HERBIVORY ON ACTIVE DEFENSE AND NON-ACTIVE DEFENSE LEGUME PLANTS: A COMPARISON OF *MIMOSA PIGRA, ACACIA COLLINSII, SESBANIA EMERUS,* AND *ACACIA FARMACIANA*

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Abstract. Certain species in the subfamily *Mimoisea (Leguminaceae)* exhibit unique defenses against herbivory. *Mimosa pigra* has an uncommon physiological characteristic of closing its leaflets when touched, which may be an active defensive strategy against herbivory. The ant-acacia plant, *Acacia collinsii*, maintains a symbiosis with *Pseudomyrmex* ants that protect the acacia from herbivores. The objectives of this study were to compare losses due to herbivory and degree of toughness in these two species and to contrast the results to those for two similar species in the same family (*Sesbania emerus, Acacia farmaciana*, respectively) that do not exhibit active ant-herbivore defenses. Our results showed less herbivory on the actively defended *M. pigra* and *A. collinsii* suggesting that the active defenses of these plants are good deterrents of herbivory. *M. pigra* was also found to be the least tough, suggesting a tradeoff between active defense and non-active defenses. However, there was no significant difference in toughness between the *Acacia collinsii* and *Acacia farmaciana.*

Key Words: ant-acacias, herbivory, sensitive mimosa

INTRODUCTION

Plants defend their tissues against herbivory in a number of ways. Passive defenses include chemical defenses, hairs, and toughness, and active defenses include inducible defenses and mutualisms. An example of an active defense mechanisms occurs in Acacia collinsii. A. collinsii has a mutualistic relationship with ants (Pseudomyrmex spp.) in which A. collinsii provides the ants with a food source and with shelter in return for protection from herbivory (Janzen 1983). Another possible active defense mechanism is leaflet movement in response to touch. M. pigra is a low-lying sensitive herb that has the rare ability to close when stimulated by touch during the day (Janzen 1980). Both M. pigra and A. collinsii are in the legume group (tribe Mimoisea), and close their leaflets at night.

To test if the ant-acacia mutualism and daytime leaflet movement decreases herbivory, we compared M. pigra and A. collinsii to other mimoisoid plants that employ only nocturnal leaflet closure. Acacia farmaciana does not form a symbiotic relationship with acacia ants even though both Acacia species are similar in morphology and habitat type (open forest). The distribution of Sesbania emerus overlaps considerably along marsh edges with that of M. pigra; however S. emerus, which grows as a tall herb in the marsh, does not exhibit the same tactile response as M. pigra (Janzen 1980).

In this study, we compared herbivory rates in these two pairs of species in the tribe Mimoisea, one member of which employs an active defense in addition to nocturnal closure (A. collinsii, M. pigra) while the other exhibits only nocturnal closure (A. farmaciana, S. emerus, respectively). Our specific hypothesis were that: (1) in the field, the actively defended plants, M. pigra and A. collinsii, would have less herbivory on individual leaflets than the non-active defensive plants, S. emerus and A. farmasiana; and (2) actively defended plant leaves would have less constitutive defenses and therefore would be less structurally tough than passively defended plants.

METHODS

In Palo Verde National Wildlife Refuge, Costa Rica, 10 individuals of each of the four species were randomly selected. M. pigra and S. emerus were found in pairs by the marsh at the bird tower, and A. collinsii and A. farmaciana plants were found in pairs by the roadside east of the OTS field station in Palo Verde. Once the plant was selected, individual leaflets were chosen in a stratified random manner. We

selected six M pigra and A. collinsii leaves for every three S. emerus and A. farmaciana leaflets for herbivory assessment. This was done to account for differences in leaf size among species. Herbivory was assessed by grouping the extent of leaf tissue damage and loss into nine categories: 0%, 0-5%, 5-10%, 10-20%, 20-30%, 30-50%, 50-75%, 75-99%, 100%. (A leaf classified as 100% had no remaining tissue, but could be identified by the petiole scar or remaining leaflet petioles.)

