STREAM MACROFAUNAL COMMUNITIES

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PURPOSE

We will examine the communities and populations of aquatic macroinvertebrates (i.e. invertebrates visible to the eye) and small vertebrates (primarily small fish) that live in two similar freshwater streams in order to determine how the communities of these streams are similar or differ from each other. We will relate the differences in the chemistry of these streams (determined in our last investigation) to any observed differences in the communities.

DESCRIPTION

Stream macrofauna are collected using a sampling technique called the kick sample, where stream sediments (e.g. gravel, leaves) in front of a net are kicked in order to carry aquatic organisms from the sediments downstream into the net. By standardizing the time over which the sample is collected, it is possible to collect samples that can be compared among streams.

Comparisons are made by counting all organisms found within samples and sorting them into major taxonomic group. From these data, the communities of the two streams can be characterized in terms of community composition, taxonomic richness and relative population levels. The prevalence or rarity of taxonomic groups within samples can be related to characteristics of streams, such as substrate (soil or rock) type, stream flow rate, and water chemistry.

THEORY

Certain types of aquatic organisms are associated with certain types of stream conditions. An examination of stream taxa can tell us much about the nature of a stream, including whether the stream is suffering from pollution. For example, high populations of mayflies and stoneflies are generally associated with clean, stony, fast-moving streams with high levels of dissolved oxygen. Mosquito, midge, and certain types of beetle larvae are often more associated with less clean, slower moving streams with lower oxygen levels. Certain types of caddisflies are often found associated with leaves that accumulate at the bottom of streams, and worms and leeches may be found more commonly in muddy or low oxygen areas.

Macrofaunal communities may differ in taxonomic composition, taxonomic richness and population densities of component taxa. In stressed communities, taxonomic richness is often reduced and communities tend to be dominated by a few abundant taxa. In clean water environments, community richness is often great and individuals tend to be more evenly distributed among the taxa. Taxonomic richness and the evenness of population distribution are the components of what traditionally has been called species diversity.

METHODS

Kick samples are gathered by placing an aquatic dip net just downstream from a sampling point. Rocks and other materials in front of the net are then kicked sideways (not toward the net) in an attempt to dislodge aquatic organisms living among them. This is done for a set length of time, generally 30 seconds. At each river sampled, five kick samples are collected from locations that are at least 10 m apart. The contents of each kick sample plus some stream water (to provide water-dwelling organisms with an oxygen-containing environment) are placed in a plastic bucket and brought into the laboratory for analysis.

ANALYSIS

Laboratory analysis consists of placing several teaspoons of the sample at a time into a white plastic tray and picking out with forceps the aquatic organisms present. Once separated from the sample, the organisms are sorted into major taxonomic groups (generally class or order, depending on the type of organism) and counted. Pictoral keys will be provided in order to facilitate identification. Sorting provides a measure of community composition and

counts provide information on relative population levels (although, to be sure, there can be considerable variance in sampling results even within one stream system). Data are recorded on the attached tally sheet.
Once data are tallied, compute taxonomic richness for each river. Its value may be determined by developing an EXCEL spreadsheet in which column A lists the taxonomic categories, column B lists the numbers of organisms found in one river, and column C lists the organisms found in the other river. Click in a space below the population counts in columns B and C, choose FUNCTION from the drop down menus, choose COUNT, and then highlight all the values in the column. Pressing ENTER returns the number of taxa in the column.

Community evenness may be computed with the coefficient of variation (CV), which is defined as the standard deviation of the sample divided by its mean. It provides a measure of how variable populations within a river are.

To compute the mean, click on a space below columns B and C into which the value is to be calculated. Choose FUNCTION from the drop down menus, choose AVERAGE, and then highlight the values in the column. Press ENTER to return the mean. Similarly, in the row below this one, compute the standard deviation by choosing FUNCTION from the drop down menus, choosing STDDEV, and then highlighting the values in the column. Pressing ENTER returns the standard deviation. We will also compute the sum of each column for use later in diversity calculations using this same approach. In this case, choose SUM fromthe FUNCT ION list.

In the row below the standard deviation calculation, compute the coefficient of variation. Click in the space below the standard deviation, press = to turn on the function feature, click on the value for STDDEV, press /, and click on the value for MEAN. Pressing ENTER returns the coefficient of variation. A larger number indicates greater variability among the taxa in terms of their populations (the populations are less evenly distributed among the taxa) and a smaller number indicates less variation (the populations are more evenly distributed among the taxa). The completed spreadsheet should look approximately like this:

A	B	C
	Blackstone River	Mumford River
Worm	55	23
Leech	23	34
Snail	2	22
Clam	1	21
Sowbug	1	11
Crustacea		3
Stonefly		5
Mayfly		17
Dragonfly		3
Bugs		1
Alderfly		1
Fly		1
Sum	82	142
Richness	5	12
Mean	16.4	11.83333333
Std. Dev.	23.53295562	11.22362227
Coeff. Variation	1.434936318	0.948475122

Although ecologists have largely abandoned the concept of species diversity (it loses information by making one metric of taxonomic richness and evenness and can produce results of ambiguous meaning), the following formula based on Shannon and Weaver's information theory still has some utility:

$$H' = -\sum_{i=1}^{S}(p_i \ln p_i),$$

where H’ is the index of diversity, p_i is the proportion of individuals of taxon *i*, and S is the total number of taxa in the community. Information theory examines how individuals and taxa are encountered during a random walk across a landscape.

