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A PILOT STUDY TO CONTROL *LUTZOMYIA UMBRATILIS* (DIPTERA: PSYCHODIDAE), THE MAJOR VECTOR OF *LEISHMANIA BRAZILIENSIS GUYANENSIS,* IN A PERI-URBAN RAINFOREST OF MANAUS, AMAZONAS STATE, BRAZIL

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In the second half of 1980, 112 (or ca. 16%) of the inhabitants of the new settlement of São José, city of Manaus, contracted cutaneous leishmaniasis whilst clearing their properties of terra firme *rainforest. With the aid of SUCAM, the authors carried out a pilot study to investigate the feasibility of reducing populations of* Lutzomyia umbratilis, *the local silvatic vector of* Leishmania braziliensis guyanensis, *by spraying insecticide on its favoured diurnal resting sites, the bases of the larger forest trees. Most man-vector contact is at these resting sites and, therefore, it was encouraging to record a marked reduction of the tree-base populations of* L. umbratilis *for 21 days following just* one *application of D.D.T. emulsion in an area 200 m square. Most of the treated trunks were not occupied by* L. umbratilis *for at least eleven months. Suggestions for extending the pilot study are made, and the need for collaboration with a clinical team is emphasized.* Leishmania b. guyanensis *is the aetiological agent of "pian bois", which is hyperendemic from French Guiana to central Amazônia. In the absence of proven vaccines or methods of vector control, some simple methods for limiting transmission of* Le. b. guyanensis *to man are listed.*

In 1980, local government sold forested land on the northern periphery of Manaus (now the bairro, or quarter, of São José) in order to relocate some of the least privileged of the city's inhabitants. Dirt roads, for access, were bulldozed through the forest, and drinking water was provided. Starting in July 1980, families constructed wooden houses on their small properties, which they cleared of forest. These families were effectively living in the tall, multi-storeyed, primary rain forest (or *terra firme* forest) that is the local source of most human infections of cutaneous leishmaniasis (Arias & Freitas, 1977, 1978).

From September to December 1980, the Instituto de Medicina Tropical de Manaus (I.M.T.M.) registered 112 new cases of human cutaneous leishmaniasis (including many infants) among the ca. 700 inhabitants of São José (see Fraiha, 1983). Thereafter, no more land was settled whilst the government agencies responsible for public health sought advice on how to control, or limit, transmission of leishmaniasis.

The Superintendência de Campanhas de Saúde Pública (SUCAM) considered the possibility of vector control and, knowing of their specialist interests, approached the authors' institutes for assistance. Epidemiological investigations under the direction of Prof. R. Lainson (Instituto Evandro Chagas, Fundação SESP, Belém) and Dr. J.R. Arias (Instituto Nacional de Pesquisas da Amazônia, Manaus) had established that *Lutzomyia umbratilis,* a phlebotomine sandfly, is the major vector of *Leishmania braziliensis guyanensis,* the parasite responsible for most human cutaneous leishmaniasis in the *terra firme* forests of northeast Amazônia (Arias & Freitas, 1977, 1978; Lainson et al., 1976, 1979). Working in *terra firme* forests on the property of the Companhia JARI Florestal e Agropecuária Ltda., in north Pará State, the Belém team had shown that the most man-vector contact occurs during the day, near the favoured resting sites of *L. umbratilis,* which are the bases (up to 5 m above the ground) of large trees of girth > 1 m; this had suggested the possibility of vector control over limited areas (Lainson & Shaw, 1979; Ready, Lainson, Shaw & Ward, unpublished observations).

Knowing of this work, Dr. P.L. Tauil° of SUCAM (Brasília) invited the Instituto Evandro Chagas to undertake, in collaboration with SUCAM, a pilot study to investigate the feasibility of local control of *L. umbratilis* in the peri-urban forests of Manaus (SUCAM had limited any "domestic" transmission of leishmaniasis in São José by spraying D.D.T. in the houses soon after their occupation). Consequently, one of us (P.D.R.) made an exploratory visit to Manaus in November 1980. The leishmaniasis research team of I.M.T.M. decided that the spraying of insecticide in the forests of São José would jeopardize the clinical and epidemiological programmes to which they were fully committed but, fortunately, an alternative site was available nearby, in Parque das Laranjeiras. One of us (J.R.A.) was working in the forests of Parque das Laranjeiras (a more expensive housing development just 5 km west of São José) and, throughout 1980, had isolated many stocks of *Le. b. guyanensis* from man, *L. umbratilis* and marsupials trapped in these forests (Arias & Naiff, 1981).

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Knowing that the diurnal resting sites of *L. umbratilis* are highly aggregated, selective spraying of a residual insecticide was indicated; D.D.T. was chosen because it is inexpensive (being prepared by SUCAM of Manaus) and its application is a routine procedure for SUCAM field teams in Amazonas State. The pilot study was planned only as an empirical trial: using simple procedures, could *L. umbratilis* populations be substantially reduced in a small area, and for how long? Many problems suggested themselves, including: the difficulty of access to the tree trunks to be sprayed; the premature removal of the D.D.T. from the trunks by heavy tropical rain (for this reason, D.D.T. was applied as an emulsion rather than as a suspension of wettable powder); and, changes in the behaviour of the vector in response to contamination of its preferred resting sites.

The present paper is a full report on the pilot study carried out in Parque das Laranjeiras in 1981 and includes the results of other, ancillary experiments. A preliminary report was submitted to SUCAM in April 1981.

MATERIAL AND METHODS

We decided to treat with D.D.T. an area of forest 200 m square and to monitor changes in *L. umbratilis* populations from the centre of the area. In effect, we wanted to test the possibility of protecting a settlement with a band of D.D.T.-treated forest 100 m in depth, as well as providing some protection to those entering the forest. (There were no suitable, recently-cut forest-edges for this study; all *terra firme* forest in the Parque das Laranjeiras was surrounded by dense secondary scrub-forest).

