Distribution of Sandflies (Diptera:Psychodidae) on Tree-trunks in a Non-flooded Area of the Ducke Forest Reserve, Manaus, AM, Brazil

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Sandflies were collected in the base of tree-trunks in the seasons of high and least rainfall in the Ducke Forest Reserve, near Manaus in the State of Amazonas. Lutzomyia umbratilis *was the most abundant sandfly species.* Caryocar villosum, Chrysophyllum amazonicum, Dinizia excelsa, Eschweilera atropetiolata *and* Parkia multijuga *were the tree species on which most sandflies were collected and relative abundance were related to trunk characteristics. Seasonal patterns of sandfly distribution in the forest were observed.*

Key words: tree - sandflies - Ducke Reserve - Amazonas - Brazil

Tropical forests are famous for being the most species rich ecosystems on earth (Gentry 1992). In some of these forests, such as in the Brazilian Central Amazon, the phlebotomine sandflies show a high diversity index ($a = 10.0 \pm 1$, Barrett et al. 1996) and an adaptation to diverse biotopes (Christensen et al. 1983).

Shaw and Lainson (1972) and Ready et al. (1983, 1984) studied the association of some sandfly species with phyto-ecological and phyto-topographical features of forested areas in the Brazilian Amazon: *Lutzomyia flaviscutellata* occurred in non-climax primary and secondary forests and *Lu. wellcomei* in the higher topographical elevation forest.

Lu. umbratilis populations, vectors of *Leishmania* (*Viannia*) *guyanensis* an aetiological agent of "pian-bois", are mostly distributed in higher topographical elevation areas, and may be seen resting on the bases of tall trees (girth > 1m and furrowed bark) throughout the day (Ready et al. 1983, 1985, Barrett et al. 1991).

The bases of tall trees have been considered as a link between the canopy (where *Le.* (*V.*) *guyanensis* cycle develops) and the forest floor where human infection by *Lu. umbratilis* occurs (Geoffroy et al. 1986). Studies of these habitats with respect to sandfly populations are of great importance in the planning of control strategies in non-flooded primary rain forested areas, where agro-forestry, road building and urban area enlargement projects, are underway.

There is a need to investigate the relationship between sandflies and the morphological characteristics of trees that might be favouring vector species of sandflies, in particular the sandfly distribution and interspecific competition at a height ranging from 0 to 2 m above ground level in a non-flooded primary forest area. This is the objective of the present work.

Experimental area - The study area, Ducke Forest Reserve (DRF), is located in the Brazilian Central Amazon, between the geographic coordinates (02º55' to 03º00'S and 59º53' to 59º59'W). It encompasses an area of 10,072 ha, and is approximately 80 to 100 m above sea level.

Further geomorphologic, vegetational and climatic characteristic are described by Penny and Arias (1982), Franken et al. (1992) and Rodriguez (1995).

MATERIALS AND METHODS

Sandflies were collected during high and low rainfall periods (February to April and July to September 1993). The sampling was carried out in the first and third week of each study month, three days a week, from 07:00 to 15:00 hr.

The study area was subdivided in two subareas of 5,000 m^2 each. Sandflies were collected by suction devices and by active searching on 36 tree-trunks, belonging to 21 species (Table I), with a CDC modified light trap (Cabanillas et al. 1995) and collecting with 10x1.5 mm glass tubes.

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Received 3 July 1998
Accepted 10 February 1999

TABLE I

List of the tree species (with code of identification) on which the sandflies were collected

Scientific name	Code	Family
Anacardium spruceanum	An.	Anacardiaceae
Aspidosperma odiscolor	As.	Apocynaceae
Chrysophyllum amazonicum	Ch.	Apocynaceae
Geissospermum sp.	Ge.	Apocynaceae
Ephedranthus amazonicus	Ep.	Anonaceae
Protium sp.	P1	Burseraceae
Caryocar villosum	Ca.	Caryocaraceae
Dinizia excelsa	Di.	Mimosaceae
Inga sp.	In.	Mimosaceae
Parkia multijuga	P2	Mimosaceae
Piptadenia suaveolens	P3	Mimosaceae
Pithecolobium racemosum	P4	Mimosaceae
Brosimum parinaroides	Br.	Moraceae
Bochoa sp.	Bo.	Cesalpinaceae
Swartzia schomburgkii	Sw.	Cesalpinaceae
Couratari longipedicelata	Co.	Lecythidaceae
Eschweilera atropetiolata	Es.	Lecythidaceae
Sloanea brachytepala	Sl.	Elaeocarpaceae
Vantanea sp.	Va.	Humiriaceae
Sacoglottis matogrossensis	Sa.	Humiriaceae
Palicourea grandifolia	Pa.	Rubiaceae

The peculiarities of each tree trunk were noted. For example, bark type (smooth or furrowed), development of buttress roots and diameter of core trunk, measured immediately above the uppermost junction of the highest buttress with the trunk (Smith 1972).

