

DISTRIBUTION OF *Atta* (HYMENOPTERA - FORMICIDAE) IN "TERRA-FIRME" RAIN FOREST OF CENTRAL AMAZONIA: DENSITY, SPECIES COMPOSITION AND PRELIMINARY RESULTS ON EFFECTS OF FOREST FRAGMENTATION. (\*)

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SUMMARY

One hundred and fourteen hectares of a "terra-firme" rain forest 70 km north of Manaus, Amazonas, Brazil, were surveyed for leaf-cutting ant colonies (*Atta* spp). One half of this area was in isolated forest fragments (surrounded by pastures or second growth) of two sizes: 1 and 10 ha. The other half was in non-isolated fragments (connected to a large patch of forest) of the same sizes. Only two species occurred in this forest: *Atta sexdens sexdens* L. and *A. cephalotes* L. The first was the most abundant species with a mean density of 0.35 colonies per ha. The mean density of *A. cephalotes* colonies was 0.03 per ha.

The density of colonies was not significantly different between the isolated fragments and the continuous forest. Furthermore, the species composition did not change with isolation. However, pre-isolation data and long term monitoring are necessary to conclude that the isolation of a forest fragment has no effect upon *Atta* colonies.

The non-uniform spatial distribution of *Atta* colonies within the "terra-firme" forest must be taken into account when selecting conservation areas in the Amazon, in order to preserve this important group of ants together with their native habitat.

INTRODUCTION

The leaf-cutting ants of the genus *Atta* are the most evolved group of the Neotropical tribe Attini (Weber, 1966), a unique tribe among ants that cultivates fungi as a food source. The *Atta* species construct large and conspicuous subterranean nests, which can support a population of a few million ants (Weber, 1982).

Little is known about the distribution of the *Atta* species within the Amazon region and the few works about this subject are most concerned with agro-forestry systems (Gonçalves, 1957; Ribeiro & Woesnerr, 1979), since some species are considered major pests

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of crops and plantations. Information on undisturbed areas is lacking. Moreover, in the last two decades, the Amazon forest has been rapidly cleared for agriculture and ranching (Fearnside, 1982), causing the fragmentation of a once continuous habitat. The consequences of the habitat destruction itself and that of the subsequent isolation of the forest remnants for the original *Atta* populations is still largely unknown.

This paper deals with the distribution of *Atta* in the dominant forest habitat of the Amazon region, the "terra-firme" rain forest. Some preliminary data on effects of isolation of forest fragments upon the distribution of *Atta* are also presented.

## METHODS

This study was conducted at the Fazendas Dimona, Esteio and Porto Alegre (Fig. 1) located 70 km north of Manaus, Amazonas, Brazil (2°25'S, 59°50'W) as part of the Minimum Critical Size of Ecosystem Project (MCSEP) (Lovejoy, 1980). The climate is tropical and the annual precipitation is approximately 2100 mm (Ribeiro, 1976). The vegetation, a "terra-firme" (never-flooded) rain forest, is primary and evergreen. In these ranches (fazendas) the primary forest is being cleared to plant pastures. As Brazilian law requires that one half of the area of the ranches must be preserved as forest, this permitted the MCSEP to create forest fragments of various sizes. Originally, the fragments of smaller sizes were named as 1 and 10 ha fragments, although they are somewhat larger: 1.7 and 13 ha respectively, if we also include a 5 m wide corridor (cleared of vegetation in the isolated fragments) which delimits the fragment. In this paper the original nomenclature will be followed.

Five isolated (fragments number 1104, 1112, 2107, 2108, 3114) and 5 non-isolated (fragments nº 1101, 1102, 1105, 1109, 1113) 1 ha fragments (Fig. 1) and 4 isolated (nº 1202, 1207, 2206, 3209) and 4 non-isolated (nº 1201, 1204, 1208, 1210) 10 ha fragments were surveyed for *Atta* colonies between October 1985 and January 1986. A non-isolated fragment is one connected to a large patch of forest and an isolated fragment is one surrounded by pastures or second growth. The 10 ha fragments were surveyed by walking transects, parallel to each other and 20 to 35 m apart, pausing every 15 to 20m to carefully look for nests or foraging trails, which were used as an indicator of nest proximity. In the 1 ha fragments, following the same process, the most external 25m of the fragments was surveyed (i.e. an area of nearly 1 ha). This method limited the survey to mid-age and mature nests, estimated as having a surface area of up to 0.5 square meters.

