

A New Trap For Glossina Morsitans as a Strategy for Quality Improvement of African Trypanosomiasis Control

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Abstract
The effectiveness of 4 traps including a newly designed trap for *Glossina morsitans* were compared. The traps were: the F3 trap, Epsilon trap, the new trap [Mbangala Trap] and Challier-Laveissier trap (biconical trap). All experiments, baited with acetone were replicated four times in 4 x 4 latin squares. The SPSS programme version 16 was used to analyze the data. Data were transformed to percentages (%) for comparison of trap catches and also subjected to a log (n+1) transformation prior to analysis of variance using F-test for significance between means and multiple comparison between trap types. Results showed that the new trap was most effective trap against *G. morsitans*. Out of a total of 782 flies caught within 16 days, the new trap caught 368 flies, representing 49%. This is followed was used to analyze the data. by Epsilon trap 26%; F3 trap 16% and biconical trap 9%. In the new trap, less material is required than for the biconical, F3 or Epsilon trap; the constructional details of the trap is given using locally available materials. The next step is to test the trap as a component of an appropriate technology for community participation and quality improvement of *G. Morsitans control.*
Keywords: Tsetse, Glossina morsitans, Tsetse traps, New trap [Mbangala Trap]

1. Introduction

It has become necessary to develop traps for sampling and control of *Glossina* with the particular emphasis on the search for traps capable of monitoring low tsetse population (Hall, 1986), evaluation for catching Glossina and, even for trap efficiency. Previously, the biconical trap (Challier & Laveissier, 1973) was used widely in Africa both for sampling and control especially for *G. palpalis* and as a standard with which to compare new designs. But the biconical trap is not the most effective trap for other *Glossina* species (Flint, 1985); and catches nine times greater using F2 trap developed following some basic guidelines (Vale, 1982) was reported. Efforts to reduce the cost is now on cost reduction and increase in efficiency. This was later replaced by the F3 trap, a blue version of the F2 and therefore taken as the starting point in an attempt to produce a cheaper, yet effective trap.

Although the Epsilon trap has been found to be very efficient for *Glossina morsitans* (Flint, 1985; Green & Flint, 1986) it is not easily affordable and there is the need to develop traps for cost-effective *Glossina* surveys and control.

This research therefore concentrates on the development of a new trap [Mbangala Trap], effective for *Glossina morsitans* using cheaper and more affordable materials readily available to the local migratory pastoralists. This new trap has been compared with other traps: F3, Epsilon and biconical traps. All experiments, baited with acetone were replicated four times in 4 x 4 latin squares. The SPSS Programme version 16 was used to analyze data. Results were that, catches for the new trap were significantly ($P < 0.05$) greater than the catches for Epsilon Trap and catches of the Epsilon Trap were significantly ($P < 0.05$) greater than the F3 trap; while catches of the F3 trap were significantly ($P < 0.05$) greater than the biconical trap.

1. Materials and Methods

Study area And Experimental design

Experiments were performed at Mbangala, Chunya a District in Tanzania (Longitude 8^o – 8^o 40'S and Latitude 32^o 15'- 33^o E) from January to February 2013. The study area consists mainly of Miombo Woodland with *Brachystegia Speciform* being the dominant trees of about 8-10 metres tall. Others are: *Isoberlina combretum*, *Diplorychus Spp*, *Terminalia Spp* and *Acasia Spp* all rangig between 5 to 8 metres in height.

Experiments were usually conducted from 15:30 hours and the catches were collected on 24 hour bases. All experiments were replicated four times in 4x4 Latin squares, so that position and day effects could be separated from treatment effects. The traps were placed 100 metres from each other at the trapping locations. Data were transformed to percentages for comparison of trap catches and also subjected to a log (n+1) transformation prior to analysis of variances using F-test (Zar, 1984;Kirkwood *et. al*; 2003) was used to test for significances between means.

Odour bait

Traps were baited with c.500 mg/h acetone in a standard dispenser of 250 me battle With an aperture of 0.6 cm.

The odour baits were positioned on the ground 30 cm from the base of the trap for biconicals and 30 cm in front of the entrance for F3, Epsilon and the new traps.

Results

The Tatal numbers and percent (%) catches of G. morsitans are presented in Table 1. [Table 1]

And Table 2 presents daily catches of Glossina morsitans (Log (x+1) of the various sites of the latin square design [Table 2]

Analysis of male and female catches are presented [Table 3]. The analysis for Total *Glossina morsitans* catches were analysed and presented in Table 4 and Table 5

Trap Designs.