Forest sites: the multi-storeyed primary rain forest (or *terra firme* forest) of the Parque das Laranjeiras is restricted to small stands (ca. 0.5 km square) isolated by secondary growth (or *capoeira*). Two stands of similar *terra firme* forest, 1.5 km apart, were chosen for the pilot study; one to provide a treatment pilot, and the other to provide a control plot. In each stand, the boundaries of 200 m square experimental plot were marked by cutting a perimeter path. Each "square" was marked in quarters by cutting two paths that crossed near the centre of the plot, next to a large-boled tree (the "centre tree") on which *L. umbratilis* was very abundant. Each plot contained numerous tree boles of large diameter that were known to support large *L. umbratilis* populations in which infections of *Le. b. guyanensis* were common. The experimental plots (like the settlement in São José) stood on the edge of a low plateau (ca. 50 m above sea-level) with 10 m of scrub separating each from an access dirt road; approximately one-half of each plot (that further from the road) sloped down towards swamp forest (or *igapó*).

Application of insecticide: 09.15-12.15 local time, 22 January 1981. In the treatment plot, four "Hudson" manually-pressurized applicators were used to spray an emulsion of D.D.T. on the bottom 4 metres of each of 439 tree boles and the surrounding soil up to 1 metre away. This included *all* trees in the plot with a girth > 1 m, which are the favoured diurnal resting sites of *L. umbratilis.*

The insecticide was applied in each quadrant of the plot by a separate team, consisting of a SUCAM employee operating on "Hudson" applicator, a field technician cutting away any impeding vegetation and a supervisor (the authors and one senior technician) who ensured that every target tree was correctly sprayed. The "Hudson" applicators were operated in the standard manner, being regularly shaken to maintain a well-mixed D.D.T. emulsion and pumped to maintain a pressure of 50-75 p.s.i. The D.D.T. emulsion was prepared by mixing, in each applicator, 1 litre of 80% emulsifiable concentrate (420 gm D.D.T.; 105 gm Triton, kerosene and Xylol) with 10 litres of water. On average, a surface area of 210 m^2 was covered per litre of D.D.T. concentrate (i.e. an average application of 2 gm D.D.T./m^2).

Sampling of *L. umbratilis* for the pilot study:

Tree trunk populations: for each day's collection, from 09.00-10.00hrs, a pair of men used manual aspirators to catch phlebotomines from the bases (up to 1.5 m above the ground) of large-bole trees (girth > 1 m) in each plot. Starting from the "centre tree", 15 minutes were spent in each quadrant: torches aided searches of the darker recesses of buttress roots, but the captures were not meant to be exhaustive; each trunk was scanned once only, and a maximum of 3 minutes was spent at trees where phlebotomines were abundant. Six men with much experience of this type of collection were employed; each morning, the two plots were sampled simultaneously by randomly-selected pairs of men. Samples were not taken on rainy mornings, when *L. umbratilis* is difficult to find.

Night-flying populations: two CDC miniature light-traps were hung in vertical alignment, 15m and 1m above the ground, on two opposite sides of the "centre tree" in each experimental plot and run for entire nights (17.30, or 20.00 after man-biting catches, to 08.30) (see Arias & Freitas, 1982; Ready, Lainson & Shaw, 1983).

Nocturnal man-biting populations: platforms were constructed 15m above the ground in the "centre tree" of each experimental plot. Simultaneously in each plot, from 19.00 to 20.00hrs on dry evenings, a man sat on the platform and another on the ground below, and each aspirated all phlebotomines bitting his arms and bare torso. Movement and the use of white torch-light was kept to a minimum.

Le. b. guyanensis* infections in *L. umbratilis: some, or all, of the female *L. umbratilis* aspirated from tree trunks in each plot were dissected and *Le. b. guyanensis* infections recorded following the methods of Arias & Freitas (1978).

D.D.T. in bark samples: Dr. Scott Ramos, of the Department of Phytochemistry of I.N.P.A. (Manaus), kindly estimated the quantities of D.D.T. and its isomers in bark samples from the two plots using a gas chromatography and mass spectrophotometry apparatus. Samples were compared against a standard containing 68.16% pp' D.D.T., 30.48% op' D.D.T., 1.23% op' D.D.D. and 0.13% pp' D.D.D.

Susceptibility of *L. umbratilis* to D.D.T.: non-gravid, unengorged females of *L. umbratilis* were aspirated between 10.00 and 12.00hrs from tree bases in the treatment plot and, within two hours, tested for susceptibility to D.D.T. using W.H.O. test kits for small haematophagous insects and D.D.T.-impregnated papers prepared by W.H.O. (Geneva). Ambient, laboratory, temperature and humidity were maintained at $25^{o} \pm 2^{o}C$ and 80-95% RH, respectively.

Repellent effect of emulsifying agent (and insecticide) in D.D.T. emulsion: this was a follow-up experiment performed in December 1981-January 1982 and prompted by observations made during the main pilot study of early 1981. A third stand of *terra firme* forest was selected and 20 large-boled trees were tagged of those long-known to support large diurnal populations of *L. umbratilis*. The trees were treated as four groups of five near-neighbours with, on average, 5m separating each tree. On 9 December 1981, using "Hudson" applicators, the first five tree bases and surrounding soil were sprayed (as described above) with a suspension of D.D.T. wettable powder (75% weight/volume); the next group was sprayed with the D.D.T. emulsion of the pilot study; and the third group was sprayed with a suspension of the emulsifying agent without any D.D.T. (i.e. 10 litres of water mixed with 1 litre of concentrate containing 105gm of Triton, kerosene and Xylol alone). The fourth group of trees was left as a control.

Each morning, between 10.00 and 12.00, a pair of men sampled the tree bases, at 4-5.5m and 0-1.5m above ground-level. On each tree base, exhaustive simultaneous collections of resting phlebotomines were made using manual aspirators.

