An overview of the ant fauna (Hymenoptera: Formicidae) of the state of Maranhão, Brazil

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Abstract. The state of Maranhão, located in northeastern Brazil, comprises three biomes: Amazonian, Caatinga, and the Cerrado. To date, 99 ant species have been recorded in the literature from the state. In the present work, we provide for the first time a profile of the ant fauna in the state based on data from the historical literature and Brazilian institutional collections. The updated records on ant diversity for the state of Maranhão revealed a total of 279 species, belonging to 71 genera and 10 subfamilies. In total, 180 species are recorded for the first time in the state, of which four species recorded for the first time in Brazil. In summary, apart from documenting the ant fauna of the region, these results provide a basis for further studies and may contribute to future conservation efforts for the biomes present in this complex landscape.

Key-Words. Distribution, Amazon, Caatinga, Cerrado, Checklist.

INTRODUCTION

Understanding the distribution of species is essential to determine regional and global patterns of biodiversity (Dalzochio et al., 2018). In this sense, taxonomic inventories contribute to characterize areas of endemism, reveal taxonomic novelties and improve scientific collections (Moura et al., 2014; Freitas et al., 2017). Further, the analysis of species distribution databases can help to identify gaps in sampling and species records, and can also be used in macroecological studies, species distribution modeling and to promote conservation strategies (Gasper et al., 2016).

Maranhão is a northeastern state in Brazil and comprises a total area of 329,642.170 km² (IBGE, 2018). Its political boundaries are the Atlantic Ocean to the north, the state of Tocantins to the south, the state of Piauí to the east, and the state of Pará to the west (Chaves et al., 2016). The state...
is located in a heterogeneous landscape area under the influence of three biomes: Amazon, Cerrado, and the Caatinga. The vegetation cover – encompassing 14 different vegetation types – reflects the transition between super-humid and semi-arid climates (Santos et al., 2010; IBGE, 2018).

Similar to other states in Brazil, Maranhão has suffered with high human impact, mainly from the early 1960s, through the construction of highways, agricultural and mining projects (Celentano et al., 2017). Impacts include large-scale forest conversion to pasture or by “babaçu” palm trees (Orbignya phalerata Mart.) (Santos et al., 2010), and the expansion of agroindustry has converted large natural areas into grain crops (Brasil, 2009; Santos et al., 2010). In addition, other human activities, such as occupation, recreation and tourism (Chaves et al., 2016) have also a negative impact and have caused severe loss of biodiversity, resulting in drastic changes of the landscape.

The biodiversity of Maranhão is extremely diverse (Chaves et al., 2016; Desidério et al., 2017). Compared to other Brazilian states, however, the ant diversity is poorly known. The most recent information on ant species diversity in the state recorded 99 species, belonging to 37 genera and seven subfamilies (Janicki et al., 2016). This represents about ¼ of ant diversity in the state of Goiás and 35% of the ant species richness described for the state of Mato Grosso do Sul (Janicki et al., 2016), two other Brazilian states comparable in size to Maranhão.

Since the end of the 20th century, collective efforts of several research groups, carrying out inventories in different areas and employing complementary sampling methodologies, resulted in a significant increase in our knowledge about ant diversity in this state. Thus, the aim of this study is to present an updated list of the ant species in the state of Maranhão, considering recent field expeditions as well as material deposited in the main Brazilian ant collections. We also discuss some relevant aspects about the profile of the ant fauna, recovering the history of ant studies historically carried out in the state. Overall, our findings should be of great help in creating measures for species preservation and species recovery plans and represent the basis for future research.

**MATERIAL AND METHODS**

**Data from collections and literature**

We listed material obtained from six Brazilian ant collections (Table 1), which have historically acted as main depositary institutions for samples collected in the state of Maranhão. We also compiled data from literature, including collection events focused on partial surveys of Maranhão ant fauna (Table 2).

**Identifications and taxonomic validation**

Ants were identified by the authors of the present study using taxonomic keys, comparing specimens with myrmecological collections, or by sending them to specialists (see “Acknowledgements”). The final list containing all specimens was verified by authors of this study (JAS, LPP and RMF). Species with dubious identification were carefully examined and, when necessary, have been removed from final data set.

**Distribution and maps**

The biomes present in Maranhão are the Amazon Forest, characterized by tall trees and periodic to permanently flooded plains; this biome is present in the north and, essentially, in the west portion of the state. The Cerrado covers the south, central and northeast areas of the state, formed by open grasslands (Cerrado aberto) to patches of dense vegetation (Cerradão). Finally, Maranhão presents a small and fragmented portion of...
the Caatinga biome, in the extreme east of the state, characterized by the presence of bushy vegetation with deep roots, cacti and bromeliads (Spinelli-Araujo et al., 2016).

We used shapefiles from the state of Maranhão made available by the Ministério do Meio Ambiente (MMA) (http://mapas.mma.gov.br/i3geo/datadownload.htm#). We used a classification in “meso-regions” pre-established by the government agency, in order to describe and discuss our results. We also used shapefiles provided by MMA for the three main biomes present in the state, to overlap sampling points and the main ecosystems in Maranhão.

For the confirmation of sampled sites (Table 3) and maps preparation, the geographical coordinates, when not available on the specimens’ label, were obtained from the IBGE (2011) or georeferenced using Google Earth Pro. In those cases, because we did not have access to the exact point of the sample site, we adapted a classification by the IBGE. Whenever the IBGE classified a municipality covering two biomes, we used the “transition” term after the government classification. For instance, the municipality of Imperatriz, which is classified by IBGE as “Amazon/Cerrado” biomes, becomes for the purpose of this study, “Amazon-Cerrado transition”. For specific sites and localities for which names have been historically altered, we consulted Vanzolini & Papavero (1968) and Vanzolini (1992). The geographical records were mapped using QGIS v2.18.2 (QGIS Development Team, 2019).

RESULTS

Based on data from Brazilian collections (Table 1) and published literature (Table 2), we recorded a total of 279 ant species for the state of Maranhão, belonging to 71 genera and 10 subfamilies (Table 4), and sampled across 65 localities (Table 3). The subfamily Myrmicinae was the most diverse, with 126 species, followed by Ponerinae (36 species), Formicinae (35 species), Dolichoderinae (27 species), Ectatomminae (25 species), Pseudomyrmecinae (16 species), Dorylinae (10 species), Amblyoponinae (2 species), and Paraponerinae and Proceratiinae (1 species each).

The majority of records (214 species) was concentrated along the Amazon region, followed by the Cerrado (129 species), the Amazon-Cerrado transition regions (80 species) and finally the Cerrado-Caatinga transition region where only one species was recorded (Fig. 1). A total of 180 ant species were recorded for the first time in the state, and four species were recorded for the first time in Brazil (Table 4).

DISCUSSION

The first expeditions focused on studying the ant fauna of the state of Maranhão were performed in the late 1940s, with collections in the Cerrado areas undertaken by the myrmecologists Cincinnati Gonçalves and Walter W. Kempf. During the next three decades, collections by researchers, enthusiasts, and professional collectors had pursued the same goal – discovering new taxa and increasing the coverage of ants in scientific collections (Kempf, 1972a). Differently, from the 1980s until the beginning of the 21st century, the main purpose of the expeditions was to carry out environmental impact assessment programs (Brandão et al., 2011). On the other hand, from the late 20th century, with the hiring of researchers at universities in the state of Maranhão, several expeditions have been conducted focusing on ecological studies and reporting faunal inventories (Ramos et al., 2015; Gutiérrez et al., 2017; Silva et al., 2017).

Museums, scientific collections, and historical published literature all contain important information on species distributions recorded as presence data (Newbold, 2010). The accuracy of the distribution data is important for several applications in biology and for species conservation planning (Graham et al., 2008). Despite the concern to accurately document of species distribution that began in the first half of the 19th century (Vanzolini, 2004), for the ants this occurred in the second half of the 20th century. In the case of the records analysed in this work, the specific localities and geographic coordinates became available in the late 20th century.

