



Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Disease

journal homepage: www.elsevier.com/locate/apjtd



Document heading doi: 10.1016/S2222-1808(12)60079-6 © 2012 by the Asian Pacific Journal of Tropical Disease. All rights reserved.

## Phlebotomine fauna in the Ponta Porã city: epidemiological importance in border line between Brazil and Paraguay

Ana Rachel Oliveira de Andrade<sup>1\*</sup>, Maria Elizabeth Moraes Cavalheiros Dorva<sup>1</sup>, Sonia Maria Oliveira de Andrade<sup>1</sup>, Alisson Marques<sup>2</sup>, Baldomero Antonio Kato da Silva<sup>3</sup>, Renato Andreotti<sup>1,4</sup>

<sup>1</sup>Post Graduate Program in Infectious and Parasitary Diseases. Federal University of Mato Grosso do Sul, Brazil

<sup>2</sup>Zoonosis Control Center, Municipal Secretariat Health of Ponta Porã, MS, Brazil

<sup>3</sup>Post Graduate Program in Health and Development of the Central West Region. Federal University of Mato Grosso do Sul. Associated Professor of Federal University of Piauí, Brazil

<sup>4</sup>Embrapa Beef Cattle, Campo Grande, Brazil

### ARTICLE INFO

#### Article history:

Received 15 July 2012

Received in revised form 12 October 2012

Accepted 28 October 2012

Available online 28 October 2012

#### Keywords:

Vector ecology

Sandfly fauna

Visceral leishmaniasis

### ABSTRACT

**Objective:** To identify the urban phlebotomine sandfly fauna in Ponta Porã, Mato Grosso do Sul State, Brazil. **Methods:** The captures were undertaken from April 2009 to March 2010 with CDC light traps in 14 ecotopes (intra and peridomicile) in different areas of the city, Shannon traps being used in areas with abundant vegetation. **Results:** A total of 707 specimens were captured with CDC light traps (565 males and 142 females) and 155 specimens (112 males and 43 females) with Shannon traps, a total of 862 phlebotomines. The specimens captured belonged to eight species: *Lutzomyia longipalpis* (Lutz & Neiva, 1912), *Evandromyia cortelezzi* (Brethes, 1923), *Sciopemyia sordelli* (Shannon & Del Ponte, 1927), *Pintomyia pessoai* (Coutinho & Barretto, 1940); *Pintomyia monticola* (Costa Lima, 1932); *Brumptomyia brumpti* (Larousse, 1920); *Nyssomyia whitmani* (Antunes & Coutinho, 1939) and *Psathyromyia shannoni* (Dyar, 1929). *Lutzomyia longipalpis*, the main vector of *Leishmania (Leishmania) chagasi*, was the species most frequently captured (97.03%) and also the most abundant according to the standardized abundance index (SAI)=0.86. **Conclusions:** The highest species richness was captured, with CDC light traps, inside the domiciles and the species diversity and evenness in the peridomicile, clearly indicating a preference for anthropic environments.

## 1. Introduction

Visceral and cutaneous leishmaniasis are parasitic diseases caused by several protozoal species of the genus *Leishmania* that determine different clinical forms[1]. All the species of the genus are transmitted by the bite of infected females of the Phlebotominae subfamily, belonging to the genus *Lutzomyia* in the New World and *Phlebotomus* in the Old World[2].

The State of Mato Grosso do Sul (MS) has been presenting high rates of infection of *Leishmania (Leishmania) chagasi*, the agent of visceral leishmaniasis, in both humans and dogs, other human infections by *Leishmania* spp, agents of cutaneous leishmaniasis, and also a great number of

*Leishmania* sp. vectors[3–5].

The environmental changes caused by the intense migratory process, the increasing urbanization and socioeconomic pressures have triggered the expansion of endemic areas and the occurrence of new outbreaks. Sandfly species become resistant to adverse conditions and approach the peridomicile increasingly, facilitating the transmission of these diseases[6].

Ponta Porã was considered a silent area or a region without transmission of visceral leishmaniasis (VL) until the appearance of the first human case in 2007. Thereafter, it was included among the vulnerable cities that, according to the Ministry of Health, do not present autochthonous cases of human and/or canine visceral leishmaniasis, but meet one or more of the following criteria: cities neighboring those reporting VL cases; those having intense migratory flux; or those belonging to the same road axis as cities with disease cases[7].

