Original Article

MYRMECOFAUNA OF URBAN GARDENS IN SOUTHEAST REGION OF BRAZIL

MIRMECOFAUNA DE JARDINS URBANOS NA REGIÃO SUDESTE DO BRASIL

Manuella Rezende VITAL[1]; Mariana Monteiro de CASTRO[1]; Viviane ZERINGÓTA[1]; Fábio PREZOTO[1]

1. Laboratório de Ecologia Comportamental e Bioacústica – LABEC, Universidade Federal de Juiz de Fora, Campus Universitário, Bairro Martelos, Juiz de Fora, MG, Brazil. marimc.jf@gmail.com

ABSTRACT: In an urban environment, ants can find shelter for the construction of their nests and resources available for survival. Myrmecofauna surveys have been conducted in forest fragments and residential areas, but there are few studies on the occurrence of these insects in urban gardens. For this reason, the aim of this study is to know the composition of ant communities in urban gardens in the city of Juiz de Fora, southeast region of Brazil. Samples were taken from six gardens between November 2005 and June 2006. We used a consortium of three methodologies: active searching, baits and pitfall traps. We collected specimens of 26 genera and seven subfamilies. The subfamily Myrmicinae was the most diverse, and the genus *Wasmannia,* was considered the most constant, followed by *Camponotus* and *Linepithema*. The efficiency index of the methodologies demonstrated that active searching was the most efficient (96.15%) methodology. This method is efficient and sufficient for sampling ants in urban gardens, since 25 of the 26 genera sampled, presenting seven exclusive genera. The green area was not positively correlated with the diversity of ant genera in the urban gardens, demonstrating that other variables may be involved.

KEYWORDS: Squares. Surveying. Urban Ants.

INTRODUCTION

Ants belong to the order Hymenoptera and to a single family, Formicidae, which comprises about 16 subfamilies with more than 290 genera. It is estimated that there are 25000 species of ants worldwide (WARD, 2010), 12500 of which have already been described (BOLTON et al., 2006). Ants act in nutrient cycling (HÖLLDOBLER; WILSON, 1990; FOWLER et al., 1991; MOUTINHO et al., 2003), in seed dispersal (PETERNELLI et al., 2004) and as predators of other arthropods (FOWLER et al., 1991) having a role in behavioral ecology and interactions (DEL-CLARO, 2008). They are the most adapted to urban environment, and in Brazil about 50 species are recognized as urban pests, causing damage in the countryside, towns and to public health (BUENO; CAMPOS-FARINHA, 1999; CAMPOS-FARINHA et al., 2002).

The world's population is moving more and more to urban areas, and in 2008, by the first time, it was announced that more than half of the population was living in urban areas. By 2025, it is estimated that two thirds of people will be living in cities (BOTKIN; KELLER, 2011). These changes make urban pests pose a growing public health problem in large cities (RUST; SU, 2012). The availability of shelter and food provides a suitable environment for the proliferation of different species of synanthropic animals (OLIVEIRA; CAMPOS-FARINHA, 2005).

Although shelter pest species considered, the green spaces have shown a great potential as sites for biodiversity conservation, given that these places offer conditions for survival of many animal species (WHITMORE et al., 2002; SATTLER et al., 2010). The conservation of native ant species and potentially others animals may represent an important function of urban gardens, working as refuges for these species (PACHECO; VASCONCELOS, 2007). Moreover, these environments can also act as ecological corridors for many species (MENKE et al., 2010). Several factors related to the urban gardens as size, age, shape and distance from the periphery of the city can be decisive in diversity and species richness, which demonstrate the influence of the structure of the site and surrounding to the composition of ant species in these spaces (CARPINTERO AND REYES-LÓPEZ, 2014).

Moreover, gardens play important roles in the urban environment, such as community integration and improvement of environmental quality (CARVALHO et al., 2003). Studies of ant diversity occurring in this environment can help to control and appropriate management of these species, which will contribute to the improvement of human welfare by reducing the risk of accidents (ZERINGÓTA et al., 2014). Therefore, studies in urban environment may answer some questions, like: What species occur in this location? What is the best method to record these species? In order to

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contribute to increased understanding of these questions, this study aimed to know the composition of ant communities in those environments.

