Relationships Between Soil Fauna and Soil Pollutants

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Introduction

Soil faunal activity is essential for the functioning of all terrestrial ecosystems. Soil fauna are important in the physical and chemical transformation of litter, the maintenance of soil fertility, and sustained productivity. By-products of human activities (e.g., air pollutants) affect the proper functioning of the soil fauna with a concomitant decrease in long term soil productivity. In Europe, changes in soil acidity (pH) induced by air pollution have been reflected in alteration of the soil fauna (Hågvar 1987). The fauna could therefore be used as early indicators of changes brought about in soil properties by pollutants (see Paoletti *et al.* 1991). In Canada, studies of this nature are lacking and even baseline data against which changes could be measured are not yet available. Our Acid Rain National Early Warning Systems (ARNEWS) plots, designed to detect early signs of damage in forests, provide an opportunity to observe possible changes in the soil fauna. Collembola were selected for initial study because of other information on collembolan diversity in immature Douglas-fir stands, especially stump data which have already been collected.

Objectives

(1) To study changes in soil fauna, specifically Collembola, at the Shawnigan Lake site between 1973 and 1992; and (2) to develop hypotheses (related to deposition, soil type, and selected indicator species) that could be tested under controlled laboratory conditions.

Methods

Soil samples were collected during October 1973 and October 1992 at the Shawnigan ARNEWS site. For both sampling occasions, sampling grids (3 m x 3 m) were located on the north, east, and west side in the buffer zone of control plot # 2-72. Each grid was subdivided into 1 m^2 microplots. One microplot was selected at random from each grid. Three soil cores were taken from each microplot using a 5 cm diameter soil corer. Samples from two of the cores contained L-H horizons and 0-3 cm mineral layer. The third core contained L-H, 0-3, 3-6, and 6-9 cm soil depths for a total of 24 samples.

Collembola were extracted from organic layers (L-H) using a high gradient apparatus. Mineral layers were extracted by Murphy split-funnel. Collembolan specimens were counted under a dissecting microscope. Mounting and identification of specimens followed Christiansen and Bellinger (1980-81), but some of their subgenera designations were considered as genera, agreeing with many other authorities.

Results and Discussion

Thirty-three species were identified from the 1973 samples and 53 species from the 1992 samples (Table 1 and Appendix 1 and 2). Only 12 species were common for both sampling times. These results are difficult to compare for two main reasons. First, the time lapse of 19 years would have permitted the build-up of organic matter and provided increased living space for more species. Second, there is a lack of information on species distribution of Collembola in British Columbia to permit speculation of possible occurrences of various species during early stages of development of Douglas-fir forests. It is likely that the additional species occurring in 1992 were also present in the site in 1973, but in such low numbers as to evade detection. Only 24 samples were collected from each sample time and, considering the patchy distribution of many soil fauna species, a large number of samples might be required for a more realistic comparison.

TABLE 1. Number of collembolan species identified from 1973 and 1992

	1973		1992
Total no. spp.	33		53
No. common spp.		2	
No. spp. common from stump study	11		17

Stumps seem to be a more stable habitat for Collembola, with little change in the faunal composition during forest succession (Setälä and Marshall, in these proceedings). Species composition of stumps also seems very different. A comparison of stumps and soil showed that only 11 and 17 species were common in stumps and soil for 1973 and 1992, respectively (Appendix 1 and 2). At least one dominant species in stumps (*Folsomia* n. sp.) has not yet been found in soil at this site. Another dominant stump species, *Anurophorus septentrionalis*, is rare in soil at the site.

The Anurididae were conspicuously absent from the 1992 samples. A few species in other families found in 1972 were also missing from the 1992 samples. Conversely, many species found in 1992 were not collected in 1973. It is therefore unlikely that the fauna are being adversely affected by pollutants as observed elsewhere (Rusek [1993]). Subtle alterations in oviposition, fecundity, and longevity of Collembola effected by changes in pH (Hågvar and Abrahamsen 1980) require much more detailed life-history studies. Further research should be directed at establishing a more exhaustive species list for the site from other material collected in the 1970s, and at doing additional sampling. A complete species list and detailed life cycle information could help to determine indicator species. Hypotheses on impacts of pollutants on Collembola could then be tested under controlled laboratory conditions.

