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Ant communities *(Hymenoptera: Formicidae)* in urban centers of the Alto Tietê, São Paulo, Brazil

Comunidades de formigas **(Hymenoptera: Formicidae)** *em centros urbanos do Alto Tietê, São Paulo, Brasil*

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ABSTRACT: The Alto Tietê municipalities have rich remnants of Dense Rain Forest in their vicinities. Considering the environmental importance of the Alto Tietê as water source and that of ants as components of tropical biodiversity, this paper aimed at describing the diversity, composition and similarity of the ant fauna in urban centers of different cities. Samples were collected in houses and city squares. Seven subfamilies and 87 species were recorded, of which 39% are commonly found in the Atlantic Forest remnants adjacent to the cities. *Linepithema neotropicum* is dominant in areas outside the houses and in squares. In each municipality, in the area inside the houses, there is a dominant species. *Tapinoma melanocephalum* was recorded preferably in the area inside the houses. Five exotic species were recorded mainly in the city of Mogi das Cruzes, SP, Brazil.

KEYWORDS: exotic species; Atlantic Forest; houses; squares; *Linepithema neotropicum*.

RESUMO: Os municípios do Alto Tietê possuem em suas adjacências ricos remanescentes de Floresta Ombrófila Densa. Considerando-se a importância ambiental da região do Alto Tietê como fonte de água e das formigas como componentes da biodiversidade tropical, este trabalho teve como objetivo descrever a diversidade, a composição e a similaridade da fauna de formigas nos centros urbanos de diferentes municípios. As coletas foram realizadas em casas e praças. Foram registradas 7 subfamílias e 87 espécies, das quais 39% são comuns nos remanescentes de Mata Atlântica que se localizam nas adjacências das cidades. *Linepithema neotropicum* é dominante na área externa das residências e nas praças. Em cada município, na área interna das residências, tem-se uma espécie dominante. *Tapinoma melanocephalum* foi registrada preferencialmente na área interna das residências. Foram registradas cinco espécies exóticas, em especial, no município de Mogi das Cruzes.

PALAVRAS-CHAVE: espécies exóticas; Mata Atlântica; casas; praças; *Linepithema neotropicum*.

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Urban ecosystems are characterized as spatially heterogeneous and temporally dynamic sites (Mcintyre et al., 2001), where anthropogenic interferences modify the soil structure, climate, the hydrological cycle (Yamaguchi, 2004) and reduce the biological diversity (Mcintyre et al., 2001; Yamaguchi, 2004).

Among the social insects, some ant species have adapted their life styles to urban ecosystems, being the most abundant insects (Mcintyre et al., 2001). In Brazil, it is estimated that 50 ant species are pests (Bueno; Campos-Farinha, 1999).

Some of the species that reside in the urban environment are invasive species and interfere with native ant communities, causing the biodiversity loss (Holway; Suarez, 2006).

Considering (1) the environmental role played by the Alto Tietê region, since 64% of its territory are inserted in remnants of Dense Rain Forest and their municipalities are part of the Reserva da Biosfera do Cinturão Verde of São Paulo city (Pagani, 2012), and (2) the ants as an important component of the tropical biodiversity, this study aimed at describing the diversity, composition and similarity of the ants among different urban centers.

Samples were collected in three municipalities of the Alto Tietê (Table 1), located next to remnants of Dense Rain Forest (Kamura et al., 2007; Munhae et al., 2009). In the central region of each city, five districts and four squares were chosen.

Samples were collected every two months for a year. In each district, five houses were randomly selected. In the inner area (kitchen, laundry and bathroom), baits were offered (Piva; Campos, 2012) for 24 h. In the outer area (garage, yard and garden), ants were collected with tweezers and brushes (time in each residence: 20 min, by 3 collectors). In the squares, samples were collected using the sampling design proposed by Munhae et al. (2009) with sardine baits preserved in edible oil.

