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DECOMPOSITION PROCESSES AND SOIL MESOFAUNA GROUPS IN POST-FIRE SUCCESSIONAL *PINUS HALEPENSIS* FORESTS OF GREECE

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Abstract

The effects of fire severity on both the structure of soil arthropod community and the cellulose decomposition were studied in a Mediterranean Aleppo pine forest burned by a large-scale wild summer fire. A severely and a less-severely burned stand (at 400m and 660m respectively) of the above forest were chosen for the purpose of this study.

The sampling was carried out from October 1994 to October 1995 and five expeditions were done. The temporal variations of arthropod density were examined by collecting samples of 625 cm^2 from the burned organic horizon and extracting the animals by means of a Berlese-Tullgren apparatus. The cellulose mass loss was studied by using litterbags of medium mesh size containing filter paper of known dry weight.

The findings derived from this approach indicate that the highest the severity of burning, the lower the number and the density of arthropod taxa and the faster the cellulose mass loss.

Keywords: Mediterranean, Greece, *Pinus halepensis* Mill, litterbags, cellulose mass loss, arthropods, organic horizon

Introduction

The decomposition of organic matter accumulated on the soil surface is the primary mechanism by which organic matter and nutrients are returned to forest soils (Aber and Mellilo 1980). The rate of decomposition depends on many abiotic and biotic factors, namely climate, chemical composition of organic matter, structure, moisture and aeration of soil and the synergistic activity of decomposer microflora and saprophagous and microphytophagous invertebrates (Singh and Gupta 1977). Although the contribution of the above invertebrates to the primary decomposition is small, their consumption stimulates both microfloral growth and decomposing activities so that decomposition rates are enhanced (Anderson 1973).

Fire destroys the litter layer, occasionally fermentation and humus layers and, consequently, induces notable changes in the biological activities of the soil subsystem. Despite the ecological

importance of fires in ecosystems of Mediterranean basin, there is scarce information on community structure of soil invertebrates (Athias-Binche 1976, Athias-Binche et al. 1987, Prodon et al. 1987, Sgardelis & Margaris 1993, Sgardelis et al. 1995, Betch and Cancela da Fonseca 1995) and decomposition processes after fire in these regions (Arianoutsou and Margaris, 1982).

The objectives of this study are:

(I) To quantify the organic matter mass loss and

(II) To estimate the soil arthropod density at two sites with *Pinus halepensis* Mill. constituting a gradient of fire intensity.

Methods

A large-scale wildfire on mountain Dirfys burned 700 ha in July 1994. The understorey vegetation before fire consisted mainly of *Quercus coccifera* and *Phillyrea latifolia*. The soil parent material is limestones.

In this forest area two adjacent stands were differentially burned as it is concluded from the layers of organic horizon consumed by fire and the effects of fire on plants. The first stand was severely burned. There were no needles on the pines and the soil was covered by a thick layer of ash with white-gray color. In this stand the organic horizon was completely consumed by fire. The second stand was less-severely burned. Yellow-brownish needles were found on pines and several shrubs were not completely destroyed by fire. In this stand the mineral soil was covered by three layers. The lowest layer was thin and consisted of humus which not completely consumed by fire, the middle layer was a thick black ash layer while the upper layer being also thin consisted of yellow needles fallen after fire-event.

Sampling was carried out from October 1994 to October 1995 and five expeditions were done.

The study of soil arthropod community was realized by collecting sample units with a sharp edge quadrant of 25x25 cm, randomly chosen. On each sampling date 10 samples were collected, that is five samples per stand. In the severely burned stand each sample unit consisted of the ash layer. In the less-severely burned stand the sample units comprised the layer of dead needles, the ash layer and the humus layer. The arthropods were extracted from the samples by means of a Berlese-Tullgren apparatus. The specimens were collected in 75% ethanol solution with 5% glycerine, identified to the level of order and counted under a stereomicroscope.

