Microfauna food preference and removal across UMBS burn chronosequence

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Abstract

The University of Michigan biological station burn plots are representative of a secondary successional chronosequence, describing forest succession atop a sandy outwash physiography. We examined arthropod preference between four treatments of rice throughout five different burn plots on property (1911, 1932, 1964, 1980, and 1998 burns). Rice grains were kept plain, or coated in butter, sugar, or salt, and then placed into the burn plots. To ensure only microfauna gained access to the food, we crafted wire cages to enclose the four rice treatments. We placed cages in each burn plot for 24 hours. We collected replicates and counted the remaining grains of rice to determine total food removed, and then analyzed the results for each treatment. We found no significant results in difference in arthropod food preference, however we did find a statistically significant difference in amount of rice removed in the different burn plots. We also found a significant difference in units rice removed of the butter and sugar treatments, compared to the control group. We observed a decrease in rate of food consumption across older forests. We believe temperature to be a more influential environmental condition than we had anticipated. 24 hours is not indicative of the average conditions of any forest, possibly resulting

in our inconclusive data, but we hope our research can better help understand the influence forest age has on its microfuana community and their search for food.

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Introduction

Forest successional history influences animal diversity and species composition. Mature forests have been observed to offer the highest functional diversity, and as succession of a forest continues, existing communities broaden their occupied regions (Whitfeld *et al*., 2014). These relationships and patterns of succession offer information about an ecosystem and its future. For example, geographical patterns of ant colonization are used as indicators of ecological change (King *et al*., 1998). One study found that influential plant species in forest succession will most likely be unable to disperse quickly enough to keep up with climate change, therefore altering distribution of fauna that rely on those species (Davis, 1988). Long term ecological processes, such as climate change and forest succession, are difficult to study since data are only available after large stretches of time.

There are five experimental burn plots on property at the University of Michigan Biological Station that represent a chronosequence of differently aged plots within an ecosystem. Across a chronosequence there is variation in soil pH, flora diversity, and limiting resources such as nitrogen and magnesium (Lichter, 1998). We wanted to see if this variation influences arthropod preference for certain nutrients. The burn plots offer a look at slow-paced processes, such as secondary succession of a forest after a fire, without time acting as a limiting factor.

Ecosystems are experiencing change on a wide-scale level at an alarming rate. Before recent conservation efforts were enacted to limit human impact, deforestation was wiping out 25,000-50,000 km^2 of land per year in the Amazon rainforest (Shukla *et al*., 1990). Disturbance is a natural process observed across all environments, such as the process of deforestation, a form of secondary succession, similar to forest fires, attributed to human influence. We looked to see if arthropods have a preference between rice coated in sugar (carbohydrates), rice coated in salt, and rice coated in butter (lipids), and if amount consumed varies across the burn chronosequence. We hypothesize the microfauna will seek out the energy-rich simple carbohydrates found in sugar, and that food consumption by arthropods in a recently disturbed area will be lower than a more mature forest, due to their being fewer species. Mature forests have a more complex and layered canopy (Barnes, 1980). We hypothesize that due to canopy coverage creating shade on the forest floor, arthropod food consumption will be inversely correlated to soil surface temperature. As mentioned earlier, disturbance is coupled with a decrease in animal species diversity. We also hypothesize that we will see a similar trend of decreasing number of species with decreasing forest maturity. To help answer our questions, we analyzed biotic and abiotic forest ecosystem interactions.

Methods

We cooked 2,000 grains of long-grain rice in boiling water for 15 minutes. Once they were cooled and blotted dry with paper towels, we coated 500 of them in about three tablespoons of powdered sugar, 500 in three tablespoons of unsalted butter, and 500 grains in three tablespoons of table salt. We kept the remaining 500 grains plain for the control group. We analyzed food removal at the 1911, 1936, 1954, 1980, and 1998 burn plots. Petri dishes held 10 grains of one type of rice, and we positioned a 6x5x1cm five-sided cage made of chicken wire above four petri dishes, all containing differently treated rice. The cages ensured no macrofauna took any of the food. We randomly placed five groups of four, two meters apart in a section of each burn plot, totaling 100 food samples; however, we repeated the process two separate occasions. We placed the food out at 8 am, August 4th, and again on the 9th. At the end of the 24 hour periods, we retrieved the petri dishes and determined units of rice removed.