The material was initially separated into subfamilies and genera according to Bolton (2003) and Bolton et al. (2006), except for the group of genera centered in *Prenolepis*, that follows the classification of LaPolla et al. (2010). Subsequently, the material was separated into morphospecies, comparing the specimens with those from the Formicidae collection of Alto Tietê (University of Mogi das Cruzes, São Paulo state). The species were identified by comparison with specimens deposited in the Museum of Zoology, University of São Paulo (MZUSP) and with the literature. Vouchers were deposited at the University of Mogi das Cruzes.

The richness is the total number of species in each collection site; the occurrence frequency data were obtained from a matrix of presence and absence. The richness estimator Chao2 was applied using the software EstimateS, version 8.2 (Colwell, 2009) to determine the expected number of species. The Shannon-Wiener diversity and Pielou Evenness were calculated using the software DivEs (Rodrigues, 2007). The similarity among the ant communities was calculated using the Jaccard similarity index (Magurran, 1988).

In urban centers of Alto Tietê, 7 subfamilies, 34 genera and 87 morphospecies/ant species were recorded. Specifically, 63 species (84 estimated) were recorded in the squares: 51 in the area outside the house (65 estimated) and 26 in the area inside the house (35 estimated). The Myrmicinae subfamily was the richest in all urban centers.

Exotic species were recorded, such as: *Cardiocondyla wroughtonii* Forel, *Monomorium floricola* Jerdon, *Pheidole megacephala* Fabricius, *Paratrechina longicornis* Latreille and *Tapinoma melanocephalum* Fabricius.

The ant communities in the squares of Mogi das Cruzes, São Paulo state, are richer and more diverse in comparison with other cities; in the area outside the house, the opposite pattern was recorded (Table 2 and Fig. 1). Ant communities in the area inside the house are similar in the three municipalities (Table 3).

Table 1. Characterization of the municipalities of Alto Tietê for urban ant collection.

Municipalities of Alto Tietê	Number of inhabitants	Coordinates/altitude (m)	% of protected territory*	Urban center
Mogi das Cruzes	387.241	23º52'22" S; 46º18'55" W/ 742	65	High commercial activity, little wooded
Biritiba-Mirim	29.694	23º34'40" S; 46º02'34" W/ 784	89	Low commercial activity, wooded
Salesópolis	16.573	23º31'85" S; 45º50'77" W/ 798	98	Low commercial activity, wooded

*Law nº 9.866.

Table 2. Total number of ant species recorded in the urban centers of the Alto Tietê, São Paulo, Brazil, and results of Shannon-Wiener diversity and Pielou Evenness.

	Mogi das Cruzes			Biritiba Mirim			Salesópolis		
	Square	House		Square	House		Square	House	
		Internal	External		Internal	External		Internal	External
Total of species	51	12	23	41	16	40	42	15	39
Shannon-Wiener Diversity	1.660	1.033	1.306	1.583	1.040	1.549	1.564	1.016	1.543
Evenness	0.967	0.927	0.959	0.975	0.947	0.960	0.963	0.864	0.963