The decomposition activity in the two stands was studied by estimating the rate of mass loss and the decomposition parameters of cellulose. Filter paper of high quality, that is pure cellulose, was cut in pieces, oven-dried, weighted, enclosed in nylon bags of 100 cm^2 and placed into the ash layer. On each expedition five bags were taken from each stand. Filter papers were oven-dried at 70^{0}C and the dry mass loss of cellulose (soil-free) was estimated after burning in a muffle furnace at 500^{0}C for 4.30 hours.

Results

The temporal distribution of soil arthropods and the rate of cellulose mass loss in the studied stands are showed in the Figure 1 and Figure 2 respectively.

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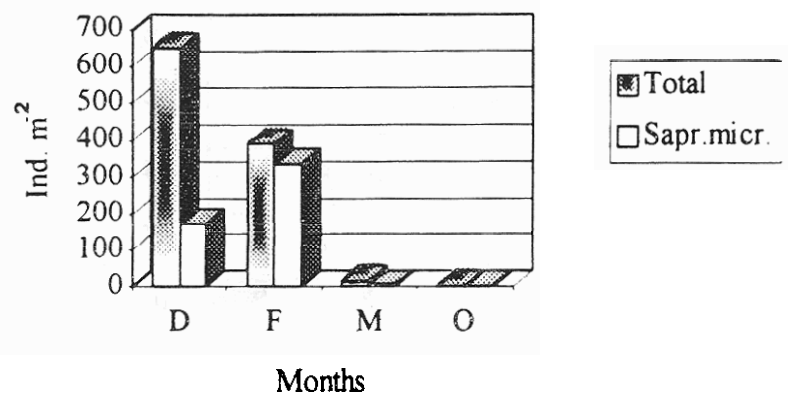

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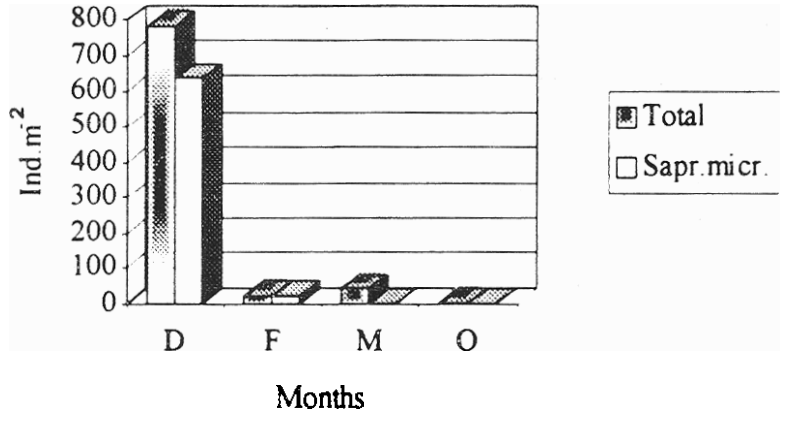

Figure 1. Temporal variations of soil arthropod density in the less-severely (L.S.) and the severely (S.) burned stand

The average density of soil arthropods in the less-severely and the severely burned stand is 350.6 ind.m $^{-2}$ and 279.5 ind.m $^{-2}$ respectively. In both stands the peak of density of soil arthropods occurs in December. In February a second peak of density observed in the less-severely burned stand. From the above figures it is obvious that the second peak of soil arthropods density in the less-severely burned and the first in the severely burned stand are attributed to the saprophagous–microphytophagous microarthropods namely Acarina and Collembola.

