DISTRIBUTION AND ABUNDANCE OF ANTS IN A BRAZILIAN SUBTROPICAL COFFEE PLANTATION

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ABSTRACT

The ground and arboreal ant fauna were surveyed by pitfall trapping, tree beating and by baiting in a 400 m² area of coffee plantation at Viçosa, Minas Gerais, Brazil. A total of 37 ant species were sampled in the plantation, with 29 being present on the ground and 12 on the trees. Only four species were common to both strata. The biscuit/honey/fish baits which were placed on the ground and in trees were largely exploited by ground- and tree- dwelling ants respectively. Maps of the distribution of arboreal ants suggested that the most frequently occurring ants were distributed in a mosaic-like manner. However, the numbers of ant individuals in tree-beat samples suggested that, with the possible exception of Crematogaster sp. 59, none of the species reached the numerically dominant status of ants which have been observed elsewhere in the tropics. The possible reasons for the lack of dominant ants in this subtropical plantation are discussed and the overall findings are then related to the potential value of ants in the limitation of pests of coffee.

INTRODUCTION

There are many instances of ants being utilised to limit pests, both in the tropics or neotropics, and in temperate ecosystems (see reviews in Gotwald 1986, Majer 1986 and Way & Khoo 1992). However, for various reasons, most of the ant species within a region do not function as significantly beneficial species.

Finnegan (1971) lists the criteria used for evaluating predacious ant species as potential biological control agents. These are: (1) **Size**. Large size of individual ants is usually considered a desirable quality, particularly when the pest is large or well protected. If the ant has large colonies, the size of individuals is not necessarily important. (2) **Food Requirements and Nest Populations**. Species with large colonies, and hence food requirements, are considered to be the most desirable. (3) **Colonial Nests**. Species with multidomous colonies, or with the ability to produce numerous additional colonies over adjacent areas, are particularly useful. By this attribute, ants are able to occupy considerable areas at high densities. (4) **Queens**. Species with more than one queen or with a queen replacement system are considered to have longer-lived colonies. (5) **Ant-Homoptera Relationships.** Ants which tend and encourage undesirable Homoptera often bring about results that offset any benefits.

To Finnegan's criteria we add the following: (6) **Species Habitat Range.** Species with broad habitat ranges are potentially more amenable to being promoted in areas where they are not already present. Important characteristics include the ranges of temperature, moisture and insolation that can be tolerated, and also the ability to tolerate seasonal fluctuations in these factors and in food resources. (7) **Dominance Hierarchy.** Species that are unlikely to be outcompeted by other ants in the crop are desirable.

Room (1973) has drawn up a formalised scheme for selecting and developing ants as pest control agents. His scheme is shown in Figure 1. **Stage 1** involves definition of the pest or the pest complex. The biology of the pest is evaluated and their interaction with the crop is elucidated. **Stage 2** involves identification of potentially useful ant species. **Stage 3** is concerned with demonstrating whether or not any ant species has controlling effects on the pest complex. This may be evaluated by a sampling program designed to show how ant and pest species are distributed with respect to each other. Researchers are warned of spurious ant control effects resulting from ant and pest having different habitat preferences rather than from the ant having any direct negative influence on the pest.

