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SURVEY OF SANDFLY FAUNA (DIPTERA: PSYCHODIDAE) IN UBERLÂNDIA, MINAS GERAIS STATE, BRAZIL, 2003 – 2004

Márcia Beatriz Cardoso de PAULA(1), Amaral Alves de SOUZA(1), Alessandro Ambrósio dos REIS(1), Jean Ezequiel LIMONGI(1,2), Adalberto de Albuquerque PAJUABA NETO(1) & Elisângela de Azevedo Silva RODRIGUES(1)

SUMMARY

We analyzed the sandflies around houses and domestic animal shelters located in residences close to forests in localities on the banks of the Araguari River, Uberlândia, MG, from February 2003 to November 2004. The phlebotomines were captured in the peridomiciliary area, where Shannon traps were utilized in the peridomicile and CDC traps in animal shelters. 2,783 specimens of sandflies were captured, 2,140 females (76.9%) and 643 males (23.1%), distributed between 17 species. The most abundant species was *Nyssomyia neivai* (88.1%), followed by *Nyssomyia whitmani* (3.1%). The presence of *Lutzomyia longipalpis* was also confirmed, it is the main vector of *Leishmania (L.) infantum chagasi* which causes visceral leishmaniasis. The presence of species involved in the transmission of leishmaniases in the municipality of Uberlândia is cause for concern. The presence of *L. longipalpis* indicates that its urbanization may not have been aleatory and instead occurred through the destruction of wild ecotopes. More studies of their occupation in anthropic environments need to be made.

KEYWORDS: Leishmaniasis; Ecology; Insect vectors; Epidemiology.

INTRODUCTION

The leishmaniases are complex infectious and parasitic diseases with zoonotic characteristics. Despite the fact that two million new cases of different clinical forms occur every year and 350 million people are at risk of contracting leishmaniases, the disease is part of a group of traditionally neglected tropical diseases that contribute to the maintenance of inequality and represent a strong obstacle to developing countries[2,9,13].

The disease is caused by various protozoa species of the genus *Leishmania*. Depending on the species involved and the parasite-host relationship have different clinical forms[13]. *Leishmania (Viannia) braziliensis, L. (V.) guyanensis, L. (L.) amazonensis* and recently *L. (V.) lainsoni, L. (V.) naiffi, L. (V.) lindenberg* and *L. (V.) shawi* have been most frequently associated with American tegumentary leishmaniasis (ATL). This disease affects the skin, mucous and cartilaginous structures of the nasopharynx and is transmitted by different species of sandflies[2,4].

In the New World *Leishmania (L.) infantum chagasi* is the species most commonly isolated in patients with American Visceral leishmaniasis (AVL). This is a chronic and severe form of leishmaniasis that is potentially fatal to humans when the proper treatment is not administered. It presents various clinical and epidemiological aspects and characteristics for each region where it occurs[2,8]. Over recent years, the significant increase in deforestation has favored the adaptation of vectors and reservoirs to anthropic environments and consequently the increased human exposure to the parasite[12].

The first human outbreak of ATL in the Triângulo Mineiro and Alto Paranaiba in the state of Minas Gerais, Brazil, occurred between July and November 1987. Twenty-five cases were diagnosed. After the analysis of the origin of the patients, it was concluded that autochthonous cases were in the Araguari River Valley. *Leishmania braziliensis* was identified as the species responsible for the outbreak[20].

Following a survey of the 25 notification forms of the patients involved in this outbreak, a study was conducted in 2001 in areas where the transmission of the disease occurred. The identification of phlebotomine sandfly fauna in the region showed the presence of transmitting vectors of ATL in environments with varying degrees of anthropization[19].

In addition, in January 2008 the first case of human visceral leishmaniasis occurred in the urban area in a child six-months and 22 days old, born and raised in Uberlândia, who had no history of travel to areas where the transmission of AVL is endemic. Epidemiological investigations have confirmed the autochthony of the disease[23].

