

PUBLIC HEALTH

Phlebotomine Sand Flies (Diptera: Psychodidae) of the State of Minas Gerais, Brazil

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ABSTRACT - The phlebotomine sand fly fauna of the State of Minas Gerais is presented based on an extensive review of the literature. The fauna, which is a rich one, is currently known to consist of at least 93 species included in 16 genera. The genus *Evandromyia* (16 spp.) is the most representative one, followed by *Micropygomyia* (13 spp.), *Psathyromyia* (12 spp.), *Brumptomyia* (11 spp.), *Pintomyia* (9 spp.), *Lutzomyia* (7 spp.), *Psychodopygus* (7 spp.), *Martinsmyia* (4 spp.), *Nyssomyia* (3 spp.), *Deanemyia* (2 spp.), *Expapillata* (2 spp.), *Pressatia* (2 spp.), and *Sciopemyia* (2 spp.). The genera *Bichromomyia*, *Trichopygomyia*, and *Migonemyia* are represented by only one species. An updated list of phlebotomine sand fly species occurring in Minas Gerais is provided. Finally, the importance of the species of public health concern is discussed.

KEY WORDS: Phlebotominae, leishmaniase

Phlebotomine sand flies play an important role in the transmission of disease agents to human beings. They are responsible for the transmission of intracellular protozoan parasites of the genus *Leishmania* Ross, the causative agents of a group of diseases collectively known as the leishmaniases (Desjeux 2004). Nowadays, over 460 phlebotomine sand fly species are known to occur in the Americas (Galati 2003a). In this region, approximately 40 species are involved in the transmission of *Leishmania* parasites (Killick-Kendrick 1990, Lainson & Shaw 2005).

In Brazil, the leishmaniases have a broad distribution and account for a great burden in terms of morbidity and mortality, which, together with other arthropod-borne diseases like malaria, represent the Achilles' heel of public health in Brazil in terms of disease control. The burden of leishmaniases is greater among the poorest segments of society, particular, but not exclusively, in the Northeastern region (Lainson & Rangel 2005, Dantas-Torres & Brandão-Filho 2006). Nowadays, the leishmaniases are also well established in other regions, including large urban areas of Southeastern Brazil, such as the metropolitan region of Belo Horizonte in the State of Minas Gerais (Passos *et al* 1993, Oliveira *et al* 2001).

Historically, the leishmaniases are endemic to Minas Gerais; the first cases were reported in the municipality of Uberaba, during the late in 1910s (Rabello 1917). Currently, the leishmaniases are widely spread in this state. Visceral leishmaniasis is a major public health problem in many municipalities of Minas Gerais (Barata *et al* 2004, Monteiro

et al 2005), including in Belo Horizonte, the state capital (Silva *et al* 2001).

The first contributions to the study of phlebotomine sand flies of Minas Gerais took place at the beginning of the 1910s (Lutz & Neiva 1912), when Dr. Adolf Lutz and Dr. Arthur Neiva, working in the municipalities of Além Paraíba and Cordisburgo (Maquiné Cave), described two species that today are known as *Lutzomyia longipalpis* (Lutz & Neiva) and *Nyssomyia intermedia* (Lutz & Neiva). During the second half of the 20th century, the phlebotomine sand fly fauna of Minas Gerais was extensively studied and a number of species were recorded and/or described (Martins *et al* 1956, 1982, Falcão 1963, Gomes *et al* 1978, Mayrink *et al* 1979, Rangel *et al* 1985, Falcão *et al* 1988, Passos *et al* 1993, Genaro *et al* 1996, Marcondes 1996, Andrade Filho *et al* 1997, 1998, 1999a,b, Brazil *et al* 1997, Gontijo *et al* 2002).

According to the last lists of phlebotomine sand flies of Brazil, the fauna of Minas Gerais is known to consist of 82 species (CIPA 1999, Aguiar & Medeiros 2003, Galati 2003a). However, these lists are currently out of date. The present article intends to provide an updated list of phlebotomine sand flies occurring in Minas Gerais, based on an extensive review of the literature.

Material and Methods

The present study was based on an extensive search of the literature regarding records of phlebotomine sand flies

in the State of Minas Gerais, Southeastern Brazil. All papers found, from 1912 to 2008, were carefully reviewed, including original descriptions of many species. The nomenclature of phlebotomine sand flies follows the classification system recently proposed by Galati (2003b). Abbreviations of genera and subgenera names are according to Marcondes (2007).

Data on phlebotomine sand flies occurring in Minas Gerais were compiled from several papers: Lutz & Neiva (1912), Newstead (1914), França (1920), Larrousse (1920), Lutz (1922), Newstead (1922), Brèthes (1923), Pinto (1926), Dyar (1929), Costa Lima (1932), Root (1934), Costa Lima & Antunes (1936), Mangabeira (1938, 1942), Barretto & Coutinho (1941), Barretto *et al* (1956), Martins *et al* (1957, 1961, 1962a, 1962b, 1964, 1970, 1972, 1975, 1982), Martins & Silva (1965, 1968), Ryan *et al* (1986), Dias *et al* (1987), Galati *et al* (1989, 1995), Andrade Filho *et al* (1999a, 2002).

Information on phlebotomine sand fly species occurring in Minas Gerais available at the CIPA Group website (<http://cipa.snv.jussieu.fr>), which is an on-line taxonomic catalogue of American sand fly species, was also used.

Additional locality records are according to information provided in the reference book *American Sand Flies (Diptera: Psychodidae, Phlebotominae)*, by Martins *et al* (1978), and also based on several entomological surveys (Marcondes 1996, Andrade Filho *et al* 1999c, 2007, Santos de Marco *et al* 2002, Hamilton *et al* 2004).

Phlebotomine sand fly species found in Minas Gerais but not included in previous lists (Young & Duncan 1994, CIPA 1999, Aguiar & Medeiros 2003, Galati 2003a) and some synonyms (i.e., species that are included in the present checklist, but have been regarded as synonyms by some authors) are also discussed. Likewise, phlebotomine sand fly species epidemiologically involved in the transmission of *Leishmania* parasites are highlighted.

Results

The phlebotomine sand fly fauna of Minas Gerais is currently known to consist of 93 species included in four subtribes, 16 genera, 14 subgenera, 13 series and two species groups. Phlebotomine sand fly species described based on material collected from Minas Gerais (a), species endemic to Minas Gerais (i.e., only recorded in this state) (b) and species of public health concern (c) are highlighted.

