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Ants (Hymenoptera: Formicidae) from an Amazonian fragmented landscape, Juara, Mato Grosso, Brazil, with new records of ant species

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Abstract. The state of Mato Grosso is the 3rd largest Brazilian state, is covered with three major Brazilian biomes, including the Pantanal, Cerrado, and Amazonia. To date, 449 ant species are recorded in literature for the state. In the present work, we documented the ants sampled along a fragmented landscape, in the municipality of Juara, in the Cerrado-Amazon transition zone in the state of Mato Grosso, Brazil. The ant species were captured with Pitfall traps installed in 20 trails with 10 traps in each (totaling 200). Our results show 151 species, belonging to 43 genera and eight subfamilies, of which 28 species were recorded for the first time in the state and five species recorded for the first time in Brazil. Most genera collected were *Pheidole* Westwood, 1839 (45 species) followed by *Crematogaster* Lund, 1831 (11 species). By highlighting species recorded for the first time in state of Mato Grosso and Brazil, we hope to encourage new discoveries and increase the general knowledge of the ant fauna of different biomes in the region.

Key-Words. Distibution; Neotropical fauna; Pitfall trap; Sampling method; Species inventories.

INTRODUCTION

The state of Mato Grosso is the 3rd largest Brazilian state (IBGE, 2017) and as well as the Amazon and Cerrado, there is still the Pantanal in its political-geographic limits (Silva *et al.,* 2013; Mateus *et al.,* 2016; Vicente *et al.,* 2016). In the region of Meridional Amazon present in the north of the state of Mato Grosso, there is a great extension of Forest of transition between Amazonia and Cerrado (Paolucci *et al.,* 2016; Vicente *et al.,* 2016). The biodiversity of southern Amazonia is sparsely known (Santos-Silva *et al.,* 2016; Vicente *et al.,* 2016) especially in these transition areas (Paolucci *et al.,* 2016; Vicente *et al.,* 2016).

In relation to regional ant fauna, 449 species were recorded for the Mato Grosso state, belonging to 78 genera and nine subfamilies (Janicki *et al.,* 2016). In recent years the number of inventories published in the region has increased (*e.g.,* Battirola *et al.,* 2005; Rocha *et al.,* 2015; Vicente *et al.,* 2016). This scenario has been reversed due to Formicidae characteristics such as ease of sampling because of its high abundance, species richness and relatively well-known taxonomy, biology and ecology, added to the role of biodiversity in ecosystem functioning making ants an attractive group to evaluate and monitor environmental attributes (Agosti *et al.,* 2000; Ribas *et al.,* 2012). In addition, online tools are available for species identification and distribution (*e.g.,* Antweb.org, AntMaps.org [Janicki *et al.,* 2016], AntWiki and others) increasing the number of taxonomists and consolidating working groups.

Considering that strategies for the conservation and knowledge of Brazilian biodiversity are based mainly in species richness, the role of species lists is central for knowledge of the ant fauna

(Ulysséa *et al.,* 2011; Suguituru *et al.,* 2013). For this reason, and due to the vegetation formations of the region, this work aimed to describe the richness and composition of the ant fauna between an Amazon-Cerrado ecotone landscape in the city of Juara, MT, Brazil. We intend to present a list of the ant species of the region with new records for the state of Mato Grosso and to Brazil.

MATERIAL AND METHODS

Study area

Samples were carried out on four fragments in a whole fragmented Amazon landscape immersed in a pasture matrix on the banks of the Arinos river, municipality of Juara, north of Mato Grosso state, Brazil (09°28'S, 55°50'W). Juara has an area of 22,622 km^2 with 34.87% of its original area deforested (INPE, 2015; IBGE, 2017). The vegetation of the region is characterized by the transition of Cerrado-Amazon areas (Ávila & Kawashita-Ribeiro, 2011) and by secondary forests, with the presence of rocky outcrops and agricultural activities. The sampling protocol used in this study is the RAPELD methodology (Costa & Magnusson, 2010). Each Module has sets of five trails of 250 m in length at a minimum distance of 1 km from each other, totaling twenty trails (Fig. 1). Module 4 is the nearest to the urban center, about 8.5 km in distance, and Module 2 and 3, the farthest, at about 29.5 km.

