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ATTRACTION OF SAND FLIES (DIPTERA: PSYCHODIDAE) TO LIGHT TRAPS IN RURAL AREAS OF MINAS GERAIS STATE, BRAZIL

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ABSTRACT. The objective of this study was to detect phlebotomine sand fly vector species by using light traps, and thus determine the risk of cutaneous leishmaniasis (CL) transmission in rural areas of the Viçosa microregion, Minas Gerais State, Brazil. Sand flies were captured with Shannon-like and Falcão light traps hung between 1830 and 2230 h on 22 nights. Four sampling points where CL transmission occurs naturally were chosen. A total of 888 sand flies was collected. The most abundant species was *Lutzomyia intermedia.* Shannon-like traps caught significantly more *L. intermedia,* perhaps because of a greater surface area on which the insects can land or because they reflect more light. The positive phototaxis observed in *L. intermedia* and *L. whitmani* may pose a greater risk of transmission of *Leishmania* in houses where an external light source is situated close to a light-colored wall that reflects light and that have adjacent bushes or trees and domestic animal shelters within 50 m.

KEY WORDS Vector ecology, sand flies, *Lutzomyia intermedia,* phototaxis

INTRODUCTION

Cutaneous leishmaniasis (CL) is a zoonotic disease, the transmission of which in Brazil involves a silvatic mammal reservoir, a phlebotomine sand fly vector (Diptera, Psychodidae), and some secondary vertebrate hosts. The vectors of the leishmaniases in the New World are *Lutzomyia* França, 1920 (Young and Duncan 1994), and common species suspected in CL transmission in southeastern Brazil include *Lutzomyia intermedia* (Lutz and Neiva, 1912) and *L. whitmani* (Antunes and Coutinho, 1939). *Lutzomyia intermedia* may be found in environmentally altered areas such as plantations, as well as around human dwellings (Gomes et al. 1980).

Insects perceive and respond to environmental stimuli by using visual and olfactory cues. Visual capacity varies from simple responses to levels of illumination to the perception of objects. Vision is important for mating, dispersal, foraging, oviposition, diapause, and the search for resting sites. Some dipterans are able to detect ultraviolet light of wavelengths of 340–360 nm, which allows them to identify plants with flowers that have patterns that indicate nectaries. Species with crepuscular and nocturnal activity, such as phlebotomine sand flies, prefer light levels close to those encountered during these periods (Allan et al. 1987).

Little is known of the flight activation mechanism in phlebotomines, whether related to the search for food or for other resources. Chaniotis (1983) showed that addition of dry ice to light traps increased collections of female phlebotomines in Panama. Aguiar et al. (1985, 1989) and Gomes et al. (1989) demonstrated the attraction of phlebotomines to light traps placed at several points within a forest as well as within and around human dwellings. According to Mellor et al. (1996), the type of vision of *L. longipalpis,* a vector of visceral leishmaniasis, should be similar to that of insects that possess "slow eyes." These generally have weak, slow flight. The spectral sensitivity of *L. longipalpis* is similar to that of *Aedes aegypti* (L.) (Diptera, Culicidae) (Muir et al. 1992), with maximum sensitivity in the 360- to 490-nm region (between ultraviolet and blue-green-yellow).

The objective of this study was to collect sand flies with light traps (Shannon-like and Falcão models), and thus help estimate the risk of CL transmission in rural areas of the Viçosa microregion, Minas Gerais State, Brazil.

MATERIALS AND METHODS

The Viçosa microregion (20–21°S, 42–43°W) lies within the Zona da Mata region of Minas Gerais State, Brazil, where the predominant climate is cwa (Köppen), a moderately humid subtropical climate with a hydrological deficit from May to September and rains from December to March (Golfari 1975). The 3 cities listed below were selected for this study.

Viçosa: Viçosa (20°45′20″S; 42°52′40″W) has a mean annual rainfall of 1,500–2,000 mm, relative humidity of approximately 80%, and an annual temperature range of 14.0–26.1°C. The topography varies from 650 to 870 m above sea level (masl). Approximately 3% of the area is flat, 12% is undulating, and 85% is mountainous (IBGE 1999). Two localities were studied. Buieié is a large area of pasture surrounding a small settlement, with plots of fast-growing cultivated plants such as

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maize and some sparsely distributed animal shelters (cattle pens, pigsties, and chicken houses). This area possesses few trees of medium size and thus is exposed to strong winds and high temperatures. Piúna has a great variety of habitats near houses, including pastures and coffee or sugarcane plantations. Domestic animal shelters (corrals, pigsties, and chicken houses) are abundant. Houses are surrounded by many medium-sized and large trees that provide shade and windbreaks.

