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ANTS (HYMENOPTERA, FORMICIDAE) RICHNESS AND COMPOSITION IN URBAN HABITATS

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ABSTRACT

Ants are a very rich and cosmopolitan group of insects. The ants' colonies are composed by different castes, in which each individual has its function in the colony (i.e. workers, soldiers, and the queen). This amazing organization in castes is the main responsible for their evolutionary success and their adaptation in distinct types of habitats. Two thousand species of ants in Brazil have already been described, and almost 50 of them adapted to live in urban habitats. Ants are considered urban pests, mainly because they physically carry disease organisms and because they damage household appliances. We sampled urban ants in the city of Jataí - GO, located in a region of Brazilian Cerrado, in the Southwest of the State of Goiás. To better demonstrate the ant fauna of this region, we sampled the ants inside houses and in the backyards. We tested if (1) the species richness is higher in backyards than inside houses. We also tested whether (2) ant species composition differs from those within residences in relation to the ones in backyards. We sampled 47 species of ants belonging to six subfamilies. Backyards had significantly higher species richness than within residences. This result was expected, since the backyards are heterogeneous environments and provide more resources, refuges and a better microclimatic quality, allowing a greater amount of species to coexist. This result was expected, since the backyards present vegetation (mainly Poaceae and fruit plants) and exposed soil, allowing the occurrence of species that need these resources. These results show that knowledge of the richness and composition of the myrmecofauna living in urban areas may be fundamental for the elaboration of management, control and conservation plans of the ants.

Keywords: Backyards; Residences; Urbanization; Heterogeneity.

RESUMO

Riqueza e composição de formigas (Hymenoptera, Formicidae) em habitats urbanos. As formigas pertencem a um grupo de insetos cosmopolita e muito rico em espécies. As colônias de formigas são compostas por muitas castas, em que cada indivíduo tem sua função na colônia (exemplos, operárias, soldados e a rainha). Esta surpreendente organização em castas é a principal responsável pelo seu sucesso evolutivo e por suas adaptações em diferentes tipos de hábitat. Já foram descritas 2.000 espécies de formigas no Brasil, e quase 50 delas são adaptadas a ambientes urbanos. As formigas são consideradas pragas urbanas, principalmente porque elas transportam fisicamente organismos portadores de doenças e porque elas danificam eletrodomésticos. Nós amostramos formigas urbanas no município de Jataí – GO, localizado em uma região de Cerrado Brasileiro, no Sudoeste do Estado de Goiás. Para demonstrar melhor a mirmecofauna desta região, nós coletamos as formigas dentro de residências e nos quintas das mesmas. Nós testamos se (1) a riqueza de espécies é maior nos quintais do que dentro das residências. Também testamos se (2) a

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composição de espécies de formigas difere dentro das residências em relação aos quintais. Nós amostramos 47 espécies de formigas, pertencentes a seis subfamílias. Os quintais apresentaram uma riqueza de espécies significativamente maior do que dentro das residências. Este resultado era esperado, já que os quintais são ambientes heterogêneos e fornecem mais recursos, refúgios e uma melhor qualidade microclimática, permitindo que uma maior quantidade de espécies coexista. A composição de espécies de formigas nos quintais foi completamente distinta da composição de espécies dentro das residências. Este resultado era esperado, já que os quintais apresentam vegetação (principalmente Poaceae e plantas frutíferas) e solo exposto, possibilitando a ocorrência de espécies que precisam desses recursos. Estes resultados mostram que o conhecimento da riqueza e da composição da mirmecofauna que habitam em áreas urbanas pode ser fundamental para a elaboração de gerenciamento, controle e planos de conservação das formigas.

Palavras-chave: Quintais; Residências; Urbanização; Heterogeneidade.

INTRODUCTION

Studies with faunistic reports are very important for the knowledge of the biodiversity, which provide support for actions on conservation and management (Lutinski *et al.,* 2013), mainly in areas undergoing rapid environmental degradation (Lewinsohn *et al.,* 2005), such as in urban areas. Increasing urbanization makes intact natural areas to be completely fragmented (McIntyre *et al.*, 2001; Yamaguchi, 2005), which may affect species communities, both in positive and in negative ways. Some species become very abundant and dominant, when there is supply of unoccupied niche and in absence of competing species or natural enemies (McKinney, 2006). While other species decline in abundance or may even be extinguished from an area due to habitat loss, competition and the introduction of exotic species (McKinney, 2006).

