

# Effects of Long-Term Grazing on Abundance and Diversity of Soil Mesofauna

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Soil fauna play important roles in soil development (Pawluk 1985), soil fertility maintenance (Seastedt 1984), and the decomposition of organic matter in grassland habitats (Wallwork 1976). Decomposition and nutrient recycling are essential soil processes to maintain a healthy and sustainable grassland ecosystem. Soil fauna influence bacterial and fungal biomass via grazing, liberating immobilized nutrients, and stimulating further fungal and bacterial activity, as well as, enhancing plant growth (Parkinson 1988, Setälä 1995). These organisms may also be useful as bioindicators of soil health (Wallwork 1988, Linden et al. 1994, Pankhurst et al. 1995, Van Straalen and Verhoef 1997).

The diversity and abundance of soil organisms is influenced not only by available food resources, but also by changes to physical and chemical properties in the soil. Grazing can influence chemical, physical, and biological properties of the soil.

There has been little research on soil fauna of grasslands in Canada (Willard 1973a, 1973b) and no research to date on soil fauna in grasslands of southern BC. Furthermore, there is limited research on the impacts of grazing on soil organisms. The purpose of this preliminary survey was to examine possible relationships between soil mesofauna and grazing.

## ***Sampling and Analyses***

Five soil cores (5 cm in diameter) were collected from FS treatment and ungrazed exclosures during late August and early October 1998. Two sampling units were randomly selected within grazed and ungrazed areas. Each core was divided into two samples: 0 to 4 and 4 to 8 cm. All samples were extracted for one week using a high-gradient extractor (Lussenhop 1971). Faunal samples were examined under a dissecting microscope. All fauna were sorted, counted and identified to the following levels (i) mites to suborder, (ii) springtails to family, and (iii) all remaining fauna to the lowest possible level.

**Table 1. Mean relative abundance (% of total) for soil mesofauna collected in August 1998.**

Soil mesofauna	Depth (cm)	Lower pasture No. 1		Lower pasture No. 2		Middle pasture		Average	
		Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed
Oribatida	0 - 4	0.0	0.4	0.0	1.0	0.0	0.2	0.0	0.5
	4 - 8	0.3	0.0	0.0	0.4	0.0	0.0	0.1	0.1
Mesostigmata	0 - 4	0.8	0.0	0.0	0.6	0.0	0.2	0.3	0.3
	4 - 8	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.1
Prostigmata	0 - 4	45.9	99.3	45.2	48.4	95.5	48.8	62.2	65.5
	4 - 8	49.7	99.2	49.4	47.9	45.3	0.0	48.1	49.0
Astigmata	0 - 4	0.8	0.0	0.0	0.0	0.0	0.0	0.3	0.0
	4 - 8	0.0	0.0	0.0	0.7	3.1	0.0	1.0	0.2
<b>Total Acari</b>	0 - 4	47.5	99.7	45.2	50.0	95.5	49.3	62.7	66.3
	4 - 8	50.0	99.6	49.4	49.1	48.4	0.0	49.3	49.6
Entomobryidae	0 - 4	2.5	0.3	0.0	0.0	0.0	0.0	0.8	0.1
	4 - 8	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.1
Onychiuridae	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Collembola</b>	0 - 4	2.5	0.3	0.0	0.0	0.0	0.0	0.8	0.1
	4 - 8	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.1
Homoptera	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
	4 - 8	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.2
Nematoda	0 - 4	0.0	0.0	4.8	0.0	0.0	0.0	1.6	0.0
	4 - 8	0.0	0.0	0.6	0.0	0.8	0.0	0.5	0.0
Formicidae	0 - 4	0.0	0.0	0.0	0.0	2.3	0.0	0.8	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.1
Copepoda	0 - 4	0.0	0.0	0.0	0.0	2.3	0.0	0.8	0.1
	4 - 8	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0