Leaf toughness of each species was measured by using a leaf toughness meter, in which the grams of pressure needed to puncture a hole in the leaves was measured. In each trial, two subleaflets were stacked and used.

RESULTS

We found that leaf loss was significantly lower on M. pigra than on S. emerus (t-test, t=3.47, df=18, P=0.003, Fig. 1). Leaf loss on A. collinsii , however, was not significantly different from A. farmaciana (t=1.03, df=18, P=0.33, Fig 1).

M. pigra leaflets were significantly less tough than S. emerus leaflets (t-test, t=5.95, df=18, P<0.001). However, we found no difference in leaf toughness between A. farmaciana and A. collinsii (t-test, t=0.33, df=10, P=0.75).

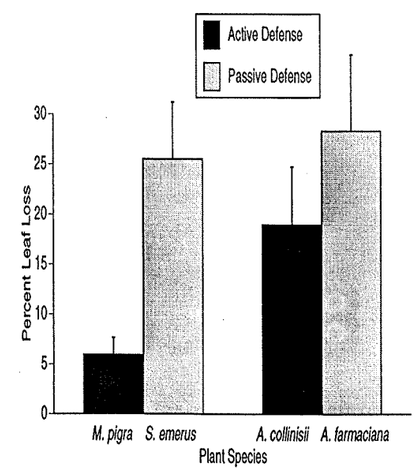

FIG. 1. Herbivory comparisons between actively defended plants (*M. Pigra* and *A. collinsii*) and passively defended plants (*A. collinsii* and *A. farmaciana*). Means ± S.E., n= 10 for each species.

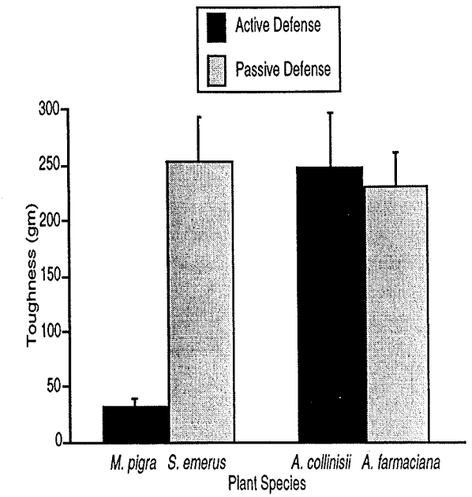

FIG. 2. Toughness comparisions using a toughness meter on actively defended (*M. pigra* and *A. collinsii*) and passively defended (*S. emerus* and *A. farmaciana* plants).

DISCUSSION

Field results showed that M. pigra suffered less herbivory, even though it was less tough than S. emerus. This supports our hypothesis that M. pigra's rare touch-induced leaflet movement may require energy expenditure that could otherwise be allotted to constitutive physical defenses, such as toughness or passive chemical defenses. This is consistent with the proposition that M. pigra has invested in movement response to defend against herbivory, while S. emerus may invest in a different type of defense, such as leaf toughness or defensive chemicals.

Though not significant, A. farmaciana had more herbivory than A. collinsii. It is possible that A. farmaciana does not invest in active defenses but in chemical defenses or leaf toughness instead. The lack of statistical significance maybe due to greater variation in the acacia plants than the mimosa and to the small sample sizes. We did not have the equipment to quantify defensive chemicals in the leaves, but we measured leaf toughness in both species. Our hypothesis that A. collinsii would be less tough than A. farmaciana was not supported, suggesting that A. farmeciana may invest in some other form of defense, possibly chemicals such as alkaloids, to deter herbivory.

Our results suggest that if M. pigra's sensitive leaf closing is an active defense, it may even be more effective than passive defenses such as leaf toughness or chemical defenses in deterring herbivory. Further research should examine leaf palatability and to determine if species that do not invest in active defenses allocate their resources to passive chemical defenses.

LITERATURE CITED

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