RESULTS

Changes in populations of *L. umbratilis* during the pilot study:

Tree trunk populations: the (daily) relative estimates of *L. umbratilis* populations (♂ and ♀) in each experimental plot are shown in Fig. 1. The tree trunk populations in the plot treated with D.D.T. emulsion were significantly reduced from the day after spraying until 12 February 1981, a total of 21 days ($p < 0.001$ for a two-tailed Mann-Whitney U test – see Siegel, 1956). Indeed, for the first ten days after spraying

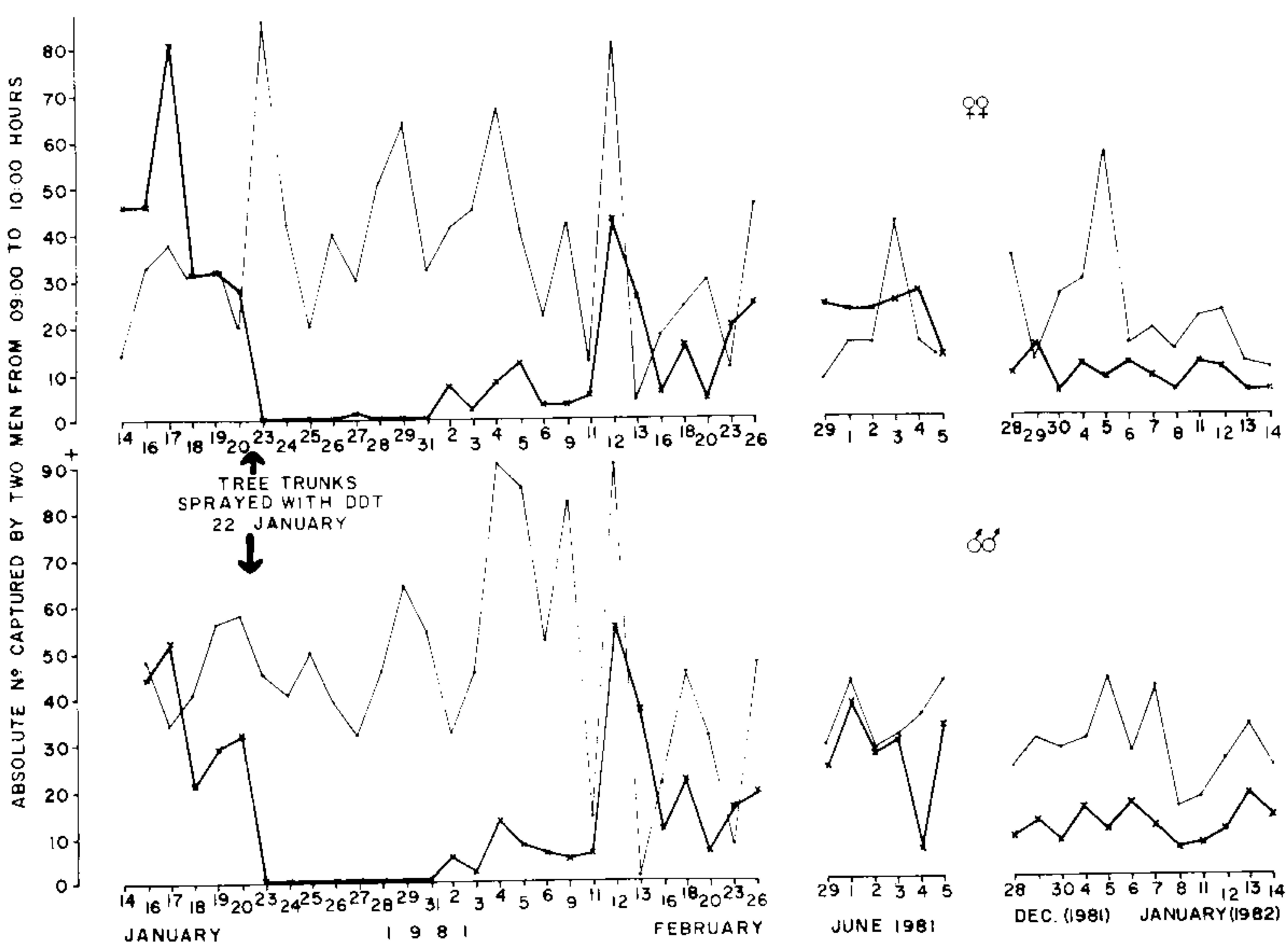

Fig. 1: daily catches of *L. umbratilis* from tree bases (x—x = plot sprayed with D.D.T.; •—• = control plot).

only one phlebotomine was seen (and caught) on the treated surfaces, and this was a non-gravid female of *L. umbratilis*. Fig. 1 fails to show one important result: throughout February 1981 nearly all *L. umbratilis* caught in the D.D.T.-treated plot came from six tree-bases. One tree, near the centre of the plot, provided most *L. umbratilis*, which was abundant on a termitarium. The restricted distribution of *L. umbratilis* in the treatment plot contrasted with the (expected) widespread occurrence of this species in the control plot, and this difference was maintained in June and December 1981.

In addition, following spraying there was a significant difference between the two plots in the proportions of female *L. umbratilis* in different physiological states: throughout February 1981, but not before or afterwards, the proportions of gravid females of Christophers' oocyte stages III/IV and V (see Clements, 1963) in the treatment plot were significantly smaller than expected (for X^2 |sprayed *vs.* unsprayed| $p \leq 0.001$), indicating much mortality, or stage-specific emigration, in at least one population cohort (Fig. 2).

