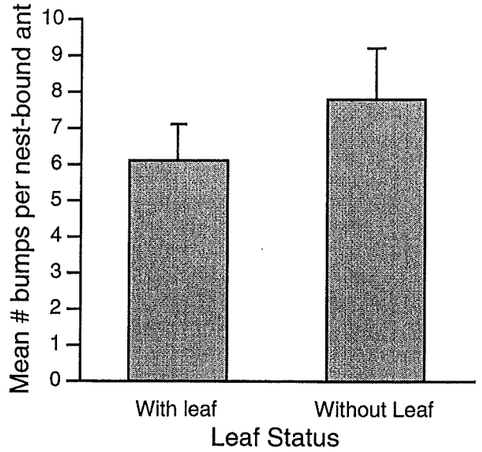

Fig. 1. Number of bumps between nest-bound ants with or without leaves and outbound ants. The number of bumps was averaged across 27 individuals of each leaf-status from three trails (means ± 1 SE, n = 27).

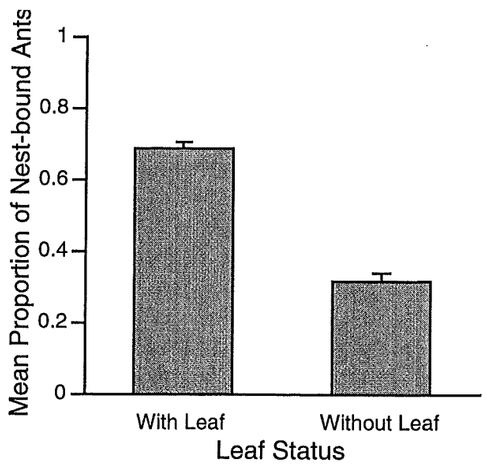

Fig. 2. Proportion of nest-bound ants with leaves and without leaves. Ant movement was counted twice at three reference points per ant trail. Counts were averaged across three trails (means ± 1 SE, n = 18).

without leaves were a mixture of soldiers and workers (personal observation).

Discussion

The high proportion of nest-bound ants carrying leaves (Fig. 2) suggests that ants were at the daily height of their foraging (Wirth et al. 1997). Perhaps the observed 32% of nest-bound ants without leaves do not go directly between the nest and food source but instead alternate direction on the trail. The lack of significant difference in the frequency of bumping between nest-bound ants carrying leaf fragments and those without leaves (Fig. 1) suggests that all nest-bound ants bump equally regardless of leaf load, and thus participate equally in communication, assuming this behavior is involved in some communication. On the other hand, bumps may be random contacts between ants and are not indicative of communication. Further research should consider the relationship between bumps and ant foraging rates, abundances on trails, and agonistic encounters to determine whether the contact is indeed communicative.

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The formation and dissolution of leaf piles on trails of leaf-cutter ants

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Abstract: Leaf-cutter ants (*Atta colombica*) sometimes drop their leaf fragments in a pile along an ant trail before reaching the nest, frequently in areas of intense sunlight. We hypothesized that ants form piles when they reach sunlit areas to avoid temperature-induced physical stress, and carry leaf fragments only in cooler sections of the path. We manipulated sunlight on leaf-cutter ant trails to assess its role in the formation of leaf piles. The number of leaf-carrying ants moving along the shaded trail before reaching the leaf pile and those moving away from the pile toward the nest were counted before and after experimentally shading the trail. The experimental introduction of shade on the path caused a significant increase in the number of leaf-carrying ants heading past the pile, indicating that *A. colombica* alter leaf carrying behavior based on sunlight-induced temperature change.

Key Words: Atta colombica, *heat stress, temperature*

Introduction

Leaf-cutter ants, *Atta colombica*, travel from a central nest site in columns to cut and collect plant parts that they use as substrates for growing fungi as food (Stevens 1983). The paths along which they travel are often cleared of leaf litter (Stevens 1983). Occasionally, ants drop their plant fragments in a pile on the ant trail and return to foraging sites (Cover et al. 1997). Cover et al. (1997) found that piles were formed more frequently on sunnier, warmer trails than on those in the shade. They also observed that ants picked up fragments on these dump piles, either moving them to another sunny area or to the nest, when shade encroached on a leaf pile. We hypothesized that sun exposure on the paths results in increased temperature causing the ants to pile plant fragments. To test this, we predicted that the experimental provision of shade would induce the ants to resume carrying the fragments.

Methods

On the afternoon of 1 February 2001, we located seven leaf piles along *A. colombica* trails on a lawn and the airstrip near the Estación Sirena, Corcovado National Park, Costa Rica. Both trails were in large exposed areas with no tree cover, although portions were shaded by the short grass and by trees surrounding the lawn and airstrip. At each leaf pile, we chose two points on the ant trail for observation: one within the naturally shaded area approaching the leaf pile (origin) and one within the sunny area past the leaf pile (destination) (Fig. 1). Before experimental shading, we counted the number of leaf-carrying ants passing each observation point for 1.5 min. The path on either side of the leaf pile (including both observation points) was then shaded by holding a 1.3 m by 0.7 m towel. During experimental shading, we again counted the number of leaf-carrying ants passing the origin point and the number passing the destination point during a 3 min. interval. Data with equal variances were analyzed with one-way ANOVA, while those with unequal variances were analyzed with Welch's ANOVA.

