P. flavicornis had a proportionally greater initial response to the disturbance than *P. spinicola*, though this trend was not significant (Kruskal-Wallis, Z= -1.54, P=0.12). *P. spinicola* maintained its higher post-disturbance activity level through the 10 minute trial, while the activity level of *P. flavicornis* decreased after the first minute (Kruskal-Wallis, Z=2.68, P=0.007).

Discussion

The pre-disturbance activity level of *P. spinicola* was greater than *P. flavicornis*, supporting our initial hypothesis, and consistent with the suggestion of Gilmartin *et al.* (1991) that P. *spinicola* patrols host trees more than does *P. flavicornis*. However, this difference may result from higher population densities of *P. spinicola* on the trees we tested, rather than intrinsic behavioral differences between the species. Contrary to our hypothesis, the initial response of *P. flavicornis* was proportionally stronger than that of *P. spinicola*. The post-disturbance activity level of *P. spinicola* was sustained for the duration of the trial. This result supports the conclusions of previous studies that *P spinicola* removes encroaching vegetation more effectively than *P. flavicornis* (Bansak et al., 1993; Cook et al., 1993).

It would be useful to extend the duration of the trial to observe the long-term response to the disturbance. Additionally, the use of non-lignified vine segments could provide the ants with a more realistic simulation of a growing vine.

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Behavioral response of *Crematogaster sp.* to introduced conspecifics from neighboring and distant *Acacia collinsii*

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Abstract We tested the behavioral response of ants of *Crematogaster* sp. to conspecific individuals introduced from other *Acacia collinsii* trees of distances of 1 m and 10 m. *Crematogaster* sp. reacted more aggressively to ants from other trees than to ants reintroduced from their own tree. After 10 minutes, no foreign ants were accepted. In contrast, all home ants were accepted. The distance between acacia trees had no effect on behavioral response.

Key Words: intraspecific behavior

Introduction

Crematogaster sp. is one of three mutualistic species of ant that lives in *Acacia* sp. trees in the dry forest of Palo Verde National Park, Costa Rica (Janzen, 1983). Colonies of the genus defend the acacia tree they inhabit from plant and animal invaders (Janzen, 1983). Ants should defend their home, even against invaders of their own species, in order to protect the resources the tree provides for their own colony (i.e., food and shelter). However, conspecifics from nearest neighbor trees may belong to the same colony. Thus, aggression between ants from nearest neighbor trees may be less than between ants from trees further apart. Thus, we hypothesized that 1) *Crematogaster* sp. would act more aggressively towards conspecifics from neighboring trees versus ants from their own tree, and 2) *Crematogaster* sp. would act less aggressively towards conspecifics from nearest-neighbor trees than those from trees 10 m away.

Methods

We observed *Crematogaster* sp. on eight "focal" *Acacia collinsii* trees located in secondary dry forest subject to grazing during the annual wet season, 3 km southeast of the OTS Field Station at the Palo Verde National Park, Guanacaste, Costa Rica. Focal trees were separated by at least 20 m. For each focal tree, one *Crematogaster* sp. individual was collected from that tree, one from the nearest neighboring tree (1 m), and one from an acacia >10 m away. Each collected ant was marked with Liquid Paper™ and introduced to the focal tree. The reintroduced ant from the focal tree acted as a control for the effects of the Liquid Paper, the disturbance created by handling the ants, and the disturbance associated with the introduction of the ants. Each marked ant was placed on the same branch of each focal tree, and its behavior was observed for ten minutes.

Encounters were defined as any interaction between an ant from the focal tree and the introduced ant. We categorized interactions as "aggressive" if biting, stinging or grappling occurred, and "passive" for head-to-head antennae rubbing. An ant was considered "eliminated" if it was killed, thrown off the tree, or immobilized by one or more focal tree ants. We recorded the time to the first encounter by focal tree ants; the final status of the introduced ant (either accepted, eliminated, or unencountered by focal tree ants); behavior of the host ants on the first and fifth encounter with the introduced ant (aggressive or passive); and the time from the first encounter to the elimination of the introduced ant, if that occurred. During the experiment, introduced ants did not interact with one another, and the behavioral responses to the three ants on each branch were considered independent.

Results

The time to the first encounter (sting, bite, or antennae rub) was similar for all introduced ants (ANOVA, $F_{2,21}$=0.67, P=0.52). The mean times until first encounter were 33s ± 16, 39s ± 13, and 55s ± 14 for the 0 m, 1 m, and 10 m treatments respectively. The behavior of focal tree ants during the first encounter did not differ across treatments (Fig. 1). In general, first encounters tended to be passive.

