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The Distribution and Bioecological Aspects of Sandflies (Diptera, Psychodidae) in the Municipality of Araguaína, State of Tocantins, Brazil

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Abstract

Sandflies are nematocerous dipterans that present significant diversity and geographic distribution and are responsible for the transmission of protozoa of the genus Leishmania. In Brazil, *leishmaniases* is emerging and is undergoing a clear geographic expansion, marked in all geographic regions. In recent decades, the state of Tocantins has reported human cases of visceral and tegumentary *leishmaniasis* and, in this context, knowledge about the composition of the sandfly fauna and distribution of these dipterans can contribute to surveillance and control actions. Monthly captures with CDC light traps (model HP) were carried out during 42 months in four monitoring stations (EM), two in the urban area and two in the rural area of the municipality of Araguaína, located in the northern region of Tocantins. A total of 8,518 sandflies, belonging to 37 species, were captured and the presence of five potential vectors of *Leishmania* spp., *Lutzomyia longipalpis*, *Bichromomyia flaviscutellata*, *Psychodopygus ayrozai*, *Nyssomyia whitmani* and *Nyssomyia antunesi* were detected. The analysis of ISA and SISA revealed that *Evandromyia* bourrouli, *Evandromyia carmelinoi*, *Nyssomyia antunesi*, *Nyssomyia whitmani* and *Evandromyia walkeri* were the most abundant species and the six species showed significant correlation between the sandflies captured with meteorological variables of up to four months.

Keywords: Leishmaniasis Vectors; Monitoring Stations; Phlebotominae; Tocantins

Abbrevations: CL: Cutaneous Leishmaniasis; VL: Visceral Leishmaniasis; CDC: Center Disease Control; HDI: Human Development Index; MS: Monitoring Stations; HP: Hoover Pugedo; SISA: Standardized Specific Abundance Index; ISA: Specific Abundance Index; INMET: National Institute of Meteorology; DCL: Diffuse Anergic Cutaneous Leishmaniasis.

Introduction

Sand flies are insects belonging to the Psychodidae and 1000 species worldwide with relevant geographic distribution in the American Continent [1]. They inhabit forest environments, however, as a result of anthropogenic changes, they have adapted to the environments of the peridomicile and domicile, resulting in risk situations in the transmission capacity of different pathogens [2].

The leishmaniases are neglected diseases related to social and environmental conditions, they are transmitted through the bite of infected female sand flies and caused by obligate protozoa of the genus *Leishmania* [3]. Globally, leishmaniasis is among the top ten neglected tropical diseases with more than 12 million infected people, 0.9 to 1.6 million new cases each year, between 20,000 and 30,000 deaths, and 350 million people at risk of infection. The benign form, which produces limited lesions, ulcerative or not, is called cutaneous leishmaniasis. However, when lesions occur that compromise the mucous membranes of the nose, mouth and pharynx, the form is called cutaneous-mucosal leishmaniasis. If there are still individuals who present disseminated forms, this is called diffuse leishmaniasis. On the other hand, the clinical form that affects the liver, spleen, bone marrow, and lymphoid tissues is known as visceral leishmaniasis. In Brazil, are emerging diseases and in recent decades they have been expanding geographically [4]. The state of Tocantins, located in the northern region of Brazil, is the most recent Brazilian territorial unit where the two clinical forms of leishmaniasis have epidemiological relevance. In the period 2004-2019, Tocantins reported 4,632 cases of visceral leishmaniasis (VL) and 7,357 cases of cutaneous leishmaniasis (CL) and the municipality of Araguaína 1,528 cases of VL and 421 cases of CL [5]. The situation is due to changes in the landscape and land use, resulting from environmental changes caused by the construction of roads, railways, hydroelectric plants, agro-industrial expansion and migration [6]. The environmental interventions in Araguaína the greatest extent [7].

Migration played an important role in the demographic expansion and population densification of Araguaína, resulting in a significant spatial mobility, evidenced in the urban landscape with reflections on the peripheries. These are environments with rural characteristics where, initially, allotments are installed in proximity to remaining areas of the cerrado biome, resulting in vulnerable buildings and housing with poor infrastructure, poor basic sanitation and unsatisfactory essential public services [8]. The set of these events has an impact on the territory and contributes to the occurrence of emerging and re-emerging diseases, with extreme challenges for surveillance actions [9].