In urban environments, insects (mainly ants, Bueno and Campos-Farinha, 1999) invade homes, cause structural damage, such as short circuit and can contaminate foods (Bueno and Campos-Farinha, 1999; Rodovalho *et al.,* 2007; Pesquero *et al.*, 2008; Bueno and Campos, 2017). Some of them may even be carriers of bacteria, causing damage to public health (Rodovalho *et al.*, 2007; Pesquero *et al.*, 2008; Bueno and Campos, 2017). The majority of ants found in urban habitats are exotic species. These species might be competitively dominant, mainly due to the lack of natural enemies and to the facility to find food and shelters (Delabie *et al.*, 1995; Bueno and Campos–Farinha, 1999; Silva and Loeck, 1999; Oliveira and Campos–Farinha, 2005; Soares *et al.*, 2006; Bueno and Campos, 2017). Although, there is a lack of knowledge about the ants that occur outside residences in urban areas (but see Oliveira and Campos-Farinha, 2005; Pacheco and Vasconcelos, 2007, for example). Sampling at locations other than inside houses might reveal the occurrence of more species of ants, mainly the native species which are in constant interaction with their natural environment (Bueno and Campos, 2017).

One of the major factors that influence the foraging activity of ants is the environmental complexity (Holldobler and Wilson, 1990). Species richness is usually greater in structurally complex habitats (Bazzaz, 1975), as these habitats provide more resources, refuge against natural enemies and more stable climatic conditions (Bazzaz, 1975; Tews *et al.*, 2004; Yamaguchi, 2005; Pacheco and Vasconcelos, 2007). In more complex urban habitats such as squares, parks and natural areas close to cities there is a higher ants species richness as well (Pacheco and Vasconcelos 2007). Thus, in places that provide natural resource, like yards, might also reveal more species than found inside the houses.

This study aimed at evaluating the diversity of urban ants inside the houses and in the yards of five distinct regions in the city of Jatai - GO, located in the Brazilian Cerrado region. We also aimed to show which species occur inside the houses only, which species occur in the yards only, and which species occur in both environments. We also tested if (1) the ants' species richness is higher in yards than inside residences and (2) the yards have a distinct species composition in relation to inside of the residences.

MATERIAL AND METHODS

We sampled ants in Jataí city (17° 52' 33" S e 51° 43' 17" O), Southwest of Goiás State, Brazil. Jataí is in Cerrado biome, which is characterized by a gradient of vegetation that ranges from open fields to forest formation (Oliveira-Filho and Ratter, 2002). Cerrado is one of the most threatened biome of Brazil, with more than 40% of its natural vegetation converted in pastures, monocultures and urban areas (Klink and Machado, 2005).

We collected ants from March to June of 2008, in five different districts. We selected the districts closest to the center of the city (Figure 1). The ants were sampled in ten houses of each district. In each house we sampled ants inside residences and on yards (all yards had bare soil with herbs, shrubs or trees), totaling 100 samples in all the five districts (50 inside houses and 50 on yards). We collect the ants manually, in the afternoon period, and put them in alcohol 70%. In each house we had 30 min of sample effort. The ants were identified to the lowest possible taxonomic level using identification keys (Bolton, 1994; 1995; 2003; Palacio and Fernandéz, 2003) and comparisons with specimens in JLMD (Jorge Luís Machado Diniz) collection.

The sampled ants are preserved in JLMD collection, at Universidade Federal de Goiás, Brazil.

