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THE PHOTOTACTIC RHYTHMS OF SOME SANDFLIES FROM VENEZUELA *(DIPTERA: PHLEBOTOMINAE)*

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SUMMARY

In a cloud forest of north-central Venezuela, a study was made to compare the numbers of *Phlebotomus* that were captured in their natural shelters with the numbers caught in a Shannon trap. The trap was used between the hours of 5 p.m. and 01.00 a.m.; it was illuminated with a light of 500 candle power. 1) 6.534 (87%) specimens of *Phlebotomus* were captured in 21 trapping sessions over a period of seven months. The captures included nine species of the genus; 1.803 (13%) were captured in the resting sites. 2) The greatest number of insects were captured in the light trap on new moon nights. The relation between this phenomenon and others factors — the meteorological data — are discussed. 3) The insects began arriving at the trap at the end of twilight, when the light level of the environment was below 1 lux. Between 6.00 p.m. and 01.00 a.m., the plot of the arrivals at the trap shows two peaks, one between 6.00 and 9.00 p.m., the other between 11.00 p.m. and 01.00 a.m. 4) The bimodality of this curve is discussed in relation to the nocturnal activity of *Phlebotomus*, and to the recently described rhythm of the biting activity.

INTRODUCTION

WILLIAMS [14] reported that the biting rhythms of some anthropophilic species of sandflies from British Honduras show a bimodal curve with a peak of activity from 6.00 to 6.59 o' clock (p.m.), followed by a fall in activity and then a second peak between (9.00) and (9.59 p.m.).

In our studies on the phototropic behaviour of some sandflies from the "Rancho Grande" cloud forest in the north-central part of Venezuela, we observed a similar phenomenon, using instead of human baits, a lamp inside a Shannon trap.

The use of light traps to capture and survey *Phlebotomus* faunas has been common in this continent. Since the works of CHAGAS [3] different investigators have used the Shannon trap in their studies. We used this trap in order to compare its yield with the captures made by hand in the same places.

In this paper we describe the results obtained reporting the phototactic modalities of some sandflies in relation to meteorological factors, the intensity of the nocturnal background light, and especially the lunar periodicity.

PROCEDURES

The area of work has been described by SCORZA et al., indicating the biotopes of sandflies, their breeding places, the places where the captures were made, and where we installed the light-traps.

From May lst to November 27th 1964, we carried out 21 field trips, collecting sandflies in eleven different breeding places

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from 09.00 a.m. to 5.00 p.m. and then with light-trap from 5.30 p.m. until 01.00 a.m. We used a Shannon trap supplied with a butane gas lamp of 500 candles and ten meters away we placed a climatic station with a termistor-hygrometer, a photometer with a selenium cell, and a Biram anemometer. The details of the construction and functioning of this apparatus, with indications of the microclimatic measurements made in the breeding-places, has been published by SCORZA et al. Starting from at 5.30 p.m. and a 1.20 mts. height, every 15 minutes we measured temperature, relative humidity, wind velocity, background brightness, and the trap illumination.

At the end of each measurement, all *Phlebotomus* arriving at the trap were collected. In order to determine the position of the moon, its phase and the time of its setting, we consulted an astronomical calendar for specific information, in the legal time of Venezuela, on the position of the moon in relation to the 67° 30' meridian, which was the nearest to our work zone, situated at 67° 41'.

RESULTS

1) *Comparisons of the sandflies collected in their breeding places with those caught with the light trap*

We captured 7,627 sandflies of nine species; 1,083 were collected in the breeding places and 6,534 with the light trap.

In Table I, we present our results, indicating the species, sex, and number of individuals. We found seven species in the breeding places with a sharp predominance of males, with the exception of *Phlebotomus townsendi*. With the light trap, besides these species, we found also *P. ovallesi* and *P. shannoni*, two very rare anthropophilic species in this zone. In this case, with the exception of *P. venezuelensis*, female sandflies predominate.