Collections with a suction trap (a CDC modified light trap) - Sampling was carried out with a suction trap on all tree-trunks in each subarea, from ground level to 2 m above ground level. The aim was to spend no longer than 15 min sampling each tree, in order to get a standard collection time.

Active searching of sandflies - The sandflies were searched for on each tree, at the same times mentioned above for every collecting day, using a flashlight for this purpose. Flies were collected with a glass tube (two to three specimens in each tube) which was closed with cotton.

For each tree, sampling was carried out during a 15 min period, regardless of the presence or absence of sandflies, in order to establish a standard collecting period. So as not to use both collection techniques on the same tree, each technique was carried out in one subarea, which were sampled simultaneously.

Statistical analysis - The association between collection technique, abundance of sandflies and tree trunk diameter were analyzed by Spearman Rank Correlation Test (Zar 1984). The association between the former two variables with morphological characteristics of tree trunk employed a biserial point correlation test. Morphological characteristics of tree trunks were coded in relation to presence/absence.

RESULTS

A total of 3,975 sandflies was collected, belonging to 20 species. Ninety one point six percent were collected by active searching (see Materials and Methods) and only 8.9% with the suction trap. Quantitative differences due to collecting techniques and seasonality were remarkable (Table IV). However, since the main objective was the relationship between tree species and sandflies, our analyses were carried out on the total number of individuals captured with both techniques. The overall ratio of males to females was 1.8 (64.3% males and 35.8% females) and did not vary much for the same tree species or by seasons.

Lu. umbratilis Fraiha & Ward was the most frequent and abundant (85.3%) sandfly species on all sampled trees, but showed quantitative variations from tree to tree (Table II) and from season to season (Fig. 1). *Lu. dendrophila* Mangabeira and *Lu. shannoni* Dyar were also collected during the two seasons but in smaller quantities.

Lu. umbratilis was collected on 18 of the 22 tree species studied. However, 75% of all the specimens were encountered on only 12 tree species. A minimum frequency of 66.2% was founded on *Piptadenia suaveolens* and a maximum of 100% on *Geissospermun* sp. and *Pithecolobium*

TABLE II

Relative frequency of *Lutzomyia* species on each tree species sampled in the Ducke Forest Reserve

Scientific name	DAV	DEN	FLA	ROR	SCA	SHA	UMB	Others	(%)	IND
Anacardium spruceanum	0.0	1.8	0.0	0.0	0.0	9.1	89.1	0.0	100	55
Aspidosperma odiscolor	0.0	2.1	0.0	1.0	1.0	6.2	85.6	4.1	100	97
Bochoa sp.	0.0	4.7	0.0	3.1	6.3	0.0	85.9	0.0	100	64
Caryocar villosum	0.0	5.6	0.0	0.9	2.2	2.6	86.6	2.1	100	231
Chrysophyllum amazonicum	0.0	4.7	0.4	0.4	1.3	2.6	89.8	0.9	100	235
Couratari longipedicelata	0.3	6.3	0.0	0.9	1.7	5.1	84.3	1.4	100	350
Dinizia excelsa	0.1	7.4	0.1	10	1.3	6.7	82.4	0.8	100	675
Ephedranthus amazonicus	0.0	2.6	0.2	0.9	2.6	3.7	89.1	0.9	100	430
Eschweilera atropetiolata	5.5	2.0	0.0	0.4	0.4	2.4	88.2	1.2	100	254
Geissospermum sp.	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100	16
Palicourea grandifolia	0.0	6.3	0.0	6.3	0.0	12.5	68.8	6.3	100	16
Parkia multijuga	0.3	11.0	0.0	0.0	2.1	5.4	80.7	0.5	100	373
Piptadenia suaveolens	0.0	23.1	0.0	0.0	3.1	6.2	66.2	1.5	100	65
Pithecolobium racemosum	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100	37
Sacoglottis matogrossensis	0.0	0.0	0.0	0.0	0.0	0.0	97.1	2.9	100	34
Sloanea brachytepala	1.0	7.4	0.5	1.0	2.9	7.8	78.4	1.0	100	204
Swartzia schomburgkii	0.0	6.3	0.0	0.0	1.6	1.6	90.6	0.0	100	64
Vantanea sp.	1.0	5.1	0.0	4.0	2.0	2.0	85.9	0.0	100	99