The aim of this study was to identify the species of phlebotomine sandflies found in the urban area of Ponta Porã, on the Brazil–Paraguay border, so as to provide information for the leishmaniasis control program.

\*Corresponding author: Ana Rachel Oliveira de Andrade – Rua Luiz Freire Bencheitrit, 258 – Bairro Miguel Couto – CEP 79040-140 – Campo Grande – MS – Brazil.

Tel: +55-67-3306-0916

E-mail: parasitorachel@bol.com.br

Foundation Project: Supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES (Coordination for the Improvement of Higher Level Personnel), under Grant No. 2009/0369.



*brumpti*); *Psychodopygina*– *Nyssomyia whitmani* (Antunes & Coutinho, 1939) (*Ny. whitmani*) and *Psathyromyia shannoni* (Dyar, 1929) (*Ps. shannoni*). *Lu. longipalpis* was the most frequently found species, accounting for 686 (97.03%) of the sandflies captured.

The highest species (4 species) occurred in the intradomicile, and the highest diversity ( $H=0.23$ ) and evenness ( $J=0.21$ ) indices in the peridomicile of the Pousada do Bosque (Table 1). At site 6 no specimen was captured. *Lu. longipalpis* was the only species captured at all the other sites, occurring exclusively in eight of the 14 ecotopes sampled throughout the urban area of Ponta Porã (Table 1).

*Lu. longipalpis* was the most abundant species, presenting a standardized abundance index (SAI)=0.86, followed by *Ny. whitmani* (0.11) (Table 2).

**Table 2.**

SAI according to species of phlebotomines captured in Ponta Porã city, Mato Grosso do Sul State, Brazil, from April 2009 to March 2010.

Species	SAI	Position
<i>Lu. longipalpis</i>	0.86	1st
<i>Ny. whitmani</i>	0.11	2nd
<i>Ps. Shannoni</i>	0.07	3rd
<i>Ev. cortelezii</i>	0.07	3rd
<i>Br. Brumpti</i>	0.02	5th

Table 3 shows the number of phlebotomine sandflies collected monthly from April 2009 to March 2010. The Williams' geometric mean was used to quantify the frequency and regularity of the most abundant species presented in Figure 1

**Table 3**

Monthly distribution of phlebotomines captured fortnightly with CDC light traps in 14 environments of Ponta Porã city, Mato Grosso do Sul State, Brazil, from April 2009 to March 2010.

Species	2009										2010			09/10 Total	%
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar			
<i>Br. brumpti</i>	–	–	–	–	–	–	–	1	–	–	–	–	1	0.14	
<i>Ev. cortelezii</i>	–	–	–	–	1	2	–	–	2	–	–	–	5	0.71	
<i>Lu. longipalpis</i>	135	34	13	2	7	12	44	56	55	60	64	204	686	97.03	
<i>Ny. whitmani</i>	–	–	–	–	–	–	–	2	2	4	–	–	8	1.13	
<i>Ps. shannoni</i>	2	3	–	–	–	2	–	–	–	–	–	–	7	0.99	
Total	137	37	13	2	8	16	44	59	59	64	64	204	707	100	

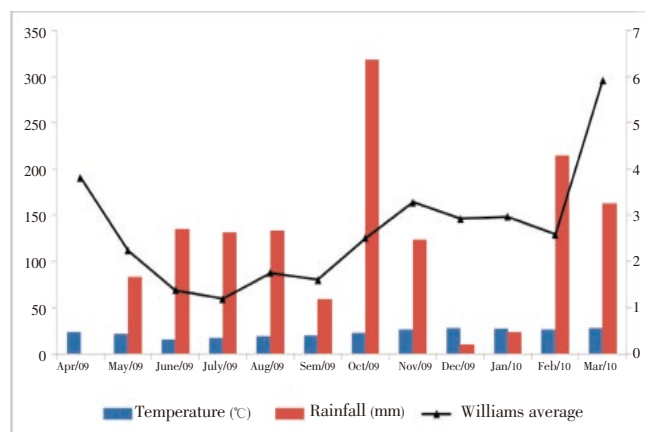
**Table 4**

Phlebotomines captured monthly with Shannon trap between 6 pm and 10 pm in an urban area of Ponta Porã city, MS, Brazil, from April 2009 to March 2010.

