

FIG. 1. Proportions (mean \pm SE) of plant material types collected across all trails by *Atta cephalotes* in Corcovado National Park, Costa Rica. ($F = 21.9$, $df = 5, 102$, $P < 0.001$; $n = 18$ trails)

of total biomass per trail. There was only one trail that had a substantial percentage (42%) of fruit. The other trails had zero or negligible percentages of fruit.

DISCUSSION

We found that leaf-cutter ants transport approximately equal proportions of leaf and flower parts to their nest, despite the far greater abundance of green leaf matter in nature. Higher flower usage may be a result of several factors. During the dry season, flower and reproductive parts that are higher in energy and contain fewer secondary defense compounds than green leaf material attract foraging ants (Wirth et al. 1997). Flowers may be less tough than leaves, which would make them easier for the ants to cut and possibly more valuable as a food source for the fungi. High variation in flower usage between trails may be related to the patchiness of flower distribution.

We found very little fruit usage at the start of the dry season. Most fruit does not ripen until the beginning of the wet season. In one trail, *Ficus* fruit, which ripens continually throughout the year, comprised 42% of the fruit usage. High usage of figs on this trail may indicate that fruit is used when it is available.

Leaf usage was observed on all trails. Leaves are available in all seasons in Corcovado National Park, so this is not unexpected. However, as the percentage of leaf use was lower than for flowers, it appears that ants do use plant parts disproportionately to their natural abundance. To further our understanding of ant preference, future studies might compare leaf cutter ant use of plant parts to their relative abundance in the local environment.

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The effects of trail obstructions on leaf transport in *Atta cephalotes*

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Abstract: We examined the response of leaf-cutter ants to trail obstructions of three sizes to determine how rapidly the ants restored baseline transport rates. Although colonies were initially affected by trail obstructions of all sizes, baseline transport rates were reestablished very quickly. Ants without leaves tended to clear the trail or establish new routes around the obstruction. They chose to clear small blockages, while building a new (longer) trail around large ones. As a result, each ant must expend extra energy to bring leaf fragments back to the colony, representing a net cost to the colony. This finding suggests that individuals may not always behave in ways that maximize the efficiency of the colony.

Key Words: leaf-cutters, response time, transport rate

INTRODUCTION

Leaf cutter ants (*Atta cephalotes*) follow chemical cues to and from their foraging sites and usually travel on trails cleared of leaf litter. The colony works as a unit to obtain plant pieces, which they use to culture a fungus, their primary food resource (Janzen 1986). Naturally occurring disturbances, such as rainstorms and falling debris may result in decreased transport and leaf acquisition rates. Therefore, it appears necessary for the colony to have some ants clear debris or establish a new chemical trail around it. We hypothesized that obstructions would decrease the transport rate of ants traveling to and from their foraging site.

French et al. (1999) demonstrated that ants employ different trail clearing strategies depending on the size of the obstruction. Based on these findings, we predicted that ants would remove small obstructions but create a new trail around large ones. We also predicted that the ants would reestablish baseline transport rates more quickly following a small disturbance than a large one. Finally, we predicted that ants carrying leaves to the nest would take a longer time to recover their initial travel rate after a disturbance than those not carrying leaves.

METHODS

On 2 February 2003 near Sirena Biological Station in Corcovado National Park, we sampled four trails of leaf-cutter ants on the Senderos Guanacaste and Naranjos. We determined their baseline transport rate by counting the number of ants crossing a point in the trail for 10 s every 1 min for 5 min. We then placed either a small, medium or large obstruction on the trail. Small obstructions consisted of one medium-sized dead leaf. Medium obstructions had three leaves, and large obstructions had five leaves. We performed the treatments in different orders at each trail to avoid any sequence effect.

We determined leaf-cutter sensitivity to trail obstructions by measuring the transport rate immediately after placing leaves on the trail. Transport rate was determined by counting the number of ants with and without leaves crossing a point 10 cm beyond the obstruction (in the direction of travel) during a 10 s time period. To determine the return time, we repeated the 10 s count every minute until baseline rates of travel were resumed. We waited 10 min between treatments to ensure that we sampled different ants and that the chemical trail was re-established. We repeated this procedure for each treatment.