DAV: *Lu. davisi*; DEN: *Lu. dendrophila*; FLA: *Lu. flaviscutellata*; ROR: *Lu. rorotaensis;* SCA: *Lu. scaffi*; SHA: *Lu. shannoni*; UMB: *Lu. umbratilis*, IND: no. of individuals.

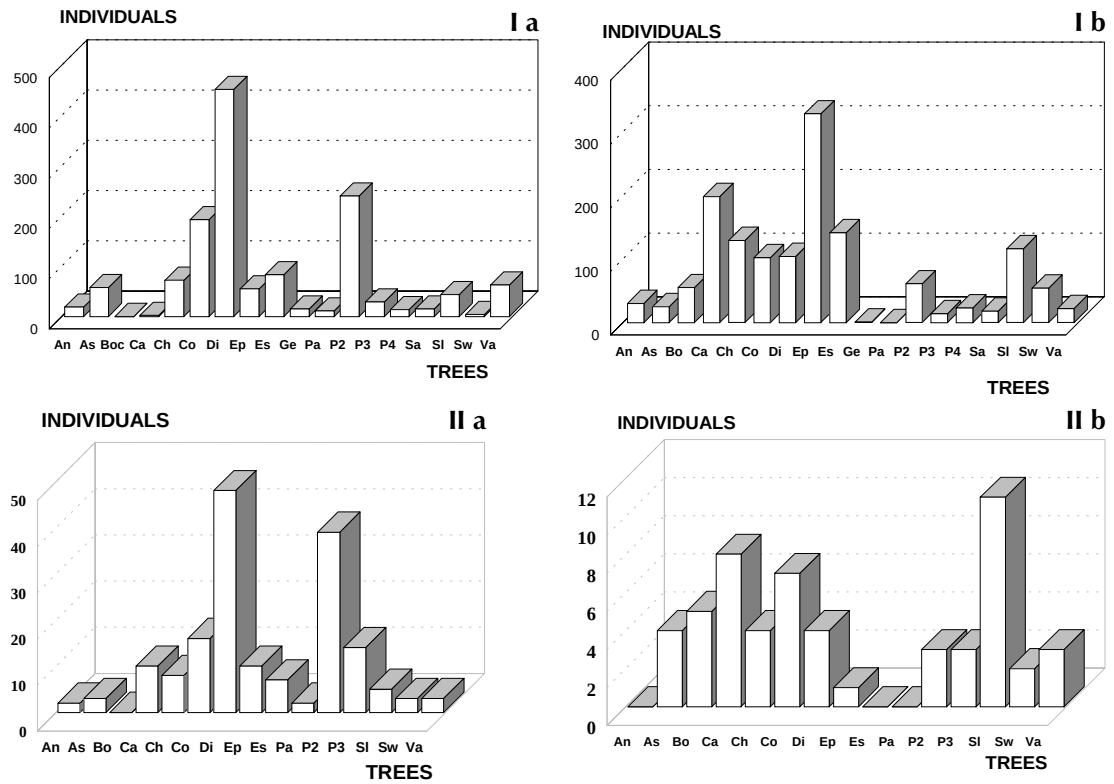

Fig. 1: distribution of *Lutzomyia umbratilis*(I) and *Lu. dendrophila*(II) on tree species in the high (a) and lower (b) rainfall seasons in the Ducke Reserve Forest. An: *Anacardium spruceanum*; As: *Aspidosperma odiscolor*; Boc: *Bochoa* sp.; Ca: *Caryocar villosum*; Ch: *Chrysophyllum amazonicum*; Co: *Couratari longipedicelata*; Di: *Dinizia excelsa*; Ep: *Ephedranthus amazonicus*; Es: *Eschweilera atropetiolata*; Ge: *Geissospermum* sp.; P2: *Parkia multijuga*; P3: *Piptadenia suaveolens*; P4: *Pithecolobium racemosum*; Sa: *Sacoglottis matogrossensis*; Sl: *Sloanea brachytepala*; Sw: *Swartzia schomburgkii*; Va: *Vantanea* sp.

