SOIL FAUNA STUDIES IN A BEECH FOREST I. COMPARATIVE STUDY IN FOREST, FOREST MARGIN AND CLEAR-CUT AREA IN HUNGARY

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Abstract

The soil fauna of a beech forest and the adjoining clear-cut area was studied during a four-year period in the Bükk Mountain (Northern Hungary). Samples were taken each month from April to November by pitfall traps. 17 taxa of the soil fauna were examined *(Scarabaeidae, Carabidae, Staphylinidae, Coleoptera, Heteroptera, Formicidae, Isopoda, Araneidae, Phalangidae, Pseudoscorpionidae, Julidae, Glomeridae, Polydesmidae, Lithobiidae, Geophilidae, Scendylidae,* and *Blattidae).* We have demonstrated that the fauna of the forest, forest margin and clear-cut area can be separated by multivariate methods. From zoological point of view, the width of the forest margin was approximately 10 metre. Our result also suggest that the distance from the forest appears to be more important in determining the faunistical composition of the sites than the exposure on the slope. *Collembola* and *Oribatidae* were the dominant taxa of the forest. Diversity of predator species was lower, while the abundance of litter-decomposers were higher in the forest than elsewhere. The abundance of *Coleoptera* was also higher in the forest than in the clear-cut area. The fauna of the forest margin was more similar to the fauna of the clear-cut area than to the fauna of the forest.

Key words: beech forest, clear-cut area, forest margin, soil fauna.

Introduction

This article is related to the „Rejtek Project" Research Programme, which involves a study of the processes of secondary succession after clear-cutting of a beech forest developing on shallow soil derived from limestone in the Northern Hungarian Central Range (JAKUCS, 1987).

A comparative faunistical study was carried out on the sampling sites in the research area, to examine the changes in the meso- and macro-fauna of the soil after clear-cutting. There were studied 16 broad taxa of the soil fauna *(Scarabaeidea, Carabidae, Staphylinidae, Coleoptera, Heteroptera, Formicidae, Isopoda, Araneidae, Phalangidae, Pseudoscorpionidae, Julidae, Glomeridae, Polydesmidae, Lithobiidae, Geophilidae, Scendylidae* and *Blattidae)* to explore whether there were any differences between the soil fauna of the forest, forest margin and clear-cut area. These taxa represent different strategies of resource utilisation, reproduction, etc., i. e. to some degree different guilds of the fauna. We were also interested in the problem of habitat preference of broader taxa, not species.

Sampling area, sampling methods and data processing

The research area is situated in the Northern Hungarian Central Range (Bükk Mountains) on a broken karst limestone area in the eastern part of the southern Bükk. The area was marked out in 1980 on a wider, south-narrowing ridge covered by an approximately 100–200 year old beech forest *(Melico-Fagetum)* in 1980. The closure of the canopy ranged from 75% to 80%. Shrubs developed considerably only in the forest covering the south-western slope. In January of 1981 clear-cutting was performed on an area of 4 hectares for experiments. A more detailed description of the studied area and the research programme are in the paper of JAKUCS (1987).

The soil fauna was studied in samples of size 25x25 cm, which is a standard plot size (LOKSA, 1966; MÜLLER, 1965). Sieving was used to separate animals from the soil and vegetable material. The remaining organisms were picked up individually from the soil samples. Pitfall traps were used to study the macro-fauna; it is applied extensively to study surface dwellers, such as spiders, *Collembola,* ants and *Coleoptera* beetles. Glass containers (7.5 cm in diameter) was used as a trap, with ethylene glycol as killing-preservative. Traps were located in three rows on the north-eastern slope. The first row of traps was situated on the upper part, the second on the middle part, and the third at the foot of the slope. The first two traps in the row were in the forest, the third in the forest margin, the fourth–sixth in the clear-cut area, and the seventh in the forest margin on the opposite side of the clear-cut area. Samples were taken each month from April to November.

The fauna of sample localities were analysed by multivariate methods. These techniques allow the comparison of a series of samples whose variation is considered to be due to several causes. Cluster analysis and principal coordinates analyses were performed via the Euclidean distances with oblique coordinates (ORLÓCI, 1978). The total linkage method was used to cluster the traps. Calculations were done by the NuCoSA package (TÓTHMÉRÉSZ, 1993).

Results and discussion

Both cluster analysis and principal coordinates analysis suggest that there are three typical parts of the study area based on the distribution of meso- and macro-fauna: forest, forest margin and clear-cut area. Three groups of sample sites are demonstrated by the dendrogram of the cluster analysis (Fig. 1). The first one (clear-cut area) comprises traps 1, 8, 16, 19, 20, 21 and 22; the second one (forest

margin) includes the traps 2, 3, 9, 12, 13, 10 and 11; and the third group (forest) includes the traps 4, 5, 6, 7, 14, 15, 17, and 18. The three groups can be clearly observed.