Studies on sand flies in Tocantins have been carried out in recent years [6,7,10-12]. First investigations were about the description of new species [13-16]. The assessment of the fauna composition of these dipterans in some municipalities reported the presence of 14 species [17]. Sand fly captures in four municipalities in the central region of Tocantins recorded the finding of 32 species [18]. In Porto Nacional, a new species captured in peridomiciliary areas was described, *Micropygomyia (Silvamyia) echinatopharynx* [19]. The vector monitoring carried out during the construction of the Peixe Angical Hydroelectric Power Plant in Palmeirópolis, south of Tocantins, revealed the presence of a new species of sand fly captured in a sandstone cave, *Lutzomyia (Lutzomyia) elizabethrangelae* [20].

In Porto Nacional, a bioecological study carried out in an area of VL transmission and impacted by the construction of the Lajeado Hydroelectric Power Plant identified the presence of 48 sand fly species, 22 of which were first recorded in the state of Tocantins, as well as the presence of seven potential vectors of leishmaniasis, with a predominance of *Lu. longipalpis* in urban areas and *Nyssomyia whitmani* in rural areas [10].

Research carried out to assess the diversity of sandflies in Taquaruçú, near the capital of Tocantins, Palmas, identified 32 species, where *Mi. goiana* was the most abundant, with the detection of the vectors *Lu. longipalpis* and *Ny. whitmani*. [11]. In Guaraí, central area of Tocantins, captures made in the periurban area and in a rural settlement recorded 43 species, where *Ny. whitmani* was the most abundant chicken coop in the peri-urban environment. In the area of the rural settlement inserted in a sylvatic environment, Evandromyia bourrouli showed higher frequency in captures with CDC (Center Disease Control) trap and *Psychodopygus complexus* in Shannon trap. Also in this locality, the species *Ps. ayrozai* and *Ps. complexus* were found naturally infected with *Leishmania (Viannia) braziliensis* by multiplex PCR (Polymerase Chain Reaction) [6].

Knowing the quantity of species in a given area with records of vector-borne diseases can significantly contribute to the planning of control actions and implementation. The evaluation of the bioecological aspects of vector species and the interrelationships with pathogens, natural hosts and the human population, mediated by the interference of environmental factors, can contribute to the detection of potential changes in the transmission profile of vector-borne diseases [9]. The present study aims to contribute to the knowledge of the composition of the sand fly fauna, register the presence of potential vectors of *Leishmania* spp. and generate data on the bioecology of these dipterans in the municipality of Araguaína with the occurrence of cases of leishmaniasis, in the perspective that contributes to control actions.

Material and Methods

Study Area

The municipality of Araguaína is located in the north of the state of Tocantins (07º11'28"S and 48º12'26"W) (Figure 1), along the Belém-Brasília highway. It is the largest economic center in the state and the second most important municipality. The population is estimated at 150,484 inhabitants, covering an area of 4,004,646 km^2, population density of 37.62 (inhabitant/km^2). The Municipal Human Development Index (HDI) is 0.752 [21]. The climate is tropical humid, keeping warm all year, with a maximum temperature of 32ºC and a minimum of 20ºC. The vegetation is irregular, characterized by the greater extension of the Cerrado, in addition to riparian and tropical forests. The hydrographic is formed by the Araguaia River and its tributaries [22].

