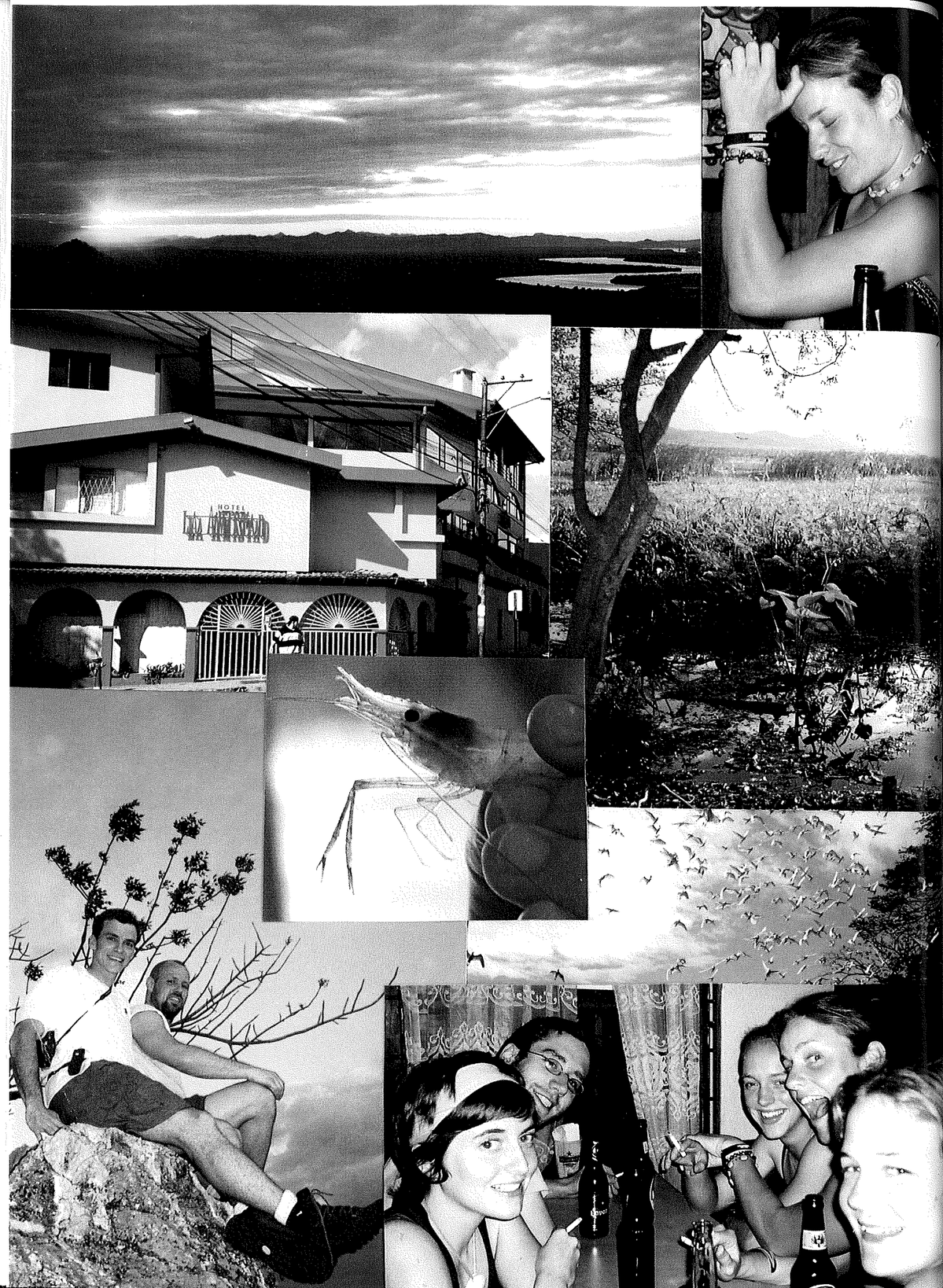

Relationship between herbivory damage and resident ant species in *Acacia collinsii*