The list include the species *Brumptomyia ortizi* Martins, Silva & Falcão (Caparaó), *Br. travassosi* (Mangabeira) (Viçosa), *Evandromyia bacula* (Martins, Falcão & Silva) (Sete Lagoas, AJA - personal observation), *Ev. cortelezzii* (Brèthes) (Intanhomi, Pedra do Indιά, Sacramento, Santa Luzia), *Ev. corumbaensis* (Galati, Nunes, Oshiro & Rego) (Uberlândia), *Micropygomyia breviducta* (Barretto) (Além Paraíba), *Mi. micropyga* (Mangabeira) (Parque Nacional Cavernas do Peruaçu-São João das Missões, Itacarambi and Januária); *Mi. trinidadensis* (Newstead) (Montes Claros, Porteirinha, Vazelândia), *Pressatia choti* (Floch & Abonnenc) (Timóteo), *Psychodopygus carrerai carrerai* (Barretto) (Além Paraíba), and *Ps. fairchildi* (Barretto) (Parque Estadual do Rio Doce-Cava Grande). These species were not included in the previous lists either by omission or because there were

recorded in Minas Gerais only recently (see Discussion).

Six phlebotomine sand fly species are endemic from Minas Gerais. For two of them, *Deanemyia appendiculata* (Martins *et al*) and *De. ramirezi* (Martins *et al*), the only *bona fide* records of their presence in Minas Gerais are their original descriptions.

Brumptomyiina Artemiev

Brumptomyia França & Parrot (11 spp.): *Br. avellari* (Costa Lima)^a, *Br. brumpti* (Larrousse), *Br. cardosoi* (Barretto & Coutinho), *Br. cunhai* (Mangabeira), *Br. guimaraesi* (Coutinho & Barretto), *Br. mangabeirai* (Barretto & Coutinho), *Br. nitzulescui* (Costa Lima), *Br. ortizi* Martins *et al*, *Br. pinto* (Costa Lima)^a, *Br. travassosi* (Mangabeira), and *Br. troglodytes* (Lutz).

Lutzomyiina Abonnenc & Leger

Sciopemyia Barretto (2 spp.): *Sc. microps* (Mangabeira) and *Sc. sordellii* (Shannon & Del Ponte).

Lutzomyia França (7 spp.): *Lu. alencari* Martins *et al*^a, *Lu. amarali* (Barretto & Coutinho), *Lu. cavernicola* (Costa Lima)^a, *Lu. ischnacantha* Martins, Souza & Falcão^b, *Lu. ischyracantha* Martins *et al*^b, *Lu. longipalpis* (Lutz & Neiva)^{a,c}, and *Lu. renei* (Martins, Falcão & Silva).

Migonemyia Galati (1 sp.): *Mg. migonei* (França)^c

Pintomyia Costa Lima (9 spp.): *Pi. bianchigalatae* (Andrade-Filho *et al*)^a, *Pi. christenseni* (Young & Duncan), *Pi. damascenoi* (Mangabeira), *Pi. fischeri* (Pinto)^c, *Pi. mamedei* (Oliveira *et al*), *Pi. misionensis* (Castro), *Pi. monticola* (Costa Lima), *Pi. pessoai* (Coutinho & Barretto)^c, and *Pi. serrana* (Damasceno & Arouck).

Expapillata Galati (2 spp.): *Ex. cerradincola* (Galati *et al*) and *Ex. firmatoi* (Barretto *et al*)^a.

Pressatia Mangabeira (2 spp.): *Pr. choti* (Floch & Abonnenc) and *Pr. equatorialis* (Mangabeira).

Trichopygomyia Barretto (1 sp.): *Ty. longispina* (Mangabeira).

Evandromyia Mangabeira (16 spp.): *Ev. bacula* (Martins *et al*), *Ev. callipyga* (Martins & Silva)^b, *Ev. carmelinoi* (Ryan *et al*), *Ev. cortelezzii* (Brèthes), *Ev. corumbaensis* (Galati *et al*), *Ev. costalimai* (Mangabeira), *Ev. edwardsi* (Mangabeira), *Ev. evandroi* (Costa Lima & Antunes), *Ev. lenti* (Mangabeira)^a, *Ev. petropolitana* (Martins & Silva), *Ev. sallesi* (Galvão & Coutinho), *Ev. rupicola* (Martins *et al*), *Ev. teratodes* (Martins *et al*), *Ev. termitophila* (Martins *et al*)^a, *Ev. tupynambai* (Mangabeira), and *Ev. walkeri* (Newstead).

Psychodopygina Galati

Psathyromyia Mangabeira (12 spp.): *Pa. aragaoi* (Costa Lima)^a, *Pa. barretto* (Barretto) (Mangabeira), *Pa. brasiliensis*

(Costa Lima), *Pa. dendrophyla* (Mangabeira), *Pa. hermanlenti* (Martins *et al*)^a, *Pa. lanei* (Barretto & Coutinho), *Pa. lutziana* (Costa Lima)^a, *Pa. pascalei* (Coutinho & Barretto), *Pa. pelli* (Sherlock & Alencar), *Pa. pestanai* (Barretto & Coutinho), *Pa. runoides* (Fairchild & Hertig), and *Pa. shannoni* (Dyar).

Martinsmyia Galati (4 spp.): *Mt. cipoensis* (Martins *et al*)^a, *Mt. gasparviannai* (Martins *et al*), *Mt. minasensis* (Mangabeira)^b, and *Mt. oliveirai* (Martins *et al*)^a.

Psychodopygus Mangabeira (7 spp.): *Ps. ayrozai* (Barretto & Coutinho)^c, *Ps. carrerai carerai* (Barretto), *Ps. davisi* (Root), *Ps. fairchildi* (Barretto), *Ps. hirsutus hirsutus* (Mangabeira)^c, *Ps. lloydii* (Antunes), and *Ps. matosi* (Barretto & Zago).

Bichromomyia Artemiev (1 sp.): *Bi. flaviscutellata* (Mangabeira)^c.

Nyssomyia Barretto (3 spp.): *Ny. intermedia* (Lutz & Neiva)^{a,c}, *Ny. neivai* (Pinto)^c, and *Ny. whitmani* (Antunes & Coutinho)^c.

Sergentomyiina Artemiev

Deanemyia Galati (2 spp.): *De. appendiculata* (Martins *et al*)^b and *De. ramirezi* (Martins *et al*)^b.

Micropygomyia Barretto (13 spp.): *Mi. acanthopharynx* (Martins *et al*), *Mi. borgmeieri* (Martins *et al*)^a, *Mi. breviducta* (Barretto), *Mi. capixaba* (Dias *et al*), *Mi. ferreirana* (Barretto *et al*)^a, *Mi. longipennis* (Barretto), *Mi. micropyga* (Mangabeira), *Mi. oswaldoi* (Mangabeira), *Mi. peresi* (Mangabeira), *Mi. quinquefer* (Dyar), *Mi. schreiberi* (Martins *et al*), *Mi. trinidadensis* (Newstead), and *Mi. villelai* (Mangabeira).

Discussion

The phlebotomine sand fly fauna of Minas Gerais. In the present article, we comprehensively reviewed the literature on phlebotomine sand fly fauna of Minas Gerais, which is currently known to consist of at least 93 species in 16 genera; most of them belong to the subtribe Lutzomyiina. In comparison with other states within the Southeast region of Brazil (see Aguiar & Medeiros 2003), the phlebotomine sand fly fauna of Minas Gerais is very rich in terms of species diversity.

