Soil Micro-Arthropods: Berlese Funnel Extraction
Teacher Instructions (Lesson Plan)

This protocol is intended for use within the framework of a research project. Please see the **"Design and Analysis" section of the website for details on conducting a research project.

Objectives:

- Assess the diversity and numbers of microarthropods.
- Collect soil samples
- Identify, count, and archive specimens.
- Calculate Diversity Index.
- Construct models of ecosystem.
- Write up a scientific style report of findings.

Students Required: Teams consisting of 3 or 4 each

Estimated Time: approximately 15 non-consecutive days

1. Preparation and Initial Site Visit
    a. Preparation for data collection: discussion about ecologic topic, practice with identification tool, finalize team plan for data collection (55 minutes)
    b. Site visit (55 minutes)
2. Soil Sample Collection (55 minutes)
3. Micro-Arthropod Extraction (1-2, 55 minute periods)
4. Sort and Label Specimens (2-3, 55 minute periods)
5. Enter and Analyze Data (3-4, 55 minute periods)
6. Write-up and Present Data
8. Develop Final Models of Ecosystems

Overview of Tasks:

Part 1: Preparing and Initial Site Visit

1. Introduce students to the student instructions and discuss importance of study. Look at examples of different micro-arthropod groups you might find.
2. Examine map and lay out sampling technique. Assign students to their sampling locations.
3. Gather equipment and make an optional initial site visit to lay out plan.

Part 2: Data Collection

1. Student groups gather equipment and travel out to the field site.
2. Collect specimens using the techniques outlined in the student instructions and your journal. Mark the approximate locations where specimens were collected on the map.
3. Store soil samples in large, sealed container that allows ventilation until next class period.

Part 3: Sorting and Identifying Specimens

1. Back in the classroom, extract specimens as outlined in the student instructions.
2. Sort specimens using an ID key (such as that found at http://ecoplexity.org/node/144). Attach appropriate labels.
3. Record data in data sheets with appropriate names and numbers.
4. Option: preserve some specimens with labels for an insect collection (bug board, etc.)

Part 4: Analyzing Data

1. Enter data into worksheet for analysis of species richness and diversity index (Option: calculate variance using ANOVA worksheet).
2. Examine and compare specimens with sampling locations.
3. Option: Have teams pool finalized numbers into class results and discuss. What is the relationship between species and location? What species were more prevalent? What factors (environmental and human) may have contributed to your results, i.e., what were the conditions of the areas you sampled

Part 5: Write-up of results and Presentations

1. Each team should write-up a summary of methods, data and results (option: Present findings to an audience of community members, scientists, etc.)
2. Have students prepare final ecosystem models.

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Student Instructions

Why study Terrestrial Arthropods?

Arthropods are joint-legged animals with segmented bodies and an exoskeleton. This diverse group is comprised of the insects, arachnids (spiders, mites and scorpions), crustaceans (shrimp, lobster, crabs, etc.), millipedes and centipedes. Far more species of arthropods exist than all the other higher order animals put together. They currently make up nearly 62% of the total known species of all organisms with new species of arthropods being continually discovered.

Whether measured by species numbers, numbers of individuals, or mass of living tissue, arthropods make up the largest, most diverse, and least understood component of most terrestrial ecosystems. Their extreme variety and small size have enabled them to fill virtually every niche available in these ecosystems. Traditionally, forest entomologists have viewed arthropods in terms of their negative impacts on timber production. Less attention has been given to the critical roles they play in the functioning of these ecosystems.

Although arthropods live and feed on virtually every part of the plants in terrestrial ecosystems, these same plants also depend upon arthropods for their own survival. Aside from serving as agents of pollination and seed dispersal for a large percentage of plants, arthropods are the major force that decomposes dead materials into nutrient rich topsoil needed for plants to grow.

Arthropods also serve as the largest prey base for small predators, sustaining other arthropods, amphibians, reptiles, birds and small mammals, which, in turn, sustain the larger predators. Without arthropods, most terrestrial ecosystems would rapidly collapse. So why should a high school ecology class study arthropods? For one thing, despite their critical roles in ecosystem functioning and nutrient cycling, a general lack of information about arthropods persists. Student investigations of arthropods could help to fill the gaps in scientific knowledge about invertebrates and the ecosystems they inhabit.

Monitoring the presence or absence of arthropod species with well-known ecologies can also be a useful tool to understanding an ecosystem as a whole. When a species is identified as being closely tied with particular ecosystem characteristics it can be considered an indicator species.

