same size. If colonies were different sizes we would need to know if smaller colony size is a specific trait of black ants before concluding that the red is a better patroller of the host plant.

In addition, observation of recruitment levels for intrusions on black host trees were seen to be much higher than recruitment for intrusions on red host trees. Black hosts' response to invaders most often involved large aggregations of black ants on or near the red intruder, where as red hosts often took on their intruder in smaller numbers.

Further investigations should attempt to measure other factors involved in defense, such as recruitment. Also, more knowledge of the effect of such controls as size of colony or definition of recognition is needed to ascertain whether the demonstrated trends are truly species specific or applied only to our particular host colonies.

Table 1 Percentage measurement of the status of the intruder ant on a host ant tree after time period of five minutes (N=10x2).

scenario	jumped/ thrown off	cut up	immobilized	free&removed
Red Intruder Black Host	10%	70%	20&	0%
Black Intruder Red Host	50%	30%	10%	10%

Table 2 Chronological measurement of intruder/host interactions for each scenario. Mean interaction time (s) (N_1) $[N_2]$

	Red intruder ->	Black host	Black intruder->	Red host
time from deposit until removal	1.22.5	(8)	66.4	[8]
time from deposit until grapple	44.3	(10)	40.0	[6]
time from grapple until removal	78.9	(8)	44.5	[4]
time from deposit until first contact	43.1	(10)	12.1	[8]
time from first contact until immobilization	30.0	(9)	24.0	[2]

1. Note: removal implies cut up, thrown off, or jumped off-not human induced removal.

Literature Cited (T.Y.)

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DEFENSIVE RESPONSES OF ACACIA ANTS

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Abstract (A.B., V.V.)

Pseudomyrmex belti ants protect Acacia collensii trees by attacking herbivorous predators. We investigated these defensive responses, by measuring the instances of ant visitations to test sites in 2-5 min periods under different treatments. These treatments were 1) smears of insects vs. non insects, for which one of two tests was significant; 2) smears of herbivorous insects vs. non herbivorous insects which was not significant; 3) clipped leaves vs. unclipped leaves, which was not significant; and 4) crushed Acacia vs. non Acacia leaf mean. We observed that both crushed leaf smears elicited a vigorous response, though we could not statistically test significance.

Introduction (T.G., G.G., G.K.)

It is well documented that Acacia ants protect Ant Acacia trees (Acacia collensii) by attacking herbivores (Pseudomyrmex belti) that forage on trees. However, we have seen several insect herbivores (bugs and walking sticks) present on plants which did not evoke an apparent defensive reaction from the resident ants. These herbivores could pose a potential disadvantage to the trees, and therefore to the ants as well. Why don't all herbivores, then, elicit a defensive reaction from acacia ants? In our project, we examined defensive reactions to a number of plant and animal extract applications.

Our project was designed to study the cues that elicit defensive responses from the ants. We examined two possibilities: (1) the invading insect elicits the defensive response, or (2) a chemical from a damaged plant elicits the defensive response.

Our two hypotheses for the first half of the experiment were: (A) The ants respond more vigorously to an insect smear than to a non-insect smear of similar size and consistency. (B) The ants react more vigorously to an herbivorous insect smear than to an insect predator smear. Our two hypotheses for the second half of the experiment were: (C) The ants respond defensively to leaf removal, and (D) the ants will respond more vigorously to a crushed Acacia leaf smear than to a smear of crushed leaves from another plant.

Methods (T.Gr., G.G., G.K., V.V.)

We conducted our project on the peninsula leading to the bird tower at Palo Verde, Costa Rica, between 0800 and 1200 on January 8, 1991. We used partially shaded trees between 1.5 and 2 meters tall that appeared to have active colonies.

We prepared smears by grinding test material with a mortar and pestle and added water to achieve a similar consistency. For each trial we applied the smears with a cotton ball to similarly sized branches at the base of thorn pairs approximately the same distance from the tree trunk. A new pair of branches was chosen for each trial and we switched trees after several trials. We measured ant response by counting the number of ant visitations within 2 cm of the smear during 30 second intervals. A separate count was tallied for each 30 second interval, recounting any ants that left the area and reentered. Two people were assigned to count the ants in each treatment. Two treatments and 2 trials were run for each experiment.

To test the first hypothesis (A), we performed two experiments. In the first, we observed the response of the ants to a grasshopper smear versus a mud smear. This was designed to test if the ants responded to visual cues. If both smears received equal visitations by the ants, it would indicate that the ants were not responding preferentially to any chemical cues.

In the second treatment we replaced the mud smear with a smear of strong smelling sun tan lotion. This treatment was designed to test if the ants could differentiate between chemical cues. If both smears received equal visitations, the ants were not responding preferentially to specific chemical cues, in this case, those emitted by grasshoppers versus those from the suntan lotion.