Checklists of phlebotomine sand fly species occurring in Minas Gerais have appeared in textbooks (Martins *et al* 1978, Aguiar & Medeiros 2003, Galati 2003a). These lists were not intended to treat exclusively the phlebotomine sand fly fauna of Minas Gerais, but also of other Brazilian states (Aguiar & Medeiros 2003) or other American countries (Martins *et al* 1978, Galati 2003a). To the best of our knowledge, this is the first comprehensive review exclusively dedicated to the study of the phlebotomine sand fly fauna of Minas Gerais.

Comments on the validity of some phlebotomine sand fly species found in Minas Gerais. *Micropygomyia ferreirana*

(Barretto, Martins & Pellegrino) was described based on a single male specimen collected in the municipality of Jampruca (Barretto *et al* 1956). In their book, Martins *et al* (1978) mentioned *Mi. ferreirana* as occurring in several municipalities of Minas Gerais and stated that its female was already known, although undescribed. Dias *et al* (1989) described the female and redescribed the male of *Mi. ferreirana*. Examining the types of both species, Galati *et al* (2002) noticed some morphometric similarities between *Mi. ferreirana* and *Mi. borgmeieri* (Martins, Falcão & Silva) and proposed their synonymy. Based on their original descriptions, males of *Mi. ferreirana* and *Mi. borgmeieri* present some differences in relation to size of the head, clypeus, antenna, number of setae on the gonocoxite, and size and form of the paramere. Thus, we follow Dias *et al* (1989) in maintaining both species as valid, until their synonymy status is reassessed.

Martins *et al* (1978) mentioned the presence of *Lu. spinosa* (Floch & Abonnenc) in some municipalities of Minas Gerais. According to Young & Duncan (1994), *Lu. spinosa* is in part a synonym of *Lu. damascenoi* (Mangabeira) – *Pi. damascenoi*, according to Galati (2003a) – and in part a synonym of *Lu. christenseni* Young & Duncan – *Pi. christenseni*, according to Galati (2003a). Aguiar & Medeiros (2003) have included both of them in their list of phlebotomine sand flies of Minas Gerais, but it is not clear whether both species occur in Minas Gerais (EAB Galati, personal communication). In fact, Young & Duncan (1994) were not clear in relation to the actual distribution of *Pi. damascenoi* and *Pi. christenseni* in Brazil. The presence of *Pi. christenseni* in Minas Gerais has recently been confirmed (Andrade Filho *et al* 2008), but the presence of *Pi. damascenoi* is uncertain (JD Andrade Filho, personal communication).

During the 1970s, Forattini (1973) cited *Mi. goiana* (Martins, Falcão & Silva) as a junior synonym of *Mi. trinidadensis* and Martins *et al* (1978) considered *Mi. villelai* (Mangabeira) as a junior synonym *Mi. trinidadensis*. Later, Williams (1988) argued that *Mi. trinidadensis* would be a combination of several sibling species. Curiously, *Mi. villelai*, *Mi. goiana*, and *Mi. trinidadensis* were subsequently been considered as valid species (Williams 1991). Contrary to Forattini (1973) and Martins *et al* (1978), Galati (2003a) has recently listed *Mi. goiana* as a junior synonym of *Mi. villelai*. Although very closely related, *Mi. villelai*, *Mi. goiana*, and *Mi. trinidadensis* appear to be distinct species, which perhaps should be grouped separately. A detailed study of the type-specimens of *Mi. trinidadensis*, *Mi. villelai*, and *Mi. goiana* in comparison with new specimens collected from their type localities would resolve this taxonomic question.

There has been much discussion on the synonymy of *Ny. intermedia* and *Ny. neivai* (Pinto). The two species were considered synonymous by Martins *et al* (1978) and Young & Duncan (1994). However, Marcondes (1996) have removed *Ny. neivai* from the synonymy with *Ny. intermedia*, based on examination of the female spermathecae. Moreover, Andrade Filho *et al* (2003) observed some morphological differences in the tips of genital filaments of the males. Undoubtedly, *Ny. intermedia* and *Ny. neivai* are morphologically very close (Andrade Filho *et al* 2006). On the other hand, the differences noticed by Marcondes (1996) and Andrade Filho *et al* (2003) are sufficient to separate them as distinct species.

Phlebotomine sand fly species recently recorded in Minas Gerais. The most recent list of phlebotomine sand flies found in Minas Gerais is that of Aguiar & Medeiros (2003). Galati (2003a) also provided data on the known distribution of phlebotomine sand flies occurring in all Brazilian states, which includes Minas Gerais. However, these lists were incomplete and several other species have been recorded since then. The phlebotomine sand flies that are known to occur in Minas Gerais but that were not cited in their lists include: *Ev. cortelezzii*, *Ps. fairchildi*, *Mi. breviducta*, and *Ps. carrerai carrerai* (Gomes *et al* 1978, Rangel *et al* 1985, Alexander *et al* 2001).

The phlebotomine sand flies that have been recorded in Minas Gerais during the last six years include: *Br. ortizi*, *Br. travassosi*, *Br. troglodytes*, *Mi. micropyga*, *Mi. trinidadensis*, *Ev. corumbaensis* (Santos & Brazil 2003, Barata *et al* 2004, 2005, 2008, Lemos *et al* 2004, Monteiro *et al* 2005, Dias *et al* 2007, Saraiva *et al* 2006), *Ev. bacula* (AJA, personal observation), and *Pr. choti* (Souza *et al* 2009).

Lemos *et al* (2004) recorded a single male of *Ev. corumbaensis* in Uberlândia. This phlebotomine sand fly species is part of the *cortelezzii* complex, which includes *Ev. cortelezzii*, *Ev. sallesi*, and *Ev. edwardsi*, all recorded in Minas Gerais. According to Carvalho *et al* (*in press*), *Ev. corumbaensis* occur only in Center-West Region. Therefore the record of this phlebotomine sand fly in Minas Gerais needs to be confirmed (JD Andrade Filho, personal communication).

Aguiar & Medeiros (2003) included *Psathyromyia pelloni* (Sherlock & Alencar) in their list of phlebotomine sand flies of Minas Gerais, but its presence in this state is doubtful (Martins *et al* 1978) and needs confirmation. Similarly, the presence of *Ny. singularis* (Costa Lima) in Minas Gerais, and even its validity, deserves further study.

The local fauna of phlebotomine sand flies can vary widely. As many municipalities of Minas Gerais are completely unexplored, new collections of phlebotomine sand flies would be greatly appreciated. Hopefully, these collections are much likely to reveal the existence of unknown species.

