location, then the occurrence was listed as an aggressive bout.

After 10 min, the focal male was captured and marked with a paint pen. Bees were then released at the same site and the site was observed for another 10 min to estimate site fidelity. After 24 hours, the sites were checked for re colonization by a marked or new male.

RESULTS

I observed 12 males, nine of which were in a 30 m stretch of the path. The hovering sites occupied a space estimated to be approximately 0.03 m3. The distance of a male hovering site to a potential nest site did not differ significantly from the distance of a randomly selected point along the transect to a potential nest site (t=0.868, df=22, P=0.394; Fig. 1). The trees in which the territories were established were of several different species, none of which were flowering at the time.

Patrolling behavior was observed in only five of the 12 males. Of those five males that patrolled, the mean number of patrols was 3 and the mean duration of individual patrols was 9 s. Two of the 12 males were observed in aggressive encounters (chasing) with non-territory holding males. Aggressive encounters in these two cases lasted approximately 10 s .

Over a two day period, no marked bees returned to their territories, nor did other bees reoccupy an abandoned territory once the resident bees were removed.

Two females were observed feeding on flowers along the path, however, the females never landed close to any male hovering sites. No feeding behavior was observed in the hovering males.

DISCUSSION

Little is known about the mechanisms behind carpenter bee behavior (Frankie et al. 1983). Although two aggressive encounters between conspecifics were observed (suggesting potential territorial behavior), I found no patterns between the selection of territory sites and the examined surrounding resources. Therefore, the hover sites may not function as territories where resources or reproductive activities are concentrated. However, the high energy expense imposed on male carpenter bees by this behavior implies some benefit. Perhaps the behavior increases male reproductive success through some other means.

One possible explanation could be that the hover sites are for mating displays. The loud buzzing could be an auditory signal for informing females of male locations. The qualitative observation that nine of the

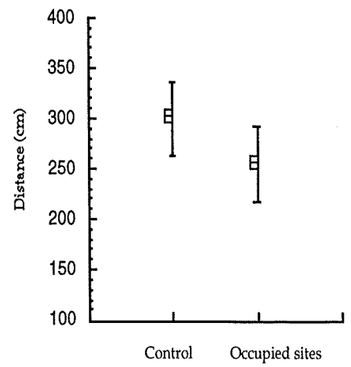

FIG. 1. A comparison of the positions of potential nesting sites relative to male territories. Potential nesting sites are defined as dead trees >10 cm DBH. For the control, distance represents the linear distance to a potential nesting site from a randomly selected point on the trail. In the occupied sites, this measurement is the linear distance between hovering individuals and potential nesting sites. The differences between mean distances is not significant.

12 focal males were found along a 30 m stretch of the path is interesting. Clumped mating display behaviors have been documented in other organisms, such as manakins (Stiles and Skutch 1989) and mud-puddle frogs (Rand 1983). Perhaps clumping mating behavior occurs in some insects as well. By aggregating, male carpenter bees may increase their individual reproductive success by increasing the overall audible signal for females. This phenomenon and the advantages that it confers to males warrants further investigation.

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EFFECTS OF RUFOUS-NAPED WREN NEST CONSTRUCTION ON THE BEHAVIOR OF ACACIA ANTS

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Abstract. Campylorhynchus rufinucha, the Rufous-naped Wren, often nests in acacias that are defended from herbivory and shading by ants of the genus *Pseudomyrmex.* We hypothesized that ants acclimate to the construction of wren nests and that the process and materials used in building the nests are the stimuli for this acclimation. We found no evidence for differential response or acclimation of ants to disturbances associated with nests and disturbances not associated with nests. We noticed, however, that ant response was not necessarily harmful to the nest or to the birds. We speculate that there is a commensal relationship between the wrens and the ants.

Key words: Acacia collinsii, Campylorhynchus rufinucha, commensalism, disturbances, habituation, Pseudomyrmex

INTRODUCTION

The Rufous-naped Wren, *Campylorhynchus rufinucha*, frequently makes its nest in the branch forks of the bull-thorn Acacia, *Acacia collinsii*, which is also inhabited by symbiotic ants of the genus *Pseudomyrmex.* The ants feed on the plant's Beltian bodies and extrafloral nectaries, and in return the ants defend the plant from herbivory and competition. It has been suggested that the acacia-ants eventually habituate to the presence of wren nests. The ants do not harm the birds inside and they protect the nests from predatory snakes and mammals (Skutch 1960, Janzen 1969). We observed that when wrens land in active nests, the disturbances elicit no response from the ants. We hypothesized that if the acacia-ants acclimate to disturbances caused by the nesting wrens, then the total number of ants responding to a wren nest should decrease over time. We also predicted that the materials and process used by wrens to construct their nests would trigger less total ant response than disturbances caused by similar but non-nest building activities.

METHODS

Early in the dry season, we selected nine ant-acacia trees without nests located alongside the road west of the OTS Biological Field Station in Palo Verde National Wildlife Refuge. All of the trees we selected were inhabited by the acacia-ant species *P. nigrocincta.* We selected trees of the same size and health. Using gloves and a plastic bag, we collected several uninhabited Rufous-naped wrens' nests in order to obtain the proper materials which could be used to simulate the construction of new wrens' nests.