TABLE III

Relative frequency of *Lutzomyia* species sampled on different tree species in the Ducke Forest Reserve

Scientific name	DAV	DEN	FLA	ROR	SCA	SHA	UMB	Others
Anacardium spruceanum	0.0	0.5	0.0	0.0	0.0	3.3	1.8	0.0
Aspidosperma odiscolor	0.0	1.0	0.0	3.6	1.7	3.9	3.0	11.1
Bochoa sp.	0.0	1.5	0.0	7.1	6.8	0.0	2.0	0.0
Caryocar villosum	0.0	6.5	0.0	7.1	8.5	3.9	7.1	13.9
Chrysophyllum amazonicum	0.0	5.5	25.0	3.6	5.1	3.9	7.5	5.6
Couratari longipedicelata	5.0	11.1	0.0	10.7	10.2	11.8	10.5	13.9
Dinizia excelsa	5.0	25.1	25.0	25.0	15.3	29.4	19.9	16.7
Ephedranthus amazonicus	0.0	5.5	25.0	14.3	18.6	10.5	13.7	11.1
Eschweilera atropetiolata	70.0	2.5	0.0	3.6	1.7	3.9	8.0	8.3
Geissospermum sp.	0.0	0.0.	0.0	0.0	0.0	0.0	0.6	0.0
Palicourea grandifolia	0.0	0.5	0.0	3.6	0.0	1.3	0.4	2.8
Parkia multijuga	5.0	20.6	0.0	0.0	13.6	13.1	10.8	5.6
Piptadenia suaveolens	0.0	7.5	0.0	0.0	3.4	2.6	1.5	2.8
Pithecolobium racemosum	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0
Sacoglottis matogrossensis	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.8
Sloanea brachytepala	10.0	7.5	25.0	7.1	10.2	10.5	5.7	5.6
Swartzia schomburgkii	0.0	2.0	0.0	0.0	1.7	0.7	2.1	0.0
Vantanea sp.	5.0	2.5	0.0	14.3	3.4	1.3	3.0	0.0
(%)	100	100	100	100	100	100	100	100
Total	20	199	4	28	59	153	2800	36

DAV: *Lu. davisi;* DEN: *Lu. dendrophila;* FLA: *Lu. flaviscutellata;* ROR: *Lu. rorotaensis;* SCA: *Lu. scaffi;* SHA: *Lu. shannoni*; UMB: *Lu. umbratilis;* IND: no. of individuals.

racemosum (Table II). However, if we analyze the occurrence of *Lu. umbratilis* on the total number of inspected trees, we find that only 0.6% and 1.3% of the flies were collected on the latter two tree species (Table III).

Lu. dendrophila and *Lu. shannoni* apparently are associated with specific tree species, at least up to a height of 2 m above ground level (Figs 1, 2). Few specimens of *Lu. dendrophila* were caught on *Anacardium spruceanum*, *Aspidosperma odiscolor* and *Eschweilera atropetiolata*. Few specimens of *Lu. shannoni* were collected on *Caryocar villosum*, *Chrysophyllum amazonicum*, *E. atropetiolata*, *Swartzia schomburgkii* and *Vantanea* sp. Both sandfly species occurred on the same trees, except for *Bochoa* sp. (Fig. 2). The relationship of *Lu. umbratilis* and *Lu. dendrophila* represented at least 23% of the total sandflies collected, on all inspected tree, whereas the relationship of *Lu. umbratilis* with *Lu. shannoni* represented only 6.2%.