(1) Centro de Controle de Zoonoses de Uberlândia, Uberlândia, MG, Brazil. E-mails: mbecpaula@yahoo.com.br, amaral-72@hotmail.com, alessandroareis@hotmail.com, jeanlimongi@gmail.com, pajuabaneto@yahoo.com.br, elisangelarodrigues@yahoo.com.br
(2) Instituto de Ciências Biomédicas, Universidade Federal de Uberlândia, Uberlândia, MG, Brazil.
Correspondence to: Marcia B. C. de Paula. E-mail: mbecpaula@yahoo.com.br

From February 2003 the Laboratory of Entomology of the Center for Zoonosis Control, an agency of the Health Department of Uberlândia, Minas Gerais, has standardized the Epidemiological Monitoring of canine visceral leishmaniasis in accordance with the provisions of the Ministry of Health. The objective of this study was to identify the phlebotomine fauna existing in 33 localities along the river Araguari from February 2003 to November 2004.

MATERIAL AND METHODS

Study area: The municipality of Uberlândia (18° 54' 41" S and 48° 15' 44" W) is located in the southern Triângulo Mineiro, west of state of Minas Gerais in southeastern Brazil (Fig. 1). The total area of the municipality is 4,115.82 km², and it is physically characterized by the predominance of cerrado, with altitude levels ranging from 863 m above sea level. The climate is classified, according to Koppen, as type AW (tropical sub-warm and subdry), with a mean annual temperature of 23.7 °C and mean annual rainfall of around 1,709 mm.

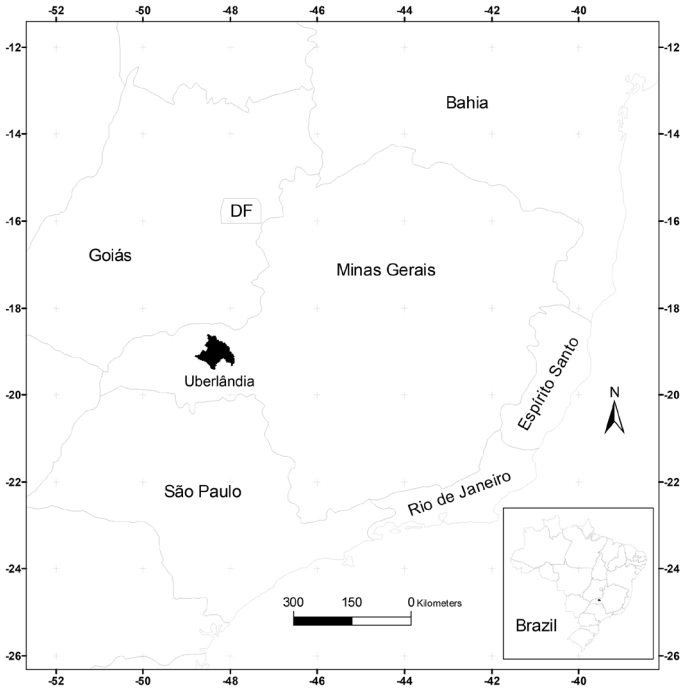

Fig. 1 - Location map of the municipality of Uberlândia.

Uberlândia is situated in the area of the Tablelands and Plateaus of the Paraná Sedimentary Basins. Its natural vegetation is the cerrado, a type of vegetation typical to the savannah, with gallery forest[7,33]. It is located between the rivers Tejuco and Araguari, both tributaries of the Rio Paranaíba. The study area is located at the banks of the River Araguari in a rural area (Fig. 2). The Araguari River Basin is located in the mesoregion of the Triângulo Mineiro and Alto Paranaíba. Covering a total of 13 municipal seats and featuring a drainage area of 21,566 km², the basin has an estimated population of 741,486 inhabitants[17] The river rises in the Araguari National Park of Serra da Canastra in São Roque de Minas and is 475 km long[5]. The study sites were those located in areas surrounding homes, characterized by the presence of primary forest and/or secondary riparian vegetation, the presence of decaying organic matter, the presence of stones, orchards, animal shelters, farms and banana plantations.