Data sampling

The ant inventory was conducted in February 2015 in four areas (denominated here as a module). In each module we collected in five trails, with a distance of 1,000 meters between them (Fig. 1), totalizing 20 sample units. Of these 20 trails, four were planted on the islands of the Rio Arinos. In each trail, we used two sampling methods, the first consisting of ten solo pitfall traps, distributed with a distance of 15 m between them. The traps remained for 72 consecutive hours in each sampling area.

In addition to pitfall traps, we use a second method, attractive baits of sardine and honey. The baits placed on 20cm × 10cm paper napkin 10 meters distance from each other in an intercalated manner on the ground and vegetation. We randomized the first stratum to be sampled. We put about 5 g of sardines on the ground and in understory trees we put a teaspoon of bee's honey. Therefore, we had 20 sub-sample baits in each trail that remained exposed for approximately one hour. Unfortunately, the information on the type of bait and the stratum in which it was placed was not recovered.

Ant identification

To identify subfamilies and genera of sampled ants we used the dichotomous key available in Baccaro *et al.* (2015). Thereafter, we used several taxonomic keys

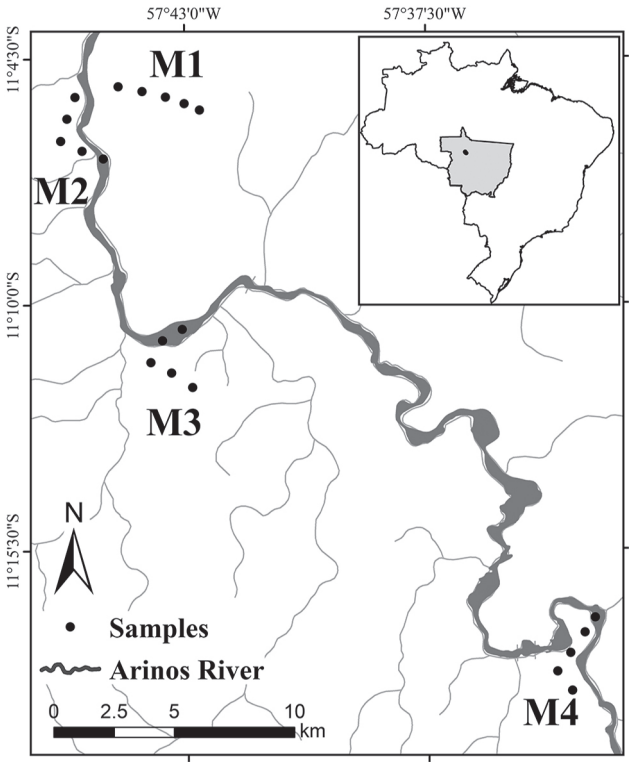

Figure 1. Map indicating the Modules (M) where the samples were collected in the municipality of Juara, north of Mato Grosso state, Brazil. The four points on the Arinos River represent samples taken on islands.

(Brandão, 1990; Fernández, 2003; Longino, 2003; Wilson, 2003; Mackay & Mackay, 2010; Fernandes *et al.,* 2014) to identify to a specific level or to separate into morphospecies. We also made comparisons with specimens deposited at the Entomological collections of the Museu Paraense Emílio Goeldi (MPEG) and Padre Jesus Santiago Moure of the Departamento de Zoologia da Universidade Federal do Paraná (DZUP) and consulted specialists to confirm species identification (see Acknowledgements).

Repositories

The ant vouchers were deposited at the Laboratório de Ecologia de Comunidades of the Centro de Biodiversidade da Universidade Federal de Mato Grosso (UFMT), Entomological Collection of the Museu Paraense Emílio Goeldi (MPEG) and Coleção Entomológica Padre Jesus Santiago Moure of the Departamento de Zoologia da Universidade Federal do Paraná (DZUP).

RESULTS

We recorded a total of 151 species and morphospecies of ants belonging to 43 genera and eight subfamilies (Table 1). The most specious genus was *Pheidole* with 45 species (30% of Mirmicinae), of which 27 species are unidentified. Other representative genera regarding the number of species were *Crematogaster* with 11 species and posteriorly *Camponotus, Gnamptogenys,* and

Table 1. List of ant species recorded at an Amazonian fragmented landscape, municipality of Juara, Mato Grosso state, Brazil. Twenty four ants species were sampled for the first time in Mato Grosso state* and four ant species sampled for the first time in Brazil**.