C. villosum, *C. amazonicum*, *Dinizia excelsa*, *Ephedranthus amazonicus*, *E. atropetiolata*, *Couratari longipedicelata* and *Parkia multijuga*

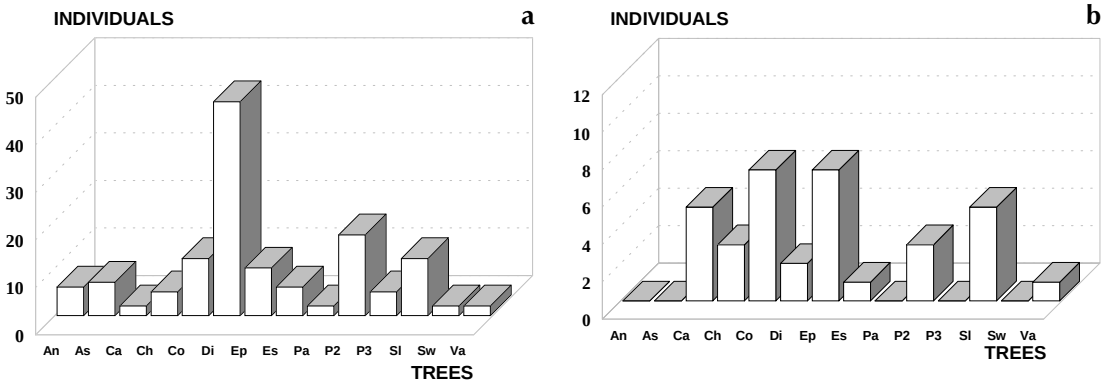

Fig. 2: distribution of *Lutzomyia shannoni* on tree species in the high (a) and lower (b) rainfall seasons in the Ducke Reserve Forest. An: *Anacardium spruceanum*; As: *Aspidosperma odiscolor*; Ca: *Caryocar villosum*; Ch: *Chrysophyllum amazonicum*; Co: *Couratari longipedicelata;* Di: *Dinizia excelsa*; Ep: *Ephedranthus amazonicus*; Es: *Eschweilera atropetiolata*; Pa: *Palicourea grandifolia*; P2: *Parkia multijuga*; P3: *Piptadenia suaveolens*; Sl: *Sloanea brachytepala*; Sw: *Swartzia schomburgkii*; Va: *Vantanea* sp.

TABLE IV

Abundance of sandflies according to collection technique and season in a plateau area of the Ducke Forest Reserve

Tree species	Active search		Suction		Total	
	Rainy	Drier	Rainy	Drier	Rainy	Drier
Anacardium spruceanum	29	30	0	0	29	30
Aspidosperma odiscolor	88	112	5	0	93	112
Bochoa sp.	0	53	0	7	0	60
Brosimum parinaroides	0	1	0	0	0	1
Caryocar villosum	415	196	67	16	482	212
Chrysophyllum amazonicum	60	117	13	12	73	129
Couratari longipedicelata	173	93	20	9	193	102
Dinizia excelsa	476	485	33	29	509	514
Ephedranthus amazonicus	45	298	10	30	55	328
Eschweilera atropetiolata	73	175	10	16	83	191
Geissospermum sp.	15	1	0	0	15	1
Inga sp.	0	0	0	0	0	0
Palicourea grandifolia	11	0	0	0	11	0
Parkia multijuga	222	56	25	5	247	61
Piptadenia suaveolens	29	9	0	5	29	14
Pithecolobium racemosum	14	23	0	0	14	23
Protium sp.	0	24	0	5	0	29
Sacogloyyis matogrossensis	15	18	0	0	15	18
Sloanea brachytepala	25	108	12	14	37	122
Swartzia schomburgkii	4	54	0	0	4	54
Trachiniquia sp.	0	0	0	0	0	0
Vantanea sp.	51	22	12	0	63	22
Total	1745	1875	207	148	1952	2023

sheltered the largest number of sandfly species and individuals throughout the study period, whereas *Geissospermum* sp. and *P. racemosum* were frequented only by *Lu. umbratilis*. *Palicourea grandifolia* and *Bochoa* sp. were frequented by *Lu. umbratilis, Lu. dendrophila, Lu. shannoni, Lu. scaffi* and *Lu. rorotaensis* (Table II, Figs 1, 2).

Seasonality - The sandfly distribution by tree species, at a height from 0 to 2 m above ground level, seemed to follow a seasonal pattern. *D. excelsa, P. multijuga* and *C. longipedicelata* presented the largest number of sandflies in the high rainy season; whereas *C. longipedicelata, C. amazonicum, E. amazonicus, E. atropetiolata* and *Sloanea brachytepala* were frequented more in the low rainy season.

