International Scholars Journals

International Journal of Veterinary Medicine and Animal Health Vol. 9 (5), pp. 001-006, May, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Spatial distribution of tsetse flies in the Blue Nile State, Sudan

Mohammed A. Basheer[1]*, Yassir O. Mohammed[2], Mo,awia Mukhtar Hassan[1], Mohamed A.[2], Mohamed M. Mohamed-Ahmed[3] and Intisar E. El Rayah[1]

[1]Tropical Medicine Research Institute (TMRI), P. O. Box1304, Sudan.
[2]Veterinary Research Institute (VRI), Animal Resources Research Corporation (ARRC), P. O. Box 8067, Sudan.
[3]Veterinary Medicine and Animal Production College, Sudan University of Science and Technology, Sudan.

Accepted 26 September, 2017

The present study was carried out to spot the limit of tsetse fly belt in the Blue Nile State as the consecutive ecological changes tend to create significant modification in tsetse distribution. The survey was carried out for three weeks during March, 2011. Traps were placed in various vegetation types assumed to possibly harbor tsetse flies and were placed 200 m for three days at each site and harvested after 24 h. The sites where tsetse flies were encountered were marked using Global Positioning System (GPS) and the maps were generated. Tsetse geo-distribution generated map revealed that *Glossina fuscipes fuscipes* and *Glossina morsitans submorsitans* co-existed in Yabus District. Nevertheless our findings of *G. m. submorsitans* in the area far north is not surprising given that tsetse populations are known to recover from refugia following intervention or re-colonisation of a cleared zone from neighboring sources. However, *G. f. fuscipes* using biconical traps were only encountered in the river Khor Yabus extending to the East up to Platoma more than 35 linear Km west from the Ethiopian border. The apparent densities vary from 0.3 to 8 flies/trap/day, and tremendously decreased from east to west. The *G. m. submorsitans* flies using transect fly-round technique were caught north of its previously known limits which amounted to roughly 45 linear km north of River Khor Yabus to areas which had been assumed as devoid of the species

Key words: Spatial-distribution, *Glossina fuscipes fuscipes*, *G. morsitans submorsitans,* Blue Nile State, Sudan.

INTRODUCTION

Gambian or Rhodesian form of Human African Trypanosomiais (HAT) is an extremely fatal parasitic disease transmitted by the tsetse fly. Tsetse flies have been associated with the transmission of African trypanosomes since a century ago (Aksoy et al., 2003). Although seven species of *Glossina* were recognized in the Sudan (Lewis, 1949), only *Glossina fuscipes fuscipes* has been implicated on HAT transmission. The Sudan has suffered series of epidemic of HAT (Snow, 1984). Although Sudan lies in the interface of the geographical distribution of the two types of sleeping sickness, Gambian form caused by *Trypanosoma brucei gambiense* remains a public health problem in the country (Moore et al., 1999; Moore and Richer, 2001; Mohammed et al., 2010a). Nevertheless, an epidemic attributed to *Trypanosoma brucei rhodesiense* causing the acute form of the disease was reported in Sudanese/ Ethiopian boarder in 1970s (Baker, 1974). Rhodesian sleeping sick-ness is primiarily a zoonotic infection with known large anaimal reservior (Fèvre et al*.,* 2001). Considering the current instability in the Blue Nile region that is resulting in movement of refugees and livestock, there is a high probability to culminate in an epidemic and create an overlap of the two forms of sleeping sicknes in the region.

In the Blue Nile State, the tsetse belt comprises a fringe of the Ethiopian tsetse area within the Sudan frontier. *G. m. submorsitans* and *G. f. fuscipes* co-existed with

*Corresponding author. E-mail: bashirm59@yahoo.com. Tel: +249 0114624863. Fax: +249 (0) 183 781845.

overlapping distribution (Kheir et al., 1995). A focus of *G. tachinoides* was discovered at Kigille of about Latitude 9°N (Lewis, 1949), and it is thought to be absent from the main tsetse area. *G. pallidipes* was detected only in the Boma Plateau, River Kurun and Katchikan along Akobo valley (Lewis, 1949). Tsetse distribution surveys of 1984 (Kheir et al., 1995; Mohamed-Ahmed, 1989) revealed that *G. f. fuscipes* and *G. m. submorsitans* were encoun-tered only in river Khor Yabus indicative of a retreat of the belt, south of Lewis' (1949) distribution limit due to drought.

