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THE CONTROL OF CHAGAS' DISEASE TRANSMISSION IN MAMBAÍ, GOIÁS-BRAZIL (1980-1981)

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BHC application in Mambaí in 1980 resulted in a significant decline but not elimination of domiciliated T. infestans. T. sordida *peridomestic populations persist and could pose a threat to interupting human transmission of T. cruzi. The results of one massive attack spray application alone was compared with this application plus one selective application as regards the presence of* T. infestans *in houses one year later. No significance difference could be detected. It is likely that for interruption of* T. infestans *transmission cheaper procedures can be devised than those currently in use. A further pilot study of a virgin community afflicted by* T. infestans *transmission is indicated since Mambaí cannot be regarded as a representative area for those still awaiting insecticide application.*

Key words: *Trypanosoma cruzi. Triatoma infestans. Triatoma sordida.* Insecticide.

In previous publications we have described the ecology of *Triatoma infestans* in the municipality of Mambaí, Goiás[4 6]. In four years of observation (1975-1979) a significant increase in house infestation with these bugs was observed. It was agreed with the Ministry of Health to apply BHC insecticide in 1980 in Mambaí and study the long term effects of such a programme on the control of domestic bugs and the transmission of *Trypanosoma cruzi* to man. This paper records results of the first two years of this activity, the year in which the insecticide was applied (1980), and the results of vigilance for bug presence in houses in the area in 1981.

MATERIAL AND METHODS

The preparatory phase and the attack phase followed the regulations laid down by the Ministry of Health of Brasil (SUCAM) for Chagas' disease combat[9]. The area had already been mapped but such maps of 58 individual farms and the Village of Mambaí were revised, checked, and each house examined for bug presence by one of two experienced technicians working for half an hour. Live bugs were withdrawn by manual capture after Pyrethrum application and subsequently identified as regards species, stage etc. Previous studies on the infection rate with *T. cruzi* are available[4] so this was not repeated. As previously shown in the area, in many houses live bugs cannot be captured at the time of examination but there is definite evidence of bug infestation in the form of cast skins, eggshells and faeces. This was also noted. The bug capture procedure was also applied to chicken houses.

The attack phase was implemented in Mambaí between May and September 1980 and has already been described[5]. Briefly all communities in which evidence of bug infestation was found were subjected to the massive attack phase. Here *all* houses and outhouses are sprayed in the infested locality irrespective of whether bugs were captured in the individual houses. All furniture was removed on the day of the spraying. All external and internal wall surfaces were sprayed and the interior of the roof. Table and bed surface received similar treatment. The dose was calculated as approximately 0.5gm γ isomer BHC per square metre. The municipality is approximately bisected by a road and houses to the south of the road (Zone B) received a further selective spray application at least 90 days after the first. This is known as a selective spray because on the second spraying only houses where bug presence was recorded are sprayed. This procedure is usually recommended to kill residual bug populations and young larvae that have emerged from eggs which are not affected by BHC. In this way it was hoped to

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compare Zone A to the north of the road receiving only the massive attack phase with Zone B where a further selective application had been applied.

Large self sealing labelled plastic bags were distributed to some households with known bug infestation with instructions to put any bugs found after initial spraying in the bags which were subsequently collected. A biological assay of efficiency of insecticide application and rate of decay of activity was carried out monthly in ten houses at 4 sites (bedrooms, one livingroom and one kitchen wall) using ten live first instar *Dipetalogaster maximus* exposed to the sprayed surface and secured in flat tins covered in netting nailed to the wall. Such tins were examined daily to measure mortality. By September 1980 the house spraying programme was completed. Before the rains in November, in all houses with evidence of bug infestation, two Gomez Nunez traps were fixed to the wall over the principle beds.

In 1981 the vigilance phase took the form of a survey using the manual capture method carried out by SUCAM personnel in April and May. This was followed by a second manual capture extending over the ensuing months and the examination of the two Gomez Nunes boxes. Also each householder was furnished with a small labelled plastic bag, with name and address, in which any bug found in the house was sent to the Medical Post in the town. Full vigilance in 1981 then consisted of two manual capture visits, one examination of two Gomes Nunez boxes and plastic bag notification. The later method has the advantage that bugs can be counted and identified without opening the bag which is then burned. All houses with persistent bug populations were scheduled for respraying before the rains in 1981. The data collected before November first 1981 have been analysed. Because evidence of bug infestation cannot be used as a measure of control, since it persists after successful spraying, only live bug capture can be regarded as an indication for further BHC application to the house.