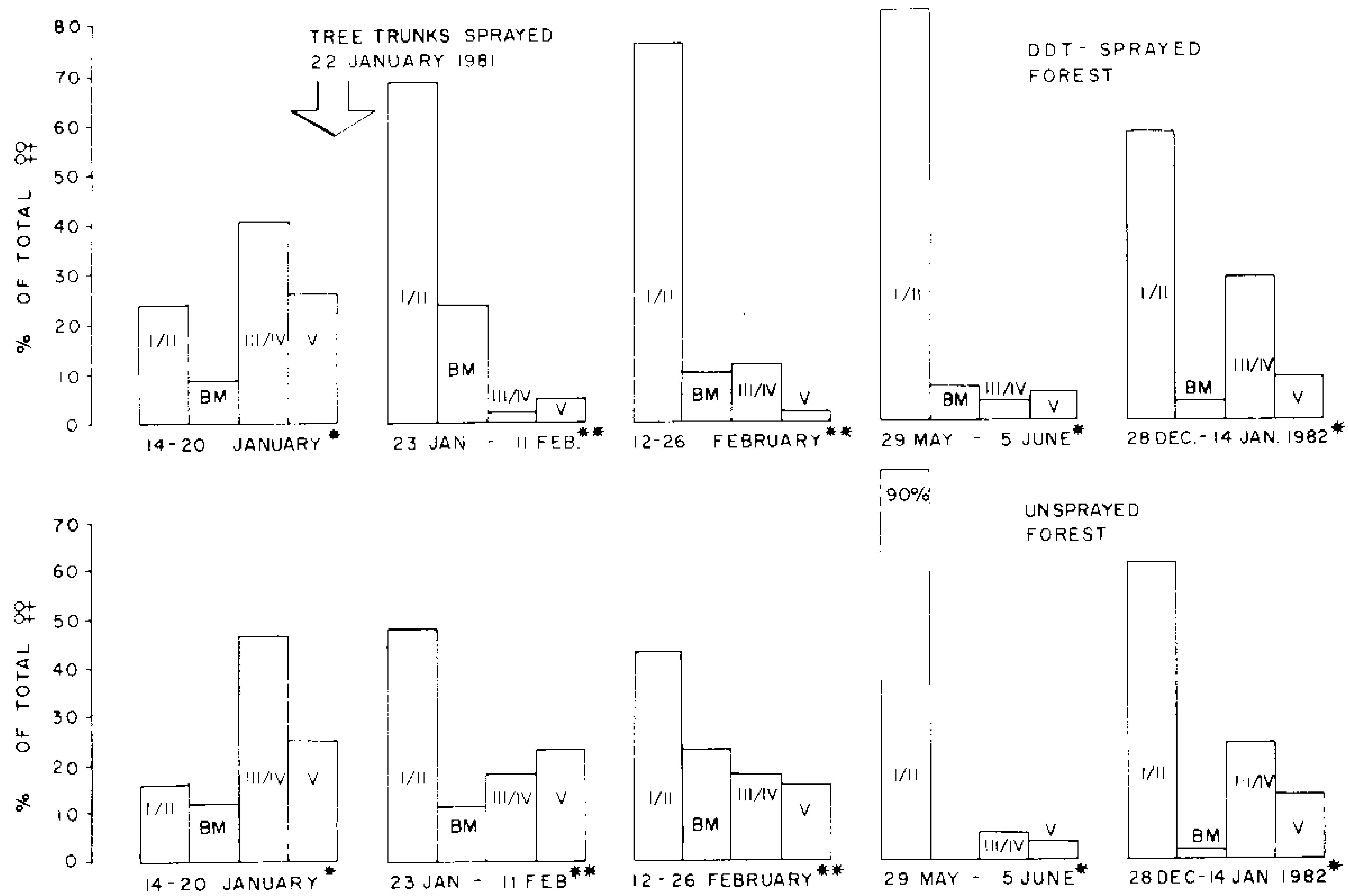

Fig. 2: structure of ♀ populations of *L. umbratilis* caught on tree bases (Oocyte developmental stages. I/II = non-gravid; B.M. = non-gravid with blood meal; III/IV = maturing oocytes; V = fully-formed eggs). Comparisons between populations in sprayed and unsprayed forests: ** = statistically significant (p | X^2 | < 0.05); * = not statistically significant (p | X^2 | > 0.05).

Night-flying populations (CDC light-trap captures): figs. 3 and 4 show the recorded fluctuations at two "centre trees", expressed as an average for the two samples at each height. They are not obviously correlated with the recorded fluctuations of the tree-trunk populations. If the treatment of tree bases with D.D.T. had any effect on the numbers of *L. umbratilis* caught in CDC traps, then the effect was restricted to the forest canopy (15 m above the ground, where more activity normally occurs) for the four nights following spraying. Non-gravid females always formed at least 94% of the *L. umbratilis* females caught 15 m above the ground in each plot. In contrast, 21-55% of *L. umbratilis* females caught at ground-level contained mature oocytes of Christophers' stage V; and, following spraying, there was no significant reduction in this proportion in the treatment plot.

Following spraying, there was no significant change in the numbers of the other species of phlebotomines commonly caught in the CDC traps in both plots – anthropophilic species included *L. anduzei* and *L. antunesi* (mostly at 15 m) and *Psychodopygus* species.

Nocturnal man-biting populations: no significant reduction was observed following D.D.T. treatment. As expected, most activity was in the canopy (Fig. 5). Following spraying, there were no significant reductions in the numbers of other phlebotomines caught biting man. (The dominant man-biters were *L. umbratilis* and *L. anduzei* in the forest canopy, and *Ps. squamiventris* and *L. umbratilis* at ground-level).