Most of the ant records for the state of Maranhão remained unavailable to the specialized public for a long time, while many other records remained unidentified at a specific level. In this sense, our study has analyzed both the material deposited in Brazilian collections (Table 1) and the records in the published literature (Table 2), revealing that 64% of species were recorded in the state for the first time. Further, we made an additional effort.
Table 3. Information from the sampled sites for the state of Maranhão. The abbreviations are as follows: (Am) Amazon, (Ce) Cerrado, (ACT) Amazon-Cerrado transition, (CCT) Cerrado-Caatinga transition. (*) For the geographic coordinates attributed in this work.

| Locality | Coordinate | Physiognomy | Code |
|----------|------------|-------------|------|
| 15 km E of Canindé, Aldeia Araçu, Igarapé Gurupi-Uma | 02°34'S, 46°02'W* | Am | 1 |
| Açailândia | 04°52'30"S, 47°17'40"W | Am | 2 |
| Açailândia, Fazenda Pedro Maranhão | 04°56'48"S, 47°30'17"W | Am | 3 |
| Açailândia, Horto Fazenda Pompeia | 04°52'30"S, 47°17'40"W | Am | 4 |
| Alcântara | 02°20'56"S, 44°29'01"W* | Am | 5 |
| Alcântara, Só Assim | 02°20'38"S, 44°28'30"W* | Am | 6 |
| Aldeia do Ponto | 05°07'01.21"S, 45°08'59.99"W* | Ce | 7 |
| Alto Turiaçu | 01°39'46"S, 45°22'19"W* | Am | 8 |
| Alto Turiaçu, Aldeia Gurupiuna | 02°51'44.66"S, 46°15'29.79"W* | Am | 9 |
| Bacabal | 04°13'30"S, 44°46'48"W* | ACT | 10 |
| Balsas | 08°34'19.6"S, 46°42'28.2"W | Ce | 11 |
| Balsas, Córrego Xupé | 07°31'58"S, 46°02'09"W | Ce | 12 |
| Balsas, Fazenda Unha de Gato | 08°34'06"S, 46°42'38"W | Ce | 13 |
| Balsas, Gerais de Balsas, Rio Mandacaru | 08°32'32"S, 46°36'18"W | Ce | 14 |
| Balsas, Mata do Capão do Catulé | 08°32'32"S, 46°36'18"W | Ce | 15 |
| Barão de Grajaú, Bem Quer | 06°07'01.21"S, 45°08'59.99"W* | Ce | 16 |
| Barão do Corda | 05°50'43"S, 42°12'20"W* | Ce | 17 |
| Boa Esperança | 05°50'43"S, 42°12'20"W* | Ce | 18 |
| Carolina | 07°19'58"S, 47°28'09"W* | Ce | 19 |
| Carolina, Pedra Caída | 07°02'30.39"S, 47°26'35.95"W* | Ce | 20 |
| Cassia | 04°31'32"S, 45°21'21"W | Ce | 21 |
| Centro Novo do Maranhão | 04°30'35.70"S, 46°40'40.73"W | Am | 22 |
| Chapadinha, Anapurus | 03°40'19"S, 43°17'40"W | Am | 23 |
| Chapadinha, Fazenda Unha de Gato | 03°41'34"S, 43°17'40"W | Am | 24 |
| Codó | 04°27'18"S, 43°53'09"W* | Ce | 25 |
| Estreito | 06°50'45"S, 43°53'09"W* | Ce | 26 |
| Estreito, Fazenda Planalto | 06°35'59.3"S, 43°53'09"W* | Ce | 27 |
| Estreito, Ilha do Cabral, Rio Tocantins | 06°31'54.1"S, 43°53'09"W* | Ce | 28 |
| Grajaú, Rio Santana | 05°49'08"S, 43°53'09"W* | Ce | 29 |
| Gurupi | 04°22'09.04"S, 45°26'35.92"W | Ce | 30 |
| Imperatriz | 05°50'43"S, 42°12'09"W* | Ce | 31 |
| Imperatriz, Ribeirãozinho | 05°30'38"S, 47°28'46"W* | Ce | 32 |
| Imperatriz, Reserva do 50º Batalhão de Infantaria e Selva | 05°35'59.3"S, 43°53'09"W* | Ce | 33 |
| Imperatriz, Sítio Moisés | 03°36'44.00"S, 45°19'59.90"W | Ce | 34 |
| Imperatriz, Tocantinópolis | 05°30'38"S, 47°28'46"W* | Ce | 35 |
| Itinga do Maranhão | 05°07'01.21"S, 45°08'59.99"W* | Ce | 36 |
| João Lisboa | 05°19'46.30"S, 47°19'13.00"W | Ce | 37 |
| Lagoa Grande do Maranhão | 04°31'54.4"S, 43°26'32.6"W | Ce | 38 |
| Lagoa Verde | 03°50'43"S, 45°58'48"W* | Ce | 39 |
| Lagoa Grande do Maranhão | 04°31'54.4"S, 43°26'32.6"W | Ce | 40 |
| Lagoa Grande do Maranhão | 04°31'54.4"S, 43°26'32.6"W | Ce | 41 |
| Livramento | 04°31'54.4"S, 43°26'32.6"W | Ce | 42 |
| Livramento | 04°31'54.4"S, 43°26'32.6"W | Ce | 43 |
| Livramento | 04°31'54.4"S, 43°26'32.6"W | Ce | 44 |
| São Francisco do Brejão | 05°17'19.0"S, 47°15'01.7"W | Ce | 45 |
| São José de Ribamar, Sítio Aguahy | 02°38'59.30"S, 44°08'49.63"W | Ce | 46 |
| São Luís | 02°31'48"S, 44°18'10"W* | Ce | 47 |
| São Luís, Maracana, Sítio Mangalhão | 02°31'48"S, 44°18'10"W* | Ce | 48 |
| São Luís, Maracana, Sítio Mangalhão | 02°31'48"S, 44°18'10"W* | Ce | 49 |
| São Luís, Reserva Alumar | 02°31'48"S, 44°18'10"W* | Ce | 50 |
| São Luís, Reserva da CAEMA | 02°31'48"S, 44°18'10"W* | Ce | 51 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 52 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 53 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 54 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 55 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 56 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 57 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 58 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 59 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 60 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 61 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 62 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 63 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 64 |
| São Mateus | 02°31'48"S, 44°18'10"W* | Ce | 65 |
Table 4. List of taxa recorded in the state of Maranhão and the occurrence data of the species in the literature and localities and biome present in the state. The codes of localities follow Table 3. (*) new record for Maranhão, (**) new record for Brazil, (Am) Amazon, (Ce) Cerrado, (ACT) Amazon-Cerrado transition, (CCT) Cerrado-Caatinga transition.