**Table 2. Mean relative abundance (% of total) for soil mesofauna collected in October 1998.**

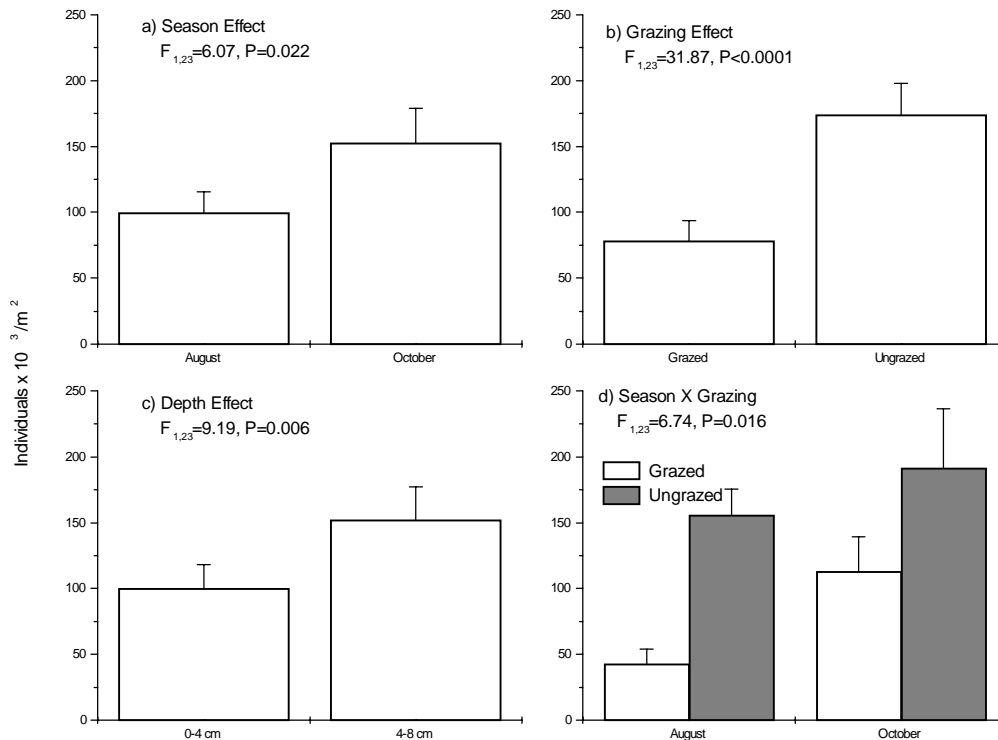
Soil mesofauna	Depth (cm)	Lower pasture No. 1		Lower pasture No. 2		Middle pasture		Average	
		Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed	Grazed	Ungrazed
Oribatida	0 - 4	0.0	0.2	0.0	0.0	0.5	0.4	0.2	0.2
	4 - 8	0.0	11.3	0.6	0.3	0.0	0.0	0.2	3.9
Mesostigmata	0 - 4	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1
	4 - 8	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.8
Prostigmata	0 - 4	50.0	49.5	0.0	49.0	98.0	48.0	49.3	48.8
	4 - 8	0.0	81.5	96.9	49.3	48.3	0.0	48.4	43.6
Astigmata	0 - 4	0.0	0.0	0.0	0.5	1.5	0.0	0.5	0.2
	4 - 8	0.0	2.6	0.0	0.0	0.4	0.0	0.1	0.9
<b>Total Acari</b>	0 - 4	50.0	49.7	0.0	49.5	100.	48.9	50.0	49.3
	4 - 8	0.0	97.8	97.6	49.6	48.7	0.0	48.8	49.1
Entomobryidae	0 - 4	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.2
	4 - 8	0.0	2.2	2.4	0.1	0.0	0.0	0.8	0.8
Onychiuridae	0 - 4	0.0	0.0	0.0	0.5	0.0	0.8	0.0	0.5
	4 - 8	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.1
<b>Total Collembola</b>	0 - 4	0.0	0.3	0.0	0.5	0.0	1.1	0.0	0.7
	4 - 8	0.0	2.2	2.4	0.4	0.0	0.0	0.8	0.9
Homoptera	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nematoda	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0
Formicidae	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.9	0.0	0.3	0.0
Copepoda	0 - 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4 - 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

There was a large amount of variation in the abundance of other groups (Tables 10 and 11), so we restricted the analysis to the prostigmatid mites. The raw abundance of this group was log-normally distributed and we conducted a four-factor ANOVA of natural log values with season, site, core depth, and grazing as main effects. All main effects and interactions were tested against the residual error term.