Species	6 pm to 7 pm		7 pm to 8 pm		8 pm to 9 pm		9 pm to 10 pm		Total		MF	% MF
	M	F	M	F	M	F	M	F	M	F		
<i>Ev. cortelezii</i>	–	2	–	–	–	–	–	–	–	2	2	1.3
<i>Lu. longipalpis</i>	2	–	1	–	13	3	–	–	16	3	19	12.3
<i>Ny. whitmani</i>	–	3	–	4	5	3	1	–	6	10	16	10.3
<i>Pi. monticola</i>	–	2	–	–	–	–	–	–	–	2	2	1.3
<i>Pi. pessoai</i>	8	4	9	4	1	2	–	2	18	12	30	19.3
<i>Ps. shannoni</i>	35	3	15	5	18	4	4	–	72	12	84	54.2
<i>Sc. sordellii</i>	–	–	–	–	–	–	–	2	–	2	2	1.3
Total	45	14	25	13	37	12	5	4	112	43	155	100

M=male; F = female.

and Table 3.



**Figure 1.**

Mean monthly temperature (°C), monthly rainfall (mm) and monthly frequency (Williams' geometric mean) of *Lu. longipalpis* captured in 14 ecotopes of Ponta Porã, MS, Brazil, from April 2009 to March 2010.

There was positive and significant correlation ( $r=0.7755$ ;  $P=0.003$ ) between temperature and Williams' geometric mean. When analyzed monthly rainfall and Williams' geometric mean, there was no correlation ( $r=-0.04494$ ;  $P=0.8897$ ). No correlation was also observed between the variables temperature and monthly rainfall ( $r = -0.1304$ ;  $P = 0.6862$ ).

With the Shannon trap, 155 specimens were captured (112 males and 43 females); 2.6:1 ratio. These samples belong to two sub-tribes, six genera and seven species: *Lutzomyiina* – *Lu. longipalpis*, *Ev. cortelezii*, *Sciopemyia sordellii* (Shannon & Del Ponte, 1927), *Pintomyia pessoai* (Coutinho & Barretto, 1940) and *Pintomyia monticola* (Costa Lima, 1932) and *Psychodopygina*:

*Ny. whitmani* and *Ps. shannoni*. The most frequently captured species were *Ps. shannoni* (54.2%) and *Pi. pessoai* (19.2%). The highest numbers of phlebotomine sandflies (38.1%) occurred between 6 pm and 7 pm, when 45.0 % of *Ps. shannoni* specimens and 40.0% of *Pi. pessoai* were captured; however, *Lu. longipalpis* (84.2%) and *Ny. whitmani* (50.0%) presented their highest frequencies between 8 pm and 9 pm. Only females of *Ev. cortelezzii*, *Pi. monticola* and *Sc. sordellii* were captured; among the species both sexes of which were captured, females predominated over males only for *Ny. whitmani* (62.5%), the former being the less frequent for *Lu. longipalpis* (6.25%), *Pi. pessoai* (40.0%) and *Ps. shannoni* (14.3%).

A female of *Ev. cortelezzii* captured on Shannon traps, installed in the central area of the city was found to be infected by flagellates in the midgut and hindgut of the digestive tract, accounting for 14.3% of all samples of this species.

#### 4. Discussion

*Lu. longipalpis* is among the species most frequently caught in Ponta Porã. In studies carried out by Oliveira *et al*[3] this species was not the most abundant; however, its gradual adaptation to urban areas in different regions of Mato Grosso do Sul is noteworthy[4,14].

It is important to emphasize that this species is the main vector of the etiological agent of visceral leishmaniasis in the State and participates actively in the epidemiological chain of this disease in Brazil[2]. Our findings are consistent with those of the literature regarding the expansion of the geographical distribution of *Lu. longipalpis*, this expansion probably being a direct consequence of changes in the ecosystems caused by human predatory actions and deforestation[15,16].

