Ant species (Hymenoptera, Formicidae) of forest fragments and urban areas in a Meridional Amazonian landscape

Article *in* Check List · May 2016

DOI: 10.15560/12.3.1885

3 authors, including:

Ricardo Eduardo Vicente

Universidade Federal de Mato Grosso (UFMT)

12 PUBLICATIONS **13** CITATIONS

SEE PROFILE

Rodrigo Machado Feitosa

Universidade Federal do Paraná

51 PUBLICATIONS **146** CITATIONS

SEE PROFILE

Check List the journal of biodiversity data

LISTS OF SPECIES

Check List 12(3): 1885, 11 May 2016 doi: http://dx.doi.org/10.15560/12.3.1885
ISSN 1809-127X

Ant species (Hymenoptera, Formicidae) of forest fragments and urban areas in a Meridional Amazonian landscape

Lorhaine Santos-Silva[1], **Ricardo E. Vicente**[2] and **Rodrigo M. Feitosa**[3]

1 Universidade Federal de Mato Grosso, Acervo Biológico da Amazônia Meridional (ABAM), Laboratório de Ecologia e Taxonomia de Artrópodes Terrestres, Avenida Alexandre Ferronato, Setor Industrial 78557-267, Sinop, MT, Brazil
2 Universidade Federal de Mato Grosso, Laboratório de Ecologia de Comunidades, Instituto de Biociências, Av. Fernando Correa da Costa s/n, Coxipó, 78557-267, Cuiabá, MT, Brazil
3 Universidade Federal do Paraná, Departamento de Zoologia, Caixa Postal 19020, 81531-980, Centro Politécnico, Curitiba, PR, Brazil
* Corresponding author. E-mail: lorhaine.silva@gmail.com

Abstract: In this paper we list the ant species collected in both remaining forests and urban areas in a South Amazonian landscape. The list includes 102 species, of which 29 are new records for the state of Rondônia, Brazil. This work demonstrates the gap in ant biodiversity surveys for Meridional Amazon as well as encouraging further research in this region.

Key words: Amazon Forest; anthropic species; Neotropical Region; Rondônia; taxonomic gap; disturbance specialists

INTRODUCTION

Considering the arthropods that inhabit the soil or the canopy of tropical forests, ants (Insecta, Hymenoptera, Formicidae) are among the most abundant organisms, accounting for 90% of the individuals and up to 95% of the animal biomass in some localities (Moffett 2000). Ants are a diverse group of eusocial insects both morphologically and behaviorally with about 13,000 described species (Kaspari 2005; Brandão et al. 2009; Bolton 2015). They play key roles in the environment, interacting with many organisms (Toro et al. 2012; Gallego-Ropero et al. 2013; Vicente et al. 2014), including other ants (Toro et al. 2012; Powell et al. 2014), and are considered ecosystem engineers (Toro et al. 2012). Therefore, ants are excellent models for biodiversity assessments and reliable biological indicators given their high diversity, easy sampling and relatively well-settled taxonomy (Agosti et al. 2000).

Despite the importance of ant inventories to support decision-making and mitigation plans of biodiversity loss (Alonso and Agosti 2000) and ant diversity in the Neotropical region (Kempf 1972; Brandão 1991; Fernandez and Sendoya 2004), local inventories of the Brazilian ant fauna are historically concentrated in areas of the Cerrado (Schoereder et al. 2010; Camacho and Vasconcelos 2015), Atlantic Forest (Silva et al. 2007; Melo et al. 2014), and more recently in some localities of the Pantanal (Battirola et al. 2005; Silva et al. 2013) and Caatinga (Neves et al. 2013; Ulyssea and Brandão 2013). However, local surveys in the Brazilian Amazon have focused primarily on the central and eastern areas (Santos et al. 2008; Harada et al. 2013; Miranda et al. 2012).

Rondônia is a Brazilian state located near the border with Bolivia, in the meridional Amazon, whose biodiversity is not well known (Petini-Benelli 2015), especially regarding ants. To contribute to the knowledge of the ant diversity of the region that represents one of the main taxonomic gaps for the Neotropical fauna, this paper lists the ant species found in urban areas and Amazon Forest fragments in the municipality of Cacoal, Rondônia, Brazil.

MATERIALS AND METHODS

The study was conducted in the municipality of Cacoal, Rondônia, Brazil, a South Amazonian landscape, in the coordinates 11°26′19″ S, 061°26′50″ W (Figure 1). Samples were collected between May and August 2013 in 24 locations, including 16 collecting sites in urban backyards, with different distances, sizes and periods of human occupation, and eight collection sites in forest fragments surrounding the city, also different in size, matrix types and degrees of conservation (Figure 2). At all sampling sites two collection methodologies were used. In the first methodology 10 attractive traps containing about 1 cm^3 of carbohydrate (honey) and protein (sardine) baits were placed. All traps were randomly exposed at an average distance of 5 m from each other, at ground level, for a period of about 1