Subfamily/Species	Number of taxa and method of sample
DORYLINAE	1 genus and 2 species
Eciton	2 species
Eciton burchellii (Westwood, 1842)	Pitfall
Eciton aff. *burchellii*	Pitfall
DOLICHODERINAE	4 genera and 8 species
Dolichoderus	4 species
Dolichoderus attelaboides (Fabricius, 1775)	Pitfall and bait
Dolichoderus bidens (Linnaeus, 1758)	Pitfall
Dolichoderus bispinosus (Olivier, 1792)	Pitfall
Dolichoderus imitator Emery, 1894	Pitfall
Dorymyrmex	1 species
Dorymyrmex insanus (Buckley, 1866)	Pitfall and bait
Linepithema	2 species
Linepithema cerradense Wild, 2007*	Pitfall and bait
Linepithema neotropicum Wild, 2007	Bait
Tapinoma	1 species
Tapinoma ramulorum Emery, 1896	Bait
ECTATOMMINAE	2 genera and 12 species
Ectatomma	4 species
Ectatomma brunneum Smith, 1858	Pitfall
Ectatomma lugens Emery, 1894	Pitfall
Ectatomma muticum Mayr, 1870*	Pitfall and bait
Ectatomma tuberculatum (Olivier, 1792)	Pitfall and bait
Gnamptogenys	8 species
Gnamptogenys acuminata (Emery, 1896)	Pitfall
Gnamptogenys concinna (Smith, 1858)	Pitfall
Gnamptogenys horni (Santschi, 1929)	Pitfall
Gnamptogenys mina (Brown, 1956)*	Pitfall
Gnamptogenys moelleri (Forel, 1912)	Pitfall and bait
Gnamptogenys relicta (Mann, 1916)	Pitfall
Gnamptogenys vriesi Brandão & Lattke, 1990	Pitfall
Gnamptogenys aff. *lanei*	Pitfall
FORMICINAE	4 genera and 19 species
Brachymyrmex	2 species
Brachymyrmex sp.1	Pitfall and bait
Brachymyrmex sp.2	Bait
Camponotus	8 species
Camponotus atriceps (Smith, 1858)	Pitfall
Camponotus femoratus (Fabricius, 1804)	Pitfall and bait
Camponotus leydigi Forel, 1886	Pitfall and bait
Camponotus novogranadensis Mayr, 1870	Pitfall and bait
Camponotus planatus Roger, 1863	Pitfall and bait
Camponotus substitutus Emery, 1894	Pitfall and bait
Camponotus sp.1	Pitfall
Camponotus sp.2	Pitfall
Gigantiops	1 species
Gigantiops destructor (Fabricius, 1804)	Pitfall
Nylanderia	8 species
Nylanderia fulva (Mayr, 1862)	Pitfall and bait
Nylanderia steinheili (Forel, 1893)	Pitfall and bait
Nylanderia aff. *caeciliae*	Pitfall
Nylanderia sp.1	Bait
Nylanderia sp.2	Pitfall and bait
Nylanderia sp.3	Pitfall
Nylanderia sp.6	Pitfall
Nylanderia sp.7	Pitfall and bait
MYRMICINAE	21 genera and 90 species
Acromyrmex	1 species
Acromyrmex sp.1	Pitfall
Apterostigma	3 species