Phlebotomine sand fly species of public health concern found in Minas Gerais. The leishmaniasis are endemic in Minas Gerais. The causative agent of visceral leishmaniasis in Minas Gerais is *Leishmania* (*L.*) *chagasi* Cunha & Chagas (Silva *et al* 2001), which is currently considered to be a junior synonym of *L. (L.) infantum* Nicolle (Lukeš *et al* 2007). In this state, cases of cutaneous leishmaniasis are caused by *L. (Viannia) braziliensis* and rarely by *L. (L.) amazonensis* Lainson & Shaw (Passos *et al* 1999).

The phlebotomine sand flies responsible for transmission of *Leishmania* spp. in each disease focus in Minas Gerais are relatively poorly known. In most cases, the incrimination of a given species in the transmission cycle has been based on circumstantial evidence; that is, its presence or absence in a given area, and its relative abundance to that of other species in a given area where cases of leishmaniasis have been notified. Obviously, there are other aspects that must be considered when implicating a given phlebotomine sand fly species as a vector of a given *Leishmania* species (for a review, see Killick-Kendrick 1990).

Similarly to what occurs in most parts of Brazil, *Lu.*

longipalpis plays a major role in the zoonotic transmission cycle of the causative agent of visceral leishmaniasis in Minas Gerais. This phlebotomine sand fly has a broad distribution in this state usually occurring where cases of visceral leishmaniasis have been reported (Souza *et al* 2004, França-Silva *et al* 2005, Michalsky *et al* 2007). Since *Lu. longipalpis* was originally described in 1912, it has been recorded in 49 or so municipalities of Minas Gerais (Andrade *et al* 2007, Carvalho *et al* 2008, Souza & Borges 2008). An average of 295 cases of visceral leishmaniasis is notified annually in Minas Gerais (Ministério da Saúde 2007a).

In relation to cutaneous leishmaniasis, the scenery is quite different. The role of each species in the transmission of may vary widely from municipality to municipality and even within municipalities. Among the phlebotomine sand flies that may be implicated in the transmission of *L. (V.) braziliensis* in Minas Gerais, *Ny. intermedia* and *Ny. whitmani* (Antunes & Coutinho) are those that deserves the most attention. Both species are suspected to be involved in the transmission of *L. (V.) braziliensis* in other parts of Brazil (Marcondes *et al* 1998, Andrade Filho *et al* 2007, Costa *et al* 2007), are highly anthropophilic, and are often present in foci of cutaneous leishmaniasis in Minas Gerais (Casanova 2001, Lemos & Lima 2005).

Both *Ny. intermedia* and *Ny. whitmani* have a broad distribution in Minas Gerais, frequently occurring in sympatry (Brazil *et al* 2006, Resende *et al* 2006, Loiola *et al* 2007). Since its original description in 1912, *Ny. intermedia* has been recorded in 74 or so municipalities of Minas Gerais. *Nyssomyia whitmani* is also widely spread in this state; it is known to occur in at least 76 municipalities (Hermeto *et al* 1998, Santos *et al* 2003, Margonari *et al* 2006). An average of 1,793 cases of cutaneous leishmaniasis has been notified in Minas Gerais (Ministério da Saúde 2007b).

It is important to highlight that *Ny. intermedia* occurs in sympatry with *Ny. neivai* in Minas Gerais (Andrade Filho *et al* 2007). *Nyssomyia neivai* has been recorded in 21 municipalities (Marcondes *et al* 1998, Andrade Filho *et al* 2007). It is a suspected vector in the municipality of Corinto, where it represents 90% of the phlebotomine sand flies caught (Andrade Filho *et al* 2007, Saraiva *et al* 2008). However, its role as a vector needs confirmation.

Other species that may eventually play a local role in the transmission of *L. (V.) braziliensis* in Minas Gerais are: *Bichromomyia flaviscutellata* (Mangabeira), *Migonemyia migonei* (França), *Pi. pessoai* (Coutinho & Barretto), *Ps. ayrozai* (Barretto & Coutinho), *Pi. fischeri* (Pinto), and *Ps. hirsutus hirsutus* (Mangabeira) (Rangel *et al* 1985, Andrade Filho *et al* 1997, Santos de Marco *et al* 2002, Souza *et al* 2004, Saraiva *et al* 2006). These species are suspected to be involved in the transmission cycle of *L. (V.) braziliensis* elsewhere in Brazil (Lainson 1983, Killick-Kendrick 1990, Peterson & Shaw 2003, Rangel & Lainson 2003), with the exception of *Bi. flaviscutellata* which is the primary vector of *L. (L.) amazonensis* (Lainson & Shaw 2005).

In the present article, we comprehensively reviewed the available literature about phlebotomine sand flies of Minas Gerais. Nearly a century after the first contributions to the knowledge of the phlebotomine sand fly fauna of this state, much work has been done, but it is evident that there is a

lot of work to do.

From an entomological point of view, there appears to be many phlebotomine sand fly species to be known, because the fauna of many municipalities of Minas Gerais is completely unknown. From the epidemiological standpoint, it seems evident that much study is required to improve our current understanding on the distribution and behavior of phlebotomine sand flies of public health significance. A better understanding of these aspects is seminal for any vector control program to achieve success.

We hope that the present work will somehow contribute to the knowledge of distribution of phlebotomine sand flies of Minas Gerais. Finally, but not less important, we believe that our review will encourage other similar studies about the phlebotomine sand fly fauna of other Brazilian states.