The four types of traps used are described below, and their efficacies for Glossina morsitans are compared. The diagrams of traps show both plan (form above) and three dimensional views. The scale on all traps is the same, so that they can be compared directly.

(a) The F3 trap

From outside, the trap is blue box (Fig IC) and then from lower half is folded in to give an entrance with a horizontal shelf above. Except for the rear, all inside surfaces of the upper half of the trap are black, including the shelf. All inside surfaces of the lower half are blue, except for the rear which is black, (Fig I).

The cone is recessed half way into the trap, and is an asymmetric pyramid with its apex to the fore of centre and level with the trap top (Fig ID) made of plastic bottles and a collecting bag.

A blue tarpaulin groundsheet forms the floor of the trap and this can be greased or sprayed with an insecticide to deter ants. The trap is supported internally by a tubular frame, which also provides an external cage support. [Fig. 1]

(b) The Epsilon Trap

The Epsilon trap is blue outside, with the lower half of the front folded back into the trap to give a horizontal shelf. The target is a black vertical piece of cloth (0.5 x 1m) sewn into the rear of the trap and all other inside surfaces are blue. The cone is recessed, with its apex level with the top and forward of centre. It uses the same plastic cage design but lacks a groundsheet. It is supported internally by aluminium poles held upright by guy ropes. (Fig 2)

(c) The Biconical Trap (Challier-Laveissier)

The Biconical Trap consists of two cones each 80 cm wide, the upper comes each 73 cm high and the cower 60 cm high, joined at their widest point. The trap body is kept open by a metal or hoop sewn into the seam where the two cones join. The blue lower cone has four entrances, approximately 30 cm high and 20cm wide. The upper netting cone has a 12 mm hole to allow flies order (but not exit). He cage. Verticaly dividing the inside of the trap is a black craciform, which acts as both a target and baffle. For sampling, the trap is supported by a central pole; for control it is frequently hung from a convenient branch. When free-standing, the weight of the trap is supported at the upper cone apex by a welded wire cone, which also supports the Geigy cage (Fig 3).

[F3 and Epsilon traps were supplied by Low and Bonar Harare Zimbabwe (Flint, 1985), while the Biconical Traps, (Challier & Laveissier, 1973) and new trap were made from lightweight blue and black polyester/cotton and white nylon netting (Fig 4)**]**

Constructional details of the New Trap.

The new trap [Mbangala Trap = name of the study area] is blue outside, with the upper half of the front (120 x 22 cm) sewn separately to the 3 edges of the main cloth and then stitched to the white net. The target is a black piece of cloth 22 cm x 26 cm sewn onto each of the 3 blue cloth (90 cm x 52 cm). The cone is recessed, with the apex level with the top and forward of centre. It uses same plastic cage design as other 3 traps explained earlier but lacks ground sheet. The trap is supported by aluminium poles held upright by guy ropes (Fig 4) and constructional details in Appendix 1.

Discussion

Overall, 782 flies were caught during the 4 days. Of these, the new trap caught 49%. This is followed by the epsilon trap 26%; F3 trap and the Challier-Laveissier trap caught 16 % of flies. Thus it is statistically evident using the F-test that catches for the new trap is significantly ($p < 0.05$) more efficient than the epsilon trap; catches for the epsilon trap is more efficient ($p < 0.05$) than the F3 trap. The F3 trap is more effective than the Challier-Laveissier trap.

Furthermore, it was observed from the findings that there were more female flies (63%) as compared to males (37%). This may be explained by the fact that female flies live longer than male flies; thus under laboratory conditions, about 63 days in male and 140 days in female Glossina morsitans morsitans Westwood (Lehane & Mail, 2008).

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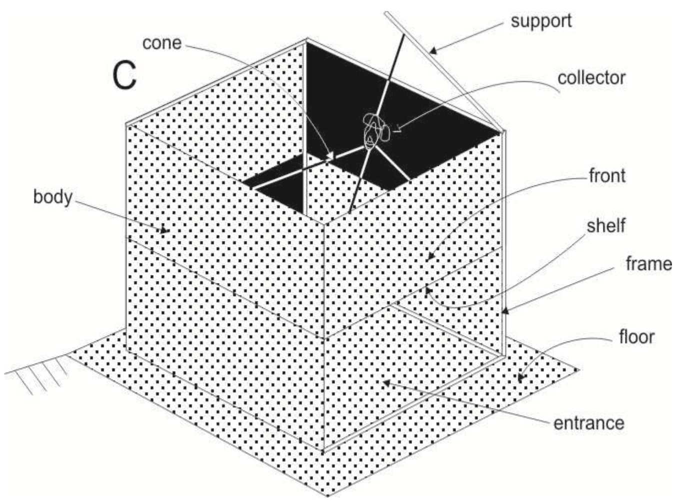