The second most abundant species, *Ny. whitmani*, is involved in the transmission of cutaneous leishmaniasis in several regions of Brazil. It was present both indoors and in areas surrounding homes, which shows that it has become adapted to human-modified environments[17]. In Mato Grosso do Sul, it has been found in several towns, including Antonio Joao, which borders on the municipality of Ponta Porã[18]. This species is widespread, representing an ample adaptation to different ecological niches and triggering behavioral changes in different populations[19–24].

The species diversity index of phlebotomine sandflies ranged from  $H=0$  to  $H=0.23$ . Its highest value was found in the peridomicile of Pousada do Bosque, a place with an accumulation of garbage and profuse surrounding vegetation, an environment favorable to species richness, as observed by Oliveira *et al*[3].

The most numerous capture of specimens occurred at Site 3, followed by those at Pousada do Bosque and Site 2. All three domiciles are located in the central area of the city and have in common nearby hen-houses and decomposing organic matter, features favorable to vector development, especially of *Lu. longipalpis* that is usually found in anthropic environments. Further study should be undertaken in the area so that the relationship between capture sites, quantity of cases reported and number of specimens captured may be established.

In relation to the proportion that each species contributes to the community of a particular ecotope, it can be observed that the highest value was seen around the peridomicile of Pousada do Bosque. It is worth noting that this site is located in the central area of Ponta Porã, which may favor the spread of leishmaniasis in the urban core. The presence of only

one species can be observed at sites where  $J=0$ ; it being important to highlight that the higher the value, the greater the occurrence of equal proportion between the species.

The correlation between the mean temperature and rainfall in the region over the period analyzed and the frequency and regularity of the most abundant species collected (*Lu. longipalpis*) was investigated. On the scale, had a close-to-1 value, indicating maximum abundance. These data have already been observed by some authors in studies conducted in other regions of Mato Grosso do Sul State[4,6].

This species was captured throughout the year. Control measures against the vector in these periods are highly to be recommended[25].

Although acknowledging that the study of seasonality shows reliable and consistent data only after at least two consecutive years of investigation to compare the results, thus reducing the margin of error of atypical years, this study indicated a density reduction of phlebotomine sandflies in the cold months, probably due to unfavorable environmental conditions for immature forms.

Although the requirements of vector incrimination of *Ev. cortelezzii* have not been met, the increase of its frequency in the peridomicile, and the environmental conditions favorable to the persistence of the enzootic cycle of Leishmania are factors indicating its vector potential. Even though, more studies about this species should be conducted as suggested by Carvalho *et al*[26].

Among the species captured in Shannon trap, useful capture method for analyzing the anthropophilic species, there is the presence of *Lu. longipalpis* and *Ny. whitmani*, both involved in cutaneous and visceral leishmaniasis transmission. *Ps. shannoni* predominated among the species. This species has been found to be attracted by humans in several regions, in Mato Grosso do Sul, its epidemiologic importance has been observed in several studies, because eventually can feed on man[6,27,28].

Even if this species is not associated with leishmaniasis transmission, it should be studied as it is an important arbovirus transmitter[29].

This study was undertaken in an urban area, which accounts for the low number of specimens of some of the species captured, the natural habitat of which is the forest environment.

In brief, the eight species captured in this study are part of the already known phlebotomine sandfly fauna of Mato Grosso do Sul, three of them, known as vectors of Leishmania sp agents: *Ny. whitmani* and *Pi. pessoai*, are vectors of cutaneous leishmaniasis agents, and *Lu. longipalpis*, the most abundant species, is the main vector of the LV agent. The high frequencies of this last species in the anthropic environment associated with the presence of canine cases of visceral leishmaniasis represent favorable conditions for the expansion and urbanization of human cases.

Due to the geographical location of the area studied and considering its epidemiologic importance as a city of LV transmission, it is essential to be aware of the vector's dispersal and the need to conduct entomological studies and sample surveys for canine information so that the data may serve as a basis for the design of strategies for prevention and control before the disease spreads further, as has already been occurring in many cities of Mato Grosso do Sul.

#### Conflict of interest statement

We declare that we have no conflict of interest.

