Table 2 Change in number of ants within 10cm after treatments on three individuals of Acacia collensii.

	String					Control		
Vine	-	-	-	-	-	-	-	-
	+6	-3	-3	+6	+2	-2	-1	+1	-4
	+2	-2	-3	+7	+2	-5	0	0	-4
	-1	-4	-3	+1	0	-5	+1	-1	-5
	-2	-3	-3	+1	0	-5	-2	0	-5
	-2	-4	-3	+3	+2	-5	-3	0	-5
	-3	-5	-3	0	0	-5	-1	-2	-5
	+2	-4	-3	-2	-1	-3	-2	-1	-5
	-2	-5	-3	-1	0	-5	0	-1	-4

	String					Control		
Vine	-	-	-	-	-	-	-	-
	-6	+1	-2	0	+7	+1	0	0	+2
	-1	+1	-2	0	+7	+1	0	0	-1
	+1	0	0	+1	+6	-1	0	0	-1
	+3	+2	-2	+6	+4	0	0	0	-1
	+2	+1	-1	+8	+3	-2	+2	+2	-3
	+3	0	-1	+12	+1	-1	+2	+1	-2
	+2	0	-5	+11	+1	-3	+2	0	-1
	+2	0	-4	+10	-2	-3	+2	+1	-1

Literature Cited

University of Chicago Press, 1983. P. 762-

AGGRESSIVE DEFENSE RESPONSE TO INTRUDER ANTS BETWEEN TWO SPECIES OF ACACIA TREE ANTS

Eddie Gilmartin, Todd Gorman, Ashley Mattoon, Lisa Taboada, and Todd Young

Abstract (T.Y.)

Pseudomyrmex ferruginea (red) colonies and Pseudomyrmex belti (black) colonies respond with different aggressive behavior when individuals of the other species are present on the host Acacia (Acacia collensii) tree. After depositing single ants at five minute spacings, data on time to contact, grappling immobilization(s), and removal were taken. The red ants were significantly faster in physically removing the black ants. Fifty percent of the black ants jumped off the tree before the red ants could remove them. Although black ants took longer than red ants to remove intruders of the other species, black ants were more aggressive in the sense that they engaged all red ants in physical combat and dismembered or removed 70% of the red ants (compared to 30% of black ants killed or removed by red ants).

Introduction (A.M., L.T.)

One of the characteristics of the obligate mutualism of the Acacia tree (Acacia collensii) and its resident ants is the ants' aggressive defense of its host tree. The Acacia tree is host to two different species of ants, red (P. ferruginea) and black (P. belti). Each tree contains only one species. They may be in close proximity, yet each species of ant remains antagonistic to any foreign ant of the other species on its tree. Such antagonistic responses are provoked by a variety of signals. Both species are sensitive to chemical signals, vibrations, and visual cues. An intruder can elicit the following responses: mobbing, grappling, stinging, dismembering, and expulsion from the tree. It has been noticed in nature that few Acacia trees can be found free of an ant colony. Colonies of both species are continually being established in unoccupied and possibly occupied trees. Considering the proximity and comparability of the two separate species of ant and the possibility of invasion by foreigners, we examined whether there are differences in the aggressiveness and success of each species in the defense of its tree. As we had no reason to believe that any difference existed, our hypothesis was that there would be no difference in each species aggressiveness or ability to defend its colony from foreign Acacia ants.

Methods (T.G.)

We selected one Acacia tree inhabited by red ants and one inhabited by black ants to which we would make intruder introductions; the trees were of roughly comparable size and activity of ants. In order to avoid agitating the trees prior to these introductions, we collected intruder ants from 2 other colonies. We collected enough of each species to make 10 reciprocal introductions. In making the introductions, we randomly chose 10 branches of comparable ant activity between 71-141cm height on the tree, so that we could easily view the interactions. We began placement on the lower chosen branches and moved up for our introductions, so that if an intruder ant were dropped accidentally, it would not land on a branch to be tested soon thereafter.