Cajuri: Cajuri (20°47′26″S, 42°47′48″W) has a mean annual rainfall of 1,700 mm and an annual temperature range of 14.4–26.5°C. Elevation is 600–1,006 masl, with topographical relief characterized by flat (5%), undulating (30%), and mountainous (65%) areas (IBGE 1999). This area has extensive cover of natural vegetation and large coffee plantations that border the forest. The climate of this region is somewhat hotter than that of the others. Some houses are situated very close to coffee plantations and wooded areas and have animal shelters such as chicken houses and pigsties in their yards.

Teixeiras: Teixeiras (20°39′04″S, 42°51′24″W) has a mean annual rainfall of approximately 1,500 mm and an annual temperature range of 14–26°C. Elevation is 607–929 masl and topographical relief is distributed among flat (18%), undulating (55%), and mountainous (27%) areas (IBGE 1999). Although this area retains scattered fragments of forest, the most representative vegetation types are cultivated banana, coffee, and citrus. Also, pastures and animal shelters (chicken houses, pigsties, and corrals) are present in the peridomiciliary areas, which are shaded by medium-sized and large trees.

To measure the difference between the attractiveness of the 2 trapping methods, choice of traps that could function simultaneously in the same areas was necessary. Sand flies were captured by using 1 Shannon-like light trap and 5 Falcão light traps (like Centers for Disease Control light traps [Aguiar et al. 1985]) deployed from 1830 to 2230 h on 22 nights, distributed between the dry (12 nights) and rainy (10 nights) seasons. This collection period is optimal for Neotropical sand fly activity (Forattini 1973, Gomes et al. 1989, Galati et al. 1996). Collections in the Shannon-like trap were divided into 8 intervals of 30 min each per night.

The Shannon-like trap consists of a white sheet in the form of a tent with 2 open sides. A 300-V lamp is hung from a wooden or bamboo pole that raises the center of the trap, preventing it from being damaged by heat from the light source. Sand flies are attracted to the trap by the lamp itself as well as the reflection on the walls, and they can be collected with manual aspirators. The dimensions of the Shannon-like trap (2.5 m long, 2.5 m wide, and 3 m high) that was used were selected so that heat from the lamp would not accumulate in its interior and act as an additional or alternative attractive stimulus. In addition, manual collecting was restricted to short periods in an attempt to reduce host attraction by the scent or exhaled CO_2 of the collectors. Thus, sand flies resting on the trap walls only were collected during the 1st 10 min of each 30-min interval between 1830 and 2230 h, leaving the remaining 20 min for the scent and CO_2 exhaled by the collectors to disperse.

All the sampling points were in the peridomiciles of houses in rural areas, which commonly had animal shelters nearby and diverse surrounding vegetation, with the exception of 1 locality in Viçosa (Buieié), where the peridomicile and adjacent areas formed a large open pasture. All the peridomiciles had a light source on the external wall of the house that remained lit throughout the night. The Shannon-like trap was set up at least 35 m from the houses and their associated animal shelters. Five Falcão light traps were hung around the peridomestic area in animal shelters or in trees at the borders of plantations and the edges of wooded areas (where present). Traps were hung approximately 35 m apart and at least 35 m from houses. Each collection night, in relation to the 2 types of light traps, represents a sampling unit.

The phlebotomines captured were taken to the laboratory, stored in 70% alcohol and finally cleared and mounted for identification by using Young and Duncan (1994), with confirmation of identifications by using the original published descriptions and comparison with specimens from the reference collections of the Quantitative Ecology Laboratory of Universidade Federal de Viçosa and the Leishmaniasis Laboratory of Centro de Pesquisas René Rachou–Fiocruz.

The means of the most abundant species captured in the Shannon-like and Falcão light traps were compared by using the nonparametric Kruskal–Wallis test. The means of the most abundant species also were tested in relation to the localities sampled. The χ^2 test was used to analyze the difference between the frequencies (the presence–absence in the samples) of the species, in the different traps and localities.