The latest civil strife has curtailed normal human activities and influenced animals' density and distribution. Consecutive, heavy rainy seasons have changed the habitats of the area. This change in ecology of the region can create significant modification in tsetse distribution, thus, reliable information on tsetse distribution pattern is highly demanded. The sound knowledge of tsetse ecology (Jordan, 1974) required, includes the density of tsetse fly, species diversity, distribution limits and habitat vegetation type (Allsop, 1984). In this paper, we report the results of a survey to define the tsetse distribution pattern in the Blue Nile State, Sudan.

MATERIALS AND METHODS

Study area

The field work was conducted in Kurmuk Locality, the southern region of the Blue Nile State. The State lies in south-eastern part of the Sudan bordering Ethiopia. The majority of the local population are agro-pastoralists. Kurmuk locality lies entirely between latitudes 9° to 10°N and longitudes 30°30` to 32°45`E. The various villages and locations surveyed for tsetse fly occurrence in the Kurmuk locality, Blue Nile State, Sudan are shown in Figure 1.

The climate is tropical, characterized by minimal variations in seasonal temperatures. The rains decrease from southeast to north with total annual means ranging between 650 to 1200 mm. The study area lies within the Savannah belt, with extensive clay (flood) plains transected by a vast number of seasonal watercourses, broken in the south by mountains ranges of the Ingassana Hills. The most dominant feature of the locality is River Khor Yabus.

The vegetation cover is interrupted by several villages, hamlets and numerous plots for subsistence farming. Overall, three main types of vegetation predominate: riverine gallery forest along the watercourses; derived savanna woodland consists of evergreen broad-leafed trees that lie in the east and south part; open savanna woodland mainly consists of *Acacia* forest lies northward. The main grasses are of the *Imperata*, *Panicum* and *Andropogon* species together with *Combretum glutinosum* and various climbers and bamboo thickets are present along the banks of watercourses.

Capture of flies using biconical traps

To establish the tsetse distribution pattern in the study area, unbaited biconical traps (Challier et al., 1977) were used. The vegetation types were categorized, and the traps were located using the stratified random sampling technique for monitoring tsetse prevalence and for assessing species diversity and distribution. The traps were placed in the various vegetation types deemed to harbour tsetse flies at 1 m from the vegetation edge as recommended by Mohamed-Ahmad and Wynholds (1997) and were placed 200 m apart for three days at each location. The survey was carried out for three weeks in March, 2011 during the dry season. Flies were harvested after 24 h, counted, identified and examined for tenerality. The apparent density of tsetse at each location was calculated from the mean catch ± SE / trap / 24 h. The tenerality and sex ratio of flies in the total catch of the biconical traps were compared (pooled males and females) as desrcibed by Pollock (1992).

Transect fly-round

Using a vehicle and black screen, the patrol was operated in the morning from 7:30 to 10:00 h across the county. The path was laid along road and track regardless of the type of vegetation encountered for a linear distance of 5 to 8 km away from the camp. The vehicle stops every 500 m for 5 to 10 min. The present flies were collected using a hand net then counted and sorted. The sites where tsetse flies encountered were marked using Global Positioning System (GPS) and the maps were generated using GPS (ARC,DIS version 9.3) software.

RESULTS

During the course of the collection period, a total number of 369 flies were collected from Yabus vicinity using biconical traps. The flies were identified as *G. f. fuscipes* which were only encountered in gallary forest along river Khor Yabus and close edges of its tributaries, from Sudan-Ethiopian border in the East to Platoma more than 35 km in the West. The apparent densities varied and tremendously decreased from east to west along the river (Table 1). The catch composition of ***G**. f. fuscipes* is represented in Table 2.