We used a one-way ANOVA to examine the difference in number of species across the five burn plots, and a two-way ANOVA to compare the amount of each type of food removed across the different burn plots. Similarly, to examine temperature correlation with food removal, we ran a regression analysis with temperature data.

Results

We found no significant results to indicate there was a preference for type of food removed, however there were differences between the differently aged burn plots. We used SPSS to perform a one-way ANOVA comparing average units of rice removed across the different treatments – uncoated rice, butter-coated, sugar-coated, and salt-coated, and found no statistically significant results among the four treatments (F_3, 199 = 2.340, $p > .05$; Fig. 1). We also performed a one-way ANOVA comparing the average number of grains of rice removed across the five burn plots. There was a significant difference in average number of rice removed between the five plots (F_4, 199=9.403, $p< .01$; Fig. 1). Rather than there being greater food removed at older plots, we found that the youngest two plots allotted greater food removal. A two-way ANOVA was used to analyze preference in food type consumption between the different plots. We found no significant results between the four treatments and the age of the burn plots (F_{12}, 199 = 1.605, $p > .05$; Fig. 1) We also performed a post-hoc comparison using the Fisher LSD test that determined the 1936, 1980, and 1998 burn plots had significantly more grains of rice removed than the remaining two plots. The post-hoc comparison also identified the butter-coated rice grains and the sugar-coated rice grains were removed significantly more than the control rice, but there was so significant difference between the butter and sugar-coated rice. We are lead to believe that microfauna populations do in fact differ across the differently aged plots, but their preference for certain food is either nonexistent, or does not depend on forest age. We performed a regression analysis on a forest's age impact on mean units of rice removed. We observed a trend between increase in forest age and a decrease in rice removed, but results were not statistically significant.

Discussion

Contrary to our hypothesis, we observed a negative correlation between the age of UMBS burn plots and food removal. We attribute this deviation from the expected outcome to the high albedo found within the younger burn plots. Older forests tend to have a more established microfauna community, but they also see a decrease in soil temperature with the increase in canopy complexity. Decreased temperature poses a threat on terrestrial arthropod's metabolic rate, and therefore its locomotion and feeding habits (Block, 1981). We suggest that the rate of food consumption completed by forest microfauna relies heavily on the ambient temperature, and while an increasing trend is also seen with forest age, the burn plots we observed were still too young to observe any age-based correlation. We failed to recognize the timeline of forest succession, and how long the process is in comparison to the start of the burn plot chronosequence. The oldest plot we analyzed is 104 years old, yet old-growth structural characteristics are not observed in forests until they reach 275-300 years old (Luch *et al.*, 1994). The 1911 burn plot may be the oldest stand we looked at, but it is far from old growth, and therefore has not yet reached its species carrying capacity.

We suspect the observed results were due to a combination of forest age and albedo. Younger forests have greater solar radiation reaching the surface of the soil, and thus the fauna that live there. The increased heat allows for higher metabolic rates of the organisms, which in turn consume more food, as well as provides a source of energy to move farther and faster away from their homes. We recommend future studies to observe temperature's influence on food consumption. This phenomenon combined with the increased animal diversity found in older forests may result in the trend we observed. The 1964 burn plot is comprised of many tree individuals with a complex canopy, lowering soil surface temperature, resulting in the microfauna having slower metabolic activity. Similarly, the plot is not developed enough to have the diverse microfauna communities needed for high rates of food consumption. Older forests may receive less solar radiation on their topsoil, but the increase in number of animal individuals may keep the rate of food consumption high.

