



The control of *Glossina morsitans morsitans* (Diptera: Glossinidae) in a settled area in Petauke District (Eastern Province, Zambia) using odour-baited targets

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ABSTRACT

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A trial to control *G. m. morsitans* with the use of 980 odour-baited, insecticide-impregnated targets was conducted in a 300 km² area in the Eastern Province of Zambia between 1989 and 1991. The area is highly cultivated and cattle density is high (about 8 cattle/km²). Targets were deployed along roads and tracks. Deployment was restricted to suitable tsetse habitat. The effect of the targets on the tsetse population and on the transmission of tsetse-transmitted trypanosomosis was monitored by means of man-walked fly rounds and sentinel herds, respectively. The apparent density of tsetse in the trial area and in adjacent areas, declined rapidly after targets had been deployed. Trypanosomosis incidence in the trial area decreased significantly but did not completely disappear. Results from the trial show that odour-baited targets are effective in controlling *Glossina m. morsitans* in highly cultivated areas even when deployment is restricted to suitable tsetse habitat. It is concluded that tsetse control operations should be chosen such that either the invasion pressure is low from adjacent areas, or the size of the area is big enough, so that a central challenge-free area can be created.

Keywords: Control, *Glossina morsitans morsitans*, odour-baited targets, Petauke District, tsetse-transmitted trypanosomosis, Zambia

INTRODUCTION

In much of Zambia, bovine trypanosomosis retards agricultural development. The disease transmitted by tsetse, *Glossina* spp., depresses every aspect of live-stock production, making it impractical to keep domestic animals in areas heavily infested by the flies. During the past decades several attempts, by means of both aerial and ground spraying, have been made to control tsetse in the Eastern Province (Evison & Kathuria 1984). Most of these operations caused considerable reduction in fly density, or removed flies completely from some areas. Unfortunately, owing to financial constraints on the Department of Veterinary

and Tsetse Control Services and the lack of effective means of preventing invasion, most of the former controlled areas were reinfested with the flies.

The development of odour-baited targets as a low-technology method of controlling *Glossina m. morsitans* Westwood and *G. pallidipes* Austen, in Zimbabwe (Vale, Hargrove, Cockbill & Phelps 1986), and the successful application of this method to control *G. m. centralis* Machado in the Western Province of Zambia (Willemse 1991), led to the trial described in this paper. The objective of the trial was to investigate the efficacy of odour-baited targets to control *G. m. morsitans* in highly cultivated areas with patchy tsetse distribution. At the same time, a methodology for use of odour-baited targets in such cultivated areas was developed.

MATERIALS AND METHODS

Trial area

The trial was conducted in 300 km² of the Chimpundu area in Petauke District. It is situated between the Great East Road in the north, the Mozambican border in the south, the Chikalawa Road in the west and the Sinda Road in the east (Fig. 1). The natural vegetation is *Brachystegia*. Hills in the area carry extensive woodlands of *Brachystegia* spp. whereas approximately 70% of the lowland has been cleared for cultivation (subsistence farming). The area carries about 8 cattle/km² together with goats, pigs and a few game animals, mainly small antelopes. The tsetse species present is *G. m. morsitans*, which takes 75 % of its blood meals from cattle (Van den Bossche & Staak 1997). There are three main seasons: rainy (November to April), cold dry (May to August) and hot dry (September to October).

Targets

The S-type target (Vale, Lovemore, Flint & Cockbill 1988), developed in Zimbabwe, was used in the trial. It consists of a central piece of black cotton cloth, 0,7 x 1,0 m, flanked on each side by fine black terylene netting, 0,5 x 1,0 m. Targets were fixed on a metal frame rotating in the wind around a central post.

Odour attractants

Acetone was dispensed from 500 ml brown glass bottles. Its vapour diffused through a 4,5 mm aperture in the lid, resulting in an average dose of 250 mg/h. Bottles were placed in front of the target or attached to the top of its horizontal support; they were replenished at 3-monthly intervals. For the first 3 months of the trial, 3-*n*-propylphenol/1-octen-3-ol/4-methylphenol (ratio of mixture: 1/4/8) polyethylene sachet dispensers (150 µm thick, surface area 30 cm²) were used as an additional odour attractant (Vale & Hall 1985). The sachet was placed in a pocket at the top of the central panel of the cloth.

