Discussion

Evidently, crab densities were so high that our marked crabs were a tiny proportion of the total population. As a result, we were unable to relocate any marked individuals or to draw a conclusion regarding migration between the two habitats. Our experimental results indicate that forest edge hermit crabs consistently out-compete tide pool crabs and probably prey on them. Size differences alone could explain the patterns in our results. It would be a simple matter to test this hypothesis experimentally. It seems clear that competition is more important than food preference in hermit crab habitat partitioning on Playa Sirena.

Literature Cited

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Structural characteristics and invertebrate communities of leaf-cutter ant refuse mounds

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Abstract: Leaf-cutter ants (*Atta cephalotes*) cut leaves and use them to cultivate fungus in the nest. Spent leaf material is then deposited in refuse mounds, which provide food resources for many invertebrates. The goals of this study were to describe the structural characteristics of the mounds and to explore the relationships between mound structure and invertebrate distribution and abundance. In total, 26 morphotypes were identified in eight orders. The biomass index was highest in the upper two layers of the mound, in which temperature increased with layer thickness. Temperature and thickness of the layers within refuse mounds apparently influence invertebrate distribution and abundance.

Key Words: Atta cephalotes, *temperature*

Introduction

The leaf-cutter ants (*Atta cephalotes*) that occur throughout the Costa Rican lowland forests have a large impact on nutrient cycling in this system. Leaf-cutters transport harvested plant parts to their nest, where they serve as a medium for fungal growth. The ants consume the fungal hyphae and, ultimately, discard spent fungus in mounds near a nest entrance. These mounds provide a food source and habitat for many invertebrates. (Stevens 1983)

Little is known about the structure of refuse mounds and the invertebrates that inhabit them. The goals of this study were: (1) to describe the structural characteristics of the refuse mounds; and (2) to explore the relationship between the mound structure and invertebrate distribution and abundance.

Methods

To describe the structure of refuse mounds, I sampled six mounds between 4 - 6 February 2003 in Corcovado National Park, Costa Rica. I first measured the height and basal radius, and thus calculated an estimate of the volume of each mound. To determine the vertical profile, I dug into the mound and measured the thickness and temperature of each layer, distinguishable by texture and color.

I sampled invertebrates within the mounds by first taking 450 mL samples of refuse from each layer. After identifying morphotypes to order or family, I divided them into six size classes. I totaled the number of individuals in each size class for each layer and used these numbers to calculate a biomass index for each layer.

Results

Total volume of the refuse mounds ranged from 10 L to 414 L. Each mound had three distinct layers, referred to as the "surface", "subsurface", and "core." The core was significantly thicker than the surface and subsurface layers ($F = 12.27$, $df = 2, 15$, $P < 0.01$). Mean thickness was 1.2 cm for surface, 3.4 cm for subsurface, and 29.0 cm for core layers. Temperature increased with thickness in both the surface (Fig. 1; $r^2 = 0.71$, $df = 5$, $P = 0.03$) and subsurface ($r^2 = 0.67$, $df = 5$, $P = 0.05$) layers. Average mound temperature (adjusted for volume) was greater than average air temperature at the time of sampling ($F = 6.72$, $df = 11$, $P = 0.03$).

In total, I identified 26 morphotypes of invertebrates. 17 morphotypes (including eight larvae morphotypes) were coleopterans, including carrion beetles (Silphidae) and rove beetles (Staphylinidae). The remaining nine morphotypes belonged to the following orders: Hymenoptera (other than leaf-cutter ants), Chelonethida, Collembola, Thysanura, Thysanoptera, Homoptera, and one Acarina. Invertebrate body length

