Identification of landing Site Preference of Fully-fed *Glossina pallidipes* and *Glossina morsitans* (*diptera: glossinidae*)

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ABSTRACT

An experiment to identify landing sites of fully fed Glossina pallidipes and Glossina morsitans was set up at the end of the winter season in Zimbabwe at Rukomichi Research Station. Five experiments subjected to three treatments differing in duration of catch, interval of catch and landing position were performed. A mean catch of 13 was recorded for 15-minute interval catches on logs wrapped in black cloth for the same species. Site and treatment had a significant effect on mean catch levels for Glossina morsitans (LSD=0.0979) and Glossina pallidipes (LSD=0, 1409). The mean catch (1644) for both fully fed Glossina morsitans and Glossina pallidipes was highest for 15-minute interval catches on unwrapped upright logs. This was twice higher than the overall mean catch recorded for continuous catch on unwrapped upright logs indicating the repellent effect of man on Glossina morsitans and Glossina pallidipes. Unwrapped upright logs could alternatively be used to catch Glossina pallidipes and Glossina morsitans after feeding for the purpose of biological and chemical assays to determine the effectiveness of chemicals on trials. This could also avoid the rubbing effect on the animal body and hence eliminating contamination on the hand-nets

Keywords: *Landing preference, tsetse behaviour, Bioassays, insecticides, Glossina pallidipes (GP), Glossina Morsitans (GM), hand-nets, mortality*

INTRODUCTION

Tsetse flies have become a menace in agricultural activities such that people are no longer comfortable to settle in tsetse fly infested areas. Tsetse flies of the species *Glossina* *morsitans* and *Glossina pallidipes among others* transmit trypanosomiasis disease in animals which is also referred to as sleeping sickness or nagana. Control of trypanosomiasis is currently through eradication of tsetse flies which are trypanosome vectors (Child, 1998) and this was initially through destruction of potential tsetse fly habitats (Schillhorn, 1997). However, this technique was leading to deforestation. The technical tools now commonly used for tsetse fly eradication include stationary artificial baits consisting of traps or insecticide-treated screens known as targets and the treatment of cattle using pour-on formulations of pyrethroids (Toure and Mortelmans, 1996; Lindh et al, 2009; Molyneux, 1997). Initially this was done through the use of organochlorine compounds such as dieldrin and dichlorodifluorotriphosphate (DDT) (Warnes, 1997).

The organochlorines were stable and produced sufficient toxicity to tsetse flies when sprayed on the ground, but their use was withdrawn due to adverse environmental effects (Warnes, 1997). For instance, a research that was carried out in Zimbabwe at Kariba detected organochlorine pesticides residues in human milk samples which are harmful to human (Chikuni et al, 1997). When targets were first used in the early 1980s DDT and dieldrin were insecticides used as wettable powders. These were highly effective but readily washed away by rain and left white deposits that partially mask the blue and black color of targets (Van den Bossche and Vale 2000; Vale *et al*, 2005). Organophosphates and carbamates such as Malathion and carbaryl respectively lack sufficient toxicity and hence they are less effective.

Formulations of pyrethroids particularly the "cyano group" are toxic, stable but mildly toxic to animals (Vale *et al*, 2005) and have been targeted for use in tsetse fly control. Currently Deltamethrin and Alphacypermethrin pyrethroid formulations are in use for trypanosomiasis control in Zimbabwe. Experiment carried out by Van den Bossche (1996) indicates that mortality increases for mature and immature flies exposed to Deltamethrin in the hunger cycle. However, the use of Deltamethrin instead of DDT greatly increases the costs of ground spraying (Warnes, 1997). In order to develop cost effective and environmentally sound methods for tsetse control, more chemicals have to be put on trials for assessment. At Rukomichi Research Station various chemicals are tested for effectiveness. Insecticide assessment is done through biological and chemical assays (Vale et al, 2005). Chemical analysis gives the amount of the chemical present on target samples on monthly basis for a one-year period. This analysis helps to determine durability of the chemical when exposed to natural physical environmental factors.