Insecticide

All targets were treated with 0,1 % deltamethrin (Glossinex 200 S.C.[®], Coopers) applied by knapsack sprayers to both sides of the cloth and netting until run-off. Spraying intervals varied from 2 months during the rainy season to 3 months during the dry season. Eighteen months after the initial deployment, all targets were resprayed with 0,6% deltamethrin, and the spraying interval was increased to 9 months. This significantly reduced the amount of maintenance work.

Target deployment

To optimize the efficacy of the targets, targets were deployed in suitable tsetse habitat only. Areas of

tsetse habitat suitable for target deployment were identified by the use of 1/50 000-scale maps and 1/30 000-scale aerial photographs. Target deployment was facilitated by erecting most of the targets at 250 m intervals along roads. All equipment was transported by 4-WD vehicles and was hand-carried from the road to the selected deployment site. Each target site was identified by blazing trees along the roads. Teams of 12 people each deployed an average of 25 targets per day. The risk of targets being burned by bush fires was reduced by clearing all vegetation within 3 m of the target. All targets were numbered and mapped. A total of 980 targets were deployed during the cold dry season (July) giving an overall target density of 3,3 targets per km².

Target maintenance

Three permanent field camps within the trial area were used for maintenance operations (Fig. 1). Every working day, maintenance teams were sent to inspect and, if necessary, maintain targets. Torn, stolen, or faded cloths were replaced, odours were replenished and regenerating vegetation around the target was cleared. Extra casual labourers were employed for target re-sprays. To improve mobility, all labourers were issued with bicycles.

Monitoring of the tsetse population

A total of 15 fly rounds (Potts 1930) were traversed inside (fly-round numbers 1, 2, 3, 4, 5, 8 and 10), adjacent to (fly-round numbers 6, 7, 11, 12, 13 and 15), and outside the trial area (fly round numbers 9 and 14) (Fig. 1). The fly rounds were approximately 6 km long with stops at 200 m intervals. Teams of two men, carrying a 1,5 x 1,0 m black screen and a bottle of acetone (250 mg/h), traversed each fly round at least seven times per month. To produce sufficient pre-control data, tsetse monitoring started 18 months before the onset of the trial. The apparent density of tsetse was calculated as the monthly average catch per stop (Fig. 2). Apparent densities in the trial area and adjacent area were expressed as percentages of the apparent densities in the untreated area (Fig. 3). The corrected percentages were calculated by means of the following formula (Küpper, Ebl, Van Elsen & Clair 1982):

$$\left[\left[E_i \cdot (C_m/C_i) - E_m \right] / \left[E_i \cdot (C_m/C_i) \right] \right] \cdot 100$$

E_i = initial apparent density in the trial area
 E_m = apparent density in the control area per month
 C_i = initial apparent density in the untreated area
 C_m = apparent density in the untreated area per month

Trypanosomosis monitoring

To monitor the effect of tsetse control on the transmission of tsetse-transmitted trypanosomosis, the