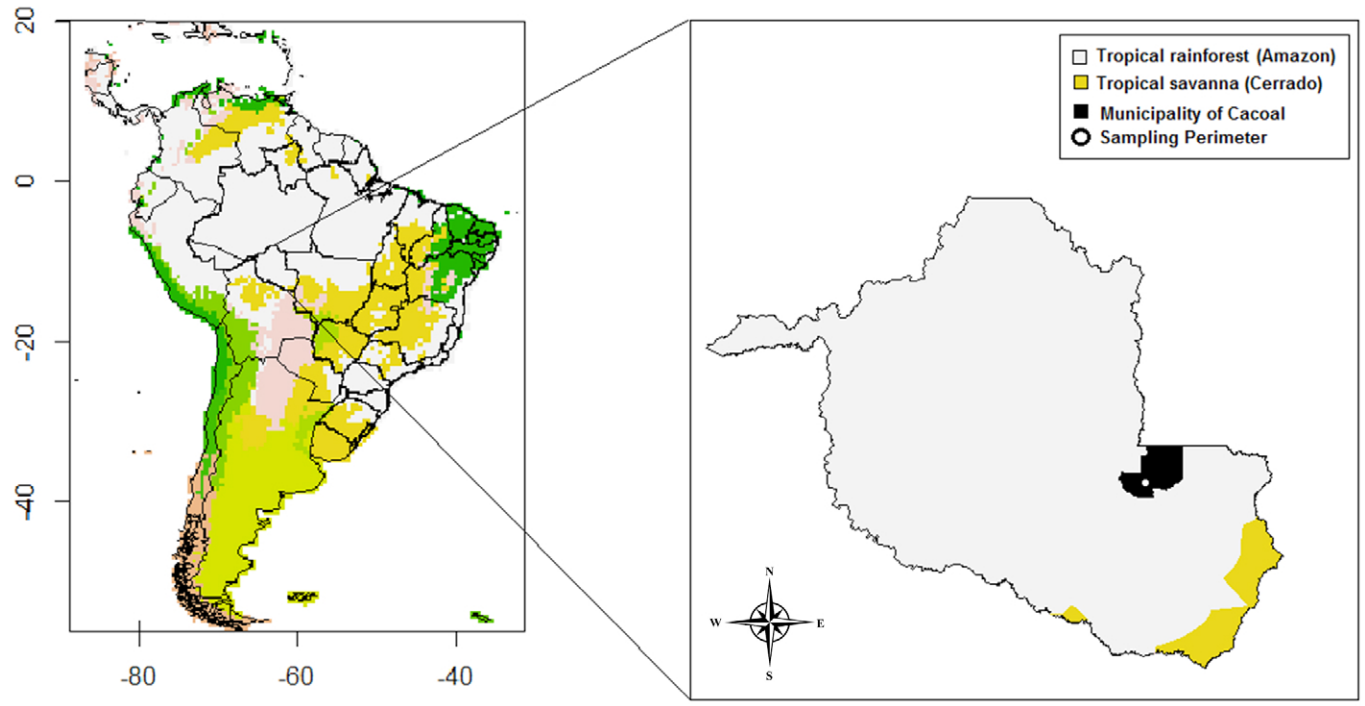

Figure 1. Map showing the state of Rondônia, the municipality of Cacoal (black area), and the sampling perimeter (white circle).

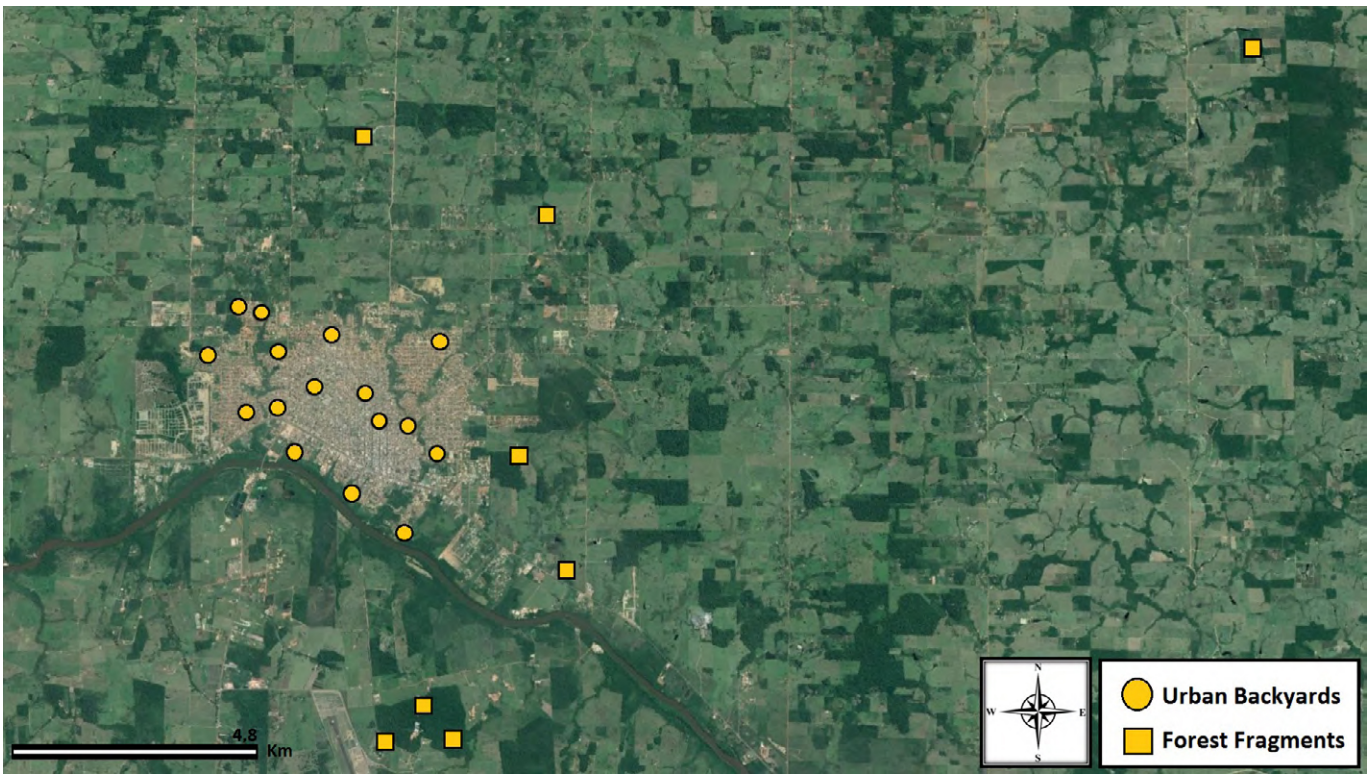

Figure 2. Collecting points at the municipality of Cacoal, state of Rondônia. Urban backyards are represented by yellow circles and forest fragments by yellow squares. Scale bar: 4.8 km.

hour. In the second methodology, an area of 10 m^2 was demarcated, where active search was conducted to capture all the individuals found foraging within the perimeters of the collection site during a period of one hour, with the help of tweezers, brushes and plastic vials containing alcohol. In this methodology, an exhaustive search was conducted in most of the micro-habitats of the previously defined areas, such as buildings, wood piles, construction waste, vegetation, rotting logs, twigs, and litter. Although the distance between the bait may have generated a subsampling (see Baccaro et al. 2011), the complementarity of the methods may have minimized this problem, which is corroborated by the high diversity of ants sampled in this study.

