CHICAGO BOTANIC GARDEN

Activity 1.5: Leaf Litter Ecology Lab

Grades 7 – 9

Description: In this activity students examine the ecology of a local leaf litter (the forest floor) community. Students will collect and identify the living organisms in a plot, identify the tropic levels, and create a food web and a pyramid of biomass.

Note: This lab should be done in the early fall to ensure that there are insects for students to observe. It is adaptable to the time and resources you may have. *Time can be adjusted for any of the variations or extensions listed below*. The lab can be completed as written in as little as 50 minutes if the teacher provides the leaf litter and specific identification of the animals is not required. Lab teams of three seem to work well with roles such as two "bug wranglers" and one ID specialist/sorter.

Total time: One to two 45-minute class periods

Materials:
Part 1

- Leaf litter, rotting sticks, detritus collected by you or the students
- Large white sheets of paper for sorting organisms
- Small containers with lids for holding leaf litter animals (film canisters or baby food jars are some options)
- 2-4 notecards per group for collecting animals
- Forceps
- Magnifying glasses and/or dissecting scopes
- Invertebrate, arthropod, or insect ID guides and/or computers with internet access
- Digital scales for massing plants and animals

National Science Education Standards

C4a A population consists of all the individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

AAAS Benchmarks

5D/E2 Insects and various other organisms depend on dead plant and animal material for food.

5A/M5 The cycles continue indefinitely because organisms decompose after death to return food materials to the environment.

5E/M3b Organisms get energy from oxidizing their food, releasing some of its energy as thermal energy.

5D/M4 All organisms, both land-based and aquatic, are interconnected by their need for food. This network of interconnections is referred to as a food web. The entire Earth can be considered a single global food web, and food webs can also be described for a particular environment. At the base of any food web are organisms that make their own food, followed by the animals that eat them, then the animals that eat those animals, and so forth.

5E/H3 The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment. Continual input of energy from sunlight keeps the process going.

Guiding Questions
- What organisms are present in a leaf litter community?
- What are the ecological relationships between members of a leaf litter community?

Assessment
- Student lab report

Vocabulary

Trophic Level: The position an organism occupies in a food chain. Trophic levels are often represented by numbers, starting at level 1, with primary producers such as plants. Further trophic levels are numbered subsequently according to how far the organism is along the food chain.

Level 1: Plants and algae make their own food and are called primary producers.
Level 2: Herbivores eat plants and are called primary consumers.
Level 3: Carnivores that eat herbivores are called secondary consumers.
Level 4: Carnivores that eat other carnivores are called tertiary consumers.
Level 5: Apex predators that have no predators are at the top of the food chain.

The path along the chain can form either a one-way flow, or a food web. In real world ecosystems, there is more than one food chain for most organisms, since most organisms eat more than one kind of food or are eaten by more than one type of predator. Ecological communities with higher biodiversity form more complex trophic paths.

Pre-Activity
Collect the leaf litter
- *Safety precautions*: Soil and leaf litter should be taken from known areas where pesticides, herbicides, etc., are not used. Gloves should be worn when collecting and handling leaf litter. Care should be taken for mold pollen allergies.
- You can collect litter the day before in large plastic storage tubs and then dole out a healthy handful or two to each lab team. They can then sort through the material carefully on the large, white paper at their desks or lab benches
- Avoid collecting litter from forest preserves or other areas that forbid the removal of plant material or other organisms.
- Common organisms found include: ants, beetles, earthworms, slugs, spiders, millipedes, centipedes, pillbugs (isopods), mites, and even the occasional pseudoscorpion.

Lab Notes
- The light background of the white paper makes it much easier to find these often tiny organisms.
- When catching and putting insects, etc., into jars, the forceps will sometimes crush them. Letting the little crawlers walk up onto a notecard and then carefully dropping it into a container is an effective method.

- Have your students spread out the litter slowly on their paper and then watch for movement. They will be amazed at what they will find if they can just be patient and watch for 30 seconds.
- When students are finished with the material, they can place it, organisms and all, right back into the tub so it can be used for the next class. When you are finished with all the litter you can replace it where it was collected.

Classroom Safety Precautions

- Ensure that students have no ***severe*** mold or pollen allergies. In all but the most extreme cases, this should not be a problem. You may want to have a number of surgical masks on hand if students are concerned.
- Ensure that where you collect the leaf litter is pesticide- and herbicide-free.
- You may want to caution your students to sort though litter with the forceps instead of using their bare hands. You may want to provide non-latex plastic gloves for students who may be sensitive.

Procedures

1. Ask students: *what do you think of when you hear the word "carnivore?"* They may mention lions, sharks, or any number of large animals. Tell the students that there are carnivores and herbivores that are smaller than a quarter, and they all live in a thin layer of decomposing plants that they may never notice when walking outside.

2. Introduce the lab to the students: Tell students that they will be studying in detail the ecology of a local leaf litter (the forest floor) community. (Note: It is important to establish the concept of leaf litter as decomposing leaves on the forest floor, rather than "litter" as trash.) Explain that they will collect and identify all the living organisms in a sample plot, separate the living things from the sample, and measure their mass to determine the total biomass of the sample. They will then construct the food chain of which the organisms are a part by looking at the trophic levels of each insect, or where they occur within a food chain. (Note: Review producers, consumers, herbivores, carnivores, and decomposers if your students have not covered food webs recently.) They will use this information to construct a pyramid of biomass and a food web to get a clearer idea of the ecological relationships between the members of this community.