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References

- Aguiar G M, Medeiros V M (2003) Distribuição regional e habitats das espécies de flebotomíneos do Brasil, p.207-255. In Rangel E F, Lainson R (eds) Flebotomíneos do Brasil, Fiocruz, Rio de Janeiro, 367p.
- Alexander B, Freitas J M, Quate L W (2001) Some Psychodidae (Diptera) from Atlantic Forest in South-Eastern Brazil, with descriptions of *Trichomyia dolycopogon* sp. nov. and *Trichomyia riocensis* sp. nov. Brazil J Biol 61: 467-474.
- Andrade A J, Andrade M R, Barata R A, Pinto M C, Dias E S, Eiras A E (2007) Quatro novos registros da fauna flebotomínica do gênero *Lutzomyia* spp. França (Diptera: Psychodidae: Phlebotominae) do distrito rural de Brejo do Mutambal, Varzelândia (MG), Brasil. Neotrop Entomol 36: 980-983.
- Andrade Filho J D, Aguiar G M, Dias E S, Falcão A L (1999a). Description of *Lutzomyia bianchigalatae* n. sp. a sand fly within the subgenus *Pintomyia* Costa Lima, 1932 (Diptera: Psychodidae). Mem Inst Oswaldo Cruz 94: 757-762.
- Andrade Filho J D, Carneiro A P S, Lima M L N, Santiago R M, Gama M A, Santos C A, Falcão A L, Brazil R P (1997) Flebotomíneos de Timóteo, Estado de Minas Gerais, Brasil (Diptera: Psychodidae). Cad Saúde Públ 13: 767-770.
- Andrade Filho J D, Lima M L N, Falcão A L, Brazil R P (1998) Sazonalidade dos flebotomíneos (Diptera, Psychodidae) dos arredores da Gruta da Lapinha, município de Lagoa Santa, Minas Gerais, Brasil. Rev Bras Entomol 42: 93-95.
- Andrade Filho J D, Falcão A L, Brazil R P (1999b) Nota sobre *Lutzomyia mamedei*, Oliveira, Afonso, Dias & Brazil, 1994. An Soc Entomol Bras 28: 355-356.
- Andrade Filho J D, Falcão A L, Brazil R P (1999c) Geographical distribution of *Lutzomyia carmelinoi* Ryan, Fraiha, Lainson & Shaw (Diptera: Psychodidae). 3rd International Symposium on Phlebotominae Sandflies, Montpellier, França.
- Andrade Filho J D, Galati E A B, Falcão A L (2003) Redescription of *Nyssomyia intermedia* (Lutz & Neiva, 1912) and *Nyssomyia neivai* (Pinto, 1926) (Diptera: Psychodidae). Mem Inst Oswaldo Cruz 98: 1059-1065.
- Andrade Filho J D, Galati E A B, Falcão A L (2006) Polymorphism, inter-population and inter-specific variation in *Nyssomyia intermedia* (Lutz & Neiva, 1912) and *Nyssomyia neivai* (Pinto, 1926) (Diptera: Psychodidae: Phlebotominae). Rev Bras Entomol 50: 385-396.
- Andrade Filho J D, Galati E A B, Falcão A L (2007) *Nyssomyia intermedia* (Lutz & Neiva, 1912) and *Nyssomyia neivai* (Pinto, 1936) (Diptera: Psychodidae: Phlebotominae) geographical distribution and epidemiological importance. Mem Inst Oswaldo Cruz 102: 481-487.
- Andrade Filho J D, Oliveira A G, Falcão A L, Brazil R P (2002) Redescription of the male of *Lutzomyia lutziana* (Costa Lima) and description of the female (Diptera: Psychodidae). Mem Inst Oswaldo Cruz 97: 217-219.
- Andrade-Filho J D, Oliveira R C, Fonseca A R (2008) Flebotomíneos (Diptera: Psychodidae) coletados com armadilha Malaise no Centro-Oeste de Minas Gerais. Neotrop Entomol 37: 104-106.
- Barata R A, Antonini Y, Gonçalves C M, Costa D C, Dias E S (2008) Flebotomíneos do Parque Nacional Cavernas do Peruaçu, MG. Neotrop Entomol 37: 226-228.
- Barata R A, França-Silva J C, Fortes-Dias C L, Costa R T, Silva J C, Vieira E P, Prata A, Michalsky E M, Dias E S (2004) Phlebotomine sand flies in Porteirinha, an area of American visceral leishmaniasis in the state of Minas Gerais, Brazil. Mem Inst Oswaldo Cruz 99: 481-487.
- Barata R A, França-Silva J C, Mayrink W, Silva J C, Prata A, Lorosa E S, Fiúza J A, Gonçalves C M, Paula K M, Dias E S (2005) Aspects of the ecology and behaviour of phlebotomines in endemic area for visceral leishmaniasis in state of Minas Gerais Rev Soc Bras Med Trop 38: 421-425.
- Barretto M P, Coutinho J O (1941) Contribuição ao conhecimento dos flebotomos de São Paulo. IV: Descrição de três novas espécies. Pap Avulsos Zool 1: 143-158.
- Barretto M P, Martins A V, Pellegrino J (1956) Notas sobre flebotomíneos do Nordeste do estado de Minas Gerais, com as descrições de duas espécies novas (Diptera, Psychodidae). Folia Clin Biol 26: 47-56.
- Brazil R P, Carneiro L V, Andrade Filho J D, Alves J C M, Falcão A L (1997) Biologia de *Lutzomyia lenti* (Mangabeira) (Diptera: Psychodidae). An Soc Entomol Brasil 26: 191-193.
- Brazil R P, Passos W L, Fuzari A A, Falcão A L, Andrade Filho J D