Apterostigma megacephala Lattke, 1999	Pitfall
Apterostigma urichii Forel, 1893	Pitfall
Apterostigma sp.2	Pitfall and bait
Atta	2 species
Atta sexdens (Linnaeus, 1758)	Pitfall
Atta aff. *bisphaerica*	Pitfall and bait
Blepharidatta	1 species
Blepharidatta brasiliensis Wheeler, 1915	Pitfall and bait
Cardiocondyla	1 species
Cardiocondyla obscurior Wheeler, 1929	Pitfall
Carebara	1 species
Carebara brevipilosa Fernández, 2004	Pitfall
Cephalotes	1 species
Cephalotes atratus (Linnaeus, 1758)	Pitfall and bait
Crematogaster	11 species
Crematogaster brasiliensis Mayr, 1878	Pitfall and bait
Crematogaster carinata Mayr, 1862	Pitfall and bait
Crematogaster erecta Mayr, 1866	Pitfall and bait
Crematogaster evallans Forel, 1907*	Pitfall
Crematogaster flavosensitiva Longino, 2003*	Pitfall
Crematogaster levior Longino, 2003	Pitfall and bait
Crematogaster limata Smith, 1858	Pitfall and bait
Crematogaster nigropilosa Mayr, 1870	Pitfall and bait
Crematogaster sotobosque Longino, 2003*	Bait
Crematogaster tenuicula Forel, 1904	Pitfall and bait
Crematogaster sp.1	Pitfall
Cyphomyrmex	4 species
Cyphomyrmex laevigatus Weber, 1938	Pitfall and bait
Cyphomyrmex vorticis Weber, 1940*	Pitfall
Cyphomyrmex aff. *minutus*	Pitfall
Cyphomyrmex aff. *rimosus*	Pitfall
Megalomyrmex	1 species
Megalomyrmex sp.1	Pitfall and bait
Mycetophylax	1 species
Mycetophylax sp.1	Pitfall and bait
Mycocepurus	1 species
Mycocepurus smithii (Forel, 1893)	Pitfall
Nesomyrmex	1 species
Nesomyrmex sp.1	Pitfall
Ochetomyrmex	1 species
Ochetomyrmex neopolitus Fernández, 2003	Pitfall and bait
Octostruma	1 species
Octostruma balzani (Emery, 1894)	Pitfall
Pheidole	45 species
Pheidole biconstricta Mayr, 1870	Pitfall and bait
Pheidole bufo Wilson, 2003	Pitfall and bait
Pheidole cataractae Wheeler, 1916*	Pitfall and bait
Pheidole coffeicola Borgmeier, 1934*	Pitfall
Pheidole deima Wilson, 2003*	Pitfall
Pheidole germaini Emery, 1896	Bait
Pheidole leonina Wilson, 2003*	Pitfall
Pheidole lovejoyi Wilson, 2003*	Pitfall
Pheidole microps Wilson, 2003**	Pitfall
Pheidole oxyops Forel, 1908	Pitfall
Pheidole paraensis Wilson, 2003*	Pitfall
Pheidole scolioceps Wilson, 2003*	Bait
Pheidole sculptior Forel, 1893**	Bait
Pheidole sensitiva Borgmeier, 1959*	Pitfall and bait