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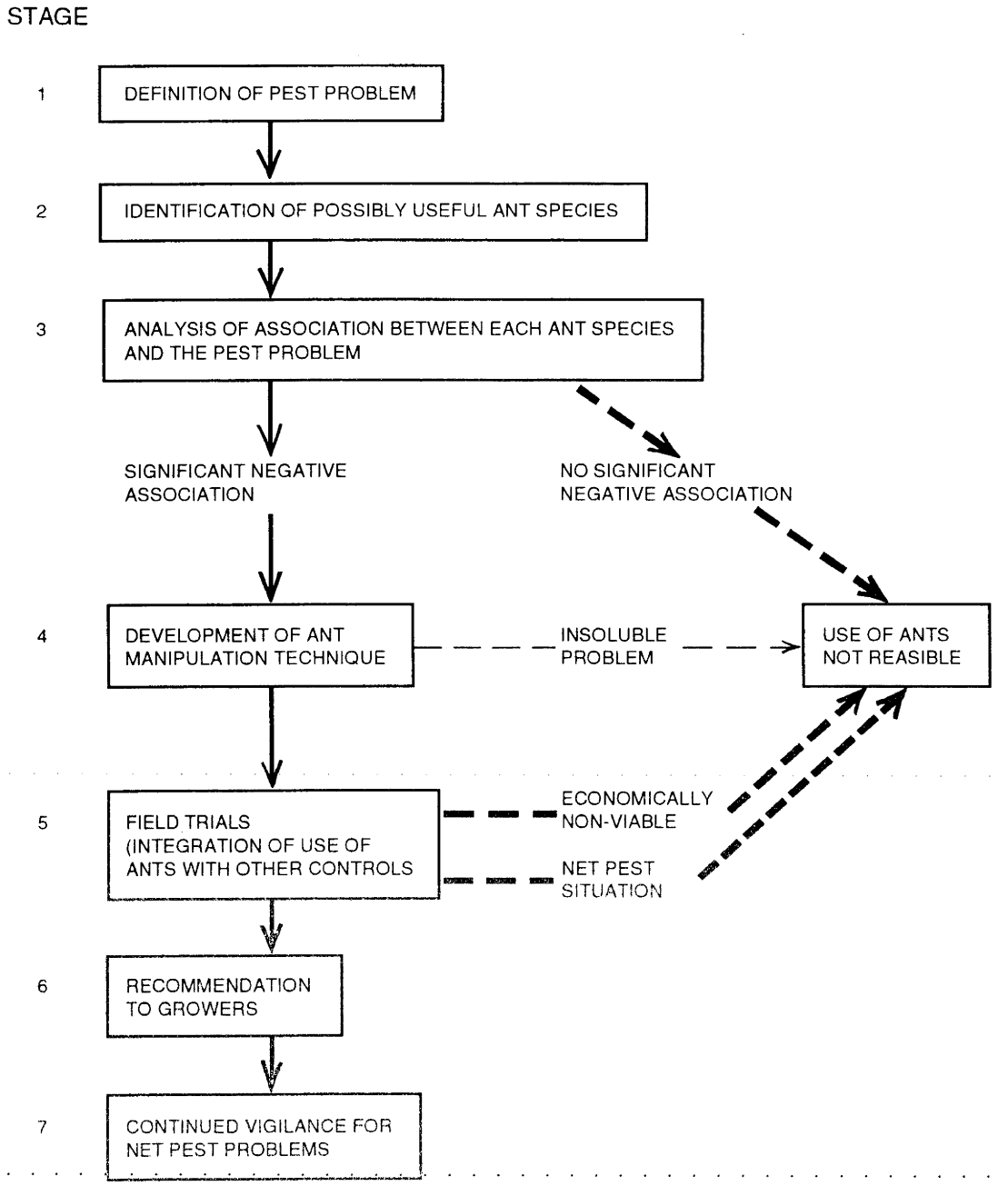
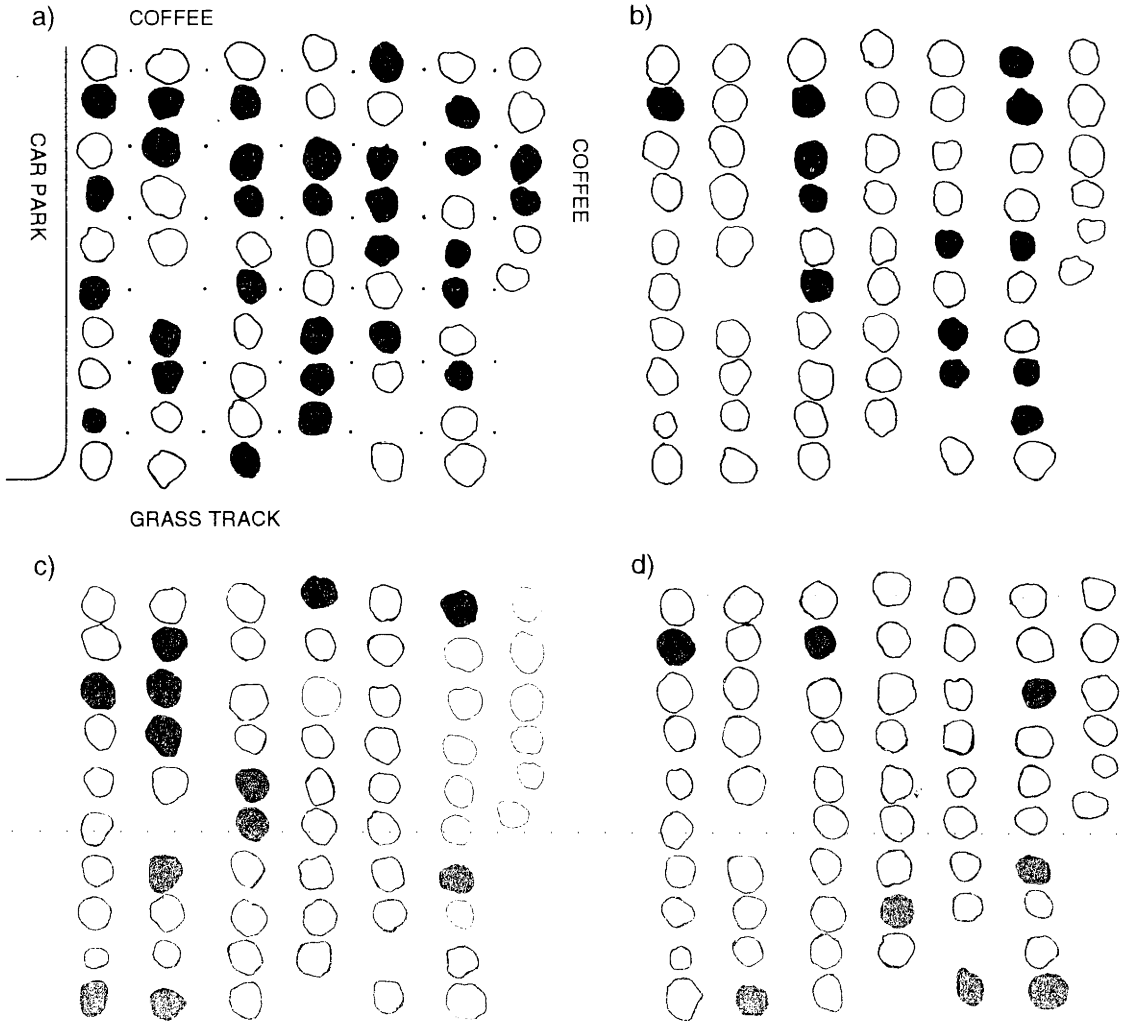
Figure 1. **Suggested scheme for the selection and development of an ant as a pest control agent (redrawn from Room, 1973).**



