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Research

Phlebotominae (Diptera: Psychodidae) and Biomes in the State of Mato Grosso do Sul, Brazil

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Abstract

The state of Mato Grosso do Sul, Brazil is an important region of South America regarding leishmaniasis, with the great diversity of sandflies reported since 1938 and wide biodiversity represented by its biomes (Atlantic Forest, Cerrado, and Pantanal). A checklist of sandflies is presented here for the state and respective biomes. The data base was compiled from primary and secondary data. The primary data collection involved automatic light traps at Miranda–Abobral Pantanal subregion and in subregion Baixa Nhecolândia of Pantanal. The secondary data were obtained from entomology scientific collections and a literature review of articles from 1938 to 2019, including entomological museum collections. A total of 71 species were reported, belonging to 14 genera and 13 subgenera, in 61 municipalities of the state, including the type locality of 9 species, and the first report of *Lutzomyia cruzi* (Mangabeira 1938), vector of *Leishmania infantum* (Nicolle 1937), in the Pantanal region of Miranda–Abobral. Other vector species, *Bichromomyia flaviscutellata* (Mangabeira 1942), *Lutzomyia longipalpis* (Lutz & Neiva 1912), *Nyssomyia antunesi* (Coutinho 1939), *Nyssomyia intermedia* (Lutz & Neiva 1912), *Nyssomyia neivai* (Pinto 1926), and *Nyssomyia whitmani* (Antunes & Coutinho 1939), are reported in the entire area of the state. Maps containing the distribution of sandflies on Mato Grosso do Sul biomes were produced. The eclecticism of the species in relation to their ecotypes was observed, with several species using the three biome types as habitats and breeding sites.

Key words: biome, inventory, leishmaniasis, pantanal, review

Phlebotomine sandflies are dipterans of interest regarding public health because they include vector species of *Leishmania* spp. (Ross 1903) (Kinetoplastida: Trypanosomatidae) (Killick-Kendrick 1990). Leishmaniasis is prevalent in 98 countries and is one of the six most important tropical diseases in the world, with approximately 50,000–90,000 new cases of visceral leishmaniasis (VL) each year and 0.6–1 million new cases of cutaneous leishmaniasis (CL) (WHO 2020).

Phlebotomine sandflies are found in all continents, except polar areas. Of the 1,008 taxa described in the world, species and subspecies (977 current and 31 fossils), 539 are recorded in the Americas, with 522 current and 17 fossils (Shimabukuro et al. 2017, Galati 2018). In Brazil, Lutz and Neiva (1912) described the first species of Phlebotominae: *Psychodopygus squamiventris* (Lutz & Neiva 1912), *Lutzomyia longipalpis* Lutz & Neiva 1912, and *Nyssomyia intermedia* Lutz & Neiva 1912. In the entire country, studies of fauna

and identification of new species have been conducted in different regions by different authors (Lima 1931; Barretto and Coutinho 1941; Damasceno et al. 1949; Barretto 1951; Forattini 1971, 1973; Martins et al. 1978; Aguiar and Medeiros 2003; Lainson and Rangel 2005).

Currently, about 282 species have been reported in the Brazilian territory (Shimabukuro et al. 2017, Galati 2018), several classified as vectors of *Leishmania* spp., such as *Bichromomyia flaviscutellata* Mangabeira 1942, *Lu. longipalpis*, *Lutzomyia cruzi* Mangabeira 1938, *N. intermedia*, *Nyssomyia neivai* Pinto 1926, *Nyssomyia whitmani* Antunes & Coutinho 1939, *Nyssomyia umbratilis* (Ward & Fraiha 1977), *Psychodopygus wellcomei* (Fraiha, Shaw & Lainson 1971), and *Trichophoromyia ubiquitalis* (Mangabeira 1942) (Lainson et al. 1992, Rangel and Lainson 2009, Lainson 2010, Aguiar and Vieira 2018).

In the state of Mato Grosso do Sul, located in the Central–West Region of Brazil and covering the Atlantic Forest, Cerrado, and Pantanal biomes, 65 species of phlebotomine sandflies had been recorded (Aguiar and Vieira 2018). Among these species phlebotomine sandflies, several are vectors of *Leishmania* spp., such as *Bi. flaviscutellata*, *Lu. cruzi*, *Lu. longipalpis*, *N. intermedia*, *N. neivai*, and *N. whitmani*. Historically, the state of Mato Grosso do Sul is an endemic area of VL and CL, with the report of the first case of VL with parasitological confirmation in 1913 (Migone 1913). Between 2013 and 2015, 445 cases of CL were reported, and between 2011 and 2020, 1,705 cases of VL were documented in the state, distributed throughout 46 of its 79 municipalities (Mato Grosso do Sul 2020). Among these 46 municipalities, 6 are epidemiologically classified as areas of intense transmission of VL: Aquidauana, Campo Grande, Corumbá, Coxim, Anastácio, and Três Lagoas (Mato Grosso do Sul 2017).

Considering the substantial number of reported leishmaniasis cases and the growing development of ecotourism in the state Mato Grosso do Sul, knowledge of the fauna of phlebotomine sandflies is becoming relevant and reinforces the importance of checklists for this group in the region. This information enable taxonomic identification and may support epidemiological studies on these diseases and vector control. The present work is aimed at presenting an updated checklist of reported phlebotomine sandfly species and their distribution in the municipalities and biomes of the state of Mato Grosso do Sul, Brazil.

Materials and Methods

Study Area

The state of Mato Grosso do Sul (Fig. 1), with an area of 357,145.535 km^2, is in the Central–West Region of Brazil and occupies 22.2% of this region. It has 79 municipalities and 165 districts, with a population of 2,778,986 residents (Instituto Brasileiro de Geografia e Estatística [IBGE] 2019a). It borders two countries and five Brazilian states: to the north, it borders the state of Mato Grosso, to the west Bolivia and Paraguay, to the south Paraguay and the state of Paraná states, and to the east, the states of São Paulo, Minas Gerais, and Goiás states. The most prevalent climate is tropical wet and dry (Aw) (Mato Grosso do Sul 2008), with a rainy season in the summer (October to March) and a dry season in the winter (April to September). In its area to the north, the equatorial climate of humid Amazon masses predominates, with high average temperatures in the winter and high rainfall rates in the summer. In the central area, the summer is rainy and the winter is warm and dry, with prevalence of the tropical climate, alternating between low temperatures at the end of autumn

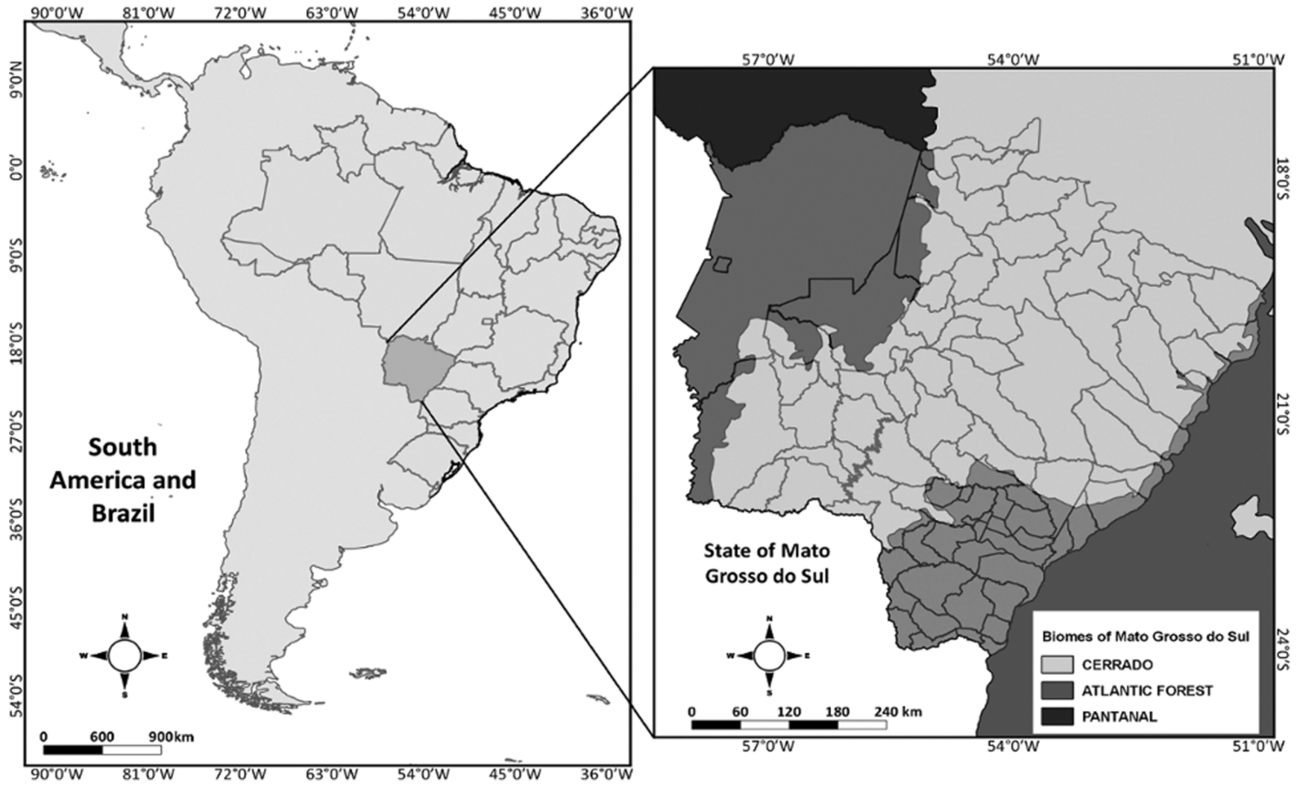

Fig. 1. Location of the study area, state of Mato Grosso do Sul, Brazil. The map of South America, Brazil and Mato Grosso do Sul (and the shapefile used to generate it) used for the elaboration of Fig. 1 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

and raining late summer. The climate of the areas to the east and to the south is predominantly tropical, with a warm and dry winter, and to the west, hot and humid with little wind. The annual rainfall rate of the state is approximately 1,500 mm (Mato Grosso do Sul 2008, IBGE 2019a).

The predominant vegetation is composed of Savannah (Cerrado), which occupies ~65% of the area of the state. To the west, the vegetation is composed by Chaco, a characteristic phyto-physiognomy of Pantanal of the south and southeast of the state of Mato Grosso, and to the south and east is composed of Atlantic Forest. The state of Mato Grosso do Sul also includes the southern part of the Pantanal plain, the largest floodplain in the world, with more than 110,000 km^2, sustaining rich biodiversity (Brasil 2007, Mato Grosso do Sul 2008, IBGE 2019a).

Data Collection

The data base was compiled from primary and secondary data.

Primary Data

Collection procedures involved automatic light traps (Falcão 1981), at Pantanal Study Base of the Federal University of Mato Grosso do Sul (BEP/UFMS) (19°34′36.70″S 57°1′8.39″W), at Pousada Passo of the Lontra Parque Hotel (19°34′46.71″S 57°1′14.06″W), both located in the Miranda–Abobral Pantanal subregion, and at Fazenda Barranco Alto (19°32′59.85″S 56°9′0.00″W), in Baixa Nhecolândia Pantanal subregion. Sandflies were collected between January and June 2015 and January and February 2016. The traps were installed between 06:00 p.m. and 06:00 a.m. The insects were clarified and assembled according to Forattini (1973). In order to identify the species, the structures of the head, thorax, and abdomen were used, with emphasis on the genitalia, following the classification proposed by Galati (2018). The abbreviation of genera and subgenera is in agreement with Marcondes (2007) and Galati (2018).

Secondary Data

Data referring to phlebotomine sandfly species reported in Mato Grosso do Sul state were obtained from scientific literature between 1938 and 2019 (Mangabeira Filho 1938; Barretto 1951; Forattini 1954, 1971; Martins and Silva 1963; Martins et al. 1978, 1984; Williams and Carvalho 1979; Galati et al. 1985, 1989, 1995, 1996, 1997, 2001, 2003a, b, 2006; Dias et al. 1986, 1991; Marcondes 1995; Marcondes et al. 1998; Santos et al. 1998, 2001, 2003, 2011, 2013; Galati and Nunes 1999; Oliveira et al. 2000, 2001, 2003, 2006, 2008a, b, 2010, 2012a, b, 2013, 2015a, b, 2017a, b; Braga-Miranda and Galati 2005; Braga-Miranda et al. 2006; Ferreira Júnior 2006; Marassá et al. 2006; Oliveira 2006; Paiva et al. 2006, 2010; Andrade Filho et al. 2007; Nascimento et al. 2007; Silva et al. 2007, 2008; Nunes et al. 2008; Pita-Pereira et al. 2008; Andrade et al. 2009, 2011, 2012; Dorval et al. 2009, 2010; Lopes 2009; Savani et al. 2009; Almeida et al. 2010a, b, 2013, 2015, 2019a,b; Santos 2010; Brilhante et al. 2011, 2015, 2019; Canesin 2011; Fernandes et al. 2011, 2013, 2017; Gomes et al. 2012; Ishimi 2012; Casaril et al. 2014; Cunha et al. 2014; Leite 2015; Ribeiro et al. 2015; Souza 2015; Figueiredo et al. 2016; Infran et al. 2017; Galati 2018; Barrios et al. 2019; Casaril et al. 2019). Data referring to 34 phlebotomine sandfly species from 12 localities of Mato Grosso do Sul reported in the Coleção de Flebotomíneos/FIOCRUZ-COLFLEB (Centro de Pesquisas René Rachou/CPqRR -Fiocruz; colfleb.fiocruz.br/catalogue) were also compiled (Fiocruz 2020). Collections deposited in *SpeciesLink* (splink.cria.org.br/) were registered. Species were compiled by male and or female sex.