Using transect fly-round technique the *G. m. submorsitans* flies were caught in bulk of 12, 5, 3 and 9 flies in the region of Eylel, Oas, Maguf, and Ora woodland forest, respectively. The fly was restricted to the Savanna woodland where they roamed widely in the wetter parts and concentrated on the mesophytic vegetation of the watercourses in the drier parts. The fly has moved further north of its previously known limits amounting to roughly linear 45 km North of River Khor Yabus to areas where they were presumed devoid (Figure 2).

DISCUSSION

The present survey revealed that *G. f. fuscipes* and *G. m. submorsitans* co-existed with overlapping distribution in Yabus District, the Blue Nile State. Previous comprehensive reviews have described the distribution pattern of *Glossina* species and the northern limit of tsetse belt in the Blue Nile State (Lewis, 1949; Yagi and Razig; 1971). Mohamed-Ahmed, (1989) discovered the retreat of the tsetse belt south of Bedford and Lewis' distribution limit and attributed this recession to drought.

The latest civil strife which had stricken the region has curtailed normal human activities, altogether with the

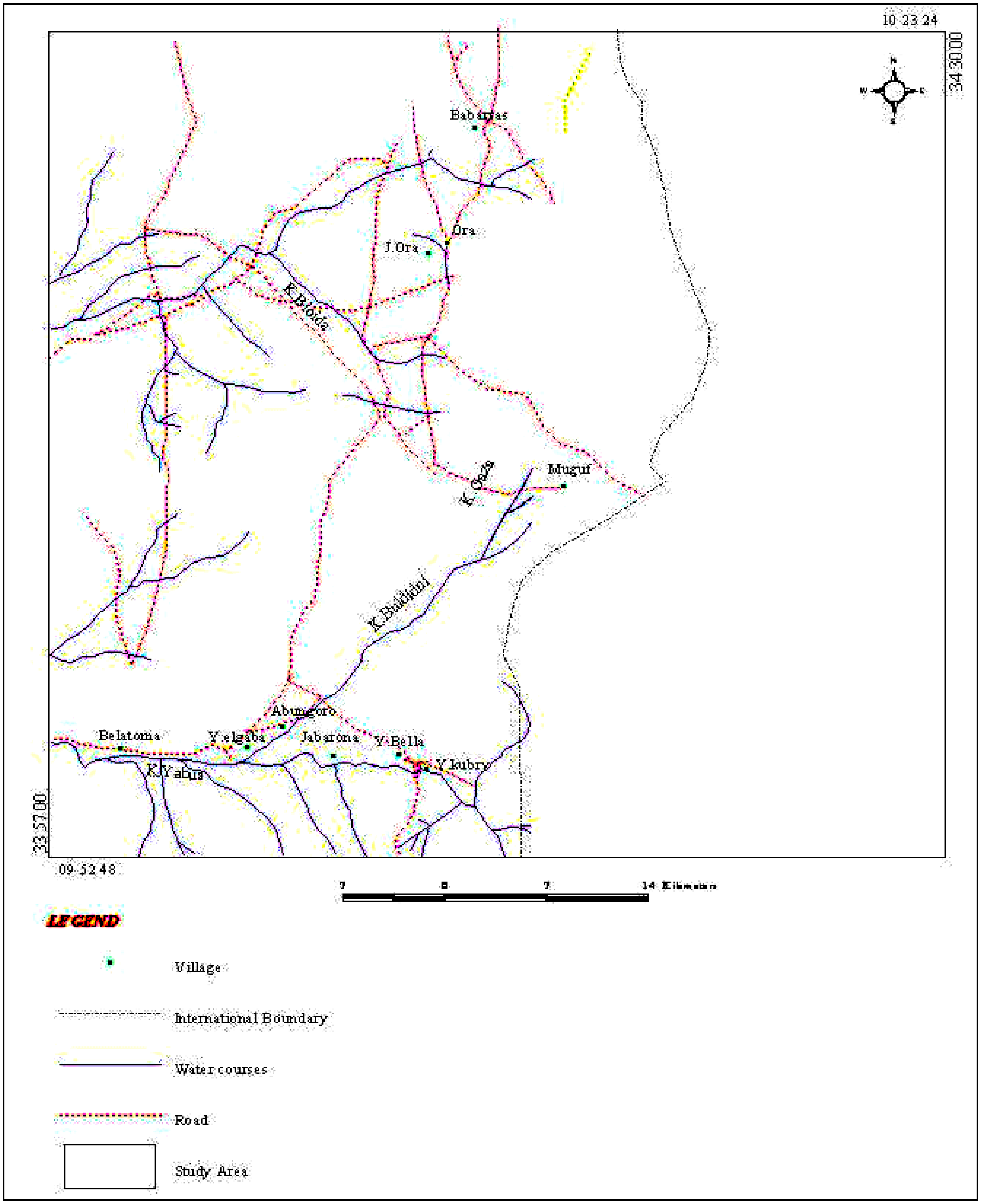

Figure 1. Map of the study area showing the various villages and locations surveyed for tsetse fly occurrence in the Blue Nile State, Sudan.

successive heavy rainy seasons resulting in augmentation of vegetation densities and forest extension. This has modified the ecology of the area; subsequently tsetse flies belt has extended to the north. A trend in vegetation densities considerably affects tsetse apparent density and distribution, although obligatory association

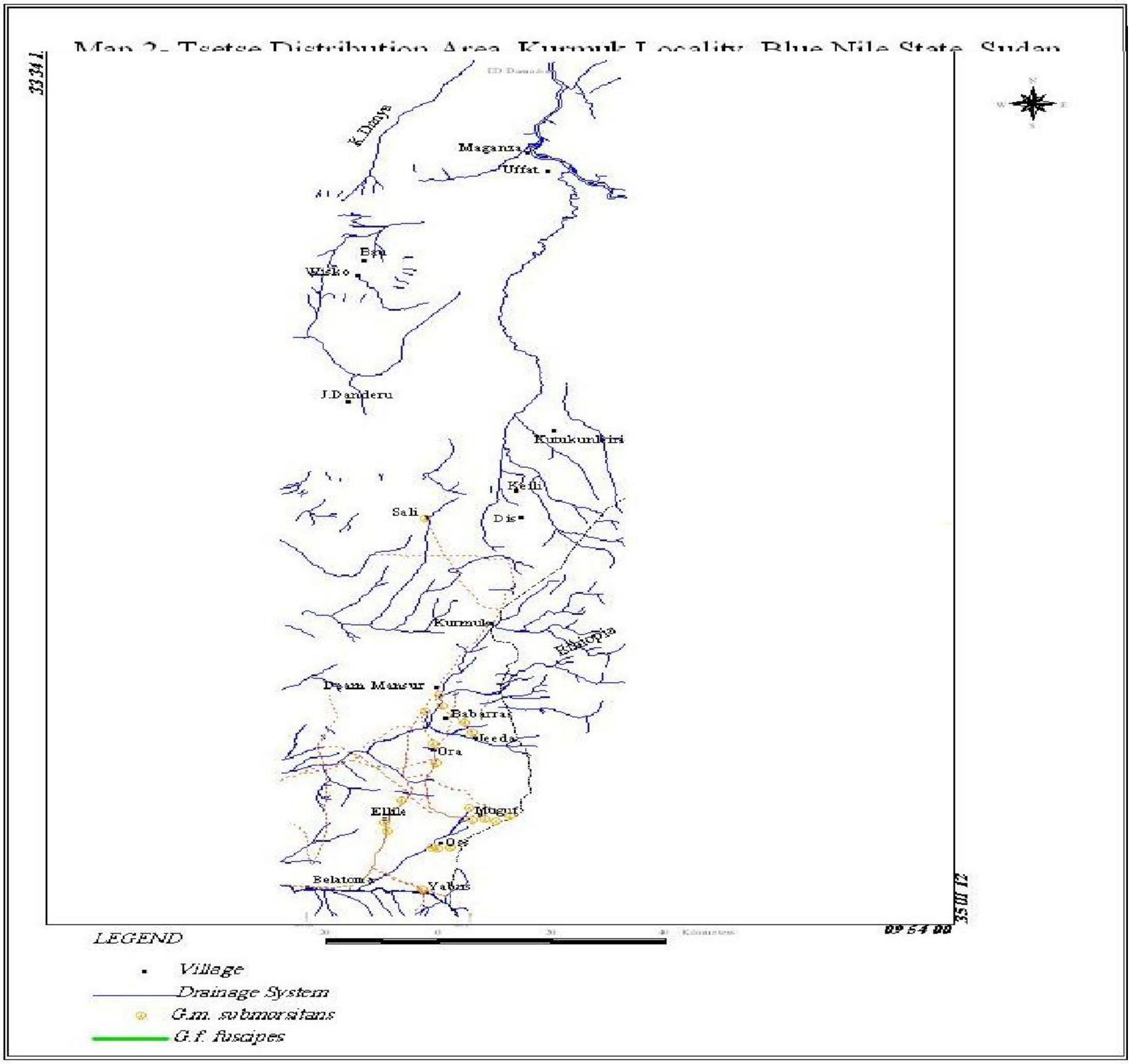

Figure 2. Map showing tsetse fly geo-distribution pattern in the study area.

Table 1. Locations where *G. f. fuscipes* was encountered and the fly apparent density.

Location	Apparent density± SE
Yabus	8.00 ± 1.53
Yabus El Kubree	4.33 ±1.45
Yabus el Ghaba	2.67 ± 0.88
Yabus Balah	1.00 ± 0.58
Platoma	0.33 ± 0.33

relation does not exist between *Glossina* and the vegetation communities. Hence, the most critical point to establish is spotting the distribution limits of tsetse flies in the Blue Nile State.

The present survey was carried out to renovate tsetse geo-distribution map in the Blue Nile State. Generally the obtained result contradict Mohamed-Ahmed (1989) findings who mentioned that *Glossina* flies are encountered only around River Khor Yabus and southward while the area lying to the north are tsetse free zones. Nevertheless our findings of *G. m. submorsitans* in the area far north is not surprising given that tsetse populations are known to recover from refugia following intervention or re-colonization of a cleared zone from neighboring sources. Tsetse populations can also fall to levels that cannot be detected and could have prevented Mohamed-Ahmed from detecting any of the *Glossina*

Table 2. Catch composition of G. *f. fuscipes* in white biconical trap sited in the River Khor Yabus habitats.

Composition	Male	Female	Total	Sex ratio (Male : Female)
Teneral	96	92	188	1 : 0.96
Nonteneral	72	109	181	1 : 1.51
