DIRUNAL AND TEMPERATURE RELATED PATTERNS IN ATTA CEPHALOTES TRAIL USE

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ABSTRACT (AEL & JJR)

Ants of the species Atta cephalotes cut and transport leaf pieces to their colony to maintain fungal gardens. We investigated variation in the relative proportions of ants moving to and from the colony as a function of time of day and temperature. As we predicted, more ants were leaving early in the morning and more were returning in late morning with a similar pattern in the afternoon. However, the trends in ant movements were not correlated with temperature.

Key Words: Atta cephalotes, leaf-cutter ant, diurnal patterns

INTRODUCTION (JJR)

The leaf-cutting ants Atta cephalotes are abundant in the tropical wet forest of the Osa Peninsula in Costa Rica. The ants harvest leaves from a variety of trees by cutting them into pieces and carrying them back to the nest. Colonies, up to five million individuals in size, maintain a group of trails, often clearing them of debris. The trails are used concurrently by ants leaving the nest and by those returning.

We hypothesized that the relative proportion of ants moving to and from the next vary diurnally due to changes in ambient temperature. Specifically, we predicted that ants avoided mid-day heat by leaving the colony early and returning by late morning. We also predicted that as air temperature decreased in the early afternoon more would be leaving to gather leaves and that more would be returning before dusk.

We expected that this diurnal pattern would be more pronounced in colonies that experience a greater diurnal variation in temperature.

METHODS (AEL)

We performed this study along the Sendero Rio Sirena in Corcovado National Park, Costa Rica. In order to measure Atta cephalotes colonies with different diurnal temperature ranges, we chose three colonies in areas of varying canopy cover. The first was in the most open (sunny) area, the second was in nearly full shade, and the third was partially covered by canopy. For each colony, we selected observation points along three ant trails which were representative of that colony's canopy cover. We measured ant activity of all trails at 30-60 minute intervals between 07:30 and 16:00. Over a period of 30 seconds, we counted the number of ants travelling past the selected observation point in both directions as well as the number of these returning to the colony with leaf pieces. At this time, we also took ambient temperature readings at the three observation points and averaged them as a measure of temperature for each colony.

Table 1: Repeated measures ANOVA testing for variation in air temperature explained by colony, time and the interaction of colony and time.

	df	MS	F	p
colony	2	7.712	28.888	0.0008
time	10	4.750	20.108	<0.0001
colony x time	20	0.819	3.482	<0.0001

Table 2: Repeated measures ANOVA testing for variation in direction of ant movement explained by colony, time, and interaction of colony and time.

	df	MS	F	p
colony	2	0.010	1.25	0.35
time	11	0.033	1.90	0.05
colony x time	22	0.022	1.30	0.21

We performed two repeated measures ANOVA to analyze the variation between colonies, the direction of ant movement, and temperature over time. We also did a regression of the direction of ant movement as a function of temperature.

RESULTS (JJR & AEL)

There was a strong positive correlation between the number of ants returning to the nest and the number of leaf pieces being carried ($r = 0.92$, $p < 0.01$; Figure 1). Temperature varied significantly across the three colonies and throughout the day (Figure 2, Table 1). Direction of ant movement varied during the day but not across the colonies (Table 2).

In the morning there were consistently more outgoing ants than incoming ants, with a peak at 10:05 (outgoing ants/total ants = 0.63; Figure 3). In the afternoon there were generally more incoming ants than outgoing ants, with a peak at 14:31 (outgoing ants/total ants = 0.41; Figure 3).

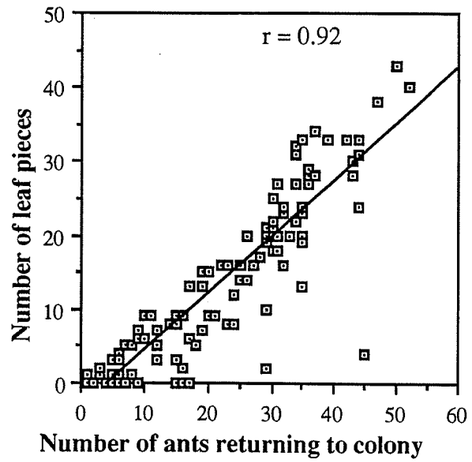

Figure 1. Correlation of number of ants returning to colony and number of leaves arriving at colony. All colonies, trails and times combined.