References

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APPENDIX 1
1973 Species List

Total species: 33

Anurididae
*Friesea wilkeyi, Morulodes serrata**

Brachystomellidae
Odontella biloba, Odontella cornifer, Odontella rossi*

Dicrytomidae
Ptenothrix maculosa*

Entomobryidae
Entomobrya assuta, Entomobrya menentotoma, ***Sinella*** **(S.)** ***curviseta***

Hypogastruridae
Mitchellania virga*, ***Mitchellania vulgaris****, *Xenylla affiniformis*

Isotomidae
Folsomia candida, Folsomia fimetaria, *Folsomia nivalis**, *Proisotoma* (P.) *mackenziana*

Neanuridae
Micranurida sp., *Neanura* (*Deutonura*) *frigida, Neanura setosa, Pseudachorutes curtus, Pseudachorutes subcrassoides*

Neelidae
Megalothorax minimus*

Onychiuridae
Archaphorura absoloni, Onychiurus dentatus, Onychiurus eous, ***Onychiurus flavescens****, ***Onychiurus millsi, Onychiurus ramosus****, Onychiurus reluctus, Mesaphorura pacifica**, ***Mesaphorura yosiii****, *Protaphorura uenoi*

Tomoceridae
Tomocerus flavescens*

* indicates species also found in stump study (Setälä and Marshall, in these proceedings): 11

Species in bold face: common species between 1973 and 1992: 12

APPENDIX 2
1992 Species List

Total species: 53

Brachystomellidae
Odontella sp., *Xenyllodes* sp.? *armatus*

Dicrytomidae
Ptenothrix maculosa*

Entomobryidae
Entomobrya sp., ***Sinella* (*Sinella*) *curviseta***, *Sinella* sp. (no eyes), *Sinella* sp.

Hypogastruridae
Ceratophysella krafti, *Mitchellania horrida*, ***Mitchellania virga****, ***Mitchellania vulgaris****, *Mitchellania wallmoi*, *Willemia biseta*, *Willemia denisi**, *Willemia intermedia*

Isotomidae
Cryptopygus sp.? *exilis*, ***Folsomia candida*, *Folsomia fimetaria***, *Folsomia stella**, *Isotoma* (*Desoria*) *agrelli*, *Isotoma* (*Desoria*) *ekmani**, *Isotoma* (*D.*) *multisetis*, *Isotoma* (*D.*) *tariva*, *Isotoma* (*D.*) *trispinata*, *Isotoma* (*D.*) *uniens**, *Anurophorus* (*Pseudanurophorus*) sp. ? *arcticus*

Neanuridae
Christobella ornata, *Christobella* sp.?(4 eyes), *Micranurida pygmaea*, *Neanura persimilis*, *Paranura colorata**, *Paranura* sp.1, *Pseudachorutes* sp., *Pseudachorutes* sp. (PAO-10)

Neelidae
Megalothorax minimus*

Onychiuridae
*Lophognathella choreutes**, *Mesaphorura macrocheata**, ***Mesaphorura yosii****, *Multivesicula punctata*, *Protaphorura cocklei**, ***Onychiurus* (*Onychiurus*) *flavescens****, ***Onychiurus* (*O.*) *millsi*, *Onychiurus* (*O.*) *ramosus***, *Sensiphorura marshalli*, *Tullbergia ruseki*

Sminthuridae
Arrhopalites clarus, *Arrhopalites* sp., *Sminthurides* (*Denisiella*) *sexpinnatus*, *Sminthurides* (*Stenadicia*) sp.

Tomoceridae
*Tomocerus brevimucronatus**, *Tomocerus curtus*, *Tomocerus dubius*, ***Tomocerus flavescens****, *Tomocerus lamelliferus*

* indicates species also found in stump study (Setälä and Marshall, in these proceedings): 17

Species in bold face: common species between 1973 and 1992: 12