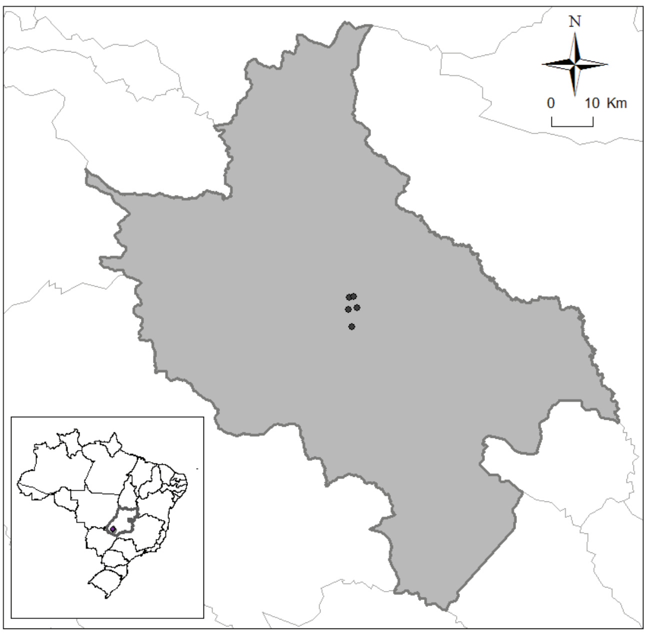

Figure 1. Map of Jataí – GO, showing the points of the districts in which we sampled the ants.

Statistical Analysis

We used the first order Jackknife to estimate the total ants' richness in all the districts, inside houses and on yards. We performed a T test to verify if the ants' richness on yards was higher than inside residences. The predictor variable was the place of sample (yards and inside residence) and the answer variable was the ants' richness. We performed a non-metric multidimensional scaling (NMDS) based on Sorensen distance to assess differences in ants' composition between residences (inside) and yards. We assessed the differences in species composition using an Analysis of Similarities (ANOSIM) with 1000 random permutations. All the analysis was made on R (The R Development Core Team 2010). To perform the T test we used the "lm" function from the package stats (Chambers, 1992). We performed the NMDS using the "metaMDS" function from the Vegan package (Faith *et al.,* 1987). We performed ANOSIM using the "anosim" function from the Vegan package (Clarke, 1993).

RESULTS

We collected 1,150 individuals belonging to 47 species of ants (inside houses and on yards). The species were distributed in six subfamilies: Dolichoderinae, Ectatomminae, Formicinae, Myrmicinae, Ponerinae and Pseudomyrmecinae (Appendix 1). Myrmicinae was the richer subfamily, with 29 species; Formicinae with eight; Dolichoderinae and Ectatomminae with three; Ponerinae and Pseudomyrmex with two species (Appendix 1).

The most frequent species were *Dorymyrmex* sp1 and *Pheidole megacephala* (Fabricius, 1793) (33%), followed by *Tapinoma* sp1 (23%), *Solenopsis saevissima* (Fr. Smith, 1855) (17%) and *Paratrechina* sp1 (16%) (Appendix 1). Yards presented more quantity of exclusive ants' species, with 28 (59.5%) in total (Figure 2). We found just four exclusive species inside houses (Figure 2). Fifteen species occured in both habitats (Figure 2).

Yards presented more than the double of species richness than inside houses ($t_{1,94}$ = 24,36, p < 0,0001, Figure 3, Table 1). The same pattern was observed for the extrapolated richness (Table 1).

The ants species composition was very dissimilar between yards and inside houses (NMDS, Stress = 16.8, Figure 4). The diagram of the NMDS shows clearly that the fauna sampled inside the houses (on the left of the diagram) are very far from the fauna sampled in the yards (on the right of the diagram, Figure 4). This difference in the myrmecofauna composition between yards and inside houses was confirmed by ANOSIM (r = 0.65, p = 0,001).