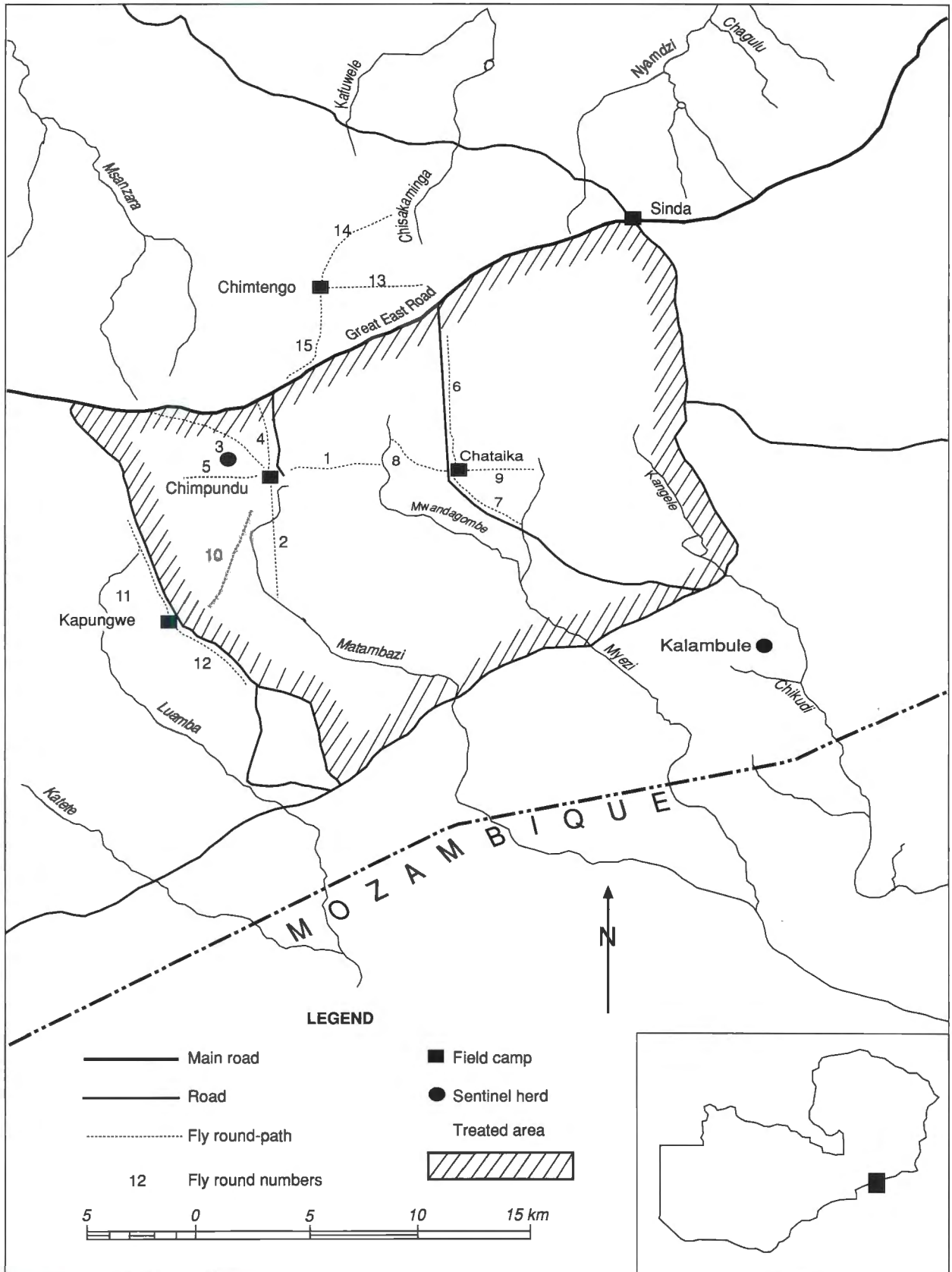


FIG. 1 Map of the trial area, fly-round transects, location of field camps and sentinel herds

trypanosomosis incidence in cattle was assessed in two sentinel herds, one inside (Chimpundu) the trial area and one 5 km outside it (Kalambule) (Fig. 1). Each herd consisted of 20 adults of mixed breed and belonged to local farmers. The cattle were kept under traditional village management. Each month blood taken from the jugular vein of each animal was examined for trypanosomes using the haematocrit-centrifuge phase-contrast, technique (Murray, Murray & McIntyre 1977), and its packed-cell volume (PCV) was measured. Blood smears stained with Giemsa were also examined for the presence of trypanosomes (Table 1, Fig. 4). Infected animals received a curative treatment of diminazene aceturate (Berenil[®], Hoechst) at a dose of 3,5 mg/kg, by intramuscular injection. Fifteen months after the onset of the trial, blood samples were taken from 20 adult cattle and 20 calves (6–12 months old) inside and outside the trial area (Table 1), to compare the prevalence of trypanosomal antibodies. The samples were analysed by use of the immunofluorescent antibody test (IFAT) (Katende, Musoke, Nantulya & Goddeeris 1987).

RESULTS

Apparent density

The apparent densities of tsetse outside the trial area (Fig. 2) tended to be lowest in May/June (cold dry season) and highest a few months later (hot dry season).