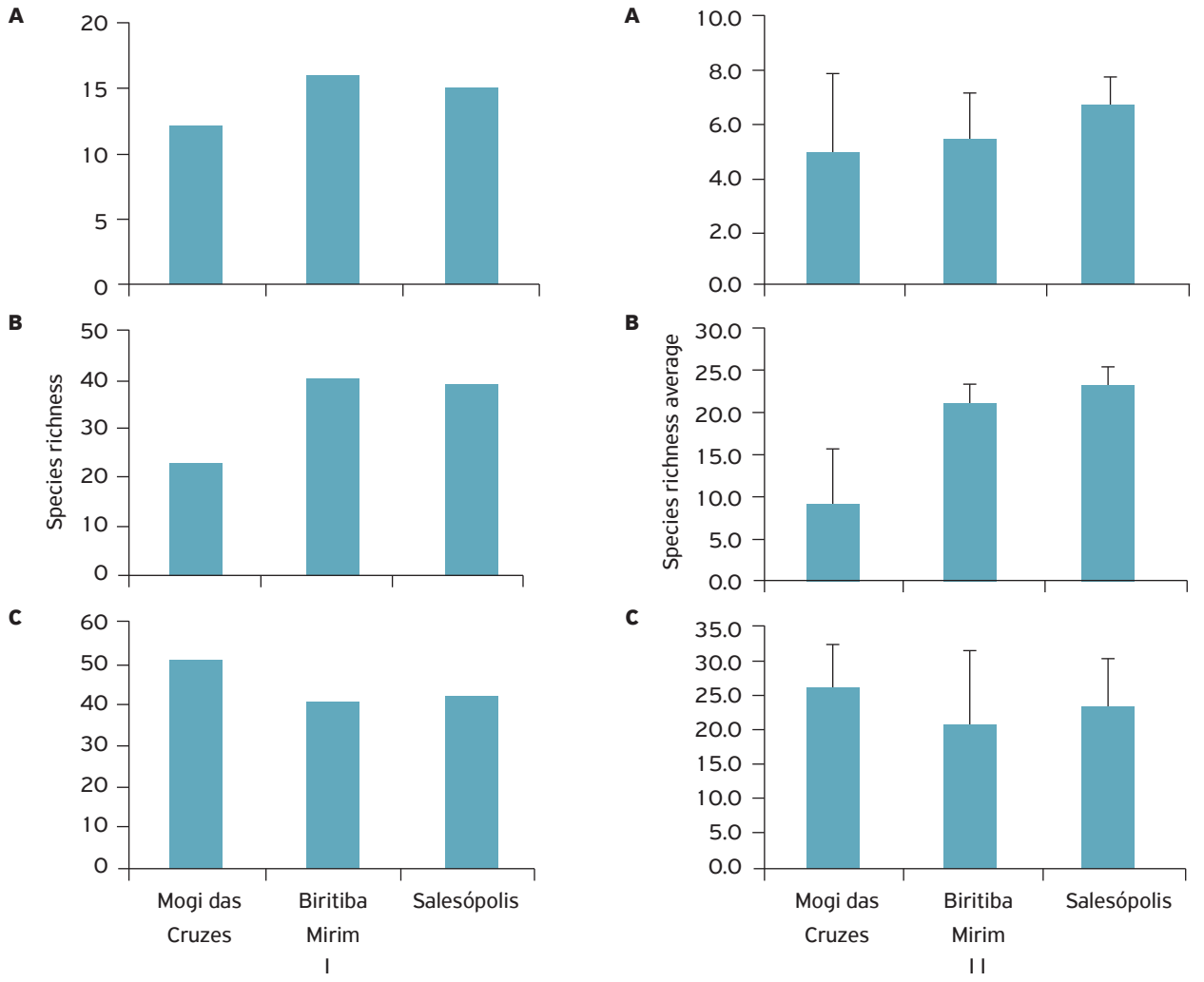

Figure 1. Total (I) and average (II) richness of ants according to the municipality and collection site in the urban centers. (A) area inside the house; (B) area outside the house; (C) squares. Vertical bar: standard deviation.

Table 3. Results of the Jaccard similarity index among the different urban centers in Alto Tietê, São Paulo, Brazil.

Municipalities	Squares	Houses	
		Inner area	Outer area
Mogi das Cruzes *versus* Salesópolis	0.41	0.35	0.28
Mogi das Cruzes *versus* Biritiba Mirim	0.41	0.34	0.28
Salesópolis *versus* Biritiba Mirim	0.35	0.34	0.36

Linepithema neotropicum Mayr exhibits strong dominance in the area outside the houses and in the central squares of Alto Tietê (Fig. 2). In each municipality, in the area inside the houses, there is a different dominant species (Fig. 2). *T. melanocephalum* was recorded, preferably in the areas inside the house.

The urban fauna is composed mainly by *T. melanocephalum*, *P. longicornis*, *Nylanderia* sp.1 Mayr, *Wasmannia auropunctata* Roger, or species of *Brachymyrmex*, *Camponotus*, *Monomorium*, *Pheidole* and *Solenopsis*.