Biological assays are carried out by exposing tsetse flies to insecticides on trials. The use of tsetse fly targets is an option but the insects can also be eradicated by spraying chemicals directly to the animal body (Hay, 1997). Assessment of animal spraying chemicals can be evaluated by catching tsetse flies that land on the animal body to feed. The flies are caught using tsetse fly hand-nets designed to catch the flies as they land to rest or feed. Mortality of tsetse flies that land on treated animals can be effectively assessed if the 'rubbing effect' of tsetse fly hand-nets on the animal body is eliminated. This rubbing on the animal body contaminates the catching instrument. The results obtained will not reflect the true efficacy of the chemical under investigation. Mortality analysis is expected to reflect chemical effectiveness due to insect contact with the treated animal and not the contaminated hand-net. Investigations on the landing preference of *Glossina pallidipes* and *Glossina morsitans* will help to eliminate the rubbing effect on the chemically-treated animals. This improves the standards of assessing insecticides on trials and the quality of results on bioassays.

MATERIALS AND METHOD

The study was carried out in Zimbabwe at Rukomichi Research Station where there is a high population of *Glossina pallidipes* and *Glossina morsitans.* It consisted of five experiments and each with three treatments. An ox was used as the tsetse fly host in all the experiments carried out in the study. Each experiment consisted of three treatments A, B and C. They differed on catching period, catching intervals and the position where the *Glossina morsitans* and *Glossina pallidipes* were caught. The treatments were alternated on three sites in the mopani and riverine vegetation using a three by three Latin-square design. The sites were separated by a distance of 300-500 meters. Each treatment consisted of 24 logs each measuring one meter in length and with a diameter ranging from 15-20cm (Figure 1) for the upright set up. A radius of three meters was maintained per site as the distance between each log and the cage containing the ox. The cage was for restricting ox movements. A wind vane and hand-nets were used for measuring wind direction and catching tsetse flies on each site respectively. Each experiment had a control treatment where tsetse flies were caught directly on the animal body.

Table 1: Description of individual experimental designs

Tts	Exp. 1	Exp. 2	Exp. 5	Exp. 3	Exp. 4
A	Catching on horizontal logs wrapped in alternating blue and black cloth * ***	Catching directly on the animal body (Control) * ***	Catching directly on the animal body (Control) ** ****	Catching directly on the animal body (Control) ** ****	Catching directly on the animal body (Control) ** ****
B	Catching on horizontal logs wrapped in black cloth * ***	Catching on horizontal logs wrapped in black cloth * ***	Catching on unwrapped upright log * ***	Catching on horizontal logs wrapped in black cloth * ***	Catching on unwrapped horizontal logs * ***
C	Catching directly on the animal body (Control) * ***	Catching on horizontal logs wrapped in blue cloth * ***	Catching on unwrapped upright log ** ****	Catching on horizontal logs wrapped in black cloth ** ****	Catching on unwrapped horizontal logs ** ****

Source: Experimentation 2012. *Duration of catch is continuous** *Duration of catch is two (2) minutes***
*Catching interval is continuous**** *Catching interval is after 15 minutes*****
Tts = Treatment; Exp.= Experiment

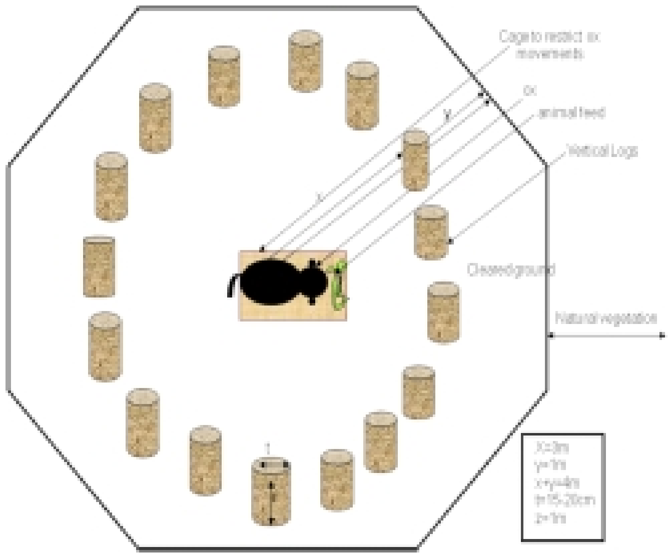

Figure 1: Upright natural logs design

NB: *The diagram is showing 16 logs for the general set up appearance; however 24 logs were used on the experiment.*