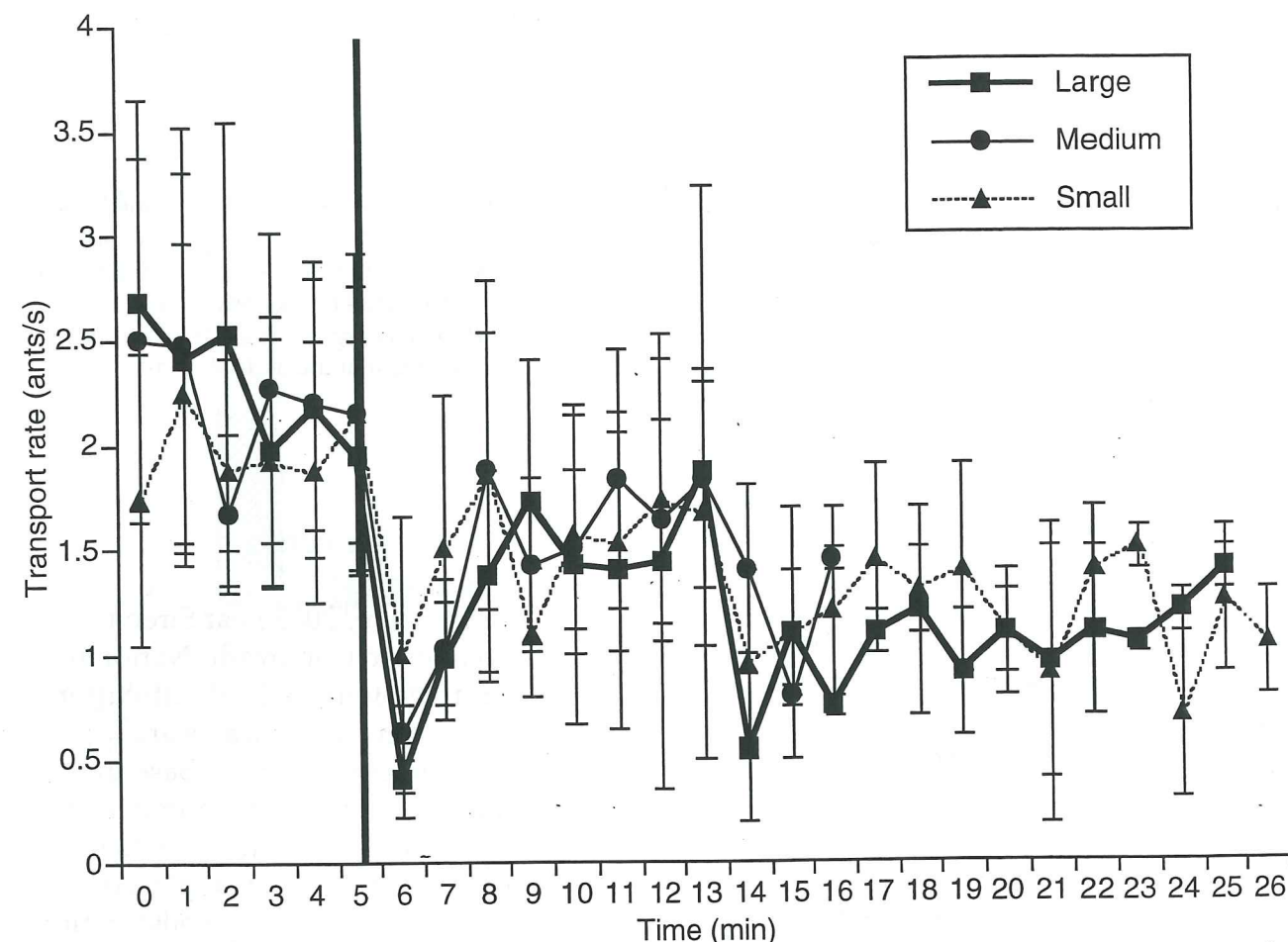


FIG. 1. Changes in overall transport rate by *Atta cephalotes* in response to large, medium and small obstructions (large = five leaves, medium = three leaves, small = one leaf) in Corcovado National Park, Costa Rica. The vertical line at time 5 indicates the time of the disturbance. Data represent means \pm SE.

RESULTS

We found no significant difference in sensitivity or return time between small, medium and large obstructions ($F = 0.94$, $df = 16, 4$, $P = 0.59$). We could not test for an effect of trail because we were only able to run one replicate per trail. However, we noticed (post hoc) a large difference in baseline transport rates among trails. By grouping the trails according to baseline rates, we found a significant drop in transport rate immediately following all disturbances, but differences between the treatments remained insignificant (Fig. 1). Additionally, there was no significant difference in sensitivity or recovery time between ants with and without leaves ($F = 0.02$, $df = 1, 22$, $P = 0.90$; $F = 0.02$, $df = 1, 22$, $P = 0.88$).

DISCUSSION

Leaf cutter ants responded differently to obstructions of different sizes. The ants moved the blockage when faced with a small obstruction, but established a new trail around medium and large obstructions. However, both of these responses appear to be equally effective in restoring baseline rates since small, medium, and large obstructions had no lasting effect on overall transport rate. A possible explanation for this finding may be that colonies establish transport rates at less than maximal levels so that frequent obstructions can be tolerated without creating major traffic jams.

Additionally, there was no significant difference in transport rates following disturbances between ants carrying leaves

and ants without leaves. Observationally, it appeared that ants without leaves tended to move the obstruction or reestablish the chemical trail, which allowed the ants carrying leaves to continue towards the nest.

Ants formed a new chemical trail around large blockages rather than moving them. This action seems to imply that *Atta cephalotes* workers fail to respond in a way maximizes colony efficiency, since all the ants on the trail then have to expend extra energy to circumvent the blockage. Future studies should examine whether the trail around the blockage is a temporary solution to restore flow while they remove the blockage, or a permanent alteration that represents a net cost to the colony.

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