The ants collected were initially identified with the dichotomous key of Fernández (2003) to the genus level and then separated into morphotypes. Later, they were identified to species following the bibliographic information present in the same work and deposited in the Coleção Entomológica Padre Jesus Santiago Moure of the Departamento de Zoologia da Universidade Federal do Paraná (DZUP), Brazil. The classification follows Bolton (2015). To determine the distribution of species we consulted the interactive map AntMaps.org (2015), an application created based on bibliographic database of the Global Ant Biodiversity Informatics (GABI) Project. The database, updated weekly, has so far compiled ca. 1.6 million records for about 15,000 species/subspecies in 8,430 publications, museum collections and specimen databases (Economo et al. 2015). We also performed a search using the Scopus and ISI Web of Science portals to identify papers on taxonomic revisions, biology, distribution, and also regional lists of species.

Figure 1 was made using the R software v. 3.2.1 (R Core Team 2015) with the packages dismo (Hinmans et al. 2015) and maptools (Bivand and Lewin-Koh 2015) and Figure 2 with Google Earth™.

RESULTS

A total of 102 ant species was recorded, belonging to eight subfamilies and 38 genera (Table 1). The subfamily with the highest number of species was Myrmicinae (53 species), followed by Formicinae (18), Ponerinae (13), Ectatomminae and Pseudomyrmicinae (six species), Dolichoderinae (five), and Dorylinae and Paraponerinae (one species). The richest genus was *Pheidole* (19 species), followed by *Camponotus* (10), *Crematogaster* (seven species), *Pseudomyrmex* (six species) and *Solenopsis* (five species). Regarding the habitat type, 56 species were collected in urban backyards, 75 in forest fragments and 29 in both habitats. Twenty-nine species are recorded for the first time in Rondônia, 11 specific to urban backyards, 11 in forest fragments and seven occurring in both habitats. Among the collected ants, five are known worldwide as tramp ants, including *Tapinoma melanocephalum* (Fabricius, 1793), *Wasmannia auropunctata* (Roger, 1863) (except for Neotropical region from where it is native), *Tetramorium bicarinatum* (Nylander, 1846), *Brachymyrmex patagonicus* Mayr, 1868, and *Paratrechina longicornis* (Latreille, 1802); the last three represent new occurrence records for the state of Rondônia.

DISCUSSION

The overall species richness found in this inventory corresponds to that reported in other ant surveys (Ryder-Wilkie et al. 2010; Neves et al. 2013; Melo et al. 2014). Myrmicinae, Formicinae and Ponerinae are the subfamilies with higher generic and specific diversity, respectively (Bolton 2015). The same is true for the genera *Camponotus* and *Pheidole* that presented a high diversity in this study, and are also the more speciose ant genera in the world (Fernández and Sendoya 2004; Ryder-Wilkie et al. 2010). *Pheidole*, for example, is known for its hyper-diversity with more than 1,000 described species (Wilson 2003; Bolton 2015) of which about 460 occur in the Neotropical Region (Fernández and Sendoya 2004). *Camponotus* has about 1,100 described species worldwide, of which about 350 are Neotropical (Fernández and Sendoya 2004; Bolton 2015).

Many of the species collected here have wide distributions, including the Amazon biome (Fernández and Sendoya 2004; Miranda et al. 2012; Lutinski et al. 2013). However, 29 species are recorded for the first time in Rondônia, including some species considered tramp ants such as *Brachymyrmex patagonicus*, *Paratrechina longicornis* and *Tetramorium bicarinatum* (Chacón de Ulloa 2003; MacGown et al. 2007; Hita-Garcia and Fisher 2011). *Brachymyrmex patagonicus*, popularly named "Dark Rover Ant" is native to the Neotropics, but is an introduced species in the Gulf Coast region of the United States (MacGown et al. 2007). *Paratrechina longicornis* is a pantropical tramp-species introduced in the Neotropics (Fernández and Sendoya 2004), including several Brazilian states (Kempf 1972). However, the

Table 1. List of ant species recorded in each habitat type (urban backyards and forest fragments) in state of Rondônia, the municipality of Cacoal, Brazil. * New records for Rondônia.