Intruder ants were introduced singly at the approximate center of the chosen branch on the introduction tree. To avoid possible injury to the ant, we most often transferred it with a loose twig, though tweezers were carefully employed sometimes as well. We began timing when the intruder first climbed onto the branch. In order to assess the overall ability of the host ants to defend, we measured time to first contact of the intruder with a host ant, time of any grapples, immobilization(s), and time of resolution (defined as where the intruder either jumped off, was dismembered and or ejected). If the situation had not been resolved after 5 minutes, we removed the intruder in order to perform enough samples within our time constraints. Ten introductions were made to each tree. We used the G-test to compare if resolutions with either colony were significantly different, and a Mann Whitney-U test to compare the different time measurements between the colonies.

Results (T.G., E.G.)

10% of red intruders jumped off the black host tree while 70% were dismembered or thrown off; 20% remained immobilized on the tree after 5 minutes. However, on the red host tree, 50% of the black intruders jumped off the host tree, 30% remained to resolution, and 10% were still immobilized after 5 minutes. No red intruders remained free on the black host for five minutes; however one red intruder (10%) was able to remain free on the black host tree for five minutes.

Although we did not observe a significant difference between the outcome of the trials for the two species ($G=3.4$, $df=3$, $p > 0.05$), there were strong trends for black intruders to jump off red host trees (50% did so), and for red intruders to remain on the black host tree until resolution. When intruders did not jump off, black host subdued 100% of the intruders, while red hosts subdued only 80%. We added 0.5 to each of the values in the contingency table in order to remove zeros.

It took black host ants significantly more time to resolve the intrusion of a red ant than it took red hosts to resolve black ant intrusions ($U = 55$, $n = 8$, $n_2 = 8$, $p < 0.05$, Table 2). It took black ants significantly more time than red ants to contact an intruder ($U = 62$, $n = 10$, $n_2 = 8$, $p < 0.05$, Table 2) and grapple with the intruding ant ($U = 47.5$, $n_1 = 10$, $n_2 = 6$, $p < 0.05$, Table 2). There were no significant differences in the time from first grappling to resolution between the two host species ($U = 22$, $n_1 = 10$, $n_2 = 8$, $p > 0.05$), nor was there a significant difference between the time it took host species to immobilize intruders after initial contact ($U = 9$, $n_1 = 9$, $n_2 = 2$, $p > 0.05$).

Discussion (L.T., A.M., E.G.)

The two species of ants inhabiting the acacia trees studied showed definite differences in the aggressiveness of their response to foreign invaders. Invaders remained on the red ant host tree for significantly less time. Most measures of other reaction intervals were also significantly lower for red ant hosts. However, in terms of effectiveness, black hosts were more thorough in eliminating invaders; they had a 100% success rate, while red hosts had only a 80% success rate. In addition, in the black hosts' response there appeared to be more of an intent to fully incapacitate the intruder, while the red hosts tended to throw invaders off the tree intact.

Initial observation led us to believe that red hosts were better patrollers of their tree than black hosts. Red hosts were visible on acacia branches and stems in much greater numbers than black. Thus, after introducing a black ant intruder to a red ant tree, the red hosts encountered the intruder with much greater alacrity than showed by black hosts encountering red intruders. However, these initial encounters were often not immediately followed by grappling and immobilization. Although black ant hosts did not spend as much time patrolling their tree as red ants, most initial encounters with red intruders were followed by grappling and immobilization.

The speed to resolution for the black intruders on the red host tree could be attributed to the red ants' superior ability to resolve conflicts, in that they quickly threw three invaders off the tree. However, it is also important that five of the eight black intruders jumped off of their own accord. Therefore, we could not conclude whether red hosts are indeed faster in resolving invasions. Perhaps the black intruders were intimidated by red ant signals and were in essence forced off the tree by the host.

Differences in colony size would have had significant effect on the efficiency of hosts to patrol their plants. We selected similar size trees with the assumption that this indicated similar size colonies. As time to first contact illustrates, the red hosts were superior in their patrols. However, this conclusion of superior speed in resolving invasions quickly, by better detection, rests on the assumption that the colonies were the

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.)

Conover, W.J. (1971) Practical Nonparametric Statistics. John Wiley & Sons.