Results

The number of leaf-carrying ants passing the naturally shaded origin point did not change with the experimental addition of shade (ANOVA, $F = 0.01$, $df = 1$, $P = 0.92$; Fig. 2). The experimental introduction of shade on the previously sun-exposed path resulted in a significant increase in the number of leaf-carrying ants passing the destination point (Welch's ANOVA, $F = 13.99$, $df = 1$, $P = 0.008$; Fig. 2). Thus, with the addition of shade, ants

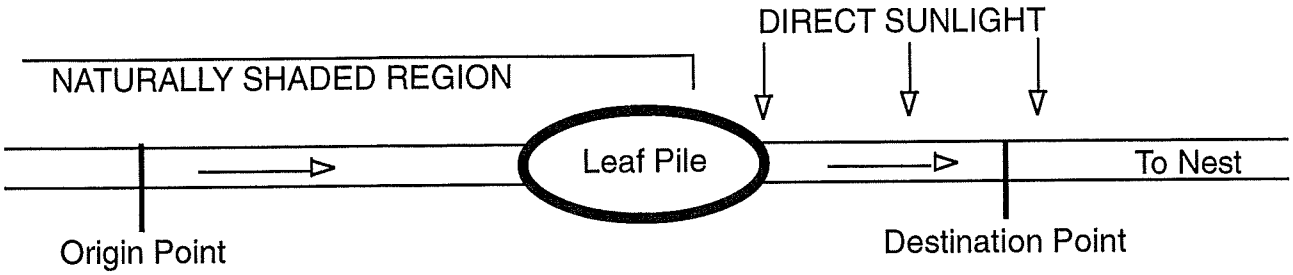

Fig. 1. Schematic of *A. columbica* path with leaf pile. Origin and destination haphazardly selected in a naturally shaded area and in a sunlit area, respectively. Experimental shade was introduced over the leaf pile in the sunlit portion of the path.

resumed their transport of leaves toward the nest. We also observed that ants dropped the fragments almost immediately upon leaving the experimentally shaded area of the path, and returned back along the shaded trail.

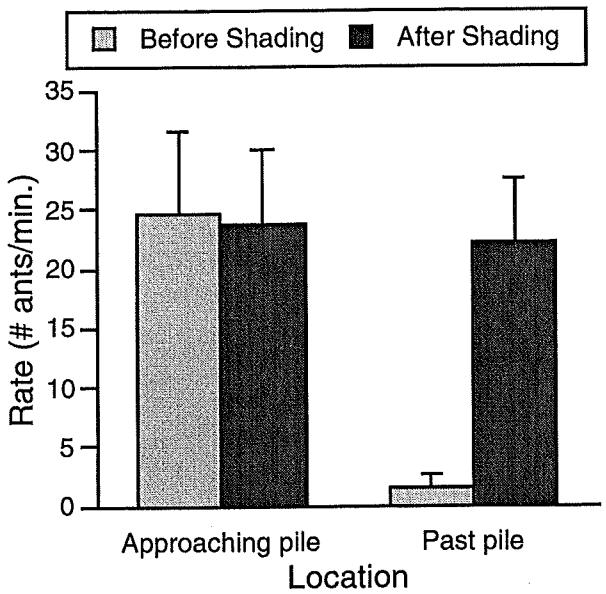

Fig. 2. Number of leaf-carrying ants crossing lines approaching and past leaf piles (heading towards the nest) before and after the experimental introduction of shade across the path (mean ± 1 SE). The path approaching the pile was naturally shaded and the path past the pile was naturally in full sun.

Discussion

Leaf-cutter ants ceased carrying leaf fragments and formed leaf piles upon moving from shaded areas to areas of high sun exposure, and resumed carrying fragments past the piles when shade was introduced over the paths (Fig. 2). These results suggest that sunlight and/or temperature has a direct effect on the tendency of these ants to carry leaf fragments. We suggest temperature may be the more important factor, as it undoubtedly increases with sun exposure and time of day (Cover et al. 1997) and probably results in increased physical stress on the ants. We propose that it is more energy-efficient or perhaps physically necessary for the ants to stockpile the leaves, and carry them further only when the path is shaded and cooler.

To more accurately determine the stimuli for the stockpiling behavior, further studies might separate the effects of light and temperature, or investigate whether preexisting plant fragments on a trail will cue the ants passing that point to drop their fragments at that site. Further study might also investigate whether ceasing travel across sunny paths affects the overall efficiency of the ants.

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