Figure 1: F3 trap

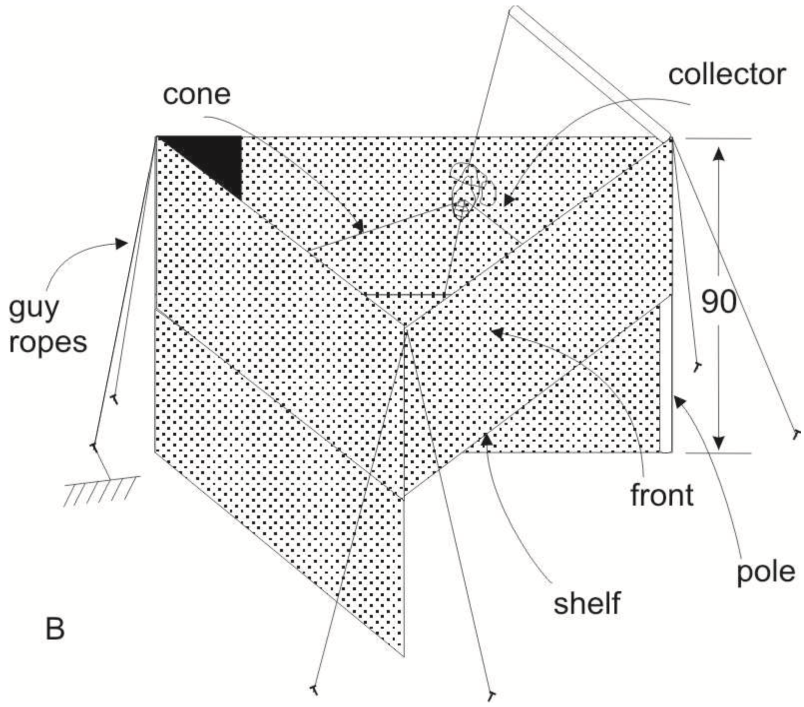


Figure 2: Epsilon Trap

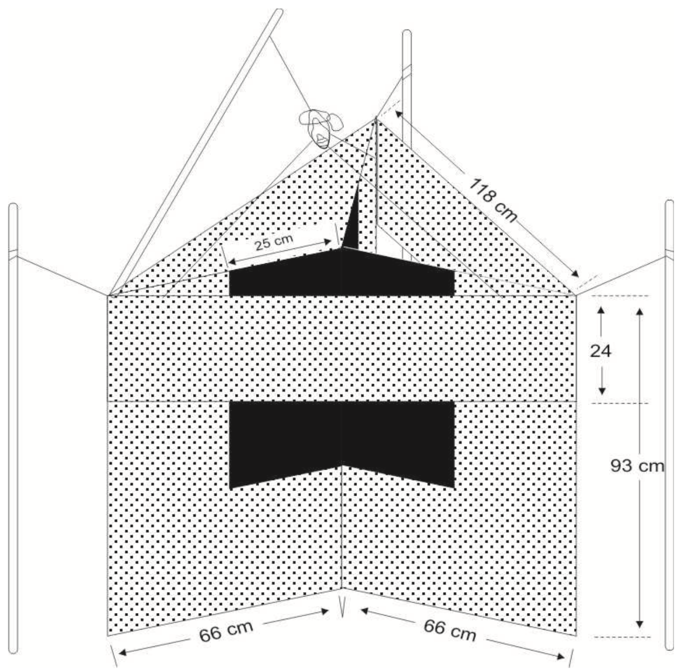


Figure 3: The new Trap

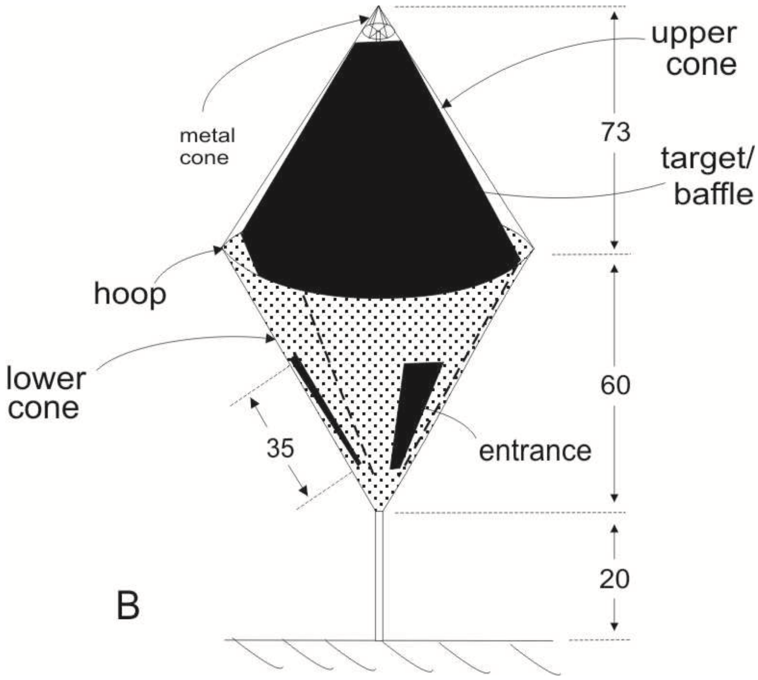


Figure 4: Challier-Laveissier Trap (Biconical Trap)

Analysis of Results

The dependent variable here is the number of *Glossina morsitans* [insects] caught
Using the independent variables of replicates, days and trap types,
The null hypotheses to be considered are:

H_0: There is no significant difference in the no. of insects caught

a. Between the different replicates of the experiment