- (2006) The peridomestic sand fly fauna (Diptera: Psychodidae) in areas of cutaneous leishmaniasis in Além Paraíba, Minas Gerais, Brazil. *J Vector Ecol* 31: 418-420.
- Brèthes J (1923) Un *Phlebotomus* nuevo para la Republica Argentina (*Phlebotomus cortezezzii*). *La Semana Méd* 30: 361-364.
- Carvalho G M A, Andrade Filho J D, Falcão A L, Rocha Lima A C V M, Gontijo C M F (2008) Naturally infected *Lutzomyia* sand flies in a *Leishmania*-endemic area of Brazil. *Vector Borne Zoonotic Dis* 8: 407-414.
- Carvalho G M A, Brazil R P, Falcão A L, Andrade Filho J D (in press) Distribuição geográfica do complexo *cortezezzii* (Diptera: Psychodidae: Phlebotominae) no Brasil. *Neotrop Entomol*.
- Casanova C (2001) A soil emergence trap for collections of phlebotomine sand flies. *Mem Inst. Oswaldo Cruz* 96: 273-275.
- CIPA 1999 Computer-aided identification of phlebotomine sandflies of America. Cipa-DB. <http://cipa.snv.jussieu.fr>. Accessed in 21/06/2007.
- Costa Lima A (1932) Sobre phlebotomos americanos (Diptera: Psychodidae). *Mem Inst Oswaldo Cruz* 26: 15-69.
- Costa Lima A, Antunes P C A (1936) Sobre um novo phlebotomo encontrado no Norte do Brasil. *Brasil Méd* 50: 419-422.
- Costa S M, Chenichel M, Bandeira V, Zannuncio J C, Lainson R, Rangel E F (2007) *Lutzomyia (Nyssomyia) whitmani* s.l. (Antunes & Coutinho, 1939) (Diptera: Psychodidae: Phlebotominae): geographical distribution and the epidemiology of American cutaneous leishmaniasis in Brazil - Mini review. *Mem Inst Oswaldo Cruz* 102: 149-153.
- Dantas-Torres F, Brandão-Filho S P (2006) Visceral leishmaniasis in Brazil: revisiting paradigms of epidemiology and control. *Rev Inst Med Trop São Paulo* 48: 151-156.
- Desjeux P (2004) Leishmaniasis: current situation and new perspectives. *Comp Immunol Microbiol Infect Dis* 27: 305-318.
- Dias E S, Falcão A L, Silva J E, Martins A V (1987) Descrição de uma nova espécie do subgênero *Helcochyrtomyia*, *Lutzomyia capixaba* sp. n. (Diptera, Psychodidae, Phlebotominae). *Mem Inst Oswaldo Cruz* 82: 193-196.
- Dias E S, Falcão A L, Silva J E, Martins A V (1989) Redescricao do macho e descricao da fêmea de *Lutzomyia (Helcochyrtomyia) ferreirana* (Barretto, Martins & Pellegrino, 1958) (Diptera, Psychodidae, Phlebotominae). *Mem Inst Oswaldo Cruz* 84: 245-248.
- Dias E S, França-Silva J C, Silva J C, Monteiro E M, Paula K M, Gonçalves C M, Barata R A (2007) Flebotomíneos (Diptera: Psychodidae) de um foco de leishmaniose tegumentar no estado de Minas Gerais. *Rev Soc Bras Med Trop* 40: 49-52.
- Dyar H G (1929) The present knowledge of the American species of *Phlebotomus* Rondani (Diptera, Psychodidae). *Am J Trop Med Hyg* 10: 112-124.
- Falcão A R (1963) Susceptibilidade ao DDT e ao Dieltrin, de uma população normal de *Phlebotomus longipalpis* em Minas Gerais, Brasil. *Rev Bras Malariol D Trop* 15: 411-415.
- Falcão A R, Pinto C T G, Gontijo C M F (1988) Susceptibility of *Lutzomyia longipalpis* to deltamethrin. *Mem Inst Oswaldo Cruz* 83: 395-396.
- Forattini O P (1973) Entomologia médica. Psychodidae. Phlebotominae. Leishmanioses. Bartonelose. São Paulo, Forattini O P (ed) Edgard Blücher/EDUSP 658p.
- França C (1920) Observations sur le genre *Phlebotomus*. II. Phlébotomes du Nouveau Monde (Phlébotomes du Brésil et du Paraguay). *Bull Soc Portug Sci Nat* 8: 215-236.
- França-Silva J C, Barata R A, Costa R T, Monteiro E M, Machado-Coelho G L, Vieira E P, Prata A, Mayrink W, Nascimento E, Fortes-Dias C L, Silva J C, Dias E S (2005) Importance of *Lutzomyia longipalpis* in the dynamics of transmission of canine visceral leishmaniasis in the endemic area of Porteirinha Municipality, Minas Gerais, Brazil. *Vet Parasitol* 10: 213-220.
- Galati E A B (2003a) Classificação de Phlebotominae, p. 23-51. In Rangel E F, Lainson R (eds) Flebotomíneos do Brasil, Fiocruz, Rio de Janeiro, 367p.
- Galati E A B (2003b) Morfologia, terminologia de adultos e identificação dos táxons da América, p.53-175. In Rangel E F, Lainson R (eds) Flebotomíneos do Brasil, Fiocruz, Rio de Janeiro, 367p.
- Galati E A B, Andrade Filho J D, Falcão A L (2002) *Micropygomyia ferreirana* (Barretto, Martins & Pellegrino) as senior synonym of *Micropygomyia borgmeieri* (Martins, Falcão & Silva) and denunciation of an error of identification related to this taxon. *Entomol Vect* 9 (Suppl 1): 156-157.
- Galati E A B, Nunes V L B, Oshiro E T, Dorval M E C (1995) Descrição de *Lutzomyia cerradincola*, sp. n. (Diptera, Psychodidae, Phlebotominae) do estado de Mato Grosso do Sul, Brasil. *Rev Bras Ent* 39: 103-109.
- Galati E A B, Nunes V L B, Oshiro E T, Rego Jr F A (1989) Nova espécie de Phlebotominae, *Lutzomyia corumbaensis*, sp. n. (Diptera, Psychodidae) do complexo *Lutzomyia cortezezzii*. *Rev Bras Ent* 33: 465-475.
- Genaro O, Loiola C F, Costa A R, Silva J C, Costa R T, França-Silva J C, Costa C A, Mayrink W (1996) Reemergence of visceral leishmaniasis in the Rio Doce Valley, State of Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 91 (Suppl 1): 185.
- Gomes A C, Rabello E X, Galati E A B (1978) Flebotomíneos encontrados em galinheiros experimentais nos estados de São Paulo e Minas Gerais (Brasil) e algumas observações ecológicas. *Rev Saúde Publ* 12: 403-407.
- Gontijo C M, Silva E S, Fúccio M B, Sousa M C, Pacheco R S, Dias E S, Andrade Filho J D, Brazil R P, Melo M N (2002) Epidemiological studies of an outbreak of cutaneous leishmaniasis in the Rio Jequitinhonha Valley, Minas Gerais, Brazil. *Acta Trop* 81: 143-150.
- Hamilton J G, Brazil R P, Maingon R A (2004) Fourth chemotype of *Lutzomyia longipalpis* (Diptera: Psychodidae) from Jaibas, Minas Gerais state, Brazil. *J Med Entomol* 41: 1021-1026.
- Hermeto M V, Vieira-Dias D, Genaro O, Rotondo-Silva A, Costa C A, Toledo V P C P, Michalick M S M, Williams P, Mayrink W (1998) Outbreak of cutaneous leishmaniasis, in the Rio