If a beneficial ant is revealed, the scheme enters **Stage 4**. Here techniques are investigated to manipulate the ant distribution in order to favour its spread. This is the most difficult stage to carry out. **Stage 5** is reached when field trials are performed to evaluate the practicality of ant manipulation and the efficacy of the control. The ant-based biological control method may now become incorporated into a wider integrated pest management scheme. Finally, recommendations are made to growers on how to apply the control scheme, and for vigilance for new pest problems that may require modifications to the scheme.

Figure 2. **Map of part of the Vicosa coffee plantation showing positions of pitfall traps () and the four most frequent species of canopy-associated ants: a) =** *Crematogaster* sp. 59;

b) = *Pseudomyrmex* sp. 52; c) = *Camponotus* sp. 6; and d) = *Pseudomyrmex* sp. 50



Although the possibility of using ants in cocoa pest control has received some attention in the Brazilian State of Bahia (see review in Delabie 1990), and the Kayapó Indians have used ants of the *Azteca chartifex* gp. to limit leaf cutter ants in the State of Pará (Overal and Posey 1984), this topic has received little attention in the southern parts of Brazil. The aim of this paper is to document the distribution, diversity and abundance of the ground and arboreal ant fauna in a coffee plantation in the south of the Minas Gerais State of Brazil. Such a survey forms part of Room's (1973) **Stage 2** for the evaluation of the possible use of ants as biological control agents in coffee, or other tree crops growing within this region.

STUDY AREA AND METHODS

Observations were performed in a coffee plantation within the campus of the Federal University of Viçosa, Minas Gerais (20° 44' S, 42° 54' W). The crop, which consisted of a range of varieties of *Coffea arabica*, was planted in 1970 on a loamy soil at a spacing of 1.8 x 2.8 m. At the time of the survey the plantation consisted of trees of approximately 3 m height, with a herbaceous and grass understorey. The canopy of adjacent trees was generally not contiguous. The plot had been weeded six times a year and, in November 1987, the herbicide Gramoxone ® was applied to the ground layer of vegetation. The plantation had never been sprayed with insecticides.