Despite the presence of typically urban ant communities, the Dense Rain Forest in the vicinity of the sampled cities supports a richer fauna, which is in agreement with Kamura et al. (2007). Species recorded in squares or areas outside the houses, such as *Gnamptogenys reichenspergeri* Santschi, *Labidus coecus* Latreille, *Myrmelachista catharinae* Mayr, *M. ruszkii* Forel, *Hypoponera* spp. and *Strumygenys* spp., are common in the Atlantic Forest remnants of the municipalities here studied (Morini et al., 2012).

Among the 26 species recorded in the inner areas, *T. melanocephalum*, *P. megacephala*, *S. saevissima* Smith, *P. longicornis* and *W. auropunctata* may be considered truly associated with human habitats (Delabie et al., 1995), especially *T. melanocephalum*, which was recorded in the present and in other studies (Delabie et al., 1995; Kamura et al., 2007; Piva; Campos, 2012), more frequently in the domiciliary environment.

P. megacephala is one of the most frequent species in the areas outside the houses. Delabie et al. (1995) and

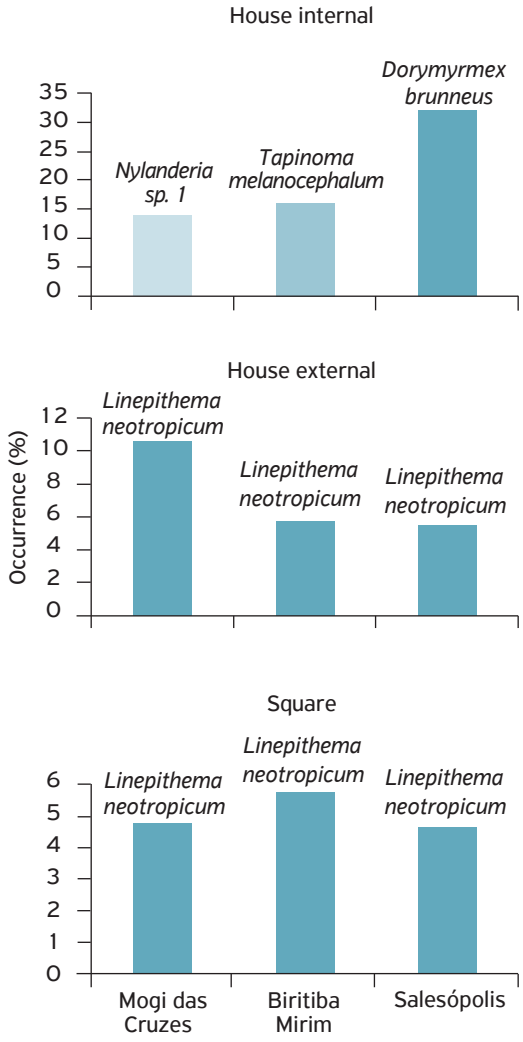

Figure 2. Most common ant species according to the municipality and collection site in the urban centers of Alto Tietê, São Paulo, Brazil.

Piva; Campos (2012) found similar results. In the present study, the occurrence of this species was higher in squares. The presence of *P. megacephala* in urban squares is also associated with poorly preserved environments (Pacheco; Vasconcelos, 2007) and it is not significant in green areas (Piva; Campos, 2012). These characteristics are present in the urban center of Mogi das Cruzes, but not of Biritiba Mirim and Salesópolis.

In the squares and areas outside the houses from the Alto Tietê, the dominant species is *L. neotropicum*, but there are no reports on its interaction with *P. megacephala*. Negative associations were found between *P. megacephala* and *L. humile* Mayr, 1868 (Haskins; Haskins, 1965) and between *T. melanocephalum* (Delabie et al., 1995; Piva; Campos, 2012) and *P. longicornis* (Delabie et al., 1995; Kamura et al., 2007; Piva; Campos, 2012). Thus, the presence of *L. neotropicum* in urban centers of the cities in Alto Tietê may represent a difference in the structure of ant communities in comparison with other urban cities in Brazil. This result may be related to the proximity of urban and forest areas, where this species is often recorded in the litter (Suguituru et al., 2011; Morini et al., 2012) in the Atlantic rainforest of south-eastern Brazil.

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