Lab 8. AQUATIC MACROINVERTEBRATE COMMUNITY STRUCTURE

A. Objectives

The objectives for this laboratory are to determine stream inputs and characteristics by examining the community composition and structure of aquatic macroinvertebrates at sites on King’s Creek and Little Kitten Creek.

B. Background

Streams (lotic systems) are characterized by a wide variety of substrates, nutrient inputs, and pollution levels. Smaller order streams may also experience seasonal and spatial fluctuations in water levels. All of these variables may influence the ability of aquatic organisms to persist. As you may be amazed to find out, aquatic macroinvertebrates are adapted in a number of ingenious ways to take advantage of this heterogeneous stream environment. Benthic macroinvertebrates are defined as invertebrates larger than 500 micrometers that are associated with stream channel substrate (bedrock, cobble, finer sediments) or with stable objects (fallen trees, limbs, or roots) within the stream. One way to categorize aquatic macroinvertebrates is based on their feeding strategy. The following groupings were proposed by Cummins and Wilzbach (1985):

Scrapers – animals adapted to graze or scrape materials from the substrate;
Shredders – animals that break down large pieces of litter to smaller pieces;
Collectors/Gatherers - animals that feed mainly on fine particulate organic matter (FPOM); Filterers - animals with special structures that can remove particulate matter from suspension; and Predators – organisms that feed on animal tissue. (See Table 12.1 for further detail)

Aquatic macroinvertebrates can also be used as biocriteria for stream quality when grouped according to pollution tolerance. Organisms have a wide variety of tolerances for changes in environmental parameters. Some are able to tolerate a wide range of conditions, while others have a smaller niche breadth and are able to persist only when conditions stay within a narrow range. In the case of benthic macroinvertebrates, different taxa have varying tolerances for pollution-induced changes in water chemistry, pH, and turbidity. Based on these tolerances macroinvertebrates can be grouped into three broad categories based on their ability to tolerate stream pollution (KDWP Stream Monitoring Program Field Manual). In addition to this basic grouping there are many other indices used to relate macroinvertebrate community structure to stream quality, for further detail consult Stagliano (2001) and Barbour et al (1999).

When determining the types of aquatic macroinvertebrates that may be present in a stream system it is necessary to understand the inputs and habitat structure available. For example, consider a grassland system vs. a forested system (Vannote et al. 1980, Wiley et al. 1990). In a grassland system the upper stream reaches lack riparian vegetation, are warmer, and have plenty of available light. Therefore, grazers and collectors would be expected to be the dominant functional groups. Further down the stream in the lower reaches, riparian vegetation is present, which shades the stream and
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cools the water temperatures. Inputs from the riparian vegetation create an environment where shredders and collectors dominate the community.

In forest systems, the relationships are reversed as the upper reaches (stream orders 1-3) are cooler and shaded by riparian vegetation while the lower reaches (stream orders 4-6) are slower, warmer, and not shaded. So, in the upper reaches most of the available energy is from external sources, and shredders and collectors dominate due to the increased presence of organic matter. In the lower reaches, the stream is not as shaded and receives less external inputs so grazers and collectors become more dominant.

C. Procedures

Study sites at Little Kitten Creek and King’s Creek will be used to compare aquatic macroinvertebrate communities. By assessing the composition of the macroinvertebrate community at the site it will be possible to understand more about the habitat characteristics, nutrient inputs, and water quality of the area. When collecting and interpreting data keep in mind the differing inputs into the two streams. King’s Creek is a second order stream located within the 1,067-hectare King’s Creek watershed. Its upper drainage basin is entirely contained within an undisturbed area of tallgrass prairie. Little Kitten Creek is a third order stream and is located within the Little Kitten Creek watershed (558 hectares). This watershed drains areas of Colbert Hills Golf Course and parts of residential Manhattan before joining with Wildcat Creek.

1. Field Methods

Samples will be collected using kick-net sampling.

Kick-net operation manual:
1. Working in teams of 2-3 position the opening of the net against the current.
2. Lower the net into the water.
3. While one person holds the net, the other two kick up rocks / sediment from the stream bottom in order to stir up any invertebrates present and flush them into the net.
4. After kick-netting is successfully completed, remove the net from the water and remove macroinvertebrates from the net into a shallow pan.
5. Classify organisms into functional groupings and pollution tolerance groupings.
2. Calculations

Use the following formulas to calculate the characteristics of the two streams based on functional feeding group ratios.