TABLE 1: **Total and frequency of the various ant species caught on the ground by pitfall trapping and on trees by beating. The percentage of ground and tree baits visited by the various ant species is also shown.**

	Ground (n = 36)			Trees (n = 63)		
	Total	% Frequency	% Baits	Total	% Frequency	% Bait
Ponerinae						
Gnamptogenys sp. 8	52	39	-	-	-	-
Hypoponera sp. 24	3	8	-	-	-	-
Hypoponera sp. 35	1	3	-	-	-	-
Odontomachus sp. 45	2	3	-	-	-	-
Pachycondyla sp. 7	1	3	-	-	-	-
Pachycondula sp. 54	1	3	-	-	-	-
Pachycondula sp. 56	3	8	-	-	-	-
Myrmicinae						
Acromyrmex sp. 57	2	6	-	-	-	-
*Crematogaster sp. 29**	-	-	-	-	-	10
*Crematogaster sp. 59**	-	-	10	105	48	10
Cyphomyrmex sp. 23	1	3	-	-	-	-
Monomorium sp. 49	-	-	-	8	8	-
Mycocepurus sp. 20	1	3	-	-	-	-
Pheidole sp. 1	6	3	-	-	-	-
Pheidole sp. 2	12	8	-	2	3	-
Pheidole sp. 11	5	3	-	-	-	-
Pheidole sp. 21	1	3	-	-	-	-
Pheidole sp. 42	1	3	-	-	-	-
Pheidole sp. 47	-	-	10	-	-	-
Solenopsis sp. 10	2	6	-	-	-	-
Solenopsis sp. 14	28	39	-	1	2	-
Solenopsis sp. 15	1	3	-	-	-	-
Strumigenys sp. 46	1	3	-	-	-	-
Tetramorium sp. 43	4	6	-	-	-	-
Tetramorium sp. 44	3	6	-	-	-	-
Pseudomyrmecinae						
*Pseudomyrmex sp. 33**	-	-	-	-	-	10
*Pseudomyrmex sp. 50**	-	-	-	15	13	-
*Pseudomyrmex sp. 51**	-	-	-	14	3	-
*Pseudomyrmex sp. 52**	-	-	-	18	21	-
Formicinae						
*Camponotus sp. 6**	-	-	-	2	19	-
*Camponotus sp. 58**	-	-	-	-	-	10
Brachymyrmex sp. 26	1	3	-	3	2	-
Brachymyrmex sp. 53	11	19	10	-	-	-
Paratrechina sp. 40	2	6	-	-	-	-
Paratrechina sp. 48	-	-	10	-	-	-
Paratrechina sp.56	1	3	-	-	-	-
Dolichoderinae						
Iridomyrmex sp. 13	-	-	10	-	-	-
Total species	-	25	5	-	9	4
		29			12	

**** Denotes species which are believed to be tree nesters***

Table 2. **The number of ant species visiting ground- and tree-baits, classified in terms of whether they are ground or tree nesting species.**

	Ant nesting habit		Total
	Ground	Tree	
Number of species at ground baits.	4	1	5
Number of species at tree baits.	0	4	4

During mid-August 1989 an area of approximately 400 m^2 was marked out for surveying the ants. A grid of 6 x 6 pitfall traps, spaced at 3 m intervals, was installed in this area (see Figure 2). The traps were of 2.5 cm internal diameter, contained an alcohol/glycerol preservative, and were run for 22 h from 0900 h onwards on 23 August 1989. The tree-associated ants on the 63 trees in the study plot were sampled by beating trees over a 70 cm diameter beating tray between 1000-1200 h on the same day.

In order to assess which ant species might rapidly respond to the existence of new food resources, 20 biscuit/honey/fish baits were placed at the base and in the canopy of 10 randomly selected trees within the plot. Baits were placed out at 1000 h on 23 August 1989 and the ants were collected from them at 1200 h.

The ants from all samples were sorted and counted to species level. They were determined at the generic level and then assigned code numbers to denote the individual species. The numbered reference collection is deposited in the Entomology Museum of the Federal University of Viçosa's Department of Animal Biology, and is named "J D Majer. Reference Collection".

RESULTS

Table 1 lists the 37 species of ants which were sampled and also shows the total and frequency of ants in the 36 pitfall traps (ground ants) and in the tree beats (arboreal ants). It also shows the frequency of ants observed at ground and tree baits.

Twenty nine ant species were present on the ground. Most of these were relatively restricted in the plot, although *Gnamptogenys* sp. 8, *Solenopsis* sp. 14 and *Brachymyrmex* sp. 53 were frequently sampled, and the first-mentioned was relatively abundant in traps. Eighty one percent of the traps contained at least one species of ant.