2) *Phototaxis of sandflies and meteorological variations*

In Table II, we summarize the results obtained with 21 light-traps; the data express the total amount of sandflies collected and the mean of the meteorological measure-

TABLE I

Comparison between the sandfly population collected at their natural breeding places and those caught at light traps

Species	Breeding Places				Traps			
	Males	Females	Total	%	Males	Females	Total	%
Phlebotomus townsendi	422	462	884	49.03	539	5.690	6.229	95.33
P. yencanensis	534	234	768	42.60	26	25	51	0.78
P. venezuelensis	11	3	14	0.78	21	13	34	0.52
P. vexillarius	90	36	126	6.99	9	36	45	0.69
P. núñez-tovari	1	1	2	0.11	4	35	39	0.60
P. scorzai	2	4	6	0.33	45	72	117	1.79
P. beauperthuyi	1	—	—	0.06	1	1	2	0.03
P. ovallesi	—	—	—	—	4	3	7	0.11
P. shannoni	—	—	—	—	—	1	1	0.02
Total	1,063	740	1,803		649	5,885	6,534	

ments made in the work-hours indicated in the third column.

A regression analysis between the number of sandflies collected each night and each of the meteorological factors showed no correlation; however, we note that highest rates of sandflies collected (1,077 and 991) corresponded to a new moon period with high temperature and the lowest rates (36 and 68) to relatively low temperature and high humidity.

We found that the number of sandflies caught at the new moon is nearly or quite double trapped at first quarter, full moon, or last quarter, as indicated in Table III. The action of the environmental brightness on the light trap collection of sandflies is evident. In Table IV, we indicate three cases

TABLE II

Results of sandfly collections with 21 light-trappings

Dates	no. of sandflies collected	Hours of collection	Luminosity in Lux *		Humidity-Temp. %	Humidity-Temp. °C	Wind mt/min
			FULL MOON				
1/5	303	3.4	1.448	0.468	91.69	20.32	17.75
24/9	185	3.3	1.516	0.083	94.29	23.14	8.14
23/10	133	5.0	1.024	0.238	89.80	25.02	28.80
29/5	252	2.8	3.439	0.478	91.57	19.84	12.71
			LAST QUARTER				
9/5	135	3.9	1.270	0.052	81.10	21.27	1.90
5/6	345	4.0	3.558	0.149	90.11	19.72	9.56
1/8	227	5.5	1.370	0.086	91.55	19.80	9.20
5/9	295	2.8	0.715	0.0045	90.20	21.30	0.00
			NEW MOON				
16/5	1.077	6.0	2.068	0.058	64.64	22.38	22.45
12/6	449	5.1	3.157	0.013	80.71	20.34	12.67
10/7	145	3.1	2.310	0.071	87.00	20.10	4.20
7/8	202	3.0	1.964	0.086	89.14	20.64	2.57
9/9	68	3.4	0.837	0.051	90.60	16.86	10.20
8/10	991	3.1	1.118	0.041	91.00	25.17	1.71
6/11	518	2.8	0.643	0.034	89.14	24.81	11.00
27/11	406	3.0	0.471	0.048	51.80	23.64	—
			FIRST QUARTER				
22/5	140	1.5	2.915	0.206	92.00	20.53	16.50
19/6	133	2.5	2.473	0.259	83.71	20.27	9.71
17/7	393	7.0	1.326	0.133	86.50	20.25	5.67
14/8	36	6.0	0.833	0.278	91.83	16.37	5.83
13/11	101	3.0	0.524	0.042	91.00	23.86	32.20

* See TETENS (1963) [10]

in which captures made when the night began yielded few or no sandflies until the moon was hidden beyond the horizon; just afterwards, the *Phlebotomus* began to arrive.

3) *Influx rate of sandflies to light trap*

In Fig. 1, we show the variations of the light through twilight at 5.00 p.m. until 01.00 a.m. hours, together with the variations of the light from the trap at the same time. The intensity of light is expressed following TETENS [10], who represents the lux values with positive numbers, adding 10 to the logarithm of the lux reading given by the photometer. In the Fig. 2, on the X axis we indicate the hours of collection, and on the Y axis, the percentage of the mean of the sandflies caught at these hours in the 21 nights of trapping. This curve exhibits two peaks, one between 7.00 and 9.00 p.m., and the other between 11.00 p.m. and 01.00 a.m.