| Taxon name | Locality | Biome | Source |
|------------|----------|-------|--------|
| Amblyoponinae Forel, 1893* | — | — | — |
| Fulakora Mann, 1919* | — | — | — |
| Fulakora degenerata (Borgmeier, 1957)** | 4, 41 | Am | Collection |
| Prionopelta Mayr, 1866* | — | — | — |
| Prionopelta antillana Forel, 1909* | 46 | Am | Collection |
| Dolichoderinae Forel, 1878 | — | — | — |
| Azteca Forel, 1878* | — | — | — |
| Azteca antillana | 13, 37 | Ce, ACT | Collection |
| Azteca chartifex | 57 | Am | Collection |
| Azteca schimperi | 57, 57 | Am | Collection |
| Dolichoderus Lund, 1831 | — | — | — |
| Dolichoderus abruptus (Smith, 1858)* | 8 | Am | Collection |
| Dolichoderus attelaboides (Fabricius, 1775)* | 1, 2, 56 | Am | Collection |
| Dolichoderus bidens (Linnaeus, 1758)* | 19 | Am | Collection |
| Dolichoderus bispinosus (Olivier, 1792)* | 5, 24, 35, 37, 39 | Am, Ce, ACT | Collection |
| Dolichoderus debilis Emery, 1890* | 19 | Am | Collection |
| Dorymyrmex Mayr, 1866 | — | — | — |
| Dorymyrmex biconis Forel, 1912* | 52 | Am | Collection |
| Dorymyrmex brunneus Forel, 1908 | 5, 13, 40, 52, 59, 61 | Am, Ce | Andrade-Silva et al., 2015; Pereira et al., 2017; Collection |
| Dorymyrmex chartifex Emery, 1896* | 57 | Am | Collection |
| Dorymyrmex chartifex | 57 | Am | Collection |
| Dorymyrmex jheringi Forel, 1912 | 11, 13 | Ce | Brandão et al., 2011; Collection |
| Dorymyrmex jheringi | 11, 13 | Ce | Brandão et al., 2011; Collection |
| Dorymyrmex pyramicus (Roger, 1863) | 11 | Ce | Brandão et al., 2011; Collection |
| Dorymyrmex spurius Santschi, 1929 | 11, 13 | Ce | Brandão et al., 2011; Collection |
| Forelius Emery, 1888 | — | — | — |
| Forelius brassilensis (Forel, 1908) | 11, 13 | Ce | Brandão et al., 2011; Collection |
| Forelius mananhoaenus Cuezzo, 2000 | 11, 13, 35, 37, 57, 62 | Am, Ce, ACT | Cuezzo, 2000; Brandão et al., 2011; Ulysséa et al., 2017; Collection |
| Forcipomyrma Emery, 1898 | — | — | — |
| Forcipomyrma manicata (Emery, 1930) | 13 | Ce | Collection |
| Gracilidris Wild & Cuezzo, 2006 | — | — | — |
| Gracilidris pombero Wild & Cuezzo, 2006 | 11, 13 | Ce | Wild & Cuezzo, 2006; Brandão et al., 2011; Collection |
| Linepithema Mayr, 1866 | — | — | — |
| Linepithema ceramadene Wild, 2007 | 11 | Ce | Brandão et al., 2011; Collection |
| Linepithema neotropiscum Wild, 2007 | 11, 13, 45 | Ce | Wild, 2007; Brandão et al., 2011; Collection |
| Tapinoma Foerster, 1850* | — | — | — |
| Tapinoma melanoccephalum (Fabricius, 1793)* | 5, 34, 40, 52, 57, 60 | Am | Collection |
| Dorylinae Leach, 1815 | — | — | — |
| Acanthostichus Mayr, 1887* | — | — | — |
| Acanthostichus brevicornis Emery, 1894* | 34, 52 | Am | Collection |
| Eciton Latreille, 1804 | — | — | — |
| Eciton burchelli (Westwood, 1842)* | 1, 21, 31, 33 | Am, Ce, ACT | Collection |
| Eciton mexicanum Roger, 1863* | 60 | Am | Collection |
| Eciton quadrinotatum (Haliday, 1836) | 1, 35, 45 | Am, Ce, ACT | Kempf, 1972a; Watkins, 1976; Collection |
| Eciton napus Smith, 1855* | 3, 31 | Am, Ce | Collection |
| Labidus Jurine, 1807 | — | — | — |
| Labidus forficatus (Latreille, 1802)* | 5, 11, 13, 14, 37, 41, 52, 56, 57 | Am, Ce, ACT | Brandão et al., 2011; Collection |
| Labidus mars (Forel, 1912)* | 34 | Am | Collection |
| Labidus praedator (Smith, 1858) | 45 | Ce | Borgmeier, 1955; Watkins, 1976; Kempf, 1972a; Collection |
| Neocerapachys Borowiec, 2016* | — | — | — |
| Neocerapachys splendens (Borgmeier, 1957)* | 5, 31, 40 | Am, Ce | Collection |
| Nomamyrmex Bergmeier, 1936* | — | — | — |
| Nomamyrmex esenbeckii (Westwood, 1842)* | 23 | Ce | Collection |
| Ectatomminae Emery, 1895 | — | — | — |
| Ectatomma Smith, 1858 | — | — | — |
| Taxon name                        | Locality | Biome | Source                                                                 |
|----------------------------------|----------|-------|----------------------------------------------------------------------|
| Camponotus brunneus Smith, 1858  | 2, 4, 5, 10, 11, 12, 13, 17, 19, 21, 34, 35, 37, 43, 48, 49, 54, 56, 57, 59 | Am, Ce, ACT | Kempf, 1972a; Brandão et al., 2011; Dáttilo et al., 2012; Andrade-Silva et al., 2015; Pereira et al., 2017; Collection |
| Camponotus edentatum Roger, 1863  | 11, 13, 44 | Am, Ce | Brandão et al., 2011; Collection                                      |
| Camponotus lagus Emery, 1894*    | 3, 19, 34, 40 | Am | Collection                                                          |
| Camponotus maximus Mayr, 1870    | 11, 13, 22, 24, 35, 45 | Ce, C | Kempf, 1972a; Brandão et al., 2011; Collection |
| Camponotus opaciventris (Roger, 1861) | 11, 13 | Ce | Brandão et al., 2011; Collection                                      |
| Camponotus permannum Forel, 1906* | 35, 37 | Ce | Collection                                                          |
| Camponotus planidens Borgmeier, 1939 | 11, 13 | Ce | Brandão et al., 2011; Collection                                      |
| Camponotus ruidum (Roger, 1860)* | 5        | Am   | Collection                                                          |
| Camponotus szaz S. Almeida Filho, 1986* | 37, 56 | Am, ACT | Collection                                                          |
| Camponotus tuberculatum (Olivier, 1792) | 2, 3, 5, 21, 37, 40, 41, 56, 57, 59 | Am, Ce, ACT | Andrade-Silva et al., 2015; Collection |
| Gnamptogenys Roger, 1863         | —        | —    | —                                                                    |
| Gnamptogenys acuminatus (Emery, 1896)* | 31, 40, 57, 58 | Am, Ce | —                                                                    |
| Gnamptogenys ammpholita Kempf, 1967    | 11, 13  | Ce   | —                                                                    |
| Gnamptogenys annulata (Mayr, 1887)* | 60      | Am   | —                                                                    |
| Gnamptogenys caelata Kempf, 1967  | 34       | Am   | —                                                                    |
| Gnamptogenys haemsci (Emery, 1902)* | 5, 6, 34, 40 | Am | —                                                                    |
| Gnamptogenys horri (Santschi, 1929)* | 5, 37, 40, 52 | Am, ACT | —                                                                    |
| Gnamptogenys laeni Kempf, 1960*   | 40       | Am   | —                                                                    |
| Gnamptogenys mina (Brown, 1956)*  | 34, 57   | Am   | —                                                                    |
| Gnamptogenys minuta (Emery, 1896) | 30, 41, 52 | Am, Ce | Dias & Lattke, 2019 Collection                                       |
| Gnamptogenys moellerei (Forel, 1912)* | 30, 41, 52, 57, 63 | Am, Ce, ACT | —                                                                    |
| Gnamptogenys rastrata (Mayr, 1866)* | 30       | Ce   | —                                                                    |
| Gnamptogenys stratiula Mayr, 1884* | 30, 32, 34, 41 | Ce, ACT | —                                                                    |
| Gnamptogenys sulcata (Smith, 1858)* | 34, 37   | Am, ACT | —                                                                    |
| Gnamptogenys triangularis (Mayr, 1887)* | 40       | Am   | —                                                                    |
| Typhlomyrmex Mayr, 1862*         | —        | —    | —                                                                    |
| Typhlomyrmex rogenhoferi Mayr, 1862* | 1        | Am   | —                                                                    |
| Formicinae Latreille, 1809       | —        | —    | —                                                                    |
| Acropyga Roger, 1862*            | —        | —    | —                                                                    |
| Acropyga geoldi Forel, 1893*     | 57       | Am   | —                                                                    |
| Acropyga smithi Forel, 1893*     | 4        | Am   | —                                                                    |
| Brachymyrmex Mayr, 1868          | —        | —    | —                                                                    |
| Brachymyrmex australis Forel, 1901 | 11, 13   | Ce   | —                                                                    |
| Brachymyrmex heeri Forel, 1874*  | 5, 34, 37, 40, 46, 52, 56, 57 | Am, ACT | —                                                                    |
| Brachymyrmex patagonicus Mayr, 1868 | 11, 13 | Ce | —                                                                    |
| Camponotus Mayr, 1861            | —        | —    | —                                                                    |
| Camponotus arboreus (Smith, 1858) | 10, 45   | Ce, ACT | Mann, 1916; Kempf, 1972a; Collection                              |
| Camponotus atriceps (Smith, 1858) | 9, 29, 37, 38, 53, 57 | Am, Ce, ACT | Dáttilo et al., 2012; Collection |
| Camponotus baizai Emery, 1894*    | 37       | AST  | —                                                                    |
| Camponotus bidens Mayr, 1870*    | 5, 31, 34 | Am, Ce | —                                                                    |
| Camponotus blandus (Smith, 1858) | 5, 11, 17, 24, 28, 31, 34, 35, 40, 43, 56, 57, 59, 65 | Am, Ce, ACT | Brandão et al., 2011; Andrade-Silva et al., 2015; Collection |
| Camponotus cameranoi Emery, 1894* | 34       | Am   | —                                                                    |
| Camponotus chartifex (Smith, 1860)* | 5        | Am   | —                                                                    |
| Camponotus crossus Mayr, 1862    | 5, 10, 11, 30, 31, 35, 37, 40, 45, 52, 56, 57 | Am, Ce, ACT | Kempf, 1972a; Brandão et al., 2011; Collection |
| Camponotus fastigatus Roger, 1863* | 37, 56   | Am   | —                                                                    |
| Camponotus fenestratus Fabricius, 1804* | 4        | Am   | —                                                                    |
| Camponotus godmani Forel, 1899*  | 5, 34, 60 | Am   | —                                                                    |
| Camponotus latangulus Roger, 1863* | 5, 34, 40, 52, 58 | Am | —                                                                    |
| Camponotus lyriformy Forel, 1886 | 5, 10, 17, 40, 43, 44, 45, 47, 53, 56 | Am, Ce, ACT | Kempf, 1972a; Collection |
| Camponotus melancotics Emery, 1894 | 37, 36, 57, 59 | Am, ACT | Andrade-Silva et al., 2015; Collection |
| Camponotus novogranadensis Mayr, 1870* | 5, 35, 37, 57 | Am, ACT | —                                                                    |
| Camponotus personatus Emery, 1894 | 11       | Ce   | —                                                                    |