We suggest future studies encompass both temperature and forest age, and their influence in rate of food consumption on the forest floor. Also, we recommend longer trial periods to better include the average conditions of a forest. In doing so, results will be more indicative of abiotic factor's influence on food removal in a forest community.

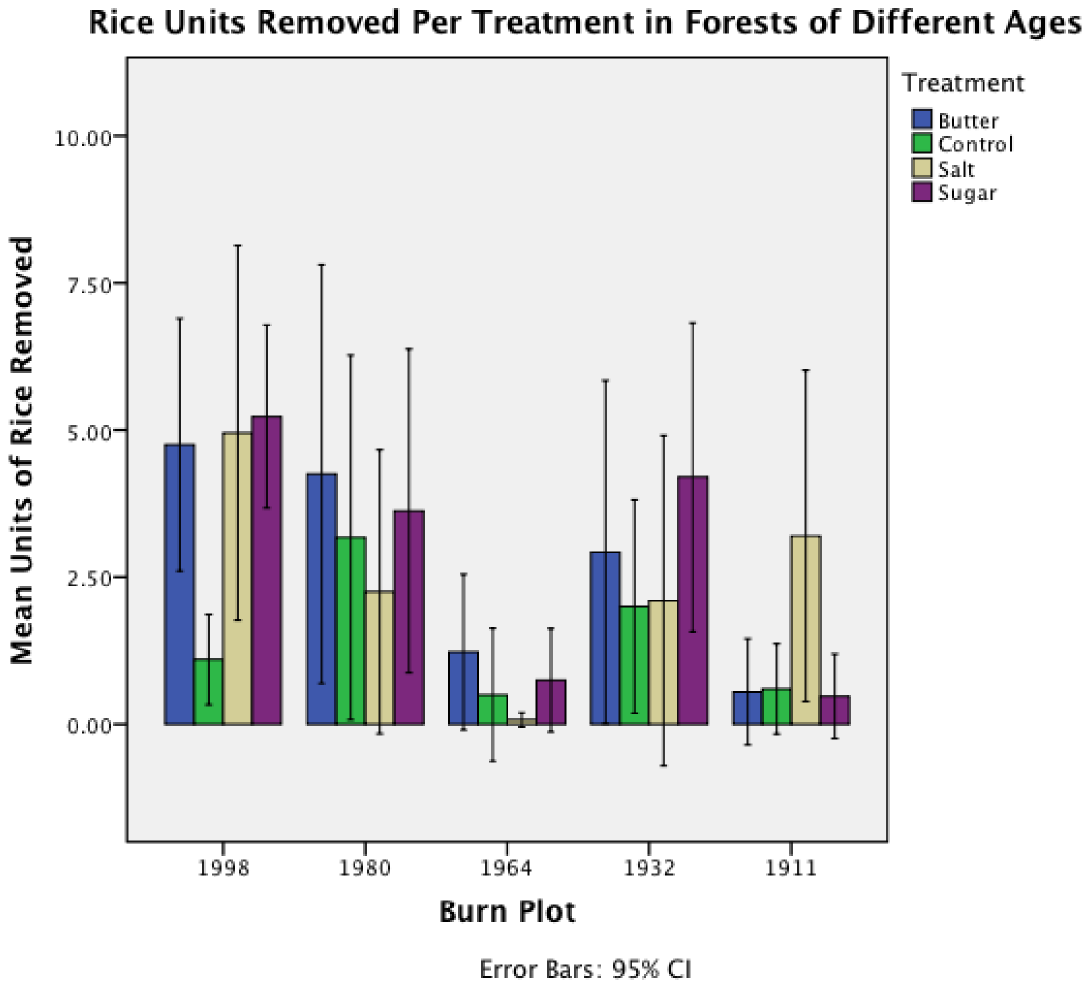

Fig. 1 Two-way ANOVA depicting mean units of rice removed of the different treatments across burn plots.

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