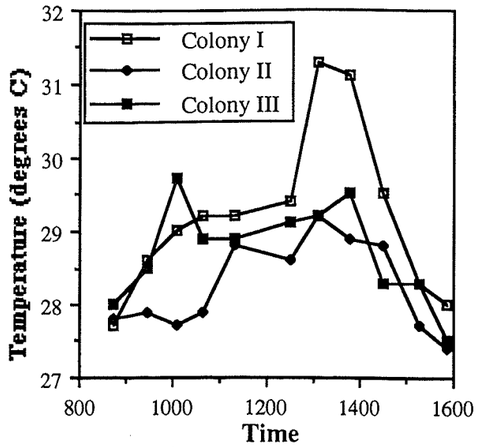

Figure 2. Diurnal temperatures at three Atta cephalotes colonies

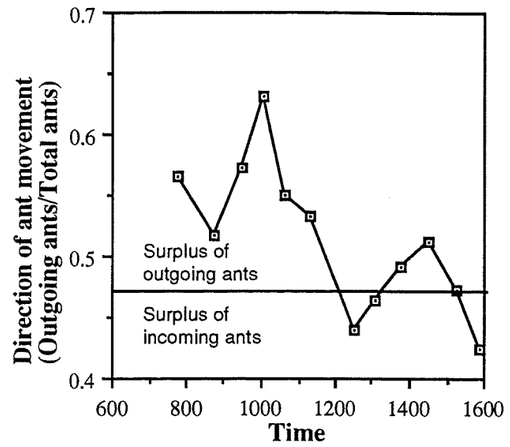

Figure 3. Diurnal pattern in the proportion of ants moving to and from the colony (n = 3 trails from each of 3 colonies)

DISCUSSION (JJR & AEL)

The strong positive correlation between the number of ants returning to the nest and the number of leaf pieces suggests returning ants are a good indicator of harvesting activity

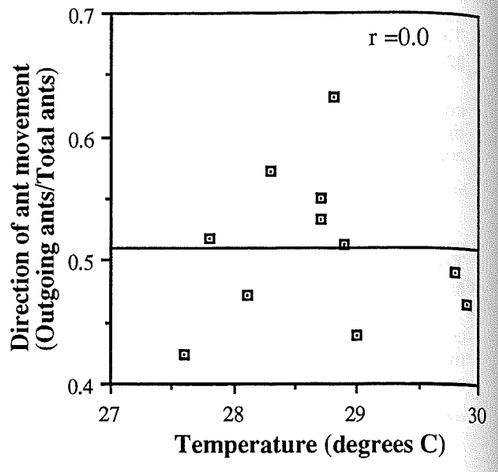

Figure 4. Effect of ambient temperature on proportion of ants moving to and from the colony (n = 3 trails from each of 3 colonies)

As predicted, direction of ant movement varied across the day. Although we found no statistical relationship between the direction of ant movement and temperature, the diurnal pattern in ant movement was consistent with our hypothesis; the peaks of outgoing ants occurred before and after the hottest part of the day. The lack of a statistically significant relationship could be explained by the peak in returning ants occurring before the peak in temperature. Ants would therefore be back at the nest before the time of greatest heat.

It is possible that the selected colonies did not differ enough in temperature range to produce significantly different patterns in the direction of ant movement.

The decrease in proportion of outgoing ants over the course of the day was very consistent across all colonies, implying that factors besides temperature may also be influencing ant behavior. Although we have no measurements, ant activity appears to decrease at night. Perhaps the ants orient themselves by compass light direction (Hölldobler and Wilson, 1990) and the benefits of improved orientation override the costs of high midday temperatures.

LITERATURE CITED

Hölldobler, B. and E.O. Wilson. 1990. The Ants. Harvard University Press: Cambridge, MA.