% tenerals	57.1%	45.8%	50.9%	-

species in the area (Okoth et al*.,* 1991).

Since the biconical trap is highly effective for sampling the tsetse (Challier et al., 1977; Odulaja and Mohamed-Ahmed, 1997), it was selected for monitoring tsetse flies. *G. f. fuscipes* which was the only species captured by biconical traps. The failure to catch *G. m. submorsitans, G. tachinoides* and *G. pallidipes* could be attributed to sensitivity of the sampling techniques applied. Trap catches for such tsetse species can be improved considerably by dispensing odours near traps (Dransfield et al., 1990). As they are known to be difficult to sample, thus they might exist in undetected numbers. However, an effective odour bait has yet to be discovered for the riverine species (Laveissiére et al., 1987), therefore unbaited traps were used.

The fly of *G. f. fuscipes* was encountered only in the gallary forest habitats along river Khor Yabus and extended for 35 km to Platoma further west of its earlier known limits (Kheir et. al., 1995). Fly species of *G. f. fuscipes* are known to be confined to gallary forest which allows such flies to penetrate into dry savanna areas (Jordan, 1986; Leak, 1999) since it provides shade and maintains a suitable microclimate for tsetse as well as habitat for their vertebrate hosts. Moreover, due to their opportunistic feeding habits (Jordan, 1989; Clausen et al., 1998) species of the palpalis group are much less affected by transformed environments.

In the current survey *G. m. submorsitans* flies were found distributed in the derived savanna woodland further north of its previously known limits (Kheir et al., 1995) amounting to roughly linear 45 km. The fly was restricted to the wooded parts as it provides favorable microclimatic conditions (resting and reproduction sites) for tsetse while the cleared parts (feeding sites) allow an abundance of hosts. In view of the fact that the fly is known to be highly sensitive to environmental modifications and their distribution and densities depend on availability of worm-blooded animals (Rawlings et al., 1993; Cuisance et al., 1984). The current north expansion of this fly could be atrributed to prevalence of domestic bovid preference potential host (Omoogun et al., 1991; Leak, 1999) that found their way to the area for summer grazing after the Comprehensive Peace Agreement (CPA).

In the current work both *G. f. fuscipes* and *G. m. submorsitans* the potential vector of HAT and African Animal Trypanosomiasis (Mohammed et al., 2010a) were found in areas where they were presumed eliminated. This finding has confirmed arguments proposing that the ecological change of the area has modified the tsetse belt. Consequently there is urgent need for area-wide surveys to answer the questions, how far northward has the fly belt advanced and what is the real impact of the northward fly belt advance on human and livestock populations.

Certainly the cumulative effects of the present advances of tsetse population with attendance of infected domestic animals will increase the risk of animal trypanosomiasis. The creation of peri-domestic environments suitable for tsetse species shall result in new epidemiological systems of HAT closely linked to hosts (De La Rocque et al., 1998). Furthermore, previous record of *T. b. rhodesiense* in the county (Baker et al., 1970) creates a vital need for area-wide survey to elucidate disease situation and parasite-vector interaction.

ACKNOWLEDGEMENTS

The Tropical Medicine Research Institute (TMRI), National Centre for Research (NCR), and Vetrinary Research Institute (VRI), Animal Resources Research Cooperation (ARRC) are acknowledge for facilitating this research financially and technically.

REFERENCES

Aksoy S, Gibson WC, Lehane M (2003). Interactions between tsetse and trypanosomes with implications for the control of trypanosomiasis. Adv. Parasitol. 53:1-83.

Allsop R (1984). Control of tsetse flies (*Diptera: Glossinidae*) using insecticides: a review and future prospects. Bull. Ent. Res. 74:1-23.

Baker JR (1974). Epidemiology of African sleeping sickness. Trypanosomiasis and Leishmaniasis with Special Reference to Chagas Disease. CIBA Foundation Symposium pp. 29-50.

Baker JR, McConnell E, Kent DC, Hady J (1970). Human trypanosomiasis in Ethiopia. Ecology of Illubabor province and epidemiology in the Baro River area. Trans. Act. Roy. Soc. Trop. Med. Hyg. 64:523-530.

Challier A, Eyraud M, Lafaye A, Laveissiere C (1977). Improving the performance of the biconical trap for tsetse flies (Diptera, Glossinidae) by the use of a lower blue cone. Can. ORSTOM, Ser. Entomol. Med. Parasitol. 15:283-286.

Clausen PH, Adeyemi I, Bauer B, Breloeer M, Salchow F, Staak C (1998). Host preferences of tsetse (Diptera: Glossinidae) based on blood meal identification. Med. Vet. Entomol. 12:169-180.

Cuisance D, Politzar H, Mérot P, Tamboura I (1984). The release of irradiated males in the campaign against tsetse IPM in the pastoral zone of Sidéradougou (Burkina Faso). J. Physi-lifting Vet. Ctry Trop. 37:449-467.

De La Rocque S, Lefrancois T, Rrifenberg JM, Solano P, Kabore I, Bengaly Z, Augusseau X, Cuisance D (1998). PCR analysis and spatial repartition of trypanosomes infecting tsetse flies in Sideradougou area (Burkina Faso). Ann. NY Acad. Sci. 849:32-38.

Dransfield RD, Brightwell R, Kyorku C, Williams B (1990). Control of tsetse fly (Diptera: Glossinidae) populations using traps at Nguruman, South-west Kenya. Bull. Entomol. Res. 80: 265–276.

Fèvre EM, Coleman PG, Odiit M, Magona JW, Welburn SC, Woolhouse MEJ (2001). The origins of a new *Trypanosoma brucei rhodesiense* sleeping sickness outbreak in Eastern Uganda. Lancet 358:625-628.