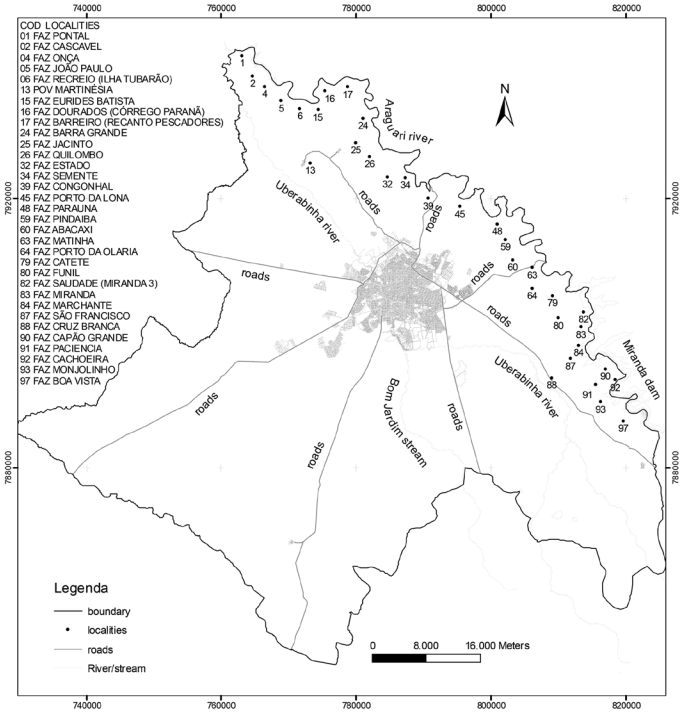

Fig. 2 - Study area with details of the localities on the banks of the Araguari River.

The Araguari River watershed is located in the southwest of Minas Gerais. This underwent great development in the 1970s due to the expansion of farming around the area of cerrado. This fact resulted in the use of water resources through the construction of hydroelectric power stations, the irrigation of large agricultural areas and urban consumption[30].

Capture of sandflies: Shannon traps were installed surrounding homes (peridomestic areas) located in close proximity to primary and secondary forest. CDC light traps were installed at animal shelters (dog kennels, poultry houses, stables and others), if present[8]. One Shannon trap and three CDC traps were used in each locality. These traps were set from 6:00 pm to 9:00 pm for three consecutive nights in each locality, always in the last week of each month, from February 2003 to November 2004, totaling 231 nights of captures with a total of 693 hours.

Following capture, the sandflies collected in the Shannon trap were stored directly in a test tube containing alcohol at a concentration of 70% and sent to the Entomology Laboratory of the Center for Zoonosis Control of the Municipality of Uberlândia for identification. The CDC traps were sent to the Laboratory of Entomology, where these insects were killed using ether, and then clarification, mounting and taxonomic identification was carried out.

Phlebotomine identification: The taxonomic keys of GALATI (2003)[14] were used for identification of the sandfly species. Specimens with missing or damaged parts that impaired identification at a specific level were taken to be *Lutzomyia* spp.

RESULTS

The phlebotomine fauna of the study area was composed of 17 species belonging to 10 genera*: Brumptomyia avellari* França & Parrot, 1921, *Evandromyia cortelezzii* (Brèthes, 1923), *Evandromyia lenti* (Mangabeira, 1938), *Evandromyia sallesi* (Galvão & Coutinho, 1939), *Evandromyia termitophila* Martins, Falcão & Silva, 1964, *L. longipalpis* (Lutz & Neiva, 1912), *Micropygomyia schreiberi* Martins, Falcão & Silva, 1975, *Migonemyia migonei* (França, 1920), *Nyssomyia neivai* (Pinto, 1926), *Nyssomyia whitmani* (Antunes & Coutinho, 1939), *Pintomyia misionensis* (Castro, 1959), *Pintomyia monticola* (Costa Lima, 1932), *Pintomyia pessoai* (Coutinho & Barretto, 1940)*, Psathyromyia lutziana* (Costa Lima, 1932), *Psathyromyia shannoni* (Dyar, 1929), *Psychodopygus davisi* (Root, 1934), *Sciopemyia sordellii* (Shannon & Del Ponte, 1927). A total of 2,783 specimens were caught, of which 2,140 were females (76.9%) and 643 were males (23.0%). Of all the females, 1,782 (64.0%) were captured in Shannon traps and 358 (12.9%) in CDC light traps. Of all the males, 365 (13.1%) were captured in Shannon traps and 278 (10.0%) in CDC light traps**.** Forty-five specimens of phlebotomine (1.6%) could not be identified and were therefore assumed to be *Lutzomyia* spp. *Nyssomyia neivai* was the predominant species, comprising 88.1% of the total number of phlebotomines collected (Table 1).