RESULTS AND DISCUSSION

Table 2: Mean catch for *G. Morsitans* and *G. pallidipes* for experimental treatments

Species	*G. Morsitans* (mean catch)		*G. pallidipes* (mean catch)		Overall mean catch for the two species
	Male	***Female***	***Male***	***Female***	
Experiment 1, Treatment A	240	408	198	876	431
Experiment 1, Treatment B	201	342	159	639	335
Experiment 1, Treatment C	186	279	177	672	329
Experiment 2, Treatment A	6	8	14	106	34
Experiment 2, Treatment B	0	3	1	23	7
Experiment 2, Treatment C	43	109	150	298	150
Experiment 3, Treatment A	0	4	23	113	35
Experiment 3, Treatment B	0	0	2	3	1
Experiment 3, Treatment C	0	4	4	42	13
Experiment 4, Treatment C	118	127	148	229	156
Experiment 4, Treatment B	114	114	130	151	127
Experiment 4, Treatment A	199	181	255	455	273
Experiment 5, Treatment A	565	1177	1164	3512	1,605
Experiment 5, Treatment B	241	590	490	1931	813
Experiment 5, Treatment C	804	1327	1330	3113	1,644

Source: Experimentation 2012.

Five experiments were carried out in the study with the purpose of identifying the landing preference of fully fed *Glossina morsitans* and *Glossina pallidipes*. The results on table 2 indicate the mean catch distribution on each experimental treatment per species and sex.

They were significant differences in catch levels which required further analysis to determine the influence of site, weather conditions and individual treatments.

Table 3: Effect of Site and Treatment on *G. pallidipes* and *G. morsitans* and individual sexes

Parameter	**Fpr value**					
	GP	***GM***	***FGP***	***MGP***	***FGM***	***MGM***
Site	0.003	0.629	0.922	0.055	0.002	0.439
Treatment	<.001	<.001	0.003	<.001	<.001	<.001
Site.Treatment	0.191	0.579	0.344	0.100	0.232	0.682

Source: Experimentation 2012. *GP = G. pallidipes; GM = G. Morsitans; FGP = Female G.. pallidipes; MGP = Male G.. pallidipes; FGM = Female G.morsitans; MGM = Male G. morsitans*

The table 3 presents the combined effect of site and treatment on *Glossina pallidipes* and *Glossina morsitans* based on data collected during the study. The effect was more pronounced on catch levels of fully fed *Glossina pallidipes* than to *Glossina morsitans.*

Table 4: Effect of site on catch distribution for *G. Morsitans* and *G. pallidipes*

Species	**Site differences**			**LSD value**
	1 vs 2	***1 vs 3***	***2 vs 3***	
G. morsitans	*0.002*	*0.040*	*0.042*	*0.0979*
G. pallidipes	*0.246*	*0.149*	*0.097*	*0.1409*

Source: Experimentation 2012.

***Site 1**- Sparse vegetation and away from streams; **Site 2**- Dense vegetation, riverine area; **Site 3**- Dense vegetation, riverine area.*

The sites employed in this research were differing in terms of distance from the riverine area and vegetation. Catch levels of *Glossina morsitans* was generally low mainly due to the stationary objects that were used in the experiments. The statistical results as indicated on table 4 are show no significant difference in the catch distribution of *Glossina morsitans* on the three sites used in the study. However, each site has a pronounced effect on *Glossina pallidipes.*

Table 5: Effect of treatment on catch distribution

Species	**Treatment differences**			**LSD values**
	A vs B	**A vs C**	**B vs C**	
G. morsitans	0.136	0.0979	0.181	0.0979
G. pallidipes	0.562	0.129	0.433	0.1409

Source: Experimentation 2012.

