Spatial activity patterns and defense behavior of *Pseudomyrmex spinicola* on *Acacia collinsii*

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Abstract: The acacia ant *Pseudomyrmex spinicola* provides protection to *Acacia collinsii* host trees in exchange for living space and food resources. Spatial patterning of *P. spinicola* activity within *A. collinsii* hosts may enhance the benefits of the mutualistic association to both species. We tested this hypothesis by measuring *P. spinicola* activity among *A. collinsii* branches with different resource levels (Beltian bodies, nectaries, thorns). Ant activity and abundance was greater on branches with more resources, but there was no significant difference in the response of ants to a simulated disturbance. This study suggests that ants may concentrate their activity where resources are abundant, but can quickly shift their distribution to respond to a disturbance in any part of the tree.

Key Words: acacia ant, mutualism, resource abundance

Introduction

The ant *Pseudomyrmex spinicola* and *Acacia collinsii* trees have a mutualistic relationship. The ants gain protein and carbohydrates from Beltian bodies and extrafloral nectaries provided by the plant, and they shelter in the plant's hollow thorns. In return, the ants patrol the tree, attack herbivores and clear surrounding vegetation (Janzen 1983). It is unknown whether ant activity patterns within a single host acacia vary with the distribution of the resources they exploit, namely Beltian bodies, nectaries and thorns. We hypothesized that ants adjust their spatial activity in relation to the local abundance of these resources on the acacias. We predicted that ant activity and ant defense would be higher on branches with more resources, namely Beltian bodies, nectaries, and/or thorns.

Methods

We conducted our study at Palo Verde National Park, Guanacaste Province, Costa Rica on 9 January 2003 between 07:30 and 11:00, east of the OTS field station. We chose healthy acacia trees 1.5 to 3 m tall that were occupied by *P. spinicola*. On each tree we chose two branches of similar length that had clear differences in leaf density (hereafter referred to as high-leaf and low-leaf). We then quantified the available resources on each branch by counting the number of thorns, extrafloral nectaries, and Beltian bodies. We used linear regressions to test whether leaf number and branch length predicted the abundance of these resources on acacia branches.

To assess the baseline, pre-disturbance ant activity on a branch, we counted the total number of ants present within a 10 s period. We then triggered a defense response by simultaneously tapping the midpoint of each branch 10 times. We counted the ants on each branch at 10, 30, 60 and 120 s after tapping. We also recorded the number of thorns occupied by ants by observing ant activity at thorn entrance holes over a 2 min period. We used paired t-tests to determine whether baseline ant activity, defense response and thorn occupancy differed between high and low-leaf branch pairs. Ant abundance was log transformed when necessary to fit a normal distribution.

Defense response was plotted against time to determine the highest point of ant activity after disturbance. Ant activity was highest after 10 s, so we used the census of ants at this time to quantify defense response. We used a paired t-test to compare the number of ants at 10 s after disturbance on high- and low- leaf branches.

Results

The number of extrafloral nectaries was positively related to leaf number (Fig. 1). The number of thorns were also related to leaf number ($r^2 = 0.53$, $P = 0.05$), but was more strongly influenced by branch length (Fig. 2). The number of Beltian bodies was not related to either leaf number or branch length ($r^2 < 0.01$, $P = 0.78$, and $r^2 = 0.12$, $P = 0.08$, respectively). The number of leaves on high-leaf branches that we had chosen to sample was significantly greater than on low-leaf branches (paired-t = -3.33, df = 12, $P < 0.01$), demonstrating that branch pairs sampled effectively represented varying resource levels for the ants.

Ant activity and thorn occupation before disturbance was greater on high-leaf branches than on low-leaf branches (Fig. 3 and Fig. 4). There was no difference in the number of ants per meter for high- and low-leaf branches after disturbance (Fig. 3). The change in ant activity was greater for low-leaf branches than for high-leaf branches, but the difference was not significant (Fig. 1).

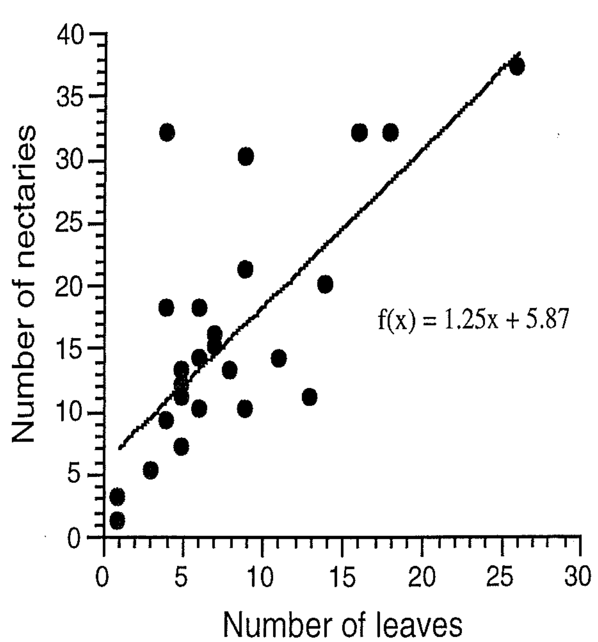

FIG 1. Number of nectaries as a function of number of leaves on *A. collinsii* branches ($r^2 = 0.53$, $P < 0.01$).