DISCUSSION

The results showed that the phlebotomine fauna from the peridomestic residences of localities along the river Araguari is diversified, with some species of epidemiological interest. *N. neivai* was the predominant species in this study. Indeed, *N. neivai* is predominant and is captured abundantly in several cutaneous leishmaniasis foci in the Southeastern and Southern regions of Brazil[3]. In Argentina, it was suspected that insects identified as *N. neivai* were vectors of parasites causing ATL, and researchers in 2006 detected the presence of this species of sandfly infected with parasites of the subgenus *Viannia*[11]. Specimens of *N. neivai* were also found infected naturally with *Leishmania (Viannia) braziliensis* in the city of Porto Alegre, Rio Grande do Sul, suggesting a potential ability of this species to transmit the parasite[25]. In our study, 69.1% of these specimens of *N. neivai* were captured in Shannon traps. Our results are consistent with other studies which have suggested that this species has a tendency to inhabit areas near the forest, since a higher number of specimens were recovered in this trap type, and has therefore proved its low potential dispersion[10].

N. whitmani was the second most abundant species in this study. Research carried out in several areas of Brazil described it as one of the few species of high adaptability to different environmental conditions, both climatic variations and variations in vegetation[26,29,36,37,38].

The wide distribution of *N. whitmani*, and their association with *Leishmania braziliensis* in different geographic regions highlights the importance of this species in the epidemiology of ATL and suggests that this species may have local importance as a vector of disease in the study area[5,6,31].

Table 1
Sandfly species captured in Uberlândia, MG, Brazil between 2003 and 2004, according to type of trap

Species	Shannon			CDC			Total (%)
	Males	Females	Total (%)	Males	Females	Total (%)	
Brumptomyia avellari	13	22	35 (1.3)	26	17	43 (1.5)	78 (2.8)
Evandromyia cortelezzii	1	11	12 (0.4)	-	3	3 (0.1)	15 (0.5)
Evandromyia lenti	1	-	1 (0.04)	10	4	14 (0.5)	15 (0.5)
Evandromyia sallesi	-	2	2 (0.1)	-	-	0 (0.0)	2 (0.1)
Evandromyia termitophila	-	4	4 (0.1)	-	3	3 (0.1)	7 (0.25)
Lutzomyia longipalpis	2	1	3 (0.1)	3	1	4 (0.1)	7 (0.25)
Lutzomyia spp.	-	37	37 (1.3)	3	5	8 (0.3)	45 (1.6)
Micropygomyia schreiberi	1	2	3 (0.1)	-	-	0 (0.0)	3 (0.11)
Migonemyia migonei	-	2	2 (0.1)	-	-	0 (0.0)	2 (0.1)
Nyssomyia neivai	298	1626	1924 (69.1)	214	315	529 (19.0)	2453 (88.1)
Nyssomyia whitmani	37	25	62 (2.2)	17	8	25 (0.9)	87 (3.1)
Pintomyia missionensis	-	12	12 (0.4)	-	-	0 (0.0)	12 (0.4)
Pintomyia monticola	1	5	6 (0.2)	-	-	0 (0.0)	6 (0.2)
Pintomyia pessoai	7	12	19 (0.7)	2	-	2 (0.1)	21 (0.7)
Psathyromyia lutziana	4	13	17 (0.6)	-	-	0 (0.0)	17 (0.6)
Psathyromyia shannoni	-	3	3 (0.1)	1	-	1 (0.04)	4 (0.1)
Psychodopygus davisi	-	3	3 (0.1)	-	2	2 (0.1)	5 (0.2)
Sciopemyia sordellii	-	2	2 (0.1)	2	-	2 (0.1)	4 (0.1)
TOTAL	365	1782	2147 (77.1)	278	358	636 (22.9)	2783 (100)

