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Collembola indicators of soil fertility

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Abstract

Pines, cedars and associations of the populations of forests are the most important types of trees in the study area. Fire is the main disturbance of the dynamics of these forests. This study aimed to analyze possible differences in chemical and biological properties of soil between six types of forest: A: burned and replanted forest with *Pinus* sp; B: Burned forest and not reforested; C: unburned forest and reforested; D: No burned and not replanted, young forest; E: Not burned and not reforested; the fire had occurred 11 years before the study. Soil properties were measured in the first 10 cm of depth that has more influence on forest recovery: Protein, humidity, dry matter and content of nitrogen (N). Burned and replanted forests had a higher protein concentration due to the type of forest and vegetation, which means that in 11 years it had regenerated by itself and the species with which this area was reforested it has prospered and the soil has good concentration of nutrients. The extreme values of proteins decrease the population of springtails. After a fire is desirable that the vegetation is restored as soon as possible to mitigate the potential loss of nutrients and promote the recovery of soil properties, which can be benefited by planting *Pinus* sp and associated with native species such as oak, fir and *Quercus*.

***Pinus*, colembolo natural forest, fire effects, postfire soil conditions.**

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Introduction

In the last decade, extensive forest fires have occurred in most continents, affecting a wide range of ecosystems (Williams & Bradstock, 2008) and the forests of the central area of Mexico have been no exception. The ecological consequences of these fires are site specific and highly associated with reproductive mode of the dominant species and the subsequent weather conditions the fire (Veblen et al., 2008). To help restore the affected ecosystems and fire management planning in these native forests, it is necessary to advance knowledge about the effect of the disturbance on the various components of the ecosystem and its resilience.

Within animal groups that live in the soil, the most important are the springtails and oribatid by their number, diversity, species abundance and activity mites. These groups are considered biogeographic and ecological indicators because of their great aptitude for speciation, estenotopía, short life and little power of dispersal of species adapted to the soil life and different soil types, and their eating habits, as degrading organic matter (Johnston, 2000; Palacios-Vargas, 2003).

Most springtails feed on fungal hyphae or decaying plant matter (Brown-Meneses et al., 2004). There are also some predatory species that feed on nematodes, rotifers and other springtails (Rusek, 1998; Palacios-Vargas et al; 2000). By its feeding they play an important role in the decomposition of organic matter and control the populations of bacteria and fungi (Palacios-Vargas et al., 2000).

Collembola are very valuable to soil structure, since most soils contain millions of its "pellets" that delay release of essential nutrients benefit the plant roots, as well as serving as a substrate for many microorganisms.

Collembola are prey to many insects, especially ants and beetles, as well as numerous predatory mites, which are a key element in the food chain (Palacios-Vargas et al., 2000). Its abundance, diversity of species and characteristics provides information on the environmental impact of ecosystems.
For areas of burned forests, there is little information regarding the use of soil fauna as bioindicator let alone using springtails, so it is necessary to study the relationship of soil components in burned forests

Objective

Relate soil nutrient status of a pine-oak forest, where a wildfire was presented with populations of springtails.

Relate the five types of variants pine oak forest species studied were developed in each of them.

Hypothesis

There is a direct relationship between the presence and size of populations of springtails and soil nutrient status.

Materials and methods

Study area. In the study area the prevailing climate is temperate humid summer long with average annual rainfall between 500 and 1,000 mm also have an annual average temperature of 15 ° c., with an average for most warmest months 10 ° C and for the coldest months can occur temperatures ranging from -3 to 18 ° C, have four distinct seasons; a relatively hot summer, autumn gradually lower temperatures with the passage of time, a cold winter and spring with higher temperatures gradually with the passage of time. No extreme weather events (Romero, 2009) is presented.

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The town lies at an altitude of 2.480 meters. The vegetation of the study area occurs in the low hills toward the high end, in the foothills of the Sierra Nevada, in the lower parts of predominantly agricultural land use temporary and the plains some areas with irrigated agriculture are located.