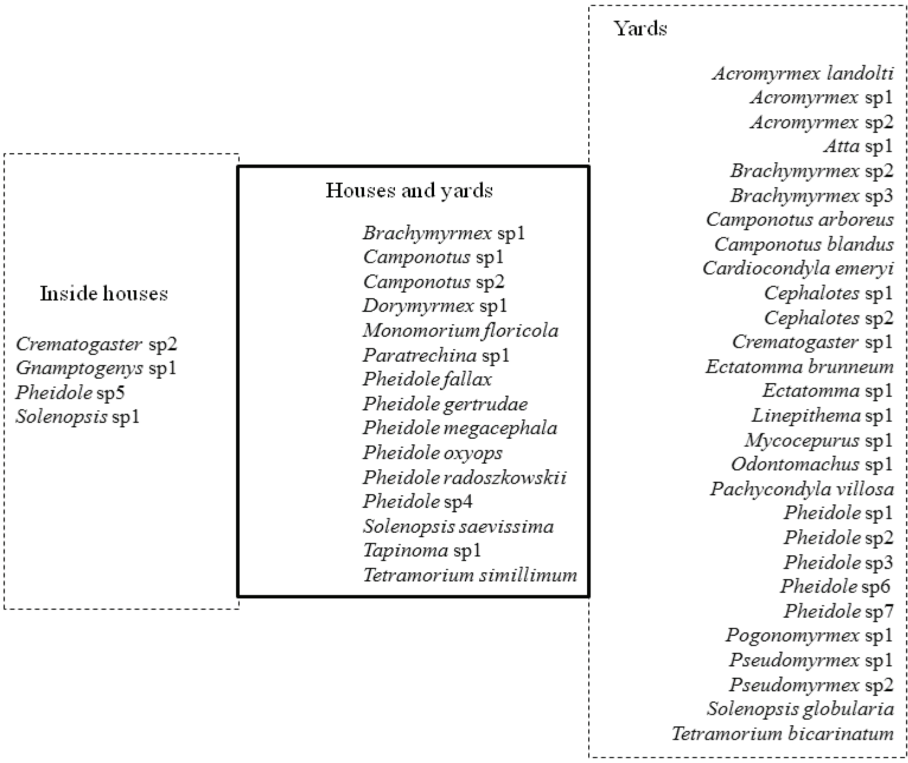

Figure 2. Species sampled inside houses, on yards and shared between yards and inside houses.

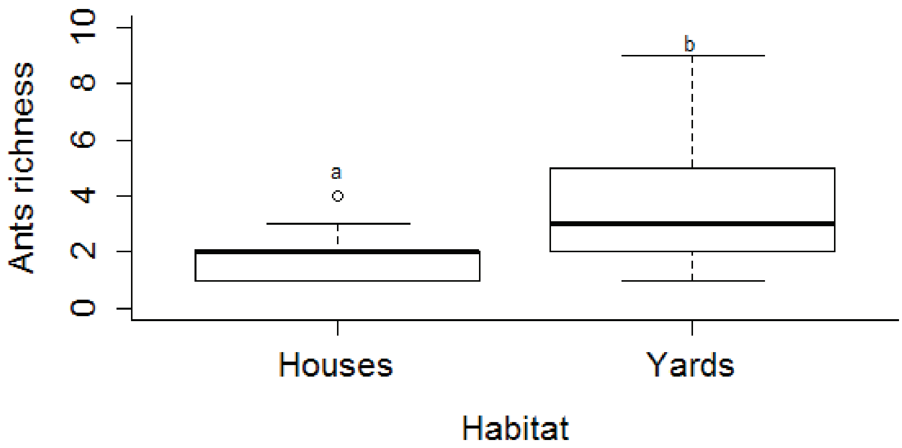

Figure 3. T test of ants species richness between yards and inside houses. Different letters mean the statistical difference between treatments.

Table 1. Observed and extrapolated (Jackknife 1) of ants richness, percentage of extrapolated richness that we sampled inside houses, on yards and in both habitats (Total).

Habitats	Observed richness	Extrapolated richness ± SD	Percentage of the extrapolated richness
Inside houses	19	25,3 ± 3,58	76%
Yards	43	54,6 ± 3,58	78%
Total	**47**	**59,3 ± 4,90**	**79%**