Twelve ant species were sampled on the trees. In this stratum *Crematogaster* sp. 59, *Pseudomyrmex* spp 50 and 52, and also *Camponotus* sp. 6 were all relatively frequent, although only the first-mentioned species was abundant on trees. All species of *Crematogaster*, *Pseudomyrmex* and *Camponotus* which were sampled are believed to be arboreal nesters. Once again, 81% of trees supported at least one species of ant. Only four ant species, namely *Crematogaster* sp 59, *Pheidole* sp. 2, *Solenopsis* sp. 14 and *Brachymyrmex* sp. 26 were common to both strata.

Eight species of ants were found at baits, with five visiting those on the ground and four visiting tree baits. As indicated in Table 2, the ground baits were largely visited by ground-dwelling species and the tree baits by tree-dwelling ants. Only *Crematogaster* sp. 59 visited baits on the ground and on trees.

In addition to considering the abundance, frequency and responsiveness of ants to food resources, it is also important to consider the distribution pattern of the ants. Figure 2 shows the distribution pattern of the four most frequently occurring arboreal species. *Crematogaster* sp. 59 showed a tendency to occupy large contiguous blocks of trees, as to a lesser extend did *Pseudomyrmex* sp. 52 and *Camponotus* sp. 6. *Pseudomyrmex* sp. 50 was generally found scattered on individual trees throughout the plot. There was a tendency for the distribution of these four species to overlap each other on individual trees. Application of Fisher's Exact Test demonstrated no significant negative or positive associations between the distribution patterns of these four ant species.

DISCUSSION

Studies on arboreal ants elsewhere in the tropics have shown that plantations of tree crops generally support a range of dominant ant species (e.g. Leston 1973, Room 1971 in Ghana; Taylor 1977 in Nigeria; Jackson 1984 in Cameroon; Way 1953 in Tanzania; Greenslade 1971 in Solomon Islands; Way *et al* 1989 in Sri Lanka; Room 1975 in Papua New Guinea; and Jaffe *et al* 1986 in Venezuela). Dominant ants are species which numerically predominate to the exclusion of other ant species (Majer 1972). Furthermore, these dominant ants are usually distributed in a three-dimensional mosaic (Majer 1976a, b and c, and also see review in Majer 1986). It is the abundance of these dominant ants, and the fact that the mosaic is amenable to manipulation, that renders these tropical ants as potentially useful biological control agents.

In terms of their abundance and distribution, the ants in the Vicosa coffee plantation do not seem to conform to the trends observed in tropical tree crops. With the possible exception of *Crematogaster* sp. 59, none of the aboreal ants reached anywhere near the numerical levels noted elsewhere in the tropics. Even in the case of *Crematogaster* sp. 59, the mean number of 3.5 ants per beat sample is low compared with what would be expected in tropical tree plantations.

There are a number of reasons why ants are not abundant in the canopy of the Vicosa coffee plantation. The first possibility is that the canopy is dominated by an arboreal ant which is largely active during the night. Although we did not perform tree beat samples at night, casual observations made during hours of darkness indicated that no species of ant was particularly abundant on trees during this period.

The second possibility is that we may have sampled ants during a period of low ant activity. However, monthly pitfall trapping in this plantation has indicated that August is not a period of low ant activity (MVB Queiroz unpublished data).

The third possibility is that arboreal ants simply do not reach the levels of abundance which has been observed in more tropical regions. This is certainly the case in the subtropical part of northern Australia where, with the exception of *Oecophylla smaragdina* and to a lesser extent *Crematogaster* spp., ants are not abundant in the canopy of tree crops and rainforest trees (Majer 1990). Our observations in tree crops and in secondary forest elsewhere in the Vicosa region suggest that this is the most likely explanation, although the causal factor for this phenomenon is not yet known.

Crematogaster sp. 59 is the only aboreal species which is sufficiently abundant and widespread in the plantation to show any potential value as a biological control agent. It is also fortuitous that it feeds both on the ground and on trees. This means that it could play some role in the limitation of both tree-dwelling and ground-dwelling pests, or alternatively in the limitation of a pest which occupies both the ground and trees.

The observations made at Vicosa do not concur with those made in cocoa in Bahia where members of the *Azteca chartifex* gp., *Azteca paraensis*, *Crematogaster* spp., *Ectatomma tuberculatum* and *Wasmannia auropunctata* can be abundant on trees (Delabie, 1990 and unpublished data). Bahia, however, has a more tropical climate than does the Vicosa region. Finally, the observations made at Vicosa are of a preliminary nature. They are presented here to provoke discussion and it is hoped that further work will follow in order to confirm or refute our observations. Only after further work is carried out will it be possible to evaluate whether any species of ants have potential value for control of pests in tree crops growing in this region.

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