| Camponotus rectangularis Emery, 1890* | 62       | Am   | —                                                                    |
| Camponotus renggeri Emery, 1894 | 11, 19, 27, 37, 42, 43, 45, 53, 56, 64 | Am, Ce, ACT | Kempf, 1972a; Brandão et al., 2011; Collection |
| Camponotus rutipes (Fabricius, 1775) | 57, 59   | Am   | —                                                                    |
| Camponotus sexen (Smith, 1858)    | 57, 59   | Am   | —                                                                    |
| Camponotus sinyuttatus (Fabricius, 1793)* | 58       | Am   | —                                                                    |
| Camponotus silvestri Emery, 1906  | 35       | ACT  | —                                                                    |
| Camponotus substitutus Emery, 1894* | 4, 10, 30, 41, 57 | Am, Ce, ACT | —                                                                    |
| Taxon name | Locality | Biome | Source |
|------------|----------|-------|--------|
| Camponotus teniscoptus Roger, 1863* | | | |
| Camponotus trapeziceps Forel, 1908* | | | |
| Camponotus trapezoideus Mayr, 1870* | | | |
| **Gigantiosci Roger, 1863** | | | |
| Gigantiosci destructor (Fabricius, 1804) | 12, 13, 14, 45, 57 | Am, Ce | Forel, 1904; Wheeler, 1922; Kempf, 1972a; Collection |
| **Hylanderia Emery, 1906** | | | |
| Hylanderia fulva (Mayr, 1862)* | 5, 10, 13, 52, 57 | Am, Ce, ACT | |
| Hylanderia guatemalensis (Forel, 1885)* | 34, 40 | Am | |
| **Paratrechina Motschulsky, 1863** | | | |
| Paratrechina longissima (Lairetelle, 1802)* | | | |
| **Myrmicinae Lepeletier de Saint-Fargeau, 1835** | | | |
| Acromyrmex Mayr, 1865 | | | |
| Acromyrmex hystru (Lairetelle, 1802) | 29 | Ce | Dmitri, 2010 |
| Acromyrmex landolti (Forel, 1885) | 11, 45, 57 | Am, Ce | Gonçalves, 1961; Kempf, 1972a; Brandão et al., 2011; Collection |
| Acromyrmex laticeps (Emery, 1905)* | 22 | Ce | |
| Acromyrmex nigrosetosus (Forel, 1908) | 22, 45 | Ce | Gonçalves, 1961; Kempf, 1972a; Collection |
| Acromyrmex rugosus (Smith, 1858) | 4, 11, 22, 45, 57, 59 | Am, Ce | Gonçalves, 1961; Brandão et al., 2011; Andrade-Silva et al., 2015; Collection |
| Acromyrmex subteraneus (Forel, 1893)* | 40 | Am | Collection |
| **Apterostigma Mayr, 1865** | | | |
| Apterostigma robustum Emery, 1896* | 34, 40, 52 | Am | Collection |
| Atta Fabricius, 1804 | | | |
| Atta cephalotes (Linnaeus, 1758) | 45 | Ce | Kempf, 1972a; Collection |
| Atta laevigata (Smith, 1858) | 45 | Ce | Kempf, 1972a; Collection |
| Atta opaciceps Borgeimeier, 1939* | 35, 37, 63 | Am, ACT | Collection |
| Atta sexdens (Linnaeus, 1758) | 11, 31, 45, 57 | Am, Ce | Gonçalves, 1942, 1947; Kempf, 1972a; Brandão et al., 2011; Collection |
| **Basileus Schulz, 1906** | | | |
| Basileus miltantis (Weber, 1950) | 4, 34, 55 | Am | Janchick et al., 2016; Collection |
| Basileus scamnognathus (Brown, 1949) | 30 | Ce | Fettos et al., 2007; Collection |
| **Blepharidatta Wheeler, 1915** | | | |
| Blepharidatta canopas Kempf, 1967 | 11, 13, 30, 32 | Ce | Silva, 2007; Brandão et al., 2011; Pereira et al., 2014; Brandão et al., 2015; Collection |
| **Cardiocondyla Emery, 1869** | | | |
| Cardiocondyla emeryi Forel, 1881* | 10, 13 | Ce, ACT | Collection |
| Cardiocondyla obscurior Wheeler, 1929* | 52 | Am | Collection |
| **Carabera Westwood, 1840** | | | |
| Carabera angulata Fernández, 2010* | 4 | Am | |
| Carabera brevipilosa Fernández, 2004* | 4 | Am | Collection |
| Carabera urichi (Wheeler, 1922)* | 34, 40 | Am | Collection |
| **Cephalotes Latreille, 1802** | | | |
| Cephalotes atroctus (Linnaeus, 1758) | | | |
| Cephalotes clypeatus (Fabricius, 1804) | 13, 9, 3, 30 | Am, Ce | De Andrade & Baroni Urbani, 1999; Brandão et al., 2011; Collection |
| Cephalotes condatus (Smith, 1853) | 45, 57 | Am, Ce | Kempf, 1972a; Kempf, 1960a; Brandão, 1991; Collection |
| Cephalotes edwardi (Forel, 1921)* | 10 | ACT | Collection |
| Cephalotes grandinosus (Smith, 1860)* | 63 | Am | Collection |
| Cephalotes maculatus (Smith, 1876)* | 5, 57 | Am | Collection |
| Cephalotes marginatus (Fabricius, 1804) | 45, 57 | Ce | De Andrade & Baroni Urbani, 1999; Collection |
| Cephalotes minutus (Fabricius, 1804) | 11, 13, 45, 52 | Am, Ce | Kempf, 1972a; Kempf, 1960a; Brandão, 1991; Collection |
| Cephalotes pilosus (Emery, 1896)* | 35, 43, 64 | Ce, ACT | Collection |
| Cephalotes pusillus (Klug, 1824) | 1, 4, 16, 17, 27, 33, 51, 52, 57, 60 | Am, Ce, ACT | Kempf, 1972a; Kempf, 1960a; Brandão, 1991; De Andrade & Baroni Urbani, 1999; Collection |
| Cephalotes serraticeps (Smith, 1858) | 9 | Am | De Andrade & Baroni Urbani, 1999; Collection |
| Cephalotes unimaculatus (Fabricius, 1804)* | 57 | Am | Collection |
| **Crematogaster Lund, 1831** | | | |
| Crematogaster abietina Forel, 1899* | 13, 30 | Am, Ce | Collection |
| Crematogaster acuta (Fabricius, 1804)* | 3 | Ce | Collection |
| Crematogaster brasilensis Mayr, 1878* | 63 | Am | Collection |
| Crematogaster curvispinosa Mayr, 1862* | 10 | ACT | Collection |
| Crematogaster erecta Mayr, 1866 | 5, 13, 40, 45, 52, 57 | Am, Ce | Kempf, 1968; Kempf, 1972a; Collection |
| Crematogaster euripus Forel, 1907* | 13, 57 | Am, Ce | Collection |
| Crematogaster kiliat Smith, 1858* | 34, 35, 37, 40, 52, 57, 63 | Am, ACT | Collection |
| Crematogaster luctuosa Forel, 1904* | 5, 34, 35, 37, 52, 57, 60 | Am, ACT | Collection |
| Crematogaster victoriae Smith, 1858 | 57, 59 | Am | Andrade-Silva et al., 2015; Collection |
| Taxon name                  | Locality | Biome | Source                  |
|-----------------------------|----------|-------|-------------------------|
| **Cyphomyrmex Mayr, 1862**  | —        | —     | —                       |
| Cyphomyrmex laevigatus Weber, 1938 | 4, 40  | Am    | Collection              |
| Cyphomyrmex major Forel, 1901 | 5, 40  | Am    | Collection              |
| Cyphomyrmex minutus Mayr, 1862 | 4, 30, 31 | Ce | Collection              |
| Cyphomyrmex peltatus Kempf, 1966 | 4, 30, 4, 34, 37, 40, 57, 60 | Am, Ce, ACT | Collection |
| Cyphomyrmex transversus Emery, 1894 | 5, 37, 40, 62 | Am, ACT | Collection |
| **Dacetum Perty, 1833**     | —        | —     | —                       |
| Dacetum armigerum (Latreille, 1802) | 4, 19  | Am    | Collection              |
| **Hylocnemi Mayr, 1812**    | —        | —     | —                       |
| Hylocnemi balzani (Emery, 1894) | 34, 37, 40, 57 | Am, ACT | —                       |
| Hylocnemi immans Kempf, 1973 | 4       | Am    | Collection              |
| Hylocnemi longiscapa Kempf, 1961 | 4       | Am    | Collection              |
| Hylocnemi poecilus Kempf, 1973 | 55     | Am    | Collection              |
| Hylocnemi reginae Kutter, 1977 | 55     | Am    | Collection              |
| **Megalomyrmex Forel, 1885** | —        | —     | —                       |
| Megalomyrmex drifti Kempf, 1961 | 60     | Am    | Collection              |
| **Monomorium Mayr, 1855**   | —        | —     | —                       |
| Monomorium flavicans (Jerdon, 1851) | 5, 40, 43, 52 | Am, Ce | Collection |
| Monomorium pharaonis (Linnaeus, 1758) | 37, 57 | Am, ACT | —                       |
| **Mycocepurus Forel, 1893** | —        | —     | —                       |
| Mycocepurus goeldii (Forel, 1893) | 11, 37, 56, 57 | Am, Ce, ACT | Brandão et al., 2011; — |
| Mycocepurus smithii (Forel, 1893) | 4, 63  | Am    | —                       |
| **Ochetomyrmex Mayr, 1878** | —        | —     | —                       |
| Ochetomyrmex neopolitus Fernández, 2003 | 4, 37  | Am, ACT | —                       |
| Ochetomyrmex semispilota Mayr, 1878 | 11, 12, 13, 45 | Ce | —                       |
| **Octotrama Forel, 1912**   | —        | —     | —                       |
| Octotrama balzani (Emery, 1894) | 30, 45, 60 | Am, Ce | —                       |
| Octotrama sheringi (Emery, 1888) | 34, 40  | Am    | Collection              |
| **Oxyepoc Santschi, 1926**  | —        | —     | —                       |
| Oxyepoc veyrenyi (Forel, 1907) | 15     | Ce    | —                       |
| **Pheidole Westwood, 1839** | —        | —     | —                       |
| Pheidole allamata Wilson, 2001 | 34, 52 | Am    | —                       |
| Pheidole dolon Wilson, 2003 | 34     | Am    | —                       |
| Pheidole fallax Mayr, 1870 | 5, 37   | Am, ACT | —                       |
| Pheidole fimbriata Roger, 1863 | 4       | Am    | —                       |
| Pheidole flavens Roger, 1863 | 45     | Ce    | —                       |
| Pheidole fracticip Wilson, 2003 | 31     | Ce    | —                       |
| Pheidole gauthieri Forel, 1901 | 34   | Am    | Collection              |
| Pheidole impressa Mayr, 1870 | 10, 57  | Am, ACT | —                       |
| Pheidole jeannei Wilson, 2003 | 37     | ACT   | —                       |
| Pheidole microps Wilson, 2003 | 41     | Am    | —                       |
| Pheidole midas Wilson, 2003 | 41, 52  | Am    | —                       |
| Pheidole obscurothorax Naves, 1985 | 29     | ACT   | —                       |
| Pheidole nadzkowksi Mayr, 1884 | 5, 34, 35, 37, 40, 52, 56, 57, 59 | Am, ACT | Andrade-Silva et al., 2015; — |
| Pheidole scalicpes Wilson, 2003 | 4, 37  | Am, ACT | —                       |
| Pheidole sensitiva Borgmeier, 1959 | 30     | Ce    | —                       |
| Pheidole susanann Forel, 1886 | 37     | ACT   | —                       |
| Pheidole synanamata Wilson, 2003 | 57, 59 | Am    | Andrade-Silva et al., 2015; Pereira et al., 2017; — |
| Pheidole transversususter Mayr, 1887 | 37    | ACT   | —                       |
| **Pogonomyrmex Mayr, 1868** | —        | —     | —                       |
| Pogonomyrmex nangeli Emery, 1878 | 14     | Ce    | —                       |
| **Procyrtocerus Emery, 1887** | —        | —     | —                       |
| Procyrtocerus goeldii Forel, 1899 | 45, 45 | Sa    | Kempf, 1972a            |
| Procyrtocerus hyleus Kempf, 1951 | 10, 45 | Ce, ACT | Longino & Snelling, 2002; — |
| Taxon name                        | Locality | Biome | Source                      |
|----------------------------------|----------|-------|-----------------------------|
| Proctocerus pictipes Emery, 1896*| 5, 40    | Am    | Collection                  |
| Rogeria Emery, 1894              |          |       |                             |
| Rogeria azatesi Kugler, 1994*    | 5, 34, 52, 57 | Am | Collection                  |
| Rogeria besucheti Kugler, 1994*  | 40       | Am    | Collection                  |
| Rogeria germaini Emery, 1894*    | 40       | Am    | Collection                  |
| Rogeria lizata Kugler, 1994*     | 58       | Am    | Collection                  |
| Rogeria scabinate Kugler, 1994   | 11       | Ce    | Brandão et al., 2011; Collection |