Data Analysis

The subdivision of Pantanal into subregions is in agreement with Mioto et al. (2012), and the classification of biomes is in accordance with the Federal Constitution, article 225 (Brasil 1988) and IBGE (2019bc).

To generate georeferenced maps, shapefiles were obtained from the database of public domain of the IBGE website (http://www.ibge.gov.br; 2019) and the species with their respective record coordinates were inserted using QGIS 2.18.10 software (OSGeo 2017).

To compare species richness among the three biomes, a Venn diagram was designed in the ClickCharts 3.01 software (NCH 2018), highlighting the number of unique species and that of common species among the areas.

The chronological graph was made using the program LibreOffice 6.4.2 (The Document Foundation [TDF] 2020).

Ethical Statement

The research group has a permanent license for the collection of zoological material issued by the Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais (IBAMA SISBio 25952-1). This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance Code 001. Field studies were carried out on two private properties, the owners of which gave permission to conduct the study in their respective intra- and peridomiciliary areas. In addition, the field studies did not involve any endangered or protected species.

Results

In the state of Mato Grosso do Sul, there are 71 known species, belonging to 4 subtribes (Brumptomyiina, Sergentomyiina, Lutzomyiina, and Psychodopygina), and 14 genera and 13 subgenera have been registered (Table 1). The state of Mato Grosso do Sul is the type-locality of nine phlebotomine sandfly species: *Evandromyia*

Table 1. Phlebotominae species (Diptera: Psychodidae) reported in the state of Mato Grosso do Sul and biomes of occurrence

Species	Biomes
1. *Bichromomyia flaviscutellata*	Atlantic Forest, Cerrado, and Pantanal
2. *Brumptomyia avellari*	Atlantic Forest, Cerrado and Pantanal
3. *Brumptomyia brumpti*	Atlantic Forest, Cerrado, and Pantanal
4. *Brumptomyia cunhai*	Atlantic Forest, Cerrado, and Pantanal
5. *Brumptomyia galindoi*	Atlantic Forest and Cerrado
6. *Brumptomyia nitzulescui* (Costa Lima 1932)	Cerrado
7. *Brumptomyia pintoi*	Atlantic Forest and Cerrado
8. *Evandromyia aldafalcaoae*	Cerrado and Pantanal
9. *Evandromyia bacula* (Martins, Falcão & Silva 1965)	Atlantic Forest and Cerrado

Table 1. Continued

Species	Biomes
10. *Evandromyia bourrouli*	Atlantic Forest and Cerrado
11. *Evandromyia carmelinoi*	Atlantic Forest and Cerrado
12. *Evandromyia cortelezzii*	Atlantic Forest, Cerrado, and Pantanal
13. *Evandromyia corumbaensis*	Atlantic Forest, Cerrado, and Pantanal
14. *Evandromyia evandroi* (Costa Lima & Antunes 1936)	Atlantic Forest, Cerrado, and Pantanal
15. *Evandromyia lenti*	Atlantic Forest, Cerrado, and Pantanal
16. *Evandromyia orcyi*	Atlantic Forest and Cerrado
17. *Evandromyia sallesi*	Atlantic Forest, Cerrado, and Pantanal
18. *Evandromyia saulensis*	Cerrado and Pantanal
19. *Evandromyia teratodes* (Martins, Falcão & Silva 1964)	Atlantic Forest, Cerrado, and Pantanal
20. *Evandromyia termitophila*	Atlantic Forest, Cerrado, and Pantanal
21. *Evandromyia walkeri*	Cerrado and Pantanal
22. *Expapillata cerradincola*	Cerrado
23. *Lutzomyia almerioi*	Atlantic Forest, Cerrado, and Pantanal
24. *Lutzomyia cruzi*	Cerrado and Pantanal
25. *Lutzomyia dispar*	Cerrado and Pantanal
26. *Lutzomyia forattinii*	Cerrado and Pantanal
27. *Lutzomyia longipalpis*	Atlantic Forest, Cerrado, and Pantanal
28. *Lutzomyia renei* (Martins, Falcão & Silva 1957)	Cerrado
29. *Martinsmyia cipoensis*	Cerrado
30. *Martinsmyia oliveirai* (Martins, Silva & Falcão 1970)	Cerrado and Pantanal
31. *Micropygomyia acanthopharynx*	Atlantic Forest, Cerrado, and Pantanal
32. *Micropygomyia echinatopharynx* (Andrade Filho, Galati, Andrade & Falcão 2004)	Cerrado
33. *Micropygomyia ferreirana* (Barretto, Martins & Pellegrino 1956)	Pantanal
34. *Micropygomyia longipennis*	Atlantic Forest, Cerrado, and Pantanal
35. *Micropygomyia oswaldoi* (Mangabeira 1942)	Cerrado
36. *Micropygomyia peresi* (Mangabeira 1942)	Cerrado and Pantanal
37. *Micropygomyia quinquefer* (Dyar 1929)	Cerrado and Pantanal
38. *Micropygomyia trinidadensis* (Newstead 1922)	Pantanal
39. *Micropygomyia villelai* (Mangabeira 1942)	Cerrado
40. *Micropygomyia vonatzingeni* (Galati 2007)	Cerrado
41. *Migonemyia bursiformis*	Cerrado
42. *Migonemyia migonei*	Atlantic Forest and Cerrado
43. *Nyssomyia antunesi*	Atlantic Forest and Cerrado
44. *Nyssomyia intermedia*	Atlantic Forest, Cerrado, and Pantanal
45. *Nyssomyia neivai*	Atlantic Forest, Cerrado, and Pantanal
46. *Nyssomyia whitmani*	Atlantic Forest, Cerrado, and Pantanal
47. *Pintomyia christenseni* (Young & Duncan 1994)	Atlantic Forest and Cerrado
48. *Pintomyia damascenoi*	Atlantic Forest and Cerrado
49. *Pintomyia fischeri*	Atlantic Forest and Cerrado
50. *Pintomyia kuscheli* (Le Pont, Martinez, Torrez-Espejo & Dujardin 1998)	Cerrado and Pantanal
51. *Pintomyia mamedei* (Oliveira, Afonso, Dias & Brazil 1994)	Atlantic Forest and Cerrado
52. *Pintomyia misionensis* (Castro 1959)	Atlantic Forest, Cerrado, and Pantanal
53. *Pintomyia monticola*	Atlantic Forest
54. *Pintomyia pessoai*	Atlantic Forest, Cerrado, and Pantanal
55. *Psathyromyia abonnenci* (Floch & Chassignet 1947)	Cerrado
56. *Psathyromyia aragaoi*	Atlantic Forest and Cerrado
57. *Psathyromyia brasiliensis*	Cerrado
58. *Psathyromyia bigeniculata*	Atlantic Forest, Cerrado, and Pantanal
59. *Psathyromyia campbelli* (Damasceno, Causey & Arouck 1945)	Cerrado
60. *Psathyromyia campograndensis*	Atlantic Forest, Cerrado, and Pantanal
61. *Psathyromyia dreisbachi*	Cerrado
62. *Psathyromyia hermanlenti*	Atlantic Forest, Cerrado, and Pantanal
63. *Psathyromyia lanei* (Barretto & Coutinho 1941)	Atlantic Forest and Cerrado
64. *Psathyromyia lutziana*	Atlantic Forest and Cerrado
65. *Psathyromyia punctigeniculata*	Atlantic Forest, Cerrado, and Pantanal
66. *Psathyromyia runoides* (Faichild & Hertig 1953)	Cerrado
67. *Psathyromyia scaffi* (Damasceno & Arouck 1956)	Atlantic Forest and Cerrado
68. *Psychodopygus claustrei* (Abonnenc, Léger & Fauran 1979)	Cerrado
69. *Psychodopygus davisi* (Root 1934)	Cerrado and Pantanal
70. *Sciopemya sordellii*	Atlantic Forest, Cerrado, and Pantanal
71. *Viannamyia furcata* (Mangabeira 1941)	Cerrado

aldafalcaoae (Santos, Andrade Filho & Honer 2001); *Evandromyia orcyi* (Oliveira et al. 2015a); *Evandromyia corumbaensis* (Galati et al. 1989); *Expapillata cerradincola* (Galati et al. 1995); *Lutzomyia almerioi* (Galati and Nunes 1999); *Lu. cruzi* and *Lutzomyia dispar* (Martins & Silva 1963); *Lutzomyia forattinii* (Galati, Rego, Nunes & Teruya 1985); and *Psathyromyia campograndensis* (Oliveria et al. 2001) (Table 2).

Regarding the recently collected material treated here as 'primary data', four species were collected: *Brumptomyia brumpti* (Larrousse 1920); *Ev. corumbaensis* and *Evandromyia walkeri* (Newstead 1914); and *Lu. cruzi* (Fig. 2). In the Pantanal of Miranda–Abobral (BEP/UFMS), a region of the municipality of Corumbá, the presence of *Lu. cruzi* was reported for the first time.

Among the 79 municipalities that constitute the state of Mato Grosso do Sul, phlebotomine sandflies are reported in 61 of them (77.21%; Fig. 3). In terms of transmission of *Leishmania* spp., these reports include vector species, *Bi. flaviscutellata*, *Lu. longipalpis*, *Lu. cruzi*, *Nyssomyia antunesi*, *N. intermedia*, *N. neivai*, and *N. whitmani*; incriminated species *Lu. forattinii*, *Migonemyia migonei* (França 1920), *Pintomyia fischeri* (Pinto 1926), and *Pintomyia pessoai* (Coutinho & Barretto 1940); and suspected species *Lu. almerioi*. The species *N. whitmani* was reported in 49 municipalities (Fig. 4), *Lu. longipalpis* in 43 municipalities (Fig. 5), and *Lu. cruzi* in 9 municipalities (Fig. 6).

Campo Grande, capital of the state of Mato Grosso do Sul, is the municipality that showed the greatest diversity, with 34 phlebotomine sandfly species reported, followed by Aquidauana (34), Dourados (32), Rio Verde de Mato Grosso (29), Bonito (28), Camapuã (25), Corguinho (25), Corumbá (23), Bodoquena (21), and Maracajú (19) (Table 2).

Regarding the biomes, 68 phlebotomine sandfly species were reported in the Cerrado biome, 38 in Pantanal, and 42 in the Atlantic Forest. Species showed eclecticism regarding the environments with 25 species reported in the three biomes of the state (Fig. 7).

The chronological graph (Fig. 8) reveals that until 1971, only five species were recorded in the state [*Lu. cruzi*, *Pi. pessoai*, *Martinsmyia cipoensis* (Martins, Falcão & Silva, 1964), *Lu. dispar*, and *Pintomyia monticola* (Costa Lima 1932)]. From 1978, an expressive number of species was recorded, among them are *Lu. longipalpis* and *N. whitmani*.

Discussion

First Records of Sandflies

In 1938, the 15th case of VL in the country in a child with an enlarged spleen and liver was described in Camapuã (at the time, Camapuan), Cerrado area. Parasitological diagnosis of an autochthonous triggered a series of searches for the insect vector in the region, and Evandro Chagas finally reported a male specimen of phlebotomine sandfly, which Mangabeira Filho later described as *Flebotomus cruzi* (=*Lu. cruzi*, sensu Galati, in honor of Oswaldo Cruz), and four female specimens, which were not identified (Chagas and Chagas 1938, Oliveira 1938, Mangabeira Filho 1938, Barretto 1951).

Since the 1950s, with the increase in the number of diagnosed cases of CL and VL in state of Mato Grosso do Sul (Arruda et al. 1949, Forattini 1954), contributions to knowing the Phlebotominae fauna diversity have been extended. Additional data on the distribution of phlebotomine sandflies in the Americas, including specimens reported in Mato Grosso do Sul, were published by Barretto (1951). *Phlebotomus intermedius* (=*N. intermedia*, sensu Galati) was reported in the municipality of Três Lagoas (Cerrado and Atlantic forest areas), and *Phlebotomus whitmani* (=*N. whitmani*, sensu Galati) was collected in Camapuã. The species *Phlebotomus pessoai* (=*Pi. pessoai*, sensu Galati) was observed in Rio Brilhante; *Phlebotomus monticolus* (=*Pi. monticola*, sensu Galati), *Ph. intermedius* (=*N. intermedia*, s. lat. sensu Galati), and *Phlebotomus migonei* (=*Mig. migonei*, sensu Galati) in Nova Andradina; and the species *Pi. pessoai* in Anaurilândia, cities included in the Atlantic Forest and Cerrado biomes (Barretto 1951; Forattini 1954, 1971).