Subfamily/Species	Number of taxa and method of sample
Pheidole strigosa Wilson, 2003*	Pitfall
Pheidole triconstricta Forel, 1886	Pitfall and bait
Pheidole vallifica Forel, 1901*	Pitfall
Pheidole vorax (Fabricius, 1804)	Pitfall
Pheidole sp.1	Pitfall and bait
Pheidole sp.2	Pitfall
Pheidole sp.3	Pitfall
Pheidole sp.4	Pitfall and bait
Pheidole sp.5	Bait
Pheidole sp.6	Pitfall
Pheidole sp.7	Pitfall
Pheidole sp.8	Bait
Pheidole sp.9	Pitfall
Pheidole sp.10	Pitfall
Pheidole sp.11	Pitfall
Pheidole sp.12	Pitfall
Pheidole sp.13	Pitfall
Pheidole sp.14	Pitfall
Pheidole sp.15	Pitfall
Pheidole sp.16	Pitfall
Pheidole sp.17	Pitfall
Pheidole sp.18	Pitfall
Pheidole sp.19	Pitfall
Pheidole sp.20	Pitfall
Pheidole sp.21	Pitfall
Pheidole sp.22	Pitfall
Pheidole sp.23	Bait
Pheidole sp.24	Pitfall
Pheidole sp.25	Pitfall
Pheidole sp.26	Pitfall
Pheidole sp.27	Bait
Sericomyrmex	2 species
Sericomyrmex saussurei Emery, 1894	Pitfall and bait
Sericomyrmex sp.3	Pitfall and bait
Solenopsis	5 species
Solenopsis invicta Buren, 1972	Pitfall and bait
Solenopsis sp.1	Pitfall and bait
Solenopsis sp.2	Pitfall
Solenopsis sp.4	Pitfall and bait
Solenopsis sp.7	Pitfall
Strumigenys	2 species
Strumigenys denticulata Mayr, 1887	Pitfall
Strumigenys zeteki (Brown, 1959)*	Pitfall
Trachymyrmex	4 species
Trachymyrmex sp.1	Pitfall and bait
Trachymyrmex sp.3	Pitfall
Trachymyrmex sp.4	Pitfall
Trachymyrmex sp.5	Pitfall
Wasmannia	1 species
Wasmannia auropunctata (Roger, 1863)	Pitfall and bait
PARAPONERINAE	1 genus and 1 species
Paraponera	1 species
Paraponera clavata (Fabricius, 1775)	Pitfall and bait
PONERINAE	9 genera and 16 species
Anochetus	1 species
Anochetus targionii Emery, 1894	Pitfall
Dinoponera	1 species
Dinoponera mutica Emery, 1901	Pitfall
Hypoponera	1 species
Hypoponera sp.3	Pitfall
Leptogenys	1 species
Leptogenys aff. *gaigei*	Pitfall
Mayaponera	1 species
Mayaponera constricta (Mayr, 1884)	Pitfall and bait
Neoponera	5 species
Neoponera apicalis (Latreille, 1802)	Pitfall and bait
Neoponera magnifica (Borgmeier, 1929)*	Pitfall
Neoponera verenae Forel, 1922	Pitfall
Neoponera villosa (Fabricius, 1804)	Pitfall and bait
Neoponera commutata (Roger, 1860)	Pitfall and bait
Odontomachus	3 species
Odontomachus chelifer (Latreille, 1802)	Pitfall
Odontomachus haematodus (Linnaeus, 1758)	Pitfall and bait
Odontomachus meinerti Forel, 1905	Pitfall
Pachycondyla	2 species
Pachycondyla crassinoda (Latreille, 1802)	Pitfall and bait
Pachycondyla harpax (Fabricius, 1804)	Pitfall and bait
Simopelta	1 species
Simopelta jeckylli (Mann, 1916)	Pitfall
PSEUDOMYRMEX	1 genera and 3 species
Pseudomyrmex	3 species
Pseudomyrmex gracilis (Fabricius, 1804)	Pitfall and bait
Pseudomyrmex peruvianus (Wheeler, 1925)**	Pitfall and bait
Pseudomyrmex tenuis (Fabricius, 1804)	Pitfall and bait