Taxon	Habitat		Voucher Code
	Backyards	Forest	
Dolichoderinae			
Dolichoderus attelaboides (Fabricius, 1775)		X	30QADA
Dolichoderus rugosus (Smith, 1858) *		X	80QADR
Dolichoderus sp. 3		X	30QADSP3
Dorymyrmex spurius Santschi, 1929 *	X		10UADS
Tapinoma melanocephalum (Fabricius, 1793)	X	X	10UATM 10QATM
Dorylinae			
Labidus praedator (Smith, 1858)		X	70QALP
Ectatomminae			
Ectatomma brunneum Smith, 1858	X	X	10UAEB 70QAEB
Ectatomma edentatum Roger, 1863		X	10QAEE
Ectatomma lugens Emery, 1894*		X	80QAEL
Ectatomma tuberculatum (Olivier, 1792)		X	20QAET
Gnamptogenys grupo *rastrata* sp. 1	X		50UAGSP1
Gnamptogenys sp. 2	X		70UAGSP2
Formicinae			
Brachymyrmex patagonicus Mayr, 1868*	X		10UABP

Continued

Table 1. *Continued.*

Taxon	Habitat		Voucher Code
	Backyards	Forest	
Brachymyrmex sp. 2	X	X	45UPBSP2 10QABSP2
Camponotus blandus (Smith, 1858)*	X	X	10UACB 80QACB
Camponotus latangulus Roger, 1863		X	30QACL
Camponotus melanoticus Emery, 1894*	X		40UACM
Camponotus novogranadensis Mayr, 1870	X	X	10UACN 30QACN
Camponotus renggeri Emery, 1894	X	X	21UPCR 10QACR
Camponotus sericeiventris (Guérin-Méneville, 1838)		X	80QACSE
Camponotus sp. 11	X	X	10UACSP11 40QACSP11
Camponotus sp. 8		X	30QACSP8
Camponotus substitutus Emery, 1894*	X		50UACSU
Camponotus vittatus Forel, 1904*	X		20UACV
Gigantiops destructor (Fabricius, 1804)		X	70QAGD
Nylanderia sp. 1		X	50QANSP1
Nylanderia sp. 2	X		26UPNSP2
Nylanderia sp. 3	X	X	30UANSP3 24QPNSP3
Nylanderia sp. 4	X		30UANSP4
Paratrechina longicornis (Latreille, 1802)*	X	X	10UAPL 20QAPL
Myrmicinae			
Acromyrmex landolti (Forel, 1885)*		X	80QAAL
Acromyrmex rugosus (Smith, 1858)	X	X	20UAAR 10QAAR
Acromyrmex subterraneus (Forel, 1893)*	X		10UAASU
Atta sexdens (Linnaeus, 1758)		X	40QAASE
Cephalotes atratus (Linnaeus, 1758)	X	X	30UACA 30QACA
Cephalotes pusillus (Klug, 1824)	X	X	20UACP 70QACP
Crematogaster carinata Mayr, 1862*	X	X	30UACC 83QPCC
Crematogaster erecta Mayr, 1866*	X	X	20UACE 80QACE
Crematogaster evallans Forel, 1907*	X	X	59UPCEV 10QACEV
Crematogaster flavosensitiva Longino, 2003*		X	30QACF
Crematogaster nigropilosa Mayr, 1870		X	40QACNI
Crematogaster obscurata Emery, 1895*	X	X	50UACO 68QPCO
Crematogaster sp. 4		X	50QACSP4
Cyphomyrmex grupo *strigatus* sp. 1		X	40QACSP1
Cyphomyrmex minutus Mayr, 1862*		X	40QACMI
Cyphomyrmex rimosus (Spinola, 1851)	X	X	60UACRI 70QACRI
Daceton armigerum (Latreille, 1802)*		X	70QADAR
Megalomyrmex ayri Brandão, 1990		X	50QAMA
Monomorium floricola (Jerdon, 1851) *	X	X	12UPMF 10AQMF
Mycocepurus smithii (Forel, 1893) *		X	70QAMS
Ochetomyrmex neopolitus Fernández, 2003		X	41QPON
Pheidole gertrudae Forel, 1886*	X		10UAPG
Pheidole sp. 1	X	X	10UAPS1 10QAPS1
Pheidole sp. 2	X	X	10UAPSP2 30QAPSP2
Pheidole sp. 3	X		70UAPSP3
Pheidole sp. 4	X	X	11UPPSP4 71QPPSP4
Pheidole sp. 5	X	X	10U1PSP5 30QAPSP5
Pheidole sp. 7		X	40QAPSP7
Pheidole sp. 8		X	54QPPSP8
Pheidole sp. 9		X	70QAPSP9
Pheidole sp.10	X		56UPPSP10
Pheidole sp. 11		X	11QPPSP11
Pheidole sp. 12	X	X	17UPPSP12 60QAPSP12
Pheidole sp. 13	X		60UAPSP13
Pheidole sp. 15	X		31UPPSP15
Pheidole sp. 16		X	52QPPSP16
Pheidole sp. 17		X	80QAPSP17
Pheidole sp.18	X		78UPPSP18
Pheidole sp.19	X		60UAPSP19
Pheidole sp. 20	X		43UPPSP20
Pogonomyrmex naegelii Emery, 1878*	X		10UAPN
Procryptocerus subpilosus (Smith, 1860)		X	70QAPS
Sericomyrmex sp. 1		X	50QASSP1
Solenopsis invicta Buren, 1972*	X		12UPSI
Solenopsis richteri Forel, 1909*	X		55UPSR
Solenopsis sp. 2	X	X	33UPSOSP2 40QASOSP2
Solenopsis sp. *3*	X		13UPSOSP3
Solenopsis sp. 4	X		51UPSOSP4
Tetramorium bicarinatum (Nylander, 1846)*	X		10UATB
Trachymyrmex opulentus (Mann, 1922)*		X	80QATO
Trachymyrmex pr. *mandibularis*	X		31UPTPM
Trachymyrmex sp. 1		X	33QPTSP1
Wasmannia auropunctata (Roger, 1863)	X	X	47UPWA 50QAWA
Paraponerinae			
Paraponera clavata (Fabricius, 1775)		X	80QAPC
Ponerinae			
Anochetus bispinosus (Smith, 1858)		X	10QAAB
Anochetus horridus Kempf, 1964*		X	60QAAH
Mayaponera constricta (Mayr, 1884)*		X	10QAMC
Neoponera commutata (Roger, 1860)		X	10QANC
Neoponera crenata (Roger, 1861)		X	30QANCR
Neoponera obscuricornis (Emery, 1890)		X	10QANO
Neoponera verenae Forel, 1922		X	60QANV
Odontomachus bauri Emery, 1892*		X	30QAOB
Odontomachus haematodus (Linnaeus, 1758)	X	X	10UAOH 10QAOH
Pachycondyla crassinoda (Latreille, 1802)		X	12QPPCR
Pachycondyla harpax (Fabricius, 1804)	X	X	10UAPH 20QAPH
Pachycondyla sp. 8		X	10QAPSP8
Pseudoponera stigma (Fabricius, 1804)		X	10QAPST
Pseudomyrmecinae			
Pseudomyrmex gracilis (Fabricius, 1804)	X	X	50UAPGR 70QAPGR
Pseudomyrmex sp. 2	X	X	40UAPSPS2 80QAPSPS2
Pseudomyrmex sp. 5	X		40UAPSPS5
Pseudomyrmex tenuis (Fabricius, 1804)		X	30QAPT
Pseudomyrmex termitarius (Smith, 1855)	X		60UAPTE
Total richness	**56**	**75**	