Due to the stepped-up fight against leishmaniasis, in the 1960s and 1970s, collections were performed in different municipalities and districts of the state, such as Aquidauana, Bela Vista, Bonito, Caarapó, Camapuã, Campo Grande, Maracajú, Miranda, and Nioaque, which revealed the species *Brumptomyia avellari* (Costa Lima 1932), *Brumptomyia cunhai* (Mangabeira 1942), *Brumptomyia galindoi* (Fairchild & Hertig, 1947), *Brumptomyia pintoi* (Costa Lima 1932), *Evandromyia bourrouli* (Barreto & Coutinho 1941), *Evandromyia carmelinoi*, *Evandromyia corumbaensis*, *Evandromyia cortelezzii* (Bréthes 1923), *Evandromyia lenti* (Mangabeira 1938), *Evandromyia termitophila* (Martins, Falcão & Silva 1964) , *Evandromyia sallesi* (Galvão & Coutinho 1939), *Evandromyia saulensis* (Floch & Abonnenc, 1944), *Lu. cruzi*, *Lu. longipalpis*, *Ma. cipoensis*, *Micropygomyia longipennis* (Barreto 1946), *Micropygomyia acanthopharynx* (Martins, Falcão & Silva 1962), *Migonemyia bursiformis* (Floch & Abonnenc 1944), *Mig. migonei*, *N. whitmani*, *Psathyromyia aragaoi* (Costa Lima 1932), *Psathyromyia lutziana* (Costa Lima 1932), *Psathyromyia punctigeniculata* (Floch & Abonnenc 1944), *Pintomyia damascenoi* (Mangabeira 1941), *Pi. pessoai*, and *Sciopemyia sordellii* (Shannon & Del Ponte 1927). These specimens are deposited in the Coleção de Flebotomíneos (Fiocruz-Colfleb). From 2009 until now, new species from the municipalities of Corguinho, Corumbá, Bonito, Selvíria, Sidrolândia, and Rio Verde de Mato Grosso were added to the collection: *Ev. orcyi*, *Ex. cerradincola*, *Lu. almerioi*, *Lu. forattinii*, *Psathyromyia brasiliensis* (Costa Lima 1932), *Psa. campograndensis*, *Psathyromyia dreisbachi* (Causey & Damasceno 1945), *Psathyromyia hermanlenti* (Martins, Silva & Falcão 1970), and *N. antunesi* (Fiocruz 2020).

Species With the Locality Type in the State of Mato Grosso do Sul

Because of the constant reports of human and canine VL, the phlebotomine sandfly fauna has become known in some regions and even new species have been described.

In Camisão, a district of Aquidauana, *Lu. dispar* was described by only one male specimen (Martins and Silva 1963). Later, this species was identified in Camapuã, with the description of females and redescription of the male, with females avidly attacking the visitors inside and outside the cave where they were captured, as this species has a close association with rocks and caves (Williams and Carvalho 1979). Aquidauana is also the type locality of *Ev. aldafalcaoae* and it was described based on the male (Santos et al. 2001) and the female in Corumbá (Braga-Miranda and Galati 2005).

The female of *Lu. cruzi* was described by Martins et al. (1984), from captures in 1970 in Camapuã, which yielded 61 males and 11 female specimens. The authors identified an error in Mangabeira's description of *Lu. cruzi* for the number of bristles in the basal tuft of the gonocoxite: six bristles were mentioned, rather than four, the actual number. *Lutzomyia cruzi* and *Lu. longipalpis* males are morphologically similar, and their differentiation is based on the appearance of bristles of the basal tuft of the gonocoxite; in *Lu. cruzi*, bristles are broad and foliaceous, whereas in *Lu. longipalpis*, thin and filiform.

Table 2. Phlebotominae (Diptera: Psychodidae) species in the state of Mato Grosso do Sul, Brazil, with bibliographic references of citations in the state, sex reported, and geographic distribution in Mato Grosso do Sul (MS)

Species	Source of information			
	Collected	Museum	Published records	Distribution in MS
			Brumptomyiina	
Brumptomyia avellari	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a (m, f), 2013, 2015, 2019a (f), 2019b (m, f); Andrade et al. 2009 (m, f); Braga-Miranda et al. 2006 (m, f); Brilhante et al. 2015 (m, f); Dorval et al. 2009 (m, f), 2010 (m); Fernandes et al. 2017 (m, f); Galati et al. 1996 (m, f), 2003a (m, f), 2006 (m, f); Galati 2018; Infran et al. 2017 (m, f); Martins et al. 1978 (m, f); Nascimento et al. 2007 (f); Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2006 (m, f), 2010 (m), 2012a (m); Paiva et al. 2006 (f); Savani et al. 2009 (f); Silva et al. 2007 (m); Souza 2015 (m)	Água Clara, Alcinópolis, Anastácio, Antônio João, Aquidauana, Bela Vista, Bonito, Brasilândia, Caarapó, Camapuã, Campo Grande, Corguinho, Corumbá, Dois Irmãos do Buriti, Dourados, Fátima do Sul, Figueirão, Guia Lopes da Laguna, Jardim, Maracajú, Miranda, Naviraí, Nioaque, Nova Andradina, Novo Horizonte do Sul, Ribas do Rio Pardo, Rochedo, Rio Verde de Mato Grosso, São Gabriel do Oeste, Santa Rita do Pardo, Paranhos e Três Lagoas
Brumptomyia brumpti	Primary data (f)	Fiocruz – COLFLEB (m)	Almeida et al. 2010a (m, f), 2013, 2015, 2019a (m, f), 2019b (m); Andrade et al. 2009 (m, f), 2011 (f), 2012 (f); Barrios et al. 2019 (m, f); Brilhante et al. 2015 (m, f); Canesin 2011; Casaril et al. 2014 (m); Dorval et al. 2009 (m, f), 2010 (m, f); Fernandes et al. 2011, 2013; Ferreira Júnior 2006; Figueiredo et al. 2016 (m); Galati et al. 1997 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Ishimi 2012 (m, f); Leite 2015 (m, f); Lopes 2009 (m, f); Martins et al. 1978 (m, f); Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m), 2006, 2010 (m), 2012a, 2015b (f); Santos 2010 (m, f); Santos et al. 1998 (m, f), 2011; Silva et al. 2008 (f)	Água Clara, Alcinópolis, Antônio João, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Brasilândia, Caarapó, Campo Grande, Corumbá, Costa Rica, Dourados, Fátima do Sul, Guia Lopes da Laguna, Inocência, Jardim, Ladário, Maracajú, Nioaque, Nova Andradina, Ponta Porã, Porto Murtinho, Rio Verde de Mato Grosso, Santa Rita do Pardo, São Gabriel do Oeste, Terenos, Três Lagoas
Brumptomyia cunhai	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a; Canesin 2011; Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (m); Galati et al. 2003a,b (m, f), 2006 (m, f); Galati 2018; Ishimi 2012 (m, f); Lopes 2009 (m, f); Santos 2010 (m, f); Santos et al. 2011; Savani et al. 2009 (f)	Aquidauana, Bodoquena, Bonito, Dourados, Jardim, Maracajú, Porto Murtinho
Brumptomyia galindoi	–	Fiocruz – COLFLEB (m)	Canesin 2011; Galati et al. 2003a,b (m, f); Ishimi 2012 (m, f); Fernandes et al. 2011, 2013, 2017 (m); Ferreira Júnior 2006 (m, f); Lopes 2009 (m); Oliveira et al. 2003 (m); Santos 2010 (m, f); Santos et al. 2011	Bonito, Camapuã, Campo Grande, Dourados, Maracajú
Brumptomyia nitzulescui	–	–	Galati 2018; Martins et al. 1978	Aquidauana
Brumptomyia pintoi	–	Fiocruz – COLFLEB (m)	Almeida et al. 2013, 2019a (m), 2019b (m, f); Fernandes et al. 2013; Galati 2018; Ishimi 2012 (m); Martins et al. 1978 (m); Oliveira et al. 2003 (m), 2006	Água Clara, Alcinópolis, Camapuã, Campo Grande, Dourados, Nova Andradina, Rio Verde de Mato Grosso
			Sergentomyiina	
Micropygomyia (Sauromyia) ferreirana	–	–	Galati 2018; Santos et al. 1998 (m, f)	Corumbá, Ladário
Micropygomyia (Sauromyia) longipennis	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a, 2015; Dias et al. 1991; Fernandes et al. 2011; Galati et al. 1996 (m, f); Galati 2018; Lopes 2009 (f); Oliveira et al. 2003 (m, f), 2006, 2012a; Santos 2010 (f); Santos et al. 2011; Silva et al. 2008 (m)	Aquidauana, Camapuã, Campo Grande, Corguinho, Dourados, Itaquiraí, Maracajú
Micropygomyia (Sauromyia) oswaldoi	–	–	Galati 2018; Infran et al. 2017 (m, f)	Aquidauana

Table 2. Continued

Species	Source of information			Distribution in MS
	Collected	Museum	Published records	
Micropygomyia (Sauromyia) peresi	–	–	Almeida et al. 2010a, 2013, 2015, 2010b (f); Barrios et al. 2019 (m, f); Casaril et al. 2014 (m, f); Dias et al. 1986 (m, f), 1991; Galati et al. 2003b (m), 2006 (m, f); Galati 2018; Infran et al. 2017 (m, f); Oliveira et al. 2010 (m, f), 2015b (m, f); Savani et al. 2009 (f); Silva et al. 2007 (m)	Alcinópolis, Aquidauana, Bela Vista, Brasilândia, Bodoquena, Bonito, Campo Grande, Corguinho, Corumbá, Jardim, Maracajú, Miranda, Nioaque, Rio Verde de Mato Grosso
Micropygomyia (Sauromyia) quinquefer	–	–	Almeida et al. 2010a, 2015, 2019a (f), 2019b (m, f); Andrade et al. 2009 (m, f); Brilhante et al. 2015 (m, f), 2019; Galati et al. 1996 (m, f), 2003a (m, f), 2006 (m, f); Galati 2018; Martins et al. 1978; Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2006, 2012a; Paiva et al. 2010 (f); Savani et al. 2009 (f)	Água Clara, Alcinópolis, Aquidauana, Bodoquena, Bonito, Camapuã, Campo Grande, Corguinho, Miranda
Micropygomyia (Sauromyia) trinidadensis	–	–	Santos et al. 1998 (m, f)	Corumbá, Ladário
Micropygomia (Sauromyia) villelai	–	–	Dias et al. 1991; Galati 2018; Martins et al. 1978	Aquidauana
Micropygomia (Sauromyia) vonatzingeni	–	–	Almeida et al. 2019b (m, f); Galati 2018	Alcinópolis, Aquidauana
Micropygomyia (Silvamyia) acanthopharynx	–	Fiocruz – COLFLEB (m)	Almeida et al. 2013, 2015, 2019b (m, f); Fernandes et al. 2013; Galati et al. 1996 (m, f), 2003a (m, f), 2006 (m); Galati 2018; Ishimi 2012 (m); Martins et al. 1978; Nunes et al. 2008 (f)	Alcinópolis, Aquidauana, Bonito, Bodoquena, Camapuã, Corguinho, Dourados, Rio Negro, Rio Verde de Mato Grosso
Micropygomyia (Silvamyia) echinatopharynx	–	–	Almeida et al. 2019b (f)	Alcinópolis
			Lutzomyiina	
Evandromyia (Aldamyia) aldafalcaoae	–	–	Almeida et al. 2010a; Barrios et al. 2019 (m); Braga-Miranda and Galati 2005; Braga-Miranda et al. 2006 (m, f); Casaril et al. 2014 (m); Figueiredo et al. 2016 (m, f); Galati 2018; Oliveira et al. 2015a (m, f); Santos et al. (2001); Souza 2015 (m, f)	Anastácio, **Aquidauana**, **Corumbá**, Guia Lopes da Laguna, Jardim, Miranda, Nioaque
Evandromyia (Aldamyia) carmelinoi	–	Fiocruz – COLFLEB (m)	Almeida et al. 2013, 2015, 2019 (f); Galati 2018; Oliveira et al. 2010 (m)	Água Clara, Antônio João, Aparecida do Taboado, Campo Grande, Cassilândia, Miranda, Nova Andradina, Novo Horizonte do Sul, Paraíso das Águas, Paranaíba, Rio Verde de Mato Grosso, Três Lagoas
Evandromyia (Aldamyia) evandroi	–	–	Almeida et al. 2010a, 2015; Dorval et al. 2009; Figueiredo et al. 2016 (f); Fernandes et al. 2011; Galati 2018; Infran et al. 2017 (f); Lopes 2009 (f); Oliveira et al. 2010 (m, f); Souza 2015 (m, f)	Aparecida do Taboado, Aquidauana, Bela Vista, Bodoquena, Coxim, Dourados, Jardim, Miranda, Rio Negro, Selvíria, Três Lagoas

