THE EFFECT OF BELTIAN BODY PRESENCE ON *PSEUDOMYRMEX SPINICOLA* DEFENSE

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Abstract. In the *Pseudomyrmex spinicola* - *Acacia collinsii* mutualistic relationship, ants are provided with Beltian bodies and extrafloral nectaries by the acacia and in return ants defend the acacia from herbivory and competing plants. Since Beltian bodies are found on new foliage, these branches are potentially more valuable than old foliage to the ants as food resources, as well as to the plant for their potential photosynthetic value. We hypothesized that, in a given *A. collinsii* individual, more ants will defend branches with Beltian bodies than those lacking Beltian bodies. We found a significantly greater number of ants on branch samples with Beltian bodies than on those without Beltian bodies, suggesting a greater defense of this foliage. Thus, the presence of Beltian bodies appears to influence the distribution of the acacia ant, leading to better protection of the acacia's new and potentially valuable foliage.

Key Words: Acacia collinsii, *ant-plant mutualism, resource distribution*

INTRODUCTION

Acacia collinsii and *Pseudomyrmex spinicola* engage in a mutualistic relationship. The benefits to the acacia include a reduction in competition with other plant species and a reduction in herbivory pressure due to the presence of ants. In return, the ant is provided with shelter and nutritional supplements in the form of Beltian bodies and extra-floral nectaries. The small, new leaves of *A. collinsii* produce Beltian bodies for the ant colony in the dry season (Janzen 1974). Abram et al. (1994) suggested that acacias possessing Beltian bodies could be better defended by their ant symbionts than those lacking these nutritious plant parts. Their observations and the fact that Beltian bodies are associated with new leaf growth suggested to us that the location of Beltian bodies might also influence the degree of ant defense within an individual tree.

It is generally thought that younger leaves are more valuable to the plant because they have a greater potential photosynthetic value than older foliage (G. Eaton, pers. comm.). We therefore hypothesized that, in a given *A. collinsii* individual, more valuable foliage (e.g., new leaves with Beltian bodies) will be better defended by ants than less valuable foliage. This hypothesis leads to the prediction that greater number of ants will be found patrolling on branches with Beltian bodies than on those without. This should be true when accounting for the number of responding ants, both prior to and after disturbance.

METHODS

The study was conducted in a tropical dry forest, approximately 200 m SE of the OTS Palo Verde field station, Guanacaste Province, Costa Rica. Data were collected between 08:30 and 11:30 on 9 January 1998. *A. collinsii* individuals were selected for sampling based on three criteria: minimum height of 2 m, presence of *P. spinicola*, and presence of at least one frond of new acacia foliage with Beltian bodies on the last 15 cm of the branch.

We sampled two branches on each of 15 acacia trees, one containing Beltian bodies and the other lacking them. Initial data collected included total branch length, height of branch tip from ground, and the number of patrolling ants. We defined patrolling ants as those present on the branch surface immediately prior to experimental manipulation. We then simulated an herbivory event by simultaneously tapping the two study branches for 10 s. Thirty-five seconds after disturbance, both 15 cm terminal branch sections were removed with pruning shears, and each was placed into an individual plastic ZipLock® bag for later analysis. In the lab, the numbers of nectaries, leaves, and habitable thorns were recorded for each sample. We then added an insecticidal strip to each bag. When all ant activity ceased within approximately two hours, we recorded the number of larva and adult ants present on each sample, including those in thorns.

We analyzed our data using one-tailed, paired t-tests, comparing number of patrolling ants, and total number of ants on branches with and without Beltian bodies. Larval data were not normal so a Wilcoxen matched -pairs signed ranks test was used to compare larvae numbers on branches with and without Beltian Bodies. Spearman rank correlations were used to compare the number of patrolling ants, total number of adults and number of larvae, with the number of thorns, leaves, and nectaries, as well as branch length and height.