specimens collected here represent the first reports for the state of Rondônia. Another widespread tramp ant, *Tetramorium bicarinatum* (Hita-Garcia and Fisher 2011; Fernández and Sendoya 2004), is also recorded for the first time in Rondônia. Still regarding the invasive ants collected in the present study, only *Wasmannia auropunctata* and *T. melanocephalum* have been previously reported for Rondônia (Mann 1916; Vieira et al. 2013). *Tapinoma melanocephalum* is normally collected in urban environments, and is considered a species of sanitary importance because it can be a vector of Gram-positive bacteria in hospitals (Vieira et al. 2013). Despite its invasive status in different regions of the world, *Wasmannia auropunctata*, cannot be considered exotic in Rondônia, since it is a typical Neotropical species.

In addition to the tramp ants, other species collected are more limited in distribution and represent new records for Rondônia. *Camponotus vittatus* Forel, 1904, here recorded for the first time in Rondônia, is a frequently collected species in Midwest and Southeastern Brazil (Ulysséa and Brandão 2013; Melo et al. 2014; Camacho and Vasconcelos 2015). *Dorymyrmex spurius* Santschi, 1929 occurs in drier environments and nests in bare soil (Shattuck 1992); therefore, it can also be found in grasslands or plantations (Brandão et al. 2011; Costa-Milanez et al. 2014). Its distribution is known for Argentina, Brazil, Paraguay and Uruguay (Shattuck 1994). The records in Brazil were limited, so far, to the states of Maranhão, Minas Gerais, Brasília (Sandoval and Zambrano 2007; Brandão et al. 2011; Costa-Milanez et al. 2014). In this work, *C. vittatus* and *D. spurius* were found only in urban backyards. Another species recorded here with considerable gaps in its distribution is *Crematogaster evallans* Forel, 1907, which has been reported for Guatemala (Branstetter and Sáenz 2012), Costa Rica, Colombia and Brazil (Longino 2003). The known distribution in the Brazilian territory is patchy, with records for Roraima (Baccaro et al. 2012; Souza et al. 2012), Pará (Santos et al. 2008), Goiás (Gallego-Ropero et al. 2013), Espírito Santo, Rio de Janeiro (Longino 2003), São Paulo (Forel 1912), Bahia and Minas Gerais (Ulysséa and Brandão 2013).

The richness of ant species in forest environments was higher (46) than that of urban backyards (27). These results can be partially explained by the presence of arboreal ants, found only in the forest fragments, such as *Camponotus latangulus* Roger, 1863, *Ectatomma tuberculatum* (Olivier, 1792) and *Daceton armigerum* (Latreille, 1802) that, even in forested environments, are more closely related with native vegetation (Marinho et al. 2002). Interestingly, despite its wide distribution along the Amazon (Azorsa and Sosa-Calvo 2008; Vicente et al. 2011), this is the first record of *D. armigerum* for the state of Rondônia.

Labidus praedator (Smith, 1858) was also collected only in forest fragments. This is an army ant species with huge colonies that requires large areas for foraging (Kaspari et al. 2011; Suguituru et al. 2015). The Ponerinae predatory ants of the genus *Neoponera*, and the species *Mayaponera constricta* (Mayr, 1884) and *Pseudoponera stigma* (Fabricius, 1804) also occurred only in forested areas. These taxa nest mainly in the soil and trunks of fallen dead trees (Schmidt and Shattuck 2014).

Others studies that compared the richness and composition of ants between disturbed and natural areas showed a similar diversity of species when compared to our results (Silva et al. 2008; Vasconcelos et al. 2006), probably related to habitat heterogeneity and resource availability (Ribas et al. 2003; Neves et al. 2013), which is higher in forested areas than in urban backyards. However, it is interesting to note that even with this difference in the richness and composition of ants between habitats, two species of tramp ants reported to the Neotropical Region (*Paratrechina longicornis* and *Tapinoma melanocephalum*) were sampled both in urban backyards and forest fragments. The presence of these species in forest remnants indicates a degree of local environmental degradation in these natural areas. Nevertheless, it is valid to recall that forest fragments are very important for the conservation of native species in changing environments (Vasconcelos et al. 2006; Pacheco et al. 2013).

This study shows that ant communities from disturbed forest areas are similar to those found in other Neotropical areas with some degree of environmental degradation. On the other hand, even with the subsampling approach of this study and the environmental degradation of forest areas highlighted by the presence of tramp ants in the fragments, species diversity of these areas is similar to others studies conducted with baits in relatively well preserved regions of the Amazonian rainforest (Baccaro et al. 2011, 2012). In this sense, this work fills important gaps in the distribution of many ant species both native and exotic due to a lack of systematic surveys of biodiversity in the meridional Amazon. Taxonomic gaps like these are recurrent in many regions of the Amazon Forest, the main tropical rainforest remaining in the world and whose insect biodiversity is still superficially known. We hope that this work may support future studies and encourage new researchers to explore the knowledge of the biodiversity in this region.