| Sericomyrmex Mayr, 1865          |          |       |                             |
| Sericomyrmex mayri Kugler, 1994*| 5, 34, 37, 45 | Am, Ce, ACT | Jesovnik & Schultz, 2017; Collection |
| Solenopsis Westwood, 1840        |          |       |                             |
| Solenopsis globularia Smith, 1858| 5, 45, 52, 59, 61 | Am, Ce | Wauters et al., 2018; Collection |
| Strumigenys Smith, 1860*         |          |       |                             |
| Strumigenys alberti Kugler, 1994| 4        | Am    | Collection                  |
| Strumigenys crassinissimus Mayr, 1887*| 30, 32, 55 | Am, Ce | Jesovnik & Schultz, 2017; Collection |
| Tetramorium Mayr, 1855*          |          |       |                             |
| Tetramorium similimum Smith, 1851| 10       | ACT   | Kempf, 1972a; Andrade-Silva et al., 2015; Collection |
| Trachymyrmex Mayr, 1893          |          |       |                             |
| Trachymyrmex bugnioni (Forel, 1912)| 11, 30   | Ce    | Brandão et al., 2011; Collection |
| Trachymyrmex hirtula Borgmeier, 1934*| 34, 35, 37, 40, 52, 57, 61 | Am | jesovnik & Schultz, 2017; Collection |
| Tranopelta Mayr, 1866*           |          |       |                             |
| Tranopelta gilva Mayr, 1866*     | 5, 57    | Am    | Collection                  |
| Wasmannia Mayr, 1893             |          |       |                             |
| Wasmannia aurantipunctata (Roger, 1863)| 5, 11, 12, 13, 15, 30, 31, 32, 34, 35, 37, 40, 52, 55, 57, 61 | Am, Ce, ACT | Brandão et al., 2011; Collection |
| Ponerinae Lepeletier de Saint-Fargeau, 1835 |          |       |                             |
| Paraponerinae Emery, 1901        |          |       |                             |
| Paraponera Smith, 1858           |          |       |                             |
| Paraponera clavata (Fabricius, 1775)| 3, 7, 19, 36, 38, 42, 45, 50 | Am, Ce, ACT | Ward & Downie, 2005; Ward, 2007; Collection |
| Dinoponera Roger, 1861           |          |       |                             |
| Taxon name                           | Locality | Biome | Source                                                                 |
|-------------------------------------|----------|-------|------------------------------------------------------------------------|
| *Dinoponera gigantea* (Perty, 1833) | 1, 11, 13, 33, 45 | Am, Ce, ACT | Kempf, 1971, 1972a; Monnin et al., 2003; Brandão et al., 2011; Collection |
| **Hypoponera** Santschi, 1938*     |          |       |                                                                        |
| Hypoponera distinguenda (Emery, 1890)* | 34       | Am    | Collection                                                             |
| Hypoponera opacior (Forel, 1893)*   | 61       | Am    | Collection                                                             |
| Hypoponera trigona (Mayr, 1887)*    | 5, 34, 52, 57 | Am | Collection                                                             |
| **Leptogenys** Roger, 1861          |          |       |                                                                        |
| Leptogenys guianensis Wheeler, 1923* | 57       | Am    | Collection                                                             |
| Leptogenys unstimulosa Roger, 1863  | 30, 63   | Am, Ce | Lattke, 2011; Collection                                               |
| **Mayoponera Schmidt & Shattuck, 2014** |          |       |                                                                        |
| Mayoponera constricta (Mayr, 1884)* | 5, 30, 35, 37, 40, 60 | Am, Ce, ACT | Collection                                                             |
| **Neoponera** Emery, 1901           |          |       |                                                                        |
| Neoponera commutata (Roger, 1860)   | 7, 21, 45, 56 | Am, Ce | Kempf, 1959; Kempf, 1972a; Collection                               |
| Neoponera marginata (Roger, 1861)*  | 57       | Am    | Collection                                                             |
| Neoponera striatodis (Emery, 1890)* | 5        | Am    | Collection                                                             |
| Neoponera unidentata (Mayr, 1862)*  | 34       | Am    | Collection                                                             |
| Neoponera venter Forel, 1922*       | 34, 37   | Am, ACT | Collection                                                            |
| Neoponera villosa (Fabricius, 1804) | 11, 13, 19, 60 | Am, Ce | Brandão et al., 2011; Fernandes et al., 2014; Collection               |
| **Odontomachus** Lateville, 1804    |          |       |                                                                        |
| Odontomachus bauri Emery, 1892*     | 11, 22, 35, 37, 57, 59, 60 | Am, Ce, ACT | Brandão et al., 2011; Andrade-Silva et al., 2015; Collection |
| Odontomachus brunneus (Paton, 1894)* | 22       | Ce    | Collection                                                             |
| Odontomachus cheilifer (Lateville, 1802)* | 57, 26   | Am, Ce | Collection                                                             |
| Odontomachus haematodus (Linnaeus, 1758) | 1, 45, 57  | Am, Ce | Janicki et al., 2016; Collection                                      |
| Odontomachus meiereti Forel, 1905*  | 34, 52   | Am    | Collection                                                             |
| Odontomachus opaciventris Forel, 1899 | 29      | ACT   | Dattilo et al. 2012                                                   |
| Odontomachus sculpitus Brown, 1978* | 5        | Am    | Collection                                                             |
| **Pachycondyla** Smith, 1858*       |          |       |                                                                        |
| Pachycondyla crossoidea (Lateville, 1802)* | 5, 30, 32, 35, 37, 52, 57, 60 | Am, Ce, ACT | Collection                                                             |
| Pachycondyla harpax (Fabricius, 1804)* | 5, 30, 31, 32, 34, 35, 37, 40, 46, 52, 55, 56, 57 | Am, Ce, ACT | Collection                                                             |
| Pachycondyla impressa (Roger, 1861)* | 5        | Am    | Collection                                                             |
| Pachycondyla lenis Kempf, 1961*     | 34       | Am    | Collection                                                             |
| Platythyrea Roger, 1863              |          |       |                                                                        |
| Platythyrea angusta Forel, 1901     | 45       | Ce    | Forel, 1904; Kempf, 1964, 1972a; Collection                           |
| Platythyrea pilosula (Smith, 1858)*  | 60       | Am    | Collection                                                             |
| **Pseudoponera** Emery, 1900*       |          |       |                                                                        |
| Pseudoponera giberti (Kempf, 1960)* | 5, 34, 40, 52, 61 | Am | Collection                                                             |
| Pseudoponera stigma (Fabricius, 1804)* | 41       | Am    | Collection                                                             |
| **Rasopone** Schmidt & Shattuck, 2014* |          |       |                                                                        |
| Rasopone arhuaca (Forel, 1901)*     | 5, 34, 41, 52, 55, 57 | Am, ACT | Collection                                                             |
| Rasopone ferruginea (Smith, 1858)*  | 5, 30, 31, 34, 40, 55 | Am, Ce | Collection                                                             |
| **Proceratiinae** Emery, 1895*      |          |       |                                                                        |
| **Discothyrea** Roger, 1863*        |          |       |                                                                        |
| Discothyrea sexarticulata Borgenmeier, 1954* | 4, 5  | Am    | Collection                                                             |
| **Pseudomyrmecinae** Smith, 1952    |          |       |                                                                        |
| **Pseudomyrmex Lund, 1831**         |          |       |                                                                        |
| Pseudomyrmex curassensis (Forel, 1912) | 5, 10, 40, 45, 52 | Am, Ce, ACT | Ward, 1989; Brandão, 1991; Collection                               |
| Pseudomyrmex elongatus (Mayr, 1870) | 10, 45   | Ce, ACT | Kempf, 1972a; Ward, 1989; Collection                                 |
| Pseudomyrmex ethicus (Forel, 1911)* | 4        | Am    | Collection                                                             |
| Pseudomyrmex filiformis (Fabricius, 1804)* | 5, 34    | Am    | Collection                                                             |
| Pseudomyrmex flavidus (Smith, 1858) | 11, 13   | Ce    | Brandão et al., 2011; Collection                                      |
| Pseudomyrmex gracilis (Fabricius, 1804) | 5, 16, 38, 40, 45, 46, 56, 57, 63 | Am, Ce, CCT | Janicki et al., 2016; Collection                                      |
| Pseudomyrmex kuenckeli (Emery, 1890) | 35, 43   | Am, ACT | Ward, 1999; Collection                                                |
| Pseudomyrmex oculatus (Smith, 1855)  | 5, 34, 40, 45, 56, 57, 63 | Am, Ce | Kempf, 1972a; Collection                                              |
| Pseudomyrmex penetrator (Smith, 1877)* | 3        | Am    | Collection                                                             |
| Pseudomyrmex pupa (Forel, 1911)*    | 56, 40   | Am    | Collection                                                             |
| Pseudomyrmex schappi (Forel, 1901)   | 52, 57, 59 | Am | Andrade-Silva et al., 2015; Collection                               |
| Pseudomyrmex sericus (Mayr, 1870)*  | 5, 40    | Am    | Collection                                                             |
| Pseudomyrmex tenuis (Fabricius, 1804) | 5, 13, 20, 27, 34, 37, 40, 45, 47, 56, 58, 60, 61, 62, 63 | Am, Ce, ACT | Forel, 1904; Kempf, 1960b, 1972a; Ward & Downie, 2005; Collection   |
| Pseudomyrmex tenuissimus (Emery, 1906) | 5, 10, 45 | Am, Ce, ACT | Mann, 1916; Kempf, 1972a; Ward, 1989; Brandão, 1991; Collection     |
| Pseudomyrmex tenuissimus (Smith, 1855) | 5, 13, 27, 43, 45, 47 | Am, Ce | Kempf, 1972a; Brandão et al., 2011; Collection                        |
| Pseudomyrmex urbanus (Smith, 1877)  | 13, 45   | Ce    | Ward, 1989; Brandão, 1991; Collection                                 |
to identify the morphospecies in ant collections. For instance, 73 ant morphospecies, belonging to 31 ant genera and two subfamilies were here identified at the specific level for the first time (Table 4).