Nylanderia with eight species each. In contrast, 51% of the genera sampled were represented by only one species.

Of these 151 sampled ant species, 23 species were collected for the first time in Mato Grosso state. Of these 23 species, three species were sampled for the first time in Brazil (Table 1). The subfamily with the largest number of species sampled for the first time in the locality was Myrmicinae, with 17 new records, 12 of which were only of the *Pheidole* genus. In relation to sampling methods, of these 151 ant species, 83 species were sampled exclusively in pitfall (55%), twelve species using baits (8%) and 56 with both methods (37%). As regards the 28 species that are new records, 16 species were sampled exclusively with pitfall and four only in baits and eight ant species in both methods.

DISCUSSION

Our results expand the current knowledge about ant species in the state of Mato Grosso, focusing in the region of Juara – in the Cerrado-Amazon transition zone. In the Neotropics, the ecotonal zones are present in many landscapes and can influence in different ways, such as faunal movement, flow of energy and nutrients, population dynamics, species interactions and changes in vegetation structure (Spector & Ayzama, 2003). In addition, the areas of transition in terrestrial ecosystems can present high species diversity and may be revealing indicators of the consequences of global climate changes (Zhu *et al.,* 2011, Malanson *et al.,* 2017).

Despite the importance of these areas for biodiversity little is known about the ant fauna in these formations

since 23 species of one inventory in an ecotone area are recorded for the first time in Mato Grosso. This number is very representative considering that it represents 15% of the sampled ant species. Including these species, three species had not been sampled so far in Brazil, which were *Pheidole microps* Wilson, 2003, *Pheidole sculptior* Forel, 1893 and *Pseudomyrmex peruvianus* (Wheeler, 1925). Among these species that were sampled for the first time in the State of Mato Grosso, 12 species were of the genus *Pheidole* (41.4%). This genus represents the second largest among ants, with 1.004 known species (Bolton, 2018) (7% of all Formicidae diversity) and the largest for the Neotropical region with over 600 species (AntWiki, 2018), which represents more than 14% of all known species for the same region. No other biogeographical region has such *Pheidole* species, apart from the Afrotropical and Indo-Autralian regions which have just over 150 species (AntWiki, 2018). Due to this large number of species, it is expected that most of the work involving fauna inventory lacks identifications for this genus. This results in a disjunctive distribution of *Pheidole* species, mainly in the southern Neotropical and consequently presenting an impressive amount of new records (12 only for the present paper). In addition to the richness, *Pheidole* lacks an efficient method of identification, since the most recent dichotomous key (Wilson, 2003) was designed only for major workers, who are relatively little sampled in passive methods (pitfall and Winkler) and the correct association with the minor workers is extremely difficult.

At the same time, the genus has an interactive key developed on the Lucid platform by *Pheidole* Working group and was updated by Longino (2009). However, this key is not appropriate for finding an exact identification but is restricted to a list of names that needs to be consulted in the descriptions and images available. The lack of studies involving the *Pheidole* taxonomy for the New World has been added to these problems, with the most recent and comprehensive publications being those of Wilson (2003) for the New World, Longino (2009) focused on Central America, and a few new species described posteriorly (*e.g., Pheidole protaxi* Oliveira & Lacau, 2015 in Oliveira *et al.,* 2015). The necessity of studies focused on *Pheidole* for these regions has already been pointed out by Longino (2009) and is one of the limits reguarding our knowledge for the genus.

Nevertheless, although not being a new record for Mato Grosso state, some species sampled are rarely collected, with several gaps in the distribution. *Dorymyrmex insanus* (Buckley, 1866) has records from the northern United States (Wheeler & Wheeler, 1988) to Paraguay (Brandão, 1991; Fernández & Sendoya, 2004) with several gaps in the Neotropic. However, its real distribution is unknown, since the last revisions of *Dorymyrmex* are sectoralized and almost absent with focus on Neotropical species (Johnson, 1989; Snelling, 1995; Cuezzo & Guerrero, 2011). For this reason, a complete review of the group focusing on tropical species is necessary and can greatly clarify and broaden the distribution of many species.

Of the 151 species sampled, 83 species were sampled exclusively in pitfall (54.97%), 12 species using baits (7.95%) and 56 with both methods (37.09%). Although bait is an attractive method, pitfall sampled more species. Ryder-Wilkie *et al.* (2010) also found this pattern comparing several methods of collecting ants in the Peruvian Amazon. This pattern can be explained by some factors. First, the attractive baits remain in the field for one hour and then the attracted ants are collected, while the pitfall, although not attracting, intercepts the ants that are foraging on the ground. In addition, ants are known for their aggressiveness and territoriality (Hölldobler, 1979; Vicente *et al.,* 2014; Dejean *et al.,* 2015), and by colonizing a resource, prevent other ants from accessing it by controlling the diversity of species in the bait while in the pitfall there is no such intervention of dominant species.

In summary, our work lists the ant diversity in a poorly known Meridional Amazon region, contributing to the knowledge of the Amazonia-Cerrado transition biomes. This work extends the distribution of 23 species for Mato Grosso state. Nevertheless, more intensive sampling at diverse locations in the region using different methods of sampling is necessary to get a more comprehensive idea about ant fauna.

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REFERENCES

Agosti, D.; Majer, J.D.; Alonso, L.E.; & Schultz, T.R. (Eds.). 2000. *Ants: Standard methods for measuring and monitoring biodiversity.* Washington, Smithsonian Institution Press.

AntWiki. 2018. *AntiWiki.* Available at: www.antwiki.org. Access in: 19/02/2018.

Ávila, R.W. & Kawashita-Ribeiro, R.A. 2011. Herpetofauna of São João da Barra Hydroelectric Plant, state of Mato Grosso, Brazil. *Check List,* 7(6): 750-755.

