Preliminary observations of soil modification by leaf-cutter ants

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Abstract: Leaf-cutter ants, *Atta colombica*, remove waste from their underground nests, creating a rubbish dump outside of the nest. We distinguished three types of soil on top of the nest: newly deposited rubbish; old rubbish; and the excavated nest itself. We compared the abundance and diversity of soil fauna among these three soil types and with forest soil unassociated with the nest. Abundance and diversity were highest in the new rubbish dump, closely followed by the old rubbish dump. Soil from the excavated nest and forest soil had similar, and much lower, abundance and diversity than soils from the dumps. New and old rubbish dumps appear to create a beneficial microhabitat for soil fauna.

Key Words: Atta colombica, *nest cleaning, soil fauna*

INTRODUCTION

Leaf-cutter ants, *Atta colombica*, cultivate fungal gardens on leaf matter in their underground nests. Workers clean the nest and gardens, carrying out rubbish composed of ant feces, dead ants, decomposed plant material and spent fungus, and deposit it on top of the nest (Stevens 1983). We observed workers dumping the "new rubbish," and noted two other distinct types of soil on the nest that differed in color, texture, and density. Under and around the light colored "new rubbish" dump was an "old rubbish" dump distinguished by its darker color. Piles of "nest soil," excavated during nest digging, covered the rest of the nest. We hypothesized that the apparent increase in organic matter in the dump soils would support a higher abundance and greater diversity of soil fauna than in the nest soil or nearby forest soil.

METHODS

This study was conducted in secondary forest near Estación Sirena in Corcovado National Park, Costa Rica. We chose the first leaf-cutter ant nest with a rubbish dump pile that we encountered off Sendero Naranjo (about 150 m from the station) for analysis of soil fauna. We sampled four different soil types: new rubbish dump (which was being brought out by leaf cutter ants from inside the nest); old rubbish dump (which was more decomposed than the new rubbish dump); nest soil; and forest soil (randomly located 5 m from the nest).

For each soil type, a composite sample was collected within 2 cm of the surface by taking a tablespoon of soil from three randomly chosen areas within the same soil type. A similar composite sample was taken at 5 cm depth for each soil type except the new rubbish dump, which was only 2 cm deep. A 30 ml aliquot of each of these samples was searched by eye and under the microscope to obtain the number of all morphospecies >1 mm present. A larger volume of soil, 10 x 15 x 5 cm^3, was collected from each soil type (except the new rubbish dump) and searched for morphospecies >3 mm. Morphospecies were identified to order.

RESULTS

Soil characteristics:

Soil from the new rubbish dump was loosely packed in small spherical balls coated with a thin layer of moisture, perhaps saliva, presumably to provide easier transport by the ants. The soil appeared to be composed of old plant and fungal material along with many dead ants. It covered an area 0.063 m^2, 2 cm deep, and graded into a darker layer that became equivalent in color and texture to the soil from the old rubbish dump. Old rubbish soil, covered a 0.39 m^2 area and was composed of very dark, rich smelling particles of organic matter. The texture was similar to the new rubbish soil but was slightly more packed down. The nest soil covered a 6.16 m^2 area and was composed of red, clay-like particles, loosely packed into small balls. Forest soil was composed of densely packed, fine red clay.

Soil community:

A total of 187 soil fauna organisms was found and identified to morphospecies. Abundance and species richness was much higher for new and old rubbish dumps than for nest or forest soils (Fig. 1 & 2). In the new rubbish dump there were 81 organisms of 10 morphospecies (surface sample only). In the old rubbish dump there were 67 organisms of 10 morphospecies (3 sampling types). Five of the morphospecies were shared between new and old rubbish dumps (Table 1). The nest and forest soils contained only one morphospecies, an Isopteran, which was present in all four soil types.

Table 1. Abundance of each soil fauna morphospecies found in the four soil types. The new rubbish dump was only sampled at the surface, while the others were sampled at the surface, depth of 5 cm, and an area 10 x 15 x 5 cm^3 (see "Methods").

Morphospecies	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
New Rubbish	2		7	2	1	20	5	18	1	2	17				
Old Rubbish	27	18	9	1	3	4						2	1	1	1
Nest Soil	7														
Forest Soil	4														

Table 2. Taxonomic groups represented by 15 morphospecies. Numbers represent morphospecies number (see Table 1).

Coleopteran adults	Insect Larvae	Isopteran	Thysanuran	Arachnid	Diplopoda
4, 6, 8, 9, 10	2, 3, 13, 14, 15	1, 11	7	5	12

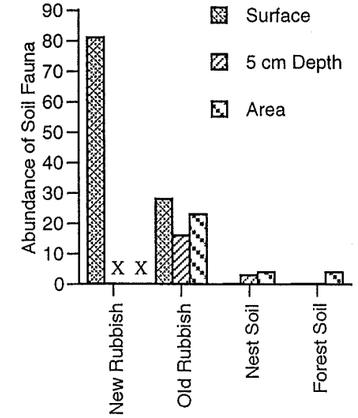

Fig. 1. Abundance of soil fauna at the surface, 5 cm deep and in a 10 x 15 x 5 cm^3 areas in four soil types around leaf-cutter ant nests near the Estación Sirena, Corcovado National Park, Costa Rica. ["X" indicates samples not obtained for the New Rubbish habitat (see methods).]

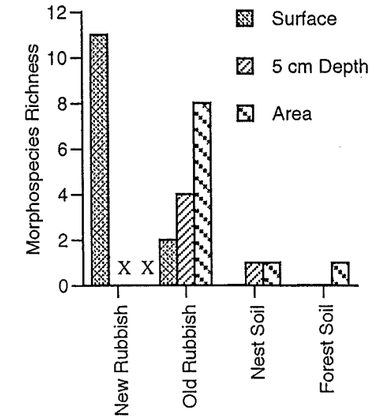

Fig. 2. Morphospecies richness of soil fauna at surface, 5 cm deep and in a 10x15x5 cm^3 area in four soil types around leaf-cutter ant nests near the Estación Sirena, Corcovado National Park, Costa Rica. ["X" indicates samples not obtained for the New Rubbish habitat (see methods).]

Discussion

The greater abundance and diversity of soil fauna in new and old rubbish dumps indicates that these soil types provide a more favorable habitat than nest and forest soils for most soil organisms. The rubbish has a high content of decomposed plant material, ant feces and dead ants, which may provide readily available nutrients for soil organisms. Additionally, the loose packing and granular texture of the rubbish piles may induce better soil aeration than the densely packed, fine particulate clay material of forest soil.

The similarity in abundance and morphospecies richness between nest and forest soils was expected since composition of these soils appeared similar. The soil habitat in new and old rubbish dumps seem particularly suitable for insect larvae, Coleopterans, and Isopterans, which composed the majority of the morphospecies in our samples. The environment created by leaf-cutter ants through their rubbish disposal seems to improve the microhabitat for a greater diversity of soil fauna.

Literature Cited

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