If one allows for this seasonal effect, there was a fairly steady increase in apparent density over the 4 years of this study. Apparent density inside the trial area was, except for the 6 months before the onset of the trial, about the same as outside the trial area. After the targets had been deployed, the catches inside the trial area declined rapidly. One month after target deployment, tsetse catches in the trial area were 81,8 % lower than catches outside the trial area (Fig. 3). A 94,8% reduction was reached 3 months later.

Except for four flies caught during the 1991 rainy season, no further fly catches were recorded.

A less drastic reduction in catches was observed in the area adjacent to the trial area. Here the apparent density declined by 38,4 %, as compared to catches outside the trial area, in the first month after target deployment. Apparent density gradually decreased during the following months, reaching a maximum reduction of 97,6 % 8 months after target deployment (Fig. 3).

Incidence of trypanosomosis

Sentinel cattle were sampled every month. The monthly incidences of trypanosomal infections in the

sentinel cattle from January 1990 to December 1991 are presented in Fig. 4.

Except for September 1990, trypanosomosis incidence in the sentinel herd outside the trial area was higher than trypanosomosis incidence inside the trial area. None of the sentinel cattle was parasitologically positive in February 1990, June 1991, October 1991 or December 1991.

Table 1 summarizes the values of trypanosomosis parasitological incidence and PCV during the course of the trial and the prevalence of trypanosomal antibodies in adults and calves 15 months after the start of the trial.

Inside the trial area, trypanosomosis incidence decreased significantly from an annual mean of 35,7 % prior to target deployment to means of 5,4% and 2,3 % in 1990 and 1991, respectively. However, outside the trial area trypanosomosis incidence remained high, with annual mean values of 30,7% and 13,3% in 1990 and 1991, respectively.

Trypanosoma congolense accounted for 96,1 % of all infections. The mean annual PCV of sentinel cattle in the trial area was 29,3% and 27,9% in 1990 and 1991, respectively. The average PCV of sentinel cattle outside the tsetse-control area was 25,6% and 25,2% in 1990 and 1991, respectively. Differences between mean annual PCVs in both sentinel herds were statistically significant (*T*-test, $P < 0,01$). Fifteen months after the start of the trial, 88,9% of the adult cattle sampled in the trial area had trypanosomal antibodies. All adult cattle grazing outside the trial area had trypanosomal antibodies.

Prevalence of trypanosomal antibodies in calves was 20% for those grazing inside the trial area and 47,9 % for those grazing outside the trial area.

DISCUSSION

Trial results indicate that odour-baited targets are very effective in controlling *G. m. morsitans*, under the conditions prevailing in the Eastern Province of Zambia. Compared with tsetse distribution in other areas where odour-baited targets have been used to control *G. morsitans* (Vale *et al.* 1988; Willemse 1991), the distribution in the trial area is patchy and the interaction between tsetse and cattle is high (Van den Bossche & Staak 1997).

The methodology used in this trial differs from that applied in other tsetse-control campaigns in which odour-baited targets are used (Vale *et al.* 1988; Willemse 1991). Owing to the high level of cultivation and the subsequent patchy distribution of tsetse habitats, targets were not deployed along gridlines but deployment was restricted to suspected tsetse habitat. This resulted in an irregular target distribution and