Treatment A- catching on the ox at 15-minute intervals (control); Treatment B- catching on the logs continuously; Treatment C- catching on the logs at 15-minute intervals

Table 5 is showing an analysis on the effect of treatment on the catch distribution of *Glossina pallidipes* and *Glossina morsitans.* The results are indicating a significant difference in catch levels between catching on the ox at 15 minutes intervals **(A)** and catching on the logs continuously **(B).** There was little or no significant difference in catch distribution between 15 minutes interval catches on the logs **(C)** and catching on the ox at 15 minutes intervals **(B).**

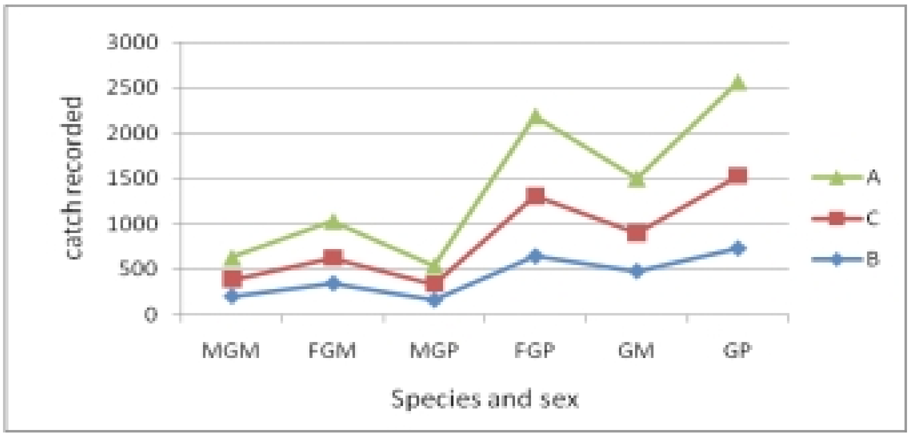

Figure 2: Treatment A, B and C for experiment 1. ***A****-catching continuously on horizontal logs wrapped in alternating blue and black cloth;* ***B****-catching continuously on horizontal black logs;* ***C****-catching continuously on the animal body (control).*

Figure 2 indicates results of the first experiment on investigations to understand tsetse fly post feeding behaviour. In this experiment, observations on the landing preference of fully fed *Glossina morsitans* and *Glossina pallidipes* were made on horizontal logs wrapped in alternating blue and black cloth; horizontal logs wrapped in black cloth and on the animal body (control). Catching was done continuously in all the treatments. Catching continuously on horizontal logs wrapped in alternating blue and black cloth **(A)** is showing elevated catches whilst low catches were recorded on horizontal logs wrapped in black cloth **(B).**

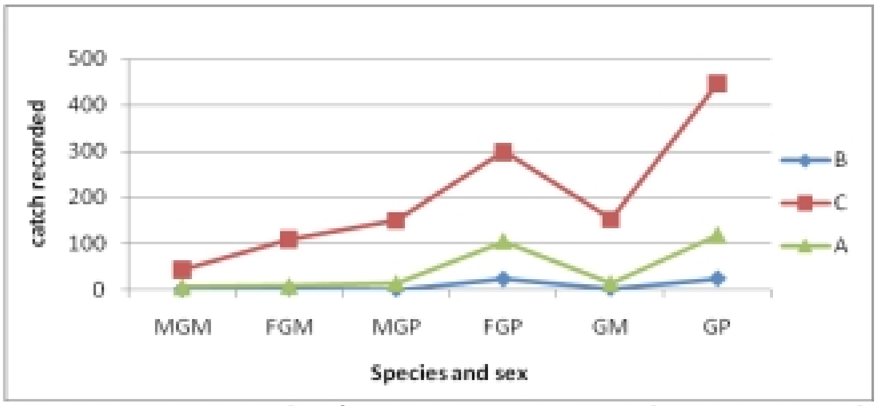

Figure 3: Treatment A, B and C for experiment 2. *A-catching continuously on the animal body (control);* ***B****-catching continuously on horizontal logs in black cloth;* ***C****-catching continuously on horizontal logs in blue cloth.*

In experiment 2 an analysis on the landing behaviour of fully fed *Glossina morsitans* and *Glossina pallidipes* was done on logs wrapped in black cloth and logs in blue cloth. The results are indicating higher catches on logs wrapped in blue cloth **(C)** and the female *Glossina morsitans* were more dominant in all the three treatments. However, low catches were recorded on horizontal logs in black cloth **(B).** In this design, catches were done continuously on the three treatments.