There is currently a movement to use arthropod indicator species in public land management practices. However, in order for this practice to be scientifically viable, clear links between particular arthropod species and certain ecosystem characteristics must be established through the gathering of baseline data. Collecting this baseline information is a time consuming process requiring repeated arthropod surveys in a wide variety of habitats. High school ecology students can fulfill a genuine need for baseline data by surveying arthropods using the field protocols developed by ecologists and posting their results on the web.

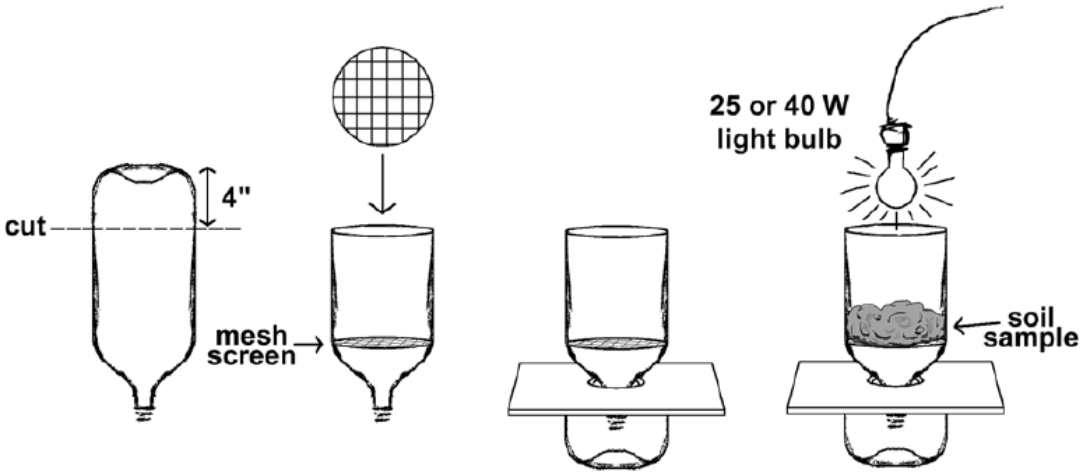
As discussed previously, arthropods have been able to fill virtually every niche available in the ecosystems they inhabit. Different sampling protocols are required to survey arthropods in different niches. The Berlese funnel protocol assesses micro-soil-dwelling-arthropods.

Materials:

Several 2 Liter Plastic Bottles
Cardboard or Plywood for Platform
Box Cutter or Scissors
Hand lens
Ruler
Pencil or Waterproof Ink
Plastic Bags
Field Notebook
Map
Hardware Cloth or Metal Mesh Screen
Trowel
Antifreeze (Non-Hazardous)
Cooking Oil
Petri Plate
24 Well Plates
Disposable Pipettes
Stereoscope

Procedure:

1. Make your Berlese Funnel Extractor in class prior to fieldwork. Directions for construction can be found in the protocol.
2. Visit your study site and prepare to take your soil sample. Remove a 10" x 10" x 2" sample of soil. Include any plant litter on surface, but do NOT include it in the 5cm depth. Cut your sample like a piece of cake, sides first, bottom last. Lift up gently with your trowel.
3. Place your sample in your plastic bag, careful not to crush your sample. Label your sample.
4. Back in the classroom, remove the sample from the bag and place in Berlese extractor. Break up any clods so that the arthropods can leave the sample. Remove any earthworms to a separate specimen vial, or else everything sticks together.



5. Turn on the 25 or 40 watt light bulb and extract for 48 hours (larger samples will require higher wattage and longer extraction times).
6. Place a jar that contains a small amount of anti-freeze under the Berlese funnel. replace the jar with a new one for an additional 24 hours or until nothing else emigrates from the soil sample.
7. Sort and identify specimens. Place the extracted sample into one or more labeled small vials. Add a few drops of cooking oil to the top of each vial to form a thin meniscus. Replace cap, agitate the mixture. Allow the oil to rise to the top for about ten minutes.
8. Pipette the critters from the oil layer into a petri plate. Remove the excess oil and glycol from the petri plate.
9. Sort the critters into piles of similar species into a wellplate by placing them in droplets of cooking oil. Identify: springtail A,B,C...mite A,B,C, etc. Count the species and record your data. You may attempt to identify species using resources such as ID keys or check Dr. Moldenke's Bugbites site at: http://ippcweb.science.oregonstate.edu/ent3/bugbytes/
   Please note that it is difficult to identify these micro arthropod species.
10. If you wish to store specimens, visit the Berlese Funnel Protocol for information.

11. Analyze your data and interpret your results. Complete your experiment as per your teacher's instructions.

Sample Data Table

Sample #	Springtail A	Beetle A	Beetle B	Beetle C	Millipede A
Sample 1					
Sample 2					
Sample 3					
Sample 4					
Totals					