We established three treatments with three trees in each experimental group. There was a control treatment with only a disturbance, a treatment with only nest materials added to the tree, and a treatment with added nest materials and a disturbance. Because these wrens generally weigh 35-40g, we produced the disturbance using a Pesola spring scale clipped to the branch and pulled several times to that weight reading in order to mimic the force of the disturbance made by a wren. To maintain consistency across treatments, all of the disturbances and nests were positioned at a height of approximately 2 m.

All trials lasted for a total of 30 min, and every 3 min during that time, we implemented the treatment and recorded the number of ants responding within an imaginary 9 cm2 zone around the disturbance from all directions. We defined "response" as the total number of ants moving into the area of disturbance or nest construction. In the control treatment trees we created wren-like disturbances, in the treatment with just nests, we placed a small handful of nest materials, comparable to the amount of materials we witnessed wrens bringing to the nest, and in the final treatment, we simulated the construction of a wren's nest by building a nest as well as causing disturbances similar to those created by a wren.

RESULTS

Ants did not acclimate to disturbances in any of the three treatments. The control group ants did not

respond differently from start to finish (F=1.54, df=8, P=0.25). Ants also responded no differently from start to finish in the treatment with nests and disturbances added (F=4.07, df=8, P=0.08). The treatment with only nests added actually showed an increase in ant response over the 30 min interval (F=11.32, df=8, P=0.01).

There was no difference in total numbers of ants responding among the treatments (F=0.319, df=6, P=0.74). However, there may be a trend toward highest ant response in the control group (Fig. 1).

Discussion

Our results did not support the hypothesis that ants acclimate to disturbances caused by and materials used by the Rufous-naped Wren as it builds its nest. We were also unable to conclude that ants respond less to wren nests and wren disturbances than to other disturbances. However, since we observed no ant response to an actual Rufous-naped Wren building a nest in an acacia tree, we suggest two possible interpretations of our results.

It is still possible that ants acclimate to the wren nests and subsequently protect the nests in the same way that they protect the rest of the tree (Janzen 1983: 559). Thirty minutes might not have been enough time for this acclimation to occur. We were also limited by our sample size. Since Acacia trees seem to vary widely in ant colony size and response to disturbances, a larger sample size would more accurately represent mean response to wren nest materials and disturbances.

To further test whether the ants acclimate to wrens' nests, it would be helpful to observe responses to the building of wren nests over much longer periods of time. It might also be revealing to compare ant responses to old wren nests in Acacia trees that already contain wren nests to responses to wren nests in trees that had not previously contained nests. Ants in the trees with nests could already be acclimated to the presence of a wren nest and might respond differently to the nest than would ants who had not yet acclimated. Our results suggest that overall ant response might decline in the presence of nests (see Fig. 1).

The second possible explanation for our results is that there is something else about the process or materials used by the wrens as they build their nests that distinguishes their disturbance from another type of disturbance. The ants may avoid the nest materials themselves or a scent that the wrens leave on the nests. It is also possible that the wren nests are simply too thick and entangled to be penetrated by the ants. To investigate the possible effects of wren scent, it would be useful to determine whether the ants respond differently to those materials that have previously been part of a wren's nest compared to those

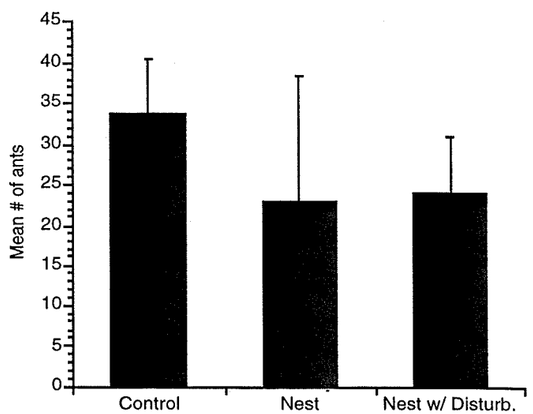

FIG. 1. Mean number of *P. nigrocincta* responding to disturbances and nest building activities for 30 min in all trees in each of three treatments (n=3 for each).

same types of materials that have never been in a wren's nest. It might also be revealing to examine ant response to wren feathers to see whether ants respond to the birds themselves.

We observed in all the treatments in which we built nests that ants initially investigated the materials and some ants even tried to remove the nests. However, within 6 min, ant response was seen only around the growing nests and never on the nest itself. Although our quantitative results suggest that the ants did not acclimate to the disturbances in terms of their total response to the simulated nest building activities, the ants did refrain from directly attacking the nests after several minutes. This suggests that the responses the ants continue to make in the presence of nests may serve to protect the nests from potential intruders.

Although we know that wren nests are tolerated by ants in the acacia trees, we still do not understand the exact mechanism for this interaction. Due to our collective observations, including one instance of a wren eating ants from an acacia tree, we suspect that the relationship between the ants and the wrens may be commensal. The wrens seem to gain a highly protected habitat for their nests, while the ants seem to gain nothing.

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