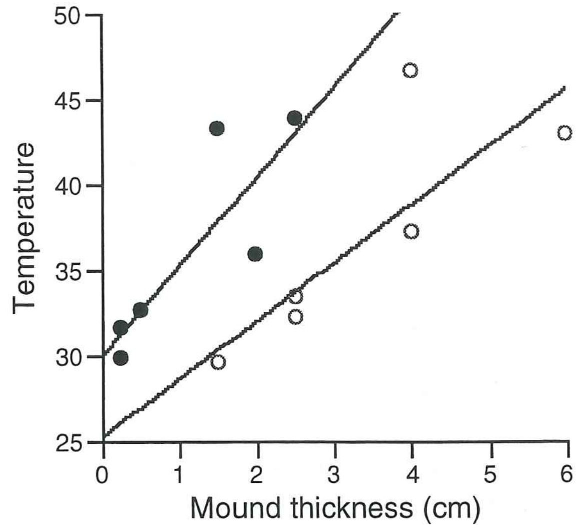

FIG. 1. Temperature increased significantly with thickness in both surface (closed circles) and subsurface (circles) layers in leaf-cutter ant refuse mounds at Corcovado National Park, Costa Rica.

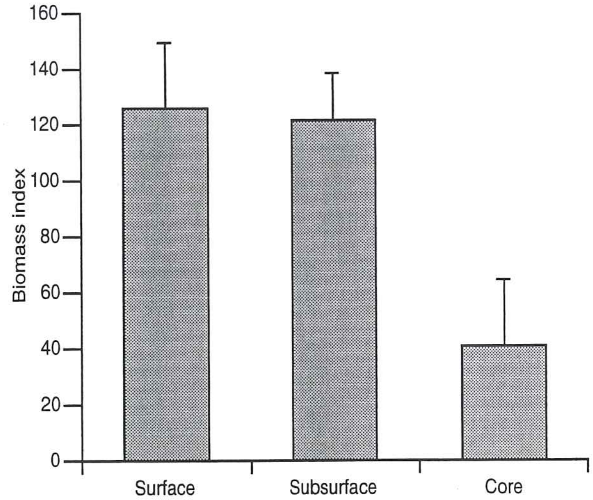

FIG. 2. Invertebrate biomass index (based on abundance and size) of the surface and subsurface layers of leaf-cutter ant refuse mounds in Corcovado National Park, Costa Rica. Biomass index was significantly lower in the core than in the surface or subsurface layers.

ranged from 1.5 mm to 21.0 mm.

The biomass index of invertebrates per unit volume in surface and subsurface layers was greater than in the core (Fig. 2; F = 4.87, df = 17, P = 0.02). Invertebrate abundance per unit volume in the surface layer increased with thickness of the layer (r^2 = 0.62, df = 5, P = 0.06). Abundance per unit volume in surface and subsurface layers also increased with temperature of these layers, but this pattern was not statistically significant (r^2 = 0.25, df = 11, P = 0.08).

Discussion

Leaf-cutter ant refuse mounds were made up of three strata that differed in texture, appearance, and often temperature. The size of refuse mounds was highly variable. Most were in shaded areas beneath branches from which ants dropped their refuse. The elevated temperatures that I observed in the surface and subsurface layers may be due to bacterial decomposition of the leaf/fungus refuse. Although the surface and subsurface layers were not as thick as the core, my data suggest that this bioactivity could be highest in those layers. Because more active ant colonies probably deposit more refuse, bioactivity may increase with colony size or activity.

Refuse mounds, particularly the surface and subsurface layers, supported a surprisingly high diversity and abundance of invertebrates. Although most were detritivorous beetles, other trophic relationships were observed. For instance, I observed two ant species preying upon coleopteran larvae within the surface layer. The feeding activities of the invertebrates and the microorganisms present in the mound may facilitate nutrient cycling initiated by the ants. These findings indicate that refuse mounds may be an important resource for invertebrate fauna.

Within each refuse mound, invertebrates were not distributed uniformly. The majority were in the surface and subsurface layers, possibly because the refuse material there was most recently deposited and, therefore, in the early, most active stages of decomposition.

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