In our data compilation, we found a number of species that were recorded for the first time in the state of Maranhão, but are widely distributed in Brazil (Janicki et al., 2016), as is the case of Dolichoderus imitator Emery, 1894 and Gnamptogenys striatula Mayr, 1884, among others (Table 4). On the other hand, some hyperdiverse and taxonomically challenging genera, such as Pheidole, had a considerable increase in the number of new records. Of the 19 species of Pheidole known to the state, 12 were recorded for the first time in the state of Maranhão, and three species were recorded for the first time in Brazil.

Not surprisingly, the data obtained from the ant literature clearly indicates that taxonomy is the discipline that most contributed to the knowledge of the ant fauna in the state. This is especially true for taxonomic revisions, which deal with large numbers of specimens (e.g., De Andrade & Baroni Urbani, 1999; Lattke, 2011). The high number of taxonomic publications in our survey is justified by the fact that this discipline was the first area of myrmecology to be developed in Brazil, allowing the formation of large repositories. However, although taxonomy is the discipline with the greatest number of published studies in relation to other areas, in the last 20 years the potential of ant fauna data has been explored in different study areas (Table 2).

Other factors that have contributed to increasing our knowledge of the ant fauna in the state of Maranhão are online tools, which provide high definition images of species (AntWeb, 2019), taxonomic literature (Bolton, 2019), geographic distribution of ant specimens (Janicki et al., 2016), and general information on ant taxa (AntWiki, 2019). These tools facilitate the identification of specimens and provide a fast and effective access to information. In addition, the improvement and development of collection methodologies (Figueiredo et al., 2013) has made the sampling more efficient.