Two other species involved in the transmission of ATL were also captured in greater quantities with Shannon traps in environments close to the forest. They are *P. pessoai* (0.7%) and *M. migonei* (0.1%), forming along with *N. neivai* 69.9% of the sandflies captured in this type of trap. The fact that *M. migonei* and *P. pessoai* were found in this type of site is consistent with the literature that considers this species to be found in wild habitats, although it has also been seen frequenting homes and wildlife shelters[15,28]. *M. migonei* is highly anthropophilic; through this adaptation to domiciliary/peridomiciliary environments, *M. migonei* can therefore maintain enzootic transmission from the adjacent secondary forests[34]. This species has been found to be naturally infected by *L. braziliensis* in other states of Brazil[24,26]. *Pintomyia pessoai* can act as a secondary vector in some areas with the presence of primary forest[15]. More recently, *P. pessoai* was the most abundant species collected in the northwestern region of the state of São Paulo[1].

On the other hand, according to the Ministry of Health (Source: SINANW-SINANNET), between 2005 and June 2010 ten patients reported having contracted the infection in a rural study area whilst fishing. However, only a single case of autochthonous human ATL was confirmed.

Through these data we can infer that, although previous studies reported that the presence of animals around the homes of rural and urban areas provided support for the colonization of sandflies, which find shelter and food at these sites, increasing the risk of leishmaniasis transmission in the study area, the species involved in transmission of ATL agents remained still, closer to the primary and secondary forest, even though these ecotopes were near the peridomicile[35,39.]

The fact that *L. longipalpis* was found has confirmed its presence in the study area, which had already been identified by other authors in ecotopes consisting of rocks, holes and scrub, located in an area where there was a large concentration of workers who were involved in the construction of a dam at the time of the research[19]. On the other hand, due to negative impacts on natural resources in the region observed during the study period, we can hypothetically suggest that the urbanization of *L. longipalpis* was not aleatory and occurred as a result of the destruction of wild ecotopes, as described by other authors[18, 22, 39].

RESUMO

Levantamento da fauna flebotomínica (Diptera: Psychodidae) no município de Uberlândia, Minas Gerais, Brasil, 2003-2004

Analisamos a fauna flebotomínica do peridomicílio e de abrigos de animais domésticos localizados em residências próximas de matas em localidades às margens do rio Araguari, município de Uberlândia-MG, de fevereiro de 2003 a novembro de 2004. Foram realizadas capturas no peridomicílio, sendo armadilhas de Shannon utilizadas no peridomicílio das residências e as armadilhas CDC em abrigos de animais domésticos. Foram capturados 2.783 espécimes de flebotomíneos, sendo 2.140 fêmeas (76,9%) e 643 machos (23,1%), distribuídos em 17 espécies. A espécie mais abundante foi *Nyssomyia neivai* (88,1%), seguida por *Nyssomyia whitmani (*3,1%). Foi confirmada também a presença de *Lutzomyia longipalpis*, o principal vetor de *Leishmania infantum chagasi*, causadora da leishmaniose visceral. Constitui-se motivo de alerta a presença de espécies envolvidas com a transmissão de leishmanioses no município de Uberlândia. A presença de *L. longipalpis* indica que sua urbanização pode não ter sido aleatória e ocorre pela destruição de ecótopos silvestres. Mais estudos sobre sua ocupação em ambientes antrópicos precisam ser realizados.