ACKNOWLEDGEMENTS

We thank the land owners who allowed us to come into their yards and properties with forest fragments to carry out the ant collection. Thanks to colleagues who helped in the field work and to the Faculdade de Ciências Biomédicas de Cacoal (FACIMED) for logistical support. REV thanks the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Brazil (CAPES) for PhD fellowship and Ecologia e Conservação da Biodiversidade

Graduate Program – UFMT for the support. LSS thanks Ciências Ambientais Graduate Program – UFMT for support. This work is publication 52 in the NEBAM technical series.

LITERATURE CITED

Agosti, D., J.D. Majer, L.E. Alonso and T.R. Schultz. 2000. Ants: Standard methods for measuring and monitoring biodiversity. Washington, D.C.: Smithsonian Institution Press. 280 pp.

Alonso, L.E. and D. Agosti. 2000. Biodiversity studies, monitoring, and ants: an overview; pp. 1–8, in: D. Agosti, J.D. Majer, L.E. Alonso and T.R. Schultz. 2000. Ants: standard methods for measuring and monitoring biodiversity. Washington, D.C.: Smithsonian Institution Press.

AntMaps.org. (2015). Accessed at http://www.antmaps.org/, 14 June 2015.

Azorsa, F. and J. Sosa-Calvo. 2008. Description of a remarkable new species of ant in the genus *Daceton* Perty (Formicidae*: Dacetini*) from South America. Zootaxa 1749: 27–38.

Baccaro, F.B., S.M. Ketelhut, and J.W. de Morais. 2011. Efeitos da distância entre iscas nas estimativas de abundância e riqueza de formigas em uma floresta de terra-firme na Amazônia Central. Acta Amazonica 41(1): 116–122. doi: 10.1590/S0044-59672011000100013

Baccaro, F.B., J.L.P. Souza, E. Franklin, V.L. Landeiro and W.E. Magnusson. 2012. Limited effects of dominant ants on assemblage species richness in three Amazon forests. Ecological Entomology 37(1): 1–12. doi: 10.1111/j.1365-2311.2011.01326.x

Battirola, L.D., M.I. Marques, J. Adis and J.H.C Delabie. 2005. Composição da comunidade de Formicidae (Insecta: Hymenoptera) em copas de *Attalea phalerata* Mart. (Arecaceae), no Pantanal de Poconé, Mato Grosso, Brasil. Revista Brasileira de Entomologia 49(1): 107–117. doi: 10.1590/S0085-56262005000100011

Bivand R. and N. Lewin-Koh (2015). maptools: Tools for Reading and Handling Spatial Objects. R package version 0.8-36. Accessed at http://CRAN.R-project.org/package=maptools, 12 June 2015.

Bolton, B. 2015. An online catalog of the ants of the world. Accessed at http://www.antcat.org/catalog, 14 June 2015.

Brandão, C.R.F. 1991. Adendos ao catálogo abreviado das formigas da região Neotropical (Hymenoptera: Formicidae). Revista Brasileira de Entomologia 35(2): 319–412.

Brandão, C.R.F., R.R. Silva and J.C.H. Delabie. 2009. Formigas; pp. 323–370, in: A.R. Panizzi and J.R.P. Parra (eds.). Bioecologia e nutrição de insetos. Base para o manejo integrado de pragas. Brasília: Embrapa Informação Tecnológica.

Brandão, C.R.F., R.R. Silva and R.M. Feitosa. 2011. Cerrado ground-dwelling ants (Hymenoptera: Formicidae) as indicators of edge effects. Zoologia 28(3): 379–387. doi: 10.1590/S1984-46702011000300012

Branstetter, M.G. and L. Sáenz. 2012. Las hormigas (Hymenoptera: Formicidae) de Guatemala; pp. 221–268 in: E.B. Cano and J.C. Schuster (eds.). Biodiversidad de Guatemala. Volume 2. Guatemala: Universidad del Valle de Guatemala.

Camacho, G.P. and H.L. Vasconcelos. 2015. Ants of the Panga Ecological Station, a Cerrado reserve in Central Brazil. Sociobiology 62(2): 281–295. doi: 10.13102/sociobiology.v62i2.281-295

Chacón de Ulloa, P. 2003. Hormigas urbanas; pp. 351–359, in: F. Fernández (ed.). Introducción a las hormigas de la región Neotropical. Colombia Bogotá: Instituto de Investigación de Recursos. Bogotá: Biológicos Alexander von Humboldt.

Costa-Milanez, C.B., G. Lourenço-Silva, P.T.A. Castro, J.D. Majer and S.P. Ribeiro. 2014. Are ant assemblages of Brazilian veredas characterized by location or habitat type? Brazilian Journal of Biology 74(1): 89–99. doi: 10.1590/1519-6984.17612

Fernández, F. 2003a. Introducción a las hormigas de la región Neotropical. Instituto de Investigación de Recursos. Bogotá: Biológicos Alexander von Humboldt. 398 pp.

Fernández, F. and S. Sendoya. 2004. List of Neotropical ants (Hymenoptera: Formicidae). Biota Colombiana 5(1): 3–93. http://www.ots.ac.cr/rdmcnfs/datasets/biblioteca/pdfs/nbina-6068.pdf

Forel, A. 1912. Formicides néotropiques. Part III. 3me sous-famille Myrmicinae (suite). Genres Cremastogaster et Pheidole. Mémoires de la Société Entomologique de Belgique 19: 211–237.

