, colonies are thought to be more active.

Temperature has a strong influence on daily and seasonal fluctuations in termite activity. Subterranean termites will not forage for food when topsoil temperatures are either too hot or too cold. They adjust their activity to seek suitable temperatures and will migrate deeper in the soil when surface temperatures are unsuitable. Foraging termites can also detect temperature gradients in the soil, and under extremely hot conditions seek out thermal “shadows” cast by vegetation, and presumably structures. When temperatures near the soil surface are too hot and the soil becomes dry, termite foraging may be significantly reduced.



Scientific Method Lab Exercise Exploring Termite Behavior

Introduction:

Today we are going to put into practice the scientific method. You will not find this method particularly foreign; in fact, the first steps of the process are used regularly by most people as they live out their daily lives. Below you will find a review of this process that will help enable you to perform this lab exercise.

Step 1: Observation

Be aware of and curious about the occurrences in your surroundings. Be a keen observer and record your observations. You will use your observations to help design your experiment.

Step 2: Develop a Question

Raise a question about what you observed. The question raised must have a “simple,” concrete answer that can be obtained by performing an experiment. For example, “What color light is optimal for plant growth?” could be answered by measuring plant growth under different lighting conditions, but “Why do plants grow better under red and blue light rather than green light?” couldn’t really be answered by carrying out a simple experiment.

Step 3: Develop a Hypothesis

Propose a hypothesis which explains what has been observed within the context of current knowledge. Your hypothesis is an “educated guess” about what you observed or what you want to test. This is a tentative answer to the question: a testable explanation for what you observed. Keep a record of your hypothesis and reasons why you developed this guess.

Step 4: Test your Hypothesis

Devise an experiment which will substantiate or refute your hypothesis. Your experiment should allow you to collect enough data to eliminate extraneous factors except the one in question (variable). Remember to control certain factors that may affect the outcome of your experiment if they were not kept constant.

Step 5: Accepting, Rejecting, or Modifying your Hypothesis

Based on the experiment performed, you must logically determine whether your data supports your hypothesis or casts doubts on its validity. There is no “right” or “wrong” answer. An experiment which refutes a hypothesis can often be more enlightening than one which substantiates the present understanding of a problem (or question you posed).



Scientific Method Lab Exercise Exploring Termite Behavior

Materials

- 6 pens (red, blue, and black Papermate and Bic brand pens)
- White paper
- Small brush
- Termites in a Petri dish

Procedure

1. Read the provided information on subterranean termites and the scientific method.
2. Using the pens, draw lines on the paper.
3. Place several termites on the paper using the brush to keep them from straying.
4. Observe the termites carefully and write down all observations.
5. Develop several hypotheses based on your observations.
6. Develop a procedure so you can test one of your hypotheses.
7. Write out your protocol and have the teacher approve the protocol before performing the experiment. Remember:

What is your variable? _____

What will be your constants (controls)? _____

How many times will you repeat this experiment? _____

8. Conduct your experiment.
9. Collect data from your experiment.
10. Analyze your data.
11. Organize your data into appropriate tables or graphs.
12. Draw conclusions. Questions to consider when drawing conclusions about your experiment:

Do the results support your hypothesis? _____

Were there any variations in the observed behaviors? _____

Were there any surprises? _____

Based on your data, would you accept, reject, or modify your hypothesis?

Explain. _____

13. Write up a lab report including all steps of the scientific method, detailed explanations of procedures used in your experiment (so that someone else could repeat your experiment), include all data you gathered in an organized presentation, and conclusions about your data.