### Results and Discussion

Just over 12,300 specimens were collected for this study with prostigmatid mites representing 94.5% of the total organisms present. There was no difference in the density of prostigmatid mites between sites, but there were significant effects of season (Figure 1a), depth (Figure 1b), and grazing (Figure 1c) as well as a significant season by grazing interaction (Figure 1d).

Deeper cores from ungrazed areas contained the most organisms and the numbers were higher at the later sampling time. Grazing was the most significant factor, explaining 29.0% of the variation in prostigmatid abundance.



**Figure 1. Density of Prostigmatid mites.**

Soil mesofauna, which includes soil organisms that range in size from 0.1 to 2 mm in width (Swift et al. 1979), are normally dominated by Acari (mites) and Collembola (springtails) and includes Protura, Diplura, Symphyla as well as smaller forms of millipedes, centipedes, spiders, potworms, and pseudoscorpions. The densities of soil mesofauna identified during this study were very different. Generally, oribatid mites are more abundant than prostigmatids (Wallwork 1976, Petersen and Luxton 1982). However, in our study, Prostigmata represented a substantially greater proportion of the mesofauna. This pattern has been previously observed in tundra, desert, and tropical grassland habitats (Petersen and Luxton 1982), however, even in these habitats, Prostigmata only represent up to 75% of the fauna. Prostigmata are a dominant suborder of mites with a broad geographic distribution and are found in all terrestrial ecosystems. Most of these mites are small, free-living fungivores and algivores in the soil. However, certain species are obligate plant feeders, specialized fungal feeders, predators and parasites. So far 1100 genera and more than 14000 species have been identified (Kethley 1990). Although their specific role in soil ecosystem is unknown, they may play the equivalent ecological role of oribatid mites (microphytophages) especially in sites where they are dominant.

Generally soil fauna are concentrated in the top five to 10 cm of most soils and their abundance and diversity decrease with depth (Wallwork 1976). However, in non-forested systems, a substantial proportion of prostigmatids can be found at depths greater than 10 cm (Kethley 1990). The study sites had a greater abundance of Prostigmata in the lower samples (4 to 8 cm) than the upper sample (0 to 4 cm). The majority of specimens observed in this study were very small prostigmatid mites (160  $\mu\text{m}$  or less in length). Small soil pore spaces can also influence the distribution of mesofauna by limiting access of larger organisms.

Seasonal changes can also influence distribution and diversity of soil fauna. Kethley (1990) noted that vertical migration is quite pronounced in grassland systems. Drier conditions in the upper soil horizons during the summer would limit soil fauna activity, while moister conditions in October would present an opportunity for increased activity and reproduction with more organic matter input and higher microbial activity. Prostigmata are able to readily take advantage of new resources and increase their populations (Kethley 1990).

Lower abundance of Prostigmatid mites on grazed sites compared to ungrazed sites indicated that grazing did influence Prostigmata density. This simple, preliminary study provides a good initial assessment of the effects of grazing on soil meso-fauna in this region. The results are encouraging and further work with more extensive sampling would be justified.

## ***Conclusions and Further Research***

If further work is considered for the soil mesofauna, several lines of examination might be considered. Seasonal sampling should continue at both 0 to 4 and 4 to 8 cm depths. The number of samples should be increased to help explore variation in densities of the groups studied and to allow an establishment of baseline data on the diversity and abundance of soil mesofauna on these sites. Due to the dominance of the Prostigmata at these sites, species level work may provide a clear picture of the impact of grazing on this Acarine suborder. In addition, identification to species level will provide much needed baseline information on the diversity and distribution of the Prostigmata.

Furthermore, measurements of soil water content and temperature, accompanied with litter measurements and plant species distribution in conjunction with sampling for soil mesofauna would allow to establish the relationships among soil chemical, physical, and biological properties and species distribution under these soil/climate conditions.

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