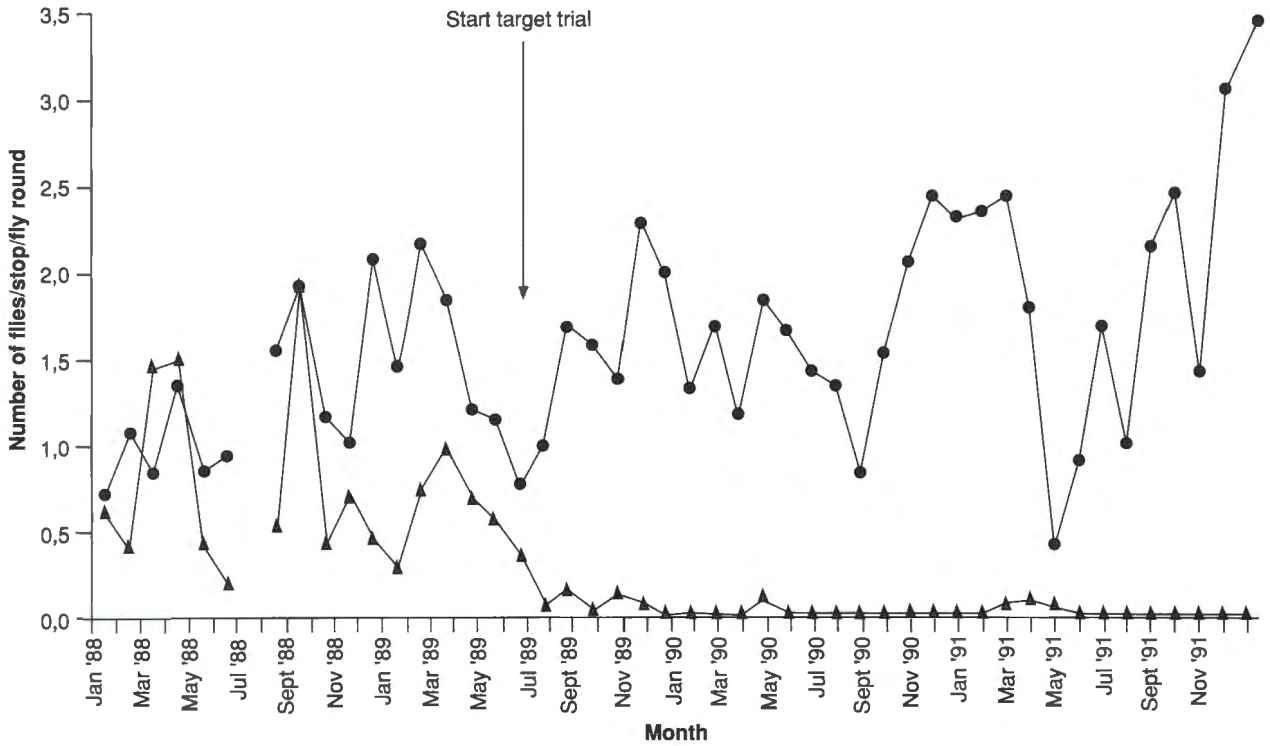


FIG. 2 Apparent density of *G. m. morsitans* inside (s) and outside (l) the trial area

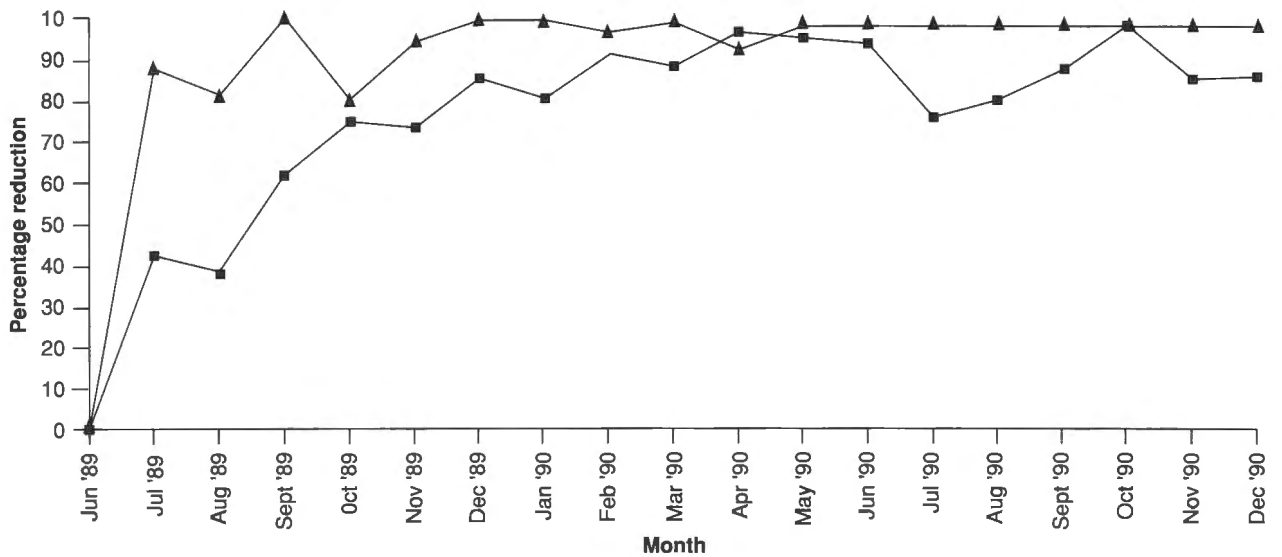


FIG. 3 Reduction of the tsetse population density (%) inside (s) the trial area, and adjacent (n) to the trial area compared with catches outside the trial area

