



SOIL BIOTA: It's a Whole New World

Katherine McCarville, Ph.D.
Associate Professor of Geosciences
mccarvillek@uiu.edu



INTRODUCTION

Encountering soil biota is an engaging and exciting activity for undergraduate students, most of whom have little or no experience with this topic. In general, I find that students have neither thought about nor encountered soil biota. They are universally surprised by the diversity and abundance of soil animals. We often find new organisms that permit modeling of curiosity and the research process.

In my upper division soil genesis class, I conduct a fairly extensive activity involving soil biota. The activity takes place over about a week, and requires two class or lab periods of 1.5 hours each. Student teams work independently during the time between those two class meetings. This class provides an opportunity to integrate students' knowledge of scientific methods, experimental design, biology and ecology. They also learn new skills or gain practice in sampling, taking microphotographs, and using dichotomous keys. In the textbook, soil biota is not addressed until Chapter 9. However, because I teach this class during an eight-week term beginning in mid-October and running through mid-December, we study soil biota early in the term.

As a group, the class develops a hypothesis that diversity and abundance of soil animals will be related to the characteristics of the area that is sampled. Looking at the locations within walking distance of our lab—which include a small greenhouse, a constructed prairie, a woodland, a fairly natural wetland, a riparian corridor, a constructed pond, cultivated cropland, lawns and athletic playing fields—we order these according to how diverse and abundant a soil biota we expect to find.



ASSIGNMENTS

2012-10-23 Soil Biota Lab
ES128 Soil Genesis
(Adapted from a course activity authored by Dr. Kim Larson, Iowa State University)

The purpose of this lab is to examine soil biodiversity and understand how the soil biota contributes to soil functions, including soil fertility. A Berlese funnel will be used to separate soil organisms from the other sample material. You will separate the organisms you find into multiple taxonomic categories, identify (to best you can), and count them. Finally, students will calculate the species diversity of each sample. Diversity will be compared among several different biotic communities.

Species diversity is a characteristic that relates to a community's level of biological organization. A community is said to have high species diversity if it has many species present at an approximately equal abundance. If a community has only a few species, it is considered to have low species diversity. The number of species in a community is very important. There seems to be evidence that the greater the species diversity, the more stable the community. When diversity is low, the community is less stable. A community with low diversity is less able to rebound from stress disturbances such as pollution and habitat disruption. The biodiversity in some communities has been severely affected by human activities.

Materials:
Dichotomous microscope
Berlese funnel apparatus
Plastic collection bag
Leaf litter
Methanol
Hand-drawn key (attached)
Pen or pencil

Procedure:

1. Set up a Berlese funnel. Use 70% ethanol in the collecting bottle. Leave the funnel set up as long as necessary to process your sample(s).
2. Show the information regarding soil biota in your textbook.
3. Take a look at the Soil Biology Primer.
4. Identify several http://soils.usda.gov/sqi/concepts/soil_biology/biology.html a. List all the names of soil organisms.
5. Prepare "The Food Web" <http://www.ars-grin.gov/soilbiology/foodweb.html>
6. Look for the IAD information on soil biodiversity - may have http://www.ars-grin.gov/soilbiology/soil_biodiversity.html Notice some of the other information that is available on the site.
7. Take a look at some of the "soil" reports...
8. On Friday, carefully identify the soil organisms (from across beyond the funnel) and count them on the contents in a Petri dish. Use the hand-drawn key (attached) to identify to the lowest possible taxonomic level that you can. Use the key!

Calculations:

Example data and calculations for relative abundance, with 7 species and total number of individuals (N) = 55:

Species (i)	Abundance (a _i)	Relative Abundance (p _i)
1	10	10/55 = 0.18
2	20	20/55 = 0.36
3	15	15/55 = 0.27
4	5	5/55 = 0.09
5	3	3/55 = 0.05
6	2	2/55 = 0.04
7	1	1/55 = 0.02

Calculate the diversity of your sample using Simpson's Index of Diversity and record in the table on the chalkboard. The following example illustrates how to calculate Simpson's Index of Diversity:

$D = 1 / \sum (p_i^2)$

$D = 1 / (0.18^2 + 0.36^2 + 0.27^2 + 0.09^2 + 0.05^2 + 0.04^2 + 0.02^2)$

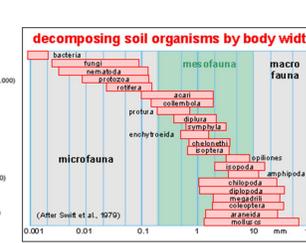
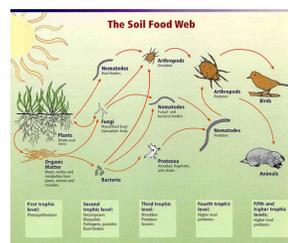
$D = 1 / (0.0324 + 0.1296 + 0.0729 + 0.0081 + 0.0025 + 0.0016 + 0.0004)$

$D = 1 / 0.2475$

$D = 4.04$

$D = 4.04$ = greater diversity

PHOTOGRAPHS



SAMPLING AND PROCESSING

In teams of two, students collect samples at two assigned locations. Most locations are sampled by two teams. Students sample leaf litter and the upper one or two centimeters of soil at each assigned location. They note the weather conditions, participants in the class, team members, soil sample numbers, and other items of interest during the sampling work.

Back in the lab, students construct a Berlese funnel from the available supplies. We use a killing jar filled with 70% ethanol to collect the soil animals. During the first lab period, they begin processing their first sample. Each sample should be processed for 24 hours. During the week, they monitor their samples and change to the second sample.

They can begin identifying organisms as soon as the first sample is completely processed. They use a binocular microscope to locate, identify and count the organisms. They compete to count the largest number of individuals and of different organisms in their samples. They calculate an index of diversity for their samples. Each team posts their results on the chalkboard.

Individual students write their own lab reports. They write about their own samples in detail, and use the class results as a background for comparison.

FUTURE ADDITIONS

Use of a scale in the photographs would be helpful. I would like to add a component that involves processing to retrieve nematodes.

REFERENCES

Ingham, Elaine R., Andrew R. Moldenke, and Clive A. Edwards, 2000, Soil Biology Primer, Ankeny, Iowa: Soil and Water Conservation Society. Available online at http://soils.usda.gov/sqi/concepts/soil_biology/biology.html. Printed copies of the Soil Biology Primer may be purchased at the Soil and Water Conservation Society online store at www.swcs.org.

Loynachan, Tom, Soil Biology Movies, Iowa State University Agronomy Department. Available online at <http://agron-www.agron.iastate.edu/~loynachan/mov/>.