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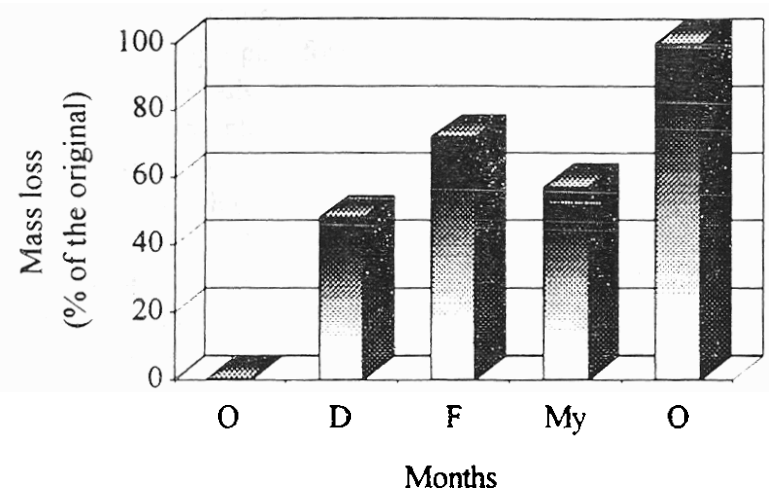

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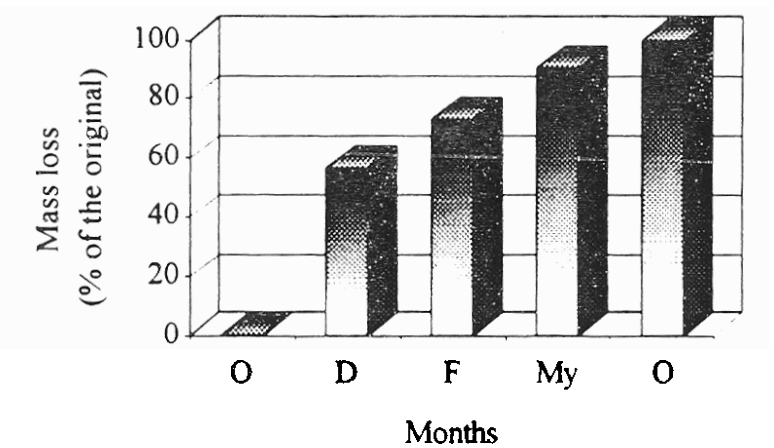

Figure 2. Cellulose mass loss in the less-severely (L.S.) and the severely (S.) burned stand. Data are expressed in ash-free dry mass remaining in the litterbags.

In both stands the cellulose mass loss is completed one year after the placement of the litterbags in the field. However the average rate of cellulose mass loss was found to be higher in the severely burned stand (63.9%) than in the less-severely burned stand (55.2%).

Discussion

Arthropods

The density of soil arthropod taxa estimated in the studied stands are similar to those found in two other burned Aleppo pine forests of Greece (Radea & Arianoutsou unpubl. data) whereas they are much lower- especially the density of saprophagous-microphytophagous taxa- in comparison with those estimated in unburned Aleppo pine forests of Greece (Radea 1989, Marmari 1991). This fact is attributed to the well-known dependence of soil arthropod abundance on both the amount of dead organic material which is accumulated on the mineral soil surface and the structural diversity of their habitat (Gill 1969, Seastedt and Crossley 1981, Bultman and Uetz 1984). Fire consumes the accumulated organic material and, consequently, reduces the quantity of available food for saprophagous taxa and alters the structural complexity and the physicochemical properties of soil organic horizon (Sgardelis and Margaris 1993, Giovannini and Lucchesi 1997).

Decomposition

The faster disappearance of cellulose mass in the severely burned stand can be explained taking into account the factor controlling the decomposition in the two studied stands. Both stand are located at high altitude and during winter are usually covered by snow for many days especially the severely burned stand. Therefore, the temperature seems to be the main environmental factor controlling the decomposition processes before the fire-event. Since the temperature of the soil raise after fire and the greatest the severity of burning the higher the soil temperature (Neal et al. 1965), the higher rate of cellulose mass loss in the severely burned stand could be easily intercepted.

However the rate of cellulose mass loss in both stands indicate a rather rapid recovery of the ability of soil organisms to decompose the filter paper likewise in phrygana (Arianoutsou and Margaris 1982, and jarrah forest (Springett 1979). On the contrary in Australian pine plantations the decomposer system requires a recovery period of at least twenty seven months before being able to function efficiently again (Springett 1976).

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