DO LEAF-CUTTING ANTS BITE OFF MORE THAN THEY CAN CHEW?

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Abstract. Leaf-cutting ants (*Atta cephalotes*) cut and carry fragments of vegetation to be used in their fungus gardens. These fragments of vegetation were proportional to the size of the ant carrying them. When this load was increased through experimental manipulation, ant velocity decreased. Thus, the amount of plant matter brought back to the colony is limited both by the size of the ants and by the size of the plant fragments they carry. These limitations are important determinants of optimal foraging strategies for the colony.

Key Words: Atta cephalotes, *leaf-cutting ant, transport load, optimal foraging*

INTRODUCTION

Leaf-cutting ants have evolved foraging strategies presumed to maximize the influx of leaf material into their nests. This leaf material is used to support a fungus garden that provides a food resource for the colony. However, two major factors limit the flow of vegetation fragments to the colony: ant size and fragment size. Seandel et al. (1993) examined ant speeds with varying loads and found a weak correlation between ant speed and leaf size, although they never adjusted for the size of the ant. A fragment that is too large for a particular ant would slow down the ant and decrease the flow of plant matter into the colony. I hypothesized that load size will be proportional to ant size and that ant speed will decrease with increased load size. I tested the latter by experimentally manipulating load size of leaf-carrying ants.

METHODS

On 19 January 1996, I studied a column of leaf-cutting ants in the tropical premontane moist forest near San Luis Biological Reserve, Costa Rica. I haphazardly collected 50 ants from the colony that were carrying approximately circular pieces of leaves. For each ant, I measured ant length and diameter of leaf fragment. Regression analyses were used to relate ant size to leaf fragment size.

I studied the effects of load size on ant speed during the mid-afternoon. I haphazardly selected an ant with a leaf and picked it up with tweezers, held it for five seconds, then set it down 5 cm from a startline marked in the trail. Ants were timed for a distance of 10 cm beginning at the startline, then picked up and started again, this time with a 8 mg weight added. This weight was a small piece of aluminum (2 x 6 mm) folded over the leaf in a way that did not seem to upset the ant's balance or have any other observable affect on the ant's behavior. The average weight of a leaf fragment was also 8 mg, so attaching the weight to the leaf approximately doubled the ant's load. This procedure was repeated for 25 ants. I compared the time to travel 10 cm with and without the extra weight using a paired t-test.

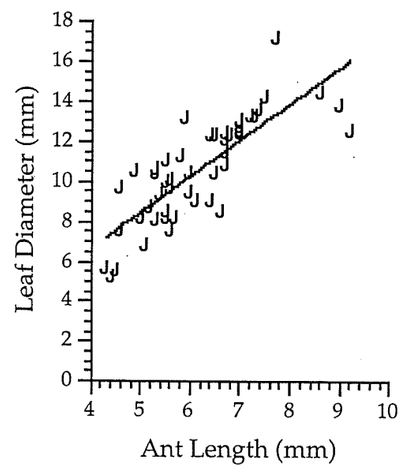

Figure 1. Leaf diameter as a function of leaf-cutter ant size ($p < 0.01$).

RESULTS

Leaf size increased with increasing ant size ($r^2 = 0.65$, $p < 0.01$, Fig. 1). Doubling the transport load of the ant slowed down the ants' travel time by an average of 8.3 seconds ($t = 56.27$, $df = 25$, $P < 0.001$, Fig. 2).

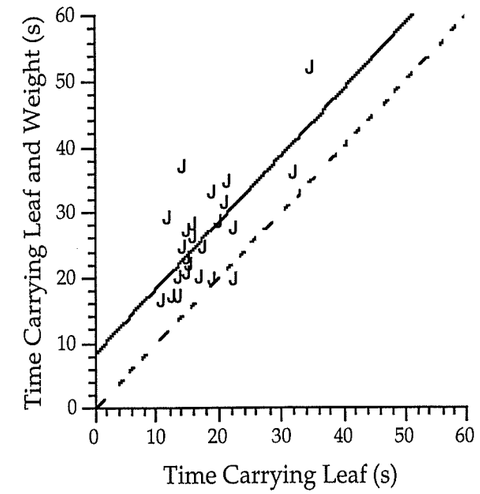

Figure 2. Travel time across 10 cm for a leaf-cutter ant carrying a leaf (x-axis) vs. carrying a leaf and an 8 mg additional weight (y-axis). Dashed line represents no difference in time between control and manipulation. Solid line represents regression of actual results.

DISCUSSION

Leaf-cutting ants carry leaf fragments proportional to their size, and carrying larger fragments results in increased transport time (Figs. 1 - 2). Seandel et al. (1993) may have found only a weak correlation between ant speed and leaf size because the ants were carrying loads proportional to their size and were therefore traveling at similar speeds.

It appears that leaf-cutting ants have evolved transportation behaviors that are consistent with the prediction of optimal foraging. On one hand, ants should carry as much plant material as possible back to the colony to maximize productivity of their fungal garden. On the other hand, ants should transport this load as quickly as possible to do the same. If ant speed decreases with increased load, then there is probably a leaf fragment size that maximizes the influx of leaf material back to the nest. Presumably, this optimal leaf size varies with ant size. By maximizing the rate of leaf mass delivery to the nest, the colony should be maximizing its nutritional resources, reproductive output, and fitness. Further study of ant speed, transport loads and costs, and theoretical biomass accumulation would be valuable to determine whether leaf-cutting ants are truly foraging at optimal levels and what impacts they are having on the tropical rainforest.

LITERATURE CITED

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