ESSAI

Volume 8 Article 22

4-1-2011

Factors that Affect the Make-up of Soil Invertebrate Community

Tim Kamin
College of DuPage

Factors that Affect the Make-up of Soil Invertebrate Community

by Tim Kamin

(Biology 2150)

ABSTRACT

Soil invertebrates play essential roles in regulating ecological processes of nutrient cycling and energy flow in ecosystems. This study investigated factors that affect soil invertebrate's assemblage structure. Seven different habitats in Northern Illinois were observed with soil samples taken from each location. Soil pH levels, moisture, temperature, and organic content were taken along with a log of organisms found in each habitat. Ordinated microinvertebrate assemblages were tested for correlation to the physical factors. Factors most important in determining community structure were soil moisture soil moisture followed by fraction organic matter.

INTRODUCTION

Soil organisms are fundamental components of soils playing a key role in many essential processes that are not directly visible to the human eye. Such processes are decomposition, nutrient cycling, and development of soil structure and aggregation (Barral and Paradelo 2009). Soil invertebrates make up a large portion of soil fauna. Soil serves as a refuge to these organisms buffering them from atmospheric extremes such as temperature, moisture, light, and wind (Ekesi and Maniania 2003, Fell and Scorzetti 2006, Gongalsky and Persson 2008, Hulugalle and Braun 1997, Salmon and Artuso 2008).

Soil temperature and moisture can affect the survivorship and fecundity of microorganism in different ways. Moderate soil moisture (3 mL) and temperature (20^{o}) has been shown to be the most suitable environment for maximal survivorship in soil invertebrates such as earthworms. Likewise, these moderate moistures and temperatures can depress aerobic metabolism (Diehl and Presley 1996). Soil temperatures above 20^{o}C depress the growth rate of invertebrate communities (Ekesi and Maniania 2003). Earthworms are especially important because they are ecosystem engineers through their roles in promoting soil quality but are affected by climate change greatly, most notably by the change in soil temperature and moisture (Eggleton and Inward 2009). Termites are major soil engineers in tropical areas where they affect soil structural stability against water flux (Jouquet and Dauber 2006). These invertebrates are dependent on organic soil content upon which they feed.

In the following study, soil factors were investigated that affected the assemblages of macroinvertebrates in different habitats in Northern Illinois.

METHODS

The studied habitats were located on main campus of College of DuPage, IL. The College maintains over 15 habitats of naturalized areas, to include reconstructed tallgrass prairie and 2 habitats of woodland. The habitats were a reconstructed prairie, vermiform composting bin, woods, old field, wood chips, and a nest of *Acanthoymyops claviger* in the prairie. Reconstruction of the prairie began in 1986. The dominant prairie flora are big bluestem (*Andropogon gerardii* Vitman), Indian grass (*Sorghastrum nutans* (L.) Nash), and prairie dropseed (*Sporobolus heterolepis* Gray). Historically, the prairie has been burned annually. Much of the college campus consists of ornamental and mowed lawn. Soil samples were randomly selected after the sites of habitats were determined. The soil samples were taken in March 2010. Soil invertebrates were extracted using a Tullgren Funnel and identified based on morphotype.

Physical measurements of soil from the habitats were also taken at the time of invertebrate sampling. An Aquaterr Temp-200 meter (Aquaterr Instruments, Costa Mesa, CA) was used to take soil moisture measurements and temperatures at 10-cm depth. Organic content was determined by soil samples at 10-cm depth, oven drying the soil to a constant weight at 70^{o}C, and then burning at 600^{o}C for 6 hours within a muffle furnace.

Correspondence analysis was used to summarize the biotic data from the sample sites along a two-dimensional plane. The coordinates of each of the first two axes, which represented the sample sites, were then tested for correlations with the physical measurements as to infer causal relationships.

RESULTS AND DISCUSSION

Table 1 shows the number of soil invertebrates found in each particular habitat. The vermiform composting bin produced the greatest number of organisms found with white mites and podurid species making most of the collection. Table 2 provides the X and Y axes of correspondence analysis, and the physical measurements taken from the soil. Habitats with similar moisture percentages were the prairie, vermiform, woods, field, and lawn where the wood chips and nest separately shared similar moisture levels. The temperature between habitats was similar except the wood chips where the temperature there was greater. Table 3 shows the product moment correlation coefficients of axes of correspondence analysis and physical measurements of the soil.

Soil moisture and temperature had the greatest affect followed by organic content as suggested by correlation analysis. The former factors indicated the importance of these factors and that they were not predictable based on previous studies. The link of soil organic matter may reflect the importance of the food source of the macro fauna.

The wood chip community and *Acanthoymyops claviger* nest habitats varied the greatest between the other habitats. The soil moisture of these habitats was dramatically lower than the others possibly because these sites were elevated and more susceptible to the effects of light and wind. The wettest sites were the shaded woods. Elevated soil temperatures in the wood chips may have been promoted by microbial activity although this was not measured.