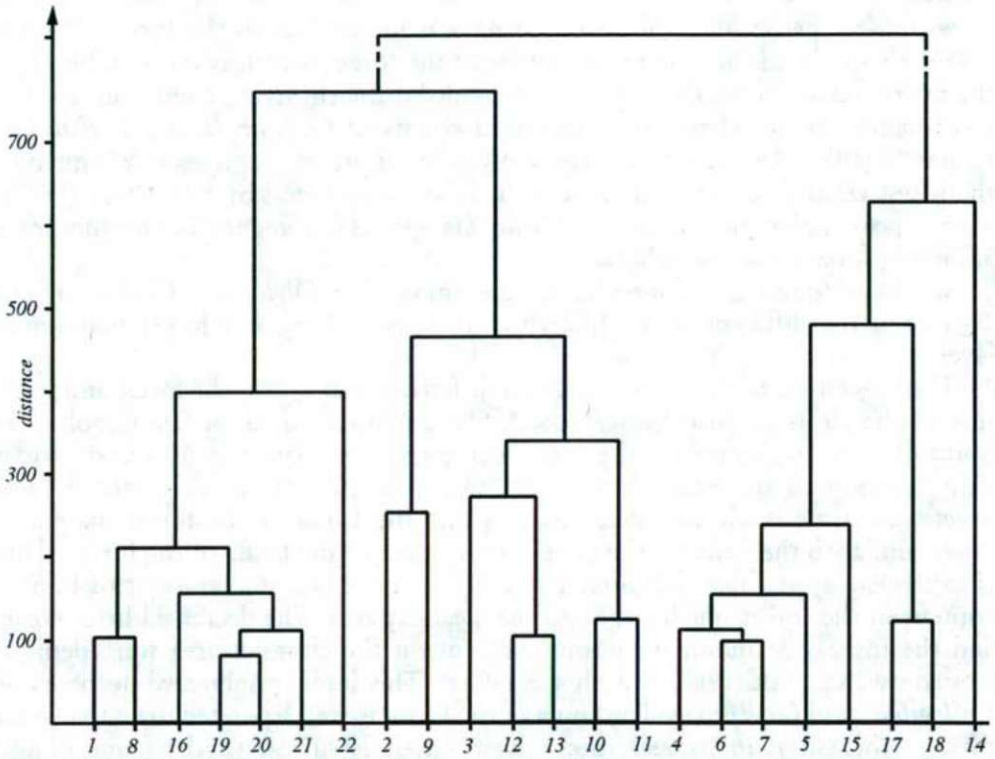

Figure 1 Dendrogram of the sampling sites basen on faunistical composition. The Euclidean distance with oblique coordinates, and the total linkage method was used.

The forest soil is covered by thick litter, and there are only a limited number of annuals. Therefore, in the forest the litter-decomposers, and species living in the litter are predominate. Diversity of predator species is limited in the forest compared to the other sites. This was also also demonstrated by KLEINERT (1977) and CYKOWSKY (1975). *Collembola* and *Oribatidae* are the dominant taxa of the soil fauna of the forest, and at the same time the litter decomposers of the soil fauna are also represented here in a greater proportion than in the clear-cut area. The number of *Coleoptera* individuals, which are faeces-decomposers, is significantly higher in the forest than in the clear-cut area. The soil microarthropods were studied by SEASTEDT and CROSSLEY (1981), and also by ABBOTT and CROSSLEY (1983). They provided evidence that the diminishing litter cover and the

increasing amount of humus resulted in the increasing numbers of *Collembola* and *Oribatidae* similarly to our result.

The soilfauna of an old oak forest and of a clear-cut *Querco-Fagetum* forest were studied by ŠUSTEK (1984), who found that the abundance of *Carabidae* and *Staphyinidae* species after the clear-cutting was lower than in the forest. ŠUSTEK (1984) also claimed that the microclimate of the forest, which is more stable than the microclimate of the clear-cut area, provided sufficient living conditions for the less tolerant species. This led to increased counts of *Collembola* and *Oribatidae*. KABACIK (1957) demonstrated that the diversity of predator species was limited in the forest relative to the clear-cut area. This was also found by KLEINERT (1977), who reported that the counts of *Carabidae* species are higher in the meadows adjoining forests than elsewhere.

We have found no differences in the amount of *Diplopoda, Chilopoda* and *Isopoda* in the different sites. Differences may be realised at a lower taxonomic level.

The vegetation of the forest margin is different from that of the forest and from that of the clear-cut area (MÉSZÁROS, 1988). Based on our data, from zoological point of view, we estimated the forest margin as approximately 10 metres wide. This agrees with the estimation of MÉSZÁROS (1989), which was based on the vegetation. Our result also demonstrates that the fauna of the forest margin is more similar to the fauna of the clear-cut area than to the fauna of the forest. This is explained by the fact that litter cover is much less, and the amount of humus content of the soil is much larger on the clear-cut area. The decreased litter cover and the increased amount of humus content on the clear-cut area were demonstrated by BODNÁR (1987) and HOLES (1989). This leads to increased numbers of *Collembola* and *Oribatidae*. The fauna of the forest is well separated from the fauna of the other sites. In some respects, however, it is similar to the fauna of the northern forest margin. The similarity of the forest and the northern forest margin is caused by the microclimatic similarity of these sites; the humidity is high, the soil temperature is low, and the insolation is lower in the northern forest margin than in the clear-cut area.

On the clear-cut area, the meso- and macro-fauna of the soil are relatively homogeneous, i. e. the similarity of the fauna in the traps was relatively high. It is also noteworthy that the distance from the forest appears to be more important in determining the similarities of the fauna of the sites than the exposure on the slope. The microclimatic conditions (soil temperature, humidity, evaporation, etc.) are extreme on the clear-cut area. Thus, only those species with a broad ecological tolerance are not influenced strongly by these factors. The diversity and phytomass of the vegetation increased after the clear-cutting (KATONA and TÓTHMÉRÉSZ, 1985); this resulted in increased numbers of phytophages and predators among the soil fauna.

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