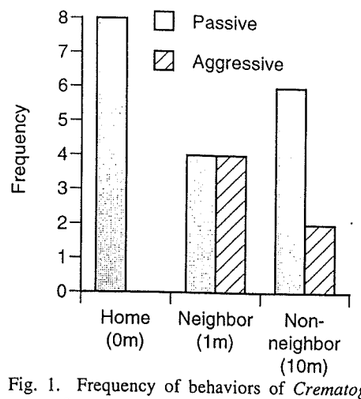

Fig. 1. Frequency of behaviors of *Crematogaster* sp. on first contact with introduced conspecific ants (n=24). Ants were reintroduced from their own tree, and introduced from a neighboring acacia tree within 1m and a non-neighbor acacia 10m away. Passive interactions were defined as antennae rubbing. Aggressive interactions were defined as biting and stinging. (n=24) (G=7.812, P< 0.099).

Introduced ants from acacia trees 10 m away were never accepted by the focal colony in the 8 trials. Although 2 out of the 8 ants (25%) from the 1 m treatments were accepted by the focal colony, the general trend was the elimination of all foreign ants (Fig. 2).

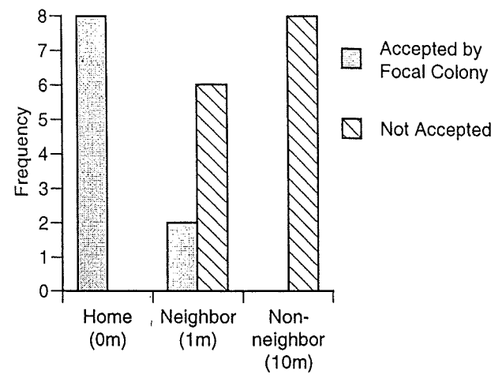

Figure 2. Final status of introduced *Crematogaster* sp. ants at the end of 10 minute trial (n=24) (G=27.6, P<0.0001).

A third of the initial encounters between ants from the focal colony and the introduced ants from 1 m away were passive. By the fifth encounter, all interactions were aggressive. However, the escalation in aggressive behavior was not significant (Fig. 3a). Aggressive behavior towards ants from 10 m away did increase significantly after the first encounter (Fig. 3b). The mean times from first encounter until elimination were 68s ± 37 and 37s ± 21 for the 1 m and 10 m treatments respectively, and did not differ significantly (ANOVA, $F_{1,8}$=0.56, P=0.48).

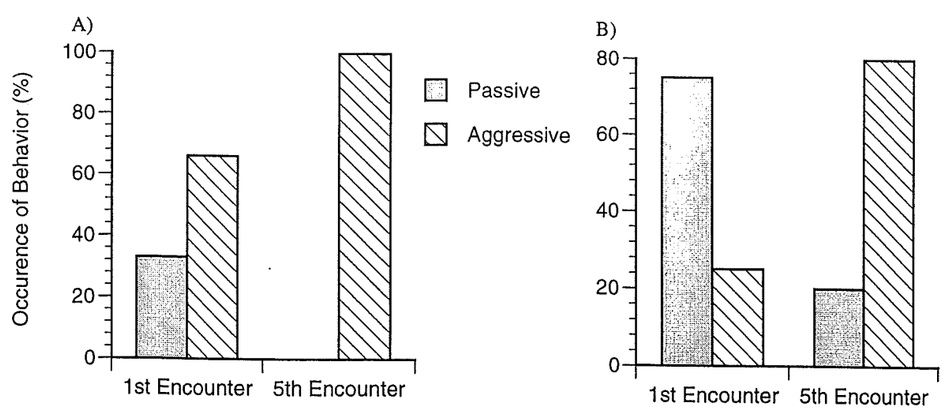

Figure 3. Escalation of response to introduced conspecific *Crematogaster sp.* ants between the first and fifth encounter with host colony ants(n=8). A. Ants introduced from nearest neighbor acacias (<1m from focal tree) (G=2.37, P=0.12). B. Ants introduced from acacias >10m away (G= 3.94, P=0.047).

Discussion

Home ants were accepted by ants on the focal tree, while foreign ants from trees both 1 m and 10 m away were either eliminated or not encountered during the trial. However, two ants from the 1 m treatment were accepted by the focal tree ants, suggesting that some colonies may inhabit two trees in close proximity to one another, perhaps colonizing neighboring trees via branches in contact, or by travel over the ground.

The initial behavior of home ants towards ants of all three treatments was generally passive (Fig. 1). We speculated that there might be castes of *Crematogaster* sp. ants, with only soldier ants making aggressive attacks on intruders. If so, the first ant from the focal tree to encounter an intruder may alert soldier ants, rather than acting aggressively. Identification of colony members or intruders may be accomplished via chemical mechanisms such as pheromones, perhaps based on genetic differences between colonies. Whatever the mode of recognition, the aggressive responses we observed would tend to protect the resources of the focal acacia tree for the resident colony.

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