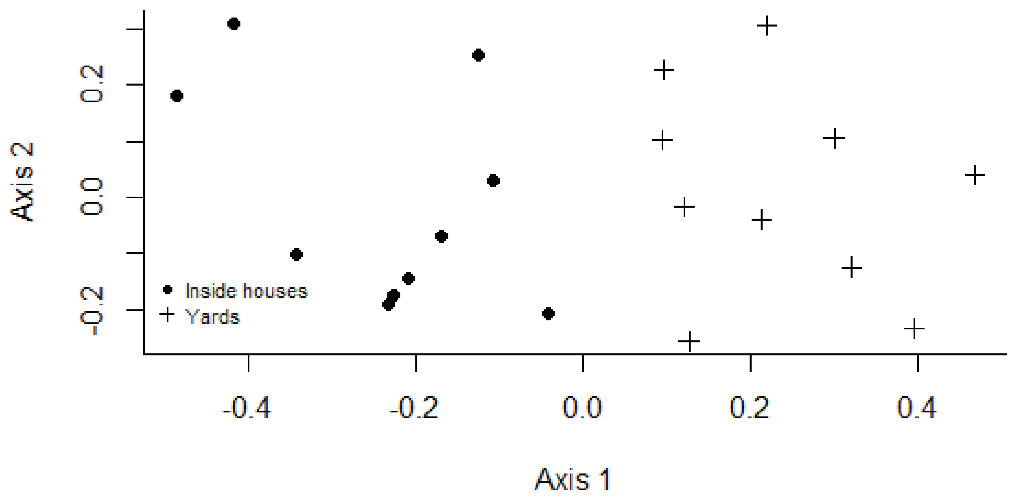

Figure 4. Analysis of the non-metric multidimensional scaling ordination of the ants fauna (Hymenoptera: Formicidae) sampled in five districts of Jataí city, Goiás, Brazil. Stress = 16.8.

DISCUSSION

The most frequent ants species sampled in the city of Jatai were sampled by other researches too, in many cities of Brazil (i.e. Delabie *et al*., 1995; Bueno and Campos–Farinha, 1999; Silva and Loeck, 1999; Oliveira and Campos–Farinha, 2005; Soares *et al*., 2006). For example: *Dorymyrmex* sp.1, *Camponotus* sp.1, *Paratrechina* sp.1, *P. megacephala*, *S. saevissima*, *Tapinoma* sp.1 and *Tetramorium simillimum* (Fr. Smith, 1851). These species are namely the truly domestic, which also forage outside residences to build nests and search for resources. The possible explanation of the higher occurrence of these species is that the majority of them are exotic. Exotic species are competitively dominant as they do not face natural enemies and can invest energy in growth and reproduction (Blossey and Notzold, 1995). For example, *P. megacephala*, is an African ant specie introduced in Brazil and is considered to be the main responsible for the competitive exclusion of other species (Pacheco and Vasconcelos, 2007). Also, competitively dominant species, such as *Tapinoma melanocephalum* and *P. megacephala*, benefit from urbanization with great disturbance, mainly because of their high capacity of dominance (Piva and Campos, 2011).

As expected, the yards were richer in species than insides houses. This result may be due to the greater amount of resources available to the species, for example, more space and habitats to build nests, as predicted by the habitat heterogeneity hypothesis (Bazzaz, 1975; Tews *et al*., 2004).

The species composition of the yards was very different from the houses (inside). Most of the species sampled in the yards were also found in the yards of residences in Maringá – PR, a city very far from Jataí - GO (Oliveira and Campos–Farinha, 2005). This result shows that the fauna of ants respond to the characteristics of the habitat, independent of the distance that they were sampled. Species occurring just on yards might need the resources that these environments provide, like as bare soil and vegetation for nesting and foraging (Oliveira and Campos-Farinha, 2005; Bueno and Campos, 2017). As for example, the species of fungus growing ants, *Acromyrmex landolti* (Forel, 1885), *Acromyrmex* sp.1, *Acromyrmex* sp.2 and *Atta* sp.1, were found only on yards. These species, in particular, need the vegetation to extract organic matter to cultivate fungi (Silva and Silvestre, 2004). In the other hand, the ants found inside houses usually build their nests inside walls and in home appliances (Bueno and Campos–Farinha, 1999).

In agreement with our results, we can affirm that, it is need to sample ants inside (i. e. Farneda *et al.*, 2007) and outside houses (i. e. Pacheco and Vasconcelos, 2007) to know the ant fauna and to better control these insects in urban environments. The preservation and cultivation of native plant species in the surroundings of houses can provide a greater coexistence of native ants' species (Pacheco and Vasconcelos, 2007), and may even decrease the probability of exotic species to occur, which are the most harmful and need to be controlled (Bueno and Campos-Farinha, 1999; Pacheco and Vasconcelos, 2007).

Here, we showed that the most common species of urban ants that we sampled were also found in many cities of Brazil, meaning that these ants have a wide range of occurrence and distribution in all the country. The samplings in both environments (inside the houses and in the yards) revealed many species of ants, in agreement with Oliveira and Campos–Farinha (2005). Many species were not found in studies that sampled inside the residences only (i.e. Delabie *et al.*, 1995; Soares *et al.,* 2006). These results show that knowing the richness and composition of the myrmecofauna that inhabits different environments in urban areas may be fundamental for the elaboration of management and conservation plans (Lutinski *et al.* 2013).