AUTHOR CONTRIBUTIONS

Márcia Beatriz Cardoso de Paula: conception and design of the study, collection, assembly, analysis and interpretation of data and drafting the article. **Amaral Alves de Souza**: collection, assembly, analysis and interpretation of data and drafting the article. **Alessandro Ambrósio dos Reis**: collection, assembly, analysis and interpretation of data and drafting the article. **Jean Ezequiel Limongi**: analysis and interpretation of data and drafting the article. **Adalberto de Albuquerque Pajuaba Neto:** analysis and interpretation of data and drafting the article. **Elisângela de Azevedo Silva Rodrigues**: conception and design of the study, collection, assembly, analysis and interpretation of data and drafting the article.

REFERENCES

1. Alessi CAC, Galati EAB, Alves JR, Corbett CEP. American cutaneous leishmaniasis in the Pontal of Paranapanema - SP, Brazil: ecological and entomological aspects. Rev Inst Med Trop Sao Paulo. 2009,51:277-82.

2. Alves WA. Leishmaniose visceral americana: situação atual no Brasil. Bol Epidemiol Paul. 2009;71:25-9.

3. Andrade Filho JD, Galati EAB, Falcão AL. *Nyssomyia intermedia* (Lutz & Neiva, 1912) and *Nyssomyia neivai* (Pinto, 1926) (Diptera: Psychodidae: Phlebotominae) geographical distribution and epidemiological importance. Mem Inst Oswaldo Cruz. 2007;102:481-7.

4. Arruda MM. Leishmanioses. [Internet]. Curitiba: Conselho Regional de Medicina Veterinária; do Estado do Paraná; 2009. [cited: 2009 Dec 20]. 22 p. Available from: http://www.zoonoses.org.br/absoluto/midia/imagens/zoonoses/arquivos_1258562831/6365_crmv-pr_manual-zoonoses_leishmanioses.pdf

5. Azevedo ACR, Rangel EF, Costa EM, David J, Vasconcelos AW, Lopes UG. Natural infection of *L. (Nyssomyia) whitmani* (Antunes & Coutinho, 1939) by *Leishmania* of the braziliensis complex in Baturité, Ceará State, Northeastern Brazil. Mem Inst Oswaldo Cruz. 1990;85:251.

6. Azevedo ACR, Vilela ML, Souza NA, Andrade-Coelho CA, Barbosa AF, Firmo ALS, *et al*. The sand fly fauna (Diptera: Psychodidae: Phlebotominae) of a focus of cutaneous leishmaniasis in Ilhéus, state of Bahia, Brazil. Mem Inst Oswaldo Cruz. 1996;91:75-9.

7. Baccaro CAD. Estudos geomorfológicos do município de Uberlândia. Soc Nat. 1989;1:17-21.

8. Brasil. Ministério da Saúde. Fundação Nacional de Saúde. Manual de vigilância e controle da leishmaniose visceral. Brasília: Ministério da Saúde; 2006.

9. Campos A. A tragédia das doenças esquecidas. Problemas Brasileiros [Internet]. São Paulo: SESC; 2009. [cited: 2009 Dec 15]. Available from: http://www.sescsp.org.br/sesc/revistas_sesc/pb/artigo.cfm?Edicao_Id=355&Artigo_ID=5506&IDCategoria=6309&reftype=1

10. Casanova C, Costa AIP, Natal D. Dispersal parttern of the sand fly *Lutzomyia neivai* (Diptera: Psychodidae) in a cutaneous leishmaniasis endemic rural area in Southeastern Brazil. Mem Inst Oswaldo Cruz. 2005;100:719-24.

11. Córdoba-Lanús E, De Grosso ML, Piñero JE, Valladares B, Salomón OD. Natural infection of *Lutzomyia neivai* with *Leishmania* spp. in northwestern Argentina. Acta Trop. 2006;98:1-5.

12. Costa JML. Epidemiologia das Leishmanioses no Brasil. Gaz Méd Bahia. 2005;75:3-17.

13. Desjeux P. Leishmaniasis: current situation and new perspectives. Comp Immunol Microbiol Infect Dis. 2004;27:305-18.

14. Galati EAB. Morfologia e taxonomia. Classificação de Phlebotominae. In: Rangel EF, Lainson R, editores. Flebotomíneos do Brasil**.** Rio de Janeiro: Editora Fiocruz; 2003. p. 23-51.

15. Gomes AC, Galati EAB. Aspectos ecológicos da leishmaniose tegumentar americana: capacidade vetorial flebotomínea em ambiente florestal primário do Sistema da Serra do Mar, região do Vale do Ribeira, Estado de São Paulo, Brasil. Rev Saúde Pública. 1989;23:136-42.

16. Hermeto MV, Vieira-Dias D, Genaro O, Rotondo-Silva A, Costa CA, Toledo VPCP, *et al*. Outbreak of cutaneous leishmaniasis in rio Doce Valley, Minas Gerais, Brazil. Mem Inst Oswaldo Cruz. 1994;89:519-21.

17. Instituto Mineiro de Gestão das Águas. Bacia hidrográfica do Rio Paranaíba. [Internet]. Belo Horizonte: Instituto Mineiro de Gestão das Águas; 2011. [cited: 2011 Aug 4]. Available from: http://www.igam.mg.gov.br/index.php?option=com_content&task=view&id=153&Itemid=140

18. Lainson R, Rangel EF. *Lutzomyia longipalpis* and the eco-epidemiology of American visceral leishmaniasis, with particular reference to Brazil: a review. Mem Inst Oswaldo Cruz. 2005;100:811-27.

19. Lemos JC, Lima SC, Costa MB, Magalhães MJ. Leishmaniose tegumentar americana: fauna flebotomínica em áreas de transmissão no município de Uberlândia, Minas Gerais, Brasil. Caminhos Geogr. 2001;2:57-73.

20. Machado MI, Nishioka SA, Ferreira MS, Costa-Cruz JM, Rocha A, Silva AM, *et al.* Leishmaniose tegumentar americana no Triangulo Mineiro e Alto Paranaíba, Minas Gerais, Brasil: aspectos clínico-laboratoriais e epidemiológicos de uma microepidemia. Rev Cent Ci Bioméd Univ Fed Uberlândia. 1992;8:17-28.

21. Margonari C, Soares RP, Andrade-Filho JD, Xavier DC, Saraiva L, Fonseca AL, *et al.* Phlebotomine sand flies (Diptera: Psychodidae) and *Leishmania* infection in Gafanhoto Park, Divinópolis, Brazil. J Med Entomol. 2010;47:1212-9.

22. Marzochi MCA, Fagundes A, Andrade MV, Souza MB, Madeira MF, Mouta-Confort E, *et al*. Visceral leishmaniasis in Rio de Janeiro, Brazil: ecoepidemiological aspects and control. Rev Soc Bras Med Trop. 2009;42:570-80.

23. Paula MBC, Rodrigues EAS, Souza AA, Reis AA, Paula FP, Pajuaba Neto AA, *et al*. Primeiro encontro de *Lutzomyia longipalpis* (Lutz & Neiva, 1912) na área urbana de Uberlândia, MG, concomitante com o relato de primeiro caso autóctone de leishmaniose visceral humana. Rev Soc Bras Med Trop. 2008;41:304-5.

24. Pita-Pereira D, Alves CR, Souza MB, Brazil RP, Bertho AL, de Figueiredo Barbosa A, *et al.* Identification of naturally infected *Lutzomyia intermedia* and *Lutzomyia migonei* with *Leishmania (Viannia) braziliensis* in Rio de Janeiro (Brazil) revealed by a PCR multiplex non-isotopic hybridisation assay. Trans R Soc Trop Med Hyg. 2005;99:905-13.

25. Pita-Pereira D, Souza GD, Zwetsch A, Alves CR, Britto C, Rangel EF. First Report of *Lutzomyia (Nyssomyia) neivai* (Diptera: Psychodidae: Phlebotominae) naturally infected *by Leishmania (Viannia) braziliensis* in a periurban area of South Brazil using a Multiplex Polymerase Chain Reaction Assay. Am J Trop Med Hyg. 2009;80:593-5.