To compute H’, extend the above spreadsheet to have a column D in which the proportion of individuals / taxon in one stream are computed (number of individuals of taxon *i* / sum of individuals in the community) and column E in which the proportion of individuals / taxon in the other stream are computed. In column F, compute the natural log of column D and in column G do the same for column E. In column H multiply column D by column F and in column I multiply column E by column G. The negative sum of columns H and I is H’ for each stream. If you are familiar with making EXCEL cell formulas, you may to develop a more sophisticated formula at the bottoms of columns B and C that will also compute H’. There are also various diversity calculators available via the intemet that you may wish to use to verify the correctness of your calculations. The expanded spreadsheet should look like the following:

A	B	C	D	E	F	G	H	I
	Blackstone River	Mumford River	P Blackstone	P Mumford	ln P Blackstone	ln P Mumford	pi ln pi Blackstone	pi ln pi Mumford
Worm	55	23	0.670731707	0.2804878	-0.399386062	-1.27122503	-0.267880895	-0.356563119
Leech	23	34	0.280487805	0.4146341	-1.271225031	-0.88035872	-0.356563119	-0.365026787
Snail	2	22	0.024390244	0.2682927	-3.713572067	-1.31567679	-0.090574928	-0.352986457
Clam	1	21	0.012195122	0.2560976	-4.406719247	-1.36219681	-0.053740479	-0.34885528
Sowbug	1	11	0.012195122	0.1341463	-4.406719247	-2.00882397	-0.053740479	-0.269476387
Crustacea		3		0.0365854		-3.30810696		-0.121028303
Stonefly		5		0.0609756		-2.79728133		-0.170565935
Mayfly		17		0.2073171		-1.5735059		-0.326214638
Dragonfly		3		0.0365854		-3.30810696		-0.121028303
Bugs		1		0.0121951		-4.40671925		-0.053740479
Alderfly		1		0.0121951		-4.40671925		-0.053740479
Fly		1		0.0121951		-4.40671925		-0.053740479
Sum	82	142						
Richness	5	12						
Mean	16.4	11.83333333						
Std. Dev.	23.53295562	11.22362227						
Coeff. Variation	1.434936318	0.948475122						
H'							0.8224999	2.592966646

INTERPRETATION

Be sure to address the following as you prepare your report:

1. Compare the species composition of the two streams. How do they differ?

2. Compare the populations of the organisms in samples from the two streams. How do they differ? Are any particular taxa particularly abundant in one stream compared to the other?

3. How do data from previous investigations into the chemistry of the water of these two streams relate to the types of organisms found? Are any of the taxa associated with particular types of chemical environments? As you answer, keep in mind particularly river nitrate, phosphate, dissolved oxygen, percent oxygen saturation, biological oxygen demand, turbidity, pH, conductivity and fecal coliform tests.

4 What factors other than differences in water chemistry might account for differences found between the samples? Were the substrates sampled exactly the same in the two streams?

5. What do you notice about the community parameters of these streams? Are there differences in the species richness and evenness of the communities of the two streams? How might these be explained in light of differences in the chemistry of the two rivers?

6. How do the diversity values compare with the values computed for diversity's components- richness and evenness? Did computing species diversity add to your understanding of the community relationships of these streams? Explain.

7. Suppose you sampled the same stream on two separate days and found that the species composition and numbers of individuals of organisms within taxa varied dramatically between days. How would this affect how you interpret your results? How could you design an experiment that better characterized the sampling variance in the data so that underlying community differences between streams could be distinguished from "background noise?"

8. Suppose you sampled each of the two streams each day for 10 consecutive days and then recorded separately the community composition in each sample. This would give you 10 measures of taxonomic richness and populations for each stream. Outline the design of such a study and identify the sources of experimental variance that the study permits you to characterize. Could you use this information to identify significant community differences between streams in light of sampling variance? How?

AQUATIC MACROFAUNA

DATA SHEET

Date collected ____ Collector _________________________________

Group	Blackstone River	Mumford River
Worm (Oligochaeta)		
Leech (Hirundinea)		
Snail (Gastropoda)		
Clam (Pelecypoda)		
Sowbug (Isopoda)		
Crayfish/ Amphipods (Crustacea)		
Stonefly (Plecoptera)		
Dragonfly/ Damselfly (Odonata)		
Alderfly/ Dobsonfly (Megaloptera)		
True Bugs (Hemiptera)		
Midges (Chironomidae)		
Other Fly Larvae (Diptera)		
Beetles (Coleoptera)		
Caddisfly (Trichoptera)		
Mayfly (Ephemeroptera)		
Fish (Osteicthes)		