Using Microbial Ecology to Teach Experimental Design and Sampling Methods

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Exercise 2: Student Handout
Community Structure and Organization

Introduction

Characteristics of microbial communities that require special sampling consideration have already been mentioned in the general introduction for this activity. Exercise 1 introduces the concept of diversity and one of the ways to measure it after taking samples from a simulated community. The bag community is of course unrealistic in many ways. An important feature of the bag community is the way the items could be thoroughly mixed between each sample. Of course, in nature, microbes and other organisms are arranged, clumped, partitioned, etc., based upon many factors that affect them: availability of sunlight, nutrients, and water; interaction with other organisms; presence of antagonistic compounds or conditions; oxygen level and overall atmospheric pressure; and more. Organization and arrangement of cells will also vary temporally. Temporal changes may be rapid (exponential growth and competition in a rich broth, for example) or slow (seasonal or climate-based change).

In this exercise, you will consider how sampling plans are designed to help understand communities at the level of structure and organization, as well as species composition (diversity). The instructor will guide you through the activities.

Preexercise questions for discussion and review

1. What is a diversity index and what does it measure?
2. Write the formula for Simpson's index of diversity, explain each of the variables, and also explain how the index is calculated.
3. List at least four characteristics of microbes that make the study of microbial diversity specially challenging.
4. When heading out to sample a microbial community, what factors will be important in the planning of your experimental design (brainstorming activity).
5. What is the size of the average prokaryotic cell? How do microbiologists detect and quantify prokaryotic cells? (List at least four general methods and briefly describe how they work.)

Step One
Your instructor will give you or your group a diagram of a sample microbial community. Before you see it, however (and remember that in the environment, microbes are typically invisible at the time of sampling), you will be asked to trace or draw three squares (representing sampling plots) on a transparency in a way that depicts your plan for sampling the community. With your partners, make a decision about how to lay out the squares, i.e., what sort of system or rules you will apply. Then, ask the instructor for your "community" diagram.

Step Two
Tape the transparency securely to your diagram and proceed to record data from each plot onto your data sheet. If you have a computer, data can be typed directly into the Excel spreadsheet, otherwise you will simply fill in the boxes on paper. Don't forget to indicate the name of the community you have been assigned. Note that species are given letters as names and you will have to make decisions about separation of taxa. Your instructor will explain.

Step Three
Take a few minutes to look closely at your "community" and discuss the following questions within your group. Your instructor may choose to open the discussion to the class or ask you to turn in your responses as part of your assignment.

Take a look at the way the cells and/or organisms are arranged and answer the following questions:

a. How is this community different from one that might exist in the water column of a lake, for example?

b. If you were to imagine a habitat that this simulated diagram might represent, what would it be?

c. When sampling a community of this sort, does the scale of the area of investigation matter? In what ways will it affect your sampling approach?

d. If you would take data from nine small plots instead of the three relatively large plots you just did (adding up to the same comparable area), which sampling approach do you feel would give a more realistic or accurate picture of the actual community? What are the advantages and disadvantages of each approach? Do you think each method would give the same calculated Simpson's index? Why or why not?

e. Finally, would a line transect approach be appropriate for sampling this community? Why or why not?

Step Four
Go ahead and prepare a new transparency, this time tracing or drawing nine small plots instead

of three large ones. Use the same system and rules that you used when laying out the larger plots. Proceed as before by recording plot data onto your data sheet.

Step Five
Draw three 6-inch transect lines on your third transparency. Before you do, establish rules for placement. Lay the transparency over the community and proceed to "walk" the transects, record the data for each one on your data sheet, as above.

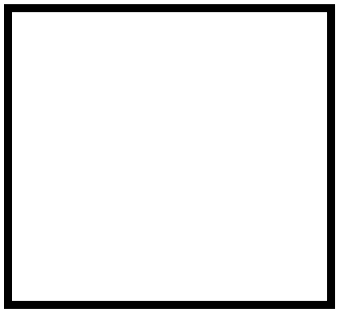
Step Six
For each of your three sets of sampling data, calculate Simpson's index of diversity. It will be helpful to use the Excel spreadsheet on your computer as a starting point. Do you obtain the same index using each of the sampling approaches? If there are differences, explain possible reasons why this occurred.

Wrap-Up and Class Discussion

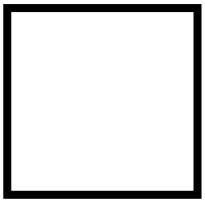
Based on your findings, which sampling approach was more satisfactory in describing the actual community composition and structure? Note, Simpson's index alone does not describe structure and organization.

Sampling plots to trace

For three large plots



For nine smaller plots



For line transect: