Rev. Elev. Méd. vét. Pays trop., 1982, **35** (2) : 165-172.

Observations on and comparisons of various traps for the collection of Glossinidae and other Diptera in Africa

by LEE RYAN and DAVID H. MOLYNEUX

Department of Biology, University of Salford, Salford M5 4WT, U.K.

RÉSUMÉ

Etudes et comparaisons de différents pièges pour la collecte de *Glossinidae* et autres diptères en Afrique

L'efficacité relative de différents pièges (pièges biconiques, pièges de Manitoba, pièges adhésifs diversement colorés ; piège de Catts ; piège à eau ; pièges de Moloo et de Swynnerton) a été comparée par des méthodes faciles à mettre en œuvre et ayant déjà fait leurs preuves. Les pièges biconiques standards capturent au moins deux fois plus de *Glossina palpalis* s.l. et de *G. morsitans centralis* que tous les autres pièges, mais ils ne récoltent que peu de simulies ou de tabanides. Les pièges Manitoba capturent huit fois plus de *Tabanus taeniola, T. gratus* et *T. par* que les autres pièges. Les pièges adhésifs, à eau et Malaise récoltent diverses espèces, mais en très faibles quantités. La capture au filet à main sur un homme appât est comparée aux pièges biconiques et à des écrans adhésifs ou électriques portés à dos d'homme pour *G. palpalis* s.l. ; à la capture dans un véhicule en mouvement et aux pièges biconiques pour *G. morsitans centralis*. Des essaims suiveurs de cette dernière espèce ont été observés et capturés ; par contre *G. palpalis* s.l. est peu attirée par l'homme. Le ton de la teinture bleue du matériel utilisé pour les pièges biconiques influe de façon décisive sur la capture de *G. tachinoides*, mais pas sur celle de *G. palpalis* s.l. La collecte de *G. morsitans centralis* à l'aide d'appareils mobiles fournit un grand nombre de mâles âgés et quelques jeunes femelles, alors qu'avec *G. palpalis* s.l. on n'obtient que de très faibles quantités de chacune de ces catégories. Par contre les pièges biconiques capturent, pour ces deux espèces, de grandes quantités de chaque sexe, avec une bonne représentation de tous les âges. L'inverse est vrai pour les femelles de *Simulium damnosum* s.l. qui approchent volontiers l'homme mais sont très peu attirées par les pièges biconiques. De petits nombres de conopides *Stylogaster leonum*, de *G. pallicera* et de *G. fusca* ont également été capturés par les pièges biconiques.

INTRODUCTION

The 3-dimensional, visually attractive traps developed specifically for tabanids, the Manitoba trap (34) and canopy trap (4), have not yet been evaluated for catching tsetse (*Glossina* spp.). Prior to this study, the biconical trap (7, 23), as far as we are aware, has not yet been used to sample tabanids or simuliids (28). Several types of traps have found only limited use sampling tsetse, such as the Malaise trap (31) sticky traps (Dr D. A. TURNER, pers. comm.) and water traps (9, 35).

Compared to the plethora of new tsetse trap designs in the first half of this century (12, 8, 33, 13, 19), the latter half has provided few new trap designs (15, 7, 18, 10). The most widely used trap for tsetse is the biconical trap (7). Five colour combinations were compared (6) showing a blue lower cone with black inner baffles to catch at least two-times more than others tested.

The present paper compares relative trapping efficiencies for tsetse and tabanids for the traps named above, including four different colour combinations of biconical trap, a smaller easier to make biconical, Moloo and Swinnerton traps. Specially constructed biconical traps were assessed for catching blackflies (*Simulium* spp.). Vector collector catches and vehicle collection catches were also made for comparison.

MATERIALS AND METHODS

The studies were undertaken during March 1979 at area I in Upper Volta, April 1979 at area III and IV in Ivory Coast, May 1979 at area II in Togo, February/March 1980 at area Va and b in Ivory Coast and June/July 1980 at area VI in Zambia as part of a project to provide automated sampling devices (25) and to study tsetse ecology (26).

Study sites

Area I harboured *Glossina tachinoides* Westwood on the River Bougouriba, 100 km from Bobo Dioulasso, Upper Volta (11°4′N, 3°30′W). Traps were placed 100 m apart upstream from the crossing of the road to Diebougou.

Area II harboured *Simulium damnosum* s.l. and *G. palpalis palpalis* R-D, at Djodje on the River Wawa at the Togo/Ghana border (7°43′N, 0°35′E).

Area III harboured *G. palpalis* s.l. and tabanids near the village of Kondorobo, 60 km from Bouaké, Ivory Coast (7°28′N, 4°35′E).

Area IV harboured *G. palpalis* s.l. on the route between Koudougou and Degbézéré, 12 km from Bouaflé, Ivory Coast (6°57′N, 5°39′W).

Area Va harboured *G. palpalis* s.l. and tabanids near the village of Zagoutta, and Vb harboured *G. palpalis* s.l., *G. fusca* and *G. pallicera* in the plantations 2 km from the village of Zagoutta, 12 km from Bouaflé, Ivory Coast (6°56′N, 5°36′W).

Area VI harboured *G. morsitans centralis* in the Kabulwebulwe Resettlement Area, Central Province, Zambia (15°S, 27°E).

Capture methods

The methods of capture used were as follows :

1. Hand netting at human bait : a) from the man, b) from the surrounding ground.
2. Hand capture in a slow moving vehicle.
3. Electric backpacks (22) having a piece of blue cotton material 50 cm long by 30 cm wide under the grid.
4. Sticky backpacks (17) of blue cotton material, 50 cm by 30 cm, covered in 3 mm thickness of Oecotak A10 non-setting adhesive as this glue was found to be superior to others available (24).
5. Manitoba traps (34), a) with and b) without the black sphere covered in Oecotak, c) with a blue sphere, d) with a dull white sphere and e) with a bright white sphere. The sphere is an 80 cm collapsible frame covered by the cotton material. This design differs from others (21, 1) in having only one central support, which does not allow as much movement of the sphere as a tripod support and which is lighter and easier to assemble.
6. Canopy traps (4) with a 1 m diameter canopy opening.
7. Sticky traps comprising 50 cm squares of cotton material covered with Oecotak, a) black, b) blue and c) bright white.
8. Malaise traps (16) modified to have a central supporting pole and three sides held open by guy lines. The three internal baffles with their attached 40 cm side baffles lead up to a collecting cone. Each trap has therefore three entrances 1.2 m high by 60 cm wide.
9. Water traps made of a 40 cm diameter 8 cm deep tray filled with water and detergent supported 1 m high, a) white, b) blue.
10. Moloo trap, (18).
11. Swynnertons AS trap (33) — a collapsible cloth model supported by two poles and guys. Skirts were attached to convert this to a Moloo trap.
12. Biconical traps (7) with diameter of 80 cm and 1.4 m high.
13. Biconical traps as described by RYAN and MOLYNEUX (23) a) with a lower blue cone of an unknown blue dyed plain weave nylon (109 gm^{-2}) and b) with an upper collecting cone of 80-mesh polyester netting.

14. Biconical traps as described by RYAN and MOLYNEUX (23) a) with blue lower cone and black baffles, b) with blue lower cone and bright white baffles, c) with black lower cone and dull white baffles, d) with black lower cone and bright white baffles.

15. Bipyramidal traps are three 80 cm sided, 1.2 m high, versions of the biconical trap and are cheaper and easier to construct.

16. Biconical traps suspended from overhead trees.

17. Biconical traps with sticky inserts placed either on the inner baffles or at the entry ports.

All traps had a sticky band on the supports 5 cm above ground to prevent access and predation by ants. Collecting cones of all traps and the complete Malaise trap were made of grey plastic coated, glass fibre netting. All other materials were unfinished cotton, dyed black, white or blue. In the description above, dull white and bright white refer to the absence or presence of optical brighteners. Blue material in the text refers to cotton dyed with Phthallogen Blue IF3GM (23).

Most traps were compared in a 5 × 5 latin square design although randomised block designs were used too, the chosen method is shown in the Results. Comparisons between traps and hand capture at human bait or vehicle are considered qualitatively, quantitative differences must be accepted with the limitations of experimental design.

Unless otherwise stated traps were spaced 50 m apart and where possible out of sight of adjacent traps. Traps were emptied at least once a day and the numbers of flies (n) transformed to $Log_{10}(n + 1)$ (38), before analysis of variance (32). Numbers in parenthesis refer to traps described above.

RESULTS

Table I shows total catch of *G. tachinoides* for the two replicate comparisons of the 3 biconical trap designs. On both occasions the large and small biconical traps (14a & 12) caught 1.5 to 6 times more flies than the biconical trap with a shiny blue lower cone (13a). In the initial trial the large biconical trap (14a) caught more than 4 times the number caught by the small biconicals, whereas the replicate showed no significant difference.

TABLE I -Number of *G. tachinoides* collected by 3 types of biconical trap in Area I compared by a randomised block design with 5 replicates during two periods of 28h with traps 100m apart and 50h with traps 30m apart

	Numbers of specimens collected in [1]			
Period of	14a	13a	12	Total
28 h	311a[2]	53c	74b	438
50 h	210a	82b	180a	472
Total	521	135	254	910

1. Trap type
   14a Biconical trap (large) with black baffles and blue lower cone
   13a Biconical trap (large) with shiny blue lower cone
   12 Biconical trap (small).
2. Numbers followed by the same letter horizontally are not significantly different at the 5 % level of confidence by analysis of variance of the transformed data ($Log_{10}(n + 1)$).

Table II shows total catch of *G. palpalis* s.l., *Tabanus taeniola* Palisot de Beauvois, *T. gratus* Leow and *T. par* Walker for the latin square designed experiment to compare 5 different traps. The biconical traps with two different coloured blue lower cones (13a & 14a) caught more than 10 times the total catch

TABLE II-Number of tabanids and tsetse collected by different traps in Area III compared by a latin square design

	Number of specimens collected in [3]					
Species	14a	13a	17	5b	6	Total
G. palpalis s.l.	200a	383a	26b	8c	2c	619
Tabanus taeniola	8b	7b	0b	68a	5b	88
T. gratus & *T. par*	2b	5b	0b	29a	1b	37
Total	210	395	26	105	8	744

3. Trap type : 5b Manitoba trap with black sphere ; 6 Canopy trap ; 13a Biconical trap (large) with shiny blue lower cone ; 14a Biconical trap (large) with black baffles and blue lower cone ; 17 Biconical trap (large) with sticky inserts.
2. As for Table I.

of biconical traps with sticky inserts, black Manitoba traps or canopy traps (17, 5b & 6) but themselves were not significantly different. Manitoba traps with black spheres (5b) caught at least 8 times more tabanids than the other traps which only caught between 6 and 12 flies over 11 days.

Table III shows total catch of *G. palpalis* s.l. for the latin square designed comparison of 12 different traps. The standard biconical trap (14a) caught at least 2 times as many flies as any other of the different coloured biconical traps (14b, c & d). The biconical with blue lower cone and bright white baffles (14b) caught at least 2 times more flies than the other colour combinations. The bipyramidal trap (15) caught less than half the number caught by the standard biconical but at least 2 times the number caught by Manitoba (5b, c, d & e), Malaise (8), Moloo (10) or Swynnerton (11) traps which all caught only in single figures each day.

Table IV shows total catch of *G. morsitans centralis* for the latin square designed comparisons of 16 different traps. The overall conclusions are much the same as for *G. palpalis* s.l. with the standard biconical (14a), blue/white biconical (14b) and bipyramidal (15) traps catching totals decreasing by factors of two or more but all three catching at least 2 times as many as the other traps.

In Area Vb 5 standard biconical traps (14a) during 10 days caught 169 *G. palpalis* s.l., 14 *G. pallicera* and 8 *G. fusca,* whereas out of 5 white, 5 blue and 4 black sticky traps only 2 *G. palpalis* were caught by the blue sticky traps. This result contrasts with results for *G. morsitans centralis* (table IV) where during 19 days 72, 50 and 12 tsetse were caught by 5 blue, white and black sticky traps (7), respectively, compared to 487 caught by 5 biconical traps.

Tabanids were caught occasionaly by biconical and Malaise traps but 8 times as many were caught using black Manitoba traps. In Area Va Manitoba traps with white, blue and black spheres caught 43, 41 and 65 *T. taeniola, T. gratus* and *T. par* and 6 conopids whereas during the same period biconical traps caught no conopids 6 *T. taeniola* and 3 *T. gratus.*

In Area II 2 biconical traps (13b) were positioned near known breeding sites of *Simulium* spp. for 8 days and captured 61 *S. damnosum* s.l. 18 *G. palpalis palpalis* and 7 *Stylogaster leonum* West. (Conopidae). When traps were raised to 2 m and 10 m or had a 12 V blacklight source incorporated only Lepidoptera and *Antocha* spp. (Tipulidae) were captured. WHO Onchocerciasis Control programme vector collectors visited the site, catching flies for 11 h on 2 days, separated by a 1-week interval and on both occasions collected in excess of 1 300 *S. damnosum* s.l.

Table V summarises results from two comparisons of different sampling techniques, the first comparing three methods of capture from a human bait (1a & b, 3 & 4) and biconical traps and the other comparing biconical traps (14a), capture from a vehicle (2) and from human bait (1a & b).

TABLE III - Number of *G. palpalis* s.l. collected by different traps in Area Va compared by a latin square design

Number of trap days	Number of specimens collected in [4] 14d	14a	14b	14c	15	5d & e	5b	8	5c	11	14a	10	All traps
2	9d	38a	26b	5d	22c	-	-	-	-	-	-	-	100
1,5	27d	159a	72b	8d	63c	-	-	-	-	-	-	-	329
3	26d	199a	148b	-	88c	-	-	-	-	-	-	-	461
2	34c	141a	53b	-	49bc	-	-	-	-	-	-	-	277
5	-	215a	154b	-	73c	37d	-	-	-	-	-	-	479
3	-	111a	56b	-	-	-	26c	15c	-	-	-	-	208
3	-	67a	39b	-	-	-	-	-	25c	3d	-	-	134
5	-	131a	-	-	-	-	-	-	30b	-	62a	12b	235
Total	96	1061	548	13	295	37	26	15	55	3	62	12	2223
Avg/trap/day	11.3	43.3	28.1	3.7	21.9	7.4	8.7	5	6.9	1	12.4	2.4	

4. As for Table IV; 2. As for Table I.

TABLE IV-Number of *G. morsitans centralis* collected by different traps in Area V compared by a latin square design

Number of trap days	Number of specimens collected in[4]															
	14b	14d	14a	14c	14a	5d&e	8	5b	15	16	5c	9a&b	7c	7b	7a	All traps
4	30b[2]	11c	96a	16b	90a	-	-	-	-	-	-	-	-	-	-	243
4	23b	7b	-	4c	92a	0d	-	-	-	-	-	-	-	-	-	126
7	48b	-	-	-	104a	-	7c	3c	29b	-	-	-	-	-	-	191
7	20b	-	-	-	106a	-	-	-	34b	109a	5c	-	-	-	-	274
19	-	-	-	-	487a	-	-	-	-	-	-	2c	50b	72b	12c	623
Total	121	18	96	20	879	0	7	3	63	109	5	2	50	72	12	1457
Total per trap day	5.5	2.25	24	2.5	21.4	0	1	4.5	0.4	15.57	0.7	0.1	2.63	3.79	0.6	

4. Trap type : 5. Manitoba traps. b - Black sphere, c - blue sphere, d - dull white sphere, e - bright white sphere. 7. Sticky traps. a - black, b - blue, c - bright white. 8. Malaise traps. 9. Water traps. a - white, b - blue. 10. Moloo trap. 11. Swynnerton trap. 14. Biconical trap (large); lower cone : baffles. a - blue : black, b - blue : bright white, c - black : dull white, d - black : bright white. 15. Bipyramidal traps. 16. Biconical trap (swinging) (14a).

2. As for Table I.

TABLE V a. Number of *G. palpalis* s.l. collected by different sampling techniques in Area IV during a 24hr period

Numbers of specimens collected in[5]				
1a & b	3	4	14a	Total
1	3	2	46	52

TABLE V b Numbers of *G. morsitans centralis*, percentage females, percentage tenerals and mean age for different sampling techniques in Area VI

Sampling methods	Number of sampling days	Sample Size Male	Sample Size Female	Mean Wing Fray Male	Mean Wing Fray Female	p.100 Female	Mean ovarian Age	p.100 Teneral Male	p.100 Teneral Female
14a	19	291	197	2.1	2.5	40.4	3.5	15.1	6.9
2	2	146	87	1.6	1.4	37.3	2.4	34.9	36.8
1a	2	110	41	1.5	1.3	37.3	1.5	21.8	65.9
1b	2	583	6	2.2	1.0	1.0	-	1.5	50.0

5. Capture methods : 1a & b Hand netting from human bait; 2 Hand capture in a slow moving vehicle ; 3 Electric backpack ; 4 Sticky backpack ; 14a Biconical trap (large).

DISCUSSION

Absolute trap efficiency is the number of flies n, expressed as a percentage, removed from a population of size N, per trapping unit per unit time. Without knowledge of population size or growth rate (27) only relative efficiency may be assessed by comparison with other traps. This study and others (30, 21, 6) determine the relative efficiency of traps to attract and retain flies. In other studies the attraction is performed by odour (10, 11, 36) and 100 p. 100 efficiency is taken as an electrocuting grid. In this study, various traps and sampling methods are compared to the biconical trap. None of the traps considered caught more than half the number of tsetse caught by biconical traps, but as is already known the Manitoba traps caught 8 times as many tabanids as other traps and Malaise, Water and Sticky traps caught a more diverse sample.

From tables III and IV, groups of traps decrease in efficiency for catching *G. palpalis* s.l. and *G. morsitans centralis* in the following order: stationary or swinging biconical (blue/black 14a) > biconical (blue/bright white 14b) and bipyramidal (15) > biconical (black/dull white 14c) and (black/bright white 14d) > Sticky traps (7), Manitoba traps (5), Canopy traps (6), Malaise traps (8), Moloo traps (10), Swynnerton traps (11), Water traps (9) where a difference is only judged significant at the 5 p. 100 confidence level or better.

Clearly the biconical shape is important as is the colouring. From table I, the exact blue dye is important to *G. tachinoides* but not to *G. palpalis* s.l. (table II) probably because the Area III habitat had dense vegetation and light reflection from the trap lower cone was less than in Area I where traps were in the open at the waters edge to catch *G. tachinoides*.

The randomised block design is useful but does not give sufficient indication of where variance occurs. Therefore the results in table I show two replicates of the same comparison in the first the 3 trap types are significantly different by factors of 6:4:1. The replicate however shows only a difference between the two standard biconicals (small and large 12 & 14a) and one with the shiny blue nylon lower cone (13a) by factors of 2.6:2.2:1. The only difference between the replicates was closer trap placement in the replicate, the poor resolution is probably due to trap interaction, a factor which can be accounted for by using a latin square design.

Replicates of traps were chosen in this study rather than time (period) replicates because although this requires more trap manufacture it is more reliable than the vast differences encountered between periods (6). Variance due to position on rows or columns was always significant, but this is to be expected in view of the literature on the importance of trap placement (3, 20, 5), further quantitative information on this subject could be gained using latin square design and trying to minimise the variance due to position. Variance due to interaction was never significant.

Differences between traps are discussed in terms of total catch since unless a trap is found that is superior to the biconical trap in total catch of males or females the detailed breakdown or analysis of physiological status is likely to be of little merit.

The comparisons of hand capture from human bait (1, 3 & 4), vehicle (2) and biconical traps (table V) shows that *G. palpalis* s.l. in Areas IV and Va approach man reluctantly a view strengthened by field observation. Male *G. morsitans centralis* on the other hand, approach men readily as the « following swarm » (2), the vehicle capture was composed of 37 p. 100 females compared to 40 p. 100 in biconical traps and 1 p. 100 in flies netted from the ground near man, but 37 p. 100 caught off man. Also the mean age of the sample (table V) is lower for hand caught flies from man or vehicle than from the ground or traps. These results show that the sampling method of choice will be determined by the exact field conditions and species under study, which will often be different (14).

The biconical traps in Area II caught only 61 *S. damnosum* in an area where the man biting rate was in excess of 700 flies/man/day. This is very poor but a trap is needed for Simuliids (37) and work of the sort described in this paper could lead to a useful alternative to capture at human bait.

An interesting additional capture was that of conopids *Stylogaster leonum* West. concurrently with *G. palpalis palpalis* (see also 29). Also, in all study sites, between 10 and 20 tsetse were trapped on the anti-ant glue bands.

The methods of trap comparison used here requires little time, finance or manpower to evaluate new and established trap designs quickly against different species in different habitats while at the same time providing data relevant to the study of *Glossina* ecology.

ACKNOWLEDGEMENTS

This work was supported by a grant from the Overseas Development Administration (Research Scheme R3425) and UNDP/FAO (ref. DP 9/5 RAF 75/001). We are also grateful to the staff of the World Health Organisation, Trypanosomiasis Research Project and UNDP/FAO Tsetse Applied Research and Training Project and staff of WHO Onchocerciasis Project for their help in the field and to the villagers of Kondorobo and Zagoutta for their helpful co-operation. Help and hospitality in the field were freely given by Drs W. KUPPER, U. ZILLMAN and H. POLITZAR, Mr and Mrs T. GOOCH and J. F. WALSH in Upper Volta, F. A. S. KUZOE, J. CULLEN, S. L. CROFT and S. COULIBALY in Ivory Coast and D. A. T. BALDRY, Y. TAZE, and J. POLLOCK in Zambia. We are grateful to Drs K. G. V. SMITH, J. E. CHAINEY and A. M. HUTSON for the identification of conopids, tabanids and tipulids, respectively. Dr J. McKY for statistical advice and to Drs A. M. JORDAN, T. LEWIS and M. W. SERVICE for their criticism of the manuscript.

SUMMARY

The relative trapping efficiency of different coloured biconical, Manitoba and sticky traps, canopy, water, Moloo and Swynnerton traps are compared by easily managed, time-efficient methods. Standard biconical traps caught at least twice as many *Glossina palpalis* s.l. and *G. morsitans centralis* as any other trap but caught only low numbers of simuliids or tabanids. Manitoba traps caught eight times more *Tabanus taeniola, T. gratus* and *T. par* than any other trap. Sticky, water and Malaise traps caught diverse species but in very low numbers. Hand netting from a human bait is compared to biconical traps, electric and sticky backpacks for *G. palpalis* s.l. and compared to capture from a moving vehicle and biconical traps for *G. morsitans centralis.* Following swarms of the latter were observed and caught but *G. palpalis* s.l. approached man reluctantly. The exact blue-dyed material used for biconical traps is critical for the capture of *G. tachinoides* but not *G. palpalis* s.l. Vector collections of *G. morsitans centralis* provided large numbers of old males and a few young females, but vector collections of *G. palpalis* s.l. provided very low numbers of either whereas in both cases biconical traps caught large numbers of both sexes with a good representation of all ages. The converse is true for *Simulium damnosum* s.l. females which approach man readily but biconical traps very reluctantly. Small numbers of conopids *Stylogaster leonum* and *G. pallicera* and *G. fusca* were also captured by biconical traps.

RESUMEN

Estudios y comparaciones de diferentes matamoscas para coger *Glossinidae* y otros dípteros en África

Se comparó la eficacia relativa de diferentes matamoscas (matamoscas : bicónicas ; de Manitoba ; adhesivas diversamente coloradas ; de Catts ; con agua ; de Moloo y de Swynnerton) mediante métodos faciles de utilizar y comprobados. Las matamoscas bicónicas standard capturan al menos el doble de *Glossina palpalis* s.l. y de *G. morsitans centralis* que todas las otras matamoscas, pero no recogen más que pocos simúlidos o tabánidos. Las matasmoscas Manitoba capturan ocho veces más de *Tabanus taenida, T. gratus* y *T. par* que las otras matamoscas. Las matamoscas adhesivas, con agua y Malaise recogen varias especies, pero poco numerosas. Se compara la captura a la red a mano sobre un hombre cebo a las matamoscas bicónicas y a pantallas adhesivas o eléctricas transportadas montadas en hombre en cuanto a *G. palpalis* s.l., a la captura en un vehículo en movimiento y a las matamoscas bicónicas por *G. morsitans centralis.*

Se observaron y se capturaron enjambres seguidores de la última especie ; en cambio, *G. palpalis* s.l. es poco atraida por el hombre. El tono de la tintura azul del material utilizado para las matamoscas bicónicas influye de modo decisivo sobre la captura de *G. tachinoides*, pero no sobre la de *G. palpalis* s.l. La recogida de *G. morsitans centralis* por medio de aparatos moviles da un gran número de machos entrados en años y algunas jovenes hembras, mientras que, se encuentran muy pocas cantidades de cada una de estas categorias en lo concerniente a *G. palpalis* s.l.

En cambio, las matamoscas bicónicas capturan importantes cantidades de cada sexo de dichas dos especies, con una buena representación de todas las edades.

Lo contrario es verdad por las hembras de *Simulium damnosum* s.l. que fácilmente se ponen en contacto con el hombre pero son muy poco atraidas por las matamoscas bicónicas. Se capturaron también números reducidos de conopides *Stylogaster leonum*, de *G. pallicera* y de *G. fusca* por las matamoscas bicónicas.

Retour au menu

REFERENCES

1. BERLYN (A. D.). Factors attracting the sheep head fly *Hydrotea irritans* (Fallen) (Diptera : Muscidae), with a note on the evaluation of repellents. *Bull. ent. Res.*, 1978, **68** : 583-588.
2. BURSELL (E.). The behaviour of tsetse flies *(G. swynnertoni)* in relation to problems of sampling. *Proc. r. Ent. Soc. A.*, 1961, **36** : 9-20.
3. BUXTON (P. A.). The natural history of tsetse flies. London, H. K. Lewis Ltd., 1955. (School of Hygiene and Tropical Medicine, Memoir No. 10.)
4. CATTS (E. P.). A canopy trap for collecting Tabanidae. *Mosq. News*, 1970, **30** : 472-474.
5. CHALLIER (A.). Trapping technology. *In* : Laird (M.), ed. Tsetse, The future for biological methods in integrated control, Ottawa, IDRC-077e, 1977, p. 109-123.
6. CHALLIER (A.), EYRAUD (M.), LAFAYE (A.), LAVEISSIÈRE (C.). Amélioration du rendement du piège biconique pour glossines par l'emploi d'un cône inférieur bleu. *Cah. ORSTOM. Sér. ent. méd. Parasit.*, 1977, **15** : 283-286.
7. CHALLIER (A.), LAVEISSIÈRE (C.). Un nouveau piège pour la capture des glossines. Description et essais sur le terrain. *Cah. ORSTOM Sér. ent. méd. Parasit.*, 1973, **11** : 251-262.
8. CHORLEY (C. W.). Traps for tsetse flies of the « crinoline » and « ventilator » forms. *Bull. ent. Res.*, 1933, **24** : 315-317.
9. DRANSFIELD (R.). Preliminary observations on the use of water traps for sampling tsetse flies in Nigeria. *Tsetse Tryp. Inf. Q.*, 1980, **3** : 7.
10. HARGROVE (J. W.). Some advances in the trapping of tsetse (*Glossina* spp.) and other flies. *Ecol. Ent.*, 1977, **2** : 123-137.
11. HARGROVE (J. W.). Improved estimates of the efficiency of traps for *G.m. morsitans* West. and *G. pallidipes* Aust. with a note on the effect of the concentration of accompanying host odour on efficiency. *Bull. ent. Res.*, 1980, **70** : 579-588.
12. HARRIS (R. H. T. P.). The control and possible extermination of the tsetse by trapping. *Act. Conv. Ter. Trop. Malar. Morb.*, 1938, **1** : 663-677.
13. JACK (R. W.). Studies in the physiology and behaviour of *Glossina morsitans* West. *Mem. Dep. Afr. S. Rhod.*, 1939, **1** : 1-203.
14. KOCH (K.), SPIELBERGER (U.). Comparison of handnets, biconical traps and an electric trap for sampling *G. palpalis palpalis* (R-D) and *G. tachinoides* West. (Diptera : *Glossinidae*) in Nigeria. *Bull. ent. Res.*, 1979, **69** : 243-254.
15. LANGRIDGE (W. P.). Tsetse fly traps and trapping methods. *In : Proc. 14th Meeting OAU/ISCTRC, Dakar, Senegal, 1975.* p. 277-281.
16. MALAISE (R.). A new insect trap. *Entomol. Tidskrift, Stockholm*, 1937, **58** : 148-160.
17. MALDONADO. *R. Soc. Sleeping Sickness Commission Bull.*, 1910, **2** : 26-27.
18. MOLOO (S. K.). A new trap for *Glossina pallidipes* Aust. and *G. fuscipes* Newst. *Bull. ent. Res.*, 1973, **63** : 231-236.
19. MORRIS (K. R. S.), MORRIS (M. G.). The use of traps against tsetse in West Africa. *Bull. ent. Res.* 1949, **39** : 491-528.
20. MULLIGAN (H. W.), ed. The African trypanosomiases. London, Allen Unwin Ltd., 1970.
21. ROBERTS (R. H.). The comparison of six tabanid traps. *Mosq. News*, 1976, **36** : 530-535.
22. ROGERS (D. J.), SMITH (D.). A new electric trap for tsetse flies. *Bull. ent. Res.*, 1977, **67** : 153-159.
23. RYAN (L.), MOLYNEUX (D. H.). Construction details of the Challier/Laveissière biconical trap. *In* : FAO/IAEA Int. Symp on « the use of isotopes for research and control of vectors of animal diseases, Vienna, 7-11 May 1979. Vienna, I.A.E.A. 1980. p. 339-353.
24. RYAN (L.), MOLYNEUX (D. H.). Non-setting adhesives for insect traps. *Ins. Sci. Its Appl.*, 1981, **2** : 349-355.
25. RYAN (L.), MOLYNEUX (D. H.), HARRISON (N.), HILLIER (M.). An automatic tsetse (Diptera : *Glossinidae*) trap. *Trop. Pest Man.*, 1981, **27** : 111-115.
26. RYAN (L.), MOLYNEUX (D. H.), KUZOE (F. A. S.). Differences in rate of wing fray between *Glossina* species. *Tropenmed. Parasit.*, 1980, **31** : 111-116.
27. RYAN (L.), MOLYNEUX (D. H.), KUZOE (F. A. S.), BALDRY (D. A. T.). Traps to control and estimate populations of *Glossina* species. *Tropenmed. Parasit.*, 1981, **32** : 145-148.
28. SERVICE (M. W.). Methods for sampling adult Simuliidae, with special reference to the *S. damnosum* complex. *Trop. Pest Bull.*, 1977, **5**, 48 p.
29. SMITH (K. G. V.), BALDRY (D. A. T.). Some Dipterous puparia resembling and found among those of tsetse flies. *Bull. ent. Res.*, 1968, **59** : 367-370.
30. SMITH (I. M.), RENNISON (B. D.). Studies of the sampling of *G. pallidipes* Aust. I. The numbers caught daily on cattle in Morris traps and on a fly round. *Bull. ent. Res.*, 1961, **52** : 165-182.
31. SNOW (W. F.), BOREHAM (P. F. L.). The feeding habits and ecology of the tsetse fly *G. morsitans submorsitans* in the relation to Nagana transmission in the Garibiai. *Acta trop.*, 1979, **36** : 47-51.
32. SOKAL (R. R.), ROHLF (F. J.). Biometry, the principles and practice of statistics in biological research. San Francisco, W.H. Freeman and Co., 1969, 776 p.
33. SWYNNERTON (C. F. M.). The tsetse flies of East Africa : a first study of their ecology with a view to their control. *Trans. r. ent. Soc. Lond.*, 1936, **84** : 1-579.
34. THORSTEINSON (A. J.), BRACKEN (G. K.), HANEC (W.). The orientation behaviour of horseflies and deer flies. III. The use of traps in the study of orientation of Tabanids in the field. *Ent. Exp. Appl.*, 1965, **8** : 189-192.
35. TURNER (D. A.). Water traps for sampling *G. pallidipes* in Kenya. *Tsetse Tryp. Inf. Q.*, 1980, **3** : 151.
36. VALE (G. A.), HARGROVE (J. W.). A method of studying the efficiency of traps for tsetse flies and other insects. *Bull. ent. Res.*, 1979, **69** : 183-193.
37. WALSH (J. F.). Sticky trap studies on *Simulium damnosum* s.l. in Northern Ghana. *Tropenmed. Parasit.*, 1980, **31** : 479-486.
38. WILLIAMS (C. B.). The use of logarithms in the interpretation of certain entomological problems. *J. appl. Biol.*, 1936, **24** : 404-414.