

Biotic and Abiotic Effects on Ant Community Structure

Julie Anne Sara Nilsen
Nathan Sanders, mentor
REU Program, RMBL
June – August, 2002

Abstract

Previous studies have shown that plant species diversity, habitat type, elevation, and temperature affect ant community structure. In this study, I examined the roles of these factors at 10 sites in and around Gothic, CO in aspen stands and meadows. Data gathered through baiting experiments and pitfall trapping found that there was no significant difference in the species richness between habitats. There was a difference, however, in ant abundance, with significantly more ants in the meadow than the aspen stand. There were also no significant effects of elevation, temperature, or plant species diversity. However, trends suggest that these factors may influence ant activity in meadows.

Introduction

A primary concern for many scientists is the homogenization of many of the Earth's ecosystems. This homogenization is due primarily to human interactions involving the extinction of native taxa and introduction of exotic species. One of the biggest fears concerns the lack of information about the ecosystem-level consequences of species extinction. Many studies are being done to try to determine the importance and roles of a particular species to ecosystems in which they live. Other studies attempt to understand the factors that influence species richness. Some factors are already known for some species, ranging from moisture, food type, energy, competition, and symbiosis, but this is only for a few species. More studies are being conducted in attempts to deduce the effect of interactions and abiotic factors on ant community structure, and answers are slowly starting to emerge, but many are trends that have yet to be applied to other communities.

Gotelli and Ellison (2002) found that latitude, along with elevation, was one of the most important factors in determining ant species density in New England bogs and forests. They also found a correlation between species density and the vegetation type, suggesting a relation between energy and community structure. Yanoviak and Kaspari (2000) found a significant difference in community structure between ants in tropical litter versus ants in the canopy. They found that due to the differences in habitat, ants have been selected for particular qualities. Specifically, they found that there were differences in the frequency and type of aggressive and defensive behavior as well as differences in the mean body size of species between the two habitats.

These studies suggest that there are multiple factors that can affect ant community structure, such as vegetation type, energy, habitat type, latitude, and interspecific interactions. If the same suite of factors affect ant community structure across multiple habitats, it would be likely that the findings stated above would also be true of the ant communities in Southwest Colorado.

Materials and Methods

At 10 Sites in and around Gothic, Co, I compared ant community structure in aspen stands and adjacent meadows. In each meadow and forest, I placed a 20 m x 20 m grid with flags marked out every 5 m, creating a 5 x 5 array in each of the habitats. At each of these sites, a number of tests and methods were conducted in order to determine ant species diversity, abundance, and interaction among species. These were pitfall traps, plant surveys, and baiting.

The pitfall traps were centrifuge tubes partially filled with a 1:1 ratio of water and Ethylene glycol buried so the lip of the container was flush with the ground. The traps were left

out for 48 hours. At the end of this period, the traps were collected and the contents were fixed with ethanol. All ants were identified and counted.

Plant sampling was conducted at five randomly chosen locations in each habitat. Specifically, the numbers of species in 0.5 m x 0.5 m plots chosen randomly about a flag were counted. In addition, the total number of species in each habitat as a whole was recorded. This gave a record of the species richness in the two habitats of each site.

Baiting experiments were conducted to examine interspecific interactions, species abundance, richness, and temperature. Every site was baited on two days. Each day of baiting consisted of placing 12 baits of 15 mL tuna and 12 of a cotton ball soaked with sugar water (1 cup sugar to 1 gallon water) on white index cards (7.6 cm x 6.4 cm) on the ground. The baits were placed in the same 5 x 5 array with one flag randomly chosen not to have bait for that day. Each bait was observed for 1 minute over a 1-hour time period. During this time the surface temperature at the bait and time observed were recorded, along with observations on which species came to the bait, relative abundance of each species, and interactions between species (specifically dominance and subordinate relationships).

Results

Individual factors defining habitat

Aspen stands and meadows did not differ significantly in the mean number of plant species ($t_{\text{paired}} = -1.02$, $df = 9$, $p = 0.34$) and the mean number of ant species ($t_{\text{paired}} = 1.35$, $df = 9$, $p = 0.21$). However, there was a significant difference in the abundance of ants between habitats ($t_{\text{paired}} = 4.26$, $df = 9$, $p = 0.002$). Temperature did differ between the two habitats (fig 1).

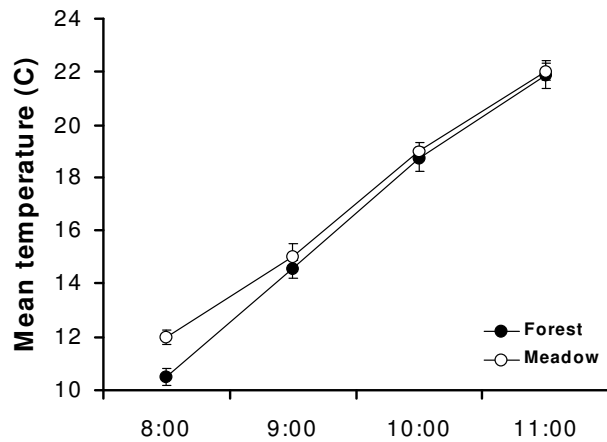


Figure 1: Mean temperature difference between bait cards in forest versus meadow. The two habitats begin at statistically different temperatures, however, they grow at about the same rate to a similar temperature.

Baiting and food preference

In comparing the number of different species that visit the two types of baits, protein (N) and carbohydrate (CHO), there was no difference in the number of species at baits of difference resource types or of different habitats (fig 2a). Ant abundance at baits did depend on the type of habitat ($p = 0.03$, $df = 1$, fig. 2b). Yet, there is still no correlation between ant abundance and food type ($p = 0.62$).