For each trial of these two treatments, we observed four consecutive 30 second periods.

We tested the second hypothesis (B) with one experiment. In this case we used the grasshopper as herbivore and a dragonfly as an example of a non-herbivore. This experiment was designed to test for species-specific responses in the ants. In this case as well, we observed for four consecutive 30-second periods.

In the second part of the experiment we examined the possibility that the plant elicited a defensive response in the ants by emitting chemicals upon maceration.

To test our third hypothesis (C), we clipped a branch just distal to the innermost set of thorns, leaving the control branch untouched. If both branches received the same number of ant visitations, we would conclude that the plant was not producing chemicals to attract ant defense. For each trial we observed ten consecutive 30-second periods.

To test our fourth hypothesis (D), we performed one final experiment, in which we studied the response of the ants to plant chemicals. To do this we smeared separate

branches with paste of either Acacia leaves or the leaves of an unidentified species of tree (compound palmate). If both smears elicited equal visitations by the ants, we would have concluded that it was not a specific chemical produced by a plant that attracts the ants. It is also possible that the plants produced equivalent chemical cues. Due to time constraints, we only performed one trial for this treatment, consisting of six consecutive 30-second periods.

Results (V.V., A.B., T.Gr.)

Significantly more ants were present at grasshopper smears than at mud smears by both non-parametric ($u = 51.8$, $n = n_2 = 8$, $p < 0.05$) and parametric ($t = 10.0$, $df = 3$, $p < 0.05$) tests. There were significantly more ants present at grasshopper smears than at suntan lotion smears as shown by a non-parametric test ($u = 50.5$, $n = n_2 = 8$, $p < 0.05$), but not by a parametric test ($t = 0.99$, $df = 3$, $p > 0.05$).

There was no significant difference in the number of ants present at grasshopper smears compared to dragon fly smears, according to both non-parametric ($u = 38$, $n = n_2 = 8$, $p > 0.05$) and parametric ($t = 0.51$, $df = 3$, $p > 0.05$) tests.

There was not a significant difference in the number of ants present at clipped leaf sites compared to unclipped sites, as shown by non-parametric ($u = 184.5$, $n = n_2 = 20$, $p > 0.05$) and parametric ($t = 0.60$, $df = 3$, $p > 0.05$) tests.

Our final treatment compared an Acacia smear to a smear of a compound palmate leaned species. We were not able to conduct statistical tests for this trial due to inadequate sample size. The data which we obtained, however, show that both smears elicited strong responses.

Discussion (G.G., G.K., A.B.)

Our first hypothesis, that the ants respond more vigorously to an insect smear than to a non-insect smear, was supported by our data. This finding suggests that ants are able to identify a foreign substance as insect or non-insect.

Neither parametric or non-parametric tests supported our second hypothesis, that the ants react more vigorously to an herbivorous insect smear than to an insect predator smear. This result indicates that the ants respond with similar levels of intensity to herbivorous and non-herbivorous insects. It appears that an invading insect provides an excitory cue for the ants, but that the ants will respond similarly regardless of the type of invading insect.

Our third hypothesis, that the ants will respond defensively to leaf removal, was not supported by our data. It appears that leaf removal does not produce sufficient tissue damage to elicit a defensive response.

We could not carry out statistical tests on our final hypothesis, that the ants respond more vigorously to a crushed Acacia leaf smear than to a smear of crushed leaves from another plant, because time constraints prevented us from obtaining a sufficient sample size. However, it seemed clear that the ants responded more vigorously to both plant smears than to any other treatment in this one trial.

One possible interpretation for our findings is that the presence of a foreign insect arouses the ants but that a full defensive response is elicited only when leaf damage accompanies the presence of the foreign insect.

There were several possible sources of error in our study. The most correctable source of error is our small sample size. More trials could give statistical significance to our observed trends. A more difficult problem to compensate for is the possible difference in tree and colony size between trials. Another major source of error was the logistical problem of keeping track of lots of small ants running around in a confined area. The large degree of variance in our ant counts suggests that this was a relevant factor.

Table 1 The four treatments we analyzed statistically are shown (below) here with mean visitation rates (x), standard deviations (sd) and the results of the Mann-Whitney U ($U=49$, $p<0.05$).

Treatment	X_1	X_2	sd.	M-W U
grasshopper(1) vs. mud(2)	0.875	2.44	0.783	52
grasshopper(1) vs. lotion(2)	0.625	1.25	0.313	51
grasshopper(1) vs. dragon fly(2)	0.690	0.938	0.124	38
clipped leaves(1) vs. nonclipped leaves(2)	0.940	0.675	0.133	262