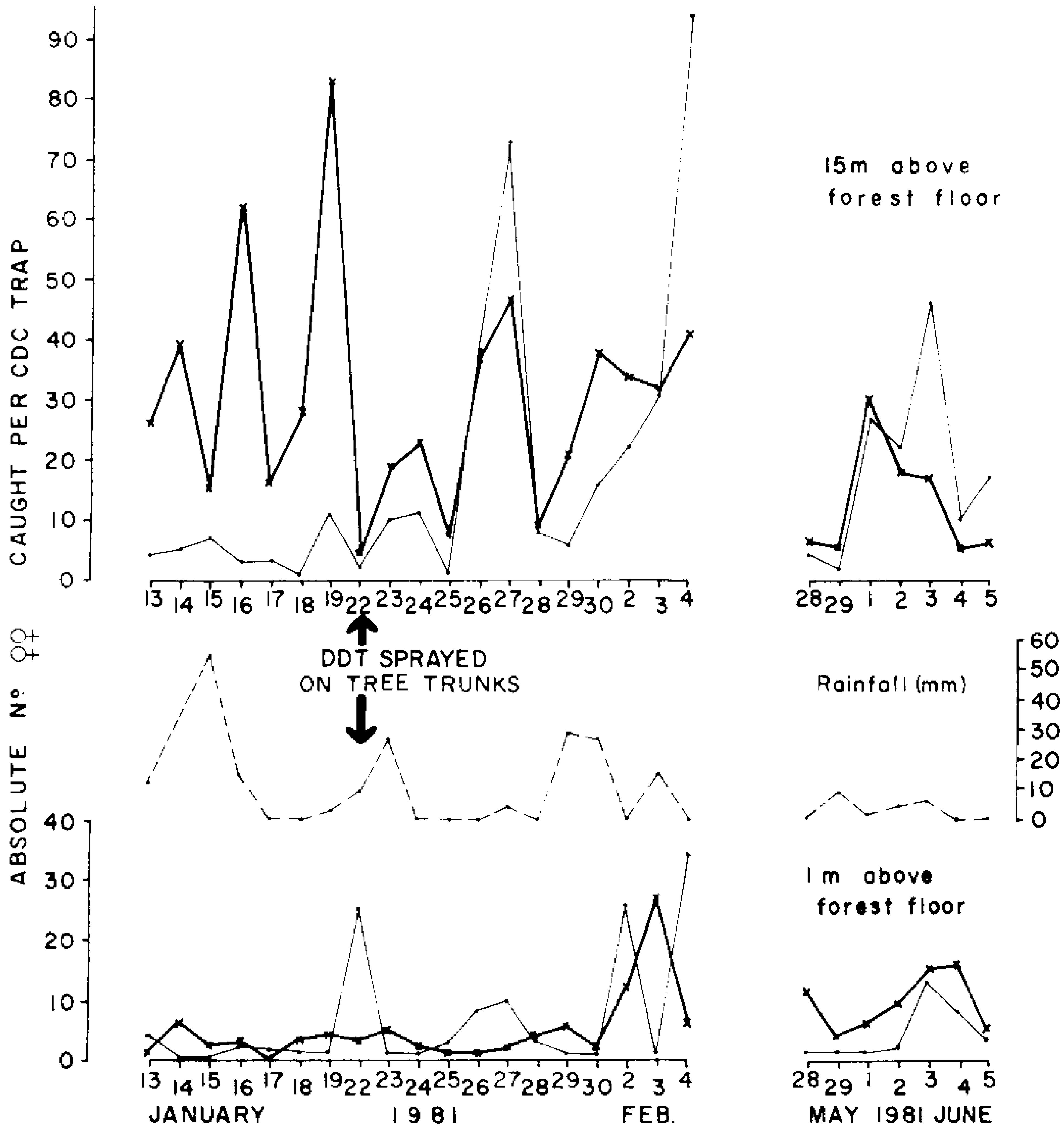

Fig. 3: daily catches of *L. umbratilis* ♀♀ in CDC miniature light traps (x—x = plot sprayed with D.D.T.; •—• = control plot).

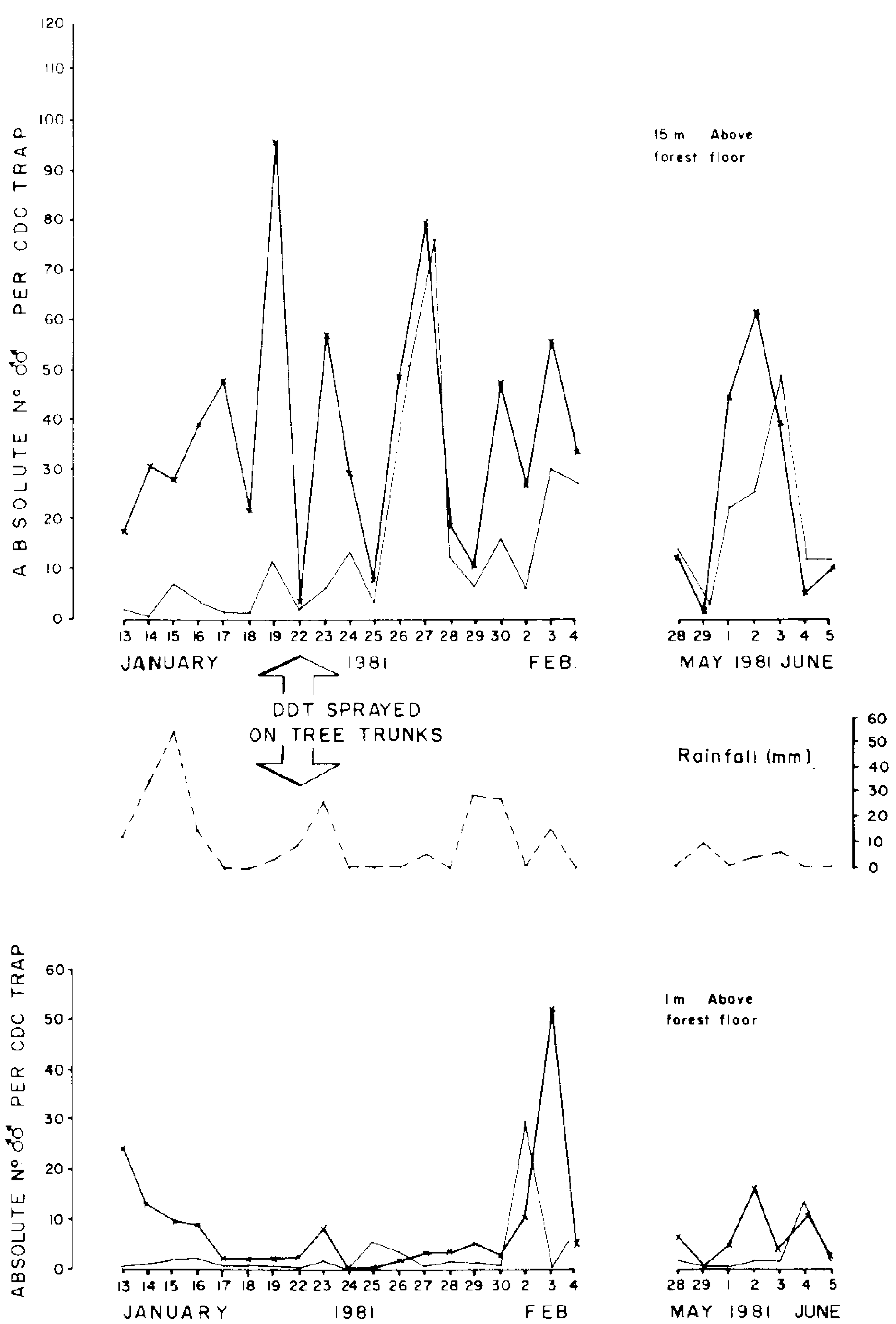

Fig. 4: daily catches of *L. umbratilis* ♂♂ in CDC miniature light traps (x—x = plot sprayed with D.D.T.; •—• = control plot).