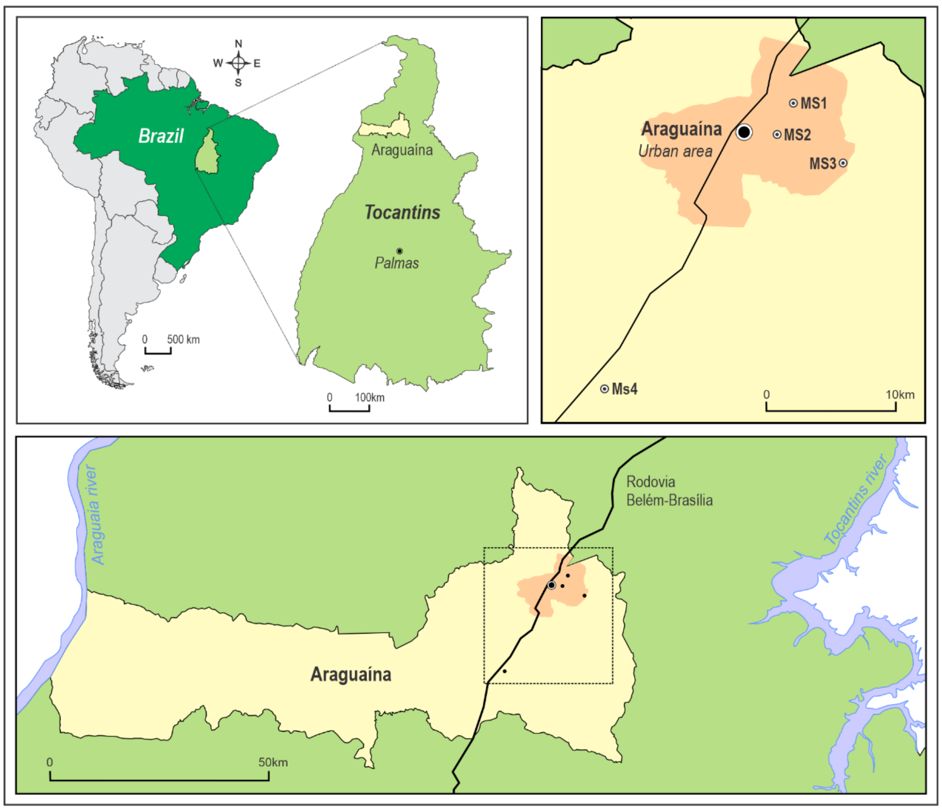

Figure 1: Araguaína map.

Capture and Processing of Sand Flies

Sand flies were captured monthly for three consecutive nights from June 2004 to December 2007 in four monitoring stations (MS) two in the urban environment (MS1 and MS2) and two in the rural environment (MS3 and MS4) (Figure 2). For the choice of locations, favorable environments for the maintenance of sand flies were considered (presence of domestic animals, shaded shelters, humidity and proximity to forest areas). In the MS of the urban environment, MS1 (Vila Goiás) (07º09'541"S 48º11'34.3"W) and MS2 (Setor Central) (07º11'11.0"S 48º12'14.6"W), the residences had chicken farms, presence of dogs, fruit trees and small vegetable gardens. In the MS of rural environment EM3 (Jacubinha) (07º12'25''S 48º9'28''W) and MS Projeto Alegre) (07°21'51.2''S 48°19'29''W), the houses they were close to the forest, with the presence of dogs, chickens, and pigs; sewage was released untreated in backyards.

CDC light traps [23] model HP Pugedo H, et al. [24] were used, installed in the evening twilight, and removed in the early morning of the following day at an approximate height of 1.5 m. The captured insects were kept in a CDC trap transport cage, killed by freezing and sorted, separating the sandflies from the other insects. Then, the processing and assembly of the specimens was carried out on a glass slide and the material covered with a cover slip [25]. The identification was carried out following the taxonomic methodology proposed by Galati, et al. [1-26] and the generic and subgeneric abbreviations [27].

Figure 2: Monitoring stations.

Data Analysis

Statistical analysis were performed using the specific abundance index (ISA) and the standardized specific abundance index (SISA) [28], using the software Microsoft® Office Excel 365 Copyright© Microsoft Corporation. The species is considered more abundant when the SISA value is closer to 1.

The sum of the monthly counts of individuals captured by species was used to generate seasonality graphs of the potential vectors identified. Among all identified species, those with at least 30 monthly observations different from zero were selected for the evaluation of correlation with meteorological data. Meteorological data for the period of captures were obtained from the main climatological station of Araguaína (07°12'S, 48°12'W), from the National Institute of Meteorology (INMET), comprising monthly values of five variables: maximum temperature, minimum temperature, mean temperature, relative humidity and total precipitation.

Univariate correlation analysis (Pearson correlation – r) was used to determine the association between the sand flies captured and the climate data obtained, with lags of 0 to 4 months. Monthly correlations with p value < 0.05 were considered significant. The calculated value of r indicates strong correlation if above 0.7.; moderate correlation is between 0.3 and 0.7.; weak correlation if between 0.1 and 0.3.; negligible correlation if below 0.1.

Seasonality plots, correlations with meteorological data and associated calculations, were performed using the R software version 4.1.0 [29].

Results and Discussion

The captures of sand flies resulted in a sampling effort of 7,560 hours, totaling 8,518 specimens, captured (4,693 males and 3,825 females), where 832 occurred in the urban environment and 7,686 in the rural environment (Table 1). Thirty-seven species were identified belonging to the genera *Bichromomyia* Artemiev, 1991, *Brumptomyia* França & Parrot 1921, *Evandromyia* Mangabeira, 1941, *Lutzomyia* França 1924, *Martinsmyia* Galati, 1995, *Micropygomyia* Barretto, 1962, *Nyssomyia* Barreto, 1962, *Pressatia* Mangabeira, 1942, *Psathyromyia* Barreto, 1962, *Psychodopygus* Mangabeira, 1941, *Sciopemyia* Barreto, 1962, *Trichopygomyia* Barreto, 1962, and *Viannamyia* Mangabeira, 1941 (Table 1).

Species	Urban Area		Rural Area		Total	%
	Vila Goiás	Setor Central	Jacubinha	Projeto Alegre		
Brumptomyia avellari	0	0	2	0	2	0,0
Brumptomyia brumpti	21	0	33	18	72	0,8
Micropygomyia rorotaensis	0	0		5	5	0,1
Micropygomyia villelai	0	0	3	0	3	0,0
Sciopemyia microps	0	0	0	8	8	0,1
Sciopemyia sordellii	53	7	36	37	133	1,6
Lutzomyia longipalpis	61	24	14	5	104	1,2
Pressatia choti	0	0	1	12	13	0,2
Trichopygomyia dasypodogeton	0	0	3	0	3	0,0
Evandromyia carmelinoi	103	5	79	64	251	2,9
Evandromyia evandroi	0	2	20	36	58	0,7
Evandromyia lenti	66	0	5	0	71	0,8
Evandromyia termitophila	0	1	1	7	9	0,1
Evandromyia walkeri	2	6	712	38	758	8,9
Evandromyia sallesi	2	4	4	4	14	0,2
Evandromyia begonae	0	15	79	0	94	1,1
Evandromyia bourrouli	140	68	3846	19	4073	47,8
Evandromyia brachyphalla	0	0	24	4	28	0,3
Evandromyia pinottii	0	0	45	7	52	0,6
Evandromyia saulensis	0	0	2	0	2	0,0
Psathyromyia aragaoi	1	11	40	25	77	0,9
Psathyromyia brasiliensis	49	13	24	6	92	1,1
Psathyromyia inflata	0	0	34	0	34	0,4
Psathyromyia lutziana	5	0	0	3	8	0,1
Psathyromyia pascalei	0	1	9	0	10	0,1
Psathyromyia runoides	0	8	46	9	63	0,7
Psathyromyia punctigeniculata	2	1	4	3	10	0,1
Psathyromyia bigeniculata	0	0	0	1	1	0,0
Psathyromyia dreisbachi	0	0	2	0	2	0,0
Psathyromyia hermanlenti	0	15	42	34	91	1,1
Viannamyia tuberculata	0	0	1	0	1	0,0
Martinsmyia oliverai	0	0	3	1	4	0,0
Bichromomyia flaviscutellata	0	0	1	0	1	0,0
Psychodopygus ayrozai	0	0	8	1	9	0,1
Nyssomyia antunesi	1	51	2048	53	2153	25,3
Nyssomyia richardwardi	0	0	1	0	1	0,0
Nyssomyia whitmani	93	1	51	63	208	2,4
Total	599	233	7223	463	8518	100,0

Table 1: Total number of sandflies captured with CDC light traps in the county of Araguaína, state of Tocantins, Brazil, June 2004 to December 2007.

All captured sand fly species in the study were present in the rural area and 17 were exclusive to this environment. In the urban area, 20 species of sand flies were recorded (Table 1).

Considering all areas of study, *Ev. bourrouli* was the species with the highest frequency with 47.8% of the total number of sandflies captured, with 208 specimens in the urban environment and 3,865 in the rural area. The *Ny. antunesi* species represented 25.3% of the total, with greater predominance in the rural environment with 2,101 specimens captured.

The species *Bi. flaviscutellata*, *Ny. richardwardi*, *Pa. bigeniculata* and *Vi. tuberculata* were the ones with the lowest frequency, with only one individual captured in the rural environment (Table 1). Potential vectors of *Leishmania* spp. registered in the study area were, *Lu. longipalpis*, *Ny. whitmani*, *Ny. antunesi*, *Bi. flaviscutellata* and *Ps. ayrozai*, where the first two had representation throughout the study period.

According to the ISA and SISA analysis, the five most abundant species were *Ev. bourrouli* (SISA=0.84); *Ev. carmelinoi* (SISA=0.79); *Ny. antunesi* (SISA=0.77); *Ny. whitmani* (SISA=0.73); *Ev. walkeri* (SISA=0.72) (Table 2).

Species	MS1 Rank	MS2 Rank	MS3 Rank	MS4 Rank	c	a	Rj	ISA	SISA
Bichromomyia flaviscutellata			31,0		31	96	31,0	31,8	-0,02
Brumptomyia avellari			27,0		31	96	27,0	30,8	0,01
Brumptomyia brumpti	8,0		13,0	10,0	31	32	31,0	15,8	0,46
Evandromyia carmelinoi	2,0	11,0	4,5	1,0	31	0	18,5	4,6	0,79
Evandromyia evandroi		13,0	16,0	6,0	31	32	35,0	16,8	0,43
Evandromyia lenti	4,0		20,0		31	64	24,0	22,0	0,27
Evandromyia termitophila		15,5	31,0	14,5	31	32	61,0	23,3	0,23
Evandromyia walkeri	11,0	10,0	3,0	4,0	31	0	28,0	7,0	0,72
Evandromyia sallesi	11,0	12,0	21,5	19,5	31	0	64,0	16,0	0,45
Evandromyia begonae		4,5	4,5		31	64	9,0	18,3	0,38
Evandromyia bourrouli	1,0	1,0	1,0	9,0	31	0	12,0	3,0	0,84
Evandromyia brachyphalla			14,5	19,5	31	64	34,0	24,5	0,19
Evandromyia pinottii			8,0	14,5	31	64	22,5	21,6	0,28
Evandromyia saulensis			27,0		31	96	27,0	30,8	0,01
Lutzomyia longipalpis	5,0	3,0	17,0	17,5	31	0	42,5	10,6	0,61
Martinsmyia oliverai			24,0	24,0	31	64	48,0	28,0	0,09
Micropygomyia rorotaensis				17,5	31	96	17,5	28,4	0,08
Micropygomyia villelai			24,0		31	96	24,0	30,0	0,03
Nyssomyia antunesi	13,5	2,0	2,0	3,0	31	0	20,5	5,1	0,77
Nyssomyia richardwardi			31,0		31	96	31,0	31,8	-0,02
Nyssomyia whitmani	3,0	15,5	6,0	2,0	31	0	26,5	6,6	0,73
Pressatia choti			31,0	11,0	31	64	42,0	26,5	0,13
Psathyromyia aragaoi	13,5	7,0	10,0	8,0	31	0	38,5	9,6	0,64
Psathyromyia brasiliensis	7,0	6,0	14,5	16,0	31	0	43,5	10,9	0,60
Psathyromyia inflata			11,0		31	96	11,0	26,8	0,13
Psathyromyia lutziana	9,0			21,5	31	64	30,5	23,6	0,22
Psathyromyia pascalei		15,5	18,0		31	64	33,5	24,4	0,20

Psathyromyia runoides		8,0	7,0	12,0	31	32	27,0	14,8	0,49
Psathyromyia punctigeniculata	11,0	15,5	21,5	21,5	31	0	69,5	17,4	0,41
Psathyromyia bigeniculata				24,0	31	96	24,0	30,0	0,03
Psathyromyia dreisbachi			27,0		31	96	27,0	30,8	0,01
Psathyromyia hermanlenti		4.5	9,0	7,0	31	32	16,0	12,0	0,57
Psychodopygus ayrozai			19,0	24,0	31	64	43,0	26,8	0,13
Sciopemyia microps				13,0	31	96	13,0	27,3	0,11
Sciopemyia sordellii	6,0	9,0	12,0	5,0	31	0	32,0	8,0	0,69
Trichopygomyia dasypodogeton			24,0		31	96	24,0	30,0	0,03
Viannamyia tuberculata			31,0		31	96	31,0	31,8	-0,02

Table 2: Index of Species Abundance (ISA) and Standartized Index of Species Abundance (SISA) analysis of sandflies captured in the county of Araguaína, state of Tocantins, Brazil, June 2004 to December 2007.

Six species showed frequency in at least 30 months of the capture period, *Lu. longipalpis*, *Ny. whitmani*, *Ny. antunesi*, *Ev. bourrouli*, *Ev. carmelinoi* and *Sc. sordellii* (Figure 3). There was a sharp peak in the number of sand flies captured between October 2006 and January 2007, reflected in all six species evaluated (Figure 3).

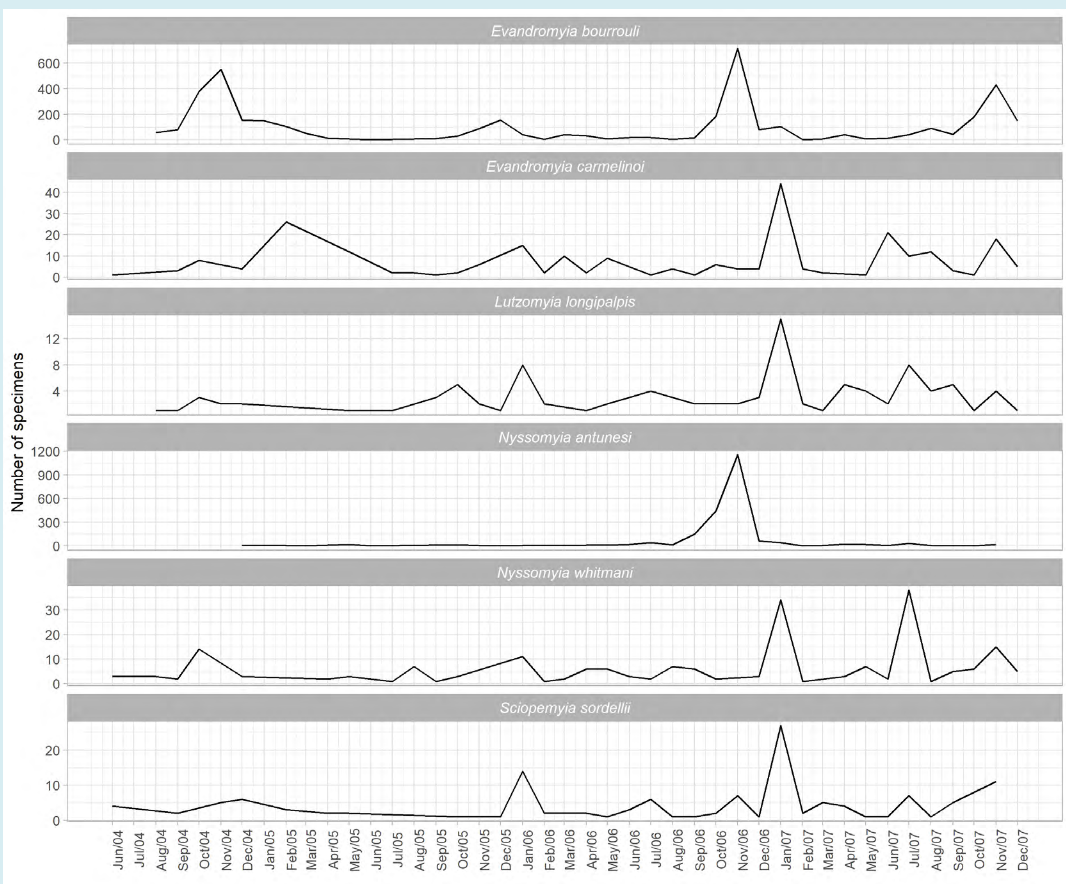

Figure 3: Seasonality plots of the selected sandfly species *Evandromyia bourrouli*, *Evandromyia carmelinoi*, *Lutzomyia longipalpis*, *Nyssomyia antunesi*, *Nyssomyia whitmani* and *Sciopemyia sordellii*. Lines represent total number of monthly captured individuals, county of Araguaína, state of Tocantins, Brazil, June 2004 to December 2007.

No significant correlations were detected between the monthly counts of the six species studied and the meteorological variables in the respective months of capture. However, when comparing the values with different lagged months, significant correlations were detected with several variables in the species *Ev. bourrouli*, *Ny. antunesi*, *Ev. carmelinoi*, *Sc. sordellii* and *Lu. longipalpis*. The results were more consistent across the different lags for *Ev. bourrouli*, which maintained positive correlations with maximum temperature and negative correlations with minimum, mean temperature, relative humidity and precipitation up to four previous months (Table 3). Among the potential vectors, *Ny. antunesi* showed a positive correlation with a maximum temperature of two previous months (r = 0.376, p = 0.037) and negative correlation with minimum temperature of the previous three months. *Lu. longipalpis* showed moderate positive correlation with mean temperature of the previous four months (r = 0.387, p = 0.031) (Table 3).

Species	Maximum Temperature	Minimum Temperature	Mean Temperature	Relative Humidity	Total Precipitation
Zero Lag					
Ev. bourrouli	-0.112	0.251	0.212	0.186	0.009
Ev. carmelinoi	-0.218	0.224	0.031	0.241	0.068
Lu. longipalpis	0.103	0.029	0.203	-0.032	-0.1
Ny. antunesi	0.035	0.134	0.227	0.044	-0.059
Ny. whitmani	0.025	0.047	0.064	0.044	-0.076
Sc. sordellii	-0.029	0.148	0.191	0.099	-0.06
One Month Lag					
Ev. bourrouli	0.149	0.099	**0.375 (.)**	-0.046	-0.156
Ev. carmelinoi	-0.293	0.332	0.071	**0.354 (.)**	0.238
Lu. longipalpis	-0.108	0.023	-0.101	0.089	0.05
Ny. antunesi	0.168	-0.002	0.261	-0.113	-0.159
Ny. whitmani	-0.115	-0.011	-0.168	0.093	0.088
Sc. sordellii	-0.162	0.14	-0.005	0.15	0.102
Two Months Lag					
Ev. bourrouli	**0.579 (***)**	-0.234	**0.395 (*)**	**-0.466 (**)**	**-0.335 (.)**
Ev. carmelinoi	-0.132	0.271	0.224	0.217	0.138
Lu. longipalpis	-0.073	0.113	0.04	0.11	0.018
Ny. antunesi	**0.376 (.)**	-0.223	0.201	-0.313	-0.214
Ny. whitmani	0.125	0.073	0.298	-0.021	-0.149
Sc. sordellii	0.058	0.17	0.268	0.031	-0.047
Three Months Lag					
Ev. bourrouli	**0.606 (***)**	**-0.604 (***)**	-0.072	**-0.614 (***)**	**-0.401 (*)**
Ev. carmelinoi	0.001	0.189	**0.351 (.)**	0.072	-0.053
Lu. longipalpis	-0.113	0.137	0.087	0.13	0.077
Ny. antunesi	0.324	**-0.411 (.)**	-0.183	-0.355	-0.208
Ny. whitmani	0.035	-0.003	0.099	-0.015	-0.041
Sc. sordellii	0.131	0.005	0.268	-0.082	-0.057
Four Months Lag					
Ev. bourrouli	**0.415 (*)**	**-0.662 (***)**	**-0.53 (**)**	**-0.506 (**)**	**-0.429 (**)**
Ev. carmelinoi	0.23	-0.037	0.222	-0.163	0.018
Lu. longipalpis	0.207	0.06	**0.387 (.)**	-0.079	-0.156
Ny. antunesi	0.138	-0.35	-0.336	-0.255	-0.228
Ny. whitmani	0.241	-0.114	0.118	-0.181	-0.197
Sc. sordellii	**0.461 (*)**	-0.175	0.343	-0.357	-0.267

Table 3: Correlations (Pearson's r) between selected sand-fly species and meteorological variables in zero to four monthly lags. Significant correlations are shown in bold.

Studies on the sand fly fauna in Tocantins have revealed new taxa [13-16], including *Micropygomyia (Silvamyia) echinatopharynx* [19], *Ma. reginae* [30] and *Lu. (Lutzomyia) elizabethrangelae* [20]. In addition to these, investigations of leishmaniasis vectors in the municipality of Porto Nacional recorded 48 species of sand flies, 22 of which were recorded for the first time in the state [10], revealing the diversity of these dipterans.

Captured sandflies in Tocantins, recording 17 species Lustosa ES, et al. [17] reported for the first time the presence of 16 species, in addition to *Br. avellari* and *Br. brumpti*, a genus that had not yet been registered, where, until then, the sand fly fauna was composed of 35 species [18]. In Guaraí, 30 species from 12 genera were captured in which *Psychodopygus* was the genus with the highest number of species, followed by *Nyssomyia*, *Evandromyia* and *Psathyromyia*, and three species were recorded for the first time, *Ny richardwardi*, *Pa. punctigeniculata* and *Ps. amazonensis* [12]. In the present study we report the finding of a species recorded for the first time in the state of Tocantins, *Psathyromyia bigeniculata*, increasing the quantity of the sandfly fauna to 74 species [31].

As for the seasonality of the vectors, some studies suggest that the highest sand fly densities correspond to periods of high precipitation, reaching maximum values shortly after the rainy season, when the temperature is a little lower, configuring excellent periods for insect activity [32-36]. We corroborate these results since correlations with climatic variables from previous months were detected. The abundance of *Ev. bourrouli* showed a negative correlation with precipitation from two to four months earlier, suggesting that the population of this species increases after periods of rain.