Jordan AM (1974). Recent developments in the ecology and methods of control of tsetse flies (*Glossina spp*.) (Diptera, Glossinidae) – A review. Bull. Entom. Res, 63: 361-399.

Jordan AM (1986). Trypanosomiasis Control and African Rural Development. Longman, London, UK.

Jordan AM (1989). Importance of land use on the incidence of *Trypanosoma brucei gambiense* sleeping sickness. Ann. Soc. Belge de Méd. Trop. 69(1):254.

Kheir SM, Abdalla HS, Rahman AH (1995). A study on tsetse and Tabanidae flies in southern Eastern Sudan. Sud. J. Vet. Sci. Anim. Husb. 34:22-28.

Laveissiére C, Couret D, Manno A (1987). Importance de la nature des tissus dans la lutte par piégeage contre les glossines., Cabiers ORSTOM, série Entomologie Médicate Et Parasitologie 25:133-143.

Leak SGA (1999). Tsetse Biology and Ecology: Their role in the epidemiology and control of trypanosomosis. CAB/ Publishing/ILRI, Nairobi, Kenya. p. 568.

Lewis DJ (1949). The tsetse fly problem in the Anglo-Egyptian-Sudan. Sud. Notes Rec. 30(2):179-210.

Mohamed-Ahmed MM (1989). Distribution of tsetse in Kurmuk District, Blue Nile Province, Sudan. Sud. J. Vet. Sci. Anim. Husb. 28(1)45-54.

Mohamed-Ahmed MM, and Wynholds, Y (1997). Effects of vegetation and weather on trap catches of *Glossina fuscipes fuscipes* near Lake Victoria, Kenya. Entomol. Exp. Appl. 65:231-236.

Mohamed-Ahmed MM, Odulaja A (1997). Diel activity patterns and host preferences of *Glossina fuscipes fuscipes* along the shores of Lake Victoria, Kenya. Bull. Entomol. Res. 87:179-186.

Mohammed YO, El Malik KH, Mohamed-Ahmed MM, Intisar ER (2010a). "Factors influencing the sero-prevalence of *Trypanosoma brucei gambiense* sleeping sickness in Juba county, Central Equatoria State, Southern Sudan" J. Pub. Health Epidemiol. 2(5):100-108.

Moore A, Richer M (2001). Re-emergence of epidemic sleeping sickness in Southern Sudan. Trop. Med. Int. Health 6(5):342-348.

Moore A, Richer M, Enrile M, Losio E, Roberts J, Levy D (1999). Resurgence of sleeping sickness in Tambura County, Sudan. Am. J. Trop. Med. Hyg. 61:315- 318.

Okoth JO, Okeith V, Ogola A (1991). Control of tsetse and trypanosomiasis transmission in Uganda by application of Lambdacyhalothrin. Med. Vet. Entomol. 5:121-128.

Omoogun GA, Dipeolu OO, Akinboade OA (1991). The decline of a *Glossina morsitans submorsitans* belt in the Egbe area of the Derived Savanna zone, Kwara State, Nigeria. Med. Vet. Entomol. 5:43-50.

Pollock ME (1992). Description and keys for the identification of *Glossina* species. In: Pollock JN (ed.), Training Manual for Tsetse Control Personnel, Volume 1. pp. 156-201.

Rawlings P, Ceesay ML, Wacher TV, Snow WF (1993). The distribution of the tsetse flies *Glossina morsitans submorsitans* and *G. palpalis gambiensis* (Diptera: Glossinidae) in the Gambia and the application of survey results to tsetse and trypanosomiasis control. Bull. Entomol. Res. 83:625-632.

Snow WF (1984). Assignment Report: Further observation on tsetse distribution, ecology and control in relation to sleeping sickness in Southern Sudan, 12 February- 13 June 1983. WHO, Geneva.

Yagi AI, Razig AMT (1971). Present status of tsetse flies and its control in the Sudan. Proceedings of the 13th International Scientific Council for Trypanosomiasis Research and Control. OAU, STRC, Lagos, Nigeria.