RESULTS

The first table shows the data of the previously reported surveys compared with evaluation carried out in 1980 before BHC application. The number of houses visited in 1980 was 1,113 but 104 do not enter the analysis because they were abandoned or in construction. The rise in the number of houses surveyed on this occasion is a reflection of the agricultural development of the region attracting settlement. The increase in bug prevalence between 1975 and 1979 has been discussed elsewhere[4]. The net effect of new house construction and the abandonment of old houses is such as to keep the rate of infestation relatively constant in 1979 and 1980 at roughly two thirds with evidence of infestation and in one third live bugs could be captured. Confirmation that evidence without live capture represents light bug infestation came from analysis of the large plastic collection bags distributed at the time of spraying. Of 107 large plastic bags returned from houses where evidences were recorded in 1980, 420 bugs were counted, a mean of 3.9 bugs per house. Of 99 houses where live captures had been made 1,417 bugs were counted a mean of 14.3 bugs per house.

Table 1 – *Prevalence of infestation with triatomine bugs in houses in Mambaí during 1975, 1979 and 1980*

Year	*Houses Examined*	*Houses with Evidences*		*Houses with Bugs*	
	Number	*Number*	*Percentage*	*Number*	*Percentagem*
1975	711	371	52%	221	31%
1979	781	485	62%	267	34%
1980	909	537	59%	272	30%

Table 2 shows the situation in Mambaí before spraying began. In previous surveys bug infestation in the rural area has always been more marked than in the town and this is illustrated again here. The relatively large number of houses infested with *Triatoma sordida* is a new development. In 1979 *T. sordida* was captured in only 3 houses. A rise has also occurred in the number of chicken

houses infested with *T. sordida*. From 31/824 (3.8%) in 1975 to 69/570 (12%) in 1980. The *T. infestans* infestation of chicken houses detected in 1975 had only increased to 9 in 1980. *T. infestans* only is recorded in mixed catches from houses since it tends to displace *T. sordida* when they are present together and previous work has shown that to date *T. sordida* has been a vector of limited significance with low infection rates with *T. cruzi* in Mambaí.

Most householders accepted the inconvenience of spraying although it entails removal of furniture, disruption of the family routine and an intense unpleasant smell for 24 hours which persists in a milder form for weeks. No toxic effects were noted either among the spraymen or the families although care has to be taken that chickens are not intoxicated by insecticide from eating dead bugs.

Two spray teams covered the area each consisting of two spraymen, an inspector and a jeep driver. They averaged about four houses per man per day depending on distances between houses, availability of water for emulsification etc. Frequent changes were made in the spraymen who bore the brunt of the labour. This probably stimulated consistent work. In 10 houses selected after spraying of the 40 wall sites repeatedly examined for evidence of effective killing activity of bugs in only one site was there evidence that the insecticide had not been evenly applied. This study will be reported in detail elsewhere. However the cost of application is an indication of why such programmes are difficult to maintain. In 1980 for a single visit for spraying the cost was about five American dollars; and its excluded the cost of administration and organisation of the programme as well as the initial evaluation phase, subsequent spray visits and vigilance procedures. Most of this 5 dollars was spent on supplementation of the salaries of field personnel, less than 20% was spent on equipment, insecticide, and gasoline. In the massive attack phase 95% of the houses were sprayed, and 96% of qualifying houses were subject to the second selective spray. Usually failure to spray was because the house was shut up and the family away, illness in the family or failure to collaborate. Such houses represent a risk to the rest of the community and had similar infestation rates in the 1981 survey as they did before the spray programme.

Table 2 – *Number of houses and chicken houses infested in 1980 in rural and urban Mambaí*

Locality	*Houses Examined*	*Houses Infested*	*Type of Infestation in Houses(*) Evidence*	T. infestans *Captured*	*Bugs Captured in Chicken houses* T. sordida *Captured*	T. sordida	T. infestans
Rural Area	724	466	227	207	32	57	9
Urban Area	185	71	38	22	11	12	0
Totals	909	537	265	229	43	69	9

(*) T. infestans only is recorded in 8 instances where both species were captured.

In Table 3 are expressed the results of the vigilance for bug presence in 1981 and these figures are compared with the prevalence of *T. infestans* and *T. sordida* in houses and chicken houses in 1980 before the control campaign.

Table 3 – *Effect of spraying in 1981 in the two areas of Mambaí*

Locality	*Total number of Houses*	*Number Sprayed Once in 1980*	*Number Sprayed Twice in 1980*	*Nº Houses with Bugs Captured* T. infestans	T. sordida	*Nº Chicken Houses with Bugs Captured* T. sordida	T. infestans
Rural Zone	724	686	221	94	23	47	4
Urban Zone	185	177	79	0	2	14	0
Totals	909	863	300	94	25	61	4

Table 4 shows that both *T. infestans* and *T. sordida* prevalence fell significantly in houses but that *T. sordida* persisted in chicken houses in spite of BHC application.