TABLE III

Comparison of the sandfly yields by different lunar phases

Full Moon		**Last quarter**		**New moon**		**First quarter**	
no. sandflies	Lux *	no. sandflies	Lux	no. sandflies	Lux	no. sandflies	Lux
303	0.468	135	0.052	1.077	0.055	140	0.206
252	0.478	345	0.149	449	0.103	133	0.259
185	0.083	227	0.081	145	0.071	393	0.133
133	0.238	295	0.045	202	0.086	36	0.278
				68	0.051	101	0.042
				991	0.041		
				518	0.034		
				406	0.048		
218	0.317	250.5	0.082	482	0.062	160.6	0.183

* See TETENS (1963) [10]

TABLE IV

Three cases of increasing yield of sandfly collection following moon setting

Date	Moon Phase	Time, number of sandflies collected and luminosity in "Lux" *									
		6.00 - 6.59 pm.		7.00 - 7.59 pm.		8.00 - 8.59 pm.		9.00 - 9.59 pm.		10.00 - 10.59 pm.	
		Sand-flies	Lux	Sand-flies	Lux	Sand-flies	Lux	Sand-flies	Lux	Sand-flies	Lux
9/3	last quarter	9	0.073	32	0.045	34	0.045	54	0.045	—	—
17/7	first quarter	0	0.239	10	0.183	11	0.103	71	0.092	301	0.048
23/10	full quarter	0	0.403	12	0.125	42	0.042	36	0.042	43	0.040

* See TETENS (1963) [10]

DISCUSSION

Considering the results obtained in the catches of sandflies made in the breeding places, and those made with the light trap, we confirm the viewpoint of BARRETTO & COUTINHO [2], who stated that light trapping was a surer and more efficient method of making surveys on the sandfly fauna. Nevertheless, species very common in the resting places, such as *P. yencannensis*, appear in very scanty numbers at the light trap despite the large number collected by hand in the biotopes.

In order to make a complete study on the chain of vectors and reservoirs that doubtless intervene as natural foci in the epidemiology of Cutaneous Leishmaniasis in Tropical America, it is necessary to consider with equal attention all the species of *Phlebotomus* from and endemic zone. WILLIAMS [13] showed how large is the variation in species found in the same area when different trapping methods are employed; in the breeding places, saurophilic species predominate whereas muridophilic species predominate with the use of traps baited with wild rats, or anthropofilic species when humans are used as bait.

Without considering the findings of leishmaniae partially pathogenic to man in lizards from the Near East and Africa that are probably transmitted by *P. minutus*, the importance of the first group of sandflies species can be appreciated from the work of MEDINA [7], who obtained positive results inoculating lizards and turtles with *L. brasiliensis*. On the other hand, the findings of

