



LESSON PLAN: Macro- and Meso-fauna Extraction

Introduction:

There is a lot of life below our feet – a single teaspoon of soil can hold over one billion microbes! In this lesson, students use hands-on methods to learn about species richness and diversity in a habitat not commonly explored – the belowground ecosystem.

Prescribed learning outcomes (PLO) are content standards for the provincial education system; they are the prescribed curriculum. The "Macro- and Meso-Fauna Extraction" lesson plan will help students to achieve the following BC PLOs¹:

- Science 10 – Life Science: Sustainability of Ecosystems (B1, B3)
- Biology 11 – Taxonomy (B1); Ecology (D1); Animal Biology (G1, G3)
- Geography 12 – Biomes (E1-E4); Resources and Environmental Sustainability (F2)
- Sustainable Resources 11 – Agriculture (A2); Forestry (C2, C3)
- Sustainable Resources 12 – Agriculture (B4, D4); Forestry (B1-B4, E2, E4)
- Processes of Science (A1-A3); Taxonomy (B1); Ecology (D1); Animal Biology (G1, G4)
- Biology 11 – Processes of Science (A2); Taxonomy (B1); Ecology (D1); Animal Biology (G1, G3)

Learning Objectives:

- Become familiar with the various ecosystem roles played by soil fauna.
- Define, extract, and quantify soil macro- and meso-fauna.
- Calculate richness and species diversity to compare the soil biology of different soil types, and then speculate as to why the different soil environments could cause these observations.

Materials:

- Berlese funnel (see notes for construction of these funnels on page 4)
- Petri dishes
- Dissecting forceps
- Dissecting microscope

Activity Description:

A Berlese funnel is used in soil biology to extract insects from a soil sample. It uses a light source (a light bulb) to repel insects in the sample to the bottom of the funnel, until they fall through a screen and into a jar of preserving alcohol.

In this activity, students will work in groups to extract both macro- and meso-fauna, using Berlese funnels, from three different soil types: potting soil, soil from a lawn, and soil from a forested

¹ Please consult the appropriate Integrated Resource Package (IRP) to identify the PLOs. A catalogue of the BC Curriculum Documents (including IRPs) can be found here: <http://www.bced.gov.bc.ca/irp/all.php?lang=en#>



site. Logistically, it typically works best to assign a group (of 2-4 people) to each soil type. There may be multiple groups for each soil type, depending on class size.

Macro-fauna extraction:

1. Collect samples by extracting a 20 cm x 20 cm block of soil, to a depth of 3 cm. In the lawn and forest soils, remove as much of the plant matter and forest floor as possible to make sure you are sampling the top of the mineral soil.
2. Place sample in a labelled plastic container.
3. Hand-sort the samples, removing any visible macro-fauna (>1 cm in body size) with dissecting forceps.
4. Place the macro-fauna in petri dishes and identify using the "ID Info" provided on page 3. May choose to use a dissecting microscope here.
5. Count and record the number of individuals of each group present in each sample.

Meso-fauna extraction:

1. Using a trowel, remove a 5 cm x 5 cm square of soil to a depth of 3 cm. In the lawn and forest soil, be sure to include the plant matter and or forest floor as well as 3 cm of the mineral soil.
2. Set-up Berlese funnels, placing an empty jar below the funnel to start.
3. Place the litter sample on top of the screen. Gently shake and tap funnel so that any loose soil falls through. Place any fallen soil back into the funnel.
4. Replace the empty jar with jar of alcohol. Turn on light over top of funnel and let sit for 7 days in a place where it will not be disturbed.
5. Etch a 1 cm x 1 cm grid onto the bottom of 4 petri dishes. Transfer an equal portion of the extraction liquid (the alcohol solution) to each petri dish (be sure to rinse the jar to ensure everything is transferred).
6. Using a dissecting microscope, observe the contents of each dish, using the grid on the dish to systematically work through the entire space.
7. Record any observations and add to the tally of individuals from the macro-fauna extraction.

Once all the organisms have been identified and counted, have students enter their data into a table set up in the following way:

Sample: Forest	Organism Group	Abundance	Proportion (p_i)	$-p_i * \ln(p_i)$
	Mites	50		
	Springtails	30		
	Isopods	10		
	Millipedes	9		
	Ants	1		
Totals				

In this table, students will calculate the following:

- Richness of organism groups:
 - equal to the sum of all organism groups



- Organism group diversity (H'), using the Shannon Index:

Let p_i = the proportion of all observed organism groups

$$H' = - \sum [p_i * \ln(p_i)] \quad \text{**Note: Higher index value = more diverse community}$$

Following calculations, the table should look like this:

Sample: Forest	Organism Group	Abundance	Proportion (p_i)	$-p_i * \ln(p_i)$
	Mites	50	0.5	0.347
	Springtails	30	0.3	0.361
	Isopods	10	0.1	0.230
	Millipedes	9	0.09	0.217
	Ants	1	0.01	0.046
Totals	5 (richness)	100	1.00	1.201 (H')

At this point, have the entire class share their final results with each other and then compare the results for each of the soil types analyzed. Either as an in-class discussion or as a written lab report, have students discuss the following:

- What important roles do invertebrate macro- and meso-fauna play in the soil ecosystem?
- Why would we be interested in the a) richness and b) diversity of organism groups in the soil?
- Which of the three soil types had the most richness/abundance/diversity? Which soil had the least? Based on your own critical thinking, what are some possible reasons for these observations?

Background on Soil Macro- and Meso-fauna:

Soil macrofauna are typically classified as the invertebrates in the soil with a body length >1 cm. Their main functions involve burrowing and mixing the soil. Some of them also play a large role in the breakdown of organic matter at the surface (a.k.a. surface litter). Examples: earthworms, millipedes, centipedes, ants, Coleoptera (adults and larvae), Isopoda, spiders, slugs, snails, termites, Dermaptera, Lepidoptera larvae, and Diptera larvae.

Soil mesofauna are of a body length between 1 cm and 1 pm; anything smaller is microfauna! They are largely responsible for fragmenting debris and contributing to good soil structure. Examples: mites, springtails, tardigrades, Enchytraeidae, and Pauropods.

Macro- and meso-faunal mostly live in the litter or in the upper few centimeters of the soil because this is where most of the food is. Food comes to these organisms as organic matter and/or other organisms. Some of the many functions affected by soil organisms include: decomposition, nutrient availability/cycling, carbon sequestration, degradation of pollutants, plant protection (through predation of pests), and soil aeration. Biodiversity of soil organisms is essential for maintaining these ecosystem functions. Low biodiversity can leave an ecosystem susceptible to extreme events in the environment; high biodiversity in a community can make an ecosystem more resilient in the face of disturbance.

There are more living individual organisms in a tablespoon of soil than there are people on the earth!



ID Info:

If students have access to laptops or computers, it can be very effective for them to look up images for organism ID on their own. Compiling photos and brief descriptions of these organisms can actually be assigned to students, in groups, as part of the preparation for this activity. Here is a list of commonly found invertebrate fauna in B.C.'s forest soils, which can be given to students as a minimum list of organisms that require photos and brief descriptions:

- Diploda (millipedes)
- Chilopoda (centipedes)
- Isopoda (woodlice)
- Psocoptera (bark lice)
- Pauropoda
- Symphyla
- Diplura
- Collembolan (springtails)
- Tardigrada (water bears)
- Rotifera
- Protura
- Insect larvae
- Araneida (spiders)
- Pseudoscorpionida
- Acari (mites)
- Nematoda (roundworms)
- Enchytraeids (pot worms)
- Annelida: Lumbricidae (earthworms)
- Coleoptera (beetles)
- Hemiptera (true bugs)
- Homoptera (aphids, psyllids)
- Diptera (flies)
- Isoptera (termites)
- Hymenoptera (bees, wasps, ants)
- Gastropoda (slugs, snails)
- Thysanura (bristletails)

Photo: Silversyrpher



- Insecta
- 3 pair legs, 10-15 mm long
- no wings
- usually elongate and flattened
- long antennae
- has a long central tail that is longer than two shorter tails

Example above: Thysanura

Some very basic sketches for a more limited list of the major types of soil fauna in B.C. can also be found here (see Fig. 2.3): <http://www.ilmb.gov.bc.ca/risc/pubs/teecolo/fmdte/soilohl.htm>

How to make your own Berlese Funnel:



Photo: Brian Gratwicke



Figure 9. A home-made Berlese funnel.

Materials:

- a one-Liter plastic milk container
- an empty glass jar or clear plastic container
- a mesh hardware cloth or aluminum window screen
- masking tape or duct tape
- rubbing alcohol (ethyl alcohol)
- 25 Watt light bulb (suggest a gooseneck lamp)

Instructions:

Cut the bottom out of the milk jug and turn it upside down over the Mason jar to make a funnel. Bend down the corners of the hardware cloth/window screen so it fits snugly inside the wide end of the funnel. Layering with two levels of the mesh/screen, one at the wide end and one at the spout, is most ideal. Collect several handfuls of humus or leaf litter and put them on top of the wire mesh. Pour 50-60 mL of alcohol into the jar. Place the funnel on top of the jar and tape the funnel to the jar to secure it. Set the light directly over the funnel.