The apparent persistence of *T. infestans* in houses at a level of 10.3% is at variance with many studies in the literature but relates to the complex and thorough vigilance using a variety of methods. For example of the two visits in 1981, 95% were examined by SUCAM personnel and 92% in the second visit by UnB. There is evidence that the *T. infestans* found in 1981 represents residual populations redetected rather than fresh invasion since only 14% of infested houses in 1981 did not have bugs in 1980. However with *T. sordida* the situation was different 56% of household infections and 51% of chicken house infections were only found in 1981.

In the second house visit in 1981 manual capture and the examination of Gomez Nunez boxes was carried out simultaneously and can be compared. Of 35 infestations 18 were detected by manual capture and 23 by the Gomez Nunez box. That only 6 captures were detected by both methods is a reflection of the very low bug density, an aspect it is impossible to measure. Over the months of 1981 however plastic bag vigilance proved the most sensitive, 50 infections being detected. Since this is a longitudinal rather than crossectional vigilance, this is hardly suprising.

The nature of our data permits examination of bug presence house by house and farm by farm. Several farms were remarkable for bug persistence. In 3 farms in Zone A and two farms in Zone B in 1981 *T. infestans* was still present in 50% or more of the houses. One farm (Jambeiro) was extraordinary for the degree of chicken house invasion by *T. sordida* 50% before spraying and 32% in 1981. Explanations are being sought to explain these inconsistencies and like the results of selective spraying of houses with residual infections will be the subject of a future report.

Some other bug species known to be present in the area were recorded in houses or chicken houses for the first time in 1981. All were adults. Two *Rhodnius neglectus* captures were made in houses and two captures of this species and two of *Panstrongylus megistus* were recorded in chicken houses.

Table 4 – *House where live bugs were captured before and after the spray programme (909 houses and 570 chicken houses)*

Type of infestation (√)	*(1980)*		*(1981)*	
	Number	*% Total*	*Number*	*% Total*
Houses with *T. infestans*	229	25.2*	94	10.3%
Houses with *T. sordida*	43	4.7**	25	2.7**
Chicken houses with *T. sordida*	69	12.1	61	10.7
Chicken houses with *T. infestans*	9	1.6	4	0.7

* X^2 = 68,614 $p < 0,05$ S
** X^2 = 4,950 $p < 0,05$ S
(√) On four occasions both species were captured together.

The effect of one or two sprayings would be most evident in 1981, since it would tend to be marked by reintroductions as time progress. Table 5 shows a most rigorous examination where houses with bug presence in 1980 and total vigilance in 1981 have been analysed. Although less infections were present in houses in 1981 that had received the double spraying the difference does not reach statistical significance. Since many positive notifications are excluded by such a criterion the overall presence of *T. infestans* in houses for farms receiving one or two sprays was also calculated. Fifty-six infestations in 412 houses sprayed once (13.6%) with residual infection did not differ significantly from 12.2%; the result of 38 infestations in 312 houses which were sprayed twice.

Table 5 – *Analysis of the effect of one or two spray applications in houses with bugs in 1980 where total vigilance was achieved in 1981 (≠)*

	Total houses with bugs in 1980	*Total houses with bugs in 1981*
Zone A, one spray	206	20*
Zone B, two spray	178	10*

* $X^2 = 2{,}219 \quad p > 0{,}05$ NS
(≠) Total vigilance = two manual captures, one examination of two Gomez Nunez boxes and plastic bag notification.

DISCUSSION

Mambaí is an area of agricultural development and as a result roads are improving, many small subsistence farms have disappeared and much of the woodland is being felled and cleared for planting and cattle grazing. Such progress is occurring in many of the remote rural areas endemic for Chagas' disease. It has an effect on Chagas' disease transmission wich is difficult to measure[11] and could affect the findings reported here.

We have some evidence now from the large plastic bag collections that the common finding of evidence of infection without the capture of live bugs represents light infestations. We have described elsewhere several factors that predispose to bug infestation[6]. Blood meal availability and combat measure initiated by the householders themselves may be factors responsible for such light infestations.

Over the years the population of Mambaí has become conditioned to the epidemiology programme and this must be a factor accounting for the high acceptance rate of the spray procedure. Refusal by the householder is his prerogative although every effort was made to persuade him. Such unsprayed infested houses act as a focus for dissemination after the control programme. The five farms with an unusual prevalence of *T. infestans* in 1981 are being examined in relation to the possible factors responsible for bug persistence. The fact that only 14% of houses in 1981 did not have bugs in 1980 points to a recuperation after spraying of bug populations persisting from 1980 as a major reason for the appearance of *T. infestans* in houses in 1981.