Baccaro, F.B.; Feitosa, R.M.; Fernández, F.; Fernandes, I.O.; Izzo, T.J.; Souza, J.L.P. & Solar, R.R.C. 2015. *Guia para os gêneros de formigas do Brasil.* Manaus, Editora INPA. DOI

Battirola, L.D.; Marques, M.I.; Adis, J. & Delabie, J.H.C. 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.

Bolton, B. 2018. *An online catalog of the ants of the world.* Available at: www.antcat.org. Access in: 19/02/2018.

Brandão, C.R.F. 1990. Systematic revision of the Neotropical ant genus *Megalomyrmex* Forel (Hymenoptera: Myrmicinae), with the description of thirteen new species. *Arquivos de Zoologia,* 31: 411-494. DOI

Brandão, C.R.F. 1991. Adendos ao catalogo abreviado das formigas da região neotropical (Hymenoptera: Formicidae). *Revista Brasileira de Entomologia,* 35: 319-412.

Costa, F.R.C. & Magnusson, W.E. 2010. The need for large-scale, integrated studies of biodiversity: the experience of the Program for Biodiversity Research in Brazilian Amazonia. *Natureza e Conservação,* 8(1): 3-10. DOI

Cuezzo, F. & Guerrero, R.J. 2011. The Ant Genus *Dorymyrmex* Mayr (Hymenoptera: Formicidae: Dolichoderinae) in Colombia. *Psyche,* 2012 (ID article 516058): 1-24. DOI

Dejean, A.; Céréghino, R.; Leponce, M.; Rossi, V.; Roux, O.; Compin, A.; Delabie, J.H.C. & Corbara, B. 2015. The fire ant *Solenopsis saevissima* and habitat disturbance alter ant communities. *Biological Conservation,* 187: 145-153. DOI

Fernandes, I.O.; Oliveira, M.L. & Delabie, J.H.C. 2014. Description of two new species in the Neotropical Pachycondyla foetida complex (Hymenoptera: Formicidae: Ponerinae) and taxonomic notes on the genus. *Myrmecological News,* 19: 133-163.

Fernández, F. 2003. Myrmicine ants of the genera *Ochetomyrmex* and *Tranopelta* (Hymenoptera: Formicidae). *Sociobiology,* 41: 633-661.

Fernández, F. & Sendoya, S. 2004. List of Neotropical ants (Hymenoptera: Formicidae). *Biota Colombiana,* 5(1): 3-93.

Hölldobler, B. 1979. Territoriality in Ants. *Proceedings of the American Philosophical Society,* 123(4): 211-218. Available at: www.jstor.org/stable/986580.

IBGE – Instituto Brasileiro de Geografia e Estatística. 2017. *Área dos municípios.* Available at: www.ibge.gov.br/home/geociencias/areaterritorial/principal.shtm. Access in: 19/02/2018.

INPE – Instituto Nacional de Pesquisas Espaciais. 2015. Available at: www.inpe.br. Access in: 19/02/2018.

Janicki, J.; Narula, N.; Ziegler, M.; Guénard, B. & Economo, E.P. 2016. Visualizing and interacting with large-volume biodiversity data using client-server web-mapping applications: The design and implementation of antmaps.org. *Ecological Informatics,* 32: 185-193. Available at: www.antmaps.org. Access in: 19/02/2018.

Johnson, C. 1989. Taxonomy and diagnosis of *Conomyrma insana* (Buckley) and *C. flava* (McCook) (Hymenoptera: Formicidae). *Insecta Mundi,* 3: 179-194.

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

Longino, J.T. 2009. Additions to the taxonomy of new world Pheidole (Hymenoptera: Formicidae). *Zootaxa,* 2181: 1-90.

Mackay, W.P. & Mackay, E.E. 2010. *The systematics and biology of the New World ants of the genus Pachycondyla (Hymenoptera: Formicidae).* Lewiston, Edwin Mellen Press. 642p.

Malanson, G.P.; Resler, L.M. & Tomback, D.F. 2017. Ecotone response to climatic variability depends on stress gradient interactions. *Climate Change Responses,* 4(1): 2-8.

Mateus, L.; Ortega, J.; Mendes, A. & Penha, J. 2016. Nonlinear effect of density on trophic niche width and between-Individual Variation in diet in a Neotropical Cichlid. *Austral Ecology,* 41(5): 492-500.