## References

- [1] Neves DP, Gomes CFL, Iglésias JDF, Barçante JMP AL, Santos L. *Dinamic Parasitology*, 3rd ed. São Paulo: Atheneu; 2009.
- [2] Marcondes CB. *Medical and veterinary entomology*. 2nd ed. São Paulo: Atheneu; 2011.
- [3] Oliveira AG, Andrade-Filho JD, Falcão AL, Brasil RP. Study of sand flies (Diptera, Psychodidae, Phlebotominae) in the urban area of Campo Grande, Mato Grosso do Sul State, Brazil, from 1999 to 2000. *Cad Saúde Pública* 2003; **19**: 933–944.
- [4] Oliveira AG, Galati EAB, Oliveira O, Oliveira GRO, Espíndola IAC, Dorval MEC, et al. Abundance of *Lutzomyia longipalpis* (Diptera: Psychodidae: Phlebotominae) and urban transmission of visceral leishmaniasis in Campo Grande, state of Mato Grosso do Sul, Brazil. *Mem Inst Oswaldo Cruz* 2006; **101**: 869–874.
- [5] Almeida PS, Nascimento JC, Ferreira AD, Minzão LD, Portes F, Miranda AM, Faccenda O, et al. Species of phlebotomines (Diptera, Psychodidae) collected in urban municipalities with transmission of visceral leishmaniasis in Mato Grosso do Sul State, Brazil. *Rev Bras Entomol* 2010; **54**: 304–310.
- [6] Andrade ARO, Nunes VLB, Galati EAB, Cardozo C, Santos MFC, Rocca MEG, et al. Epidemiological study on leishmaniasis in an area of environmental tourism and ecotourism, State of Mato Grosso do Sul, 2006–2007. *Rev Soc Bras Med Trop* 2009; **42**: 488–493.
- [7] Ministry of Health. *Guide to epidemiological surveillance*. Brasília: A Series Technical Standards and Manuals; 2009.
- [8] Brazilian Institute of Geography and Statistics. IBGE cities 2010: Ponta Porã, 2010. [Online]. Available from: <http://www.ibge.gov.br/cidadesat/painel.php?colmen=500660>. [Accessed on Feb 5, 2010].
- [9] Galati EAB. Classification of Phlebotominae. In: Rangel EF, Lainson R, editors. *Sandflies in Brazil*. 20rd ed. Rio de Janeiro: Fiocruz; 2003.
- [10] Roberts DR, His BP. An index of species abundance for use with mosquito surveillance data. *Environmental Entomol* 1979; **8**: 1007–1013.
- [11] Haddow AJ. Studies on the biting-habits and medical importance of East African mosquito in the genus *Aedes*. I. Subgenera *Aedimorphus*, *Banksinella* and *Nunnius*. *Bull Entomol Res* 1960; **50**: 759–779.
- [12] Hayek LAC, Buzas MA. *Surveying natural populations*. New York: Columbia University Press; 1997, p. 563.
- [13] CEPETEC (Center for Weather Forecasting and Climate Studies). Precipitation and Temperature of Ponta Porã. [Online] Available from: <http://bancodedados.cptec.inpe.br/climatologia/Controller>. [Accessed on July 11, 2010].
- [14] Nunes VLB, Galati EAB, Cardozo C, Rocca MEG, Andrade ARO, Santos MFC, et al. Study of phlebotomines (Diptera, Psychodidae) in the urban area of Bonito municipality, Mato Grosso do Sul, Brazil. *Rev Bras Entomol* 2008; **52**: 446–451.
- [15] Azevedo PCB, Lopes GN, Fonteles RS, Vasconcelos GC, Moraes JLP, Rebêlo JMM. The effect of fragmentation on phlebotomine communities (Diptera: Psychodidae) in areas of ombrophilous forest in São Luís, state of Maranhão, Brazil. *Neotrop Entomol* 2011; **40**: 271–277.
- [16] Prado PF, Rocha MF, Sousa JF, Caldeira DI, Paz GF, Santos Dias E. Epidemiological aspects of human and canine visceral leishmaniasis in Montes Claros, State of Minas Gerais, Brazil, between 2007 and 2009. *Rev Soc Bras Med Trop* 2011; **44**: 561–566.