- Doce Valley, Minas Gerais, Brazil. Mem Inst Oswaldo Cruz 89: 519-521.
- Killick-Kendrick R (1990) Phlebotomine vectors of leishmaniasis: a review. Med Vet Entomol 4: 1-24.
- Lainson R (1983) The American leishmaniasis: some observations on their ecology and epidemiology. Trans R Soc Trop Med Hyg 77: 569-596.
- Lainson R, Rangel E F (2005) *Lutzomyia longipalpis* and eco-epidemiology of American visceral leishmaniasis (AVL), with particular reference to Brazil: a review. Mem Inst Oswaldo Cruz 100: 811-827.
- Lainson R, Shaw J J (2005) New World leishmaniasis, p.313-349. In Cox F E G, Kreier J, Wakelin D (eds) Microbiology and microbial infections, parasitology. Topley & Wilson's, ASM Press, London, 416p.
- Larrousse F (1920) Nouvelle espèce américaine du genre *Phlebotomus*, *Phlebotomus brumpti*, sp. nov. Bull Soc Path Exot 12: 659-662.
- Lemos J C, Lima S C (2005) Leishmaniose tegumentar americana: flebotomíneos em área de transmissão no município de Uberlândia, MG. Rev Soc Bras Med Trop 38: 22-26.
- Lemos J C, Lima S C, Neto A A P, Casagrande B, Vieira G S S, Ferrete J A, Magalhães M J O (2004) Encontro de *Lutzomyia longipalpis* em área de implantação da Usina Hidrelétrica Capim Branco I, na Bacia do Rio Araguari, no município de Uberlândia, Minas Gerais - Brasil. Caminhos Geogr 12: 186-188.
- Loiola C F, Silva D A, Galati E A B (2007) Phlebotomine fauna (Diptera: Psychodidae) and species abundance in an endemic area of American cutaneous leishmaniasis in southeastern Minas Gerais, Brazil. Mem Inst Oswaldo Cruz 102: 581-585.
- Lukeš J, Mauricio I L, Schönian G, Dujardin J C, Soteriadou K, Dedet J P, Kuhls K, Tintaya K W, Jirků M, Chocholová E, Haralambous C, Pralong F, Oborník M, Horák A, Ayala F J, Miles M A (2007) Evolutionary and geographical history of the *Leishmania donovani* complex with a revision of current taxonomy. Proc Natl Acad Sci USA 104: 9375-9380.
- Lutz A (1922) Zoologia Médica. Nematoceros hematofagos não pertencendo aos culicídeos. A Folha Médica 3: 89-92.
- Lutz A, Neiva A (1912) Contribuição para o conhecimento das espécies do gênero *Phlebotomus* existentes no Brasil. Mem Inst Oswaldo Cruz 4: 84-95.
- Mangabeira O (1938) Sobre duas novas espécies de *Flebotomus* (Diptera, Psychodidae). Mem Inst Oswaldo Cruz 33: 349-356.
- Mangabeira O (1942) 7ª contribuição ao estudo dos *Flebotomus* (Diptera, Psychodidae). Mem Inst Oswaldo Cruz 37: 11-218.
- Marcondes C B (1996) A redescription of *Lutzomyia* (*Nyssomyia*) *intermedia* (Lutz & Neiva, 1912), and resurrection of *L. neivai* (Pinto, 1926) (Diptera, Psychodidae, Phlebotominae). Mem Inst Oswaldo Cruz 91: 457-462.
- Marcondes C B (2007) A proposal of generic and subgeneric abbreviations for phlebotomine sandflies (Diptera: Psychodidae, Phlebotominae). Entomol News 118: 351-356.
- Marcondes C B, Lozovei A L, Vilela J H (1998) Distribuição geográfica de flebotomíneos do complexo *Lutzomyia intermedia* (Lutz & Neiva, 1912) (Diptera, Psychodidae). Rev Soc Bras Med Trop 31: 51-58.
- Margonari C, Freitas C R, Ribeiro R C, Moura A C M, Timbó M, Gripp A H, Pessanha J E, Dias E S (2006) Epidemiology of visceral leishmaniasis spatial analysis, in Belo Horizonte municipality, state of Minas Gerais, Brasil. Mem Inst Oswaldo Cruz 101: 31-38.
- Martins A V, Brener Z, Mourão O G, Lima M M, Souza M A, Silva J E (1956) Calazar autóctone em Minas Gerais. Rev Bras Malariol D Trop 8: 555-63.
- Martins A V, Falcão A L, Silva J E (1957) Estudos sobre flebotomos do estado de Minas Gerais. I: *Phlebotomus renei* n. sp. (Diptera: Psychodidae). Rev Bras Malariol D Trop 9: 321-324.
- Martins A V, Falcão A L, Silva J E (1961) Estudos sobre flebotomos do estado de Minas Gerais. III: Descrição de "*Lutzomyia appendiculata*" sp. n. (Diptera, Psychodidae) Rev Bras Biol 21: 297-300.
- Martins A V, Falcão A L, Silva J E (1962a) Estudos sobre flebotomos do estado de Minas Gerais. V: Descrição do macho e da fêmea de "*Lutzomyia* (*Lutzomyia*) *ischyrcantha*" sp. n. (Diptera, Psychodidae). Rev Bras Biol 22: 227-232.
- Martins A V, Falcão A L, Silva J E (1962b) Estudos sobre flebotomos do estado de Minas Gerais. IV: Descrição de duas novas espécies do sub-gênero "*Lutzomyia*" França, 1924 (Diptera, Psychodidae). Rev Bras Biol 22: 39-46.
- Martins A V, Falcão A L, Silva J E (1964) Estudos sobre flebotomos do estado de Minas Gerais. VI: Descrição de "*Lutzomyia termitophila*" sp. n. and "*Lutzomyia cipoensis*" sp. n. (Diptera, Psychodidae). Rev Bras Biol 24: 309-315.
- Martins A V, Falcão A L, Silva J E (1972) Estudos sobre os flebotomos do estado de Minas Gerais. IX: Descrição de *Lutzomyia borgmeieri* sp. n. (Diptera, Psychodidae, Phlebotominae). Studia Ent 15: 497-502.
- Martins A V, Falcão A L, Silva J E (1975) Estudo sobre os flebotomos do estado de Minas Gerais. X: Descrição das fêmeas de *Lutzomyia microps* (Mangabeira, 1942) e *Lutzomyia firmatoi* (Barretto, Martins & Pelegrino, 1965) (Diptera, Psychodidae, Phlebotominae). Rev Bras Biol 35: 259-263.
- Martins A V, Falcão A L, Silva J E, Miranda Filho R (1982) Estudo sobre os flebotomos do estado de Minas Gerais. XV: Descrição do macho e da fêmea de *Lutzomyia ramirezi* n. sp. e da fêmea de *Lutzomyia alencari* Martins, Souza e Falcão, 1962. Mem Inst Oswaldo Cruz 77: 417-424.
- Martins A V, Silva J E (1965) Estudo sobre os flebotomos do estado de Minas Gerais. VII: Descrição de "*Lutzomyia callipygus*" sp. n. e de "*Lutzomyia diacantha*" sp. n. (Diptera: Psychodidae). Rev Bras Biol 25: 269-276.
- Martins A V, Silva J E (1968) *Barrettomyia* n. subg., com a descrição de uma espécie nova e da fêmea de *Lutzomyia* (*Barrettomyia*) *costalimai* (Mangabeira, 1942). Bol Mus Hist Nat UFMG Zool 3: 1-15.

