PHEROMONE - INDUCED CHANGES IN DISTURBANCE RESPONSE OF THE ACACIA ANT, PSEUDOMYRMEX SPINICOLA

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ABSTRACT (BME)

We measured changes in reaction times and recruitment rates of the species Pseudomyrmex spinicola to three types of disturbances to their host Acacia collinsii. We hypothesized that reaction time and recruitment rate during a disturbance would be significantly faster for a disturbance pretreated with conspecific alarm phenomone.

We found signficantly faster reaction times and recruitment rates to phenomone treated disturbances compared to controls. There were no differences between responses to two levels of phenomone-treated disturbances. We conclude that the alarm phenomone of P. spinicola adheres to solid surfaces, such as a piece of strong, and that the phenomone signficantly reduces the amount of time it takes ants to respond to a potentially malevolent disturbance to its host tree A. collinsii.

Key Words: Pseudomyrmex spinicola, Acacia collinsii, pheromone, disturbance

INTRODUCTION (LCB)

The relationship between the ant, Pseudomyrmex spinicola, and the tree, Acacia collinsii is a classic example of a mutualism. Food and shelter are provided to the ant by the plant in exchange for protection from herbivory and reduced competition (Janzen, 1983).

The ants attack most foreign objects in or near the plant. A previous study suggested that P. spinicola produce an alarm phenomone in the course of an attack (Balser et al., 1992FSP). We thus tested this proposition that P. spinicola produces an alarm phenomone which persists after the attack. We placed strings with various exposures to attack by conspecific ants to create disturbances on A. collinsii occupied by P. spinicola. We predicted that P. spinicola would show increased attack response as a result of these disturbances and that the response would increase with the length of time the disturbance was exposed to the phenomone.

METHODS (DJG)

The study was conduct on 9 January, 1994 at Palo Verde National Wildlife Refuge, Guanacaste Province, Costa Rica. We selected 15 Acacia collinsii trees (2.5 - 5.0cm dbh) occupied by Pseudomyrmex spinicola. Sample trees were located ~0.5km east of the OTS field station and < 100m south of the road.

We selected a single A. collinsii (8m tall, 8cm dbh) with an active population of P. spinicola as the source tree for all exposure treatments. A 12.5cm piece of string, used to simulate an intruder was introduced to this population of P. spinicola for one of three exposure times: 0, 1, or 3 minutes. Each of the 15 trees was exposed to the three treatments in a random sequence based on a modified Latin Square Design. New pieces of string were used for each exposure trial. The exposed string was placed half way in on a branch, located at breast height, on the tree and vigously tugged three times. The string was left in place until 20 P. spinicola were recruited to the string or until 5 minutes had elapsed, which ever occurred first. Thirty minutes elapsed between subsequent treatments for a given tree to allow the heightened effect of the previous treatment to decline. We recorded time until the first P. spinicola arrived, time of subsequent arrivals, total number of P. spinicola recruited (up to a total of 20 individuals), and total duration of the observations (< 5 minutes).

Colony reaction time was defined as the time from the initial appearance of the string on the branch to the arrival of the first ant. Recruitment rate was calculated as:

$$\frac{\text{(total ants - 1)}}{\text{(total time - reaction time}}$$

Ant activity appeared to vary from tree to tree, so we normalized the data by dividing each observation by the mean value of all treatments for that tree. Data were evaluated with a single factor ANOVA.

RESULTS (DBZ)

Colony reaction time to a simulated intruder was significantly reduced by previous exposure of the string to ants ($F_{42} = 7.60$, df = 2, $p = 0.0015$; Figure 1). Both 1 and 3 minute exposure treatments differed significantly from the control treatment ($p = 0.003$ and $p = 0.001$, respectively), but did not differ significantly from each other ($p = 0.73$; Fisher PLSD).

Ant recruitment rate to a simulated intruder was significantly increased by previous exposure of the string to ants ($F_{42} = 3.98$, df = 2, $p = 0.0261$; Figure 2). Both 1 and 3 minute exposure treatments differed significantly from the control treatment ($p = 0.012$ and $p = 0.034$, respectively), but did not differ signficantly from each other ($p = 0.65$).

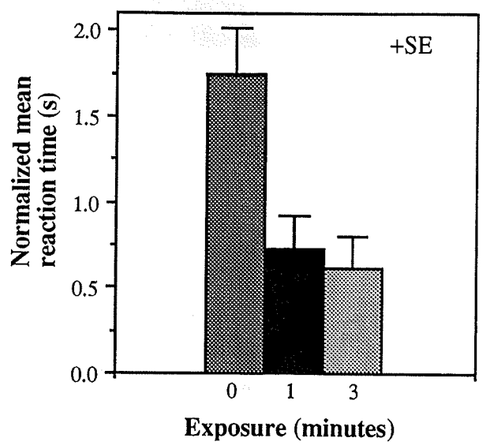

Figure 1. Mean time to first attack of surrogate intruders previously exposed to ant attack for 0, 1 or 3 minutes.

DISCUSSION (ANS)

Our data support the hypothesis that ant signals induced by disturbance to the host acacia tree evoke a more rapid response by the ants. The significant difference between reaction times and recruitment rates in the control and the two simulated intruder treatments indicates the use of a communication mechanism by P. spinicola.

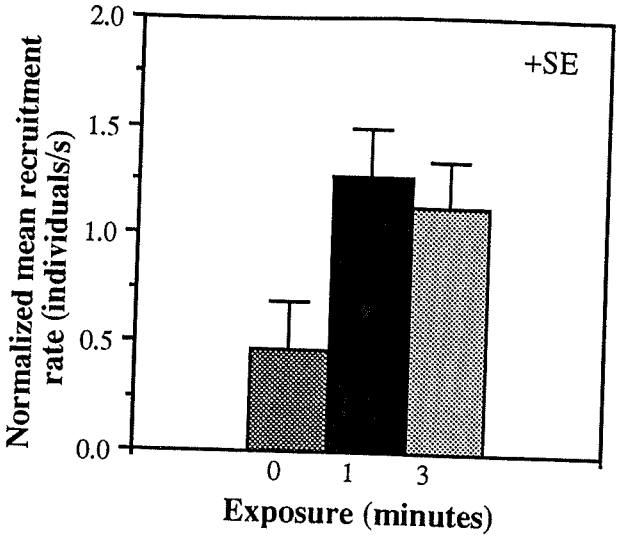

Figure 2. Mean recruitment rate for ants disturbed by a surrogate intruder exposed to ant attack for 0, 1 or 3 minutes.

The emitted signal is most likely chemical, in contrast to visual or auditory, because "vines" were transported to different trees and recognized by conspecific ants. Our data supports previous reports of ants releasing phenomones upon attacking an intruder (Janzen, 1983).

Earlier literature indicates that P. spinicola responds more aggressively to disturbance than other acacia ants found in Palo Verde (Balser et. al., 1992FSP). Signal recognition of pheromones provides one possible explanation. Because we found no signficant difference between 1 and 3 minute treatments in both reaction time and recruitment rate, either a) ant secretion of pheromone is not proportional to duration of attack or b) any response is not directly proportional to phenomone level.

As the day progressed, ant activity appeared to decrease on both the source tree and the sample trees. This study normalized the ant activity level to compare response times, but the effect of temperature, time, and radiation on the ants requires further study. The importance of wind in dispersing chemical signals and interspecific signal recognition remain to be investigated.

Ant protection of A. collinsii appears to be aided by chemical signals (phenomones) even when applied to foreign objects. They also persist after an attack. Our findings thus indicate that colony reaction time and recruitment rate increase as a result of chemical communication by P. spinicola.

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