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REFERENCES

BAZZAZ, F. A. 1975. Plant species diversity in old-field successional ecosystems in Southern Illinois. **Ecology**, **56**:485-488.

BLOSSEY, B.; NOTZOLD, R. 1995. Evolution of increased competitive ability in invasive nonindigenous plants: a hypothesis. **Journal of Ecology**, **83**:887-889.

BOLTON, B. 1994. **Identification guide to the ants genera of the world**. Massachusetts: Harvard University Press Cambridge, 222p.

BOLTON, B. 1995. **A new general catalogue of the ants of the world**. Massachusetts: Harvard University Press Cambridge, 504p.

BOLTON, B. 2003. **Synopsis and classification of Formicidae**. Gainesville, FL: American Entomological Institute, 370p.

BUENO, O. C.; CAMPOS–FARINHA, A. E. C. 1999. As formigas domésticas. In: A. M. Mariconi, (Org.). **Insetos e outros invasores de residências**. Piracicaba: Biblioteca de Ciências Agrárias de Luiz de Queiroz, 135-180p.

BUENO, O. C.; CAMPOS, A. E. C. 2017. Formigas que vivem no ambiente urbano. In: O. C. Bueno et al. (Orgs.). **Formigas em ambientes urbanos no Brasil**. Bauru, SP: Canal 6, 685p.

CHAMBERS, J. M. 1992. Linear models. In: J. M. Chambers; T. J. Hastie (Org..). **Statistical Models in S**. London: Chapman & Hall, 95-144p.

CLARKE, K. R. 1993. Non-parametric multivariate analysis of changes in community structure. **Australian Journal of Ecology**, **18**:117–143.

DELABIE, J. H. C. et al. 1995. Community structure of house-infesting ants (Hymenoptera: Formicidae) in southern Bahia, Brazil. **Florida Entomologist**, **78**(2):264-267.

FAITH, D. P. et al. 1987. Compositional dissimilarity as a robust measure of ecological distance. **Vegetatio**, **69**:57–68.

FARNEDA, F. Z. et al. 2007. Comunidade de formigas (Hymenoptera: Formicidae) na area urbana do município de Pinhalzinho, Santa Catarina, Brasil. **Revista de Ciências Ambientais**, **1**:53-66.

HOLLDOBLER, B.; WILSON, E. O. 1990. **The ants**. Cambridge: Havard University Press, 732p.

IOP, S. et al. 2009. Formigas urbanas na cidade de Xanxerê, Santa Catarina, Brasil. **Biotemas**, **22**(2):55-64.

KLINK, C. A.; MACHADO, R. B. 2005. Conservation of the Brazilian Cerrado. **Conservation Biology**, **19**:707-713.

LEWINSOHN, T. M. et al. 2005. Conservation of terrestrial invertebrates and their habitats in Brazil. **Conservation Biology**, **19**:640-645.

LUTINSKI, J. A. et al. 2013. Diversidade de formigas urbanas (Hymenoptera: Formicidae) de dez cidades do sul do Brasil/Urban ant diversity (Hymenoptera: Formicidae) in ten cities of southern Brazil. **Biota Neotropica**, **13**:332-342.

MCINTYRE, N. E. et al. 2001. Ground arthropod community structure in a heterogeneous urban enviroment. **Landscape and Urban Planning**, **52**:257-274.

McKinney, M. L. 2006. Urbanization as a major cause of biotic homogenization. **Biological Conservation**, **127**:247-260.

OLIVEIRA-FILHO, A. T.; RATTER, J. A. 2002. Vegetation physiognomies and Woody flora of the Cerrado Biome. In: P. S. OLIVEIRA; R. J. MARQUIS (Org.). **The Cerrados of Brazil. Ecology and natural history of a Neotropical savanna**. New York: Columbia University Press, p. 91-120.

OLIVEIRA, M. F. D.; CAMPOS−FARINHA, A. E. D. 2005. Formigas urbanas no município de Maringá, PR, e suas implicações. **Arquivos do Instituto Biológico de São Paulo**, **72**(1):33-39.

PACHECO, R.; VASCONCELOS, H. L. 2007. Invertebrate conservation in urban areas: Ants in the Brazilian Cerrado. **Landscape and Urban Planning**, **81**:193-199.