b. Between days of the experiment
c. Between trap types

H_1: Exploring the data showed the distribution of number of *G. morsitans* to be non-normal within each of the dependent variables as well as the overall. This limits our use of generalized linear models (parametric methods) in trying to find out these differences. However, we transform the number of insects using their natural log, the "most normal" transformation (Table 6).

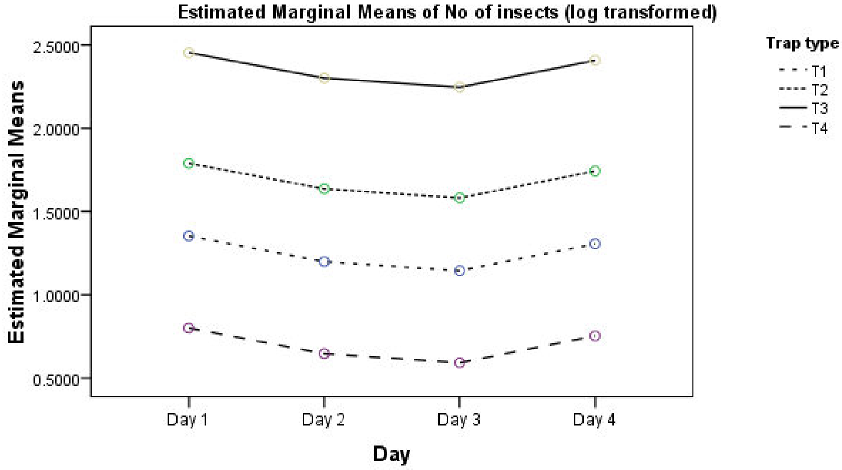


Figure 6 Marginal means of *Glossina morsitans* (Log transformed) for trap types (T1, T2, T3 and T4)