Despite the increased understanding of biodiversity in this region, sampling coverage of ant fauna in Maranhão is strongly irregular (Fig. 1). Our study showed that the Amazon is the better sampled biome and also houses the largest number of species recorded in the state (Table 4). Most collection points are concentrated in the northern region of the state (Fig. 1), which corresponds to the Coastal region of Maranhão, with the highest population density (Chaves et al., 2016), and where the main research centers are located.

While the Cerrado, which corresponds to the biome with the highest coverage in the state (64%) (MMA, 2011; Stella, 2011), remains poorly sampled with extremely sparse collections (Fig. 1). In relation to this biome, it is in the southern part of the state where most of the collection points are concentrated, which in most cases came from samples derived from environmental impact assessment programs (e.g., Brandão et al., 2011).

The Amazon–Cerrado transition regions are also undersampled in the state, with few records available from taxonomic papers (Kempf, 1972a; Brandão, 1991) and collections. If we want to understand the association between species and forest formations it is essential to characterize species diversity in ecotones, as already observed by other groups (Santos et al., 2010; Maracahipes-Santos et al., 2018).

The Caatinga biome remains largely unknown in Maranhão, represented in our study by a single record in the Cerrado-Caatinga transition region (Fig. 1). Although the biome presents a small and fragmented spatial coverage (1% of the state territorial area) (Stella, 2011), the scarcity of information about the ant fauna in the Caatinga has also been observed in other regions of Brazil (Santos et al., 1999; Ulysséa & Brandão, 2013; Leal et al., 2017). This result illustrates the need for greater collection effort to understand and preserve biodiversity in the Caatinga and, consequently, in the state of Maranhão.

One of the main limitations of the data available to date on the ant fauna in Maranhão was a strong sampling bias, with most samples being collected near the main roads (Fig. 2). This pattern of biased sampling near highways, rivers, coasts, and cities has been reported in several taxonomic groups (Hijmans et al., 2000; Kadmon et al., 2003; Reddy & Dávalos, 2003; Newbold, 2010; Santos & Hoppe, 2018), which is explained by the ease access, researchers’ interest in certain areas or taxa, and limited financial resources. However, further studies are required to reduce this sampling bias by using different collection methodologies and accessing previously unexplored sites.

Low levels of sampling in conservation areas of the state were also observed (Fig. 3). Conservation areas (i.e., national parks, ecological stations, extractive reserves,
national forests, biological reserves, among others) are of fundamental importance for biodiversity conservation (Peres, 2005) and preserving ecosystem (Hallmann et al., 2017).

To the best of our knowledge, this is the first compilation focused on studying the ant fauna of Maranhão, one of the largest geopolitical regions of Brazil. Our study significantly increase the number of ant species recorded in the state and demonstrates the importance of carrying out planned inventories for a more detailed understanding of the regional ant fauna. Finally, our data provide the baseline information to further explore the ant fauna in Maranhão, to improve current knowledge and to accurately determine the occurrence of several species.

CONCLUSION

This paper represents an updated record of the ant species occurring in the state of Maranhão, with numbers increasing from 99 to 279 species. Further collection efforts in different biomes are essential for a better understanding of the biodiversity of the state, and for planning long-term conservation action. Ongoing studies on taxonomy, natural history, and ecology are certainly expected to contribute to this.

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REFERENCES

Andrade-Silva, J.; Pereira, E.K.C.; Silva, O.; Santos, C.L.C.; Delabie, J.H.C. & Rebelo, J.M.M. 2015. Ants (Hymenoptera: Formicidae) associated with pig carcasses in an urban area. Sociobiology, 62(4): 527-532.

AntWeb. 2019. AntWeb. Available at: http://www.antweb.org. Access in: 03/01/2019.

AntWiki. 2019. AntWiki. Available at: http://www.antwiki.org. Access in: 19/01/2019.

Bolton, B. 2019. An online catalog of the ants of the world. Available at: http://www.antcat.org. Access in: 10/02/2019.

Borgmeier, T. 1955. Die Wanderameisen der neotropischen Region. Studia Entomologica, 3: 1-720.

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

Brandão, C.R.F.; Feitosa, R.M. & Diniz, J.L.M. 2015. Taxonomic revision of the Neotropical Myrmicinae ant genus Blepharidatta Wheeler. Zootaxa, 4012(1): 33-56.

Brandão, C.R.F.; Silva, R.R. & Feitosa, R.M. 2011. Cerrado ground-dwelling ants (Hymenoptera: Formicidae) as indicators of edge effects. Zoologia, 28(3): 379-387.

Brazil. 2009. Ministério do Meio Ambiente. Relatório técnico de monitoramento do desmatamento no bioma Cerrado, 2002 a 2008: dados revisados. Brasília: MMA, 67p. Available at: http://www.mma.gov.br/estruturas/sbf/chm_rbbio/arquivos/relatorio_tecnico_monitoramento_desmate_bioma_cerrado_cr_ibama_2002_2008_rev_72.pdf. Access in: 08/12/2018.

Carvalho, A.P.R.; Silva, C.G. & Fonseca, A.R. 2011. Diversidade de formigas em um hospital público no município de Chapadinha, Maranhão, Brasil. Revista de Biologia e Ciências da Terra, 11: 67-73.

Celentano, D.; Rousseau, G.X.; Engel, V.L.; Zelarayán, M.; Oliveira, E.C.; Araújo, A.C.M. & De Moura, E.G. 2017. Degradation of riparian forest affects soil properties and ecosystem services provision in eastern amazon of Brazil. Land Degradation & Development, 28: 482-493.

Chaves, L.P.F.A.; Silva, R.A.; Amaral, Y.T.; Costa, M.K.L. & Siqueira, G.M. 2016. Biogeographical diversity of north mesoregion of the Maranhão state (Brazil). Journal of Geospatial Modelling, 1: 19.

Cuezzo, F. 2000. Revisión del género Forelius (Hymenoptera: Formicidae: Dolichoderinae). Sociobiology, 35: 197-275.

Dalozchio, M.S.; Renner, S.; Spanzerla, C.; Prass, G.; Ely, G.J.; Salvi, L.C.; Dametto, N. & Périco, E. 2018. Checklist of Odonata (Insecta) in the state of Rio Grande do Sul, Brazil with seven new records. Biota Neotropica, 18: 1-14.
Dattilo, W.; Vicente, R.E.; Nunes, R.V. & Carvalho, M.S.G. 2010. First Record of the Neotropical ant genus Cephalotes (Hymenoptera: Formicidae) for Maranhão State, Brazil. Entomobrasiensis, 1: 73-82.