MATERIAL AND METHODS

The study was conducted in the city of Juiz de Fora (21°41'20" South and North 43° 20'40") in the Zona da Mata of Minas Gerais State, Southeast region of Brazil, with humid subtropical Cwa climate, according to Köppen's classification (1970). The annual average temperature is approximately 19 °C, being February the warmest month and July the coldest one, with annual average precipitation about 1600mm (INMET, 2014). Samples were collected during the day and early evening between November 2005 and June 2006 in six urban gardens, which have low vegetation and large trees. Information about the total and green area are presented in Table 1. Three months were selected in each season and each month a collection held in each of the six sites (n= 36).

Table 1. Geographic coordinates, total area and green area (m^2) of the six urban gardens studied of Juiz de Fora, Minas Gerais State, Southeast region of Brazil.

Urban Garden	Geographic Coordinates	Total area (m^2)	Green area (m^2)
A	21º44'24''S, 43º21'03''W	5.766,00	3.343,00
B	21º45'30''S, 43º21'20''W	3.108,39	2.061,77
C	21º42'22''S, 43º25'09''W	1.844,21	538,00
D	21º46'36''S, 43º20'34''W	12.510,00	5.535,42
E	21º45'40''S, 43º21'01''W	11.532,1	4.072,38
F	21º00'00''S, 43º21'29''W	4.372,53	3.761,48

The methods used were active searching, bait and pitfall trap (ALMEIDA et al., 1998). Active searching consisted of the collection of individuals found randomly when inspecting the whole garden. This method is characterized by the random walk of a person over the edge and inside the perimeter of the garden, between 9 and 16 hours. The baits were made of sardine and honey (ROMERO; JAFFÉ, 1989), being placed on a piece of aluminum foil (10 x 10 cm) and exposed for 60 minutes in the morning (10 to 11 am) and evening (7 to 8 pm). The number of baits was established according to the size of the garden, ranging from 20 to 40. For the pitfall trap, four 50 ml plastic cups, four cm in diameter, were filled with water and detergent, and they were buried so that the edge stayed at ground level and exposed for 12 hours (8 am to 8 pm). The number of pitfall traps varied between five and 15, depending on the size of the urban garden. The baits and pitfall traps were placed randomly.

After collection, the ants were placed in eppendorfs identified as containing 70% alcohol. The material was identified by genus by taxonomic key (FERNÁNDEZ, 2003) and the material was deposited in LABEC collection (Laboratório de Ecologia Comportamental e Bioacústica – LABEC from the Universidade Federal de Juiz de Fora).

The Spearman's correlation test was used to verify correlation between the size of the green area of the urban garden with the total number of ant genera found in each place. To calculate the efficiency of the methods, an efficiency index obtained was used as follows: efficiency index= total genera captured by methodology x 100 / total genera found, represented as percentage, modified by Giannotti et al. (1995).

RESULTS AND DISCUSSION

Five thousand two hundred and twenty-five individuals belonging to 26 genera and seven subfamilies were collected (Table 2). The subfamily Myrmicinae was the most diverse and representative of a total of 13 genera (50%), followed by Ponerinae and Formicinae both with three (11.54% each), Ecitoninae, Ectatomminae and Dolichoderinae with two each one (7.69% each) and Pseudomyrmicinae with one (3.85%).

The genus *Wasmannia* was considered as constant, with 100% occurrence, followed by *Linepithema* and *Camponotus*, both with 94.44%.

The presence of *Wasmannia* in all collection samples can be justified by the fact that this genus contains opportunistic species with high adaptability (DELABIE, 1988). The genus *Linepithema*, in turn, is found in urbanized areas and changes nesting sites in response to environmental variation (HÖLLDOBLER; WILSON, 1990).

Table 2. Average abundance and standard deviation of the genera of ants collected in accordance with the methods of active searching, bait and pitfall trap in urban gardens of Juiz de Fora, Minas Gerais State, Southeast region of Brazil.

