Soil Microarthropod Abundance and Species Richness in Successional Douglas-fir Forests

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Pages 96-97 *in* J.A. Trofymow and A. MacKinnon, editors. Proceedings of a workshop on Structure, Process, and Diversity in Successional Forests of Coastal British Columbia, February 17-19, 1998, Victoria, British Columbia. Northwest Science, Vol. 72 (special issue No. 2).

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Introduction

A healthy and sustainable soil system is the foundation on which the forest stands, and there is growing recognition that soil organisms play vital roles in modifying or even controlling many physical and chemical processes necessary for maintaining a sustainable soil system (Shaw et al. 1991). Yet in many cases, we do not know what species are present in the soil, and we know even less about their ecological roles, or how they respond to different forest management practices (Marshall 1993). This study examined how the conversion of old-growth forests to second-growth forests affects the abundance and biodiversity of soil arthropods in the LFH layer and in litterbags containing needle litter or wood chips.

Methods

The study was carried out at three sites on Vancouver Island, BC: Victoria Watershed South, Victoria Watershed North, and Koksilah. Each site contains stands of four ages or seres: R - regeneration, I - immature, M - mature, and O - old growth on similar slopes, aspects, and elevations (see Trofymow and Porter, this issue). In 1992, litter bags containing 50 g of chipped wood (coarse mesh bag), 50 g chipped wood (fine mesh bag), and 10 g needles (fine mesh bag), were installed on the surface in each of three subplots within each sere at each site. Litter bags were removed from the field in the fall of 1993, 1994, 1995, and 1996, at which time samples of the LFH layer were also taken. Soil microarthropods extracted in a high gradient extractor were counted and identified, with the Collembola being determined to species level.

Results and Discussion

Three-way randomized block Analysis of Variance (ANOVAs) were carried out to determine the effect of forest successional stage (sere), site, and year on the abundance of Collembola and mites, and on the species diversity (*sensu* Hill 1973) of the Collembola in each substrate. Only the sere effects will be presented here; none of the interaction terms were statistically significant. For the wood chip data, ANOVA revealed that the effect of mesh size was not significant ($p>0.05$), so data for the two different mesh sizes were combined.

In general, mites and Collembola were less abundant in the regeneration plots than in forested (i.e. immature, mature, and old growth) plots (Table 1). However, generally, numbers did not differ significantly among the different ages of forested plots except in the case of Collembola which were significantly more numerous in the LFH layer of old-growth plots than in any of the other successional stages. In the needle litter, the effect of sere on collembolan abundance was not as obvious, with only the immature sere showing significantly higher numbers than the regeneration plots. Species richness was significantly higher in LFH and needle litter samples taken from the old growth than in regeneration samples, but only in the case of needle litter data was the species richness in the old growth also significantly higher than in immature and mature samples (Table 2). No significant effect of sere on species richness of Collembola in wood chip litterbags could be demonstrated.

The same species of Collembola tended to occur in all seral stages, with differences in the fauna being due to changes in relative and absolute abundance of the species comprising the community. Although several species seemed to demonstrate a preference for certain seral stages, others did not and there was little evidence of species being confined to a particular successional stage. Principal Component Analysis revealed that the collembolan fauna of decomposing wood chips were

very similar in all seral stages except regeneration. This analysis also indicated that the compositions of the collembolan fauna of decomposing needle litter at the immature and mature seral stages were virtually identical, but the analysis separated the regeneration and old growth plots both from each other and from the immature+mature cluster.

Most of the analyses thus indicated clear differences between the soil arthropod communities of the regeneration stands and later successional stages, with only subtle differences among the soil microarthropod communities of the later stages of forest succession.

Acknowledgements

Funding for the soil arthropods portion of this study was provided by Forest Renewal BC (Reference # HQ96017RE).

TABLE 1. Effect of forest successional stage on abundance of soil microarthropods in the different substrates. Log (n+1) transformations of population counts were used. Only the sere effects of 3-way (sere x site x time) ANOVAs are presented in this table; interaction terms were never significant. Values are mean numbers/100 g of substrate. Within the same row, means followed by the same letter do not differ significantly from one another ($p<0.05$; Bonferonni adjustment for pairwise comparisons).

Parameter	Regeneration	Immature	Mature	Old growth	Sere effect
LFH layer					
Mites	1376 a	2564 b	1981 b	2890 b	$p<0.05$
Collembola	125 a	300 b	312 b	715 c	$p<0.05$
Needle Litter					
Mites	1267 a	5345 b	5057 b	4644 b	$p<0.05$
Collembola	549 a	1235 b	954 ab	1134 ab	$p<0.05$
Wood Chips					
Mites	536 a	1177 b	1367 b	1281 b	$p<0.05$
Collembola	59 a	172 b	111 b	166 b	$p<0.05$

TABLE 2. Effect of forest successional stage (sere) on species richness of Collembola. For the LFH layer and needle litter data, the sere effects of three-way ANOVAs (sere x site x time) are presented. Due to low numbers of individuals in the wood chip litterbags, data for all four years were pooled, and a two-way (site x sere) ANOVA was carried out. In all analyses, interaction terms were not significant. Within the same row, means followed by the same letter do not differ significantly from one another ($p<0.05$; Bonferonni adjustment for pairwise comparisons). Values are mean number of species/sample.

Substrate	Regeneration	Immature	Mature	Old growth	Sere effect
LFH	8.8 a	12.8 ab	11.17 ab	15.75 b	$p<0.05$
Needle litter	8.6 a	12.4 a.	11.9 a	17.1 b	$p<0.05$
Wood chips	15.2	20.2	20.2	22.5	$p=0.094$ ns

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