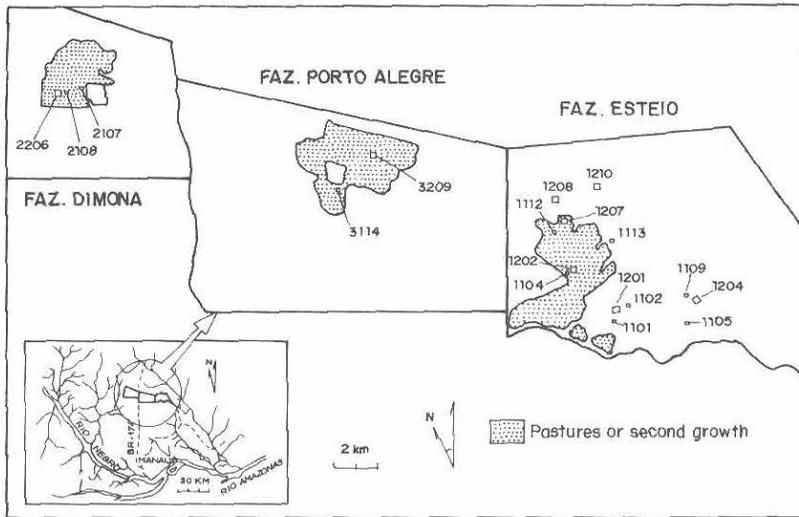


Fig. 1. Localization of the study area. Each forest fragment is identified by a number with four digits. The first digit indicates the Fazenda (ranch) (1 = Esteio; 2 = Dimona; 3 = Porto Alegre), the second indicates the size of the fragment (1 = 1 ha; 2 = 10 ha) and the two last digits are unique numbers for the fragments given in order of delimitation.

## RESULTS

### Density and species composition

The mean density of *Atta* in "terra-firme" forest was 0.38 colonies per hectare. This estimate is result of a survey of 114 ha which included both: isolated and non-isolated fragments. Only two species occurred in this forest: *Atta sexdens sexdens* L. and *A. cephalotes* L. The first one was the most abundant species and had a mean density of 0.35 colonies per ha. The maximum density of *A. s. sexdens* was 2 colonies per ha. For *A. cephalotes* the mean density was 0.03 colonies per ha and the maximum density was 1 colony per ha.

### Effects of habitat isolation

There was no difference in the density of *Atta* colonies between the 1 ha isolated and non-isolated fragments. Within the 5 isolated fragments there were 3 colonies with a maximum of 1 colony per ha. The same occurred with the 5 non-isolated fragments (Table 1). The species composition did not change with isolation. All the colonies of the 1 ha isolated fragments were of *A. s. sexdens*, the same species found in the non-isolated ones.

The 10 ha isolated fragments showed a density of *Atta* colonies 2.4 times greater than the non-isolated fragments of the same size (Table 2). However, this difference was not significant (Kolmogorov-Smirnov Test,  $Kd = 3$ ,  $p > 0.05$ ; Siegel, 1956), because the

number of colonies was variable between the isolated fragments (range: 2 to 13). *Atta cephalotes* only occurred in the isolated fragments, but all the 3 colonies were in the same fragment (nº 3209).

**Table 1.** Number of *Atta* colonies in isolated and non-isolated forest fragments of 1 ha. All colonies are of *A. s. sexdens*.

Isolated		Non-isolated	
Fragment	Colonies	Fragment	Colonies
1104	1	1101	0
1112	1	1102	0
2107	0	1105	1
2108	1	1109	1
3114	0	1113	1
<b>Total</b>	<b>3</b>		<b>3</b>

**Table 2.** Number of *Atta* colonies in isolated and non-isolated forest fragments of 10 ha. Except for 3 colonies of *A. cephalotes* in the fragment number 3209, all the colonies are of *A. s. sexdens*.

Isolated		Non-isolated	
Fragment	Colonies	Fragment	Colonies
1202	5	1201	4
1207	2	1204	4
2206	6	1208	0
3209	13	1210	3
<b>Total</b> *	<b>26</b>		<b>11</b>

(\*) Kolmogorov-Smirnov Two Sample Test,  $Kd = 3$ , N. S.