3. Pass out the student handout titled "Student Directions – Ecology of a Leaf Litter community."

4. Note: You can collect the leaf litter in advance and pass out to students, or students can collect their own leaf litter from plots of a specified size. Give students these instructions if they are collecting their own leaf litter:
    - Measure out a ½ meter by ½ meter square plot (can also be 1 foot by 1 foot). You will collect all the leaf litter from within this plot.
    - When collecting leaf litter – scoop up all material from the surface, including dead and decomposing leaf material, rotting logs, and sticks, as well as approximately 2 centimeters of the soil beneath the litter.

- All leaf litter and associated organisms should be returned to their ecosystem after the activity (the leaf litter can be brought into the classroom to complete the lab).

5. Give each team a large piece of white butcher paper, insect identification guides, magnifying glasses, Petri dishes, a tub to hold plant materials, and a dissecting microscope. If you have collected the leaf litter for the students in advance, provide each group with a sample of leaf litter along with all the associated organisms.

6. Have students place the litter on the paper and look through the material carefully for any signs of movement. Let students know it may take a while.

7. As students are collecting their insects, they should be using the microscopes to identify them and using the plastic containers to hold and categorize what they find. They should start grouping organisms based on whether they are producers, primary consumers, or secondary consumers. (Students can use species identification keys to determine whether insects are primary or secondary consumers. A list of helpful websites for insect identification is provided at the end of this lesson.)

8. Students should mass an empty tub. Then they should put all of the PLANT MATERIAL ONLY into the tub and mass it on the electronic balance. Have them subtract the mass of the tub from the mass of the plant material and the tub to get the mass of the plant matter alone. They can also mass other containers at this time since they will need that information later.

9. Have students record the tub mass and the leaf litter mass on their handout (or in their lab book).

10. Categorize all animals as herbivores or carnivores using resources provided (books or computers) and put them in separate containers. Make sure students mass the containers before putting in the animals and record the masses on their handout.

11. Mass the herbivore and carnivore groups separately. Record the masses.

12. When students have finished, discuss the results with the class. Introduce the "rule of tens," which suggests that the biomass of a given trophic level will be ten percent of the level below it, because not all energy is passed up from one trophic level to the next.

    - How well do students' pyramids fit (or not fit) the general rule of tens?
    - What are the implications for ecosystems? How many producers are needed to support on primary consumer? Secondary? Tertiary?

    Let students know they will explore the implications more in the next activity.

Extensions

- Collect leaf litter from a variety of habitats (forest, abandoned lot, lawn area) to compare results.
- Diversity indices (such as Simpson's index or Shannon-weaver diversity index) can be calculated.

Resources

- A sample food web of leaf litter organisms, and a simple identification key can be found at the Field Studies Council website. The leaf liter organisms are referred to as minibeasts. http://www.field-studies-council.org/breathingplaces/minibeasts.htm#factfile
- A more complex insect identification key is available at insectidentification.org
- A clickable guide based on overall body shape of insects can be found at BugGuide.net

Student Directions: Ecology of a Leaf Litter Community

In this study, you will examine in detail the ecology of a local leaf litter (the forest floor) community. After collecting and identifying all the living organisms in the sample plot, you will group them into producers, primary consumers (herbivores), and secondary consumers (carnivores). You will then construct a pyramid of biomass and a food web. This will give us a clearer idea of the ecological relationships between the members of this community.

Methods:

1. Your team will be given a sample of leaf litter along with all the associated organisms.
2. Look through the material carefully on your white paper. Be patient and look closely for movement.
3. Feel free to observe anything you find under the magnifying glasses and dissecting microscopes. Use the plastic containers to hold and categorize what you find.
4. Using the electronic balance, mass your tub and record the mass in the space below.
5. Put all of the PLANT MATERIAL ONLY into your tub and mass it on the electronic balance. Record the mass in the space below.
6. Mass both of your lidded containers. Record the mass in the space below.
7. Categorize all animals as herbivores or carnivores. (If you don't know, look it up in the provided books or online.)
8. Mass the herbivore and carnivore groups separately. Record the masses below.

Name_____Date: _____ Period: _____

Observations & Data

Producers (list any recognizable plant items)	Consumers (list the names of all animals found)

Mass of plant material tub _____**g**
Mass of plant material (producers) _____**g**
Mass of herbivore jar _____**g**
Mass of herbivore material (primary consumers): _____**g**
Mass of carnivore jar _____**g**
Mass of carnivore (secondary consumers) material: _____**g**

Using the masses above, construct a pyramid of biomass that accurately represents the relative number of grams of each trophic level. In other words, the more grams, the wider that level will be. Be sure to label each level on your pyramid.

In the space below (or on a separate sheet of paper) draw a food web that uses all of the organisms from your list. Be sure to include arrows and label the trophic levels.

1. **Observation Questions:** Describe any evidence you see of decomposition (material rotting and breaking down).

2. What important roles does decomposition play in ecosystems?

3. Because of their size, most decomposers cannot easily be seen. List two organisms that would fill the role of decomposer.

4. Describe what the world would be like if suddenly all decomposers died off.

5. You may have heard of the "rule of tens," which suggests that the biomass of a given trophic level will be ten percent of the level below it, because not all energy is passed up from one trophic level to the next. How well does your pyramid fit (or not fit) the general rule of tens? Use your data to back up your answer.

6. How accurate do you think your data is? What flaws or errors do you think may have affected your results?

