

MITES AND COLLEMBOLA FROM ADJACENT OVERGRAZED AND UNGRAZED PASTURES IN JACKSON COUNTY, ILLINOIS

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ABSTRACT

The mites and collembola from litter and soil samples from adjacent ungrazed and overgrazed pastures were compared. Four times as many organisms were found in the ungrazed litter samples and twice as many in the ungrazed soil samples as in the overgrazed samples. The diversity index of the ungrazed litter organisms was twice as large as that of the overgrazed litter organisms. Cold weather greatly reduced litter Cryptostigmatidae and soil Smythuridae populations.

INTRODUCTION

The effects of overgrazing on pasture soil and vegetation have been widely studied but little examination has been made of its effect on soil microarthropod communities. Mites and Collembola are an interesting and important component of soil communities and large scale ecosystem disruptions by macro-organisms should be reflected in changes in population densities and species diversity of the microarthropods. Accordingly, litter and soil samples from adjacent overgrazed and ungrazed pastures were collected. The microarthropods were isolated from the samples, classified, and compared to determine the effects, if any, overgrazing had had on the soil microarthropod community.

The one half hectare study site, located in Makanda Township on Giant City Road eight miles southeast of Carbondale, Illinois, is rolling hills of tight clay soil that has supported grassland for at least fifty years. It has been used as a pasture for cattle and horses for all of that time except in the early 1960's when it was plowed, limed, fertilized and planted to soybeans and corn for about five years. It had reverted again to heavily grazed pasture when it was purchased and fenced off in 1970. It was then mowed regularly. The clippings were composted with table scraps and other household organic residues and scattered over the pasture along with wood ashes from a large fireplace.

In 1979 the land was sold again, the strewing of compost and ashes ceased and most of it was fenced off to provide pasture for a horse and calf. The enclosed land was too small for the animals and was quickly overgrazed to 40% stubble and 60% bare ground. Soil and litter samples from inside and outside of the fence were collected and their soil microarthropods were compared.

Most studies of mites and Collembola have been conducted in forests, however, King, Hutchinson and Greenslade (1976) and King and Hutchinson (1976) in thorough pasture studies in Australia found the number of species of these organisms were reduced as the grazing intensity of sheep was increased. The evenness component of the species diversity index for Collembola increased as numbers of sheep were increased. Dowdy (1965) studying mites and Collembola on pasture and woodland sites concluded that the greatly reduced microfaunal populations found in the grasslands may have resulted from the removal by man of the original macrofaunal and floral community and its replacement with different and fewer species.

MATERIALS AND METHODS

Decimeter square samples of litter were collected. Soil samples five centimeters deep and five centimeters in diameter were removed from the center of each of the litter samples sites. Four litter and four soil samples from the overgrazed pasture were collected five meters apart along a line parallel to and two meters in from the fence on each of three sampling days. Likewise, four litter and four soil samples were collected from the ungrazed pasture every five meters along a line parallel with and two meters outside of the fence on each of the three collecting days. A total of forty-eight samples were collected. The soil surface temperature was measured each collecting day.

The samples were placed in labeled plastic ziplock bags and taken to the lab where they were put in berlese funnels and allowed to dry at room temperature for twenty-four hours. The funnels were heated for the next ten days by twenty-five watt bulbs placed 0.5 meters above them. Under the funnels were five centimeter by five centimeter collecting jars filled with thirty C.C. of a 75% isopropyl alcohol, 20% water, 5% glycerine solution, which were refilled as necessary. An extra funnel containing no sample was set up beside each of the three sets of experimental funnels to serve as a control. Jars of the preservative were placed under the control funnels.

After ten days the organisms that had accumulated in the collecting jars were washed into small petri dishes, identified and counted. Identification of the mites collected were made to suborder and of the Collembola to family using dissecting microscopes and keys from Dindal (1971), Jaques (1947), Kranz (1978) and Christensen and Bellinger (1980). Over the course of the experiment organisms from twelve litter samples from the overgrazed pasture were collected, analysed and compared to organisms from twelve litter samples from the ungrazed pasture. Organisms from twelve soil samples from the overgrazed pasture were compared to organisms from twelve soil samples from the ungrazed pasture.

A diversity index was calculated using Simpson's method (1949) for each of the four study components: overgrazed and ungrazed pasture litter samples and overgrazed and ungrazed pasture soil samples. The formula used is $D = N(N-1)/n(n-1)$ where D equals diversity index, N equals total number of all species and n equals the

number of individuals of a species. Indices from soil microarthropod samples from the two pastures were compared as were indices from the two types of litter samples.

RESULTS AND DISCUSSION

No organisms were collected in jars placed under any of the three control funnels which assured us that the organisms found in the collecting jars placed beneath the funnels containing soil and litter samples came from those samples and not from other samples, the laboratory or the equipment.

One hundred and thirty-nine microarthropod specimens were collected from ungrazed litter samples compared with only thirty-six from the overgrazed pasture. Twenty-six of the thirty-six organisms from the overgrazed site were Cryptostigmata while the remainder were of four other taxa. Fifty-four Cryptostigmata were found in litter from ungrazed sites along with twenty-six Entomobriadae, twenty Mesostigmata, twenty-six Eleutherozoa and three Smythuridae. See Table 1.