RESULTS

A total of 888 sand flies belonging to 10 *Lutzomyia* species was collected (Table 1). The most abundant species was *L. intermedia* with 715 individuals (80.5% of the total), followed by *L. whitmani, L. fischeri* (Pinto, 1926), *L. lenti* (Mangabeira, 1938), *L. migonei* (França, 1920), *L. monticola* (Costa Lima, 1932), *L. ayrozai* (Barretto and Coutinho, 1940), *L. edwardsi* (Mangabeira, 1941), *L. misionensis* (Castro, 1960), and *L. sordellii* (Shannon and Del Ponte, 1927). Male and female sand flies were captured in both traps, with the latter predominating (sex ratio 1:2.2 male : female).

A significant difference was found between the abundance (Kruskal–Wallis $H = 11.401$, df = 1, $P < 0.01$) and frequency ($\chi^2 = 4.658$, df = 1, $P <$

Table 1. Mean abundance, median, and total of phlebotomine sand flies (*Lutzomyia*) collected in light traps (Shannon-like and Falcão light traps) per night in the microregion of Viçosa, Minas Gerais State, Brazil, between October 1999 and December 2000.[1]

Species	Shannon			Falcão			Kruskal–Wallis *H*
	Mean (SD)	Median	Total	Mean (SD)	Median	Total	
L. intermedia	28.86 (40.72)	9.00	635	3.63 (6.68)	1.00	80	11.401 ($P < 0.01$)[2]
L. whitmani	3.63 (6.86)	0.00	80	1.18 (3.23)	0.00	26	1.021 ($P = 0.31$)
L. fischeri	1.45 (3.30)	0.00	32	0.13 (0.35)	0.00	3	2.719 ($P = 0.09$)
L. lenti	0.95 (1.70)	0.00	21	0.00 (0.00)	—	—	—
L. migonei	0.18 (0.39)	0.00	4	0.00 (0.00)	—	—	—
L. monticola	0.13 (0.46)	0.00	3	0.00 (0.00)	—	—	—
L. ayrozai	0.04 (0.21)	0.00	1	0.00 (0.00)	—	—	—
L. edwardsi	0.04 (0.21)	0.00	1	0.00 (0.00)	—	—	—
L. misionensis	0.04 (0.21)	0.00	1	0.00 (0.00)	—	—	—
L. sordellii	0.04 (0.21)	0.00	1	0.00 (0.00)	—	—	—
n		22			22		

[1] SD, standard deviation; *n*, number of samples.
[2] Statistically significant.

0.04) of *L. intermedia* caught by the 2 methods, with the Shannon-like trap being more attractive. No significant differences were found for the other species (Table 1).

Only *L. fischeri* showed a preference for a particular locality, being more abundant (Kruskal–Wallis $H = 14.073$, df = 3, $P < 0.003$) and more frequent ($\chi^2 = 12.919$, df = 3, $P < 0.005$) in Cajuri (Table 2). Some species, such as *L. monticola, L. ayrozai,* and *L. misionensis,* only were sampled in habitats covered by large areas of native vegetation. Buieié had the fewest species and Cajuri had the greatest number of species (Table 2).

