Journal of Ecological Research, 2, 61-63 (2000)

EFFECTS OF MOISTURE AND NITRATE LEVELS ON SOIL INVERTEBRATES IN THE MAPLE GROVE OF THE RAYSTOWN FIELD STATION

Cara J. Kelly

ABSTRACT

I investigated the effect of elevation and soil moisture on the distribution of soil macrofauna at the Raystown Field Station. I compared macrofauna densities, along with soil nitrate levels and percent moisture between Upper and Lower regions. I found the mean number of macrofauna, along with species richness, to be significantly higher in the Lower regions. Of the five most common occurring species tested, only julids were significantly more abundant in the Lower grove than in the Upper grove. The percent of moisture in the soil of the Lower grove was significantly greater than that in the Upper grove soil, while no significant difference existed in nitrate levels between the regions. These findings show that elevation affects soil invertebrate distribution as well as percent soil moisture.

INTRODUCTION

According to Connelly (unpublished), the distribution of macrofauna within the maple grove of the Raystown Field Station is unevenly distributed. Several factors are known to affect soil macrofauna distribution, including food diversity and abundance, variability of vegetation, and percent moisture (McBrayer et al., 1977). To investigate the factors contributing to distribution in the sugar grove, I determined how macrofauna richness and abundance, soil nitrate levels, and percent moisture varied with elevation. I hypothesized that high and low elevations would contain different levels of: 1) macroinvertebrate distribution, 2) soil nitrate concentrations, and 3) percent soil moisture.

METHODS AND MATERIALS

I conducted my study in the sugar maple grove of the Juniata College Raystown Field Station (Entriken Quadrangle N40° 21'29'' W78° 9'01'), located in Huntingdon County, Pennsylvania. A small intermittent stream bed runs through the foot of the ridge on which the grove is located, and overstory vegetation consists mainly of sugar maple trees (*Acer saccharum*), along with a scattering of oaks (*Quercus* sp.) and Virginia pines (*Pinus virginiana*).

I divided the grove into two regions, Upper (>880ft) and Lower (<840ft) elevations. I randomly selected ten study sites from each region, which consisted of a mixture of both pine boards and asphalt shingles. The boards and shingles were randomly placed in 1997 as part of a previous study (Kelly &

Wolf, unpublished). On two different dates, I recorded the number and species of macrofauna under each of the twenty sites.

I collected soil adjacent to the boards/shingles within 6 centimeters, and stored each soil sample in a plastic bag. Samples were kept in a cooling unit prior to analysis in order to preserve the nitrates. I weighed half of each sample to obtain a wet weight, and then dried each to a constant mass, obtaining a dry weight. Subtracting the two weights provided the percent moisture in each sample. I then calculated the amount of moisture (in grams) per ten grams of each sample, which I used as a correction factor in order to determine ten grams of each fresh sample. I extracted nitrates from the soil and measured nitrate levels in each sample by using a cadmium reduction method (Hach, 1992).

I compared macrofauna richness, percent moisture, and nitrate levels between the top and bottom of the grove using a Two-sample t-test (Heath, 1995). I also compared the number of macrofauna in the Upper grove to that of the Lower, as well as the five most abundant species using a Mann Whitney Confidence Interval (Heath, 1995). For all tests, I set $\alpha = 0.05$, and considered differences to be significant if $p < 0.05$.

RESULTS

The Lower grove had significantly greater diversity (4.95) than the Upper (2.55), (t=3.75, df=18, p=0.0018)(Table 1). Also, I found a greater number of macrofauna overall in the Lower region (10.00) than in the Upper region (5.50), (w=140.0, df=18, p=0.0088). Of the five most common occurring species, only julids were significantly more abundant in the Lower grove (3.25) than in the Upper grove (0.00), (w=144.0, df=18, p=0.0029). The Lower region contained a greater percent of moisture in the soil (19.10%) than the Upper (8.30%), (t=-6, df=18, p=0.0001). There was no significant difference in nitrate levels between the Lower (1.45) and Upper (1.197) regions, (t= -0.47, df=18, p=0.64).

Table 1. Type and number of fauna, pooled between two samples, found in the Upper and Lower Regions of the grove.

	Top of grove	Bottom of grove
Isopods	1	11
Lithobiids	6	7
Cryptopsids	2	2
Millipedes	0	1
Julids	15	154
Snails	1	3
Lycosid spiders	2	3
Crab spiders	0	2
Small spiders	6	10
Spring tails	18	19
Wood roaches	17	22
Crickets	1	2
Beetles	0	4
Ants	12	18

DISCUSSION

I found that while macrofauna diversity varied with elevation, it was unaffected by soil nitrate levels. Thus, nitrates are not a direct factor contributing to the greater species richness and greater overall

number of macrofauna found in the bottom of the grove. However, according to Ohtonen et al. (1997), nitrates govern distribution indirectly. Macrofauna, mainly arthropods, contribute to nutrient cycling by breaking down organic matter through comminution and dissemination (Moore, 1987). Comminution involves digestion of organic substrates, while dissemination involves digestion of microbial organisms. Through these processes, arthropods put inorganic nutrients (including nitrates) back into the soil, which are readily taken up by plants. The plants are beneficial to microbe biomass, which supply the arthropods with a food source (Ohtonen et al., 1997). Perhaps measuring nitrate levels in plants would more accurately represent the levels within the grove's regions.

Another factor affecting the density of macroinvertebrates is the productivity of leaf litter (McBrayer et al., 1977). While pervious studies reported that the number of macroinvertebrates present determined litter productivity (Edwards et al., 1970), McBrayer et al. shows that litter production determines and directly correlates with macrofauna densities.

Unlike nitrate levels, percent moisture varied with elevation. In addition, elevation showed similar affects on moisture levels and macrofauna abundance, indicating that soil moisture may influence macrofauna densities. Although I did not investigate a correlation between these two variables, studies have shown that macrofauna abundance is directly correlated to percent soil moisture. Evidence shows that many soil inhabitants descended from aquatic ancestors (Schaller, 1968), and thus are vulnerable to desiccation. While macrofauna eat what the ground provides, i.e. leaves, fungi, and roots, they favor food conditioned, or softened, by water (Schaller, 1968).

Further recommended studies to investigate factors governing macrofauna distribution and abundance in the maple grove include testing nitrates in surrounding plants, as previously discussed, along with correlating the abundance of plants with that of macrofauna. In addition, since variation of nitrate levels within the regions could have affected my results, one could test each of the twenty sites for a correlation between macrofauna abundance and nitrate levels. Other correlation tests could include leaf litter production versus macrofauna density and organic content of the soil versus macrofauna density.

ACKNOWLEDGMENTS

I thank Chuck Yohn, my advisor, for all his help and support, and Dr. Douglas Glazier for his previous research, which made this study possible.

LITERATURE CITED

Hach Water Analysis Handbook: 2nd Edition. 1992. Hach Co., Loveland, pp. 412- 413.

Heath, David. 1995. An introduction to experimental design and statistics for biology. UCL Press, University of Essex, England.

McBrayer, J.F., J.M. Ferris, L.J. Metz, C.S. Gist, B.W. Cornaby, Y. Kitazawa, T. Kitazawa, G.W. Krantz, and H. Jensen. 1977. Decomposer invertebrate populations in the U.S. forest biomes. Pedobiologia. **17**: 89-96.

Moore, J.C. 1987. The influence of microarthropods on symbiotic and non-symbiotic mutualisms in detrital-based below-ground food webs. Agricultural Ecosystems an Environments **24**: 147-159.

Schaller, F. 1968. Soil animals. University of Michigan Press, Ann Arbor, Michigan, USA.