slowed down or clearing the impediment.

Perhaps deeper litter also results in smaller leaf pieces being carried. If so, then this is an additional cost of a less cleared trail that we did not consider. However, it is also possible that ants are carrying larger pieces to compensate for slower movement on deeper litter.

THE EFFECTS OF LEAF LOAD AND ANT SIZE ON BIOMASS TRANSPORT RATE FOR ATTA CEPHALOTES

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ABSTRACT(LCB)

We studied three Atta cephalotes trail sites in the tropical wet forest of Corcovado National Park, Costa Rica, to investigate the relationships among ant size, size of leaf fragment, and velocity. For all three colonies larger ants tended to be faster and transport larger leaf fragments. In two colonies velocity tended to decrease as ants carried larger loads for their body. For all three colonies, the biomass transport rate (cm^2 leaf x cm /minute) increased as ants carried larger loads. Factors such as trail condition, travel distance, and area-specific mass of leaf fragment may alter the combination of ant velocity and load size that maximize biomass transport rate.

INTRODUCTION (JLB)

The leafcutter ant, Atta cephalotes, transports thousands of leaf fragments daily to sustain fungal gardens on which the colony feeds. We noticed that ant speed and leaf fragment size varied greatly within a trail. A previous study with Atta colombica at Monteverde suggested that larger ant individuals carried heavier loads (Shutler et al. 1991). We hypothesized that the speed at which A. cephalotes can travel is dependent both on its own size and the size of the leaf fragment it is carrying. We predicted that slow ants with large loads will transport equal biomass of leaf fragments as fast ants with smaller loads.

METHODS (LCB)

This study was conducted in the tropical wet forest of Corcovado National Park, Costa Rica, on 28 January 1994. We chose three leaf cutter ant trails with relatively high leaf transport activity, two that crossed Sendero Espeveles and one that crossed Sendero El Pavo. At each site, we measured the amount of time it took 35 leaf carrying ants to travel 60cm. The total number of leaf carrying individuals which entered the observation area during the time of the study were recorded to determine total trail activity.

We measured tarsal length of each selected ant and surface area of the leaf fragment it carried. Relationships among the variable were evaluated using regression analysis. We defined "loading" per ant as the residual from the regression of leaf area against ant size. Both velocity and rate of biomass transport (cm^2 leaf x cm /minute) were evaluateas a function of loading.

RESULTS (HMF)

Larger ants tended to be faster in all three colonies (Table 1), although this relationship was significant only in colony 3 (Figure 1).

As ant size increased, leaf area tended to increase in all three colonies (Table 1), but this relationship was significant only in colony 1 (Figure 2).

Table 1: Results of regressions evaluating (A) ant speed as a function of ant size, (B) leaf area carried as a function of ant size, (C) ant speed as a function of load size and (D) biomass transport rate (cm^2 leaf - cm - min^{-1}) as a function of load size.

	Colony	Intercept	Slope	SE of Slope	r^2	p
A. ant velocity vs. ant size	1	70	61	33	0.09	0.73
	2	143	21	41	0.01	0.60
	3	65	117	40	0.21	0.01
B. leaf area carried vs. ant size	1	0.40	0.58	0.27	0.12	0.04
	2	0.46	0.46	0.26	0.09	0.08
	3	0.68	0.28	0.29	0.03	0.33
C. Ant velocity vs. relative load size[a]	1	122	-38	21	0.09	0.08
	2	158	-41	26	0.07	0.14
	3	168	26	26	0.03	0.33
D. Biomass transport rate vs. relative load size[a]	1	107	102	22	0.38	<0.001
	2	127	97	22	0.39	<0.002
	3	157	202	29	0.60	<0.0001

[a]Relative load size - residuals from leaf area carried as a function of ant size (regression B).

Ants carrying relatively large loads (those showing positive residuals from the regression of leaf area vs. ant size) tended to have reduced velocity in colony 1 (Figure 3) and colony 2, but colony 3 showed the opposite trend (Table 1).

In all three colonies, biomass transport rate increased as loads grew relatively larger. Biomass transport rate in colony 3 increased faster with ant loading than in the other two colonies (slope ± SE = 202 ± 29 vs. 102 ± 22 and 97 ± 22; Table 1).

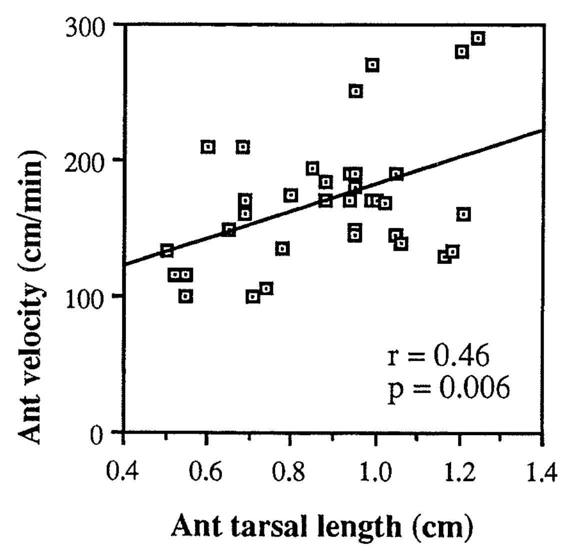

Figure 1: Relationship between ant velocity and ant size in colony 3.

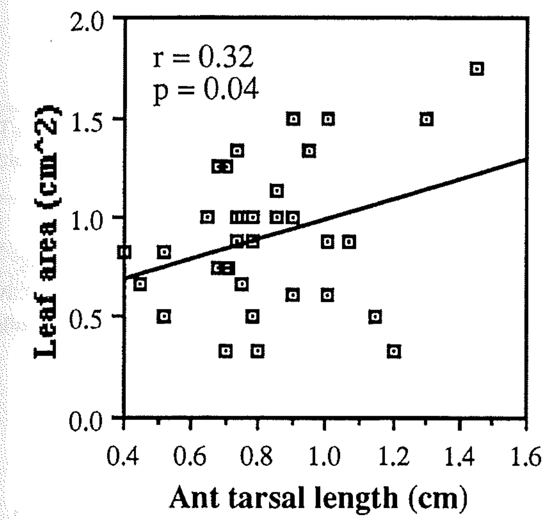

Figure 2: Relationship between leaf area transported and ant size in colony 1.

DISCUSSION (JLB)

Larger A. cephalotes appeared to travel faster and carry larger leaf fragments than smaller conspecifics. While not statistically significant across all three colonies, these trends suggest that larger ants would be better foragers for the colony's fungal garden. Carrying relatively large leaf fragments tended to reduce ant travel speed, yet resulted in a greater rate of biomass transported to the colony. The combination of ant velocity and load size that maximizes biomass transport may vary depending upon travel distance from target tree to colony, the condition of the trail, and the area-specific mass of leaf fragments. If larger ants were the optimal foragers in all conditions, we would expect to see them in greater abundance. Further study is required to characterize the circumstances in which smaller workers may be advantageous for foraging.

LITERATURE CITED

Shutler, D. and A. Mullie. 1991. "Size-related foraging behavior of the leaf-cutting ant Atta colombica." Canadian Journal of Zoology 69: 1530-1537.