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Abstract: Acacia collinsii has a mutualistic relationship with several neotropical ant species that is thought to protect the tree from herbivory. We hypothesized that the degree of herbivory damage sustained by a tree would vary with the occupying ant species. We found that trees harboring one species, *Crematogaster*, sustained significantly more herbivory damage than trees with either *Pseudomyrmex flavicornis* or *P. spinicola*. This result appears to reflect a lower level of aggressiveness in *Crematogaster* but does not suggest any difference in aggressiveness between *P. flavicornis* and *P. spinicola*. The relationship between aggressiveness, herbivory protection and host tree fitness should be further investigated for these two mutualistic ant species.

Key Words: ant-plant mutualism, Crematogaster, Pseudomyrmex spinicola, P. flavicornis

Introduction

Herbivory is an important process affecting plant fitness. In addition to consuming key components like leaves and other tissues, herbivores may transmit diseases to the plant (Begon et al. 1990). For acacia trees in neotropical dry forests, mutualistic relationships with several ant species are thought to protect the trees from herbivory and thereby increase their fitness. The ants gain nutrients and nest sites from the tree, while aggressively attacking herbivores and clearing competing vegetation around the tree (Janzen 1983, Bansak et al. 1993).

Janzen (1983) reported that ant species vary in the aggressiveness with which they attack foreign vegetation around the acacia, with *Pseudomyrmex spinicola* (formerly *P. ferruginea*) being more aggressive than *P. flavicornis* (formerly *P. belti*). *P. spinicola* has also been shown to respond more strongly to mechanical disturbances than *P. flavicornis* (Cook et al. 1993). Unlike *P. spinicola* and *P. flavicornis*, *Crematogaster* is not as aggressive and is not obligately associated with *Acacia collinsii* (Smith 1983). Given these findings, we expected that *P. spinicola* might also attack herbivores aggressively, discouraging them from grazing. Additionally, a greater reduction in vegetation by *P. spinicola* than by *P. flavicornis* or *Crematogaster* might decrease herbivore abundance near the acacia. We therefore tested the hypothesis that the degree of herbivory damage sustained by a tree will differ depending on the occupying ant species. We specifically predicted that trees harboring *P. spinicola* would have less leaf damage than trees harboring other species. We also predicted that herbivorous invertebrates would be found less often in trees occupied by *P. spinicola*.

Methods

The study was conducted on 7 January 2002, at Palo Verde National Park, Guanacaste Province, Costa Rica. We surveyed 24 ant-acacia trees, 1.5 – 4.0 m in height, within 15 m of the main access road to the O.T.S. biological station. We selected 8 trees occupied by *P. spinicola*, 8 by *P. flavicornis*, and 8 by *Crematogaster*.

Three branches were selected from each tree and herbivory damage was recorded for the 10 outermost mature leaves on each branch. If a selected branch had fewer than 10 leaves, another branch was sampled until a total of 10 leaves was reached. Each leaf was assigned a leaf-damage score of 0 when there was no herbivory damage, 1 when < 50% of leaflets showed signs of recent herbivore dam-

age or 2 when > 50% of leaflets showed damage. A leaf-damage index was then calculated as the mean score for each plant sampled. Herbivory damage was defined as visible evidence of chewing or scratching of the leaf surface. Missing sub-leaflets were not classified as herbivore damage because they could have been removed by wind, physical damage from a fallen branch, or some other means. Each tree was also scanned for 2 min for the presence and abundance of invertebrates other than ants.

Results

Trees harboring *Crematogaster*, *P. spinicola* and *P. flavicornis* showed significantly different levels of herbivory (ANOVA, $F_{2,21}$ = 5.95, $P < 0.01$; Fig. 1). A Tukey-Kramer HSD ($P < 0.05$) demonstrated that the leaf damage index was significantly higher for trees with *Crematogaster* (mean = 1.76, SE = 0.09) than for trees with either *P. flavicornis* (mean = 1.40, SE = 0.09) or *P. spinicola* (mean = 1.36, SE = 0.09). Trees with *P. spinicola* and *P. flavicornis*, however, did not differ in herbivore damage levels (Fig. 1).