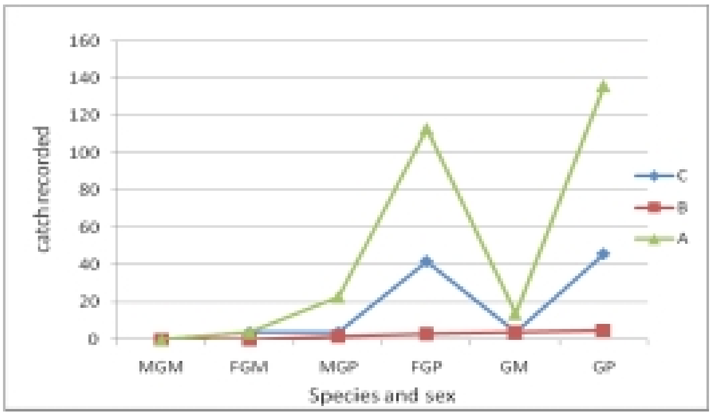

Figure 4: Treatment A, B and C for experiment 3. ***A****-catching at 15 minute intervals on the animal body (control);* ***B****-catching continuously on horizontal logs in black cloth;* ***C****-catching on horizontal logs in black cloth at 15 minutes intervals.*

This experiment was designed to introduce 15 minutes interval catches to determine its effects on catch levels of fed *Glossina morsitans* and *Glossina pallidipes*. This was designed in an effort to minimize man's presence since research have indicated that man have a repellent effect on tsetse flies (Thomson, 1982). Figure 4 is showing results of experiment 3 and more catches were recorded on 15 minutes interval catches on logs wrapped in black cloth **(C).**

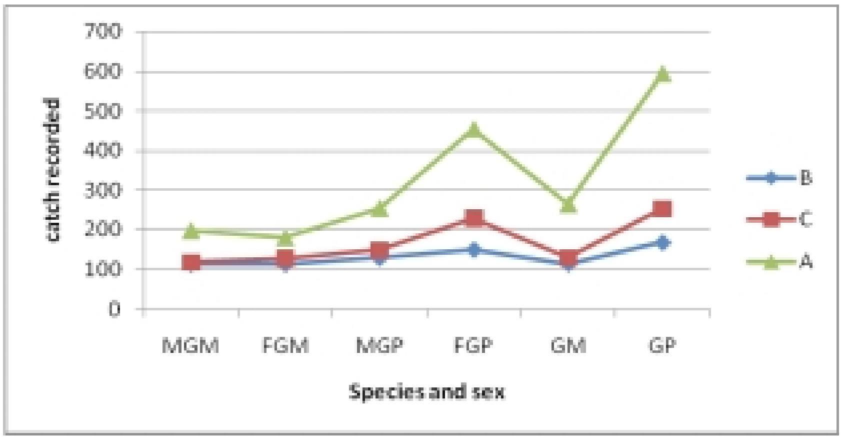

Figure 5: Treatment A, B and C for experiment 4. ***A****-catching on the animal body at 15 minute intervals (control);* ***B****-catching continuously on unwrapped horizontal logs;* ***C****-catching on unwrapped horizontal logs at 15 minute intervals.*

Figure 5 indicate results of experiment 4 after incorporating 15 minute interval catches to all the three treatments. The experiment was also designed after considering field observations which were indicating that a higher proportion of tsetse flies that land on artificial devices after feeding is very low compared to those that prefer landing on the tree branches and on the ground.

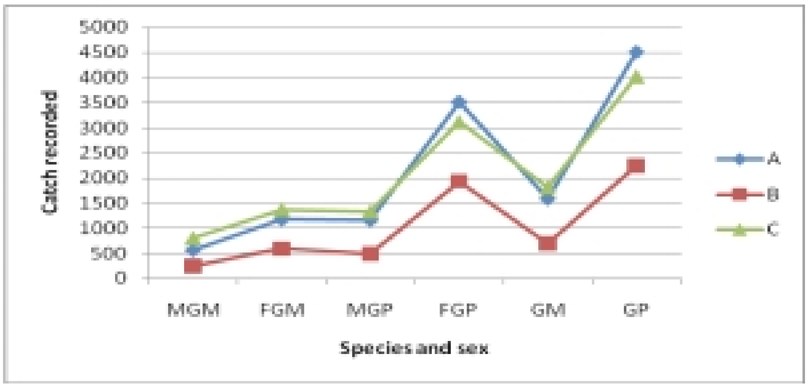

Figure 6: Treatment A, B and C for experiment 5. ***A****-catching on the animal body at 15 minute intervals (control);* ***B****-catching continuously on unwrapped upright logs;* ***C****-catching on unwrapped upright logs at 15 minute intervals.*

