Forest fire has no significant effect on abundance or diversity of edaphic arthropods at CERA

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Introduction

In a forest ecosystem, edaphic (subterranean) organisms can compose over 80% of the zoomass (Perry 1994). Invertebrate soil fauna are important for decomposing dead plant material and recycling nutrients and make up an intrinsic part of the forest food chain (McCullough et al. 1998). It is therefore important to investigate the environmental factors that can alter their population.

Fire is an environmental factor that can have great impact on various communities, including forests (Whelan 1995). It is used as a managing agent in forests, both to regulate vegetative growth and as a means of insect control (McCullough et. al. 1998). A forest's soil arthropods are affected by fire in two main ways. First, they can be killed directly by the blaze. Second, fire alters the arthropods' habitat by changing the composition of forest vegetation and by disturbing the balance of soil chemicals, water levels, and soil pH (McCullough et al. 1998; Spurr and Barnes 1964). These factors affect both their abundance and their diversity (Paquin and Coderre 1997).

We conducted our study of the effect of fire on edaphic arthropods at the Conard Environmental Research Area (CERA), an experimental prairie restoration project owned and managed by Grinnell College. The area contains many different communities including wetlands, savanna, and forest, all surrounded by prairie. We carried out our fieldwork at the Upland White Oak Forest in the northeast corner of the grounds. As a part of its management program, this forest fragment was subjected to controlled burns in April 1997 and November 1998 (DeLong 1998). We hoped to determine whether fire helps to promote a healthy forest community by investigating the response of CERA's woodland edaphic arthropods to fire, measured according to arthropod abundance and diversity.

McCullough et al. (1998) found that while controlled burns designed to reduce specific soil arthropod populations were met with limited success, the overall abundance of arthropods declined after said burns. Therefore, before we started the experimental observations, we expected that fire would decrease the abundance of arthropods while maintaining their diversity.

Materials and Methods

On the afternoon of October 14, 1999, we collected soil samples from the upland white oak forest of Grinnell College’s Conard Environmental Research Area. We sampled from nineteen moisture and eventually dropped into beakers containing 70% ethanol, where the specimens were preserved. We then used dissecting microscopes to examine and classify our specimens by order. We compared mean abundance and diversity of burned and unburned plots, using a T-test and Simpson’s Index. We also generated rank-abundance curves for both treatments.

Results

Mean total arthropod abundance did not differ between burned and unburned forest plots (*T*=.21; df=15; *P*=.83) (Figure 1). The total arthropods included specimens in the orders Acari, experimental plots measuring 25 x 25m in a checkerboard configuration, alternating according to burn treatment. We collected 10cm-deep soil samples, each taken from five randomly-selected points within each plot. We randomly selected 17 of the 19 samples because of equipment limitation and combined the five samples from each plot and placed them in Berlese funnels. The soil samples dried under 40 watt bulbs for five days. As the soil dried, the soil organisms moved down towards the Nematoda, Diptera, Hymenoptera, Coleoptera, Ephemeroptera, Homoptera, Hemiptera, Thysanoptera, Pseudoscorpions, Mecoptera, and Araneae. The order with the highest number of individuals for both treatments was Acari, while the numbers of other orders were too small for reliable statistical analysis (Figure 2). Therefore we analyzed Acari separately to see if it significantly affected the statistical results. The average number of Acari did not differ significantly between burned and unburned plots (*T*=-.16; df=15; *P*=.87). Order richness also was unaffected by burning, as burned plots had a mean of

Figure 1. Average total number of arthropods per plot unburned forest plots (n=17) and 95% confidence sh

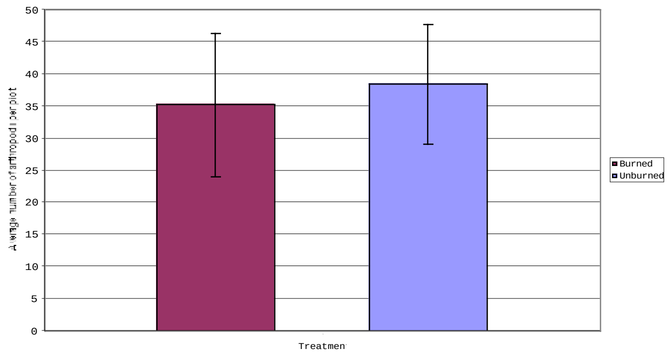
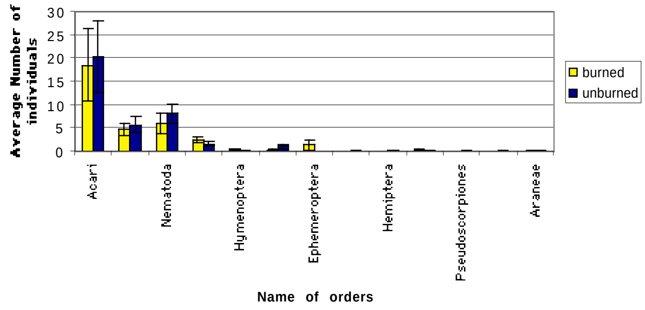


Figure 2. Average number of individuals of arthropod orders in burned and unburned forest plots (n=17) and 95% confidence intervals are shown.