Herbivorous invertebrates were present on 4 of the 24 trees sampled. One treehopper and one small moth were found on trees with *P. flavicornis*, two snails on a single tree with *Crematogaster* and one snail on a tree with *P. spinicola*. The occurrence of herbivorous invertebrates therefore does not appear to be related to particular ant species, though sample size (n = 4) was too small for statistical analysis.

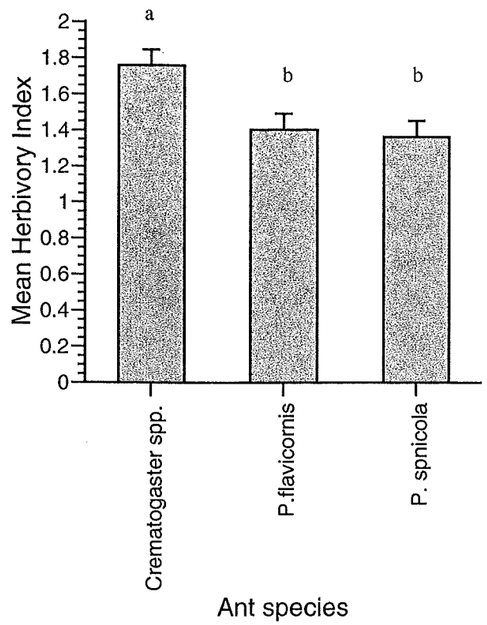

FIG. 1. Mean herbivory index (± SE) on *Acacia collinsii* trees harboring *Crematogaster*, *Pseudomyrmex flavicornis* and *P. spinicola* (n = 8 trees for each ant species). Herbivory index represents a mean of herbivory scores for each leaf sampled (n = 10/branch, n = 3 branches/tree) where 0 = no herbivory damage, 1 = fewer than 50% of leaflets damaged, 2 = greater than 50% leaflets damaged. Different letters indicate significant differences ($P < 0.05$) between species.

Discussion

Our results support the hypothesis that herbivory damage on acacia trees varies depending on which ant species is present. Trees harboring *P. spinicola* and *P. flavicornis* showed significantly less damage than trees with *Crematogaster*. Because *Crematogaster* are not obligately associated with *A. collinsii*, their fitness may not be as tightly linked to that of the tree, so it is not surprising that they may devote less energy to protecting the host tree from herbivory. Trees with *Crematogaster* may or may not sustain less herbivory damage than trees with no ants at all. Such a comparison must be made in order to accurately characterize the association between *Crematogaster* and *A. collinsii* as mutualistic, commensal or parasitic.

Contrary to our prediction, trees harboring *P. spinicola* and those harboring *P. flavicornis* did not differ significantly in herbivory damage, despite reports that *P. spinicola* is more aggressive in clearing vegetation (Janzen 1983) and shows a greater response to mechanical disturbance (Cook et al. 1993) than *P. flavicornis*. Our results, however, suggest that *P. spinicola* may not be more aggressive in attacking herbivores and deterring herbivory. The relative effects on tree fitness of reduced plant competition versus reduced herbivory with different ant mutualists are in need of further investigation.

We predicted that the incidence of herbivorous invertebrates would be lower on trees with *P. spinicola* due to both its biting and stinging response and to its more effective clearing of surrounding vegetation. However, our 2-min observation period was probably too brief to provide an adequate test of this prediction.

Finally, we did not examine whole-leaflet removal because it was difficult to determine whether this damage was due to herbivory or to other causes. Furthermore, it was beyond the scope of this study to determine whether the degree of herbivory damage we observed would be sufficient to alter the fitness of individual trees. An analysis of the relationship among ant species, herbivory and tree fitness would be a valuable next step in understanding the mutualism between ants and acacias.

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