One explanation for the increase in *T. sordida* infestation in houses and chiken houses observed in 1980 and 1981 is a reflection of the pressure on this species to invade the peridomiciliary enviroment since its natural habitat is being destroyed. The fact that the majority of records in houses and chicken houses recorded in 1981 were not present in 1980 supports this view. *T. sordida* has been recorded in sylvatic ecotopes both in Mambaí and a nearby uninhabited area of the cerrado[8]. There is also evidence from studies in the São Paulo control programme that dislocation of *T. infestans* from houses by spraying is followed by *T. sordida* colonisation[3 14]. Although *T. sordida* is the main bug intruding in the domestic enviroment after spraying, adults of both *R. neglectus* and *P. megistus* have also appeared, both of which are potential house colonisers. *T. infestans* colonisation of chicken houses has remained fairly constant at a low level over the years and may reflect attempts by this species to invade outside houses.

The fall in the number of *T. infestans* notifications in 1981 while statistically significant might seem less than expected in terms of the information available in the literature[14 15]. However the vigilance procedures adopted in this study were much more vigorous and complete than is normally the case. The importance of good vigilance has been emphasised in the literature[13]. Also, every attempt was made to visit every house since longitudinal records are being compiled on each dwelling over the years.

With the notification system used, no idea of the reduction in bug populations after spraying can be formed although we know it to be immense from previous demolition studies[1]. In our vigilan-

ce work, one live bug is enough to indicate respraying for 1982. We have simplified the vigilance in terms of a householder unit developed at Mambaí and recently described in the literature[7]. In the results section we show evidence that such multiple procedures for vigilance (manual capture, Gomez Nunez box and plastic bag notification) are more sensitive.

Our data for 1981 suggest that comparison of the effect of one massive attack spraying compared with this procedure plus a selective spray shows only a non significant difference in terms of the appearance of *T. infestans* in houses. The second procedure is far more costly. Since Pedreira de Freitas[10] emphasised the importance of selective spraying other authors have questioned the use of limited spraying procedures to effectively control *T. infestans*[12]. Being purely a house dweller this bug is particularly vulnerable to residual insecticide application. Possibly one selective spray of all infested houses and chicken houses would have had sufficient impact on this species, when accompanied by good vigilance and facilities for further selective spraying, to control transmission to man of *T. cruzi*. However further yearly vigilance studies in Mambaí must be examined before any firm conclusion can be drawn.

The procedures developed by SUCAM for initiating and consolidating control of *T. cruzi* transmission have be developed over many years and are based on great experience. They take into account human failure factors not discussed here and are aimed in general against all significant *T. cruzi* vectors in Brasil. They are the best available in any South American country and should not be modified until we are sure that there will be a gain in efficiency in terms of rapid diminution of transmission rise with less capital expenditure. It is likely that different combat schedules will be more successful with different bug vectors.

These results from Mambaí suggests it would be valuable to initiate a pilot control scheme in a virgin area of *T. infestans* transmission similar to Mambaí. Here one selective spray to all houses and chicken houses with evidence of bug infestation would be controlled with immediate installation of individual vigilance units and a central point to organise vigilance data and respraying of houses with persistent infestation. If a comparable reduction of *T. infestans* was achieved to that recorded in Mambaí then a modification in the regulations for *T. infestans* afflicted areas would be indicated. House improvement would appear to be most practical at a later stage in a control programme than the phase discussed here[2].

RESUMO

A aplicação de BHC em Mambaí, realizada em 1980, fez cair significantemente a população do T. infestans dos domicílios, mas não a eliminou totalmente.

Enquanto isto, as populações peridomésticas de T. sordida persistiram e poderão mesmo apresentar uma ameaça à interrupção da transmissão humana do T. cruzi.

Foram comparados os resultados da aplicação de inseticida em duas áreas de Mambaí em 1980: em uma delas foi feita apenas o expurgo maciço com BHC; na outra, além deste expurgo maciço foi realizado o expurgo seletivo das casas, onde foi encontrado o T. infestans. Não foi encontrada diferença significativa entre as duas áreas em 1981.

É provável que devam ser planejadas medidas mais baratas para interrupção da transmissão do T. infestans, em substituição aquelas atualmente usadas.

Além disto, estudo piloto deve ser realizado em outra comunidade onde a transmissão do T. infestans está ativa desde que Mambaí não pode ser considerada como representativa para aquelas áreas, onde ainda não se realizou nenhuma aplicação de inseticida.

Palavras chaves: *Trypanosoma cruzi. Triatoma infestans. Triatoma sordida. Inseticida.*

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