Table 2. Continued

Species	Source of information			
	Collected	Museum	Published records	Distribution in MS
Evandromyia (Aldamyia) lenti	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a,b (f), 2013, 2015, 2019a (m, f), 2019b (m, f); Andrade et al. 2009 (f); Barrios et al. 2019 (f); Braga-Miranda et al. 2006 (m); Brilhante et al. 2015 (m, f); Canesin 2011; Dorval et al. 2009 (m, f), 2010 (m, f); Fernandes et al. 2013, 2017 (m, f); Figueiredo et al. 2016 (m, f); Galati et al. 1996 (m, f), 2006 (f); Galati 2018; Infran et al. 2017 (m, f); Ishimi 2012 (m, f); Leite 2015 (m, f); Lopes 2009 (m); Martins et al. 1978; Nascimento et al. 2007 (f); Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2010 (m, f), 2012a (m, f); Paiva et al. 2006 (f), 2010 (f); Santos 2010 (m, f); Santos et al. 2011; Silva et al. 2007 (m, f); Souza 2015 (m)	Água Clara, Alcinópolis, Anaurilândia, Anastácio, Antônio João, Aquidauana, Bela Vista, Bodoquena, Bonito, Camapuã, Campo Grande, Corguinho, Corumbá, Coxim, Dourados, Figueirão, Guia Lopes da Laguna, Maracajú, Miranda, Nioaque, Nova Andradina, Novo Horizonte do Sul, Pedro Gomes, Ponta Porã, Porto Murtinho, Rio Negro, Rio Verde de Mato Grosso, Rochedo, Santa Rita do Pardo, São Gabriel do Oeste, Tacurú, Terenos, Três Lagoas
Evandromyia (Aldamyia) orcyi	–	Fiocruz – COLFLEB (m, f)	Figueiredo et al. 2016 (m, f); Galati 2018; Oliveira et al. 2015	Aquidauana, **Selvíria**
Evandromyia (Aldamyia) termitophila	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a,b (m, f), 2013, 2015; Brilhante et al. 2015 (m, f); Canesin 2011; Dorval et al. 2009 (f); Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (f); Figueiredo et al. 2016 (m); Galati et al. 1996 (m, f), 2006 (m, f); Galati 2018; Ishimi 2012 (f); Leite 2015 (m, f); Lopes 2009 (m, f); Marcondes 1995 (f); Martins et al. 1978; Oliveira et al. 2003 (f), 2006, 2008b (f), 2010 (f), 2012a (m, f); Paiva et al. 2010 (f); Santos 2010 (m, f); Santos et al. 2011; Silva et al. 2007 (m)	Aquidauana, Amambaí, Anaurilândia, Bela Vista, Bonito, Bodoquena, Brasilândia, Camapuã, Campo Grande, Corguinho, Dourados, Itaporã, Maracajú, Naviraí, Nioaque, Nova Andradina, Novo Horizonte do Sul, Paranaíba, Ponta Porã, Rio Verde de Mato Grosso, Rochedo, São Gabriel do Oeste, Selvíria, Três Lagoas
Evandromyia (Aldamyia) walkeri	Primary data (m)	–	Almeida et al. 2010a, 2015; Barrios et al. 2019 (m); Casaril et al. 2014 (m); Figueiredo et al. 2016 (m, f); Oliveira et al. 2015b (f); Souza 2015 (m)	Aquidauana, Corumbá, Miranda, Nioaque, Terenos
Evandromyia (Barrettomyia) cortelezzii	–	Fiocruz – COLFLEB (f)	Almeida et al. 2010a,b (m), 2013; Andrade et al. 2011 (f), 2012 (f); Brilhante et al. 2019; Canesin 2011; Casaril et al. 2014 (f); Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (f); Galati 2018; Ishimi 2012; Leite 2015 (f); Lopes 2009 (m, f); Nascimento et al. 2007 (f); Oliveira et al. 2003 (m, f), 2006, 2012a (m), 2015 (f); Paiva et al. 2006 (f), 2010 (f); Santos 2010 (m, f); Santos et al. 2011	Antônio João, Aquidauana, Bonito, Camapuã, Campo Grande, Corumbá, Dourados, Guia Lopes, Miranda, Nova Andradina, Novo Horizonte do Sul, Ponta Porã, Rio Verde de Mato Grosso
Evandromyia (Barrettomyia) corumbaensis	Primary data (m, f)	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a; Andrade et al. 2009 (m, f); Barrios et al. 2019 (m, f); Brilhante et al. 2019; Casaril et al. 2014 (m, f); Galati et al. 1989, 1996 (m, f), 1997 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Marcondes 1995 (m, f); Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2006, 2015b (m, f); Santos et al. 1998 (m, f); Savani et al. 2009 (f)	Bodoquena, Bonito, Camapuã, Campo Grande, Corguinho, **Corumbá**, Jardim, Ladário, Miranda, Nioaque, Porto Murtinho
Evandromyia (Barrettomyia) sallesi	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a,b (m, f), 2013, 2015, 2019 (f); Andrade et al. 2009 (m, f); Barrios et al. 2019 (f); Brilhante et al. 2019; Casaril et al. 2014 (m, f); Fernandes et al. 2016 (m, f); Figueiredo et al. 2016 (m, f); Galati et al. 1997 (m, f), 2006 (m); Galati 2018; Martins et al. 1978; Nunes et al. 2008 (m, f); Oliveira et al. 2015b (m, f); Santos et al. 1998 (m, f); Souza 2015 (m, f)	Água Clara, Alcinópolis, Anastácio, Antônio João, Aquidauana, Bodoquena, Bonito, Camapuã, Corumbá, Costa Rica, Guia Lopes da Laguna, Jaraguari, Ladário, Maracajú, Miranda, Nioaque, Nova Andradina, Novo Horizonte do Sul, Ponta Porã, São Gabriel do Oeste, Selvíria, Terenos

Table 2. Continued

Species	Source of information			
	Collected	Museum	Published records	Distribution in MS
Evandromyia (Barrettomyia) teratodes	–	–	Almeida et al. 2013, 2015, 2019b (f); Fernandes et al. 2017 (f); Galati et al. 1996 (m, f), 2001 (m, f), 2006 (m, f); Galati 2018; Leite 2015 (f); Oliveira et al. 2003 (f), 2006, 2012a; Santos 2010 (m, f); Santos et al. 2011	Alcinópolis, Bodoquena, Bonito, Camapuã, Campo Grande, Corguinho, Corumbá, Dourados, Nova Andradina, Rio Negro, Rio Verde de Mato Grosso.
Evandromyia (Evandromyia) bourrouli	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2013; Dorval et al. 2010 (m, f); Galati 2018; Oliveira et al. 2003 (m, f), 2006, 2012a	Bela Vista, Campo Grande, Novo Horizonte do Sul, Rio Verde de Mato Grosso
Evandromyia (Evandromyia) saulensis	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2015, 2019b (m, f); Galati 2018; Infran et al. 2017 (f)	Alcinópolis, Aquidauana, Coxim
Expapillata cerradincola	–	Fiocruz – COLFLEB (m)	Galati et al. 1996 (m, f); Galati 2018; Oliveira et al. 2003 (f), 2006	Campo Grande, **Corguinho**
Lutzomyia (Lutzomyia) almerioi	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a; Galati and Nunes 1999; Galati et al. 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Marassá et al. 2006 (f); Savani et al. 2009 (f); Gomes et al. 2012 (m)	Bataguassú, Bodoquena, **Bonito**, Corumbá, Porto Murtinho
Lutzomyia (Lutzomyia) cruzi	Primary data (m)	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a, 2015, 2019b (m); Barrios et al. 2019 (m, f); Barreto 1951 (m); Casaril et al. 2014 (m, f); Fernandes et al. 2017 (m, f); Galati et al. 1997 (m, f); Galati 2018; Marcondes 1995 (m, f); Martins et al. 1978, 1984 (m, f); Mangabeira Filho 1938; Oliveira et al. 2003 (m), 2006, 2015b (m, f); Pita-Pereira et al. 2008 (m, f); Santos et al. 1998 (m, f), 2013 (f), 2015 (f)	Alcinópolis, Bonito, **Camapuã**, Campo Grande, Cassilândia, Corumbá, Ladário, Paraíso das Águas, São Gabriel d Oeste
Lutzomyia (Lutzomyia) dispar	–	–	Almeida et al. 2010a, 2019b (m, f); Galati 2018; Infran et al. 2017 (m, f); Marcondes 1995 (m, f); Martins and Silva 1963; Martins et al. 1978 (m, f); Williams and Carvalho 1979 (m, f)	Alcinópolis, **Aquidauana**, Camapuã, Terenos
Lutzomyia (Lutzomyia) forattinii	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a; Barrios et al. 2019 (m, f); Casaril et al. 2014 (m, f); Galati et al. 1985, 1997 (m, f); Galati 2018; Marcondes 1995 (m, f); Oliveira et al. 2015b (m, f); Santos et al. 1998 (m, f)	Anastácio, **Corumbá**, Ladário
Lutzomyia (Lutzomyia) longipalpis	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a,b (m, f), 2013, 2015, 2019a (m, f), 2019b (m, f); Andrade et al. 2009 (m, f), 2011 (m, f), 2012 (m, f); Brilhante et al. 2015 (m, f); Canesin 2011; Casaril et al. 2019 (m); Cunha et al. 2014 (f); Dorval et al. 2009 (m, f), 2010 (m, f); Fernandes et al. 2011, 2013; Figueiredo et al. 2016 (m, f); Galati et al. 1996 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Infran et al. 2017 (m, f); Ishimi 2012 (m, f); Lopes 2009 (m, f); Marassá et al. 2006 (f); Martins et al. 1978; Nascimento et al. 2007 (f); Nunes et al. 2008 (m, f); Oliveira et al. 2000 (m, f), 2003 (m, f), 2006, 2008a, b (m, f), 2010 (m, f), 2012a (m, f), 2013 (m, f); Paiva et al. 2006 (f), 2010 (f); Santos et al. 2003 (m), 2013 (f), 2015 (f); Santos 2010 (m, f); Savani et al. 2009 (f); Silva et al. 2007 (m, f), 2008 (m, f); Souza 2015 (m, f)	Água Clara, Alcinópolis, Anastácio, Antônio João, Aparecida do Taboado, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Brasilândia, Camapuã, Campo Grande, Caracol, Corguinho, Corumbá, Costa Rica, Coxim, Dois Irmãos do Buriti, Dourados, Guia Lopes da Laguna, Inocência, Jaraguarí, Jardim, Maracajú, Miranda, Nioaque, Nova Alvorada do Sul, Paranaíba, Paraíso das Águas, Paranhos, Pedro Gomes, Ponta Porã, Porto Murtinho, Ribas do Rio Pardo, Rio Negro, Rio Verde de Mato Grosso, Rochedo, Santa Rita do Pardo, Selvíria, Sidrolândia, Terenos, Três Lagoas
Lutzomyia (Lutzomyia) renei	–	–	Galati 2018; Oliveira et al. 2003 (m); Silva et al. 2007 (m)	Campo Grande

Table 2. Continued

Species	Source of information			Distribution in MS
	Collected	Museum	Published records	
Migonemyia (Blancasmyia) bursiformis	–	Fiocruz – COLFLEB (m)	Galati 2018	Bela Vista, Campo Grande
Migonemyia (Migonemyia) migonei	–	Fiocruz – COLFLEB (f)	Almeida et al. 2010a, 2015; Canesin 2011; Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (m, f); Galati 2018; Ishimi 2012 (m, f); Martins et al. 1978; Oliveira et al. 2003 (f), 2006; Santos 2010 (m, f); Santos et al. 2011	Antônio João, Bataguassú, Bodoquena, Caarapó, Campo Grande, Dourados, Jardim, Rio Brilhante, Rio Verde de Mato Grosso
Pintomyia (Pifanomyia) misionensis	–	–	Almeida et al. 2013; Galati et al. 1996 (f); Infran et al. 2017 (m, f); Galati 2018; Ishimi 2012 (m, f)	Aquidauana, Corguinho, Dourados, Rio Verde de Mato Grosso
Pintomyia (Pifanomyia) monticola	–	–	Andrade et al. 2011 (f); Andrade 2012 (f); Forattini 1971 (f); Galati 2018; Martins et al. 1978	Dourados, Maracajú, Nova Andradina, Ponta Porã
Pintomyia (Pintomyia) christenseni	–	–	Almeida et al. 2010a, 2013, 2015, 2019b (m, f); Dorval et al. 2009 (f); Fernandes et al. 2011, 2013; Galati et al. 1996 (m, f); Galati 2018; Ishimi 2012 (m, f); Leite 2015; Oliveira et al. 2003 (f), 2006, 2008b (f), 2012a; Paiva et al. 2010 (f); Santos 2010 (m, f); Santos et al. 2011; Silva et al. 2007 (f)	Alcinópolis, Bela Vista, Bonito, Campo Grande, Corguinho, Dourados, Maracajú, Nova Andradina, Novo Horizonte do Sul, Paraíso das Águas, Rio Verde de Mato Grosso
Pintomyia (Pintomyia) damascenoi	–	Fiocruz – COLFLEB (m, f)	Galati 2018; Martins et al. 1978; Oliveira et al. 2003 (f), 2006, 2012; Silva et al. 2007 (m)	Caarapó, Campo Grande, Maracajú
Pintomyia (Pintomyia) fischeri	–	–	Ferreira Júnior 2006 (m, f); Fernandes et al. 2011; Galati 2018; Martins et al. 1978	Dourados, Bataguassú, Caarapó, Nova Andradina
Pintomyia (Pintomyia) kuscheli	–	–	Almeida et al. 2019b (m, f); Infran et al. 2017 (f); Galati et al. 2003a,b (m, f), 2006 (f); Galati 2018; Savani et al. 2009 (f)	Alcinópolis, Aquidauana, Bonito, Jardim, Porto Murtinho
Pintomyia (Pintomyia) mamedei	–	–	Ferreira Júnior 2006 (f); Galati 2018; Lopes 2009 (f)	Aquidauana, Dourados
Pintomyia (Pintomyia) pessoai	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a,b (m, f), 2013; Andrade et al. 2011 (f); Andrade 2012 (m, f); Canesin 2011; Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (m, f); Forattini 1954 (f); Galati 2018; Ishimi 2012 (m, f); Lopes 2009 (m, f); Martins et al. 1978; Santos 2010 (m, f); Santos et al. 2011	Amambaí, Aquidauana, Bataguassú, Caarapó, Camapuã (m); Dourados, Maracajú, Nova Andradina, Novo Horizonte do Sul, Rio Brilhante, Ponta Porã