an overall target density lower than the recommended four targets per km² (Vale *et al.* 1988). The selective deployment of targets in suspected habitats made targets freely available to the flies and contributed to the fast decline in the density of the tsetse population. This target-deployment strategy can, however, result in full control of the flies only if

all suspected habitats have been identified and treated with targets. The deployment of targets along roads greatly facilitated their deployment and maintenance. Though it is outside the scope of this trial, it is expected that access to targets could be an important parameter when the responsibility for target maintenance is ultimately handed over to the local

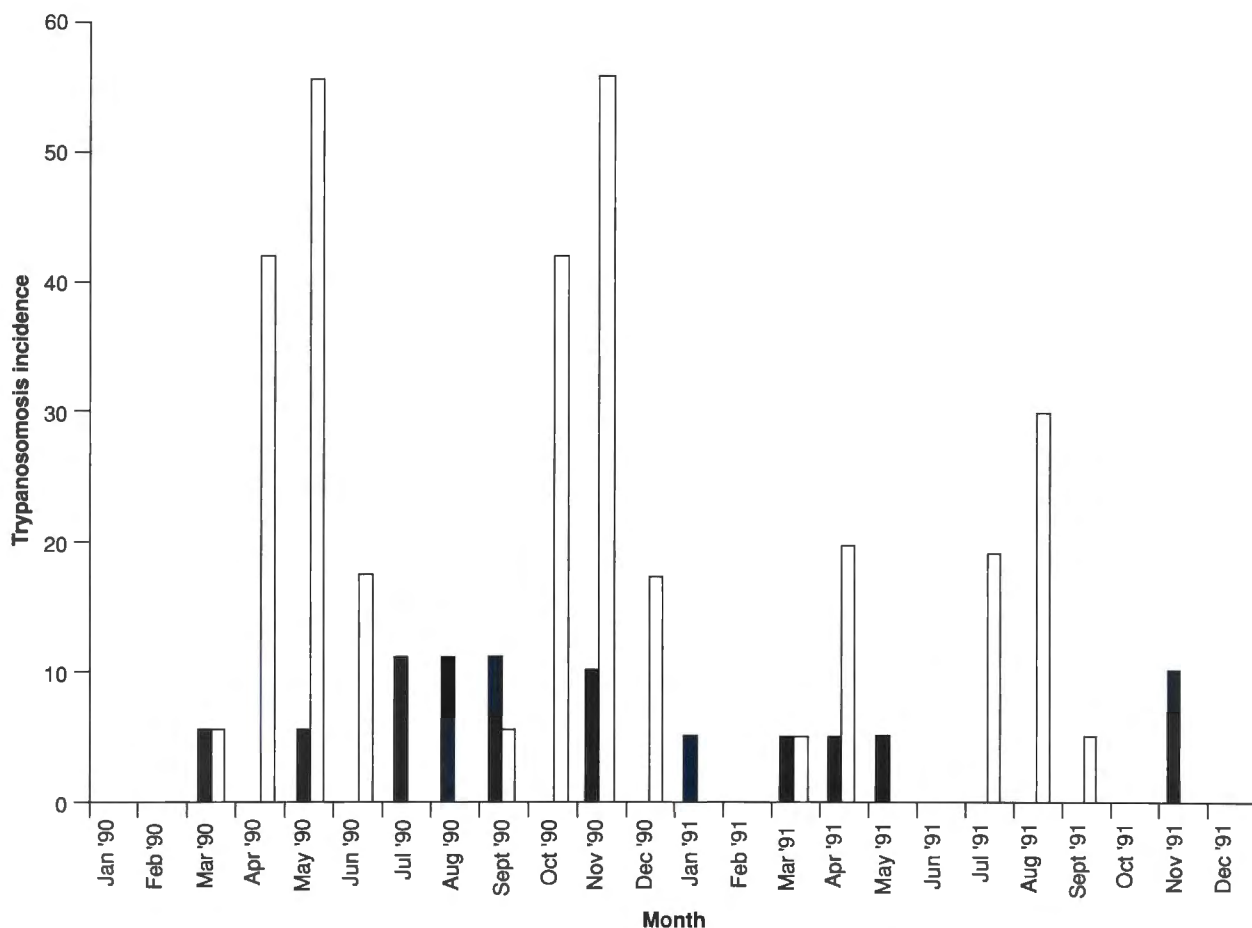


FIG. 4 Monthly incidence of trypanosomal infections in a sentinel herd inside (■) and outside (□) the trial area

TABLE 1 Mean annual values of trypanosomosis parasitological incidence and PCV in sentinel herds inside and outside the target trial area and trypanosomal antibody prevalence in adults and calves 15 months after the start of the trial

Location	Year	Parasitological Incidence (%)		Antibody prevalence (%) 15 months after trial start	
		Sentinel herds	PCV (%)	Adults	Calves
Inside	1990	5,4 ± 4,9	29,3 ± 3,5	88,9	20,0
	1991	2,3 ± 1,4	27,9 ± 4,0	—	—
Outside	1990	30,7 ± 21,5	25,6 ± 4,7	100,0	47,9
	1991	13,3 ± 11,7	25,2 ± 5,5	—	—

community. As was observed by Vale *et al.* (1988), population density of *G. m. morsitans* was reduced for several kilometres outside the trial area. This effect is attributed to the movement of tsetse into the target-treated zone.

The apparent decline of the tsetse population was associated with a significant reduction in the incidence of trypanosomosis and a significant increase in the average PCVs of cattle grazing in the trial area. PCVs are reliable indicators of anaemia (Saror

1979). Anaemia, on the other hand, is a major characteristic of bovine trypanosomosis (Murray & Dexter 1988). Significant differences between herd PCVs could, therefore, be used as an additional indicator of trypanosomal infections and tsetse challenge. It is not surprising that the serological trypanosomosis prevalence in adult cattle was high for 15 months after targets had been deployed. Trypanosomal antibody levels decline slowly when challenge is reduced (Bocquentin, Very & Duvallet 1990). The prevalence of trypanosomal antibodies in calves born