Experiment 5 was based on catch results and field observations from the previous experiments. The set up was designed to further increase catch levels. It was observed that the morsitans and pallidipes species prefer landing on the ground as well as at some height above the ground. Hence unwrapped upright logs were used in the experiment to cater for tsetse flies that prefer landing at some height above the ground.

Treatment effect on catch levels: Treatment had an impact on the landing behaviour of *Glossina pallidipes* and *Glossina morsitans* species at 5% level of significance. The distribution of *Glossina pallidipes* and *Glossina morsitans* and their position of landing preference are highly depended on treatment (<.001) as indicated on table 3. A value of 0.562 for *Glossina pallidipes* and 0.136 (table 5) for *Glossina morsitans* species indicate significant differences in catch levels between catching on the ox at 15 minutes intervals and catching on the logs continuously. Catching continuously on the logs introduces the presence of man at all times of which man has a repellent effect (Vale et al, 2000). This could have contributed to the low recordings on treatments with catches being done continuously (Figure 4 and 5). However, 15 minutes interval catches on the logs and catching on the ox at 15-minute intervals had little significant differences. Their mean value differences as shown in table 5 above did not vary significantly when compared with catching continuously on the logs. The findings implied that 15 minute interval catches which minimize man's presence increases catch levels for *Glossina morsitans* and *Glossina pallidipes*. This is an interesting finding that could alternatively be considered in the use of artificial devices to catch tsetse flies after feeding in experiments involving insecticide assessment.

Effect of site on catches: The results imply an even distribution of catches in all the three sites for the *Glossina morsitans* but the catch levels for this species were generally low (Table 2, Figures 2, 3, 4, 5 and 6). This could be due to the reason that, this strain of flies mainly prefers to attack moving bait animals than stationary objects (Thompson, 1982). For the *Glossina pallidipes* catch distribution varied significantly (0.246 for 1vs2, 0.149 for 1vs3) except for 2vs3 (0.097) (table 5). The sites 2 and 3 were towards the riverine area and the vegetation was dense and not as sparse as on site 1 in the Mopani area that recorded overall low catches. Site has a greater effect on *Glossina pallidipes* (Endeshaw et al, 1997). Research has shown that *Glossina pallidipes* and *Glossina tachinoides* were mainly encountered in wooded savanna and forest areas, and *Glossina fuscipes* in riverine vegetation. However, a decline in the prevalence of *Glossina morsitans* was observed (Endeshaw et al, 1997).

Results obtained by Mohamed-Ahmed and Wynholds (1997) for *Glossina fuscipes fuscipes* indicate that traps set at one meter from the forest edge caught 3.3 times as many males and 5 times as many females as those set inside or 10 meters away. These findings indicate that the Glossina species generally prefer dense vegetation. Vegetation is thus an important variable and hence site has an effect on the general catch levels of tsetse flies. However, the effect of site for *Glossina morsitans* is difficult to assess since this group of species prefer attacking moving objects. The effect of site was more pronounced on the *Glossina pallidipes* (0.003) as shown on table 3. In the hot season the highlighted species prefer riverine areas where there is a better shade and favorable moist air. Temperature and rainfall patterns have an effect on the distribution of tsetse flies (Hay, 1997). When the temperatures change to near normal their distribution is almost even from the riverine to sparse vegetation away from streams. This was to a larger extent noticed during the hot peak hours of the day for the pallidipes species.

Catches of *Glossina morsitans* were greatly affected by treatments and temperature. Mohamed-Ahmed and Wynholds, (1997) determine that light intensity and vegetation were the most important variables affecting the catches of each sex of *Glossina fuscipes fuscipes* in Kenya. This finding may also coincide with the effect of these variables on *Glossina morsitans* and *Glossina pallidipes*. If exposed to hot dry conditions for too long, tsetse will dry out and die (Warnes, 1997).