Subfamily/Genus		Active searching	Bait	Pitfall
Dolichoderinae				
	Dolichoderus	0.1892±0.52	0	0
	Linepithema	8.6111±5.91a	1.333±2.76b	0.1667±0.70c
Ecitoninae				
	Labidus	0	0	0.0278±0.17
	Neivamyrmex	1.4722±2.68a	1.3056±3.39a	0
Ectatomminae				
	Ectatomma	0.1667±0.51	0	0
	Gnamptogenys	0.5278±1.38a	0.0278±1.67b	0
Formicinae				
	Brachymyrmex	10.6111±11.87a	3.75±5.86b	0.75±2.1c
	Camponotus	16.1389±8.53a	0.6389±1.22b	0.6667±1.35b
	Paratrechina	6.5000±7.19a	0.1667±0.56b	0.0278±0.17c
Myrmicinae				
	Acromyrmex	6±7.21a	0.0278±0.17b	0.25±1.5c
	Atta	0.3056±0.95	0	0
	Cardiocondyla	4.3333±6.74a	1.5833±3.38b	0.0833±0.5b
	Cephalotes	0.492±1.22	0	0
	Crematogaster	5±4.15a	0.1389±0.42b	0
	Hylomyrma	0.2500±0.91	0	0
	Monomorium	1.3056±2.05a	0.7778±2.29b	0.0833±0.28b
	Octostruma	2.2222±2.95a	0.0556±0.023c	0.1389±0.42b
	Pheidole	21.1111±11.14a	6.6389±8.86b	1.0000±1.62c
	Procryptocerus	0.0556±0.23	0	0
	Solenopsis	0.08333±0.37a	0.5278±1.40a	0.4167±2.17a
	Tetramorium	0.2222±0.68a	0.0278±0.17a	0
	Wasmannia	8.3611±7.28b	21.0556±24.15a	0.8889±1.80c
Ponerinae				
	Leptogenys	0.3333±0.83a	0	0.0833±0.5a
	Odontomachus	4.0278±4.36a	0.1944±0.62c	0.5000±1.05b
	Pachycondyla	0.1389±0.68	0	0
Pseudomyrmicinae				
	Pseudomyrmex	2.6389±3.25a	0	0.0278±0.17b

Same letter do not differ significantly at 5% ($p>0.05$).

The genera with highest species richness were: *Camponotus*, *Pheidole* and *Pseudomyrmex*. Miranda et al. (2006) recorded *Camponotus* and *Pheidole* as the most common genus in an urban fragment of semideciduous forest in Southeast region of Brazil. And just as in the present study, the richness recorded by Delabie et al. (2006) in mangroves and their peripheral vegetation in

northeastern Brazil included *Camponotus* and *Pseudomyrmex*.

In relation of green areas, the test showed that the green area is not a factor that is positively correlated with the ant genera diversity (rs= -0.8281; p= 0.0418). This can be explained by the fact that other variables may be involved. For example, it is observed that the smaller urban gardens (B and C), whose showed largest number genera, showed the lowest number of large trees (26 and 20 respectively), which represents a third of the average number of trees of the other places (n= 76). The authors also speculate that other factors should be considered in future studies for these analyzes, as the age of the places, the flow of people and the anthropic action on these sites. Furthermore, it is known that some species of urban ants, such as *Solenopsis*, prefer to nest in the shaded little locations, with a high incidence of sunlight (ZERINGÓTA et al., 2014), which is not possible in the urban gardens with a high number of large trees.

Regarding the meeting of genera according to the sampling method, there were 25 in the active searching, followed by baits with 16 and pitfall traps with 15. The efficiency index of the methodologies demonstrated that the methodology of active searching was the most efficient (96.15%), followed by bait (61.54%) and pitfall (57.69%).

The richness of genera found in this study was higher than that recorded in other surveys in homes, gardens and urban forest fragments (Table 3).

Table 3. Comparison with other survey studies on ants in urban areas in Brazil.