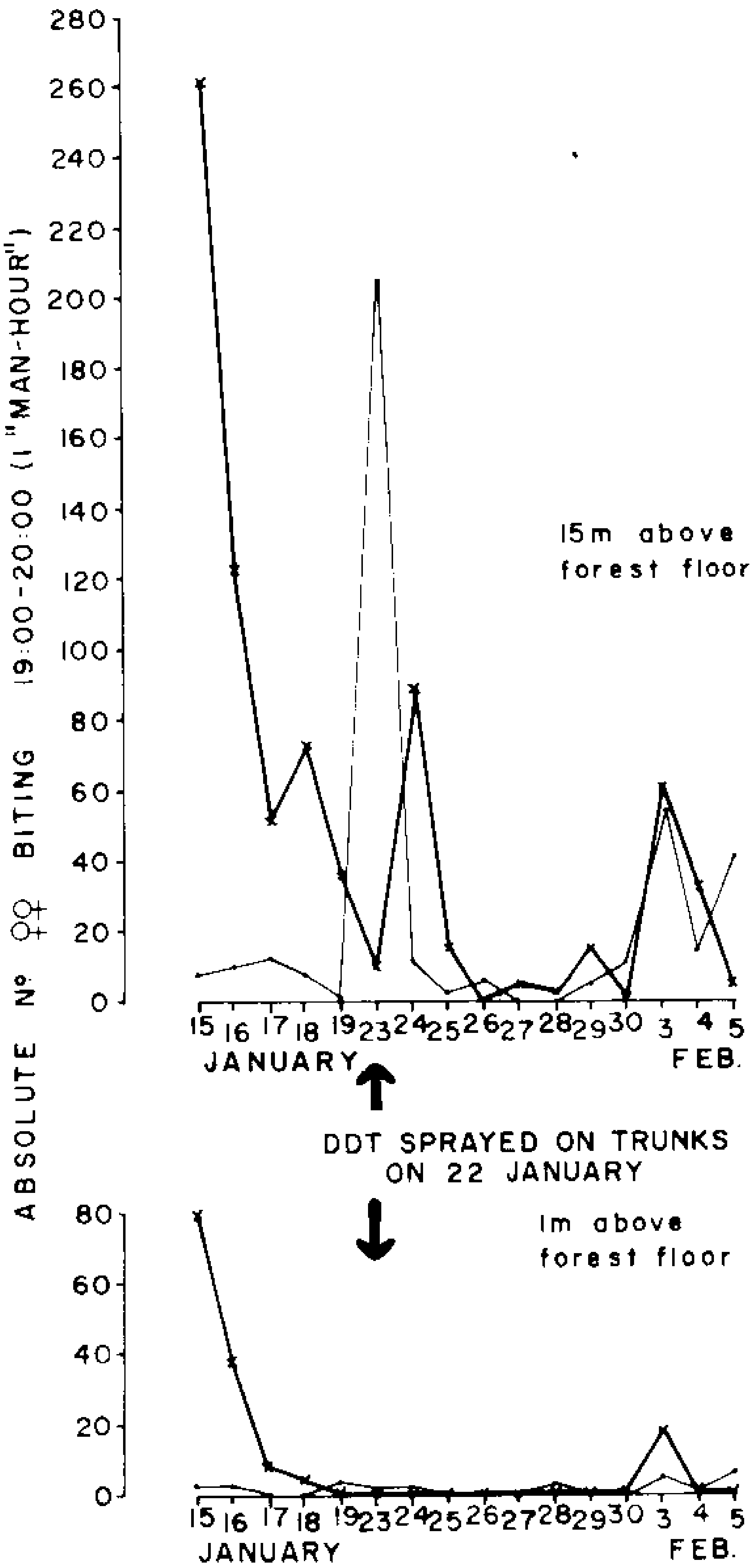

Fig. 5: daily catches of *L. umbratilis* ♀♀ from human bait (x—x = plot sprayed with D.D.T.; •—• = control plot).

Le. b. guyanensis **infections in** *L. umbratilis*: these are set out in Table I. Identification was based on morphological characters and on growth characteristics in the wild phlebotomine host (i.e. attachment in hindgut pylorus).

D.D.T. in bark samples: the distribution of D.D.T. on the treated trees was clearly far from uniform, owing to uneven application and/or uneven wash-off (Table II). Nevertheless, the results show that eight months after application substantial quantities of D.D.T. remained on the trunks despite the passage of the rainy season. We did not have the facilities to analyse significant numbers of samples.

Susceptibility of *L. umbratilis* **to D.D.T.**: groups of non-gravid and unengorged females of *L. umbratilis* were collected from the treatment plot before the tree bases were sprayed (from 18 to 21 January 1981) and their susceptibilities to D.D.T. tested (Table III). The test with "2% D.D.T." was repeated in December 1981, some eleven months after treatment: there was 100% mortality at the end of the one hour exposure period, strongly suggesting an unchanged susceptibility to D.D.T. The behaviour of *L. umbratilis* females in the test chambers never indicated irritability; they remained stationary for long periods on all the different papers.

Cost of D.D.T. application to tree bases: 16.2 litres of emulsifiable concentrate of D.D.T. were used to treat an area of 200m square. In January 1981 (when the exchange rate was US$ 1.00 = Cr$ 68,44), each 1-litre flask of concentrate cost SUCAM Cr$ 23,64, making a total cost for materials of Cr$ 382,96, or US$ 5.60. At that time, the monthly salary of a SUCAM field technician was about Cr$ 20.000, making a total cost for labour (24 man-hours) of about Cr$ 2.000, or US$ 29.2. The perimeter of a settlement such as São José is about 6 km (2 x 1 km). Therefore, the cost in materials and labour of treating the forest perimeter to a depth of 200 m (see Discussion for probable dispersal distance of *L. umbratilis*) or the whole settlement area would be 30-50x that of the pilot study, or 1,045-1,741 US$ in January 1981. Such areas could be treated by 12 two-man teams during one 5-day working week.