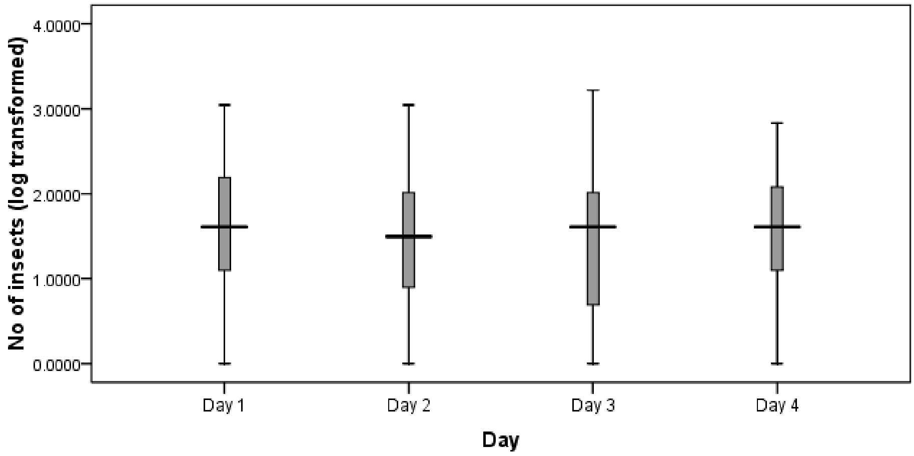
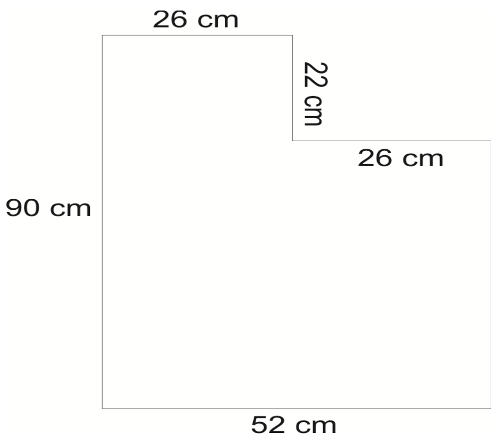


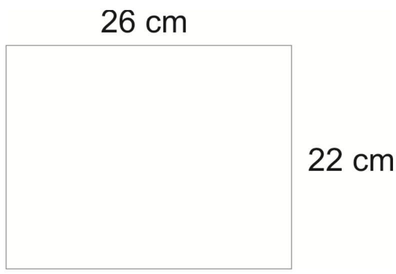
Figure 7: Numbers of *Glossina morsitans* (Log transformed) for various days of the experiment

Constructional details of the New Trap

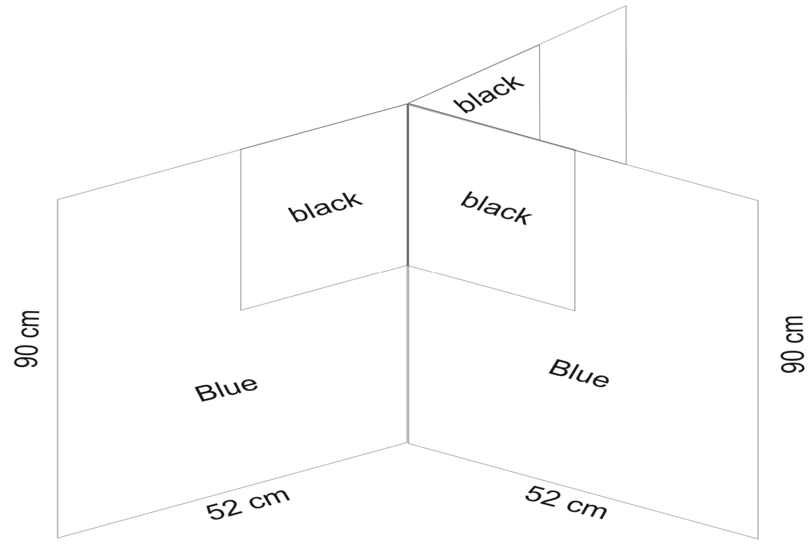
Step 1



Step 2



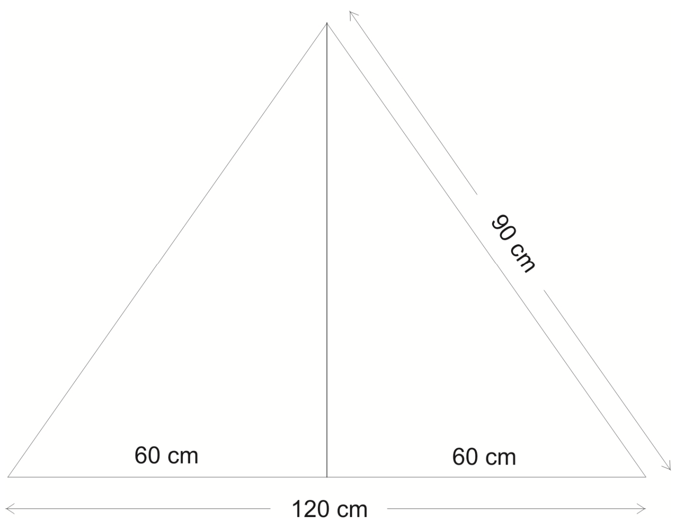
Step 3



Step 4

Cut **BD** and **EG** to make flap: lift flap to form entrance and shelf

Step 5



F3 Trap

Epsilon Trap

The new Trap (Mbangala Trap)

