Invertebrate Biodiversity and Abiotic Factors

A Carolina Essentials™ Investigation

Overview

Understanding the relationships between biotic diversity and abiotic factors in an ecosystem can be a difficult task. Using soil invertebrates, students can identify both the number of species present in a soil sample and the number of individuals within a species. With some simple math, a measure of biodiversity and effective number of species can be calculated. This information can be compared to soil pH, moisture, and temperature to develop an ecosystem model. In this activity, students construct a simple, inexpensive Berlese funnel to collect and identify soil invertebrates.

Life Sciences, Biology; Earth and Space Science, Environmental Science
Grades: 9–12

Essential Question

How do abiotic factors influence the biodiversity and density of soil invertebrates?

Investigation Objectives

1. Construct a Berlese funnel.
2. Collect and identify soil invertebrates.
3. Determine if a relationship exists between number of invertebrates, classes of invertebrates, and abiotic factors.

Next Generation Science Standards* (NGSS)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations • Students will collect invertebrate samples and explain the results based on abiotic soil factors.	**LS2 Ecosystems: Interactions, Energy, and Dynamics** **ESS2 Earth's Systems** • Students will understand the relationship between ecosystem biotic and abiotic factors.	**Patterns** • Students will establish patterns between soil invertebrate biodiversity and density and abiotic soil factors.

Safety Procedures and Precautions

Remind students to use scissors properly. Identify students who may have allergies to bug bites, insect stings, plants, or pollen. Take necessary precautions.

Disposal

Return excess soil outside. Once invertebrates are identified, flush alcohol down the sink with water. Dispose of invertebrates in the trash.

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TIME REQUIREMENTS

PREP	ACTIVITY
30 min	5 days, 95 min

Teacher Prep: 30 min

Student Activity

Funnel Construction: 20 min

Soil Collection and Testing: 30 min

Invertebrate Preservation: 4–5 days

Invertebrate Identification: 45 min

MATERIALS (PER GROUP)

Ethanol (70–95%) or isopropyl alcohol (70%), 50 to 100 mL

1 Gallon-sized plastic jug with cap

1 1000-mL beaker or 1-qt. jar

1 Square of mesh screen, 20 cm × 20 cm (1/4" hardware cloth)

1 Incandescent bulb lamp

1 Pair of scissors

1 Ruler

Tape

1 Soil sample per group from a plot that is 50 cm × 50 cm (1 to 2 cm deep)

1 Spade, shovel, or other digging tool per student

1 to 2 Invertebrate keys

1 Soil thermometer

1 pH strip

1 50-mL beaker,

1 Electronic balance

Drying oven or other heat source for desiccating soil sample

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Preparation

Berlese Funnel Construction

1. Using scissors, cut the bottom off the jug.
2. Tape around the edge of the cut end.
3. Place the milk jug spout in the mouth of the jar. The jug serves as the funnel. The jar is the collection chamber.
4. Bend the mesh screen so that it fits securely into the milk jug and forms a stable platform for the soil sample. Do not let the screen fall below the handle.
5. Assign each group of students a different area outside. Vary the amount of shade, moisture, and type of leaf litter. Have students take pictures of their assigned area.

Student Procedure

Making the Berlese Funnel

1. Using scissors, cut the bottom off the jug.
2. Tape around the edge of the cut end.
3. Place the milk jug spout in the mouth of the jar. The jug serves as the funnel. The jar is the collection chamber.
4. Bend the mesh screen so that it fits securely in the milk jug and forms a stable platform for the soil sample. Do not let the screen fall below the handle.

Abiotic Soil Properties

5. Insert the soil thermometer and record the soil temperature.
6. Remove the top 1 to 2 cm of soil and leaf litter with the Berlese funnel.
7. Take a small amount of soil without any invertebrates. Add 3 to 4 drops of water, mix well, and test the mixture with the pH paper.
8. Record the pH.
9. Place 1.0 g of soil in the 50-mL beaker.
10. Weigh the soil and beaker. Record the mass.
11. Place soil in the drying oven at 100 to 110° C or place under the incandescent bulb. Allow the soil to dry to a powder.
12. Reweigh the beaker and soil. Record the mass.

Teacher Preparation and Tips

Make sure that the tape is folded over the cut edge of the milk jug so there are no raw edges.

Keep the cap on the jug until the soil is added to prevent any loose soil from entering the jar.

Take pictures of the area and soil surface.

The final soil sample must be very dry. Drying time can take between 6-36 hours.

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Student Procedure

Invertebrate Inventory

13. Place the remaining top layer of soil into the funnel.

14. Pour 2 cm of alcohol into the beaker or jar.

15. Place the funnel on the jar. Tape a ruler or similar support to the handle of the funnel and to the side of the jar to ensure that the funnel remains steady.

16. Place the Berlese funnel under the incandescent lamp.

17. Adjust the lamp to direct the light onto the top of the sample from about 20 cm away.

18. Let the Berlese funnel stay under the light for several days.

19. Identify the invertebrates that have fallen into the alcohol.

Teacher Preparation and Tips

Do not pack the soil into the funnel.

Remove the jug cap.

The incandescent bulb serves as a heat source to drive invertebrates lower.

Tech tip: *There are many invertebrate keys online for students to use to identify animals.*

Data Tables

Soil Data

Temperature (C°)	pH	Moisture Initial Mass (g)	Final Mass (g)	Water Mass (g)
Student answers will vary.				

Soil Invertabrates

Species	Class	Number (n)
Total (N)		

Typical invertebrates may include ants, mites, spiders, springtails, termites, and centipedes.

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Analysis

1. Calculate the percentage of soil moisture.

   % soil moisture = (water mass/final dry mass) × 100

2. Calculate invertebrate density.

   Density = total number of invertebrates/area (50 cm × 50 cm)

3. Calculate the Simpson Index of Diversity.

   $D_s = 1 - [\sum n_i(n_i - 1)/N(N - 1)]$

4. Compare group results and discuss differences in invertebrate samples, locations, biodiversity, and abiotic factors.

   Answers will vary.

5. What patterns can be established between biotic and abiotic factors?

   Temperature and moisture should affect the number and type of soil invertebrates.

6. How would the season of the year impact biotic and abiotic factors?

   As seasons change, temperature and precipitation amounts change.

Helpful Links

Carolina LabSheets™: Biodiversity of Soil Animals
http://www.carolina.com/teacher-resources/Document/carolina-labsheets-biodiversity-of-soil-animals/tr32907.tr

Carolina Teacher Resources
http://www.carolina.com/resources/home.jsp

Reference Kits

Carolina Investigations® for AP® Environmental Science: Exploring Biodiversity Kit
http://www.carolina.com/ap-environmental-science-lab-kits/carolina-investigations-for-ap-environmental-science-exploring-biodiversity-kit/180604.pr

Carolina™ Physical and Chemical Properties of Soil Kit
http://www.carolina.com/environmental-science-soil-studies/carolina-physical-and-chemical-properties-of-soil-kit/182000.pr

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TEACHER NOTES