TABLE I
Leishamania b. guyanensis infections in *L. umbratilis* from Parque das Laranjeiras

		Forest treated with D.D.T. (Jan. 22 1981)	Forest not treated with D.D.T.
14-20 January 1981	Nº infected	14 (6.5%)	6 (4.1%)
	Nº dissected	217	148
	Nº + ve collections /Nº collections	6/6	4/6
23-29 January 1981	Nº infected	0 (—)	25 (8.5%)
	Nº dissected	1	295
	Nº + ve collections /Nº collections	Only 1 fly collected	6/7
5-13 January 1982	Nº infected	7 (12.5%)	8 (7.2%)
	Nº dissected	56	111
	Nº + ve collections /Nº collections	4/7	5/7

TABLE II
Weight (μg) D.D.T. in 10 cm x 10 cm bark samples from Parque das Laranjeiras ($\times 10^{-4}$ to give gm/m^2)

Bark sample		04 Feb. 1981	18 Feb. 1981	11 Sept. 1981
D.D.T. - Treated Plot	– 1	8.2	153.9	158.9
	– 2	45.9	115.7	96.7
	– 3	175.2	23.3	931.8
Untreated Plot	– 1	0.5	0.0	0.0
	– 2	0.0	0.0	2.4*
	– 3	0.1	0.6	0.0

*Post-collection contamination of sample suspected.

TABLE III
Susceptibility of *L. umbratilis* to D.D.T. in W.H.O. test kits

	At the end of one hour exposure period		At the end of one day's exposure period	
D.D.T. (%)	Nº dead/ Nº per test	Mean mortality (range)	Nº dead/ Nº per test	Mean mortality (range)
January 1981: Before spraying				
0.00% (control)	1/21 0/20 0/17	1.7% (0.0-4.7)	10/21 0/20 0/17	17.2% (0.0-47.6)
0.25%	0/7 4/13 5/22 1/14	17.9% (0.0-30.1)	2/7 10/13 15/22 8/14	62.5% (28.6-76.9)
0.50%	11/14 4/8 7/23 5/17	43.5% (29.4-78.6)	13/14 7/8 23/23 13/17	90.3% (76.5-100.0)
1.00%	10/10 6/6 14/5 28/28	98.3% (93.3-100)	10/10 6/6 15/15 28/28	100.0%
2.00%	9/9 9/9 13/13 17/17 20/20	100.0%		100.0%
December 1981: 11 months after spraying				
0.00% (control)	0/20 0/18 0/14	0.0%		
2.00%	22/22 23/23 18/18 20/20	100.0%		

Repellent effect of emulsifying agent (and insecticide) in D.D.T. emulsion: a strong smell/taste of emulsifying agent (certainly of kerosene) had been noted by all persons entering the pilot-study plot during the week after its treatment with D.D.T. emulsion (in January 1981). The present follow-up experiment showed that the emulsifying agent, as suspected, did have a repellent effect on *L. umbratilis*: no sandfly was seen on the trees sprayed with emulsifying agent alone for at least eight days following treatment and, compared with the unsprayed trees, numbers of *L. umbratilis* were much reduced for at least a further 28 days (Table IV; $p < 0.05$ for a two-tailed Mann-Whitney U test). During the observation period of 36 days, not one *L. umbratilis* was caught on any of the surfaces treated with D.D.T.; and, the trunks above the treated surfaces did not become alternative resting sites because, 4-5.5m above ground-level, the numbers of *L. umbratilis* caught on sprayed trees were never greater than the numbers caught on unsprayed trees (Table IV and Mann-Whitney tests).

TABLE IV
L. umbratilis aspirated from tree bases treated in various ways on 9 December 1981

Treatment (five trees each)		December '81					January '82				Total
		10/12	14/12	17/12	23/12	30/12	05/01	08/01	12/01	14/01	
							Females				
Unsprayed trees	– 5m*	4	8	20	11	11	7	10	9	12	92
	– 1m**	13	18	24	20	45	17	27	20	16	200
Emulsifier only	– 5m	3	5	10	17	6	7	3	6	9	66
	1m	0	0	0	1	5	6	2	5	3	22
D.D.T. emulsi-	– 5m	6	1	13	7	6	5	4	4	1	47
fiable concen'te	1m	0	0	0	0	0	0	0	0	0	0
D.D.T. wettable	– 5m	10	5	12	12	6	4	5	7	2	63
powder	1m	0	0	0	0	0	0	0	0	0	0
							Males				
Unsprayed trees	– 5m	4	18	18	12	19	12	7	11	24	125
	1m	16	15	16	23	35	13	26	28	37	209
Emulsifier only	– 5m	5	4	14	14	7	7	5	6	14	76
	1m	0	0	0	2	4	3	4	2	8	23
D.D.T. emulsi-	– 5m	5	6	14	9	8	5	2	5	9	63
fiable concen'te	1m	0	0	0	0	0	0	0	0	0	0
D.D.T. wettable	– 5m	32	4	14	8	12	5	3	8	13	99
powder	1m	0	0	0	0	0	0	0	0	0	0

* 4-5.5m above ground-level
** 0-1.5m above ground-level

DISCUSSION

The pilot study was undertaken to help us judge the feasibility of limiting transmission of *Le. b. guyanensis* to man in (and near) peri-urban forests by reducing populations of the vector, *L. umbratilis*. The relative estimates of population size and structure of *L. umbratilis* were markedly different for collections from tree trunks, CDC light-traps and human baits, as was expected from previous investigations (Ready, Lainson, Shaw & Ward, unpublished observations). Most man-vector contact occurs during the day when man disturbs the tree-base populations of *L. umbratilis*; at night, most female *L. umbratilis* seek blood meals in the forest canopy rather than at ground-level (Arias & Freitas, 1978; Lainson & Shaw, 1979; Ready, Lainson & Shaw, 1983). Therefore, it was encouraging to record a marked (and significant) reduction in the tree-base populations of *L. umbratilis* for 21 days following *one* application of D.D.T. emulsion (Fig. 1). The rarity of gravid females of *L. umbratilis* on the tree bases for 35 days following treatment does strongly suggest that the D.D.T. emulsion was killing *L. umbratilis* and not merely repelling it (Fig. 2). In fact, the D.D.T. treatment had a greater effect on the tree-base populations of *L. umbratilis* than is suggested by Fig. 1: up to one year after treatment, most *L. umbratilis* were still being collected from just six trunks, whereas normally (as in the control plot) most of the large tree trunks should have periodically supported substantial numbers of this sandfly.

