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THE AGGRESSIVENESS OF THREE SPECIES OF ACACIA ANT

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Abstract. Differential levels of aggressiveness among acacia ants may be important to the vitality of the plants they inhabit. We tested whether there were different levels of aggression among three species of *Pseudomyrmex* on *Acacia collensii* in Palo Verde, Costa Rica. Based on previous observations, we hypothesized that *P. ferruginea* would be more aggressive than *P. belti* and that *P. nigrocincta* would be the most aggressive of the three. Aggressiveness was tested by triggering defensive responses with an imitation vine. The results indicate that *P. nigrocincta* are the most aggressive; the results are inconclusive regarding a difference between *P. belti* and *P. ferruginea*. The possible implications of these findings are discussed. (JLD)

INTRODUCTION (TCB)

The interaction between the acacia tree and the ants that occupy it is an example of plant-animal mutualism in Guanacaste Province, Costa Rica. The acacia tree provides food and a place to live for the ants, and in return they protect the tree from herbivory and competing vegetation.

In Guanacaste, there are three species of ants that occupy acacias: *Pseudomyrmex ferruginea*, *P. nigrocincta*, and *P. belti*. All will remove vegetation and attack herbivores. Janzen (1983) has suggested that the three species differ in the aggressiveness of their response to a plant/animal disturbance. *P. ferruginea* has been shown to respond more quickly (more aggressively) than *P. belti*, and it is thought that *P. nigrocincta* responds still faster.

For this project, we examined the aggressiveness of each species' response by determining the time required for a set number of ants to attack an artificial vine. We hypothesized, based on Janzen's observations, that *P. nigrocincta* would respond most aggressively and *P. belti* would respond least aggressively. Therefore, we predicted that *P. nigrocincta* would respond the fastest after a vine is placed on the tree, *P. ferruginea* would be slower, and *P. belti* would be the slowest.

METHODS (ALG)

On 6 January 1992, from 0820-1125, we visited 43 occupied 2-4m acacia trees. The trees were east of the OTS field station in Palo Verde National Park, Guanacaste Province, Costa Rica. All trees were in the forest south of the road, north of Sendero la Penca and west of Sendero Guayagancito. Sixteen trees were occupied by *P. ferruginea*, 14 by *P. belti*, and 13 by *P. nigrocincta*.

To examine the aggressiveness of defense, at each tree we hung a 30cm string (diameter ≈2mm) over the penultimate node of a branch at roughly chest height. Once the string was placed, we timed how long it took an ant to discover the string, and then how long it took for 10 additional ants to discover it (a total of 11 ants), timing the arrival of each ant.

We tugged the string sharply downwards when it was first placed on the branch and every 30sec thereafter until the completion of the test. If no ants had found the string after 8min, the experiment was terminated. Strings were alternated every few tests and aired out between tests to allow any alarm pheromones to evaporate off the string.

RESULTS (CNO)

To account for the effect of time of day on ant behavior, a Spearman Rank Correlation test was performed on the ants' response time and time of day. There was no correlation in the two variables ($r<0.06$ for all tests). Therefore, we combined data for all time periods. Data for ants that did not reach eleven attacks upon the string were excluded from the analyses.

The mean times between the placement of the string on a branch of an Acacia tree to the initial ant attack for *P. belti*, *P. ferruginea* and *P. nigrocincta* were 82.4, 58.4 and 84.7sec, respectively. A student's t-test showed no significant difference between these times among the three species of ants (Table 1).

P. nigrocincta had the quickest mean time (57sec) for 10 additional ants to attack the string after the initial encounter, while *P. belti* and *P. ferruginea* took 218 and 167sec, respectively (Table 1). Using an ANOVA, the differences between these mean times was marginally significant ($p<0.10$).

An attack rate was derived by dividing the 11 attacks by the time between the discovery of the string and the eleventh ant attack on the string (Table 1). The attack rate of *P. nigrocincta*, differed from that of *P. belti* ($t=2.02$, $p<0.05$) and from that of *P. ferruginea* ($t=2.07$, $p<0.1$).

DISCUSSION (SLS)

Although our hypothesis was that more aggressive ants would discover the "vine" sooner than those less aggressive because they would be patrolling the branches more effectively, we found no difference in the discovery times of the three species. Our method of placing the string on the branch may have biased these results. Perhaps the bias could have been reduced by placing the string at least 10cm from the nearest ant.

Table 1. Responses of three acacia-ant species (*Pseudomyrmex*) to the placement of string on a branch of the host tree.

	P. belti	*P. ferruginea*	*P. nigrocincta*
#trees sampled	14	16	13
Time to initial string discovery (mean ± s. d.)	16±16 sec	30±53 sec	13±18 sec
Time of initial string discovery compared to *P. ferruginea*	t=0.88 0.2<p<0.4		t=1 0.2<p<0.4
Time between ant 1 and ant 11 attack (sec) mean±s.d.	218±203	167±132	57±35
Ant attack rates mean±s.d. (sec^{-1})	0.089±0.076	0.089±0.057	0.258±0.242
Ant attack rates compared to *P. nigrocincta*	t=2.02 0.05>p>0.02	t=2.07 0.1>p>0.05	

The data on the time between initial discovery and attack by the eleventh ant, as well as on the rate of attack after initial placement, suggest that *P. nigrocincta* was more aggressive than either *P. belti* or *P. ferruginea*. The latter two had similar levels of aggressiveness.

A problem with our experimental design which was not identified until our procedure was underway was that the alarm pheromone released by the ants accumulated on the "vine" after a number of applications. We noticed this because of the obvious sweet smell of the string. This probably biased the results by decreasing the discovery time and increasing the rate of attack with each subsequent application. We used clean strings for a number of the trials which may have caused even more variability in the data. In the same way, pheromones released by the ants on one tree could have excited the ants on a nearby tree. There was no way for us to assess the effects of the pheromone because we did not record the time that we changed the string and we could probably not smell the pheromone at as low a level as the ants could. To reduce these effects in future studies, a clean string for each trial should be used, and trees chosen for sampling should be located away from other test trees.

Finally, our definition of aggression may not have been consistent with that of previous researchers or the ants' behavior. Since we only measured the frequency of attack within a certain time period and the time it took for ants to arrive in the first place, we did not quantify other aggressive behaviors such as the number of stings per unit time (noticeably higher in *P. ferruginea*) or dragging the vine across the branch (as done by *P. belti*), both of which may be important parts of the aggressive response.

In conclusion, our results indicate that *P. nigrocincta* was more aggressive than *P. belti* and *P. ferruginea* in its attack rate and recruitment, although all three ants showed similar discovery time. These results have several important implications. First the different levels of ant aggression might allow for varying degrees of host-tree vigor. Second, some behaviors, such as higher sting rate, could be more effective at discouraging herbivores while others, like dragging a vine, could be better at removing foreign plants. These topics require additional study.

LITERATURE CITED

Janzen, Daniel H. Costa Rican Natural History. Chicago: The University Press, 1983, pp. 762-764.