DISCUSSION

In spite of being distributed in a transect to maximize the probability of attracting phlebotomines, the Falcão traps were not more effective than Shannon-like light traps. This may have been due to the low-intensity light emitted by the 6-V lamp or to the design of the trap, which does not have a large surface on which sand flies can land before being aspirated and captured. The inverse effect was observed for the Shannon-like trap, which had a large surface and also a more powerful light source (300 V). Light reflected on the white walls of the trap presumably amplified the attractive stimulus even further. According to Davies et al. (1995), the efficiency of the different types of trap in the capture of sand flies should vary according to environmental parameters and intrinsic behavioral characteristics of the species, such as anthropophily and phototaxis. Gibb et al. (1988) and Alexander et al. (1992), did not find a correlation between the attractiveness of the light trap and the physiological state of the females captured and believed that attraction was more a function of the placement of the traps. The great number of different species obtained in the Shannon-like trap suggests that it is an excellent tool to survey phototropic members of the sand fly fauna. Vexenat et al. (1986) considered the Shannon trap to be one of the best ways of obtaining a considerable number of species of both sexes, with high relative abundances. The preference for the Shannon trap was noted previously by Hashiguchi et al. (1992) in Paraguay and Salomon et al. (1995) in Argentina. Campbell-Lendrum et al. (1999) compared attraction of light traps in relation to samples of *L. intermedia* and *L. whitmani* and observed that light was clearly attractive to both species at a distance of 2.5 m. The number of females captured was greater because they were more phototactic than males. The positive phototaxis observed in *L. intermedia* and *L. whitmani,* together with the fact that the peridomiciles studied possessed characteristics that would favor the existence of resting and breeding sites, suggest a greater risk of cutaneous leishmaniasis transmission in houses where an external light source is situated close to a light-colored (white or beige) wall that reflects light, that have adjacent bushes or nearby trees, and that have domestic animal shelters. Teodoro et al. (1997) observed that peridomiciliary areas characterized by dry soils, clean, well-swept yards, few ornamental or fruit trees adjacent to the houses, and well-maintained animal shelters provided inadequate environmental conditions for the establishment of sand fly breeding or resting sites.

Cajuri was the locality with the most animal shelters and therefore the most favorable area for the establishment of sand fly breeding sites. Thus, a great variety of habitats provides a greater species richness. The marked presence of *L. fischeri* in this locality demonstrated the dependence of this species on relatively stable habitats. This result was unexpected given that *L. fischeri* is considered by many authors (Aguiar et al. 1993, 1996; Teodoro et al. 1993) to be a species able to survive in the habitats most disturbed by human activity. The efficiency of light traps also was related to the habitat where they were deployed, with traps placed in

Table 2. Mean abundance, median, and total of the phlebotomine sand flies (*Lutzomyia*) collected in Shannon-like and Falcão light traps per night in different localities of the microregion of Viçosa, Minas Gerais State, Brazil, between October 1999 and December 2000.[1]

Species	Teixeiras			Piuna			Buieié			Cajuri			Kruskal-Wallis *H*
	Mean (SD)	Median	Total	Mean (SD)	Median	Total	Mean (SD)	Median	Total	Mean (SD)	Median	Total	
L. intermedia	10.25 (19.22)	1.00	82	14.33 (23.80)	5.50	172	2.50 (2.43)	2.00	30	35.91 (49.20)	13.00	431	4.024 (*P* = 0.25)
L. whitmani	1.50 (2.44)	0.50	12	0.91 (2.06)	0.00	4	0.83 (1.99)	0.00	10	6.66 (8.94)	0.00	80	4.819 (*P* = 0.42)
L. fischeri	0.12 (0.35)	0.00	1	0.16 (0.38)	0.00	2	0.00 (0.00)	—	—	2.66 (4.16)	1.00	32	14.073 (*P* = 0.00)[2]
L. lenti	0.37 (0.74)	0.00	3	0.91 (2.06)	0.00	11	0.50 (0.16)	0.00	6	0.08 (0.28)	0.00	1	1.708 (*P* = 0.63)
L. migonei	0.12 (0.35)	0.00	1	0.08 (0.28)	0.00	1	0.00 (0.00)	—	—	0.16 (0.38)	0.00	2	2.105 (*P* = 0.55)
L. monticola	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.25 (0.62)	0.00	3	5.457 (*P* = 0.14)
L. ayrozai	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.08 (0.28)	0.00	1	2.666 (*P* = 0.44)
L. edwardsi	0.12 (0.35)	0.00	1	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.00 (0.00)	—	—	4.500 (*P* = 0.21)
L. misionensis	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.00 (0.00)	—	—	0.08 (0.28)	0.00	1	2.666 (*P* = 0.44)
L. sordellii	0.00 (0.00)	—	—	0.08 (0.28)	0.00	1	0.00 (0.00)	—	—	0.00 (0.00)	—	—	2.666 (*P* = 0.44)
n		8			12			12			12		

[1] SD, standard deviation; *n*, number of samples.
[2] Statistically significant.

habitat where the structure of the vegetation allows the passage of some light being less attractive compared to those placed in habitat where light intensity is low. Consequently, a larger number of sand flies was expected to be collected in structurally complex habitat such as Piúna and Cajuri, and a low number of specimens was expected to be collected in habitat with a low complexity, such as Buieié.

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