Digging up the Dirt on Soil Microbes

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Objective of the Lesson:

This exercise is designed to introduce students to:

- ✧ The idea of soil as a habitat for many different organisms
- ✧ Links between the biological adaptations of an organism and the physical demands of its habitat.
- ✧ Identification of various soil and aquatic organisms.

Standards Addressed:

Science

K-3	4-5	6-8
Standard 1 *Nature and Application of Science and Technology* A-1, A-2, A-3	**Standard 1** *Nature and Application of Science and Technology* A-1, A-2, A-3	**Standard 1** *Nature and Application of Science and Technology* A-1, A-2
Standard 5 *Earth's Dynamic Systems* A-1	**Standard 5** *Earth's Dynamic Systems* A-2	———
Standard 6 *Life Processes* A-1	**Standard 6** *Life Processes* B-1	———
Standard 8 *Ecology* A-1, A-2 B-1	**Standard 8** *Ecology* A-1 B-1, B-2, B-3	**Standard 8** *Ecology* A-1 B-1

Agriscience

6-8
Standard 7 *Natural Resource and Environmental Careers* B-3, B-4

Materials Needed:

For students

- 3 selected sampling plots
- 3 1-gallon buckets
- 1 4mm sieve
- 3 shovels or hand trowels
- 3 (or more) dissecting scopes
- 1 sleeve of 50 plastic Petri dishes
- 3 squirt bottles (water)
- 10 metal spatulas
- Soil corer

For instructors (Optional)

- 1 (or more) microscope
- 1 box glass slides
- 1 box cover slips
- Eyedropper(s)
- Alcohol burner and matches
- Sterile disposable loops
- 5 dilution bottles with sterile water
- Sterile disposable 10-ml pipettes
- Pipette pump
- Methyl cellulose
- Methylene blue
- Sharpies
- Paper towels

Teaching Tips:

- Students will work in groups 3.
- This exercise includes an optional component for instructors, which assumes experience with a microscope.
- Three different sites should be used for this lesson:
    1. Aquatic ecosystem with water depth not exceeding 1 ft, coastal beach.
    2. Forest ecosystem with dense floor covering, little sunlight.
    3. Field/meadow ecosystem with grass, herbaceous plants, and/or small shrubs.
- Hunt around on the slides for interesting organisms. If you find any, share them with your students! Try to make at least one slide from each sample site.

Procedure:

1. Have students go to their designated sample site and record observations about the physical aspects of the site (wet, dry, sandy, etc.) Students should then collect a soil core about the size of the bucket (or a water sample) and bring it back to the lab. Note any organisms you observed during sampling.
2. Have students identify any additional physical characteristics of the sample they collected and list as many as they can.
3. Students should break up the core into chunks using their hands. Identify any macro-organisms found.
4. Have students place small chunks in Petri dishes and break up using spatulas. Examine the soils using the dissecting scope and record any observations (draw, describe).

5. Water can be added using a squirt bottle to help break up soil and separate organisms from soil particles, sometimes easier to see. Methyl cellulose can be added to slow down fast-moving swimmers.
6. Have students share their observations and rotate through to see interesting specimens from each sample site.
7. Students should compare and contrast the organisms found in each site: what connections can be made between the types of organisms found and the environment in which they were found?
8. Students should work together to answer the questions in the following section.

✷ ADDITIONAL OPTIONAL PROCEDURE FOR INSTRUCTORS (MICROSCOPY)✷

SOIL SAMPLES:

1. Add a small sample of soil (approx 10g) to a dilution bottle. Shake vigorously to disperse the soil particles. Using a sharpie, draw a dime-sized circle on one side of a glass slide. Using a sterile loop, transfer a loopful of the soil solution onto the OTHER side of the glass slide. Spread the solution around inside your dime-sized spot. Allow to air dry.
2. When the slide is completely dry, heat fix the organisms to the slide by passing the slide quickly back and forth through the alcohol burner flame (about 4 times). Hold the slide by the edges!
3. Allow a few seconds to cool. Cover your fixed organisms with 3-4 drops of methylene blue. Wait 60 sec and drain off the excess stain.
4. Rinse the slide under a fine stream of water from a squirt bottle, tilting the slide so that the water contacts the slide ABOVE your magic dime-sized spot and runs gently over it WITHOUT washing away any organisms. Rinse until the spot appears colorless.
5. Blot the slide carefully with a paper towel. DO NOT RUB THE SLIDE!
6. The slide is now ready for microscopic observation. No cover slip is necessary.
7. If the concentration of organisms is too high, or there is too much interference from soil particles, additional dilutions can be made by transferring 10ml of soil solution to a fresh dilution bottle.
8. Alternatively, a drop of the soil solution can be prepared as a water sample, described below.

WATER SAMPLES:

1. Using an eyedropper, or a sterile loop, place a drop of water on a glass slide.
2. Cover the drop with a cover slip.
3. The slide is now ready for microscopic observation.

Check for understanding:

<u>Possible Questions</u>

1. How would you define a habitat?
2. How would you define an ecosystem?
3. What were the physical differences among the three selected sampling sites? (Ex., wet, dry, moist, sunny, shady…)

4. How did the populations of organisms differ among the sampled sites? For example, how were the organisms collected from Site 1 adapted to live in the conditions found at that site?
5. Did you see more organisms with your un-aided eye or with the help of a dissection scope or microscope? What does this tell you about life in these ecosystems?
6. What is the most important thing YOU learned from this exercise?

Suggested Answers

1. A habitat is generally described as the place or the physical location where a population of organisms live.
2. An ecosystem is usually defined as a community of organisms (that is, a group of populations) together with their physical environment. In other words, for a given space (a pond, a patch of forest), the ecosystem is all the living and non-living elements in that space.
3. Site 1 was a marine environment, including salt water and a sandy beach. No shade, so it's sunny unless there are clouds. Site 2 was a terrestrial forest with leaf litter, twigs, humus, and dark moist soil. No direct sunlight, always shaded. Site 3 was an open field with grass and herbaceous plant cover; the soil was less enriched with organic matter, not as moist. Like Site 1, no shade is available, although the plant cover protects the soil from direct sun.
4. At Site 1, we expect to find marine organisms, algae, micro-invertebrates, dinoflagellates, and other photosynthetic microbes, bacteria. These species are all aquatic and adapted to salt water. Expect the highest abundance of photosynthetic microbes due to direct sunlight. Site 2: expect to find more macro-invertebrates, beetles, grubs, and worms. Plants may include tree seedlings, mosses and ferns, very few herbaceous plants expected dues to low sunlight. Microbes expected to include molds, fungi, protozoa, possibly nematodes, rotifers, many different bacteria, lots of motile (swimming) species. These organisms are adapted to a cool, moist, dark, relatively nutrient-rich environment. Many of these organisms are decomposers. Site 3: expect to find worms, ants, possibly other insects. Many different plant species may be present on the soil surface due to availability of direct sunlight. Microbes expected to include fungi, protozoa, nematodes, many different bacteria, fewer "swimmers." Expect higher density of organisms in the rhizosphere (closer to roots) due to nutrient enrichment. These organisms are adapted to a warmer, drier, relatively nutrient-poor environment.
5. You probably saw more organisms under the dissection/microscopes. This demonstrates just how many living things (the majority!) are microscopic.
6. All answers are correct!

Summary of learned material:

Much of the life in any ecosystem cannot be seen with the naked eye, but that doesn't mean it's not there, or that it's not important! The organisms living in a particular habitat are adapted to the demands of that habitat. Habitats are diverse, and many different habitats can exist in close proximity of one another. Habitat diversity + organism diversity = ecosystem diversity. We can learn much about the functioning of an ecosystem by examining its structure and resident life forms.

Additional Resources:

General Sites:

http://www.ucc.ie/impact/agri2f.html

http://www.agric.nsw.gov.au/reader/15055

http://interactive.usask.ca/ski/agriculture/soils/soilliv/index.html

Soil Microbes and Agriculture:

http://ianrnews.unl.edu/static/0303250.shtml - Short article discussing benefits of soil microbes.

Soil Microbes and Anticancer Agents:

http://www.news.wisc.edu/view.html?get=7718 - Article about anticancer agents in microbe DNA.