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A BIOTIC INDEX OF MACROINVERTEBRATES IN A RELATIVELY HIGH QUALITY SPRING AND A MORE POLLUTED STREAM

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ABSTRACT

We compared the types of macroinvertebrates found in a high quality spring and a more polluted stream. The higher quality spring had higher densities of macroinvertebrates and more stress sensitive species than the more polluted stream. In particular, the higher quality spring contained three taxa of stoneflies (Plecoptera), which as a group are very sensitive to pollution stress, whereas none were present in the more polluted spring.

Keywords: biotic index, macroinvertebrates, pollution, springs and streams, stress tolerance

INTRODUCTION

Springs and streams are important habitats for macroinvertebrates. In biomonitoring studies, invertebrates are used more often than any other group of freshwater organisms to assess the health of aquatic environments because of their wide range of stress tolerance. The diversity and abundance of macroinvertebrates depends on water quality. Macroinvertebrates tend to be more abundant and sensitive to stress in higher quality streams than in more polluted streams (Voshell, 2002). To calculate a biotic index of water quality, macroinvertebrate abundance and composition were estimated at two streams in Huntingdon County, Pennsylvania. Muddy Run is exposed to human litter and road pollution, whereas an unnamed spring near the Raystown Field Station (Juniata College) is apparently not subjected to pollution. We predicted that Muddy Run, the more polluted stream, would have fewer, less abundant taxa of macroinvertebrates than the more pristine spring. We also predicted that the spring should have a higher biotic index, including more stress sensitive species.

SITE DESCRIPTIONS

Muddy Run is a stream that runs through Juniata College Campus and the backyards of many Huntingdon properties. This exposes it to more human pollution in the form of human litter and road/yard runoff. The streamside environment of Muddy Run is open with a few shrubs and trees.

The unnamed spring is located at the 0.4-mile point of the paved road portion of the main entrance to the Raystown Field Station property of Juniata College. This is a private forested area and is not traveled frequently. We sampled from the right hand side of this spring brook approximately 50 yards from the road.

The water temperature, pH and flow rate of each spring are indicated in Table 1. Water temperature was measured with a thermometer, pH with a Markson pH Meter, and flow rate was determined using a float, meter stick and stopwatch.

Table 2. Chemical and physical factors in Muddy Run and an unnamed spring at the Raystown Field Station on April 16, 2003.

Spring	pH	Temperature (F)	Flow rate	Mean width (m)	Mean depth (in)
Muddy Run	7.84	50.3	1m/15sec	2.8	5.7
Field Station	6.3	56.6	1m/5sec	1	2.2

METHODS AND MATERIALS

All sampling was carried out on April 16, 2003. Along a 30-m section of each stream, a random biotic sample was taken within each 1-m interval. Each sample was collected for 5 seconds in a 935-cm^3 net after stirring up the substrate. Macroinvertebrates from each sample were taken to the lab where they were counted and identified by order and family using taxonomic keys. Each taxon was classified according to their stress tolerance (following Voshell 2002).

A Mann-Whitney U test was used to compare mean densities of macroinvertebrates between the two streams. Simpson's Diversity Index was also calculated for each macroinvertebrate assemblage, as follows:

$$D = 1/\sum_{i=1}^{S} P_i^2,$$

where S = taxic richness, and P = the proportion of the total number of individuals in the assemblage that belong to the i^{th} taxon.

RESULTS

Compared to Muddy Run, the Field Station spring had three times the total abundance of macroinvertebrates and a greater average abundance per sample (Table 1). The field station spring also contained many more stress-sensitive taxa (7 versus 4 sensitive and very sensitive), whereas Muddy run had more stress-tolerant taxa (6 versus 3 moderately tolerant and very tolerant).

Muddy Run and the Field Station spring had nearly identical Simpson's diversity indices of 5.0693 and 5.0679, respectively. However, the Field Station spring had significantly higher densities of macroinvertebrates than that of Muddy Run (U = 667.0; P = 0.0003; based on 30 samples from each stream).

Table 1. Numbers of animals of various macroinvertebrate taxa collected at Muddy Run and the Field Station spring.

			Muddy Run	Field Station
Stress Tolerance	**Common Name**	**Taxon**		
moderate tolerance	leech	Annelida Hirudinae	8	0
very tolerant	segmented worm	Annelida Oligochaeta	0	2
sensitive	snail	Gastropoda Planorbidae	1	0

moderate tolerance	pea clam	Bivalvia Sphaeriidae	1	0
moderate tolerance	crayfish	Decapoda Cambaridae	0	3
tolerant	pill bug	Isopoda Asellidae	4	0
tolerant	water beetle	Coleoptera Haliplidae	4	1
very sensitive	mayfly	Ephemeroptera Ameletidae	10	32
sensitive	mayfly	Ephemeroptera Ephemerellidae	0	10
sensitive	mayfly	Ephemeroptera Potamanthidae	0	6
very sensitive	stonefly	Plecoptera Chloroperlidae	0	3
very sensitive	stonefly	Plecoptera Leuctridae	0	1
very sensitive	stonefly	Plecoptera Perlodidae	0	20
very sensitive	caddisfly	Tricoptera Glossosomatidae	1	0
very sensitive	caddisfly	Tricoptera Rhyacophilidae	0	7
tolerant	alderfly	Megaloptera Sialidae	1	0
varies in extremes	midge fly	Diptera Chironomidae	0	1
sensitive	dragon fly	Odonata Aeshnidae	1	0
very tolerant	dragon fly	Odonata Libellulidae	1	0
varies in extremes	crane fly	Diptera Tipulidae	0	5
		Total abundance	**32**	**91**
		Number of Taxon	**10**	**12**
		Average Abundance per sample	**1**	**3**

DISCUSSION

Although Muddy Run and the Field Station spring had similar taxic diversities, they differed in macroinvertebrate abundance and taxic composition. As predicted, the polluted stream Muddy Run had lower densities of macroinvertebrates and more stress-tolerant taxa, such as leeches. As expected, the unpolluted Field Station spring also had more stress-sensitive taxa. Thus, biotic indices based on the variety and abundance of macroinvertebrates appear to be useful in determining the water quality of a stream.

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LITERATURE CITED

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