- Martins A V, Silva J E, Falcão A L (1970) Estudos sobre flebotomos do Estado de Minas Gerais. VIII: Descrição de duas novas espécies, *Lutzomyia hermanlenti* sp. n. e *Lutzomyia oliveirai* sp. n. (Diptera, Psychodidae). *Rev Bras Biol* 30: 547-553.
- Martins A V, Williams P, Falcão A L (1978) American sand flies (Diptera: Psychodidae, Phlebotominae). Academia Brasileira de Ciências, Rio de Janeiro, 195p.
- Mayrink W, Williams P, Coelho M V, Dias M, Martins A V, Magalhães P A, Costa C A, Falcão A R, Melo M N, Falcão A L (1979) Epidemiology of dermal leishmaniasis in the Rio Doce Valley, state of Minas Gerais, Brazil. *Ann Trop Med Parasitol* 73: 123-137.
- Michalsky E M, Rocha M R, Rocha Lima A C, França-Silva J C, Pires M Q, Oliveira F S, Pacheco R S, Santos S L, Barata R A, Romanha A J, Fortes-Dias C L, Dias E S (2007) Infectivity of seropositive dogs, showing different clinical forms of leishmaniasis, to *Lutzomyia longipalpis* phlebotomine sand flies. *Vet Parasitol* 147: 67-76.
- Ministério da Saúde (2007a) Leishmaniose visceral (calazar) - Distribuição de casos confirmados, por Unidade Federada. Brasil, 1980-2005. http://portal.saude.gov.br/portal/arquivos/pdf/visceral_2006.pdf. Accessed in 10/XI/2007.
- Ministério da Saúde (2007b) Leishmaniose tegumentar americana - Distribuição de casos confirmados, por Unidade Federada. Brasil, 1980-2005 a. http://portal.saude.gov.br/portal/arquivos/pdf/leishmaniose_2006.pdf. Accessed in 10/XI/2007.
- Monteiro E M, Silva J C, Costa R T, Costa D C, Barata R A, Paula E V, Machado-Coelho G L, Rocha M F, Fortes-Dias C L, Dias E S (2005) Visceral leishmaniasis: a study on phlebotomine sand flies and canine infection in Montes Claros, state of Minas Gerais. *Rev Soc Bras Med Trop* 38: 147-152.
- Newstead R (1914) Notes on *Phlebotomus* with descriptions of new species. Part II. *Bull Entomol Res* 5: 179-192.
- Newstead R (1922) A new species of *Phlebotomus* from Trinidad. *Ann Trop Med Parasitol* 16: 47-50.
- Oliveira C D L, Assunção R M, Reis I A, Proietti F A (2001) Spatial distribution of human and canine visceral leishmaniasis in Belo Horizonte, Minas Gerais state, Brazil, 1994-1997. *Cad Saúde Públ* 17: 1231-1239.
- Passos V M, Falcão A L, Marzochi M C, Gontijo C M, Dias E S, Barbosa-Santos E G, Guerra H L, Katz N (1993) Epidemiological aspects of American cutaneous leishmaniasis in a periurban area of the metropolitan region of Belo Horizonte, Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 88: 103-110.
- Passos V M, Fernandes O, Lacerda P A F, Volpini A C, Gontijo C M F, Degraive W, Romanha A J (1999) *Leishmania (Viannia) braziliensis* is the predominant species infecting patients with American cutaneous leishmaniasis in the state of Minas Gerais, Southeast Brazil. *Acta Trop* 72: 251-258.
- Peterson A T, Shaw J J (2003) *Lutzomyia* vectors for cutaneous leishmaniasis in Southern Brazil: ecological niche models, predicted geographic distributions, and climate change effects. *Inter J Parasitol* 33: 919-931.
- Pinto C (1926) *Phlebotomus neivai* e *Phlebotomus fischeri* n. sp. - sobre o aparelho espicular dos flebotomos e seu valor específico. *Sciencia Med* 4: 370-375.
- Rabello E (1917) Introdução ao estudo da leishmaniose tegumentar no Brasil. *An Fac Med Rio de Janeiro* 1: 308-335.
- Rangel E F, Lainson R (2003) Transmissores de leishmaniose tegumentar americana, p.291-309. In Rangel E F, Lainson R (eds) *Flebotomíneos do Brasil*, Rio de Janeiro, Fiocruz, 367p.
- Rangel E F, Ryan L, Lainson R, Shaw J J (1985) Observations on the sandfly (Diptera: Psychodidae) fauna of Além Paraíba, state of Minas Gerais, Brazil, and the isolation of a parasite of the *Leishmania braziliensis* complex from *Psychodopygus hirsuta hirsuta*. *Mem Inst Oswaldo Cruz* 80: 373-374.
- Resende M C, Camargo M C V, Vieira J R M, Nobi R C A, Porto N M N, Oliveira C D L, Pessanha J E, Cunha M C M, Brandão S T (2006) Seasonal variation of *Lutzomyia longipalpis* in Belo Horizonte, state of Minas Gerais. *Rev Soc Bras Med Trop* 39: 51-55.
- Root F M (1934) Some American species of *Phlebotomus* with short terminal palpal segments. *Am J Hyg* 20: 233-246.
- Ryan L, Fraiha H, Lainson R, Shaw J J (1986) New phlebotomine sandflies of the *walkeri* group (Diptera: Psychodidae) from Pará state, Brazil, with a pictorial key 1. *Mem Inst Oswaldo Cruz* 81: 323-331.
- Santos T G, Brazil R P (2003) A preliminary account of the ecology of phlebotomine sandflies (Diptera: Psychodidae) from Minas Gerais, Brazil: lunar cycles and distribution by habitat. *Entomol Vect* 10: 391-399.
- Santos T G, Gaia M C M, Brazil R P (2003) Attraction of sand flies (Diptera: Psychodidae) to light traps in rural areas of Minas Gerais state, Brazil. *J Am Mosq Control Assoc* 19: 74-78.
- Santos de Marco T, Gaia M C M, Brazil R P (2002) Influence of the lunar cycle on the activity of phlebotomine sand flies (Diptera: Psychodidae). *J Am Mosq Control Assoc* 18: 114-118.
- Saraiva L, Carvalho G M L, Sanguinette C C, Carvalho D A A, Falcão A L, Andrade Filho J D (2008) Sandflies (Diptera: Psychodidae: Phlebotominae) collected on the banks of the Velhas River in the state of Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 103: 843-846.
- Saraiva L, Lopes J S, Oliveira G B, Batista F A, Falcão A L, Andrade Filho J D (2006) Study of the sand flies in American cutaneous leishmaniasis area, in the municipality of Alto Caparaó and Caparaó, Minas Gerais state. *Rev Soc Bras Med Trop* 39: 56-63.
- Silva E S, Gontijo C M F, Pacheco R S, Fiuza V O P, Brazil R P (2001) Visceral leishmaniasis in the metropolitan region of Belo Horizonte, state of Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 96: 285-291.
- Souza C F, Borges M A Z (2008) Ocorrência de *Lutzomyia longipalpis* (Lutz & Neiva, 1912) (Diptera: Psychodidae) em Timóteo, Minas Gerais, Brasil. *Cad Saúde Públ* 24: 1454-1455.
- Souza C F, Borges M A Z, Andrade A J (2009) Contribution to the knowledge of the phlebotomine sandflies fauna (Diptera: Psychodidae) of Timóteo municipality, Minas Gerais, Brazil. *Neotrop Entomol*. 38: 267-271.

- Souza C M, Pessanha J E, Barata R A, Monteiro E M, Costa D C, Dias E S (2004) Study on phlebotomine sand fly (Diptera: Psychodidae) fauna in Belo Horizonte, state of Minas Gerais, Brazil. Mem Inst Oswaldo Cruz 99: 795-803.
- Williams P (1988) Notes on *Lutzomyia* (*Helcocyrtomyia*) *trinidadensis* (Newstead, 1922) (Diptera: Psychodidae-Phlebotominae). Mem Inst Oswaldo Cruz 83: 375-383.
- Williams P (1991) Geographical distribution of the subgenus *Helcocyrtomyia*, genus *Lutzomyia* (Diptera: Psychodidae-Phlebotominae), p.535-540. In Maroli M (ed) Proc 1st Int Symposium on Phlebotomine Sandflies, Rome. Parassitologia 33 (suppl 1).
- Young D G, Duncan M A (1994) Guide to the identification and geographic distribution of *Lutzomyia* sand flies in Mexico, the West Indies, Central and South America (Diptera: Psychodidae). Mem Amer Entomol Inst, 419p.

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