in the trial area after the onset of the trial, on the other hand, was about 50% lower than in the control area. This clearly indicates a significant decrease in trypanosomosis challenge in the trial area.

From 6 months after the start of the trial, almost no tsetse were captured. Tsetse-transmitted trypanosomes were, however, still detected, though at a much lower incidence rate. Reasons for this could be manifold. The difficulty in detecting low-density *G. m. morsitans* populations, and the limited area covered by fly rounds hinder objective interpretation of entomological results. Moreover, tsetse eradication in the whole trial area cannot be guaranteed because of the invasion pressure from surrounding areas. Hargrove (1993) suggests that an 8-km-wide barrier with four targets per km² is needed to prevent invasion. This means that, in the case of this trial, only the most central part of the target area could be considered invasion free. Moreover, movements of sentinel cattle into tsetse-infested areas outside the trial block complicates interpretation of the incidence of trypanosomosis.

The problem of tsetse invasion could be solved by expanding the treated area, creating a central area where tsetse could be expected to be eradicated. However, even this might not solve the problem of cattle moving to tsetse-infested areas; which can occur during the dry season when they are in search of grazing. Trypanosomosis incidence is determined by various host- and vector-related parameters (Rogers 1988). Calculated disease-transmission thresholds and basic rates of reproduction emphasize the difficulty of controlling trypanosomosis caused by *T. vivax* or *T. congolense* by anything other than total elimination of the vector (Rogers 1988). Results of this trial and the epidemiological considerations indicate the importance of the scale at which such vector-control operations should be conducted.

Owing to the rapidly growing human population, increasing numbers of people will have to settle in or near tsetse-infested habitats. Tsetse-transmitted trypanosomosis is expected to be a serious constraint to rural development for those communities. Results of this trial show that odour-baited targets can be used to control tsetse in such settled areas. It should, however, be realized that trypanosomosis control will be achieved only through large-scale vector control resulting in almost complete absence of challenge.

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