PSEUDOMYRMEX ANT DISTRIBUTION ON *ACACIA COLLINSII* IN EARLY AND LATE SUCCESSIONAL STAGES OF A TROPICAL DRY FOREST

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Abstract. We examined the distribution of *Pseudomyrmex* ants in early and late successional stages of a tropical dry forest in Palo Verde National Park, Costa Rica. We hypothesized that the relative frequency of *P. flavicornis* to *P. spinicola* was related to successional stage. Based on their behavior, we predicted that the frequency of *P. flavicornis* would be lower in later successional stages. We found that *P. flavicornis* occupied 29% of the acacias in the early successional habitat, but only 6% in the late successional stage. *P. flavicornis* frequency may decline with increasing forest age (1) because they do not defend their host acacias well and these acacias have lower survival than those occupied by *P. spinicola*, or (2) because they are outcompeted by *P. spinicola*. Future tests of these alternatives are necessary.

Key Words: ant-acacia mutualism, Pseudomyrmex flavicornis, Pseudomyrmex spinicola

INTRODUCTION

Acacia collinsii, the swollen thorn acacia, is a pioneer species in the tropical dry forests of Costa Rica. It grows in the wake of both natural and human related disturbances (Janzen 1974). The acacia is unusual in having a mutualistic relationship with *Pseudomyrmex* ants. The trees provide food and shelter for the ants, while the ants provide protection from herbivores and encroaching vegetation. Young acacias are colonized by *Pseudomyrmex* queens who disperse from their natal colonies (Janzen 1983).

P. spinicola are more aggressive than *P. flavicornis* in their response to encroaching vegetation and in confrontations with herbivores and other intruders (Gill 1989). Thus, acacias tended by *P. flavicornis* may be less likely to reach maturity than those tended by *P. spinicola* (Gill 1989). *P. flavicornis* might also be less abundant in older stands because of competition from the more aggressive *P. spinicola*. In this study, we tested the hypothesis that the relative frequency of *P. flavicornis* to *P. spinicola* was related to successional stage. We predicted that the frequency of *P. flavicornis* would be lower in later successional stages.

METHODS

On 9 January 1998, we surveyed the abundance of *P. flavicornis* and *P. spinicola* on *A. collinsii* at two sites of different successional stages at Palo Verde National Park, Costa Rica. The late successional site, located along the Sendero Natural de Venada trail 2 km east of the OTS Biological Station, had probably never been disturbed or grazed (R. T. Holmes, pers. comm.). The early successional site, located immediately east of the field station between the road and the marsh, had been cleared and then grazed heavily by cattle until the early 1980s, but has been largely protected since that time.

We surveyed 10 groups of 20 trees on an early successional transect and 5 groups of 20 trees on a late successional transect. For each tree, we recorded ant species present and measured diameter at breast height (DBH) of the largest stem within a cluster. Within a site, all groups of trees were separated by > 50 m. Within a group, all trees were separated by > 2 m.

RESULTS

P. flavicornis occupied a higher proportion of trees in the early successional stand than in the late successional stand (29% of 200 vs. 6% of 100; $X^2 = 20.34$, $P < 0.001$). Acacia trees had a larger diameter in the late successional stand ($F_{1,296} = 28.64$ $P < 0.001$; Fig. 1). In the early successional stand, *P. flavicornis* and *P. spinicola* occupied similarly sized trees, but in the late successional stand, *P. flavicornis* occupied larger trees than *P. spinicola* (Fig 1; $F_{1,296} = 3.97$, $P = 0.047$ for the main effect of ants, and $F_{1,296} = 4.82$, $P = 0.029$ for the ant species x successional stage interaction.)

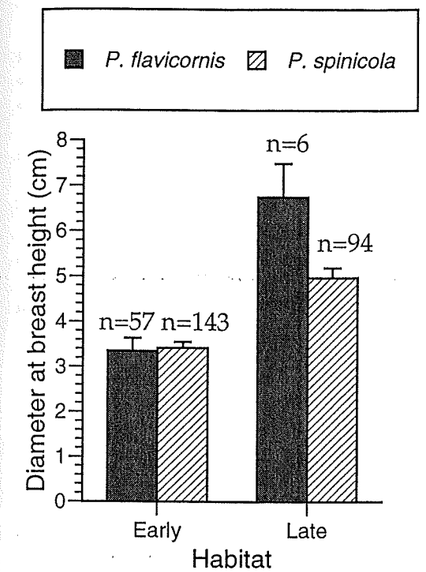

FIG. 1. Mean diameter of acacia trees occupied by *Pseudomyrmex flavicornis* and *P. spinicola* in early and late successional stages of a tropical dry forest (mean ± SE).

DISCUSSION

As predicted, the relative abundance of *P. flavicornis* was higher in early successional stands of *A. collinsii* than in late successional stands. Counter to our expectations, the late successional trees occupied by *P. flavicornis* tended to be larger than those occupied by *P. spinicola*. Our two hypotheses for decreased relative frequency of *P. flavicornis* in late successional areas do not account for this trend. There must be another mechanism influencing ant distribution. Perhaps the large, late successional trees occupied by *P. flavicornis* were not severely threatened by herbivory or encroaching vegetation.

Our hypotheses for decreased frequency of *P. flavicornis* in late successional stands require further testing. The differential tree survival hypothesis would predict that over time (early to late in succession) trees occupied by *P. flavicornis* would have lower survival than those occupied by *P. spinicola*. This hypothesis could be tested in a long term study examining the survival rate of trees occupied by both ant species. The competition hypothesis would predict that *P. spinicola* would outcompete *P. flavicornis* when there are a limited number of available small trees. There are several mechanisms that are possible. There may be: (1) differential success of queens colonizing young, previously unoccupied trees, (2) differential probability of colony death, (3) differential success in colonizing older trees vacated by colony death, and (4) differential probability of supplanting an established colony. It would also be useful to compare herbivory rates and encroaching vegetation on trees occupied by *P. flavicornis* and *P. spinicola*.

The relative abundance of *P. flavicornis* and *P. spinicola* in the Guanacaste landscape is probably a function of the relative proportion of acacia stands in different successional stages. Any processes that impact the successional dynamics of acacias (e.g., fires, floods, and land use practices such as grazing) are likely to alter the relative abundance of *P. flavicornis* and *P. spinicola*.

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