Behavioral response of *Pseudomyrmex spinicola* to encroaching vines on host *Acacia collinsii*

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Abstract: *Acacia collinsii* and *Pseudomyrmex spinicola* exhibit an obligate mutualistic relationship in which the ants remove encroaching vegetation. The specific methods by which the ants clear the tree of vegetation are unknown. We hypothesized that *P. spinicola* would preferentially attack meristematic tissue as the primary method of destroying encroaching vines. We recorded the behavioral response of individual ants to a vine segment placed on a branch of *A. collinsii*. Meristematic tissue was not preferentially attacked; instead, aggressive behavior (predominantly mandibular contact) was concentrated in the contact zone between the vine and branch. This may be because the point of contact is the site first encountered by the ants.

Keywords: *meristematic tissue, aggressive behaviors*

Introduction

The relationship between *Acacia collinsii* and *Pseudomyrmex spinicola* is a well-documented example of a plant-insect obligate mutualism. *A. collinsii* provides shelter, sugar-rich nectaries and proteinacious Beltian bodies, while *P. spinicola* clears vegetation in a 1-4 m radius, reducing competition experienced by the tree, as well as attacking potential herbivores (Janzen 1983).

How *P. spinicola* controls encroaching vegetation is not well documented. We hypothesized that *P. spinicola* would preferentially attack the meristematic tissue of the vine segment, which would effectively limit vine growth. We observed the response of P. spinicola to vine segments introduced onto a branch of *A. collinsii* to describe the mechanism of removal.

Methods

At a site about 5 km south-east of the OTS station at Palo Verde National Park, Costa Rica, that was grazed until 5 years before, we selected stands dominated by *A. collinsii*. Trees chosen for the experiment were 1-3 m tall, in comparable health, colonized by the aggressive red ant, *P. spinicola*, and had the area underneath the tree cleared of vegetation. From a single herbaceous vine species, we cut similar sized segments that contained apical and lateral meristems. The segments were placed on a healthy branch between 0.5-1 m above the ground perpendicular to an *A. collinsii* branch, and each end of the segment rested on a compound leaf.

Each of three observers recorded each identifiable discrete behavior of an individual ant and the location of that behavior on the vine. Behaviors were classified as either "mandibular contact," a quick head-tap behavior (which appeared to be a biting action); "sustained mandibular contact," which appeared to be chewing; and "abdominal contact," a tap of the posterior abdomen which visually resembled a sting. Locations were classified as stem, meristem, or zone of contact. The latter was defined as the 10 mm length centered at the point where the vine touched the branch. If an observer's ant left the vine, the next ant that climbed on the vine was observed.

To determine the proportion of time spent at different activities by ants on the vine, we recorded locations at 15-second time intervals. These behaviors were classified as sustained mandibular contact, running, resting, or pulling, i.e. those behaviors that lasted longer than the very rapid events of mandibular or abdominal contact.

We averaged the total surface area, and the separate surface areas of stem, meristem and zone of contact, over the nine vine segments, to estimate the proportions contributed by each of these locations. These proportions were used to weight the number of aggressive attacks on each location of the vine. The weighted frequencies of the behaviors could then be interpreted as frequency per unit area for each behavior on the stem, meristem and zone of contact.

Results

We found no evidence that *P. spinicola* concentrates aggressive behavior on the meristematic tissue of introduced vine segments. However, we found that the point of contact received significantly more aggressive attention than the stem or the meristem, using the weighted number of discrete aggressive events per plant part (Fig. 1, Kruskal-Wallis Test, P=0.0008). Mandibular contact was significantly more frequent in the zone of contact than on the stem or meristem. This was the most frequent aggressive behavior overall (Fig. 1, Wilcoxon Test, P=0.02; Fig. 2). *P. spinicola* on the vine spent most of their time chewing the tissue (43%) and running along the stem (39%, Fig. 3).

Discussion

If attacking meristematic tissue is a method used by *P. spinicola* to eliminate intruding vegetation, this behavior was not expressed in our experiment. The zone of contact may have had the most numerous aggressive behaviors because it was the access point from the tree to the vine, and therefore most frequently encountered by the ants. The high incidence of mandibular contact could represent exploratory rather than aggressive behavior: we could not observe this behavior or its consequences closely enough to distinguish these alternatives. The high proportion of time spent running along the stem may indicate exploratory behavior, while sustained mandibular contact may be a behavior that eventually cuts and removes encroaching vegetation.

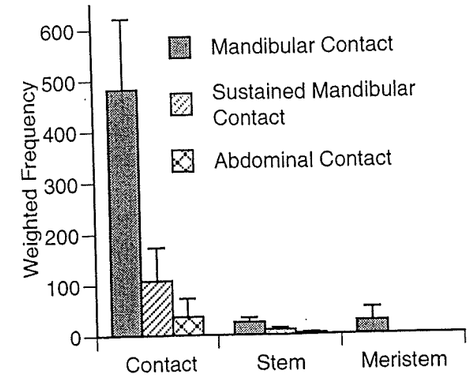

Fig. 1. Incidence of aggressive behaviors by *P. spinicola* towards introduced vine segments on *A. collinsii* hosts in 3 minutes (mean ± 1 S.E.; n=9 trees). Observations were weighted by the proportion of the segment's surface area that was the zone of contact, stem, or meristem.

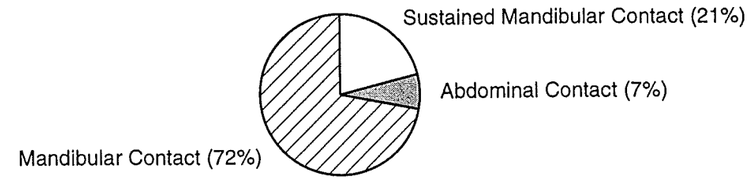

Fig. 2. Distribution of discrete behavior of *P. spinicola* in response to introduced vine segments at Palo Verde, Costa Rica.

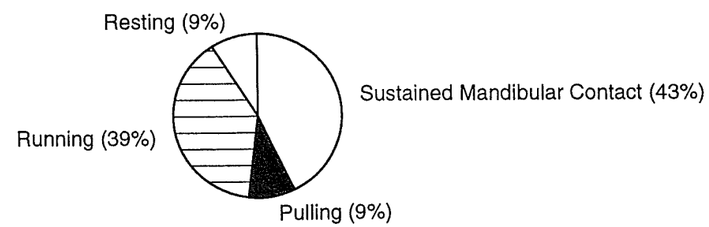

Fig. 3. Proportion of time allotted by *P. spinicola* to different activities while present on the introduced vine segments at Palo Verde, Costa Rica.

The three-minute trial period shows only the ant's initial reaction to the vine segment (which may be a general response to disturbance) rather than the specific behaviors used to remove an intruding vine. The effect of an intruding vine on the condition of the *A. collinsii* host would not be immediate. A longer trial period may be necessary to document the full range of behaviors used for vegetation removal.

LITERATURE CITED

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