Challier-Laveissier (Biconical) Trap

Table 1: Total Numbers and Percentages (%) of Male and female *Tsetse Glossina morsitans caught*

Replicates	**Trap sites**	Day 1				Day 2				Day 3				Day 4			
		MALES	**FEMALES**	**Total**	**Trap**	**MALES**	**FEMALES**	**Total**	**Trap**	**MALES**	**FEMALES**	**TOTAL**	**Trap**	**MALES**	**FEMALES**	**Total**	**Trap**
A	1	2	3	5	T4	6	12	18	T3	2	4	6	T2	2	3	5	T1
	2	2	2	4	T1	1	3	4	T4	5	7	12	T3	3	5	8	T2
	3	3	5	8	T2	2	3	5	T1	1	1	2	T4	8	11	19	T3
	4	8	13	21	T3	4	6	10	T2	1	3	4	T1	2	3	5	T4
B	5	10	18	28	T3	5	7	12	T2	2	5	7	T1	1	2	3	T4
	6	1	4	5	T4	6	8	14	T3	3	7	10	T2	2	7	9	T1
	7	4	6	10	T1	1	3	4	T4	12	25	37	T3	5	10	15	T2
	8	3	7	10	T2	3	5	8	T1	2	3	5	T4	6	11	17	T3
C	9	6	12	18	T3	2	3	5	T1	1	2	3	T4	8	17	25	T3
	10	10	15	25	T4	7	10	17	T2	5	7	12	T1	2	5	7	T4
	11	3	5	8	T1	12	20	32	T3	5	10	15	T2	4	7	11	T1
	12	2	6	8	T1	1	3	4	T4	8	11	19	T3	5	8	12	T2
D	13	4	6	10	T1	1	2	3	T4	10	15	25	T3	7	11	18	T2
	14	3	7	10	T2	2	5	7	T1	1	1	2	T4	7	10	17	T3
	15	10	21	31	T3	4	8	12	T2	3	5	8	T1	1	3	4	T4
	16	2	3	5	T4	13	21	44	T3	7	14	21	T2	5	7	12	T1
TOTALS		**73**	**133**	**206**		**70**	**119**	**199**		**68**	**120**	**188**		**68**	**120**	**188**	

∑ Males : 278 (37%)
Females: 492 (63%)

GRAND TOTAL 782

Table 2: Log_{10} (x+1) transformation of **Male** Tsetse *Glossina morsitans*

Experimental Replicates	**Trap sites**	Day 1			Day 2			Day 3			Day 4		
		MALES	**Log_{10} (x+1)**	**Trap**	**MALES**	**Log_{10} (x+1)**	**Trap**	**MALES**	**Log_{10} (x+1)**	**Trap**	**MALES**	**Log_{10} (x+1)**	**Trap**
1	1	2	0.4771	T4	6	0.8451	T3	2	0.4771	T2	2	0.4771	T1
	2	2	0.4771	T1	1	0.300	T4	5	0.7782	T3	3	0.6021	T2
	3	3	0.6021	T2	2	0.4771	T1	1	0.3010	T4	8	0.9542	T3
	4	8	0.9542	T3	4	0.6989	T2	1	0.3010	T1	2	0.4771	T4
2	5	10	1.0414	T3	5	0.7782	T2	2	0.4771	T1	1	0.3010	T4
	6	9	0.9031	T4	6	0.8451	T3	3	0.6021	T2	2	0.4771	T1
	7	4	0.6989	T1	1	0.3010	T4	12	1.1139	T3	5	0.7782	T2
	8	3	0.6021	T2	2	0.6021	T1	2	0.4771	T4	6	0.8451	T3
3	9	6	0.8451	T2	2	0.4771	T1	1	0.3010	T4	8	0.9542	T3
	10	10	1.0414	T3	7	0.9031	T2	5	0.7782	T1	2	0.4771	T4
	11	3	0.6021	T4	2	1.1139	T3	5	0.7782	T2	4	0.6989	T1
	12	2	0.4771	T1	1	0.3010	T4	8	0.9542	T3	5	0.7782	T2
4	13	4	0.6989	T1	1	1.3010	T4	10	1.0414	T3	7	0.9031	T2
	14	3	0.6021	T2	2	4771	T1	1	0.3010	T4	7	0.4031	T3
	15	10	1.0414	T3	4	0.6989	T2	3	0.6021	T1	1	0.3010	T4
	16	2	0.4771	T4	3	1.1461	T3	7	0.9031	T2	5	0.7782	T1
	∑	73	11.5412		70	9.4891		68	10.1867		68	10.7057	
	∑ X		41.9227										