Lu. umbratilis followed the pattern of the above cited species in the rainy season, but it frequented *E. amazonicus, E. atropetiolata* and *C. villosum* in larger numbers in the less rainy season. However, individuals of *Lu. umbratilis* were not frequent on *Bochoa* sp., *C. villosum* and *S. schomburgkii* in the rainy season and *Geissospermum* sp. and *P. grandifolia* in the less rainy season (Fig. 1, Ia, Ib).

Lu. dendrophila showed the same behaviour as *Lu. umbratilis* in the rainy season. However, it was more frequent on *C. villosum, C. longipedicelata* and *S. brachytepala* in the less rainy season. Males outnumbered females in both seasons, especially in the less rainy season. Individuals of *Lu. dendrophila* were not collected on *Bochoa* sp. in the rainy season and on *A. spruceanum, A. odiscolor, E. atropetiolata* and *P. grandifolia* in the less rainy season (Fig. 1, IIa, IIb).

Lu. shannoni showed a distribution pattern like that of *Lu. umbratilis* and *Lu. dendrophila* in the rainy season. However, it was collected in larger numbers on *C. villosum, C. longipedicelata, E. amazonicus* and *S. brachytepala* in the season of less rainfall, making a possible alternative peak at this time of year for the sandfly species cited above.

In the present study, tree trunks with well developed buttress roots and furrowed barks yielded larger numbers of sandflies both in the rainy and less rainy seasons (N=10; x= 259.4), followed by simple trunks (cylindrical) with furrowed barks (N=6; x= 125.5), buttress roots with smooth barks (N=7; x= 41.7) and finally simple trunks with smooth barks (N=13; x= 25.8). Correlation tests of sandflies collected with suction traps and glass tubes (active searching technique) were significant both for trees that had buttress roots ($P<0.05$) with-

out taking bark into account, and for simple trunks (cylindrical) with furrowed bark ($P<0.001$). However when correlating the sandflies collected on trees with buttress roots and furrowed bark the correlation found was highly significant ($P<0.001$). No correlation was found between the abundance of sandflies species and tree trunk diameters ($P>0.05$).

DISCUSSION

According to Lainson (1983), the sandflies in the Amazon region show strictly non-domestic habits, and according to our observations they distribute themselves in a continuous or discontinuous manner according to the ecological trend of the species. The behavioural variations of these sandflies are remarkable among species from one place to another and efforts to generalize their habitats are almost impossible (Forattini 1973). Therefore the study of their microdistribution in the forest is of major importance.

Among the trees species sampled for sandflies in our study area, five trees belonged to Mimosaceae family, three to the Apocynaceae, two to the Caesalpiniaceae, Lecythidaceae and Humiriaceae, while the others represented single species of Anacardiaceae, Anonaceae, Moraceae, Burseraceae, Elaeocarpaceae, Sapotaceae and Rubiaceae families. Most of these families (with the exception of Humiriaceae, Anacardiaceae, Elaeocarpaceae and Rubiaceae families) showed the largest number of species and individuals in the plateau plant community in DRF (Rodríguez 1995).

Morphological characteristics of some tree trunks that could be influencing the choice of resting places and sandfly distribution in primary forests of higher topographical elevation areas, have given rise to different opinions regarding the importance of these parameters. In our study area, tree trunks that showed well developed buttress roots and furrowed barks were influential in the choice of resting places, specifically of *Lu. umbratilis*. Christensen and Vasquez (1982) using both battery-operated and mouth-operated aspirators, collected 52,033 individuals belonging to 33 sandfly species in tree trunks with buttress roots in primary forest areas in Panama and stated that these microhabitats are stable (regarding meteorological factors) presenting a great diversity and larger numbers of sandflies, which use these sites as diurnal resting places. Unfortunately the authors neither reported the number nor species of trees which were searched for sandflies, which prevent us from comparing their results with those obtained in the present study. Ready et al. (1986) studied *Lu. umbratilis* ecology in a primary rain forest area in the State of Pará, Brazil, and pointed out that the choice of diurnal resting places in tree trunks by these dipterans was neither associated with classes of trunks (cylindrical with buttress root and fluted; $c^2 = 2.3$, $P>0.5$) nor the kind of bark (smooth and furrowed; $c^2 = 1.2$, $P>0.5$), except where bark was flaking off in large pieces. Barrett et al. (1991) in order to characterize natural shelters of *Lu. umbratilis* in an area of primary forest of higher topographical elevation in the Balbina, Amazonas Region, found greater numbers of individuals on furrowed bark, wrinkled or with crevices or termitarium tree trunks ($x=3.6$; $N=17$) than on those with smooth bark ($x=0.08$; $N=13$).