Discussion

We tested whether resource availability influences spatial patterning of *P. spinicola* activity within *A. collinsii* hosts. As predicted, branches with more resources such as extrafloral nectaries, thorns and leaves had greater ant activity, in terms of

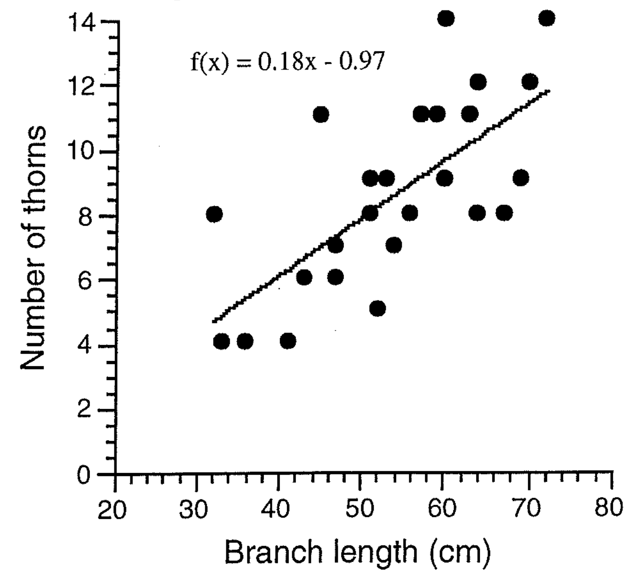

FIG 2. Number of thorns as a function of *A. collinsii* branch length ($r^2 = 0.48$, $P < 0.01$).

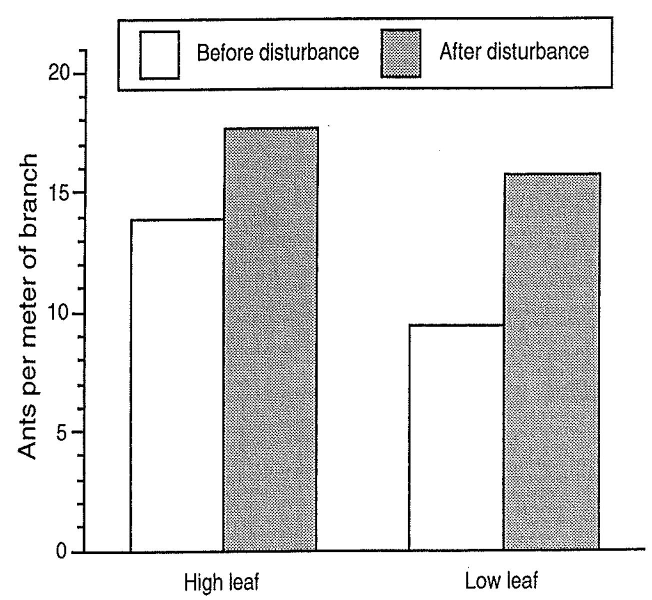

FIG 3. *P. spinicola* were more abundant on high-leaf than on low-leaf *A. collinsii* branches both before and after disturbance (paired-t = 2.79, df = 12, $P < 0.01$ and paired-t = 0.98, df = 12, $P = 0.17$, respectively). The change in number of ants observed was greater on low-leaf than on high-leaf branches, but the difference was not significant (paired-t = 1.53, df = 12, $P = 0.08$).

both number of ants and thorn occupancy. This demonstrates that ants adjust their distribution within the tree in relation to resource availability. After disturbance, the change in ant activity was not different between high- and low-leaf branches. The apparently greater defensive response of ants on the low-leaf branches suggests that ants increase their defensive activity even on branches with low resource levels. Thus, ants may respond equally to a disturbance in any part of the acacia host, regardless of local resources they may be exploiting.

This study suggests that ants may concentrate their activity where resources

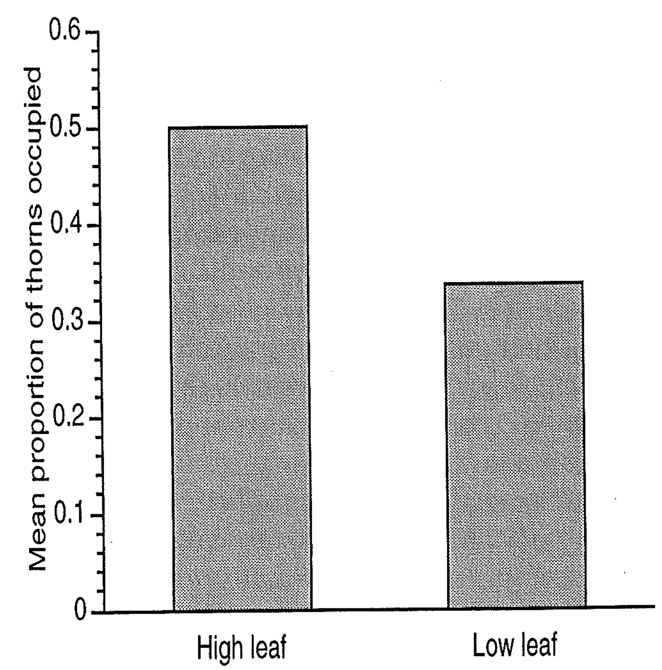

FIG 4. Mean proportion of thorns occupied by *P. spinicola* ants prior to disturbance was greater on high-leaf than on low-leaf acacia branches (paired-t = 2.73, df = 12, $p < 0.01$).

are abundant, but can quickly shift their distribution to respond to a disturbance in any part of the tree. Further investigation of the relative importance of Beltian bodies, nectaries, and thorns to spatial patterns in ant activity and defense would improve our understanding of this system.

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