Table 3: Log_{10} (x+1) transformation of **Female** Tsetse *Glossina morsitans*

Experimental Replicates	**Trap sites**	Day 1			Day 2			Day 3			Day 4		
		FEMALES	**Log_{10} (x+1)**	**Trap**	**FEMALES**	**Log_{10} (x+1)**	**Trap**	**FEMALES**	**Log_{10} (x+1)**	**Trap**	**FEMALES**	**Log_{10} (x+1)**	**Trap**
1	1	3	0.6021	T4	12	1.1139	T3	4	0.6989	T2	3	0.6021	T1
	2	2	0.4771	T1	3	0.6021	T4	7	0.9031	T3	5	0.7782	T2
	3	5	0.7782	T2	3	0.6029	T1	1	0.3010	T4	11	1.0792	T3
	4	13	1.1462	T3	6	0.8451	T2	3	0.6021	T1	3	0.6021	T4
2	5	18	1.2788	T3	7	0.9031	T2	5	0.7782	T1	2	4771	T4
	6	4	0.6981	T4	8	0.9542	T3	7	0.9031	T2	7	0.9031	T1
	7	6	0.8451	T1	3	0.6021	T4	25	1.4149	T3	10	1.0414	T2
	8	7	0.9031	T2	5	0.7782	T1	3	0.6021	T4	11	1.0792	T3
3	9	12	1.1139	T2	3	0.6021	T1	2	0.4771	T4	7	1.2553	T3
	10	15	1.2041	T3	10	1.044	T2	7	0.9031	T1	5	0.7782	T4
	11	5	0.7782	T4	20	1.3222	T3	10	0.0414	T2	7	0.9031	T1
	12	6	0.8451	T1	3	0.6021	T4	11	1.0792	T3	8	0.9542	T2
4	13	6	0.8451	T1	2	0.4771	T4	15	1.2041	T3	11	1.0792	T2
	14	7	0.9031	T2	5	0.7782	T1	1	0.3010	T4	10	1.0414	T3
	15	21	1.3421	T3	8	0.9542	T2	5	0.7782	T1	3	0.6021	T4
	16	3	0.6021	T4	21	1.3424	T3	14	1.1761	T2	7	0.9031	T1
∑			**14.3627**			**13.5205**			**13.1636**			**14.0790**	
∑ X													

Table 4: Log_{10} (x+1) transformation of Tsetse *Glossina morsitans*

Experimental Replicates	**Trap sites**	Day 1		Day 2		Day 3		Day 4	
		Log_{10} (x+1)	**Trap**	**Log_{10} (x+1)**	**Trap**	**Log_{10} (x+1)**	**Trap**	**Log_{10} (x+1)**	**Trap**
1	1	0.7782	T4	1.2788	T3	0.8451	T2	0.7782	T1
	2	0.6989	T1	0.6989	T4	1.1139	T3	0.9542	T2
	3	0.9542	T2	0.7782	T1	0.4771	T4	1.010	T3
	4	1.3424	T3	1.0414	T2	0.6989	T1	0.7782	T4
2	5	1.4624	T3	1.1139	T2	0.9031	T1	0.6021	T4
	6	0.7782	T4	1.1761	T3	1.0414	T2	1.0000	T1
	7	1.0414	T1	0.6989	T4	1.5798	T3	1.2041	T2
	8	1.0414	T2	0.9542	T1	0.7782	T4	1.2304	T3
3	9	1.2788	T2	0.7782	T1	0.6021	T4	1.4149	T3
	10	1.4624	T3	1.2553	T2	1.1139	T1	0.9031	T4
	11	0.9542	T4	1.5185	T3	1.2041	T2	1.0792	T1
	12	0.9542	T1	0.6989	T4	1.3010	T3	1.1139	T2
4	13	1.0414	T1	0.6021	T4	1.4149	T3	1.2788	T2
	14	1.0414	T2	0.9031	T1	0.4771	T4	1.2553	T3
	15	1.5052	T3	1.1139	T2	0.9542	T1	0.6989	T4
	16	0.7782	T4	1.6532	T3	1.3442	T2	1.1139	T1
∑ x		**17.1129**		**16.2636**		**15.8492**		**16.7062**	
∑ X^2		**312.2064**							