- [17] Ribeiro AL, Missawa NA, Zeilhofer P. Distribution of phlebotomine sandflies (Diptera: Psychodidae) of medical importance in Mato Grosso State, Brazil. *Rev Inst Med Trop S Paulo* 2007; **49**: 317–321.
- [18] Nascimento JC, Paiva BR, Malafronte RS, Fernandes WD, Galati EAB. Natural infection of phlebotomines (Diptera: Psychodidae) in visceral leishmaniasis focus in Mato Grosso do Sul, Brasil. *Rev Inst Med Trop S Paulo* 2007; **49**: 119–122.
- [19] Reinhold-Castro KR, Scodro RBL, Dias-Sversutti AC, Neitzke HC, Rossi RM, Kühl JB, et al. Evaluation of sandfly control measures. *Rev Soc Bras Med Trop* 2008; **41**: 269–273.
- [20] de Andrade AROL, Dorval MEMC, de Andrade SMO, Marques A, MS da Costa Lima Júnior, Baldomero. First report of natural infection of phlebotomines for *Leishmania (Leishmania) chagasi* captured in Ponta Porã, on the border between Brazil and Paraguay. *Asian Pac J Trop Med* 2011; **4**(11): 253–258.
- [21] García M, Perera WH, Scull R, Monzote L. Antileishmanial assessment of leaf extracts from *Pluchea carolinensis*, *Pluchea odorata* and *Pluchea rosea*. *Asian Pac J Trop Med* 2011; **4**(10): 836–840.
- [22] Hazratian T, Rassi Y, Oshaghi MA, Yaghoobi-Ershadi MR, Esmael. Phenology and population dynamics of sand flies in a new focus of visceral leishmaniasis in Eastern Azarbaijan Province, North western of Iran. *Asian Pac J Trop Med* 2011; **4**(8): 604–609.
- [23] Yavar R, Abedin S, Reza AM, Ali OM, Sina R, Mehdi M. *Phlebotomus papatasi* and *Meriones libycus* as the vector and reservoir host of cutaneous leishmaniasis in Qomrood District, Qom Province, central Iran. *Asian Pac J Trop Med* 2011; **4**(2): 97–100.
- [24] Dahroug MAA, Almeida ABPF, Sousa VRF, Dutra V, Guimarães LD, Soares CE, et al. The first case report of *Leishmania (leishmania) chagasi* in Panthera leo in Brazil. *Asian Pac J Trop Biomed* 2011; **1**(3): 249–250.
- [25] Souza Pinto I, Santos CB, Grimaldi Jr G, Ferreira AL, Falqueto A. American visceral leishmaniasis dissociated from *Lutzomyia longipalpis* (Diptera, Psychodidae) in the State of Espírito Santo, Brazil. *Cad Saúde Pública* 2010; **26**: 365–372.
- [26] Carvalho GM, Brasil RP, Falcão AL, Andrade-Filho JD. Geographical Distribution of the cortelezzii (Diptera: Psychodidae: Phlebotominae) Complex in Brazil. *Neotrop Entomol* 2009; **6**: 876–879.
- [27] Galati EAB, Nunes VLB, Dorval MEMC, Oshiro ET, Cristaldo G, Espíndola MA, et al. Study of the phlebotomines (Diptera, Psychodidae), in area of cutaneous leishmaniasis in the Mato Grosso do Sul State, Brazil. *Rev Saúde Pública* 1996; **30**: 115–128.
- [28] Florin DA, Lawyer P, Rowton E, Schultz G, Wilkerson R, Davies SJ, et al. Morphological anomalies in two *Lutzomyia* (Psathyromyia) *shannoni* (Diptera: Psychodidae: Phlebotominae) specimens collected from fort rucker, Alabama, and Fort Campbell, Kentucky. *J Med Entomol* 2010; **47**: 952–956.
- [29] Comer JA, Tesh RB, Modi GB, Com JL, Nettles VF. Vesicular stomatitis virus, New Jersey serotype: Replication in and transmission by *Lutzomyia shannoni* (Diptera: Psychodidae). *Am J Trop Med Hyg* 1990; **42**: 483–490.
- [30] State Department of Health of Mato Grosso do Sul State. Coordination of epidemiological surveillance. Report on the activities of surveillance and control of visceral leishmaniasis in the municipality of Ponta Pora-MS, period of 11 to 13 March 2008. Campo Grande; 2011.