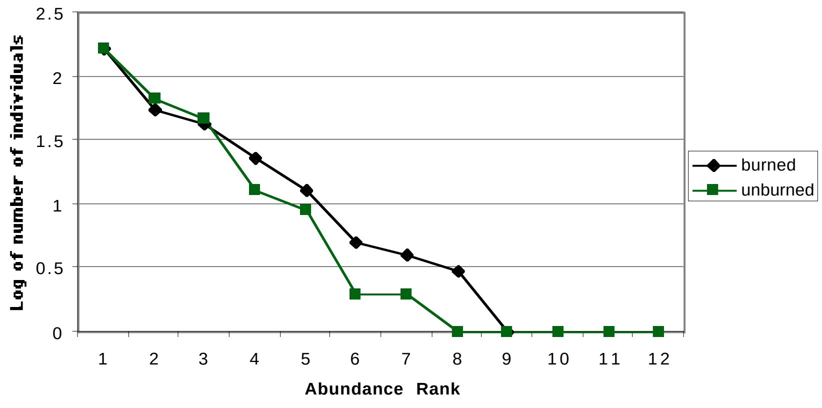
4.9±.633 and unburned had a mean of 5.5±.378 (*T*=.80; df=15; *P*=.43). Burning did not significantly influence and burned had a mean of 3.12± 1.30(*T*=-.47; df=15; *P*=.64). The rank-abundance curves for burned and unburned plots were comparable showing little variation between the treatments (Figure 3).

Discussion

We found that the abundance and diversity of edaphic arthropod populations does not vary significantly between burned and unburned forest plots. Therefore, we accept the null hypothesis and reject our alternative hypothesis that there would be fewer arthropods in burned forest plots. While some experiments show both short- and long-term effects of forest fire on edaphic arthropods (Kozlowski and Ahlgren 1974), other findings help explain why we found no significant difference between plots. For example, McCullough et al.(1998) found that while burning may have an immediate effect on arthropod diversity, as measured by Simpson's index as burned plots had a mean of 2.88± .377
edaphic arthropod populations, migration and reproduction allow them to repopulate the burned area quickly (also Spurr and Barnes 1964, citing Ahlgren). Even after a sharp fire-induced decline in arthropod population, McCullough et al. (1998) found that a rain shower helped to spur a population growth, and within three years the population was back to pre-burn levels. Although less than three years have passed since the last burn at CERA's oak forest (DeLong, 1998), the size of our plots most likely had a large impact on our results. The plots are relatively small and each burned plot is surrounded by unburned plots, which allows for rapid repopulation of burned areas by migration and reproduction.

The rapidity with which soil pH, moisture, and micro-organism levels restore themselves after fire helps to explain why arthropod abundance and diversity did

Figure 3. Rank abundance curves for total arthropod population in burned and unburned forest plots (n=17).



not differ in burned and unburned areas (Spurr and Barnes 1964; Ahlgren et al. 1965). The faster their biological niche (the soil of the forest floor) returns to normal, the faster the arthropods can re-inhabit the area. At CERA, Besse et al. (unpublished data 1999) found that soil pH and moisture did not vary significantly between burned and unburned plots. The similarities between the composition of soil in burned and unburned plots suggests that the arthropods' habitat had returned to its pre-burn state.

both burned and unburned plots, indicating that CERA's burn schedule has not deprived the forest of the necessary decomposers.

Based on our findings on how fire affects below ground arthropods, we can conclude that fire may not be a necessary management tool. Fire does not eliminate arthropods which are necessary to keep the forest healthy, nor does it promote their expansion and growth. Although our study found that fire management does not adversely affect arthropods in the long run, we do not know how arthropods react immediately after a fire. Scientists concerned with forest management should collect soil samples directly after the burn, and continue to do so periodically for a year in order to see the difference in arthropods' short- and long-term reactions to forest fire. This information will be useful in making decisions about forest management.

We found that Acari (mites and ticks) was the most prevalent order of edaphic arthropods at CERA's oak forest. Our order-abundance curve (figure 3) shows the dominance of the Acari order, which is supported by other studies (Perry 1994). Acari's prevalence is highly important to the forest ecosystem because they are mostly saprophytes, which facilitate the decomposition of dead plant matter and allow nutrients to be recycled (Paquin and Coderre 1997). Acari is still prevalent in

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