RESULTS

Branch ends with Beltian bodies had significantly more patrolling ants than those without Beltian bodies (mean diff = 3.2 ± 1.2 (SE), $t_{14} = -2.79$, $P < 0.001$) (Fig. 1). Following disturbance, the total number of ants present was significantly larger on those branches with Beltian bodies (mean diff = 4.8 ± 2.04 (SE), $t_{14} = -2.36$, $P = 0.017$) (Fig. 2). Larval numbers varied from 0 to 62 on branches with Beltian bodies and 0 to 120 on branches without Beltian bodies. The mean difference in larval numbers between the two groups was 0.067, but this difference was not significant ($t_{14} = 0.530$, $P = 0.183$).

We found no significant correlation between the number of patrolling ants and number of leaves, thorns, or nectaries, on either branch type (all $r < 0.60$, all $P > 0.05$). Furthermore, there was no correlation between the number of patrolling ants and branch end height or distance from trunk (all $r < 0.60$, all $P > 0.05$). Also, total numbers of adult ants and of larvae also were not correlated with any of these parameters (all $r < 0.60$, all $P > 0.05$).

DISCUSSION

We found significantly more total ants and more patrolling ants on branches with Beltian bodies than on those without. Thus, the presence of Beltian bodies on the new foliage of *A. collinsii* appears to be an influential factor determining location of *P. spinicola* defense. By producing Beltian bodies on its young foliage, the acacia benefits by receiving added protection from herbivores through the increased presence of ants on its most valuable foliage. Beltian body production during the dry season could thus help

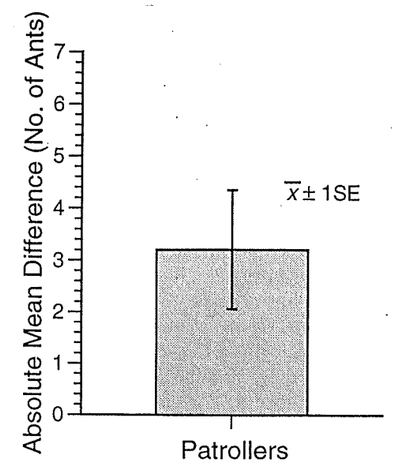

FIG. 1. Mean difference in number of patroller ants between foliage with and without Beltian bodies. A positive value indicates that foliage with Beltian bodies had more patrol ants than foliage without Beltian bodies (one-tailed paired t-test, n = 15,P = 0.02). See methods for explanation of patrol ants.

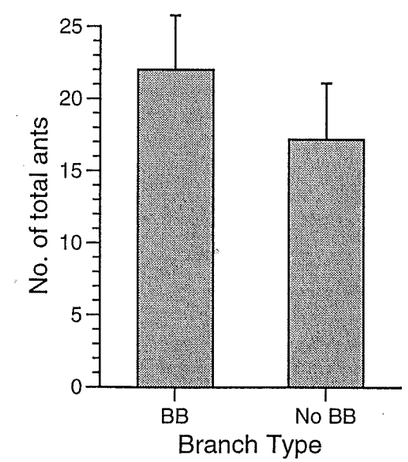

FIG. 2. Mean number (+ SE) of total ants on branches with and without Beltian bodies (BB).

acacias combat increased herbivory pressure as overall leaf foliage decreases.

The importance of the presence of high quality foliage in determining ant distribution within plants is further supported by the lack of correlation between numbers of ants and the size, abundance, and position of nectaries, thorns, leaves, and branches. Thus these other factors do not appear to affect ant distribution. The lack of correlation between ant density and nectaries was particularly surprising, considering that nectaries are an important source of food for adult ants. However, we only quantified number of nectaries rather than nectar production or quality, so that these results may be inconclusive. We also expected a correlation between the number of larvae and the presence of Beltian bodies, as Beltian bodies provide the major source of protein, lipid and carbohydrates for the larvae (Janzen 1974). The data on larval abundance , however, had a high variance, and the lack of a significant correlation may have been due to the presence of one outlier data point from a branch with old foliage. Repeating our study with a larger sample size might reveal such a relationship.

Additional studies are necessary to fully explain the relationship between valuable plant foliage and increased ant defense. The results of our study suggest that new foliage, which is probably most valuable to *A. collinsii* , is also important to *Pseudomyrex spinicola*, leading ants to allocate more defense to these regions of their host plant.

LITERATURE CITED

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