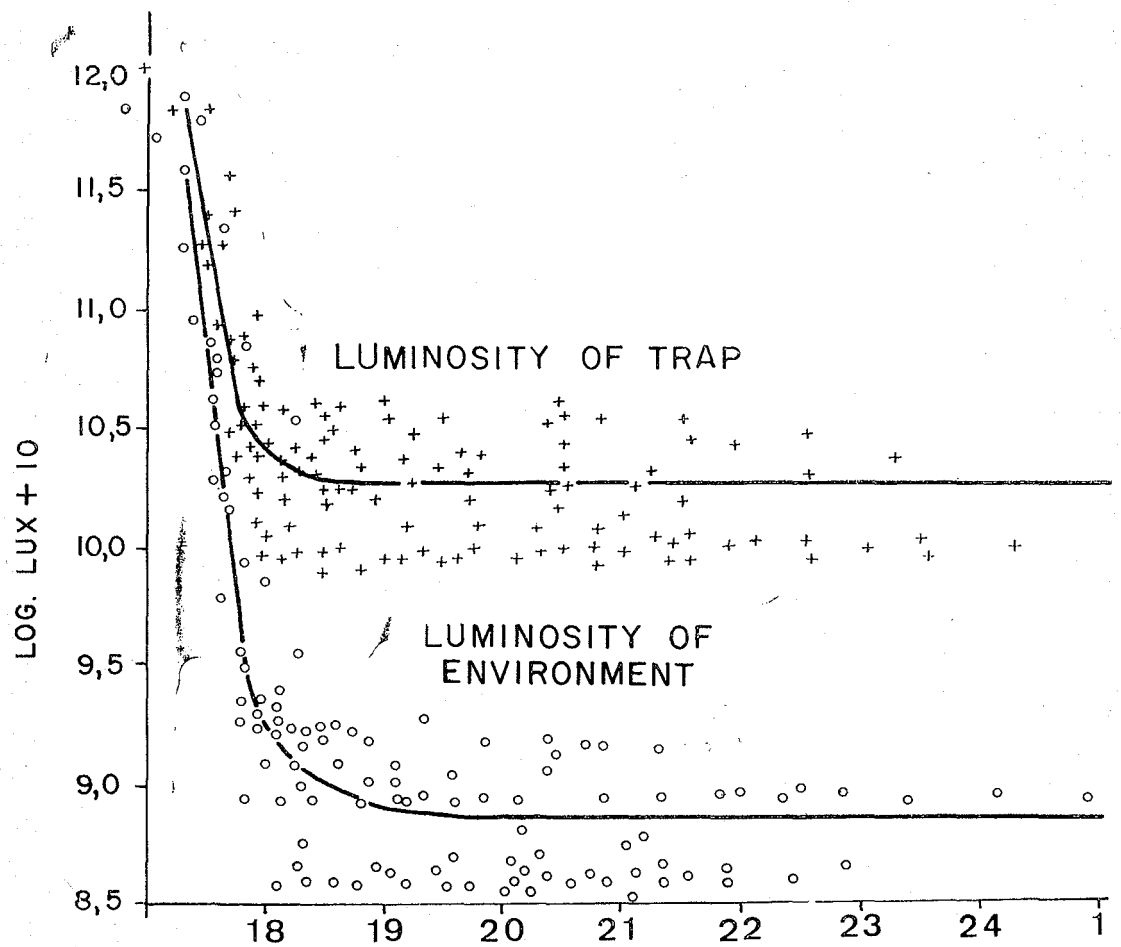

Fig. 1 — Variation of Log. of LUX values from 5 P.M. to 12 P.M.

HERTIG et al.[5], LAINSON & STRANGWAYS-DIXON [6] and DISNEY [4] establish without doubt that small rodents are reservoirs whose infection must be brought about principally through sandflies with obligate or facultative muroidophilia.

Although the light-trapping results in more sandflies in the catches, it must be done in a systematic way, considering not only the seasonal variations, as shown by SCORZA et al., but also other factors not considered to date must be born in mind, such as the influence of lunar photoperiodicity, a phenomenon seen by RIBBANS [9] in West Africa with *Anopheles funestus*, which enters houses six times more frequently on moonless nights.

The mechanism of moonlight influence on the capture of mosquitoes has been explained by WILLIAMS et al. [12] and confirmed by PROVOST [8] and BARR et al. [1]

Our findings confirm that, in the case of sandflies, the arrival of individuals at the light trap is influenced by the background brightness. In general, the higher yields of catches were obtained when environment illumination was lower than 0.150 lux, although such was not always the case; without doubt, factors other than light, such as humidity and temperature, must affect the nocturnal activity of this insect; VYUKOV [11] states that, in the case of *P. papatassi* and *S. arpaklensis*, activity depends more on light, temperature, and winds than on relative humidity. In relation to the rate of nocturnal arrival of sandflies at the light trap, we observed that it begins as soon as the twilight is over and the background brightness is lower than 1.0 lux; then, at 6.30 p.m. and onwards, it increases progressively until 9.00 p.m. and falls between 10.00 and 11.00 p.m., increasing again to form another peak at 11.30 p.m. This phenomenon, observed principally in females of the anthropophilic *P. townsendi*, is similar to that recorded by WILLIAMS [13] with *P. panamensis* and *P. shannoni*. Apparently the bimodality of the