Dattilo, W.; Vicente, R.E.; Nunes, R.V. & Feitosa, R.M. 2012. Influence of cacao cultivation on ant visitation. Sociobiology, 59(2): 549-559.

De Andrade, M.L. & Baroni Urbani, C. 1999. Diversity and Adaptation in the ant genus Cephalotes, past and present. Stuttgart, Gatcher und Verlag.

Desidério, G.R.; Barcelos-Silva, P.; De Souza, W.R.M.; Pes, A.M. & Azevêdo, C.A.S. 2017. Caddisflies (Insecta: Trichoptera) from Maranhão State, Northeast Region, Brazil: A new species, checklist, and new geographical records. Zootaxa, 4221: 151-171.

Dias, A.M. & Lattke, J.E. 2019. A new species and new records of minuta group Gnamptogenys from Brazil (Hymenoptera: Formicidae). Revista Brasileira de Entomologia, 63(1): 30-34.

Feitosa, R.M.; Brandão, C.R.F. & Dietz, B.H. 2007. Basichenos scambognathus (Brown, 1949) n. comb., with the first worker and male descriptions, and a revised generic diagnosis (Hymenoptera: Formicidae: Myrmicinae). Papéis Avulsos de Zoologia, 47(2): 31-42.

Feitosa, R.M.; Brandão, C.R.F. & Diniz, J.L.M. 2008. Revisionary studies on the enigmatic Neotropical ant genus Stegomyrmex Emery, 1912 (Hymenoptera: Formicidae: Myrmicinae), with the description of two new species. Journal of Hymenoptera Research, 17: 64-82.

Fernandes, I.O.; Oliveira, M.L. & Delabie, J.H.C. 2014. Description of two new species in the Neotropical Pachycondyla foetida complex (Hymenoptera: Formicidae: Myrmicinae), with the description of two new species. Journal of Hymenoptera Research, 17: 64-82.

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

Figueroed, C.J.; Silva, R.R.; Munha, C.B. & Morini, M.S.C. 2013. Fauna de formigas (Hymenoptera: Formicidae) atraídas a armadilhas subterrâneas em áreas de Mata Atlântica. Biota Neotropical, 13: 1-7.

Forel, A. 1904. Miscelanea myrmécològiques. Revue Suisse de Zoologie, 12: 1-52.

Freitas, M.A.; Vieira, R.S.; Entiauspe-Neto, O.M.; Sousa, T.; Souza, A.G. & Moura, G.J.B. 2017. Herpetofauna of the Northwest Amazon forest in the state of Maranhão, Brazil, with remarks on the Gurupi Biological Reserve. Zootaxa, 463: 141-155.

Gasper, A.L.; Eisenlohr, P.V. & Salino, A. 2016. Improving collection efforts to avoid loss of biodiversity: lessons from comprehensive sampling of ants. Revista Brasileira de Entomologia, 2: 209-218.

Gijhmans, R.J.; Garrett, K.A.; Huaman, Z.; Zhang, D.P.; Schreuder, M. & Bonierbale, M. 2000. Assessing the geographic representativeness of genebank collections: the case of Bolivian wild potatoes. Conservation Biology, 14: 1755-65.

Gonçalves, C.R. 1947. Saúvas do sul e centro do Brasil. Revista Brasileira de Entomologia, 9: 5-32.

Gonçalves, C.R. 1947. Contribuição para o conhecimento do género Atta Fabr., das formigas saúvas. Boletim da Sociedade Brasileira de Agronomia, 5: 333-358.

Gonçalves, C.R. 1947. Saúvas do sul e centro do Brasil. Boletim Fitossanitário, 2: 183-218.

Gonçalves, C.R. 1961. O género Acromyrmex no Brasil (Hym. Formicidae). Studia Entomológica, 4: 113-180.

Graham, C.H.; Elith, J.; Hijmans, R.J.; Guisan, A.; Townsend Peterson, A. & Loiselle, B.A. 2008. The influence of spatial errors in species occurrence data used in distribution models. Journal of Applied Ecology, 45: 239-247.

Gutiérrez, J.A.M.; Rousseau, G.X.; Andrade-Silva, P. & Delabie, J.H.C. 2017. Taxonomy of the genus Monacis Roger, from the Amazon, with further remarks on the genus (Hymenoptera, Formicidae). Studia Entomologica, 3: 385-400.

Hijmans, R.J.; Garrett, K.A.; Huaman, Z.; Zhang, D.P.; Schreuder, M. & Bonierbale, M. 2000. Assessing the geographic representativeness of genebank collections: the case of Bolivian wild potatoes. Conservation Biology, 14: 1755-65.

Instituto Brasileiro de Geografia e Estatística (IBGE). 2011. Índice de Nomes Geográficos, Escala 1:1.000.000. Base Cartográfica Continua do Brasil ao Milionésimo. Disponível em: http://www.ibge.gov.br/geociencias/cartas-e-mapsas-bases-cartograficas-continuas/15759-brasil.html?==Et==sobre. Acesso em: 03/12/2018.

Jespore, A. & Schultz, T.R. 2017. Revision of the fungus-farming ant genus Sericornymex Mayr (Hymenoptera, Formicidae, Myrmicinae). Zootaxa, 670: 1-109.

Johnson, A.D. 2015. A taxonomic revision of South American species of the genus Leptogenys (Hymenoptera: Formicidae). Part 1. Zootaxa, 4029(1): 1-142.

Kadmon, R.; Farber, O. & Danin, A. 2003. A systematic analysis of factors affecting the performance of climatic envelope models. Ecological Applications, 13: 853-67.

Kempf, W.W. 1959. Insecta Amapaensis. Hymenoptera: Formicidae. Studia Entomologica, 2: 209-218.

Kempf, W.W. 1960a. Insecta Amapaensis. Hymenoptera: Formicidae (segunda contribuição). Studia Entomologica, 3: 385-400.

Kempf, W.W. 1960b. Estudo sobre Pseudomyrmex l. (Hymenoptera: Formicidae). Revista Brasileira de Entomologia, 9: 5-32.

Kempf, W.W. 1964. Uma nova Platythyrea do Brasil (Hym., Formicidae). Revista Brasileira de Entomologia, 11: 141-144.

Kempf, W.W. 1968. Miscellaneous studies on Neotropical ants. IV. (Hymenoptera, Formicidae). Revista Brasileira de Entomologia, 11: 369-415.

Kempf, W.W. 1971. A preliminary review of the ponerine ant genus Dinoponera Roger (Hymenoptera: Formicidae). Studia Entomológica, 14: 369-394.

Kempf, W.W. 1972a. Catálogo abreviado das formigas da região Neotropical (Hym. Formicidae). Studia Entomológica, 15: 1-4.

Kempf, W.W. 1972b. A new species of the Dolichoderine ant genus Monacis Roger, from the Amazon, with further remarks on the genus (Hymenoptera, Formicidae). Revista Brasileira de Biologia, 32: 251-254.

Kempf, W.W. 1975. Miscellaneous studies on neotropical ants. VI. (Hymenoptera, Formicidae). Studia Entomológica, 18: 341-380.

Lattke, J.E. 2008. Review of the New World species of the genus Leptogenys Roger (Insecta: Hymenoptera: Formicidae: Ponerinae). Arthropod Systematics and Phylogeny, 69: 127-264.

Leal, L.R.; Leal, L.; Oliveira, P.P.; Arcovaro, G.B. & Andersen, A.N. 2017. Effects of human disturbance and climate change on myrmecochory in Brazilian Caatinga. In: Oliveira, P.S. & Koptur, S. (Eds.). Ant-plant interactions. Impacts of human on terrestrial ecosystems. Cambridge, UK, Cambridge University Press. p. 112-132.

Lima, W.R.S.; Marques, S.G.; Rodrigues, F.S. & Rebelo, J.M.M. 2013. Ants in a hospital environment and their potential as mechanical bacterial vectors. Revista da Sociedade Brasileira de Medicina Tropical, 46(5): 637-640.

Longino, J.T. & Snelling, R.R. 2002. A taxonomic revision of the Procrocyturus (Hymenoptera: Formicidae) of Central America. Contributions in Science, 495: 1-30.