Experiment 1: The results on figure 2 indicate higher catches on alternating blue and black logs (treatment A). Field observations have indicated that although higher catches were recorded on alternating blue and black cloth, a greater proportion of the flies landed on the logs wrapped in black cloth on the same treatment. This had contributed to the formation of experiment 2 with blue and black logs on separate treatments. In a simple choice of blackness *vs* whiteness, *G. m. morsitans* showed a nine-fold greater preference for black; *S. calcitrans* displayed no preference (John and William, 1987). In a research carried out by Green (1986), it was determined that landing responses for *Glossina morsitans morsitans* Westwood and *Glossina pallidipes* Austen were generally strongest on black surfaces, and weakest on white, but the results for blue were variable. The *Glossina pallidipes* recorded higher catches compared to the *Glossina morsitans* species (figure 2). The *Glossina pallidipes* are known for attacking mainly stationary baits and this justify the higher catches for this species. The *Glossina morsitans* prefer to attack moving objects at times when they are most active (Vale et al, 2005). In some long established tsetse capture methods, it was discovered that stationary baits capture female tsetse to a much greater extent than fly round (Muirhed-Thomson, 1982). In this experiment, the investigation on tsetse post feeding behaviour is based on stationary baits (figure 1) and the preliminary results seem to agree with the literature findings.

Experiment 2: Findings from experiment 1 resulted in the formation of separate black and blue treatments. As can be noted on figure 3, logs wrapped in blue cloth (treatment C) have maintained higher catches throughout the experimental period with the treatment in black cloth giving low catches. Results of this experiment contradicted the findings presented for black and blue catch levels (figure 2, figure 3). Fully fed flies recorded higher catches on blue color (treatment C) than on black (treatment A), (figure 3). Results of experiment 1 and 2 could lead to a conclusion that fully fed tsetse flies prefer landing on black color if blue and black surfaces are set in close proximity. However, if black and blue colors are on distant separate sites more catches of fed *Glossina morsitans* and *Glossina pallidipes* will be recorded on blue color. The observation that had led to the design of targets and traps was in addition based on the statistical analysis that, tsetse fly is visually attracted by blue color but when it approaches the object in blue it lands on the black surface (Vale, 2003). This was also demonstrated by Green (1993) that, the number of tsetse attracted to a target increased in the order: yellow<green<red<blue. Black was as attractive as blue but tsetse flies prefer landing on the black color (Vale, 2003). Since this experiment focused on landing behaviour of fed flies the results could be vice-versa compared to hungry flies or they may favour to land on any object around the ox's vicinity. The findings for higher catches of fed flies landing on blue colour needs further research. However, a research carried out by Green and Flint (1986) indicate that the 'best' trap material was a royal blue cotton, which reflected blue-green strongly but very little ultraviolet or green-yellow-orange. A research by Green (1993) also indicate that landing responses of *G. m. morsitans Westwood* on black and blue targets were increased up to four-fold in the presence of carbon dioxide, but no significant effect of any other odours could be demonstrated.

Experiment 3: On experiment 3, catches were recorded continuously and at 15 minute-intervals on separate treatments. The 15 minutes intervals were introduced to annul the effect of man's presence since it has been found to have a repulsion effect on tsetse flies. Man had a diminshing or repellent effect on tsetse flies, particularly to the females for the *Glossina morsitans* (Muirhed-Thomson, 1982). This affect both sexes for *Glossina pallidipes* (Muirhed-Thomson, 1982). Under these parameters the control with catches being done at 15 minute-intervals on the ox (tratment A) gave higher catches as indicated on figure 4. Catches were done soon after the fly had fed. Field observations indicated that more flies were missed since this was done at 15 minutes intervals. During that 15 minute-interval gap more flies could have been captured. As was pointed out that the act of feeding by a fly terminates in two-three minutes (Austen, 1922). This implies that in every two minutes catches are expected to be recorded. The fly sometimes partly wthdraws its proboscis and thrusts it in again and again but once a satisfactory well of blood has been tapped, the abdomen feels rapidly, it then withdraws its proboscis and flies away (Austen and Hegh, 1922). With this observation, more flies could have been captured if the intervals for catching was adjusted to less than 15 minutes. Treatment C with recordings at 15 minute-intervals on the logs gave higher catches compared to treatment B (figure 4). This explains the effect of man's presence for the lower catches in treatment B where catches were done continuously on the logs. The female *Glossina pallidipes* overally recorded higher catches (figure 4).