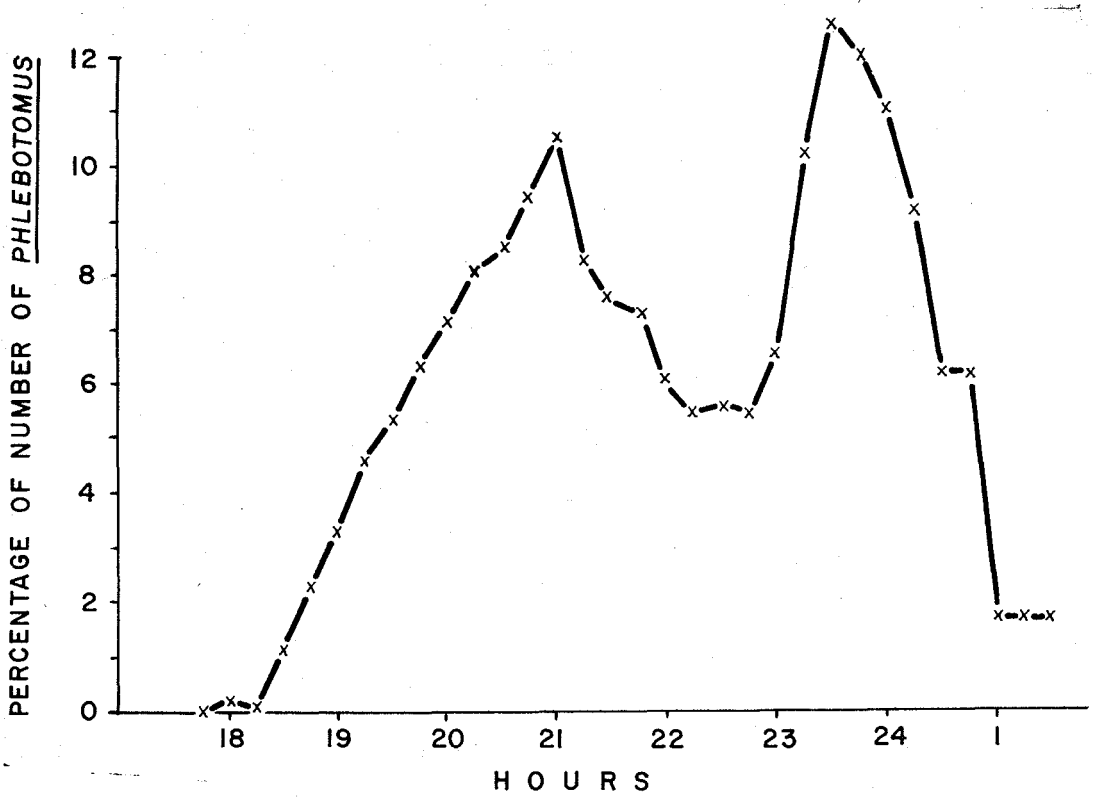

Fig. 2 — Percentage of number of *Phlebotomus* arriving to the light-trap from 6 P.M. to 1 A.M.

curve is not conditioned by extrinsic variations of stimulus but by endogenous factors as suggested by WILLIAMS [13]. Probably, the nocturnal activity of neotropical sandflies is similar to that of sandflies from palearctic regions where VYUKOV [11] observed that females of *S. arpaklensis* at the first and seventh stages of the gonotrophic cycle left their burrows at about 8.00 p.m., while females with intermediate stages of blood digestion left later.

RESUMEN

Ritmos fototácticos de algunos flebotomos de Venezuela (Diptera: Phlebotominae)

En una selva nublada del centro-norte de Venezuela se ha hecho un estudio para comparar las cantidades de *Phlebotomus* capturados en sus abrigos naturales con los atrapados con una trampa de Shannon. La trampa fué colocada entre las 5.00 p.m. y la 1.00 a.m. e iluminada con una lámpara de 500 bujías.

1) 6.534 (87%) ejemplares de *Phlebotomus* fueron capturados en 21 trampeos realizados en 7 meses, identificándose nueve especies; 1.803 (13%) fueron capturados en los sitios de reposo incluyendo nueve especies.
2) Mayor número de insectos fueron capturados con trampa luminosa en las noches de luna nueva. Se discuten las relaciones entre este factor y otros factores meteorológicos investigados.
3) Los insectos comenzaron a arribar a la trampa luminosa durante el ocaso cuando el dintel de luminosidad estuvo por debajo de un lux. Entre las 6.00 p.m. y la 1.00 a.m., la graficación del número de ejemplares llegados a la trampa luminosa sugiere una curva bimodal con dos máximas, una entre 6.00 y 9.00 p.m. y otra entre las 11.00 p.m. y la 1.00 a.m.
4) Se discute la bimodalidad de la curva en relación con la actividad nocturna de los *Phlebotomus* y sus ritmos de actividad hematofágica.

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