PALACIO, E. E.; FERNÁNDEZ, F. 2003. Clave para las subfamilias y géneros. In: F. Fernández (Org.). **Introducción a las hormigas de la región Neotropical**. Bogotá: Instituto de Investigação de Recursos Biológicos Alexander Von Humboldt, 398p.

PESQUERO, M. A. et al. 2008. Formigas em ambiente hospitalar e seu potencial como transmissoras de bactérias. **Neotropical Entomology**, **37**(4):472-477.

PIVA, A.; CAMPOS, A. E. C. 2011. Ant community structure (Hymenoptera: Formicidae) in two neighborhoods with different urban profiles in the city of São Paulo, Brazil. **Psyche, 2012**:1-8.

RODOVALHO, C. M. et al. 2007. Urban ants and transportation of nosocomial bacteria. **Neotropical Entomology**, **36**(3):454-458.

SILVA, E. J. E.; LOECK, A. E. 1999. Ocorrência de formigas domiciliares (Hymenoptera: Formicidae) em Pelotas, RS. **Revista Brasileira de Agrociência**, **5**(3):220-224.

SILVA, R. R.; SILVESTRE, R. 2004. Riqueza da fauna de formigas (Hymenoptera: Formicidae) que habita as camadas superficiais do solo em Seara, Santa Catarina. **Papéis Avulsos de Zoologia**, **44**(1):1-11.

SOARES, N. S. et al. 2006. Levantamento da diversidade de formigas (Hymenoptera: Formicidae) na região urbana de Uberlândia, MG. **Neotropical Entomology**, **35**(3):324-328.

TEWS, J. et al. 2004. Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. **Journal of Biogeography**, **31**:79-92.

The R Development Core Team. 2010. R: a language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. Disponível em: <http://www.R-project.org>. Acesso em: 30 ago. 2016.

YAMAGUCHI, T. 2005. Influence of urbanization on ant distribution in parks of Tokyo and Chiba city, Japan II. Analysis of species. **Entomological Science**, **8**:17-25.

Appendix 1. List of ants species sampled in urban habitats, with the percentage of occurrence inside houses and on yards.

Species	Urban habitats	
	Inside houses	Yards
Dolichoderinae		
Dorymyrmex sp1	11	22
Linepithema sp1		2
Tapinoma sp1	19	4
Formicinae		
Brachymyrmex sp1	1	1
Brachymyrmex sp2		4
Brachymyrmex sp3		3
Camponotus arboreus (Fr. Smith, 1858)		2
Camponotus blandus (Fr. Smith, 1858)		9
Camponotus sp1	2	3
Camponotus sp2	1	1
Paratrechina sp1	11	10
Myrmicinae		
Acromyrmex landolti Forel, 1885		2
Acromyrmex sp1		6
Acromyrmex sp2		1
Atta sp1		2
Cardiocondyla emeryi Forel, 1881		4
Cephalotes sp1		1
Cephalotes sp2		1
Crematogaster sp1		1
Crematogaster sp2	1	
Monomorium floricola (Jerdon, 1851)	2	1
Mycocepurus sp1		3
Pheidole fallax Mayr, 1870	3	5
Pheidole gertrudae Forel, 1886	2	8
Pheidole megacephala (Fabricius, 1793)	16	17
Pheidole oxyops Forel, 1908	1	4
Pheidole radoszkowskii Mayr, 1883	1	4
Pheidole sp1		2
Pheidole sp2		1
Pheidole sp3		1
Pheidole sp4	2	1
Pheidole sp5	1	
Pheidole sp6		1
Pheidole sp7		1
Pogonomyrmex sp1		14
Solenopsis globularia (Fr. Smith, 1858)		5
Solenopsis saevissima (Fr. Smith, 1858)	4	13
Solenopsis sp1	2	
Tetramorium bicarinatum (Nylander, 1846)		1
Tetramorium simillimum (Fr. Smith, 1851)	5	2
Ponerinae		
Odontomachus sp1		3
Pachycondyla villosa (Fabricius, 1804)		1
Ectatominnae		
Ectatomma brunneum Smith, 1858		3
Ectatomma sp1		1
Gnamptogenys sp1	1	
Pseudomyrmecinae		
Pseudomyrmex sp1		1
Pseudomyrmex sp2		1