Functional feeding group ratios characterizing different ecosystem parameters and characteristics (Merrit and Cummins 1996)

<table>
<thead>
<tr>
<th>Ecosystem parameters</th>
<th>Functional feeding Group ratios</th>
<th>Ratio level</th>
<th>Stream evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autotrophic / Heterotrophic</td>
<td>Scrappers/ (Shredders+Collectors)</td>
<td>Autotrophic &gt; .75</td>
<td>Depends on autochthonous inputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heterotrophic &lt; .75</td>
<td>Depends on allochthonous Inputs</td>
</tr>
<tr>
<td>CPOM / FPOM</td>
<td>Shredders / Collectors</td>
<td>In a functioning riparian ecosystem, ratio is &gt; .25</td>
<td>Depends on slow litter processing rate</td>
</tr>
<tr>
<td>Predator/Prey Ratio</td>
<td>Predators / Total of all other groups</td>
<td>Normal predator to prey balance is &lt; 0.15</td>
<td>Typical predator/prey ratio</td>
</tr>
</tbody>
</table>

Use the pollution tolerance groupings on Table 12.2 to classify organisms into the categories of Group I (very sensitive to pollution), Group II (somewhat pollution tolerant) and Group III (able to tolerate pollution). In order to calculate a rating for the stream, use the following formula (KDWP: Stream Monitoring Program Field Manual):

\[
\{(\text{Total # of Group I taxa)} \times 3\} + \{(\text{Total # of Group II taxa)} \times 2\} + \{(\text{Total # of Group I taxa)} \times 1\} = \text{Stream Quality Rating}
\]

By measuring stream quality ratings over time it may be possible to compare the relative quality of various waterways.

D. Points to Consider:

Based on the trophic ratios calculated above, is there any difference in the communities found at Wildcat Creek and King’s Creek?
Based on the pollution tolerance groupings, is there any difference in the communities found at Wildcat Creek and King’s Creek?

What stream inputs might be responsible for determining the composition of the macroinvertebrate communities at each site?
Table 12.1

Functional feeding group classification
(Cummins and Wilzbach 1985, Merritt and Cummins 1996)

<table>
<thead>
<tr>
<th>Functional Group</th>
<th>Dominant Food Resource</th>
<th>Feeding mechanism</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrapers</td>
<td>Periphyton – attached algae (diatoms) and other material growing on substrates</td>
<td>Herbivores – grazing scrapers</td>
<td>Trichoptera, Coleoptera, Ephemeroptera</td>
</tr>
<tr>
<td>Shredders</td>
<td>Living plant tissue</td>
<td>Herbivores – chewers, miners</td>
<td>Diptera, Coleoptera</td>
</tr>
<tr>
<td></td>
<td>Coarse particulate organic matter (CPOM)</td>
<td>Detritivores – chewers, borers, gougers</td>
<td>Trichoptera, Tipulidae, Plecoptera, Crayfish</td>
</tr>
<tr>
<td>Collectors/Filterers</td>
<td>Decomposing fine particulate organic matter (FPOM)</td>
<td>Detritivores – gatherers, deposit feeders, Detritivores – filterers, suspension feeders</td>
<td>Trichoptera, Diptera, Ephemeroptera, Diptera, Chironomidae</td>
</tr>
<tr>
<td>Predators</td>
<td>Prey – Other invertebrates</td>
<td>Carnivores – attack prey, pierce tissues and cells, suck fluids</td>
<td>Odonata, Plecoptera, Megaloptera</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carnivores – ingest whole (or parts of) other organisms</td>
<td></td>
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</tbody>
</table>
Table 12.2

Macroinvertebrate tolerance groupings

Group I (Sensitive to pollution, found in high quality waters):
Trichoptera (caddis fly)
Megaloptera, Corydalus (hellgrammite)
Ephemeroptera (mayfly)
Gastropoda (gilled snail)
Coleoptera, Elmidae (riffle beetle)
Plecoptera (stonefly)

Group II (Somewhat tolerant of pollution):
Coleoptera (other beetles)
Pelecypoda (clams or mussels)
Pisididae (fingernail clams)
Turbillaria (flatworms or planaria)
Diptera, Tipulidae (cranefly)
Crustacea (crayfish, scud, sowbug)
Hemiptera (water boatmen, backswimmer, toe biter, water strider)
Odonata (dragonfly, damselfly)
Megaloptera, Chauliodes & Sialidae (fishfly, alderfly)

Group III (Able to tolerate pollution):
Oligochaeta (worms)
Diptera, Simulidae (blackfly)
Hirudinea (leech)
Diptera, Chironomidae (midge, bloodworm)
Gastropoda (pouch and other snails)
Related References:


