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ECOLOGY OF SANDFLIES (DIPTERA: PSYCHODIDAE) IN A RESTRICTED FOCUS OF CUTANEUOS LEISHMANIASIS IN NORTHERN VENEZUELA. I. DESCRIPTION OF THE STUDY AREA, CATCHING METHODS AND SPECIES COMPOSITION

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A study on the ecology of phlebotomine sandfly fauna in a restricted focus of cutaneous leishmaniasis in northern Venezuela was undertaken in order to investigate the species responsible for the transmission. The study area and catching methods for phlebotomine sandflies are described. A total of 9,061 females and 1,662 males were collected during a year-term study. 12 species of Lutzomya *and 1 species of* Brumptomya *sp. were identified. Absolute and relative abundance and occurrence for each species were determined. The rel ative occurrence allowed to distinguish the common species, viz.* L. panamensis, L. ovallesi, L. gomezi, L. trinidadensis, L. atroclavata, L. cayennensis, L. shannoni *and* L. olmeca bicolor *from the rare species vis.*, L. punctigeniculata, L. rangeliana, L. evansi *and* L. dubitans. *General comments on the species composition of the sandfly fauna in this locality are made.*

Key words: ecology of sandflies – cutaneous leishmaniasis – northern Venezuela – catching methods

In order to understand the natural history of sandfly transmitted diseases it is necessary to study (i) the diversity of species and their relative abundance, (ii) the degree of anthropophily and zoophily, (iii) the vector's seasonal distribution.

In a study carried out in an endemic focus of cutaneous leishmaniasis in northern Venezuela, Carabobo State, locality San Esteban, an attempt has been made to gather all these topics. This paper is the first of the series and deals with the ecological description of the environment studied, the methods used and the sandfly species composition found.

MATERIALS E METHODS

Study area (Fig. 1) – San Esteban is a small village formed by 354 houses with about 1,500 inhabitants. It is situated in the District of Puerto Cabello, Carabobo State, at 10°26' North, 68°01" West and an altitude of 85 m above sea level. The hilly sinuous valley in which the village is spread out is crossed by a stream bearing the same name, which divides it into two parts. The northern side is connected by the main asphalted road to puerto Cabello (17 km away), one of the most important ports of the Caribbean Sea. The southern side is limited by the foothills of the mountain range called "Serranía de la Costa". The area of San Esteban was originally moist tropical forest but it has been disturbed for four centuries by the settlement of man. Three plant associations can be distinguished: (i) agricultural, (ii) secondary forest and (iii) primary forest. The "conuco", the small individual cultivated field of the Venezuelan farmer, is mostly of beans, maize and various tubers. Cultivation of bananas, avocado, cocoa, coffee and citrus fruits is done within the well advanced secondary forest, a result of wood felling and fire. Remnants of the original primary forest persist along the river and at high altitudes. The vertebrate fauna includes monkeys, ant-eaters, squirrels, armadillos, rabbits, sloths, rats and bats.

The climatic conditions are nearly uniform through the year, with the exception of rainfall which fluctuates considerably between a 4 month dry season (January to April) and an 8 month wet season (May to December) (Feliciangeli, 1987).

Sandfly collections – The main purpose of the work was to provide a qualitative and quantitative analysis of the sandfly population and to record the relative seasonal densities of each species by comparing successive samples taken in a standard way. This type of sampling does not require randomization in regard to the area as recommended for estimating total populations (Morris, 1960).

Three collecting stations were selected to include areas close to and distant from human activities: a house in the village, the peridomestic area (about 20 m from the same house)

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and the sylvatic area (200 m from one of the last houses in the village).

Flies were caught from resting sites or coming to feed on man. Each of the two standard sampling methods was used twice a month, once in the morning (0800 – 1100h) and once at night (1900 – 2200). Catches were made on the same day of each week and each method was used on alternate weeks. The flies caught were recorded, with the catching method and time of day caught, for each month. Searches in domestic resting sites included the exploration of internal and external walls and household goods. Insects, located with the help of a lamp, were captured using an oral aspirator. Trees were searched in an attempt to detect the natural resting sites of sandflies. Aerial roots, trunks and especially shaded crevices between buttresses were explored; sandflies were often caught after being disturbed by cigarette smoke. Direct bait catches were made so that anthropophilic sandfly species could be recognized and the relative probability of a man being bitten in the three different habitats estimated. The human baits were volunteers, all treated patients of leishmaniasis who were advised of the risk, probably minimal, to contract a new infection. The bait sat with his shirts off and his trousers rolled up to the knee. Sandflies were caught as they attempted to feed. Twice a month, during night catches, three additional catching methods were used: one Shannon trap with a gasoline lantern and no bait and one battery operated CDC miniature light trap were placed at the field station at about 2m above the ground level. The normal round collapsible frame of the CDC trap was replaced by a gauze-covered cage (20 cm x) to make carriage easier. The cage was kept in a damp box. In the peridomestic habitat flies were caught coming to animal bait, either pig or cow depending on availability.

After collection, the insect were transferred from aspirators to disposable plastic pots whose bottoms had been perforated and lined with plaster of Paris. The tops were covered with gauze and carried to the laboratory in polystyrene boxes with a wet cloth inside to maintain humidity. The catches were sorted at the laboratory and sandflies were mounted in Berlese's medium, sexed and identified to species.

RESULTS

Definition of terms – For the study of the phlebotomine fauna at San Esteban several terms are here used, in the sense explained below.

The "species composition" of a fly population describes the species within if, the population limits being a particular area or habitat "Abundance" expresses the number of each species collected. "Relative abundance" is the ratio of the total number of each species to the total number of sandflies collected. The term "occurrence" will be used in this paper in two senses: qualitative and quantitative. In the qualitative sense, occurrence is defined as the presence of one species in a definite place or habitat whereas, in quantitative terms, it is calculated as the number of collections in which the species occurs. The term "absolute occurrence" is a measure of success in collecting, being the ratio of the number of collections in which the species was found to the total number of collections carried out during the study period. The term "relative occurrence" describes the efficiency of each capture method for each fly species. It is expressed as the number of collections of a given method in which the species occurred divided by the total number of collections made using that method.

Sandfly population structure – Abundance and occurrence – During 13 months of study period a total of 10,723 sandflies (9,061 ♀♀ and 1,662 ♂♂) representing 13 species were collected. Table I shows the species composition giving the number of sandflies by species and sex, the sex ratio and the abundance of each species. Table II shows the occurrence of sandflies using a different scoring method. The most abundant species in the study area was *Lutzomya panamensis* (Shannon, 1926) which represented 68.7% of the total catch, followed by *L. trinidadensis* (Newstead, 1922) (12.8%), *L. ovallesi* (Ortiz, 1952) (9.78%) and *L. gomezi* (Nitzulescu, 1930) (6.02%). These same species, in different order, also scored most highly in the measure of the occurrence. *L. panamensis* was detected in 53% of the collections and *L. gomezi*, although not represented by many individuals, was found in 41% of the samples. The absolute occurrence of *L. ovallesi* and *L. trinidadensis* was about 30%. *L. cayennensis* (Fairchild & Hertig, 1948), *L. atroclavata* (Knab, 1913) and *L. shannoni* (Dyar, 1929) with low absolute occurrence (10-17%) were most common species in collections in trees. *L. olmeca bicolor* Fairchild & Hertig, 1971, although never found resting, was often caught in light traps (Table II).

Values of the absolute occurrence are dependent on the efficiency of the combined collection methods. Consequently, though a species may be constantly present in an area, the value for its absolute occurrence can be low if it is detected only by a reduced number of methods.

The relative occurrence by method therefore appeared to be the more sensitive measure to separate common species from rare

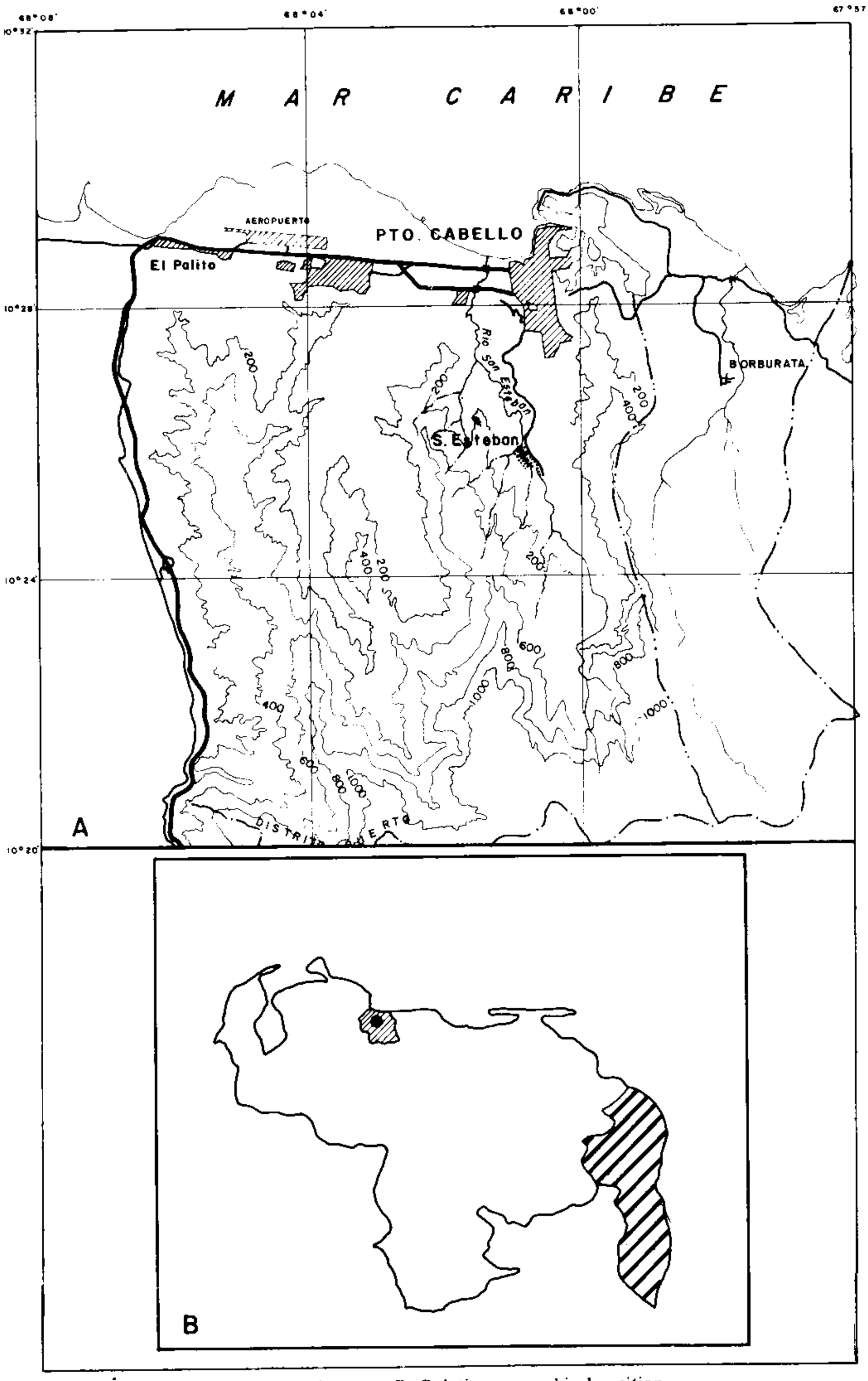

Fig. 1: A. San Esteban and nearby area. B. Relative geographical position.

TABLE I

Counts and abundance of sandflies species caught at San Esteban, Venezuela, from March 1979 to March 1980

Species	♀♀	♂♂	Total (♀♀ + ♂♂)	Sex ratio (♀♀ : ♂♂)	Abundance (%)
L. atroclavata	31	88	119	1 : 2.84	1.11
L. cayennensis	37	51	88	1 : 1.38	0.82
L. dubitans	1	0	1	1 : 0	0.009
L. evansi	1	0	1	1 : 0	0.009
L. gomezi	382	264	646	1 : 0.69	6.02
L. o. bicolor	21	11	32	1 : 0.52	0.30
L. ovallesi	976	73	1.049	1 : 0.07	9.78
L. panamensis	7.113	251	7.364	1 : 0.04	68.67
L. punctigeniculata	2	4	6	1 : 0.5	0.06
L . rangeliana	0	1	1	0 : 1	0.009
L. shannoni	15	27	42	1 : 1.8	0.39
L trinidadensis	481	892	1.373	1 : 1.83	12.80
Brumptomyia sp.	1	0	1	1 : 0	0.009
Totals	9.061	1.662	10.723	1 : 0.18	100

TABLE II

Relative and absolute occurrence by habitat and trapping methods of sandfly species at San Esteban, Venezuela (March 1979 – March 1980)

Species	House		Peridomestic area				Sylvatic area				No.** coll. times	Abs.+ occ.
	Walls (25)*	Biting man (26)	Tree (25)	Biting man (26)	Biting pig (8)	Biting cow (4)	Tree (25)	Biting man (26)	Shannon trap (23)	CDC trap (13)		
L. atroclavata	12	––	76	7.69	––	––	28	––	8.70	7.69	34	16.9
L. catennensis	16	3.85	68	3.85	––	––	24	––	4.35	15.38	32	15.9
L. dubitans	––	––	––	––	––	––	––	––	––	7.69	1	0.05
L. evansi	––	––	––	––	––	––	––	––	4.35	––	1	0.05
L. gomezi	28	15.38	8	50	87.5	75.0	16	42.3	91.3	84.61	83	41.3
L. o. bicolor	––	7.69	––	––	––	––	––	3.85	47.83	23.01	17	8.46
L. ovallesi	––	7.69	8	26.92	50	––	44	34.62	78.3	69.23	62	30.8
L. panamensis	48	26.92	28	50	100	100	28	57.69	91.3	100	107	53.2
L. punctigeniculata	––	––	8	––	––	––	12	––	––	––	5	2.49
L. rangeliana	––	––	––	––	––	––	4	––	––	––	1	0.05
L. shannoni	––	––	40	3.85	37.5	50	8	7.69	8.69	––	22	10.9
L. trinidadensis	28	3.85	88	11.5	12.5	––	92	––	4.35	23.07	61	30.3
Brumptomyia sp.	––	––	––	––	––	––	––	––	4.35	––	1	0.05

* Numbers in brackets indicate the total number of collections.
** Numbers of times in which the species was collected.
\+ = Absolute occurrence.

species. Those species which reached a relative occurrence of about 50% or more at any time in any habitat using any method, were considered as common species, i.e. *L. panamensis, L. owallesi, L. gomezi, L. trinidadensis, L. atroclavata, L. cayennensis, L. shannoni* and *L. o. bicolor*. The other species, *L. punctigeniculata* (Floch & Abonnenc, 1944), *L. rangeliana* (Ortiz, 1953), *L. evansi* (Nuñez-Tovar, 1924), *L. dubitans* (Sherlock, 1962) and *Brumptomya* sp., were considered rare species.

DISCUSSION

The species composition of a sandfly population can be considered as the result of geographical and metereological conditions and the resultant soil type and vegetation. Similarities in species composition can therefore be expected in places which show similar conditions provided the same collecting methods are used.

During March 1979 to March 1980, 13 species of sandflies formed the phlebotomine

fauna at San Esteban, an endemic focus of cutaneous leishmaniasis in Venezuela.

The majority of these species were also caught by Pifano et al. (1962) in localities at similar latitude and altitude, with ecological features comparable to those of San Esteban, a partially cleared area of lowland forest. These were around Araguita, Miranda State, at 1.00 m a.s.l. Both, Araguita and San Esteban are in the foothills of the "Serranía de la Costa". Often specific sandfly assemblages can be found in areas with similar conditions, even if they are far apart in terms of distance. *L. trinidadensis, L. shannoni, L. owallesi, L. panamensis* and *L. cayennensis* were among 22 species collected during six years in Belize (Williams, 1970). The same five species were found at Limbo Station, Panamá (Chaniotis et al., 1971) with *L. gomezi* and *L. punctigeniculata*, and at Sasardi, Panamá, *L. panamensis, L. gomezi, L. owallesi, L. trinidadensis, L. cayennensis* and *L. dubitans* (cited as *L. marajoensis*) were collected by Christensen et al. (1972). The *L. gomezi – L. panamensis* association was later recognized as a real entity since it was demonstrated that these species have a strong tendency to occur together (Rutledge et al., 1975).

Sandflies have been collected in Providencia, Colombia (Porter & De Foliart, 1981), an area which is very different from San Esteban, lying along the border between "tropical wet forest" and "tropical wet premontane" forest at an altitude of 400 to 800 m. Not surprisingly, only four species which occur at San Esteban were found *(L. panamensis, L. gomezi, L. shannoni and L. o. bicolor).* Only two of the species found at San Esteban *(L. gomezi* and *L. shannoni)* were also seen in the Serra dos Carajás in Brazil, an area of high altitude (Ward et al., 1973). A wide geographical distribution and perhaps also the relative abundance of a species may be considered as indicators of its success. Sometimes the two characters show some correlation in that wherever the fly occurs it is very abundant and nowhere it is found in low numbers. *L. trinidadensis* is an example of such fly. It was the most abundant species found resting on trees at San Esteban and in Belize (Williams, 1970), Panamá (Chaniotis et al., 1971; Cristensen, et al., 1972) and Colombia (Young, 1979). Young (1979) pointed out its "interesting distribution" indicating that, in Colombia, *L. trinidadensis* is very common and abundant in Northern Chocó but appears to be absent in forest along the Pacific Coast in Valle Department.

L. panamensis, the dominant man-biting species in San Esteban (81.3%) also scored a marked predominance at Teresita, at an altitude of 35 m in Colombia (86%) but formed only 12% of the man-biting species at Limbo Station (50-180 m) in Panamá (Chaniotis et al., 1971) and only 3% at Providencia in Colombia (400-800 m) (Porter & De Foliart, 1981). It seems therefore that the occurrence and abundance of *L. panamensis* are together inversely correlated with altitude, the higher the collection site, the rarer the fly.

L. gomezi is a very widely distributed species. Its range includes El Salvador, Nicaragua, Costa Rica, Panamá, Colombia, Venezuela, Trinidad, Equador, French Guyana, Peru and Brazil (Martins, et al., 1978). This species occurred in San Esteban in all habitats but at relatively low abundance. In Trujillo State, Venezuela, *L. gomezi* was found in only 7% of the localities below 300 m and about 25% of localities at 1000 m a.s.l. (Mogollón et al., 1977). The authors concluded that this species seems to be more successful between 200 m and 1800 m. The positive correlation between occurrence, abundance and altitude might explain the low density of *L. gomezi* at San Esteban, a place of low elevation.

On the contrary, according to Mogollón et al., (1977), the distribution of *L. owallesi* does not seem to be correlated with the altitude, this species being equally widespread in localities between 100 and 1880 m. Its abundance in San Esteban seems mainly to be related to climatic factors (Feliciangeli, 1987c).

RESUMO

Foi realizado um estudo da ecologia da fauna de flebotomíneos em um foco restrito de leishmaniose no norte da Venezuela, a fim de procurar determinar quais as espécies vetoras. São descritos os métodos de captura e a área estudada. Os totais de 9.061 fêmeas e 1.662 machos foram coletados durante um ano de estudo. Foram identificadas doze espécies de *Lutzomya* e uma de *Brumptomya*, sendo determinadas a ocorrência e a abundância absoluta e relativa de cada espécie. Foi possível distinguir as espécies comuns, como *L. panamensis, L. owallesi, L. gomezi, L. trinidadensis, L. atroclavata, L. cayennensis, L. shannoni* e *L. olmeca bicolor*, das espécies raras, como *L. punctigeniculata, L. rangeliana, L. evansi* e *L. dubitans*. São feitos comentários gerais sobre a composição da fauna flebotômica da área de estudo.

Palavras-chave: ecologia de flebótomos – leishmaniose tegumentar – norte da Venezuela – métodos de captura.

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