References	Genera	Subfamily	Collection methods	Environment	Locality
This study	26	7	1, 2, 3	Urban gardens	Juiz de Fora Minas Gerais (Southeast)
Delabie *et al.* (1995)	14	4	2	Homes	Ilhéus, Bahia (Northeast)
Silva and Loeck (1999)	12	3	1	Homes	Pelotas Rio Grande do Sul (South)
Fonseca and Diehl (2004)	19	5	3	Eucalypt	Capivari do Sul Rio Grande do Sul (South)
Schmidt *et al.* (2005)	14	5	1, 2	Forest fragment	Ilha João da Cunha Santa Catarina (South)
Lutinski and Garcia (2005)	19	6	3, 4, 5, 6	Bushes and grass (Degraded Ecosystem)	Chapecó Santa Catarina (South)
Oliveira and Campos-Farinha (2005)	24	6	1	Homes, industries and public buildings	Maringá Paraná (South)
Miranda *et al.* (2006)	8	4	2	Forest fragment	Araguari Minas Gerais (Southeast)
Soares *et al.* (2006)	9	4	2	Homes	Uberlândia Minas Gerais (Southeast)
Pacheco and Vasconcelos (2007)	39	*	3	Urban Parks, Public Squares, Natural Reserves	Uberlândia Minas Gerais (Southeast)
Dáttilo *et al.* (2011)	19	5	2, 3	Forest Fragment	Marília São Paulo (Southeast)
Piva and Campos (2012)	21	6	1, 2	Homes	São Paulo São Paulo (Southeast)
Lutinski *et al.* (2013)	37	9	1, 2	Forest fragment, Urban Gardens, Schools, Recycling Centers	Abelardo Luz, Campo Erê, Chapecó, Concórdia, Joaçaba, Palmitos, Pinhalzinho, São Miguel do Oeste, Seara e Xanxerê Santa Catarina (South)

1. Active searching 2. Bait; 3. Pitfall (or Bait-Pitfall) traps; 4. Sweeping net; 5. Entomologic umbrella; 6. Leaf litter. * Not available

Just Pacheco and Vasconcelos (2007) and Lutinski et al. (2013) found a larger number than that recorded in the present study. In case of Pacheco and Vasconcelos (2007), the authors used twice as many urban gardens, and two city parks, all well as three natural reserves, totaling 17 sampling areas. And Lutinski et al. (2013) conducted the study in three urban locations from 10 different cities. Both studies used different methodologies for collecting ants. For comparatives effects with our study, we need to take consider that as the number of species observed is dependent on the sampling effort and the method used for sampling, comparative information has limited value for analyzing different areas.

Although the active searching was shown effective in the present study, this method may not be used in all studies of the ant fauna due to the difficulty of collecting in large areas, which justified the methodology that included traps. For this study, their efficiency is due to the ease of displacement throughout the sampled area, allowing the collection of individuals in all areas. Table 3 shows the large variation in collecting ants from different methodologies, which differ greatly among studies.

CONCLUSION

The method of active searching is efficient and sufficient for sampling ants in urban gardens, since 25 of the 26 genera sampled, presenting seven exclusive genera. In addition, 14 of the 18 genera recorded in two or more methods had higher average abundance in active searching method, which may indicate greater probability of record in this method compared to the other. Their efficiency is due to the ease of displacement throughout the sampled area, allowing the collection of individuals in all areas. Therefore, the association with other methodologies showed redundant. In relation of green areas, it was evident that the green area is not a factor that is positively correlated with the ant genera diversity, showing that other variables may be involved.

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RESUMO: Em ambiente urbano, as formigas podem encontrar abrigo para construção de seus ninhos e recursos disponíveis para sobrevivência. Levantamentos da mirmecofauna já foram realizados em fragmentos de mata e áreas domiciliares, porém existem poucos estudos quanto à ocorrência destes insetos em jardins urbanos. Por esta razão, objetivou-se realizar o levantamento da mirmecofauna presente em jardins urbanos do município de Juiz de Fora, sudeste do Brasil. Foram realizadas coletas em seis jardins entre novembro de 2005 e junho de 2006. Foi utilizado o consórcio de três metodologias: busca ativa, isca atrativa e *pitfall*. Foram coletados exemplares de 26 gêneros e sete subfamílias. A subfamília Myrmicinae foi a mais diversa e o gênero *Wasmannia* considerado o mais constante, seguido por *Camponotus* e *Linepithema*. O índice de eficiência das metodologias demonstrou que a busca ativa foi a metodologia mais eficiente de coleta (96,15%). Este método é eficiente e suficiente para a coleta de formigas em jardins urbanos, uma vez que 25 dos 26 gêneros foram amostrados, com presença de sete gêneros exclusivos. A área verde não esteve correlacionada positivamente com a diversidade de gêneros de formigas nas praças, demonstrando que outras variáveis devem estar envolvidas.

PALAVRAS-CHAVE: Formigas Urbanas. Levantamento. Praças.

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