Table 2. Continued

Species	Source of information			Distribution in MS
	Collected	Museum	Published records	
Sciopemyia sordellii	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a, b (m), 2013, 2015, 2019b (m, f); Andrade et al. 2011 (f); Andrade 2012 (f); Barrios et al. 2019 (f); Braga-Miranda et al. 2006 (m, f); Brilhante et al. 2015 (m, f); Casaril et al. 2014 (f); Dorval et al. 2009 (m, f), 2010 (m); Fernandes et al. 2011, 2013; Ferreira Júnior 2006 (f); Galati et al. 1996 (m, f), 1997 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Ishimi 2012 (f); Leite 2015 (m, f); Lopes 2009 (m, f); Martins et al. 1978; Oliveira et al. 2003 (m, f), 2006, 2012, 2015 (f); Paiva et al. 2010 (f); Santos 2010 (m, f); Santos et al. 2011, 2013; Savani et al. 2009 (f); Silva et al. 2008 (f)	Alcinópolis, Aparecida do Taboado, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Camapuã, Caarapó, Campo Grande, Corguinho, Corumbá, Costa Rica, Dourados, Guia Lopes da Laguna, Itaquiraí, Jaraguarí, Jardim, Maracajú, Nioaque, Nova Andradina, Novo Horizonte do Sul, Paranaíba, Ponta Porã, Porto Murtinho, Rio Verde de Mato Grosso, Santa Rita do Pardo, Selvíria, Terenos, Três Lagoas
			Psychodopygina	
Bichromomyia flaviscutellata	–	–	Almeida et al. 2010a, 2013, 2015; Andrade et al. 2009 (m, f); Dorval et al. 2009 (f), 2010 (m, f); Fernandes et al. 2011; Galati et al. 2006 (f); Galati 2018; Gomes et al. 2012; Lopes 2009 (m, f); Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2013 2006, 2010 (m, f)	Aquidauana, Bataguassú, Bela Vista, Bonito, Campo Grande, Corumbá, Dourados, Pedro Gomes, Rio Verde de Mato Grosso, São Gabriel do Oeste, Santa Rita do Pardo, Sonora, Três Lagoas
Martinsmyia cipoensis	–	Fiocruz – COLFLEB (m)	–	Camapuã
Martinsmyia oliveirai	–	–	Almeida et al. 2010a, 2019b (m, f); Barrios et al. 2019 (m, f); Casaril et al. 2014 (m); Galati et al. 1996 (m, f), 1997 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Infran et al. 2017 (m, f); Martins et al. 1978; Oliveira et al. 2015 (m, f); Savani et al. 2009 (f); Santos et al. 1998 (m, f)	Alcinópolis, Aquidauana, Bodoquena, Bonito, Camapuã, Corguinho, Corumbá, Porto Murtinho
Nyssomyia antunesi	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2013, 2015; Fernandes et al. 2011; Galati 2018; Lopes 2009 (m); Oliveira et al. 2006, 2008b (m), 2012a; Paiva et al. 2010 (f)	Campo Grande, Coxim, Dourados, Rio Verde de Mato Grosso
Nyssomyia intermedia	–	Fiocruz – COLFLEB (m)	Andrade Filho et al. 2007; Galati 2018; Marcondes et al. 1998; Oliveira et al. 2010 (m, f); Silva et al. 2007 (m, f).	Anaurilândia, Bataguassú, Campo Grande, Miranda, Nova Andradina, Rio Brilhante, Três Lagoas
Nyssomyia neivai	–	–	Almeida et al. 2013, 2015, 2019a (m, f); Andrade Filho et al. 2007; Brilhante et al. 2015 (m, f), 2019; Canesin 2011; Fernandes et al. 2011; Ferreira Júnior 2006 (m); Galati 2018; Gomes et al. 2012 (f); Leite 2015 (m, f); Lopes 2009 (m, f); Santos 2010 (m, f); Santos et al. 2011	Água Clara, Aquidauana, Bataguassú, Bodoquena, Bonito, Brasilândia, Dourados, Guia Lopes da Laguna, Itaquiraí, Mundo Novo, Naviraí, Nova Andradina, Novo Horizonte do Sul, Rio Verde de Mato Grosso, Rochedo, Santa Rita do Pardo, Terenos, Três Lagoas
Nyssomyia whitmani	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a,b (m, f), 2013, 2015, 2019a (f), 2019b (m, f); Andrade et al. 2009 (m, f), 2011 (f), 2012 (f); Barrios et al. 2019 (m); Braga-Miranda et al. 2006 (m, f); Brilhante et al. 2015 (m, f), 2019; Canesin 2011; Dorval et al. 2009 (f); Fernandes et al. 2011, 2013, 2017 (m, f); Ferreira Júnior 2006 (m, f); Galati et al. 1996 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Infran et al. 2017 (m, f); Ishimi 2012 (m, f); Lopes 2009 (m, f); Martins et al. 1978; Nascimento et al. 2007 (f); Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2010 (m, f), 2012a; Paiva et al. 2006 (f), 2010 (f); Ribeiro et al. 2015 (m, f); Santos 2010 (m, f); Santos et al. 2011; Savani et al. 2009 (f); Silva et al. 2007 (m, f), 2008 (m); Souza 2015 (m, f)	Água Clara, Alcinópolis, Amambaí, Anastácio, Antônio João, Aparecida do Taboado, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Brasilândia, Camapuã, Campo Grande, Caarapó, Caracol, Corguinho, Corumbá, Costa Rica, Coxim, Dourados, Dois Irmãos do Buriti, Guia Lopes da Laguna, Inocência, Jaraguarí, Jardim, Laguna Carapã, Ladário, Maracajú, Miranda, Naviraí, Nioaque, Nova Alvorada Do Sul, Novo Horizonte do Sul, Paranhos, Pedro Gomes, Ponta Porã, Porto Murtinho, Ribas do Rio Pardo, Rio Brilhante, Rio Negro, Rio Verde de Mato Grosso, Rochedo, Santa Rita do Pardo, São Gabriel d' Oeste, Selvíria, Sidrolândia, Terenos, Três Lagoas

Table 2. Continued

Species	Source of information			Distribution in MS
	Collected	Museum	Published records	
Psathyromyia (Forattiniella) aragaoi	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a, 2013, 2015, 2019b (m, f); Andrade et al. 2009 (m); Braga-Miranda et al. 2006 (f); Brilhante et al. 2015 (m, f); Canesin 2011; Dorval et al. 2009 (f); Fernandes et al. 2011, 2017 (m, f); Ferreira Júnior 2006 (m, f); Galati et al. 1996 (m, f), 2006 (f); Galati 2018; Ishimi 2012 (m, f); Lopes 2009 (m, f); Martins et al.1978; Nunes et al. 2008 (f); Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2012a; Paiva et al. 2010 (f); Santos 2010 (f); Santos et al. 2011; Silva et al. 2007 (m, f)	Alcinópolis, Bela Vista, Bonito, Caarapó, Campo Grande, Camapuã, Corumbá, Corguinho, Coxim, Dourados, Naviraí, Nioaque, Novo Horizonte do Sul, Paranhos, Rio Verde de Mato Grosso, São Gabriel d' Oeste
Psathyromyia (Forattiniella) brasiliensis	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2013, 2019b (m, f); Galati et al. 1996 (m, f)	Alcinópolis, Corguinho, Rio Verde de Mato Grosso
Psathyromyia (Forattiniella) campograndensis	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a, 2013, 2019b (m, f); Andrade et al. 2009 (f); Brilhante et al. 2015 (m, f); Dorval et al. 2009 (m, f), 2010 (f); Ferreira Júnior 2006 (m, f); Fernandes et al. 2011, 2013; Galati et al. 2003a (m, f), 2006 (m, f); Galati 2018; Infran et al. 2017 (f); Ishimi 2012 (m, f); Lopes 2009 (m, f); Oliveira et al. 2003 (m, f), 2006, 2010 (f), 2012a; Paiva et al. 2010 (f); Santos 2010 (m, f); Santos et al. 2011	Alcinópolis, Aquidauana, Bela Vista, Bonito, Bodoquena, Brasilândia, **Campo Grande**, Dourados, Jardim, Ladário, Nova Andradina, Novo Horizonte do Sul, Santa Rita do Rio Pardo, Rio Verde de Mato Grosso, Três Lagoas
Psathyromyia (Forattiniella) lutziana	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a, 2015; Galati 2018; Oliveira et al. 2010 (m, f); Martins et al. 1978	Camapuã, Campo Grande, Corguinho, Nioaque, Rochedo, Terenos, Três Lagoas
Psathyromyia (Forattiniella) runoides	–	–	Almeida et al. 2013, 2015	Coxim, Rio Verde de Mato Grosso
Psathyromyia (Psathyromyia) abonnenci	–	–	Almeida et al. 2019b	Alcinópolis
Psathyromyia (Psathyromyia) campbelli	–	–	Galati et al. 1996 (m); Galati 2018	Corguinho
Psathyromyia (Psathyromyia) bigeniculata	–	–	Almeida et al. 2010a, 2013, 2015, 2019b (m, f); Andrade et al. 2009 (m, f), 2011 (f), 2012 (m, f); Barrios et al. 2019 (m, f); Braga-Miranda et al. 2006 (m, f); Brilhante et al. 2015; Canesin 2011; Casaril et al. 2014 (m); Dorval et al. 2009 (m, f), 2010 (m); Fernandes et al. 2011, 2013, 2017 (m); Ferreira Júnior 2006 (m, f); Figueiredo et al. 2016 (m, f); Galati et al. 1996 (m, f), 2001 (m, f), 2003a, b (m, f), 2006 (m, f); Galati 2018; Gomes et al. 2012 (f); Infran et al. 2017 (m, f); Ishimi 2012 (m, f); Lopes 2009 (m, f); Martins et al. 1978; Nunes et al. 2008 (m, f); Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2012a; Paiva et al. 2010 (f); Santos 2010 (m, f); Santos et al. 2011; Silva et al. 2007 (m, f), 2008 (m, f); Souza 2015 (m, f)	Alcinópolis, Amambaí, Anastácio, Antônio João, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Campo Grande, Caarapó, Camapuã, Corguinho, Corumbá, Dourados, Guia Lopes da Laguna, Jardim, Maracajú, Miranda, Nova Andradina, Novo Horizonte do Sul, Nioaque, Rio Verde de Mato Grosso, Ponta Porã, Porto Murtinho, Sidrolândia
Psathyromyia (Psathyromyia) lanei	–	–	Almeida et al. 2010a; Galati 2018; Lopes 2009 (f); Martins et al. 1978	Dourados, Guia Lopes da Laguna, Maracajú

Table 2. Continued

Species	Source of information			Distribution in MS
	Collected	Museum	Published records	
Psathyromyia (Psathyromyia) punctigeniculata	–	Fiocruz – COLFLEB (m)	Almeida et al. 2010a, 2013, 2015, 2019b (m); Andrade et al. 2009 (f); Brilhante et al. 2015 (m, f); Canesin 2011; Dorval et al. 2009 (m, f), 2010 (f); Fernandes et al. 2011; Galati et al. 1996 (m, f), 2001 (m, f), 2003 (m, f), 2006 (m); Galati 2018; Gomes et al. 2012 (f); Lopes 2009 (m, f); Nunes et al. 2008 (f); Oliveira et al. 2003 (m, f), 2006, 2010 (m, f), 2012a; Santos 2010 (m, f); Santos et al. 2011; Savani et al. 2009 (f); Souza 2015 (m)	Alcinópolis, Aquidauana, Bataguassú, Bela Vista, Bodoquena, Bonito, Campo Grande, Camapuã, Corumbá, Corguinho, Dourados, Jardim, Maracajú, Miranda, Novo Horizonte do Sul, Nova Andradina, Rio Negro, Rio Verde de Mato Grosso, Terenos, Três Lagoas
Psathyromyia (Psathyromyia) scaffi	–	–	Almeida et al. 2010a	Anastácio, Maracajú
Psathyromyia (Xiphopsathyromyia) hermanlenti	–	Fiocruz – COLFLEB (m, f)	Almeida et al. 2010a, 2013, 2015, 2019b (m, f); Barrios et al. 2019 (m); Brilhante et al. 2015 (m, f); Fernandes et al. 2011; Galati et al. 1996 (m, f); Galati 2018; Lopes 2009 (f); Martins et al. 1978; Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2012a; Paiva et al. 2010 (f); Santos 2010 (m); Santos et al. 2011; Souza 2015 (f)	Água Clara, Alcinópolis, Anastácio, Bonito, Camapuã, Campo Grande, Corguinho, Costa Rica, Coxim, Dourados, Figueirão, Miranda, Novo Horizonte do Sul, Terenos, Pedro Gomes, Rio Verde de Mato Grosso
Psathyromyia (Xiphopsathyromyia) dreisbachi	–	–	Galati et al. 1996 (m, f)	Corguinho, Rio Verde de Mato Grosso
Psychodopygus claustrei	–	–	Galati 2018; Oliveira et al. 2003 (m, f), 2006, 2008b (f), 2012a; Paiva et al. 2010 (f)	Campo Grande
Psychodopygus davisi	–	–	Almeida et al. 2010a, 2013, 2015, 2019b (m, f); Galati 2018; Galati et al. 1996 (f); Infran et al. 2017 (f)	Alcinópolis, Aquidauana, Corguinho, Rio Verde de Mato Grosso, Sonora.
Viannamyia furcata	–	–	Galati et al. 1996; Galati 2018	Corguinho

m = male; f = female; Fiocruz – COLFLEB = Centro de Referência Nacional e Internacional de Flebotomíneos. Bold: type locality in MS.