Literatures Cited

Barral, M. T. and R. Paradelo. 2009. Effect of moisture and disaggregation on the microbial activity of soil. Soil and Tillage Research 104:317-319.

Diehl, W. J. and M. L. Presley. 1996. Soil moisture and temperature interact to affect growth, survivorship, fecundity and fitness in earthworm eisenia fetida. Comp. Biochem. Physiol 114:319-326.

Eggleton, P. and K. Inward. 2009. A six year study of earthworm populations in pasture woodland in southern England shows their response to soil temperature and moisture. Soil Biology & Biochemistry 41:1857-1865.

Ekesi, S, N. and K. Maniania. 2003. Effect of soil temperature and moisture on survival and infectivity of *Metarhizium anisopliae* to four tephritid fruit fly puaparia. Journal of Invertebrate Pathology 83: 157-167.

Fell, J. W. and G. Scorzetti. 2006. Biodiversity of micro-eukaryotes in Antarctic dry valley soils with <5% soil moisture. Soil Biology & Biochemistry 38:3107-3119.

Gongalsky, K. B. and T. Persson. 2008. Effects of soil temperature and moisture on the feeding activity of soil animals as determined by the bait-lamina test. Applied Soil Ecology 39:84-90.

Hulugalle, N. R. and L. A. Braun. 1997. Residual effects of tillage and crop rotation on soil properties, soil invertebrate numbers and nutrient uptake in an irrigated vertisol invertebrate sown to cotton. Applied Soil Ecology 7:11-30.

Jouquet, P. and J. Dauber. 2006. Soil invertebrates as ecosystem engineers: intended and accidental effects on soil and feedback loops. Applied Soil Ecology 32:153-164.

Salmon, S. and N. Artuso. 2008. Relationships between soil fauna communities and humus forms. Soil Biology & Biochemistry 40:1707-1715.

Staley, J. T. and C. J. Hodgson. 2007. Effects of summer rainfall manipulations on the abundance and vertical distribution of herbivorous soil macro-invertebrates. European Journal of Soil Biology 43:189-198.

Table 1. List of soil macroinvertebrates found according to location. Symbols: P = prairie site, A = nest of *Acanthomyops claviger* in prairie, V = vermiform composting bin, W = woods, OF = old field, and WC = wood chips.

	P	A	V	W	OF	Lawn	WC
Nematoda	0	0	0	0	5	0	0
Earthworm	0	0	0	0	0	1	0
Red worm	0	0	2	0	0	0	0
Oligochaeta	0	11	0	0	0	0	3
Spider	0	1	0	0	0	0	0
White mite	0	0	269	12	2	0	0
Brown mite	0	0	0	10	7	7	0
Orbitid mite	0	0	13	0	0	0	0
Isopod	5	0	0	10	1	0	0
Centipede	0	0	0	0	0	1	0
Millipede	0	0	0	0	1	0	0
Diplura	1	4	0	1	1	2	0
Poduridae	0	0	176	0	0	0	1
Isotomidae	0	1	0	0	0	0	0
Sminthuridae	1	0	0	2	0	2	0
Entomobyriidae	0	0	3	2	0	5	0

Table 1. Continued.

	P	A	V	W	OF	Lawn	WC
Carabidae	1	0	0	0	0	0	0
Elateridae	0	0	0	1	0	0	0
Chrysomelidae sp A	1	0	0	0	0	0	0
Chrysomelidae sp B	0	0	0	0	0	1	0
Staphylinidae	0	0	0	0	0	0	1
Chironomidae	0	0	0	0	0	0	1
Drosophilidae	2	1	0	2	0	0	0
Formicidae	1	1	0	2	0	0	0

Table 2. X and Y axes of correspondence analysis and physical measurements according to location. Symbols: P = prairie site, A = nest of *Acanthomyops claviger* in prairie, V = vermiform composting bin, W = woods, OF = old field, and WC = wood chips.

	P	A	V	W	OF	Lawn	WC
X axes	0.39	-0.48	-0.66	0.40	0.73	0.68	-1.93
Y axes	-0.60	-1.08	1.07	0.18	0.38	-0.10	-0.31
Soil pH	4	5.75	3	3.75	7.5	4	5.5
Soil moisture (%)	76	46	86	91	85	80	35
Soil temperature (C^o)	15	15.6	16.7	15.6	16.7	16.7	29.4
Fraction organic content of soil	0.09	0.08	0.87	0.10	0.13	0.09	0.49

Table 3. Product moment correlation coefficients of axes of correspondence analysis and physical measurements of the soil. * denotes significance ($P \leq 0.05$).

	Physical measurements			
	Soil pH	Soil moisture (%)	Soil temperature	Fraction organic content of soil
X axes	0.01	*0.78	*-0.81	-0.62
Y axes	-0.37	0.58	-0.08	*0.76