Collembola collection. The material studied corresponds to eight collections of litter per site six sampling sites pine and oak were established in the town of Tequexquinahuac, Texcoco, State of Mexico, these collections were made weekly from 2009 to 2010. In each study site were established at randomly 1 m^2, which constituted the sampling units, they were located in different zones of the study area with six types of forest. These experimental units were established in October 2009 to 2010 in the six sites, corresponding to a period of 11 years after the event the fire that occurred in 1998. Each of these six sites was considered as a treatment and as different sample points repetitions of each treatment.

Soil properties. In October 2009, 11 years fires have occurred sampling to analyze soil properties was made; in the same six sampling sites springtails. The four parameters or soil factors, with a fundamental character as soil descriptors were: protein, moisture, dry matter and nitrogen (N). To these they were sent for analysis in the laboratory of Animal Science at the Universidad Autónoma Chapingo.

Analysis of data

Data were analyzed for each location considering the six treatments (Forest types) with their respective repetitions (A: n = 6, B: n = 6, C: n = 6, D: n = 5, E: n = 5) by analysis of variance (ANOVA), assuming that the sampling error represents the experimental error.

Prior to the ANOVA assumptions of homogeneity of variance and normality were examined. Tukey-Kramer, which is a modification of the Tukey test for designs with the SAS System 2009 program used in each of the analysis and to determine from what treatments there were differences significant.

Results and discussions

The Braquistomelidae family had a larger population in the site C, followed by site D, after the Site, Site B and A respectively.

The largest population of the Isotomidae family appeared at the site C, followed by site D, E, B and A respectively.

Entomobridae families, and Sminturidae Onychiuridae occurred in similar proportions in the five sites and fewer regarding Braquistomelidae and Isotomidae families (Figure 1).

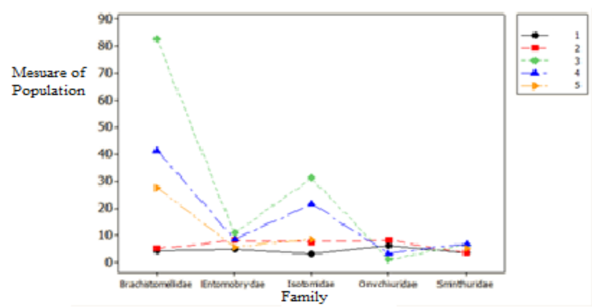

Figure 1 Population of springtails per family in the five study sites

* 1: Site A; 2: Site B; 3: Site C; 4: Site D; 5: Site E.

The greater abundance of Isotomidae, is attribuited to their species, that have been recorded as highly adaptable to disturbance caused by agricultural and forestry practices, and as mentioned Mendoza et al. (1999), they can grow in soils with low or high organic matter content (Figure 2).

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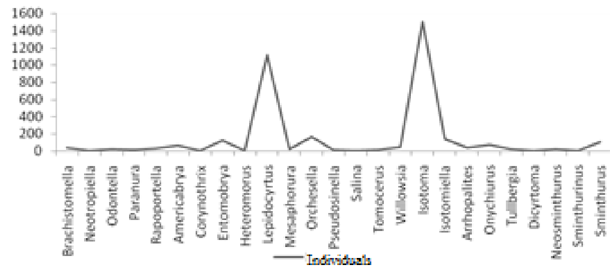

Figure 2 Population density of springtails per family present at the study sites

Statistical analysis

In the ANOVA results for populations of Collembola was no significant difference among the six types of forests pvalue = 0.0002.

In the mean comparison Tukey-Kramer high values of population of Collembola was observed in forest type C: unburned forest and reforested, although there was no significant difference with the D: Forest unburned and not replanted, young forest; where if there was significant difference from previous treatments but not to each other were: A: Burned forest and reforested; B: Burnt forest and not reforested and E: No, not reforested burned, old forest. They corroborate with Figure 1.

