WORKER ALLOCATION IN *ATTA CEPHALOTES*: TASK FIDELITY AND COMMUNICATION

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Abstract. We examined the efficiency of worker organization in colonies of*Atta cephalotes*, a tropical leaf-cutting ant. We found that debris-removal workers were never seen on the leaf-gathering trail system, nor were leaf-gathering ants ever seen at the debris pile. We also found that communication of information about the status of a trail from a returning ant to an outgoing ant involves the presence or absence of a leaf fragment in the former's mandibles, as well as chemical cues. (JLD)

INTRODUCTION (CNO)

Social insects may operate more efficiently if each individual repeats one task, rather than performing multiple tasks. We examined task and trail fidelity as well as some aspects of communication between individuals in a colony of leaf-cutter ants (*Atta cephalotes*). One caste (media workers) performs most of its work outside the nest. Media workers cut leaves and carry them to the nest in addition to removing debris from the nest (Stevens 1983).

We noticed that media workers traveling in opposite directions would sometimes touch antennae with each other. We hypothesized that the ants communicate the current operational status of the trail through this contact. On trails that are shutting down due to lack of leaf resources, fewer workers carry leaves toward the nest. This led to our second hypothesis, that the high proportion of ants without leaves returning to the nest plays a role in causing outgoing ants to change trail direction. Whether media change direction or not was used as the response variable for each antennae contact event. We tested this in (i) a trail with no active leaf transport where physical and chemical cues may signal its inactivity, (ii) a trail with active leaf transport, and (iii) an active trail where we removed leaf fragments.

METHODS (CNO)

Our study was performed on a leaf-cutter ant colony near the Sendero Rio Sirena in Corcovado National Park, Costa Rica. We marked 100 ants moving towards the nest on each of three trails with liquid paper and a toothpick. Ants were marked on each of two foraging trails and on the debris-dumping exit from the colony. Ants on a trail branching up a tree (*Zanthoxylum procurem*) were marked in yellow; on another fork of the same trail the ants were marked in pink, and on the trail leading from the nest to the trash pile the ants were marked with green. We recorded the number of ants with each color passing a reference point on each trail at ten minute intervals. Two 10-minute censuses of the total number of ants moving toward the nest past a reference point on each of the three trail sections were also taken.

In the second part of the experiment, we tested whether the absence of leaves in the mandibles of ants moving towards the nest affects the movement of ants traveling away from the nest. We used three 50cm long trail areas. One (Trail A) was the trail used earlier, which appeared to be in the process of being abandoned by the ants. The second was a branch of a fully active trail (our control) and the third was a manipulation of the active trail (Trail B). For the manipulation we removed the leaves from all of the ants traveling toward the nest on Trail B, leaving ants on the trail facing the direction they had been moving. We removed the leaves for 20 minutes before examining the response, and throughout the subsequent 25 minutes of observation. We watched each of the three areas for five 5-minute intervals, recording the number of ants moving away from the nest and towards the nest, the number of ant-ant contacts (defined as two ants rubbing antennae), and the result of the contacts (whether the ant traveling away from the nest turned around or continued its path up the trail). To standardize the frequency of encounters along each trail, we calculated an Encounter Rate Index (ERI) for each replicate by dividing the actual number of encounters by the possible number of encounters and multiplying by a factor of 10 for convenience. The replicates were averaged to find an ERI for each trail.

RESULTS (JLD)

Task Fidelity. We found that no debris-removal workers entered the foraging trails. Also, no leaf-cutting workers were found to remove trash (Table 1). In the foraging trail system, we found that, with one exception, no pink-marked media entered the yellow trail. However, a large number (38) of yellow-marked media were found on the pink trail in addition to 21 pink-marked ants (Table 2).

Table 1. Task fidelity. The number of marked ants observed in different locations.

Location	Time Observed	# Trail Media	# Trash Media
Debris pile	90min	0	206
Foraging trail system	170min	97	0

Table 2. Trail fidelity among foraging trail workers.

Location	Time observed	# yellow marked	# pink marked
Yellow trail	100min	37	1
Pink trail	70min	38	21

Communication. We found that the number of encounters between ants which caused the ants coming from the nest to retreat varied significantly among all trails. Ants on Trail A (G_{adj}=62.17, $p<0.005$) and on Trail B (G_{adj}=8.18, $p<0.005$) turned around significantly more often than ants on the control (Table 3.) However, on a per-encounter basis (using the ERI), ants on Trail A were three times as likely to turn around as ants on Trail B. However, this difference was not significant (G_{adj} = 1.98, $p>0.1$). A significant difference in ERI was found between the control and Trail A, with the control having a greater encounter rate (G_{adj} = 10.5, $p<0.005$; Table 3).

DISCUSSION (KAI)

This study supported our original hypothesis that there is task fidelity among the media caste in a colony of *Atta Cephalotes*. Our findings, however, did not indicate trail fi-

Table 3. Changes in Direction Resulting From Ants Moving in Opposite Directions.

Trail	#Encounters	#Direction Changes	ERI
A*	132	50	721
B†	135	14	282
Control	136	3	1521

*trail had greatly reduced activity level (shutting down)
†trail from which we removed leaves

delity among media on different foraging trails. Although ants from the highly active trail remained faithful (with one exception), ants from the less active trail were found to migrate to the more active trail. While watching the lower activity trail, we observed a sharp decline in the number of ants traveling in each direction, and almost no leaf transport, indicating that the trail was closing down. The trail was shut down by 2100. The abandonment of this trail, and the movement of its ants to the other trail, indicate that there may be communication between the ants regarding trail status.

By examining a control trail, a closing trail (A), and a manipulated trail (B), we tried to determine if the presence of a leaf was an indication that a trail was open. We found that ants on the control trail turned around significantly less per encounter than ants on either trail A or B. Because the number of direction changes was higher for the closing trail (A) than for the manipulated trail (B), it appears that the presence of a leaf is not the only factor in communicating that a trail is closing.

The encounter rate index (ERI) was significantly higher on the control trail than on trail A, indicating that there were more antennae contact events per ant-passing event. No difference in ERI was found between the control and trail B. We have postulated that when a trail is closing down, it would be more effective to have many encounters to dissuade workers from entering the trail, but this was not supported by our data. It appears that ants have more encounters on active trails.

Although we cannot conclude from this experiment that the ants are informing each other that the trail is closing, it is apparent that some communication is occurring, either through physical contact or chemical signals. Our results indicate that the presence or absence of a leaf carried by an ant has some effect on turnaround rate, but it does not account for every reversal.

Literature Cited

Stevens, G.S. *Atta cephalotes*. In D.H. Janzen, ed. 1983. *Costa Rican Natural History*. Univ. Chicago Press: Chicago, IL. pg. 689-90.