Table 5: Total fly catches for Trap Types for Tsetse *Glossina morsitans*

T1 (F3 TRAP)	T2 (EPSILON TRAP)	T3 (NEW TRAP)	T4 (CHALLIER-LAVEISSIER TRAP
4	**8**	**21**	**5**
5	10	18	4
4	6	12	2
5	8	19	5
7	12	28	3
9	10	14	5
10	15	37	4
8	10	16	5
5	18	25	3
12	17	28	7
11	15	32	8
8	12	19	4
10	18	25	3
7	10	17	2
8	12	31	4
12	21	44	5
∑ 125	202	386	69
Mean 14.71	**23.76**	**45.41**	**8.12**
% 16%	**26%**	**49%**	**9%**

Table 6: Tests of Between-Subjects Effects

Dependent Variable: No: of insects (log transformed)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	52.097[a]	9	5.789	22.473	.000
Intercept	286.938	1	286.938	1.114E3	.000
Replicate	4.289	3	1.430	5.550	.001
Day	.875	3	.292	1.133	.339
Trap type	46.933	3	15.644	60.736	.000
Error	30.395	118	.258		
Total	369.430	128			
Corrected Total	82.492	127			

a. R Squared = .632 (Adjusted R Squared = .603)

Table 6 shows that significant differences exist between replication of the experiments ($p<0.05$) and also between trap types ($p<0.001$) in terms of no. of insects caught. There are no significant differences between the days ($p=0.339$)

Having seen that differences exist within replicates and trap types, there is the need to find out specifically where the differences are through post-hoc comparison tests (Table 2).

Table 7: Multiple Comparisons (Replicates)

No of insects (log transformed) Tukey HSD

(I) Replicate	(J) Replicate	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	-.310427	.1268811	.074	-.641082	.020227
	C	-.487377*	.1268811	.001	-.818031	-.156722
	D	-.393888*	.1268811	.013	-.724542	-.063233
B	A	.310427	.1268811	.074	-.020227	.641082
	C	-.176949	.1268811	.505	-.507604	.153706
	D	-.083460	.1268811	.913	-.414115	.247195
C	A	.487377*	.1268811	.001	.156722	.818031
	B	.176949	.1268811	.505	-.153706	.507604
	D	.093489	.1268811	.882	-.237166	.424144
D	A	.393888*	.1268811	.013	.063233	.724542
	B	.083460	.1268811	.913	-.247195	.414115
	C	-.093489	.1268811	.882	-.424144	.237166

Based on observed means.
The error term is Mean Square (Error) = .258.

*. The mean difference is significant at the 0.05 level.

With the replicates, the differences occur between A and C ($p<0.05$) and between A and D ($p<0.05$) as shown above. There were no significant differences between other replicates (Table 7).

It is important to compare Trap types to determine their efficacies and for use in research and vector control. These traps (T, T2, T3 and T40 have been compared and presented in Table 3

Table 8. Multiple Comparisons (Trap types)

No of insects (log transformed) Tukey HSD

(I) Trap type	(J) Trap type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
T1	T2	-.436743*	.1268811	.004	-.767398	-.106088
	T3	-1.101462*	.1268811	.000	-1.432116	-.770807
	T4	.552723*	.1268811	.000	.222068	.883377
T2	T1	.436743*	.1268811	.004	.106088	.767398
	T3	-.664719*	.1268811	.000	-.995373	-.334064
	T4	.989466*	.1268811	.000	.658811	1.320120
T3	T1	1.101462*	.1268811	.000	.770807	1.432116
	T2	.664719*	.1268811	.000	.334064	.995373
	T4	1.654184*	.1268811	.000	1.323530	1.984839
T4	T1	-.552723*	.1268811	.000	-.883377	-.222068
	T2	-.989466*	.1268811	.000	-1.320120	-.658811
	T3	-1.654184*	.1268811	.000	-1.984839	-1.323530

Based on observed means.
The error term is Mean Square (Error) = .258.

*. The mean difference is significant at the 0.05 level.

Table 8 shows significant differences between all the different trap types, ($p<0.001$) in most cases. Furthermore, Graphs (Figures 5 and 6) were plotted to show differences in estimated marginal means of trap types and catches of insects (log transformed). It is clear from these graphs that the new trap (Mbangala Trap) was most effective for *Glossina morsitans*.