The ANOVA for Protein significant difference between sampling sites pvalue <0.0001 and mean comparison Tukey-Kramer found that the best treatment was the forest B: Burnt forest and reforested; although there was no significant difference with the forest C: unburned forest and reforested; where if there was significant difference from previous treatments was the D: Forest unburned and not replanted, young forest, and treatments had lower concentration of nitrogen were E: Forest unburned and not replanted, old forest and A: Forest burned and reforested

Site A (burned and reforested with pine forest) showed a decrease in proteins that are composed of nitrogen and hydrogen, this decrease is due to the tree species with which they replanted the site because in the pine needles a decrease is observed the activity of the soil microfauna that gives rise to a lower rate of litter decomposition and therefore better protein production. The cause lies in the chemical-nutritive pine litter, poorer in calcium and rich in nitrogen and resin compounds as inhibitors, waxes and lignin as indicated Schlatter and Otero (1995) features.

For forest type B (Burnt forest and not reforested) also presented a poor population of springtails but a high amount of nitrogen and hydrogen, elements that make up the protein (reflected in the Tukey-Kramer tests because they were the same results), this relationship is because in soils with excess nitrogen is a significant decrease in populations of springtails as shown Kopeszki (1997) who observed a decrease in the growth and abundance of populations of Collembola, due to the presence of acids (SO4), heavy metals and excess nitrogen fertilizers in soils. As a result, the rate of decomposition, kolMO was lower.

For forest type C: unburned forest and reforested and D: Do not burned and not replanted, young forest; had the largest population of springtails and also had a lot of protein (nitrogen, hydrogen) moderate, these forests have similar features because both were not burned; C was reforested, and D was not reforested but a young forest which can be deduced that have greater diversity of species which favors the presence of springtails in the soil. The growth rate of the population of springtails serves as a biomarker of health or soil quality as indicated Kopeski (1997). Overall the response of different ecosystems to changes in nitrogen vary with the type of vegetation, soil fertility and the ability to replenish (Wan et al., 2001).

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Fire generates different conditions on the ground, which may have implications for the emergence of seedlings (Kennard and Gholz 2001) as in *Pinus* sp. (Pauses et al., 2003). (Urretavizcaya 2005, 2006) indicates that regeneration in the short term is not controlled only by changes in soil fertility, but by a combination of factors such as the availability of seeds and changes in soil temperature patterns in the areas burned, associated with changes in tree and shrub cover after the fire (Urretavizcaya et al., 2006), factors that match the Kitzberger et al; reported. (2005).

The results of this work can contribute to recommendations regarding the further handling of a fire in the forests of the region Tequexquinahuac or regions with similar climatic conditions and vegetation in this area. It is widely known that the greatest risks of erosion after fire occur in the rainy season immediately after the disturbance (Goh and Phillips, 1991; DeBano, 2000; Robichaud et al., 2003; Neary et al., 2005; Cerda and Doerr, 2005). It is also known that timber harvesting may increase the risk of erosion and nutrient loss (Beschta et al., 1995, 2004, 2000 McIver and Starr, Page-Dumroese et al., 2006). Ensure that the post fire vegetation is established to mitigate potential losses of nutrients and promote the recovery of soil properties prior to the extraction of wood can be burned along with restoration planning for planting, a measure to implement in the management of these areas

Conclusions

Forests C and D have a higher population of springtails, which means that this type of organisms are highly sensitive to disturbances such as fires and changing vegetation when these forests are replanted.

The B and C sites had the highest concentration of protein due to the type of forest and vegetation, which means that it was regenerated in 11 years and the species with which this area prospered reforested and the soil has good concentration of nutrients.

The high concentration of proteins containing nitrogen and hydrogen reduce the rate of reproduction of Collembola and therefore their populations.

Pines by its high concentrations of inhibitors such as resin, waxes and lignin decreases decomposition rate by Collembola litter and hence protein production.

Populations with high density of Collembola was found that occurs in ground conditions with moderate protein concentration. The forests where disturbances such as fire and reforestation, did not showed the highest population of collembola.

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