## DISCUSSION

The mean density of *Atta* colonies in Central Amazonia (0.38 per ha) is similar to that found by Cherrett (1968) in an evergreen forest of Trinidad (0.6 colonies per ha), but smaller than that found by Rockwood (1973 and included references) in evergreen forests of Costa Rica (1.0 to 2.5 colonies per ha) and by Leston (1978) in Bahia, Brazil (3 colonies per ha). Although not providing density estimates, Cherrett (1981) found equal numbers of *A. cephalotes* and *A. s. sexdens* colonies in a newly felled "terra-firme" forest in the Rio Jari forestry project (Northern Amazonia). It would be interesting to know why in Central Amazonia *A. s. sexdens* is the dominant species.

The occurrence of **A. cephalotes** in only one (nº 3209) of the four 10 ha isolated fragments prevents generalization about the effects of isolation upon the species composition of the fragments of this size. Moreover, this species also inhabits the continuous forest (Vasconcelos, 1987), but probably was not found in the non-isolated fragments due to its low density (0.03 colonies per ha) and clumped distribution (Vasconcelos, 1987). The latter may also be responsible for the presence of 3 colonies in the fragment number 3209.

Although no significant difference was found between the isolated fragments and the continuous forest, we cannot conclude that the isolation of a forest fragment has no effect upon **Atta**. Even within the same size category there is a lack of uniformity in the conditions of the isolation of the fragments. They differ in time since isolation (1, 3 or 5 years), surrounding vegetation (pasture or second growth) and in the distance to the continuous forest. In this way we cannot consider n isolated fragments as n replicates and so we must to have pre-isolation data to confidently test this hypothesis.

One possible response of **Atta** to isolation would be the immigration of colonies into the fragments. However, migration of **Atta** colonies is an uncommon phenomenon and can lead to the death of the migrant colony (Rockwood, 1973). Another effect of forest isolation on **Atta** colonies could occur at the border of the fragments, where an increased tree mortality rate and subsequent invasion of secondary plant species is observed (Lovejoy *et al.*, 1984). Vegetation changes normally affect the density and/or species composition of leaf-cutting ants (Cherrett, 1981; Fowler, 1983).

This work, although not conclusive on the effects of habitat isolation upon **Atta**, provides us with some information that may be used for the conservation of leaf-cutting ants in the Amazon forest. One point that should be considered in the selection of conservation areas is that **Atta** is not distributed uniformly within the "terra-firme" forest. Even areas as large as 13 ha may be free of **Atta** species (ex: fragment nº 1208). For **A. cephalotes** this is a factor that needs special attention not only because it is the rarest species, but also because it is typical only of rain forests (Cherrett, 1968; Rockwood, 1973). Also, as Fowler *et al.* (in press) have pointed out, not all species of leaf-cutting ants are agricultural pests. Indeed most of them are endemic taxa which must be preserved together with their native habitats.

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## RESUMO

Um levantamento de colônias de saúva (*Atta* spp) foi feito em 114 hectares de uma floresta chuvosa de terra-firme situada a 70 km ao norte de Manaus, Amazonas, Brasil. Metade desta área era formada por fragmentos florestais isolados (limitados por pastagem ou capoeira) de dois tamanhos: 7 e 10 ha. A outra metade consistia em fragmentos não isolados (conectados a uma grande porção de floresta intacta). Somente 2 espécies de saúva ocorreram nesta floresta: *Atta sexdens sexdens* L. e *A. cephalotes* L. A primeira foi mais abundante e teve uma densidade média de 0,35 colônias por ha. A densidade média de colônias de *A. cephalotes* foi de 0,03 por ha.

A densidade de colônias não foi significativamente diferente entre os fragmentos isolados e a floresta contínua. Também, a composição de espécies não mudou em função do isolamento. Entretanto, dados históricos (prévios ao isolamento) e um monitoramento a longo prazo são necessários para concluir que o isolamento de um fragmento florestal não tem efeito sobre as colônias de saúva.

A distribuição espacial não uniforme das colônias de *Atta* dentro da floresta de terra-firme deve ser levada em consideração ao selecionar áreas de conservação na Amazônia, a fim de preservar este importante grupo de formigas juntamente com seu habitat nativo.

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