G1	4	0	0	0	0	2	0	0	0	6	U1	1	2	0	0	6	2	0	11
G2	0	1	0	0	0	1	0	0	0	2	U2	0	0	0	0	8	0	0	9
G3	2	0	0	0	0	0	0	0	0	2	U3	0	3	4	1	27	2	0	37
G4	0	0	0	0	0	0	0	0	0	0	U4	3	0	0	0	8	1	0	12
G5	5	0	0	0	0	1	0	0	0	6	U5	4	0	0	0	8	0	0	12
G6	6	0	0	0	0	0	0	0	0	6	U6	3	4	0	1	4	1	0	13
G7	3	6	0	0	0	3	0	1	0	13	U7	6	2	0	0	5	1	0	14
G8	3	1	0	1	0	6	3	0	0	14	U8	1	6	0	0	5	1	1	14
G9	2	1	0	0	0	15	0	0	0	18	U9	0	0	0	1	28	0	0	29
G10	2	0	0	0	0	4	1	0	0	7	U10	19	0	0	0	11	1	0	31
G11	4	2	0	0	0	5	2	0	0	13	U11	2	0	0	0	9	1	0	12
G12	0	3	0	0	0	9	0	0	0	12	U12	4	6	0	1	9	1	0	21
Total	31	14	0	1	46	72	9	1	1	99	TL	43	23	4	5	128	11	1	215

Accumulative

Total	36	14	1	2	72	9	1	1	135	46	49	14	25	182	37	1	354
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Two hundred and fifteen microarthropod specimens were found in the soil samples from the ungrazed pasture whereas only ninety-nine were collected from samples from the overgrazed pasture. Thirty-one Smythuridae, fourteen Entomobryidae and forty-six Cryptostigmatidae made up the majority of microarthropods from the grazed pasture. Forty-three Smythuridae, twenty-three Entomobryidae, one hundred twenty-eight Cryptostigmatidae, eleven Eleutherengona and three other taxa came from the ungrazed pasture soil samples. See Table 1.

The diversity index for the microorganisms from the overgrazed litter samples was 1.864 while the diversity index from the ungrazed litter was 4.136. The soil samples from the overgrazed pasture provided a diversity index of 3.020 while the soil samples from ungrazed pasture had a diversity index of 2.459.

The first set of samples were collected on January 29, 1981 at 9 a.m. while the temperature at the soil surface was 0°C. The second set of samples were collected at noon on February 19, 1981 while the temperature at the soil surface was 11°C. The third set of samples were collected at 2:30 p.m. on March 12, 1981 while the temperature at the soil surface was 11°C.

The Cryptostigmatidae were much more numerous in samples collected from overgrazed pasture during the warmer temperatures. (see Table 2). There were no Cryptostigmatidae found in litter samples from overgrazed pasture collected on the cold day whereas the litter samples collected on the warmer day averaged three Cryptostigmatidae each. Soil samples from the overgrazed pasture collected on the cold day averaged only one Cryptostigmatidae each while an average of five were found in each sample collected on warmer days.

Soil samples show the same relationship for Smythuridae: 1.5 per sample collected in the cold on overgrazed pasture, 3 per sample on the warmer days; one per sample on ungrazed pasture on the cold day, ten per sample on the warmer days. (see Table 3).

Table 2. Average number of specimens of Cryptostigmatidae per sample collected in cold temperature and warm temperature.

	Overgrazed Litter	Ungrazed Litter	Overgrazed Soil	Ungrazed Soil
0°	0	5	1	12
11°	3	4.5	5	10

Table 3. Average number of specimens of Smythuridae per sample collected in cold temperature and warm temperature.

	Overgrazed Soil	Ungrazed Soil
0°	1.5	1
11°	3	10

CONCLUSIONS

Mites and Collembola were much more numerous in litter and soil samples taken from ungrazed pasture than they were from the overgrazed pasture. Numbers of these microarthropods appear to correlate well with the general appearance of the vegetation as an index of the condition of the pastures even in winter. Considerably more species diversity was found in the litter samples from the ungrazed pasture than was seen in the overgrazed pasture—another indication of the health of the communities. The diversity indices of the soil samples did not show the same correlation. The overgrazed pasture had a slightly higher diversity index than the ungrazed one because of the very large number of Cryptostigmatidae found in the soil samples of the latter.

Litter organisms, particularly the Cryptostigmatidae seem vulnerable to cold temperature where overgrazing has reduced the ground cover. The average number of Smythuridae per soil sample was nearly the same in each pasture in cold weather but was much higher in the ungrazed pasture in warmer temperature.

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LITERATURE CITED

- Christiansen, Kenneth and Peter Bellinger. 1980. The Collembola of North America North of the Rio Grande. 132 pp. Grinnell College Press, Grinnell, Iowa.
- Dindal, D. L. 1971. Characteristics of Suborders of Acarina. Unpublished. Dept. of Soil Ecology, Suny. College of Environmental Science and Forestry, Syracuse, NY.
- Dowdy, W. W. 1965. Studies on the Ecology of Mites and Collembola. *The American Midland Naturalist*. Vol. 13: 196-210.
- Jacques, H. E. 1947 *How to Know the Insects*. pp. 49-66. Wm. C. Brown Company, DuBuque, Iowa.
- King, Kathleen L. and K. J. Hutchinson. The Effects of Sheep Stocking Intensity on the Abundance and Distribution of Mesofauna in Pastures. *Journal of Applied Ecology*. Vol. 13:41-55.
- King, Kathleen L., K. J. Hutchinson and Penelope Greenslade. 1976. The Effects of Sheep Numbers on Associations of Collembola in Sown Pastures. *Journal of Applied Ecology*. Vol. 13:731-739.
- Kranz, G. W. 1978. *A Manual of Acarology*. Second edition. 505 pages. Oregon State University Bookstores, Inc. Corvallis.
- Simpson, H. E. 1949. Measurement of Diversity. *Nature*. Vol. 163:688.