Individual habitat factors affect on ant activity

When elevation, plant species richness, and average temperature are taken into account, some trends appear concerning ant species richness and activity in the meadow (table 1).

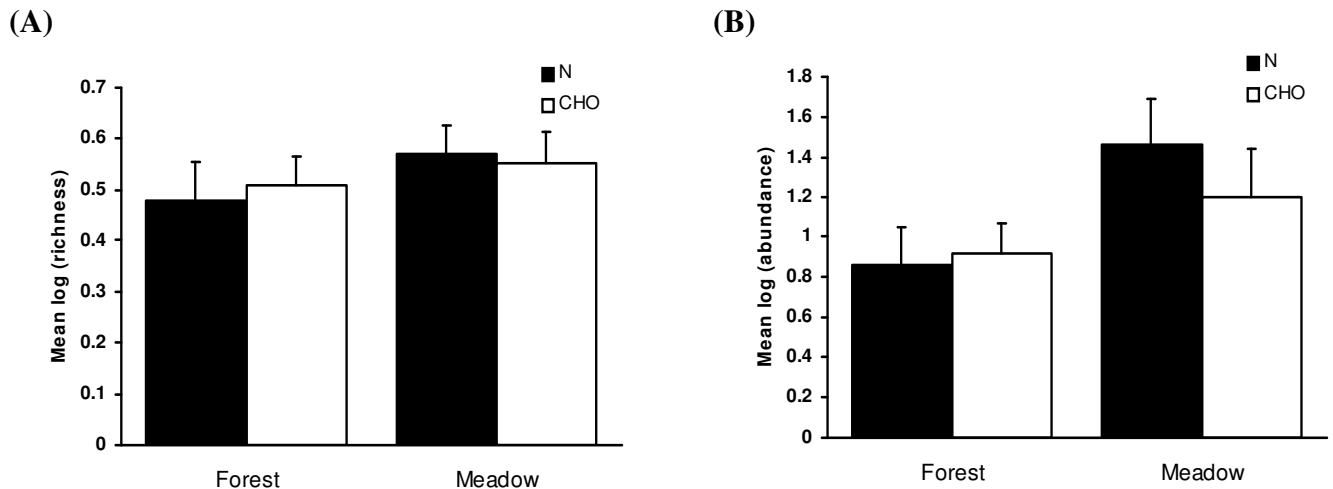


Figure 2: There is no statistical correlation between food type in species richness in either the forest or the meadow (a). However, there is a statistical correlation between food type and ant abundance, but no correlation to food type (b).

		R ²	P
Forest	Species richness	0.26	0.59
	Activity	0.03	0.52
Meadow	Species richness	0.59	0.12
	Activity	0.66	0.07

Table 1: Effects of plant species richness, elevation, and average temperature on ant species richness and activity.

	Coefficient	SE	t	P
Elevation	0.007	0.004	1.69	0.14
Plant species richness	-0.127	0.055	2.3	0.06
Average temperature	0.108	0.043	2.49	0.05

Table 2: Effects of plant species richness, average temperature, and elevation individually on ant activity.

Although there is no statistical significance, there is some suggestion that these factors may have some effect on ant species richness and ant activity. These effects become more apparent when looking at each individual factor on ant activity alone in the meadow (table 2). However, in the forest, no trends appeared concerning any of the three factors on ant species richness or activity (table 1).

Discussion

Yanoviak and Kaspari (2000) found a difference in food preference between the canopy and the leaf litter of tropical forests. Simply a difference in habitat would suggest that there should be a difference in resource availability. Because of this, it would appear that there should be a difference in food preference between aspen stands and meadows, yet no significance was found. This is likely due to the lack of difference in species richness between habitats. One would assume that if there is the same plant species richness, then there should be no difference in food availability, consequently no difference in food preference.

The lack of difference in plant species diversity also affects the ant species diversity between the two habitats. Previous findings support that there should be no difference in ant species diversity because there is no diversity in the plants. The only difference between the two habitats that appears is the difference in ant abundance. As would be expected in any forest, there is less sunlight reaching the floor than in the meadows. Consequently, there is less energy

available in forests. This statement is supported by the mean temperature difference between habitats; it is warmer in the meadow earlier in the morning, inferring that there is more energy in the meadows. There is enough plant species diversity to sustain a slew of ant species in the aspen stands, but because there is just less energy in the aspen stands, less density can be maintained.

Ant activity and species diversity was affected by habitat type to some degree. In the meadow, trends were found linking plant species richness, temperature, and elevation to both factors, but more heavily to ant activity. These findings support those of Gotelli and Ellison (2002), adding to a growing body of evidence that is showing these factors may not just be trends, but defining factors of ant community structure. Unfortunately, the data for the aspen stands showed no significant correlation, but that may be due to the relatively small sample size.

With the growing number of extinct or invasive species, it is important to understand ecosystems. With the data here and the previous studies, it may be possible to begin relying on these factors to be significant components defining ant community structure. With this known, it is possible to determine more clearly what is causing the extinction of some species and what may be allowing others to find ready spaces to invade and establish nests.

Literature Cited

- Gotelli, N. J., and A. M. Ellison. 2002. Biology at a regional scale: determinants of ant species density in New England bogs and forests. *Ecology* 83: 1604 – 1609.
- Yanoviak, S. P., and M. Kaspari. 2000. Community structure and the habitat templet: ants in the tropical forest canopy and litter. *OIKOS* 89: 259-266.