The results of the collections from CDC light-traps (Figs. 3 and 4) and human bait (Fig. 5), however, were less encouraging: there was no observed reduction in these nocturnal populations following D.D.T. treatment. The conclusion is that there was substantial nocturnal immigration from beyond the treatment plot, and/or alternative diurnal resting sites were sought by sandflies repelled by the D.D.T. emulsion on the tree bases. The follow-up experiment showed that the emulsifying agent (Triton, kerosene and Xylol) does have a repellent effect on *L. umbratilis* (Table IV). In this later experiment, *L. umbratilis* was absent from the D.D.T.-treated tree bases for at least 36 days following spraying (Table IV), compared with only ten days in the treatment plot during the pilot study (Fig. 1). This difference can be attributed to the differing proximities of untreated and treated tree bases in the two instances; in the follow-up experiment, *L. umbratilis* had alternative, untreated tree bases nearby – its long absence from the treated surfaces strongly suggests that the D.D.T. itself was having a repellent effect (Table IV).

Clearly, our pilot study could be extended in many ways; in particular: to make more meaningful absolute estimates of population changes (using mark-release-recapture and age-grading techniques – see Killick-Kendrick, 1978; Ready et al., in press); to perform tests of the susceptibility of *L. umbratilis* to D.D.T. *in situ,* on treated tree trunks; to find the optimal frequency of insecticide application for D.D.T. and other insecticides; and, to treat larger experimental areas in order to reduce any immigration (in this connection, the work of Floch (1957) and of Le Pont & Pajot (1981) suggest a barrier zone of 250m rather than 100m). However, we have taken the first step by showing that it is possible to reduce substantially (through deterrence and/or mortality), over a limited area, the epidemiologically-important tree-base populations of *L. umbratilis,* and that this is possible at low cost using D.D.T., the residual insecticide of choice in Brazil. We feel that our results are sufficiently encouraging to warrant similar insecticide trials during future forest-clearing schemes similar to São José, but *only if* such trials could be linked to clinical/parasitological programmes that could monitor and correctly identify new human infections of *Le. b. guyanensis.*

There is a real need to find better ways of limiting transmission of *Le. b. guyanensis* to man, because "pian bois" (the human disease for which the parasite is responsible) is hyperendemic throughout a large geographical region, from French Guiana to Manaus, which is being exploited for its natural resources (see Lainson, 1982). At present, certain recommendations can be made: where it is economically possible, forests should be felled by small gangs of men, using bulldozers and chain-saws, in order to limit the number of persons at risk; the inhabitants of new settlements should sleep at least 250m away from the forest edge and use mosquito nets of small mesh (6 apertures/mm^2); and, during the day, the bases of the larger forest trees should be avoided.

Other attempts to control phlebotomines in neotropical forests: a literature search has shown that as early as 1957, Floch and colleagues had attempted to control the vectors of *Le. b. guyanensis* in the forests of French Guiana by spraying, indiscriminately, tree bases and animal burrows with 5% D.D.T. in kerosene ("dans du pétrole"). No phlebotomines (the specific vector of *Le. b. guyanensis* was then unknown) were found in the treated resting sites during the six once-weekly diurnal searches that followed spraying and, therefore, Floch (1957) claimed success. However, Floch (1957) did not identify or quantify the sandflies caught before treatment (nor did he maintain a control) and, therefore, it is impossible to judge his conclusion. Extensive collections have convinced us that animal burrows are rarely occupied by *L. umbratilis,* which Floch knew as *Phlebotomus anduzei* (see Ward & Fraiha, 1977).

Recently, Chaniotis et al. (1982) published the results of a pilot study to control phlebotomines in a neotropical forest in Panama. The aim was to reduce the risk of contracting leishmaniasis within prescribed areas used by military troops: ". . . an average 30% reduction of anthropophilic sand flies was achieved in 9 months by utilizing malathion as 2% EC spray [*on tree bases*] or 95% ULV fogging applied bimonthly". Unfortunately, specific vectors were not targeted, or monitored, and (following some unusual weather) phlebotomine populations in general were small.

RESUMO

No segundo semestre de 1980, 112 (ou aproximadamente 16%) dos habitantes do recém estabelecido bairro de São José, cidade de Manaus, contraíram leishmaniose, durante o desmatamento que realizavam em seus lotes localizados na floresta tipo "terra firme". Com a ajuda da SUCAM, os AA. realizaram um estudo piloto para investigar a viabilidade de redução das populações de *Lutzomyia umbratilis,* o vetor silvático de *Leishmania braziliensis guyanensis,* borrifando inseticidas na base das árvores grandes da floresta que são os lugares preferidos de repouso diurno destes insetos.

A maioria do contato homem-vetor ocorre nestes lugares de repouso diurno (o vetor sendo mais ativo à noite nas copas das árvores) e, assim sendo, foi animador constatar uma nítida redução das populações de *L. umbratilis* nas bases das árvores por um período de 21 dias após uma única aplicação de emulsão de D.D.T. numa área de 200m quadrados. Quantidade apreciável de D.D.T. permaneceu na base das árvores por pelo menos oito meses, o que proporcionou a não ocupação das mesmas por *L. umbratilis* durante pelo menos onze meses. Os resultados mostram que a emulsão de D.D.T. teve efeito repelente e letal (*L. umbratilis* foi altamente suscetível ao D.D.T. em "kits" da O.M.S.). Em contraste com as populações das bases das árvores, as populações noturnas de *L. umbratilis* (capturadas em armadilhas de luz tipo CDC, ou atacando ao homem) não foram significantemente reduzidas pelo tratamento com D.D.T., o que sugere a possível existência de apreciável imigração noturna em áreas experimentais e/ou que lugares de repouso alternativo tenham sido procurados pelos flebótomos.

São apresentadas sugestões para ampliar o estudo piloto e a necessidade de colaboração com uma equipe clínica é enfatizada. A *Leishmania b. guyanensis* é o agente etiológico de uma forma de leishmaniose tegumentar humana ("pian bois") hiperendêmica numa vasta extensão geográfica que se estende da Guiana Francesa à Amazônia Central, ao Norte do Rio Amazonas. Na ausência de uma vacina comprovada ou de métodos eficientes de controle do vetor, alguns métodos simples são oferecidos para limitar a transmissão de *Le. b. guyanensis* ao homem.

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