Gallego-Ropero, M.C., R.M. Feitosa and J.R. Pujol-Luz. 2013. Formigas (Hymenoptera, Formicidae) associadas a ninhos de *Cornitermes cumulans* (Kollar) (Isoptera, Termitidae) no Cerrado do Planalto Central do Brasil. EntomoBrasilis 6(1): 97–101. doi: 10.12741/ebrasilis.v6i1.283

Harada, A.I., P.R.S. Farias, L.F.C. Lopes, A.G. Silva and A.D.S. Brandão. 2013. Assessment of ant communities in secondary forest in the eastern amazon. Comunicata Scientiae 4(2): 186–194. http://dialnet.unirioja.es/servlet/articulo?codigo=4407604

Garcia, F.H. and B.L. Fisher. 2011. The ant genus *Tetramorium* Mayr (Hymenoptera: Formicidae) in the Malagasy region—introduction, definition of species groups, and revision of the *T. bicarinatum*, *T. obesum*, *T. sericeiventre* and *T. tosii* species groups. Zootaxa 3039: 1–72. http://www.mapress.com/zootaxa/list/2011/3039.html

Hijmans, R.J., S. Phillips, J. Leathwick and J. Elith. (2015). dismo: Species Distribution Modeling. R package version 1.0–12. Accessed at http://CRAN.R-project.org/package=dismo, 14 June 2015.

IBGE (Instituto Brasileiro de Geografia e Estatística). 2004. Mapa da vegetação brasileira. 3ª edição. Mapas Murais, 1:5.000.000. Brasil: Ministério do Planejamento, Orçamento e Gestão.

Kaspari, M., S. O'Donnell, J. Lattke and S. Powell. 2011. Predation and patchiness in the tropical litter: do swarm-raiding army ants skim the cream or drain the bottle? Journal of Animal Ecology 80: 818–823. doi: 10.1111/j.1365-2656.2011.01826.x

Kaspari, M. 2005. Global energy gradients and the regulation of body size: worker mass and worker number in ant colonies. PNAS 102: 5079–5083. doi: 10.1073/pnas.0407827102

Kempf, W.W. 1972. Catálogo abreviado das formigas da região neotropical. Studia Entomologica 15: 3–344.

Longino, J.T. 2003. The *Crematogaster* (Hymenoptera, Formicidae, Myrmicinae) of Costa Rica. Zootaxa 151: 1–150.

Lutinski, J.A., B.C. Lopes and A.B.B. Morais. 2013. Urban ant diversity (Hymenoptera: Formicidae) in ten cities of southern Brazil. Biota Neotropica 13(3): 332–342. doi: 10.1590/S1676-06032013000300033

MacGown, J.A., J.G. Hill and M.A. Deyrup. 2007. *Brachymyrmex patagonicus* (Hymenoptera: Formicidae), an emerging pest species in the southeastern United States. Florida Entomologist 90(3): 457–464. doi: 10.1653/0015-4040(2007)90[457:BPHFAE]2.0.CO;2

Mann, W. M. 1916. The Stanford Expedition to Brazil, 1911, John C. Branner, Director. The ants of Brazil. Bulletin of the Museum of Comparative Zoology 60: 399–490. http://biodiversitylibrary.org/page/30207876

Marinho, C.G.S., R. Zanetti, J.H.C. Delabie, M.N. Schlindwein and L.S. Ramos. 2002. Diversidade de formigas (Hymenoptera: Formicidae) da serapilheira em eucaliptais (Myrtaceae) e área de cerrado de Minas Gerais. Neotropical Entomology 31(2): 187–195. doi: 10.1590/S1519-566X2002000200004

Melo, T.S., M.C.L. Peres, J.L. Chavari, A.D. Brescovit and J.H.C. Delabie. 2014. Ants (Formicidae) and spiders (Araneae) listed from the Metropolitan Region of Salvador, Brazil. Check List 10(2): 355–365. doi: 10.15560/10.2.355

Miranda, P.N., M.A. Oliveira, F.B. Baccaro, E.F. Morato and J.H.C. Delabie. 2012. Check list of ground-dwelling ants (Hymenoptera: Formicidae) of the Eastern Acre, Amazon, Brazil. Check List 8(4):

722–730. doi: 10.15560/8.4.722

Moffett, M.W. 2000. What's 'up'? A critical look at the basic terms in canopy biology. Biotropica 32(4): 569–596. doi: 10.1111/j.1744-7429.2000.tb00506.x

Neves, F., K.S. Queiros-Dantas, W.D. Rocha and J.H.C. Delabie. 2013. Ants of three adjacent habitats of a transition region between the Cerrado and Caatinga biomes: The effects of heterogeneity and variation in canopy cover. Neotropical Entomology 42(1): 258–268. doi: 10.1007/s13744-013-0123-7

Pacheco, R., H.L. Vasconcelos, S. Groc, G.P. Camacho, and T.L.M. Frizzo. 2013. The importance of remnants of natural vegetation for maintaining ant diversity in Brazilian agricultural landscapes. Biodiversity and Conservation 22(4): 983–997. doi: 10.1007/s10531-013-0463-y

Petini-Benelli, A. 2015. Novelties in *Catasetum* (Orchidaceae) in the state of Rondônia, Brazil. Feddes Repertorium 125(1–2): 14–24. doi: 10.1002/fedr.201400028

Powell, S., K. Del-Claro, R.M. Feitosa and C.R.F. Brandão. 2014. Mimicry and eavesdropping enable a new form of social parasitism in ants. The American Naturalist 184(4): 500–509. doi: 10.1086/677927

Prado, L.P. and C.R.F. Brandão. 2013. A catalogue of *Cephalotini* ant types (Hymenoptera: Formicidae: Myrmicinae) deposited in the Museu de Zoologia da Universidade de São Paulo, Brazil. Papéis Avulsos de Zoologia 53(20): 285–293. doi: 10.1590/S0031-10492013002000001

Quirán, E.M., J.J. Martínez, and A.O. Bachmann. 2004. The Neotropical genus *Brachymyrmex* Mayr, 1868 (Hymenoptera: Formicidae) in Argentina. Redescription of the type species, *B. patagonicus* Mayr, 1868; *B. bruchi* Forel, 1912 and *B. oculatus* Santschi, 1919. Acta Zoológica Mexicana 20(1): 273–285. http://www.redalyc.org/articulo.oa?id=57520119

R Core Team (2015). R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. Accessed at http://www.R-project.org/, 12 June 2015.