Experiment 4: From the raw data it was possible to compare catch levels amomg treatments. Field observations had indicated that the proportion of tsetse flies that land on the artificial devices after feeding is very low compared to those that prefer landing on the tree branches and on the ground. Others even fly a distant away from the host after imbibition. This field observation had led to a futher modification of the experimental treatments whereby color was no longer being considered. The new design was taking into account devices that were as attractive as the natural resting sites of tsetse after feeding. Since these were mainly tree trunks and branches, the control was now compared with unwrapped horizontal natural logs. The *Glossina morsitans* displays a preference for baobab trees as resting sites, although any other kind of trees are preferred (Austen and Hegh, 1922). As indicated on the graph on figure 5, the control had higher catches followed by treatment C with catches done at 15 minute-intervals on the horizontal logs. The *Glossina pallidipes* had higher catches with the female flies dominating overally (figure 5). However, during the course of the experiment it was noted that flight path height of tsetse after feeding was important. The morsitans and pallidipes species prefer settling in colour conditions being correct, upto a full height being available (Austen and Hegh, 1922). In experiments carried out by Vale, the flight path of fed flies was below 95cm, meaning that flight path of tsetse after feeding is low and towards the ground and vegetation (Muirhed-Thomson, 1982). *G. m. morsitans* landed twice as frequently on a 15×30-cm vertical black stripe as on a horizontal one, but *S. calcitrans* preferred the horizontal one (John and William, 1987). There was need to further modify the treatments to take into account the flight path height of tsetse after feeding.

Experiment 5: Field observations indicated that the morsitans and pallidipes species prefer landing on the ground as well as at some height above the ground. The preferred landing site is depended on the fly's position on the animal body during feeding. The majority of flies feeding on the lower part of the legs landed on the ground and on the lower parts of tree trunks. Those that feed at any other position on or above the belly, landed on tree trunks and branches. Christopher Doku and John Brady (1989) in their laboratory set-up research have indicated that *Glossina morsitans prefers landing on upright devices than on horizontal features*.The set up of unwrapped upright logs was then designed with the aim of catching as many flies as was possible (figure 1). *Glossina morsitans* species rest upto six ft from the ground and female *Glossina morsitans* usually choose black tree trunk surfaces at 3-4ft from the ground, they mainly settle on the lower of the branches (Austen and Hegh, 1922). With the new set-up (experiment 5), the catch level has increased overally with *Glossina pallidipes* catches for the control and 15 minute-interval catches on the artificial devices exceeding four thousand (Figure 6). *Glossina morsitans* have maintained lower catches compared to the *Glossina pallidipes* and this was due to some reason that they mainly prefer attacking moving objects. The 15 minute-interval catches concurred with the repellent effect of man. From the results on figure 6, more flies were captured from the 15 minute-interval catches that minimise man's presence. Overally, the results of the control and treatment C indicates a small difference in terms of catch levels (Figure 6). Research has indicated that in Cote d'Ivore mean infection rates for herds inside tsetse fly control areas were significantly reduced compared to cattle outside tsetse control areas (Menninger, 1996). There is need to develop more cost effective methods for tsetse control. The use of Deltamethrin in place of DDT for ground spraying is more costly (Warnes, 1997). Controlling the disease through eradication of the vector is effective but it is important to develop new insecticides and techniques that can be used at low costs. Ground spraying is costly and alternatively pour-ons or insecticide treated animals can be used. This calls for the need to continuously develop new chemicals for use to control tsetse flies.

CONCLUSION

Glossina pallidipes and *Glossina morsitans* prefer landing mostly at some height of one meter and towards the ground after feeding. This mainly depends on the position that they take during their feed on the animal host. Man had a repellent effect on both fully fed *Glossina pallidipes* and *Glossina morsitans*. Unwrapped upright logs could alternatively be used to catch *Glossina pallidipes* and *Glossina morsitans* after feeding for the purpose of biological and chemical assays to determine the effectiveness of chemicals on trials. This could also avoid the rubbing effect on the animal body and hence eliminating contamination on the hand-nets.

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