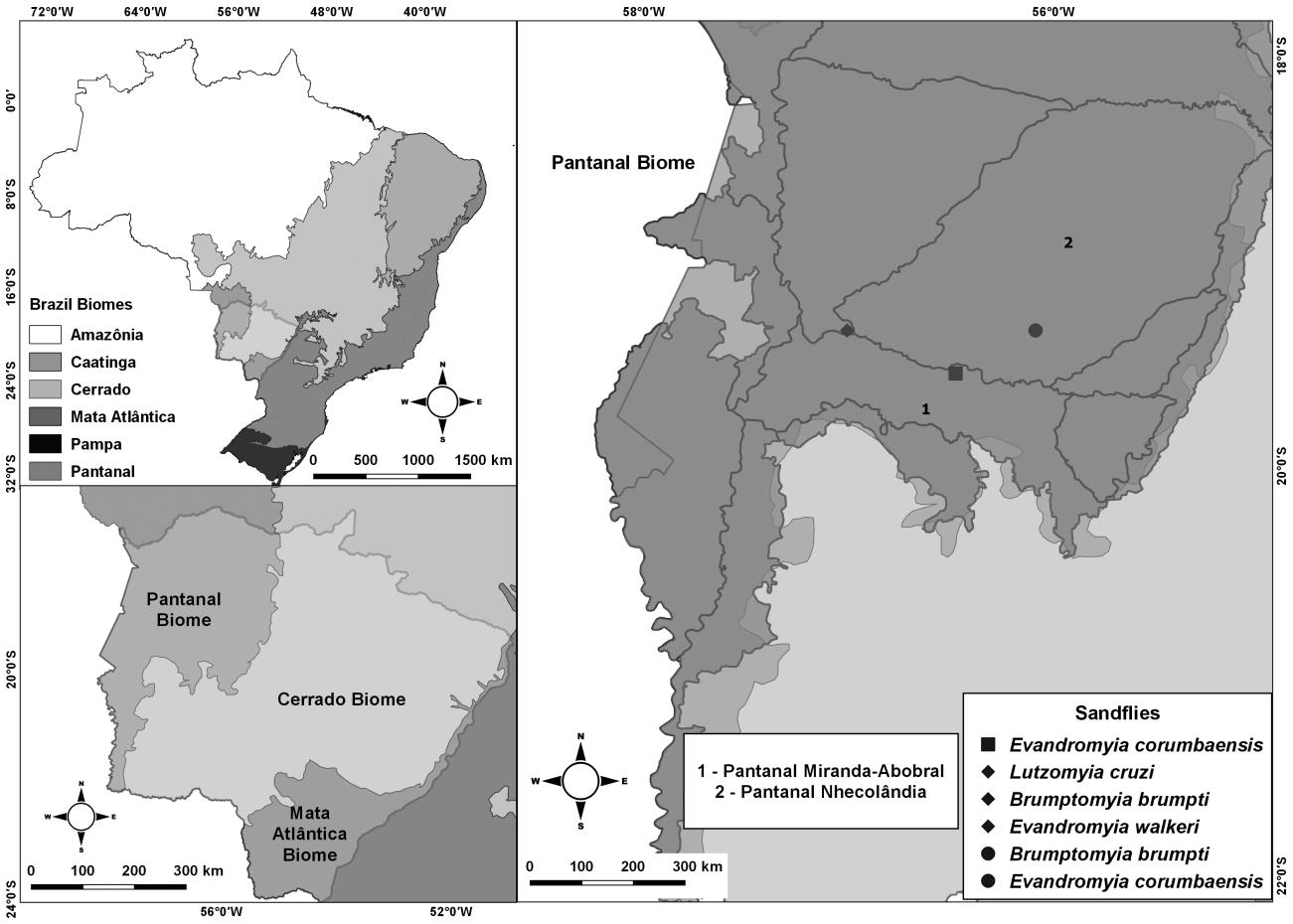

Fig. 2. Distribution of phlebotomine sandfly species reported in primary data in the Pantanal biome, Mato Grosso do Sul, Brazil. The map of Brazil, Mato Grosso do Sul, and biomes (and the shapefile used to generate it) used for the elaboration of Fig. 2 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

The females of these two species are morphologically indistinguishable (Martins et al. 1984).

From the municipality of Corumbá, a region composed of Pantanal and Cerrado biomes, *Lu. forattinii*, a species with anthropophily behavior, was described (Galati et al. 1985) and reported with the presence of *Leishmania infantum* (Pita-Pereira et al. 2008). Also in Corumbá, *Ev. corumbaensis*, belonging to the *cortellezii* complex, was another species described (Galati et al. 1989).

In Corguinho, another species was described and denominated *Ex. cerradincola* because of its occurrence in Cerrado areas (Galati et al. 1995, 1996). From specimens collected in Serra da Bodoquena, a tourist region with several caves, *Lu. almerioi* was described (Galati and Nunes 1999). In the research conducted in several caves, forests, and domiciliary environments, this species has shown extremely anthropophily behavior (Galati et al. 2006). The presence of flagellates in females of this species and DNA from *Le. infantum* and *Leishmania* (*Viannia*) sp. have been reported (Savani et al. 2009). *Psathyromyia campograndensis* was described from specimens of Campo Grande (Oliveira et al. 2001), and *Ev. orcyi* was described from specimens of Selvíria (Oliveira et al. 2015).

Lutzomyia longipalpis

The finding of the vector *Lu. longipalpis* in the urban area of Campo Grande, an intense transmission area of VL (Mato Grosso do Sul 2017), was reported for the first time by Oliveira et al. (2000). The DNA of *Leishmania* spp. was detected in *Lu. longipalpis* females from Campo Grande, captured in the human intra- and peridomicile (Silva et al. 2008, Paiva et al. 2010), and in females captured in the peridomicile of residences in the municipality of Antônio João, reported the flagellate as *Le. infantum*, by dissection and PCR (Nascimento et al. 2007). DNA from flagellates, such as *Le. infantum*, *Leishmania amazonensis* (Lainson & Shaw 1972), and *Le.* (*Viannia*) sp., were detected in females collected in Serra da Bodoquena, in an agricultural settlement of the municipality of Bonito (Savani et al. 2009). The urbanization and anthropization capacity of this vector explain its wide distribution throughout the state of Mato Grosso do Sul: it is present in 43 municipalities, all with cases of VL, in both rural and urban areas, in the intradomicile, in shelters of domestic animals in the peridomicile, as well as in natural ecotopes (Galati et al. 1996, 2003; Oliveira et al. 2003, 2006, 2010; Oliveira 2006; Silva et al. 2007; Andrade et al. 2009; Almeida et al. 2010a, b, 2015; Souza 2015).

Lutzomyia cruzi

For more than 50 years, it was believed that *Lu. longipalpis* was the only vector of *Le. infantum* in Brazil (Rangel and Vilela 2008). Nonetheless, diagnosis of the disease in locations where there was no such vector led to the idea that other phlebotomine sandfly species could be involved in the epidemiology of the disease. In Corumbá and Ladário, cities with human and canine VL cases, Galati et al. (1985,

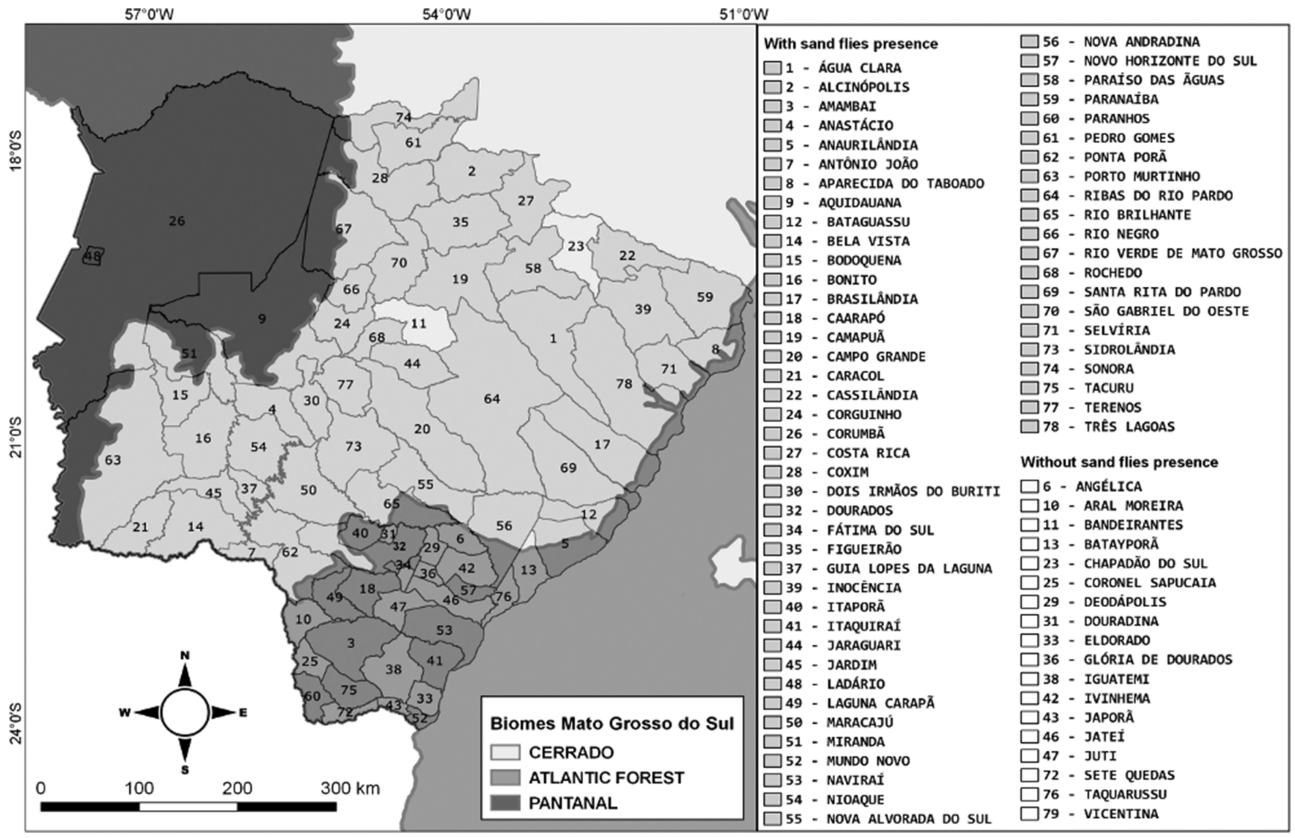

Fig. 3. Municipalities of the state of Mato Grosso do Sul with and without records of phlebotomine sandflies (Diptera: Psychodidae). The map of Mato Grosso do Sul and biomes (and the shapefile used to generate it) used for the elaboration of Fig. 3 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

1989, 1997) did not report the presence of *Lu. longipalpis* but found *Lu. cruzi* representing 90.3% of the total number of phlebotomine sandfly sampled, suggesting their participation in the transmission of *Le. infantum* (Galati et al. 1997). After these studies, *Lu. cruzi* females were incriminated due to the finding of promastigotes in the suprapapillary portion of 14 females (Santos et al. 1998) and detection of DNA of *Le. infantum* (Pita-Pereira et al. 2008). Afterwards, their vector competence was demonstrated for *Le. amazonensis* and *Le. infantum* (Oliveira et al. 2017a, b). The preference of *Lu. cruzi* for Cerrado and Pantanal biome areas is reported mainly in Mato Grosso, which includes the Pantanal biome of this state, which extends to Mato Grosso do Sul state (Missawa and Lima 2006, Ribeiro et al. 2007, Missawa et al. 2011, Brito et al. 2014).