Also tree trunk diameters, a variable which according to Ready et al. (1986) would be related to the choice of tree trunks as a resting place, could not be confirmed as a determinant of abundance, neither in the present study ($P>0.05$ both with CDC trap and glass tube) nor that of Barrett et al. (1991). It is probable that results differ because of different samples sizes [$N=144$ in Ready et al. (1986); $N=30$ in Barrett et al. (1991) and $N=36$ (in the present study)], the use of different collection techniques [suction and sticky traps used by Ready et al. (1986); glass tubes by Barrrett et al. (1991); and suction traps and glass tubes used in this present study], different collecting seasons and time periods [rainy season by Ready et al. (1986); drier season by Barrett et al. (1991) and seasons of heavy and light rainfall in the present study].

French researchers pointed out that tree structure, nature and position in relation to the edge of the forest should determine the longitudinal sandfly distribution. However, Geoffroy et al. (1986) stated in addition that some tree species seem to be favoured by sandflies as resting, blood feeding and maintenance places, or as a support for the development of immature stages.

The tree species *D. excelsa*, *C. villosum*, *E. amazonicus*, *C. amazonicum* and *C. longipedicelata* were used by 65.3% of the collected sandflies as diurnal resting places. These trees show certain common characteristics: tall trunks, buttress roots and furrowed barks. Buttress roots are frequent in some large tree species occurring on soils offering a poor carrying capacity substrate [soil characteristic in plateau areas studied by Rodriguez (1995) at DFR] or have poorly developed open roots and are subject to wind gusts (Henwood 1973). Richards (1966) also stated that the trend to produce buttress roots has heritable and environment components.

According to Rodríguez (1995), *D. excelsa* accounts for 20% of the dominance [in the silvicultural sense, see Beard (1944)] and contributed to 9.9% of the canopy in a plateau plant commu-

nity in DFR. *Caryocar glabrum* (*C. villosum*, species of the same genus, researched in this present study), *A. spruceanum* and *Couratari* cf. *guianensis* (*C. longipedicelata*, explanation similar to the latter), were also important in their role of dominance.

Other tree species with simple (cylindrical) trunk but with furrowed bark, such as *E. atropetiolata* and *P. multijuga* belonging to families Lecythidaceae and Mimosaceae, contributed 5.9% and 20.5% of the total relative dominance in this plateau plant community, and these also sheltered large numbers of sandflies (14.6% of the total collected).

The presence of sandflies on any tree is not related to the tree family, but rather to the tree species, at least seasonally (Figs 1, 2, Table III) and there is a general trend for the grouping of the most and the least abundant sandfly species on the same trees, which was also observed by Chaniotis et al. (1972) (Panama), Geoffroy et al. (1986) (French Guyana) and by Ready et al. (1986) (Pará, Brazil).

Rutledge and Ellenwood (1975) stated that several tree species have different effects on the microenviroment in terms of shading, rain protection and composition, quantity and physical properties of the organic detritus. Factors such as floristic structure type, ground topography and tree morphologies, influence the forest microclimate as well as the frequency and distribution of sandfly populations in primary rain forest (Scorza & Ortiz 1960, Rutledge et al. 1976, Le Pont & Pajot 1980).

Therefore, it may be inferred that distribution throughout the year of the three most abundant sandfly species (*Lu. umbratilis*, *Lu. dendrophila* and *Lu. shannoni*) in the plateau area of our study might be influenced by tree species. However, further studies with larger numbers of trees, taking into account the characteristics pointed out by this study and assembled in relation to tree species, should help to test further this hypotheses. They would also be helpful for a better understanding of cutaneous leishmaniasis epidemiology caused by *Le.* (*V.*) *guyanensis*, mainly with respect to the behaviour of the major vector, *Lu. umbratilis*. Such detailed studies should help map the probable distribution patterns of this dipteran over plateau areas in the Brazilian Central Amazon.

ACKNOWLEDGMENTS

To Mr JC Hurtado Guerrero for help with the statistical data analysis and Dr B Robertson for the English revision.

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