Ribas, C.R., J.H. Schoereder, M. Pic and S.M. Soares. 2003. Tree heterogeneity, resource availability, and larger scale processes regulating arboreal ant species richness. Austral Ecology 28(3): 305–314. doi: 10.1046/j.1442-9993.2003.01290.x

Ryder-Wilkie, K.T., A.L. Mertl and J.F.A. Traniello. 2010. Species diversity and distribution patterns of the ants of Amazonian Ecuador. PLoS ONE 5(10): e13146. doi: 10.1371/journal.pone.0013146

Sandoval, V.E. and G. Zambrano. 2007. Catálogo de las hormigas presentes en el Museo de Historia Natural de la Universidad del Cauca. Popayán: Taller Editorial de la Universidad del Cauca. 60 pp.

Santos, J.C., J.H.C. Delabie and G.W. Fernandes. 2008. A 15-year post evaluation of the fire effects on ant community in an area of Amazonian forest. Revista Brasileira de Entomologia 52(1): 82–87. doi: 10.1590/S0085-56262008000100015

Schmidt, C.A. and S.O. Shattuck. 2014. The higher classification of the ant subfamily Ponerinae (Hymenoptera: Formicidae), with a review of ponerine ecology and behavior. Zootaxa 3817(1): 1–242. doi: 10.11646/zootaxa.3817.1.1

Schoereder, J.H., T.G. Sobrinho, M.S. Madureira, C.R. Ribas and P.S. Oliveira. 2010. The arboreal ant community visiting extrafloral nectaries in the Neotropical cerrado savanna. Terrestrial Arthropod Reviews 3(1): 3–27. doi: 10.1163/187498310X487785

Shattuck, S.O. 1992. Generic revision of the ant subfamily Dolichoderinae (Hymenoptera: Formicidae). Sociobiology 21(1): 1–181.

Shattuck, S.O. 1994. Taxonomic catalog of the ant subfamilies Aneuretinae and Dolichoderinae (Hymenoptera: Formicidae). University of California Publications in Entomology 112: 1–241.

Silva, F.H.O., J.H.C. Delabie, G.B. Santos, E. Meurer and M.I. Marques. 2013. Mini-winkler extractor and pitfall trap as complementary methods to sample Formicidae. Neotropical Entomology 42(4): 351–358. doi: 10.1007/s13744-013-0131-7

Silva, R.R., R.M. Feitosa and F. Eberhardt. 2007. Reduced ant diversity along a habitat regeneration gradient in the southern Brazilian Atlantic Forest. Forest Ecology and Management 240(1–3): 61-69. doi: 10.1016/j.foreco.2006.12.002

Souza, J.L.P., F.B. Baccaro, V.L. Landeiro, E. Franklin and W.E. Magnusson. 2012. Trade-offs between complementarity and redundancy in the use of different sampling techniques for ground-dwelling ant assemblages. Applied Soil Ecology 56: 63–73. doi: 10.1016/j.apsoil.2012.01.004

Suguituru, S.S., M.S.C. Morini, R.M. Feitosa and R.R. Silva. 2015. Formigas do Alto Tietê. Bauru: Canal 6. 456 pp.

Toro, I.D., R.R. Ribbons and S.L. Pelini. 2012. The little things that run the world revisited: a review of ant-mediated ecosystem services and disservices (Hymenoptera: Formicidae). Myrmecological News 17: 133–146.

Ulyssea, M.A. and C.R.F. Brandão. 2013. Ant species (Hymenoptera, Formicidae) from the seasonally dry tropical forest of northeastern Brazil: a compilation from field surveys in Bahia and literature records. Revista Brasileira de Entomologia 57: 217–224. doi: 10.1590/S0085-56262013005000002

Vasconcelos, H.L., J.M.S. Vilhena, W.E. Magnusson, and A.L.K.M. Albernaz. 2006. Long-term effects of forest fragmentation on Amazonian ant communities. Journal of Biogeography 33: 1348–1356. doi: 10.1111/j.1365-2699.2006.01516.x

Vicente, R.E., J. Dambroz and M. Barreto. 2011. New distribution record of *Daceton boltoni* Azorsa and Sosa-Calvo, 2008 (Insecta: Hymenoptera) ant in the Brazilian Amazon. Check List 7(6): 878–879. doi: 10.15560/7.6.878

Vicente, R.E., W. Dáttilo and T.J. Izzo. 2014. Differential recruitment of Camponotus femoratus (Fabricius) ants in response to ant garden herbivory. Neotropical Entomology 43: 519–525. doi: 10.1007/s13744-014-0245-6

Vieira, G.D., T.C. Alves, O.B. Silva, F.A. Terassini, N.C. Paniágua and C.B.G. Teles. 2013. Bactérias Gram positivas veiculadas por formigas em ambiente hospitalar de Porto Velho, Estado de Rondônia, Brasil. Pan-Amazônica de Saúde 4(3): 33–36. doi: 10.5123/S2176-62232013000300005

Wilson, E.O. 2003. *Pheidole* in the New World: a dominant, hyperdiverse ant genus. Cambridge: Harvard University Press. 818 pp.

Author contributions: LSS collected the data and wrote the text, RMF identified the ant species and wrote the text, REV wrote the text.

Received: 5 August 2015
Accepted: 8 April 2016
Academic editor: Marcelo Ribeiro Pereira