Lutzomyia cruzi belongs to the *Lu. longipalpis* species complex, and both have been reported in sympatry in the cities of Alcinopólis (Almeida et al. 2015), Bonito (Almeida et al. 2015), Campo Grande (Oliveira et al. 2003), Camapuã (Martins et al. 1978, Almeida et al. 2015), Corumbá (Santos et al. 2003), and Paraíso das Águas (Almeida et al. 2015). Although *Lu. longipalpis* had been reported in Camapuã (Martins et al. 1978, Almeida et al. 2015) and Corumbá (Santos et al. 2003), other recent studies by different authors using a high sampling effort did not indicate the presence of this vector in these municipalities (Casaril et al. 2014, Oliveira et al. 2015, Fernandes et al. 2017, Barrios et al. 2019).

The Vectors of CL Etiological Agents

Among the vectors of CL etiological agents in Latin America, the species *N. whitmani* is an important vector of *Leishmania braziliensis* (Vianna 1911) (Andrade Filho et al. 2007, da Costa et al. 2007, Rangel and Lainson 2009), and its high prevalence in various regions of the state of Mato Grosso do Sul reveals a substantial degree of adaptation to the urban environment with the presence reported in 49 of the 79 municipalities of this state. In some municipalities, such as Corguinho (Galati et al. 1996), Camapuã (Fernandes et al. 2017), the Serra da Bodoquena region (Bonito, Bodoquena, and Jardim) (Galati et al. 2006), and Bonito (Brilhante et al. 2015), which include Cerrado biome, this species is prevalent and abundant, showing a high degree of anthropophily and constant frequency in forest environments undergoing a degradation process (Nunes et al. 1995, Galati et al. 1996, Brilhante et al. 2015). In the Pantanal biome, *N. whitmani* was collected in orchards but in very low density (Braga-Miranda et al. 2006).

Nyssomyia intermedia and *N. neivai* had also been reported in the state of Mato Grosso do Sul. *Nyssomyia intermedia* is incriminated as a vector of *Le. braziliensis*, with predominance in some Brazilian states, especially in the southeastern region, as Espírito Santo, São Paulo, and Rio de Janeiro (Andrade Filho et al. 2007, Rangel and Lainson 2009), but this species is not very abundant in Mato Grosso do Sul state. With a wide distribution in the country, mainly in the state of São Paulo and in the Southern region of Brazil, this species showed a noticeable degree of anthropophily and its presence is reported inside residential environments (Andrade Filho et al. 2007). *Nyssomyia neivai* is also incriminated as a vector of *Le. braziliensis* owing to the detection of DNA of *Le.* (*Viannia*) spp. (Oliveira et al. 2011) and *Le. braziliensis* (Pita-Pereira et al. 2009). This species is present in 18 municipalities of the state of Mato Grosso do Sul. In the city of Naviraí, located in

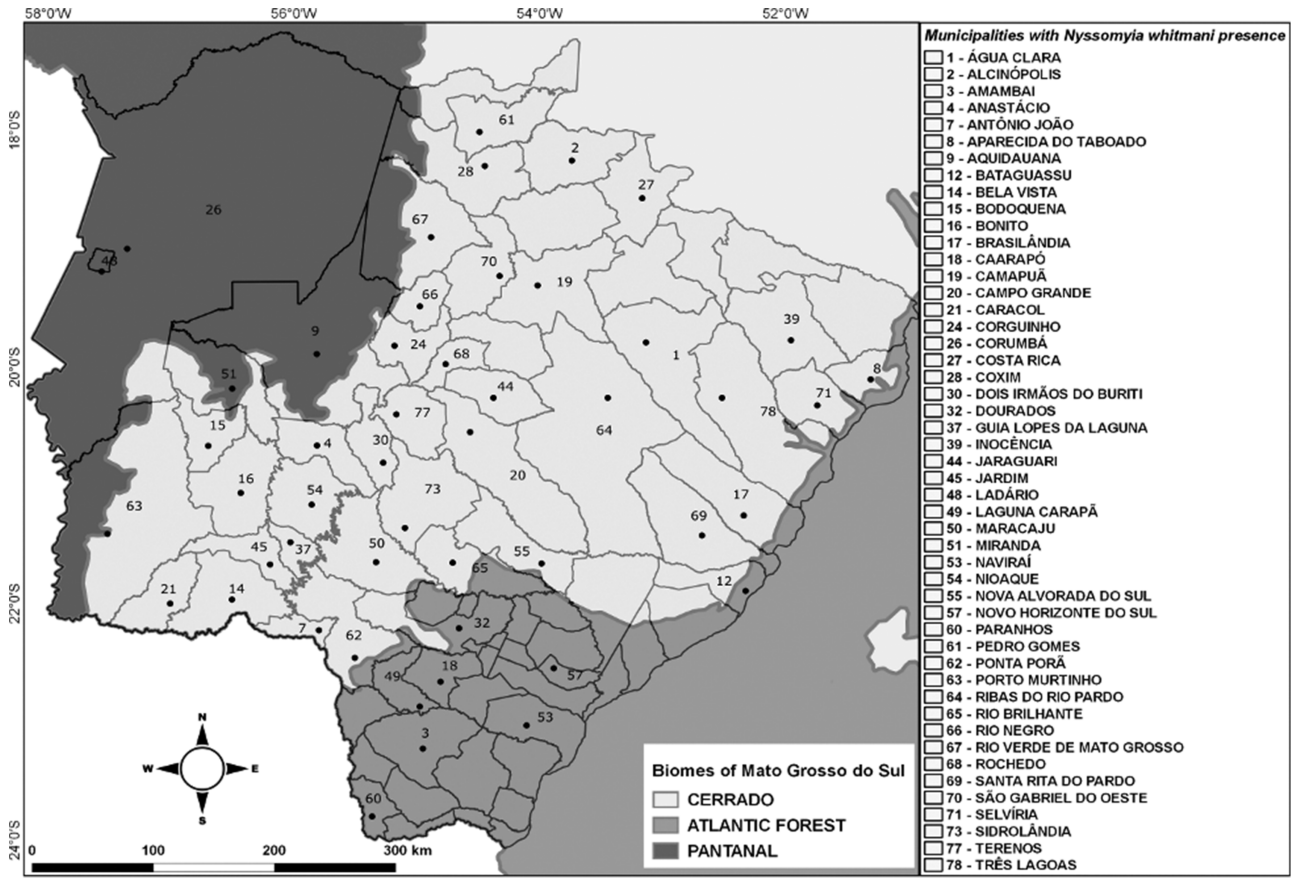

Fig. 4. Distribution of *Nyssomyia whitmani*, the vector of *Leishmania* spp., in the state of Mato Grosso do Sul, Brazil. The map of Mato Grosso do Sul and biomes (and the shapefile used to generate it) used for the elaboration of Fig. 4 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

the southern region of Mato Grosso do Sul state, which includes the Atlantic Forest biome, *N. neivai* was found to be dominant, representing 99.6% of the individuals sampled (Almeida et al. 2013). Its presence was also detected in areas near the banks of Miranda River, an important tourist center in the state of Mato Grosso do Sul, in the municipality of Bonito, a Cerrado area (Brilhante et al. 2011, 2015, 2019). *Nyssomyia intermedia* and *N. neivai* are grouped in the *N. intermedia* complex (Marcondes 1995, Rangel and Lainson 2009) and occur in sympatry in some localities of the state, in the municipalities of Bataguassú, Nova Andradina, and Três Lagoas.

Another species of epidemiological significance is *Bi. flaviscutellata*, incriminated as a vector of *Le. amazonensis*, an etiological agent of the most severe clinical form of the disease: the diffuse anergic form of CL. This phlebotomine sandfly species is characteristic of the Amazon Forest and Cerrado biomes (Ribeiro et al. 2007) and is believed to participate in the enzootic cycle of the CL agent in Bela Vista (Cerrado area), with confirmation of human cases (Dorval et al. 2006), and in Bonito, with identification of an infected specimen (Nunes et al. 2008). *Bichromomyia flaviscutellata* has been showing behavioral changes, with adaptation to peridomiciliary environments because of invasion of these niches by natural reservoirs of *Le. amazonensis*, such as rats of the genus *Proechimys* (Rodentia: Echimyidae) (Allen 1899), searching for food in the anthropized environment (Rangel and Lainson 2009). The efficiency of the Disney trap at collecting this vector is evident due to a greater presence of females in the collections (Shaw and Lainson 1972, Dorval et al. 2010), which are attracted by sentinel rodents (Lainson and Shaw 1968).

Incriminated Species

The presence of the species *Mig. migonei* in the urban area of Campo Grande (Oliveira et al. 2003) and Dourados should be a predictor of possible CL outbreaks because of its synantropic behavior, with constant presence on peridomiciliary environments (Loiola et al. 2007, Ishimi 2012) and detection of DNA of *Le. braziliensis* in this species (Pita-Pereira et al. 2005). Pessôa and Coutinho (1941) found leptomonas flagellates of *Le. braziliensis* suggesting its vector competence. It is likely that *Mig. migonei* is also a species susceptible to the infection by *Le. infantum* (Galvis-Ovallos et al. 2017), as it was detected with DNA of this parasite in Northeast Region of Brazil (de Carvalho et al. 2010, Rodrigues et al. 2016). Besides, high rates of infection, with metacyclic forms, have already been observed (Guimarães et al. 2016). It is also found that in the state of Mato Grosso (Ribeiro et al. 2007) and in Mato Grosso do Sul, it occurred in nine municipalities: Antônio João, Bataguassú, Bodoquena, Caarapó, Campo Grande, Dourados, Jardim, Rio Brilhante, and Rio Verde de Mato Grosso.

Pintomyia pessoai was found to be the second most frequent species in a native environment in Ponta Porã (Andrade et al. 2012) and Dourados (Ishimi 2012) and is related to peridomiciliary environments nearby forests. This proximity

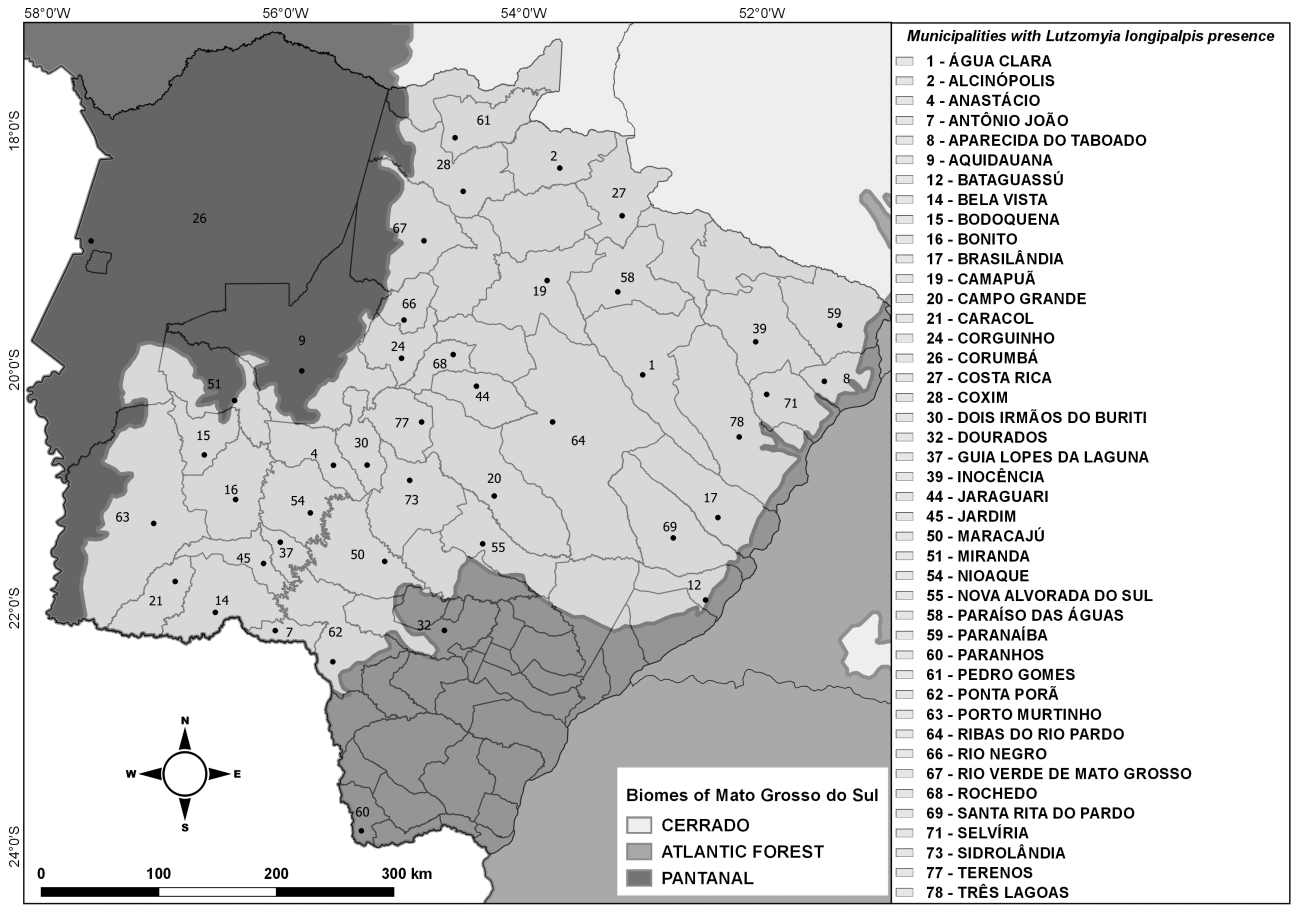

Fig. 5. Distribution of *Lutzomyia longipalpis*, the vector of *Leishmania infantum*, in the state of Mato Grosso do Sul, Brazil. The map of Mato Grosso do Sul and biomes (and the shapefile used to generate it) used for the elaboration of Fig. 5 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

of ecotypes favors the circulation of etiological agents of leishmaniasis as phlebotomine sandfly females can get infected when feeding on blood in reservoirs located inside the forest. Switching between these two environments can modify the CL epidemiology. Coutinho (1940) found flagellate forms in the anterior region of the digestive tract of *Pi. pessoai* females, compatible with *Le. braziliensis*, and infection by these parasites was confirmed in murine models after inoculation of this species by Forattini et al. (1972).