Regarding the vectors of pathogenic agents of leishmaniasis, three vectors of CL (*Ny. whitmani*, *Ps. ayrozai*, *Bi. flaviscutellata*) were identified, in addition to one (*Ny. antunesi*) suspected of being a vector of *L. lindenbergi* and *Lu. longipalpis*, the most important vector of *L. infantum*. The species *Ev. bourrouli* was the one with the highest number of captured individuals, considering the captures in all locations, especially those in the rural area, in agreement with what was observed in captures with light traps in the municipality of Guaraí, also in the state of Tocantins [6].

On the other hand, *Ny. whitmani*, the most important vector of *L. braziliensis* in Brazil, had the highest number of sandflies captured in the MS of the urban área, however,, was the second most widely distributed species in the rural environment, close to the sylvatic environment, corroborating previous studies [37,38]. The population peaks of *Ny. whitmani* occurred in October 2004, August 2005/2006 and January 2007, reinforcing what was observed in previous investigations, with population peaks at different times of the year [39-41]. The presence of the species has already been reported predominantly in the rural environment in other locations from the state of Tocantins, as in Porto Nacional [10], district of Taquaruçú, near the capital Palmas [11] and in a settlement in the municipality of Guaraí [6].

The species *Ny. whitmani* is incriminated as the main vector of *L. braziliensis* in Brazil [42,43]. It has a wide geographic distribution where it is registered in 26 Brazilian states [44]. Its frequency was initially associated with the wild environment during the colonization of the Southeast and South regions, however, studies revealed its high density, monthly fluctuation and adaptation to the domestic environment [37-45]. Evidence point to *Ny whitmani* being in an adaptation process for impacted areas, with loss of vegetation cover on the outskirts of counties, associated to the expansion of CL in Brazil. In Tocantins, *Ny. whitmani* has already been registered in most municipalities with cases of CL, associated with anthropogenic impacted areas [46]. Thus, the data observed in Araguaína suggest the possibility of *Ny. whitmani* to participate in the CL transmission cycle.

The sand fly *Ps. ayrozai* was captured only in the rural environment. This species is related to the transmission of *L. naiffi*, with few human cases recorded in the states of Pará and Amazonas [47]. The specie *Ps. complexus* was also captured only in the rural environment and is a species with wild habits, highly anthropophilic and inhabiting areas of primary forest, in high density, following the behavioral pattern of species of the genus *Psychodopygus* [48-51].

Studies to investigate the high incidence of CL in road construction workers in Serra dos Carajás, Pará state, with the presence of *Ps. complexus*, indicated this species as a potential vector of *L. braziliensis* in the area [52]. Although in Araguaína only one female was captured naturally infected, its occurrence in the municipality is of great epidemiological relevance.

The species *Bi. flaviscutellata* is a vector of *L. amazonensis*, the etiological agent of the clinical form of diffuse anergic cutaneous leishmaniasis (DCL) with an important geographic distribution and found in different habitats. The species has already been registered in the state of Tocantins, concomitant with reports of three autochthonous human cases of DCL. Some studies emphasize the importance of alerting health authorities when carrying out entomological surveillance actions [50,53,54].

The record of *Lu. longipalpis*, the main vector for *L. infantum* in Brazil, reinforces its importance and participation in occurrence of human cases of VL in of Araguaína, mostly captured in urban areas. The record of human and canine cases of the disease in the urban environment may have a correlation with the frequency of *Lu. longipalpis*, supporting the hypothesis of the vector urbanization process [55].

In Araguaína there are many settlement areas close to forest environments, establishing close contact between the human population and the sand fly vectors. The peridomestic environment has favorable conditions for the development and maintenance of vectors, such as the presence of shelters for domestic animals, accumulation of decomposing plat organic matter, irregular garbage collection, resulting in suitable environments for the development of immature forms of sandflies. Associated with the record of vector species of the causative agents of leishmaniasis, the mentioned factors contribute to the occurrence of human cases.

This evidence suggests the need for constant vector monitoring, as well as research for dogs with VL, as surveillance measures. Also, education actions by health agents in communities are important instruments in the prevention of local VL.

Conclusion

In the municipality of Araguaína, leishmaniasis is an important problem, especially the visceral form. The knowledge and detection of vector species of *Leishmania* spp. can contribute to the importance of entomological monitoring actions. The implement health promotion actions in communities as instruments in the prevention.

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