Oliveira, M.L.; Mariano, C.S.F.; Costa, M.A.; Delabie, J.H.C. & Lacau, S. 2015. *Pheidole protaxi* sp. nov. (Hymenoptera: Formicidae), new species from tabuleiro forests of the Atlantic Forest biome. *Sociobiology,* 62(4): 533-537.

Paolucci, L.N.; Maia, M.L.B.; Solar, R.R.; Campos, R.I.; Schoereder, J.H. & Andersen, A. 2016. Fire in the Amazon: impact of experimental fuel addition on responses of ants and their interactions with myrmecochorous seeds. *Oecologia,* 182: 335-346. DOI

Ribas, C.R.; Campos, R.B.; Schmidt, F.A. & Solar, R.R. 2012. Ants as indicators in Brazil: a review with suggestions to improve the use of ants in environmental monitoring programs. *Psyche,* 2012 (article ID 636749): 1-24. DOI

Rocha, W.D.O.; Dorval, A.; Peres Filho, O.; Vaez, C.D.A. & Ribeiro, E.S. 2015. Ants (Hymenoptera: Formicidae) as Bioindicators of Environmental Degradation in Poxoréu, Mato Grosso, Brazil. *Floresta e Ambiente,* 22(1): 88-98.

Ryder-Wilkie, K.T.; Mertl, A.L. & Traniello, J.F.A. 2010. Species diversity and distribution patterns of the ants of Amazonian Ecuador. *Plos One,* 5(10): e13146. DOI

Santos-Silva, L.; Vicente, R.E. & Feitosa, R.M. 2016. Ant species (Hymenoptera, Formicidae) of forest fragments and urban areas in a Meridional Amazonian landscape. *Check List,* 12(3): 1-7.

Silva, F.H.O.; Delabie, J.H.C.; Dos Santos, G.B.; Meurer, E. & Marques, M.I. 2013. Mini-Winkler extractor and pitfall trap as complementary methods to sample Formicidae. *Neotropical Entomology,* 42(4): 351-58.

Snelling, R.R. 1995. Systematics of Nearctic ants of the genus *Dorymyrmex* (Hymenoptera: Formicidae). *Contributions in Science, Natural History Museum Los Angeles,* 454: 1-14.

Spector, S. & Ayzama, S. 2003. Rapid turnover and edge effects in dung beetle assemblages (Scarabaeidae) at a Bolivian Neotropical Forest-Savanna Ecotone. *Biotropica,* 35: 394-404.

Suguituru, S.S.; Rodrigues de Souza, D.; Bortoli Munhae, C.; Pacheco, R. & Morini, M.S.C. 2013. Diversidade e riqueza de formigas (Hymenoptera: Formicidae) em remanescentes de Mata Atlântica na Bacia Hidrográfica do Alto Tietê, SP. *Biota Neotropica,* 13(2): 141-152.

Ulysséa, M.A.; Cereto, C.E.; Rosumek, F.B.; Silva, R.R. & Lopes, B.C. 2011. Updated list of ant species (Hymenoptera, Formicidae) recorded in Santa Catarina State, southern Brazil, with a discussion of research advances and priorities. *Revista Brasileira de Entomologia,* 55(4): 603-611. DOI

Vicente, R.E.; Dáttilo, W. & Izzo, T.J. 2014. Differential recruitment of *Camponotus femoratus* (Fabricius) ants in response to ant garden herbivory. *Neotropical Entomology,* 43: 519-525. DOI

Vicente, R.E.; Prado, L.P. & Izzo, T.J. 2016. Amazon rainforest Ant-Fauna of Parque Estadual do Cristalino: understory and ground-dwelling Ants. *Sociobiology,* 63(3): 894-908. DOI

Wheeler, G.C. & Wheeler, J. 1988. A checklist of the ants of Wyoming. *Insecta Mundi,* 2(3-4): 230-239.

Wilson, E.O. 2003. Pheidole in the new world: a dominant, hyperdiverse ant genus. Cambridge, Harvard University Press.

Zhu, X.; HU, Y. & Gao, B. 2011. Influence of environment of forest-steppe ecotone on soil Arthropods community in northern Hebei, China. *Procedia Environmental Sciences,* 10: 1862-1867.

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