Psathyromyia shannoni × *Psathyromyia bigeniculata*

While performing a taxonomic revision of the Shannoni series, Sábio et al. (2014) revalidated *Psa. bigeniculata*, removing it from the synonymy of *Psa. shannoni* Dyar, 1929. In addition, they considered that the specimens identified belong to *Psa. shannoni* in Brazilian territory, and the majority of them belong to *Psa. bigeniculata*. Currently, differentiation between species is carried out by analyzing coloration of the thorax. *Psathyromyia bigeniculata* is widely distributed in Mato Grosso do Sul, with reports in 27 municipalities and high density in 2 environments (forested and peridomiciliary) in Campo Grande (Oliveira et al. 2012) and Bonito (Brilhante et al. 2015). It also shows a natural infection rate of 0.23% by flagellates (Brilhante et al. 2015). In the municipality of Corguinho, this species is the second most frequent, both in the Shannon trap and with human bait (Galati et al. 1996).

Phlebotomine Sandflies in Important Ecotourism Area

Mato Grosso do Sul has two important ecotourism centers, the Bonito region, with clear and translucent waters result from the association with limestone rocks and caves, and Pantanal in the south of Mato Grosso state: a region with wild populations with extensive biodiversity, scenic beauty, and dynamic hydrological regimes (Harris et al. 2006). In Bonito, the presence of phlebotomine sandflies is constant and has been reported since the 1970s, with high diversity and abundance, with description of new species, and reports of females naturally infected with *Leishmania* spp. flagellates (Galati and Nunes 1999; Galati et al. 2001, 2003a,b, 2006; Nunes et al. 2008; Andrade et al. 2009; Savani et al. 2009; Almeida et al. 2010a; Brilhante et al. 2011, 2015, 2019; Fiocruz 2020). As of 2014, however, the region has sporadic transmission rates (Mato Grosso do Sul 2017).

In the Pantanal region, the municipalities of Corumbá and Ladário, located in the upper part of the Pantanal plain, are endemic for VL, and the urban phlebotomine sandfly fauna is relatively well known. Regarding the Pantanal plain, which alternates between periods of droughts and floods, studies on the fauna of these insects are scarce, with reports only about Pantanal of Corumbá, where sandfly density is very low and *Lu. cruzi* not being collected (Braga-Miranda and Galati 2005, Braga-Miranda et al. 2006). However, the presence in high densities in the urban

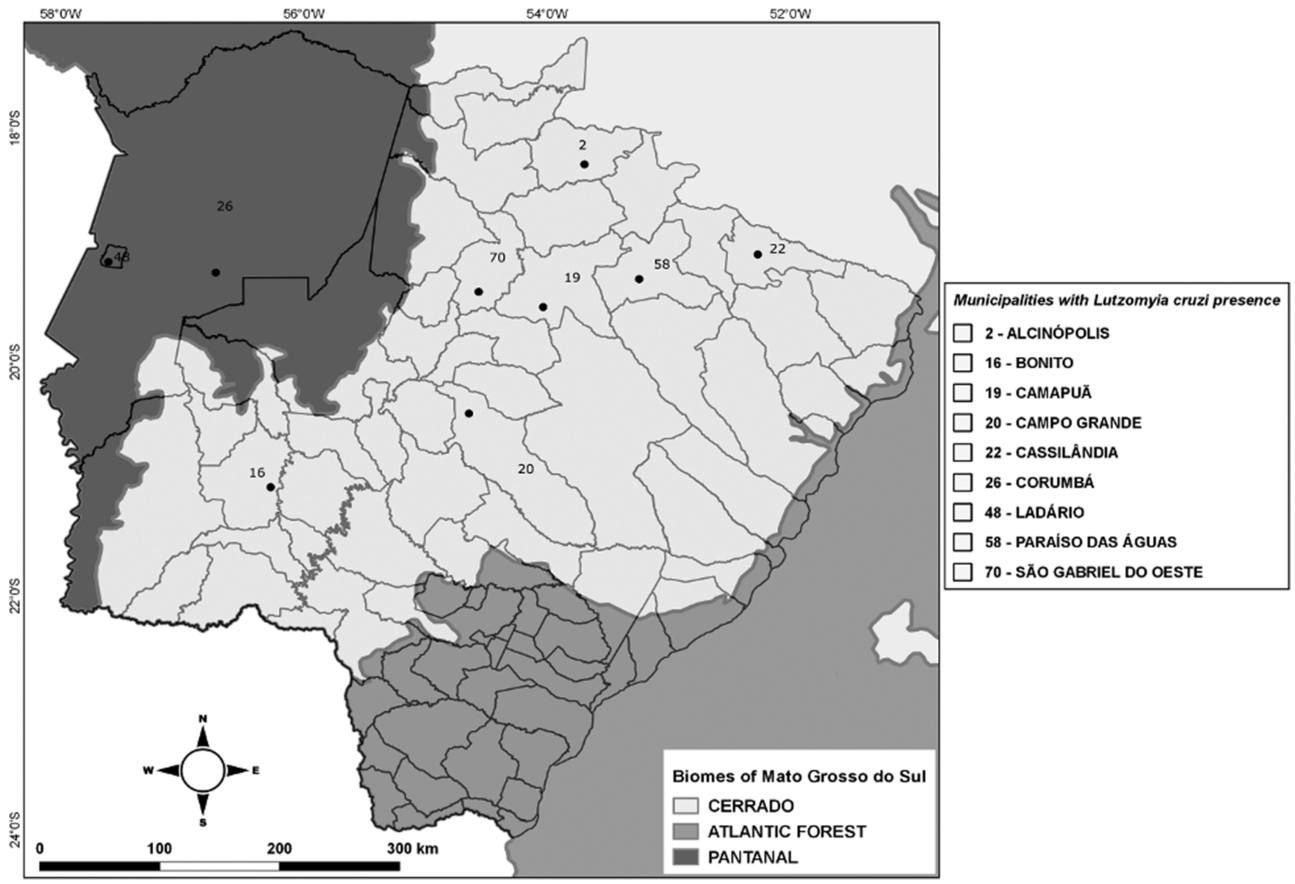

Fig. 6. Distribution of *Lutzomyia cruzi*, the vector of *Leishmania infantum*, in the state of Mato Grosso do Sul, Brazil. The map of Mato Grosso do Sul and biomes (and the shapefile used to generate it) used for the elaboration of Fig. 6 was extracted from the database of public domain of the Brazilian Institute of Geography and Statistics.

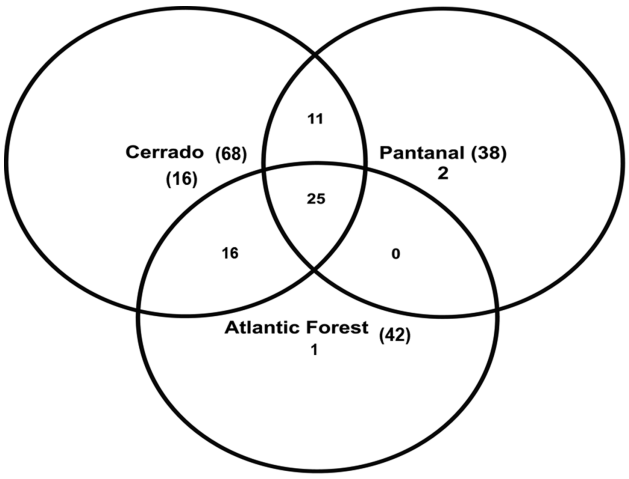

Fig. 7. A Venn diagram revealing eclecticism of the species within the biomes of the state of Mato Grosso do Sul, Brazil. Exclusive species at the intersections between biomes and the unique number of species in each biome.

and wild areas of *Lu. cruzi* (Barrios et al. 2019) reinforces the concern regarding VL because this insect can participate in the epidemiology of these diseases in both environments. Tourism activity expanded in the region in recent years and one of the major problems in the fight against these diseases is the lack of information about the impact on public health. Accordingly, the epidemiological research should take into account the uniqueness of this biome.

Phlebotomine Sandfly Distribution in Biomes

Mato Grosso do Sul is highly representative of the abundance and richness of phlebotomine sandfly species in the world, thus

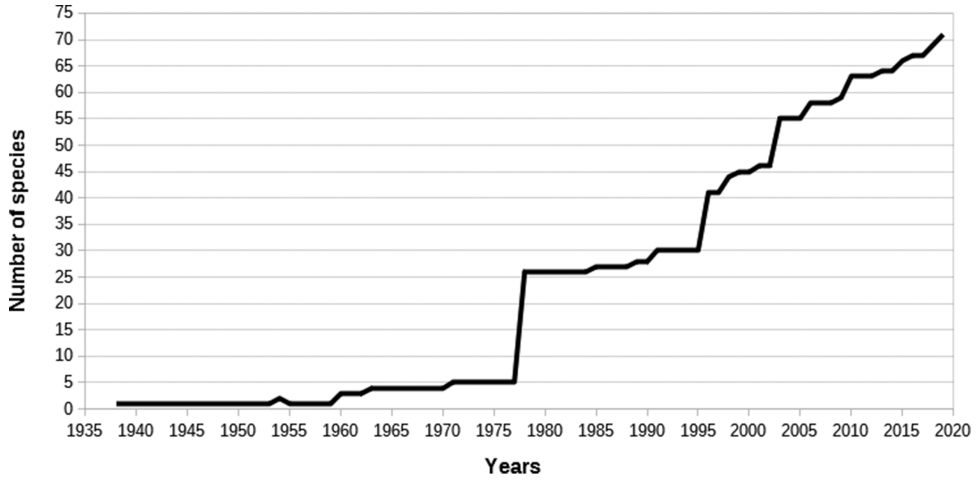

Fig. 8. The chronological graph revealing scientific production and Phlebotominae species of the state of Mato Grosso do Sul, Brazil.

accounting for 13% of the species of America and 25% of the species in Brazil. Phlebotomine sandflies are reported in almost the entire state of Mato Grosso do Sul, which shows a wide distribution of these insects in the region. The geographic distribution pattern of phlebotomine sandflies in Mato Grosso do Sul suggests that ~41% of the municipalities with phlebotomine sandflies are composed of the Cerrado biome, 26% of the Cerrado and Atlantic Forest, 16% of the Cerrado and Pantanal, and only 15% of the Atlantic Forest, mostly present in the southern region of the state. It is observed that the main vector species present in the state exhibit adaptation to the three biomes, with high densities of these insects, such as *Bi. flaviscutellata*, *Lu. Longipalpis*, and *N. whitmani*. The urbanization and adaptation of these insects promote the geographic expansion of this disease in the country, thus evidencing the pattern of distribution of leishmaniasis.

It is worth mentioning that this checklist shows the results of entomological research conducted until 2020 and the lack of records of these insects in some municipalities does not mean that they are not present. Some species have been reported only once in Mato Grosso do Sul and are no longer recorded in new studies, in the same locations. It might be resulted from insufficient sampling or misidentification of the species due to the difficulties of morphological identification os some species of sandflies. The chronological graph shows that from the 1970s, scientific production contributed significantly to the knowledge of a greater number of Phlebotominae species in Mato Grosso do Sul. The opening and improvement of roads, equipment, investments in research, technology, and manpower generated conditions to subsidize, leverage, and disseminate the research of sandflies in the State, and publications have been increasing over the years with regard to the quantity and quality. Fauna inventories provide knowledge that supports tools for understanding phlebotomine sandfly fauna in specific regions with a peculiar climate and vegetation and may facilitate epidemiological studies of the disease in question.

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