ANNUAL AND DIEL HARVEST RATES OF LEAF-CUTTER ANTS

ANITA L. MANNAN, E. HANK TALIAFERRO, MATTHEW K. LITTLE

Abstract. Atta cephalotes are possibly the most significant herbivores of the tropical rainforest. Each year, they cut an estimated 4.8 tons of leaves/hectare, or 4.2 percent of the rainforest's gross primary productivity, to maintain their extensive fungal gardens. This leaf matter is carried to the colony around the clock, but the majority is harvested during daylight hours with a peak occurring in the late afternoon.

Key words: Atta cephalotes, *biomass, gross primary productivity, harvest rate*

INTRODUCTION

Atta cephalotes, the leaf-cutter ant, is a major neotropical herbivore estimated to have a density of three colonies per hectare in Corcovado National Park (O. Lopez, pers. comm.). Each colony has a number of trails which radiate up to 100 m into the forest (pers. obs.). Ants gather and ferry large amounts of plant material along these trails to fungal gardens in their colonies.

Our objective in this study was to quantitatively estimate the rate at which leaf cutting ants harvest plant material in the Corcovado ecosystem. To obtain these estimates, we assessed the relative importance of (1) diurnal activity patterns in ants, (2) variation in colony size, and (3) the specific mass (mg / mm^2) of foliage being harvested to harvest rates.

METHODS

We studied three active leaf-cutter ant colonies in a secondary lowland tropical rainforest in Corcovado National Park, Costa Rica on 31 January 1996. All trails leading to each colony were located, and on each trail the number of leaf fragments passing a given point within 5 minutes was recorded. This protocol was repeated every three hours beginning at 0800 and ending at 2000 in order to assess temporal variation. For the 2000 measurement, leaf biomass was only measured at one colony and the proportional decrease from 1700 until 2000 for that colony was used to extrapolate values for the remaining two colonies. During each count, 35 leaf fragments were collected and weighed in order to estimate average leaf mass transported at that time.

Total biomass estimates for each colony were based on the total number of leaf fragments transported to the colony during the day and the average leaf mass. Two way ANOVAs were used to examine differences in average leaf mass between colonies at different times of the day and temporal variability in biomass carried to the colonies. Because sample size was low, a Kruskall-Wallis non-parametric test was used to rank colony size and evaluate differences as measured by total biomass carried to each colony.

RESULTS

In the three colonies, we estimated the average hourly harvest rate at 155 g, 269 g, and 122 g of leaf tissue. Hourly biomass harvest rates varied somewhat between colonies ($F = 4.17$, $df = 2$, $P = 0.07$). Biomass carried to the colonies was greater in the late afternoon than in the morning and subsided by early evening (Fig. 1; $F = 9.34$, $df = 3$, $P = .011$). Average leaf mass varied among colonies ($F = 19.4$, $df = 2$, $P = 0.002$) but was independent of the time of day (Fig. 2; $F = 0.85$, $df = 3$, $P = 0.52$). There was no significant variation in leaf-cutter colony size based on total biomass transported (Kruskall-Wallis $df = 2$, $P = 0.58$). Assuming an average of 3 leaf-cutter colonies per hectare, we estimated that the average annual harvest of leaf-cutter ants was 4.78 metric tons $\cdot$ $ha^{-1} \cdot yr^{-1}$.

DISCUSSION

We estimate that in a tropical rainforest leaf-cutter ants harvest an average of 4.78 metric tons•ha-1•yr-1 of leaf biomass to support their fungal gardens. Gross primary productivity in tropical forests has been estimated at 112.5 tons $\cdot$ $ha^{-1} \cdot yr^{-1}$ (Stevens 1983). Leaf-cutters thus consume approximately 4.2% of gross primary productivity. If total herbivory is about 10% of primary production (Coley et al. 1985), leaf-cutter ants would comprise 42% of herbivory in this forest.

Our final estimation of leaf-cutter harvest rate was particularly sensitive to several variables. The size of

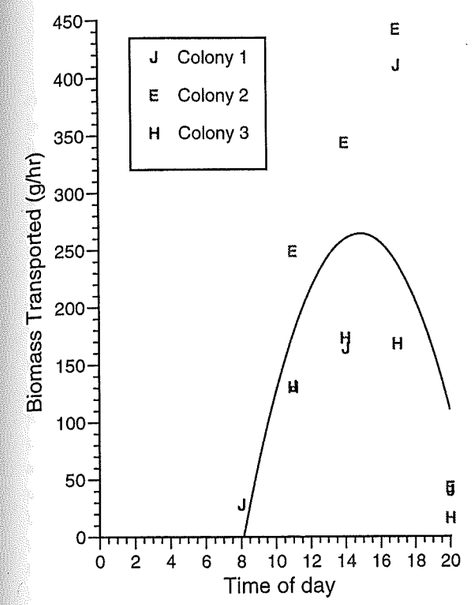

Fig. 1. Temporal Variationin leaf biomass entering three Atta cephalotes colonies at Corcovado National Park, Costa Rica on 31 Jan, 1996. ($r^2 = 0.052$).

the colonies could have had a large impact on our final estimation. The three colonies observed were of similar size, but if they are not representative of average colony size, our results may have been skewed. Our value for the density of colonies was a rough estimation and may change significantly from forest to forest. The mass of the average leaf fragment varied by as much as 50% among colonies, probably because the ants were collecting leaves from different tree species. Our estimate is thus very sensitive to the type of vegetation the ants were collecting at the time we observed them. A study which observed a larger number of colonies feeding on different vegetation types would ensure a more accurate estimate. In addition, we only sampled colonies in secondary forest. Leaf cutter harvest rates may differ between primary and secondary forests due to differences in vegetation types. Nonetheless, the shear magnitude of our results indicates that the impact of leaf-cutter ants in tropical wet forests is impressive: these ants are probably the strongest single force of herbivory in these environments.

LITERATURE CITED

Coley, P. D. 1983. Intraspecific variation in herbivory on two tropical tree species. Ecology **64**: 426-433.

Stevens G. C. 1983. *Atta cephalotes*. Pages 688-691 *in* D. H. Janzen, editor. Costa Rican Natural History. University of Chicago Press, Chicago, Illinois, USA.