26. Queiroz RG, Vasconcelos IA, Vasconcelos AW, Pessoa FA, Sousa RN, David JR. Cutaneous Leishmaniasis in Ceará State in northeastern Brazil: incrimination of *Lutzomyia whitmani* (Diptera: Psychodidae) as a vector of *Leishmania braziliensis* in Baturité municipality. Am J Trop Med Hyg. 1994;50:693-8.

27. Rangel EF, Souza NA, Wermelinger ED, Azevedo ACR, Barbosa AF, Andrade CA. Flebótomos de Vargem Grande, foco de leishmaniose tegumentar no estado do Rio de Janeiro. Mem Inst Oswaldo Cruz. 1986;81:347-9.

28. Rangel EF, Lainson R. Proven and putative vectors of American cutaneous leishmaniasis in Brazil: aspects of their biology and vectorial competence. Mem Inst Oswaldo Cruz. 2009;104:937-54.

29. Rodrigues EAS, Andrade Filho JD, Limongi JE, Paula MBC. Sandfly fauna (Diptera: Psychodidae) in Parque do Sabiá complex, Uberlândia, Minas Gerais, Brazil. Rev Inst Med Trop Sao Paulo. 2011;53:255-8.

30. Rodrigues SC, Silva, TI. Dam construction and loss of geodiversity in the Araguari river basin, Brazil. Land Degrad Dev. 2012;23:419-26. doi:10.1002/ldr.2157

31. Saraiva L, Lopes JS, Oliveira GB, Batista FA, Falcão AL, Andrade Filho JD. Estudo dos flebotomíneos (Diptera: Psychodidae) em área de leishmaniose tegumentar americana nos municípios de Alto Caparaó e Caparaó, Estado de Minas Gerais. Rev Soc Bras Med Trop. 2006;39:56-63.

32. Saraiva L, Carvalho GML, Gontijo CMF, Quaresma PF, Lima ACVMR, Falcão AL, *et al.* Natural infection of *Lutzomyia neivai* and *Lutzomyia sallesi* (Diptera: Psychodidae) by *Leishmania infantum chagasi* in Brazil. J Med Entomol. 2009;46:1159-63.

33. Schiavini I, Araújo GM. Considerações sobre a vegetação da reserva ecológica do Panga (Uberlândia). Soc Nat. 1989;1:61-5.

34. Shimabukuro P, da Silva T, Fonseca F, Baton LA, Galati EAB. Geographical distribution of American cutaneous leishmaniasis and its phlebotomine vectors (Diptera: Psychodidae) in the state of São Paulo, Brazil. Parasit Vectors. 2010;3:121.

35. Silva AR, Martins G, Melo JEM, Araújo JP, Mendes MG. Surto epidêmico de leishmaniose tegumentar americana na colonização agrícola de Buriticupu (MA). Rev Inst Med Trop Sao Paulo. 1979;21:45-50.

36. Souza CF, Borges MAS, Andrade AJ. Contribution to the knowledge of the phlebotomine sand flies fauna (Diptera: Psychodidae) of Timóteo Municipality, Minas Gerais, Brazil. Neotrop Entomol. 2009;38:267-71.

37. Teodoro U, Balduíno J, Thomaz-Soccol V, Barbosa OC, Ferreira MEMC, Lozovei AL, *et al*. Environmental sanitation and peri-domiciliar organization as auxiliary practices for the control of phlebotomines in Paraná State, Southern Brazil. Braz Arq Biol Tecnol. 1999;42:307-14.

38. Teodoro U, Alberton D, Kühl JB, Santos ES, Santos DR, Santos AR, *et al*. Ecology of *Lutzomyia (Nyssomyia) whitmani* in an urban area in Brazil. Rev Saude Publica. 2003;37:651-6.

39. Ximenes MF, Souza MF, Castellón EG. Density of sandflies (Diptera: Psychodidae) in domestic and wild animal shelters in an area of visceral leishmaniasis in the State of Rio Grande do Norte, Brazil. Mem Inst Oswaldo Cruz. 1999;94:427-32.

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