Research Note on Eradication of Tsetse Flies Using the Sterile Insect Technique: The case of Zanzibar and Mafia Island Tanzania.

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Abstract

Efforts to control trypanosomiasis through tsetse control in Tanzania began more than 70 years ago by the use of techniques such as bush clearing, extermination of wild animals as hosts, insecticide spraying on the fly habitat or host animals or screens and the use of traps. Although the technologies reduced tsetse flies tremendously, the success remained short lived in most cases because tsetse population in tsetse-suppressed areas frequently recovered. Recently an environmental friendly technology, Sterile Insect Technique (SIT), in tsetse was introduced in Tanzania. The technology when integrated with other environmental benign technology results into complete eradication of tsetse flies thus giving a long lasting solution. SIT was successfully used on Zanzibar Island where tsetse fly was eradicated in 1997. Following the Zanzibar success, a study was conducted on Mafia Island to assess the potential of implementing SIT in order to eradicate tsetse flies on the island. A preliminary tsetse survey was conducted on Mafia Island using odour baited sticky panels, vavoua and biconical traps. Only ***Glossina brevipalpis*** *was caught in biconical and vavoua traps. From the study it is concluded that Mafia like Zanzibar, presents a situation for successful SIT application because it is isolated and has only one species of tsetse.*

Keywords: Tsetse eradication, sterile insect technique, Tanzania.

Introduction

A total area of 10 million km² of Sub-Saharan Africa, (32 countries) is infested by twenty-two species of tsetse fly. According to the report of FAO 1994, direct losses in milk yield, meat production, and costs of trypanosomiasis control programme are estimated to range between US$ 0.6 and 1.2 billion each year. The potential farmproduction lost yearly due to this disease cost at least US$ 4 billion. Human trypanosomiasis, known as "Sleeping Sickness" is among the most debilitating disease in Sub-Saharan Africa. Over 55 million rural people are at risk and over 300,000 people are infected. Tanzania has over 60% of the country infested with seven different species of tsetse fly, these flies have excluded cattle from a large portion of good grazing lands leading to problems of over grazing in the small (10%) tsetse free

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lands (MAC, 1997). Losses due to mortality and reduced milk yield are estimated at US$ 7.98 million annually.

Efforts to control tsetse flies in Tanzania began more than 70 years ago. The measures depended on eliminating wild animals that serve as tsetse host, clearing bush lands and spraying insecticides on tsetse habitat. Several safer control measures have recently been developed and applied. These involve the use of synthetic pyrethroids applied on cattle as dip wash/pour-on or applied on screens and the use of traps baited with odour attractants. At the beginning of 1989 Mkwaja ranch in Pangani, Tanzania made the first large-scale trial on the use of synthetic pyrethroid to control tsetse flies but could not promise complete eradication (Fox *et al.*, 1993). Following the success of this trial the Kagera Livestock Development Programme (KALIDEP) western Tanzania started using the insecticide in 1990/91. All the trials were successful in suppressing tsetse populations and reducing disease problem (Fox *et al.*, 1993).Sterile Insect Technique (SIT) was developed several decades ago on other insect pests (Knipling, 1964). SIT seems to provide the final component to an integrated control for tsetse eradication. It is safe and environmentally sound. Activities on the use of SIT for tsetse control in Tanzania started in late 1971 (Williamsons *et. al.*,1983). In 1994 the United Republic of Tanzania in collaboration with the International Atomic Energy Agency (IAEA) embarked on a project to eradicate tsetse fly on Zanzibar Island (an area of 1600km^2) using SIT. The project was successfully completed in 1997 (Msangi *et al.*, 1998). Following the Zanzibar success, SIT technique has been considered appropriate for application on MafiaIsland in order to solve their current problem of trypanosomiasis. The purpose of this article is to describe how the Zanzibar Tsetse campaign was conducted and won and show how the method is being applied on Mafia Island.

Materials and Methods

Zanzibar tsetse campaign

SIT technology

SIT relies on rearing large numbers of insects in laboratory to produce enough males which are sterilized with low doses of gamma radiation without causing any damage to the behaviour of the male fly. The irradiated males are released in the field in large numbers to out compete the indigenous fertile male flies. When sufficient sterile males are released over a long period, fertile population does not occur and the population declines to extinction.

Fly production

Production of surplus male tsetse flies for the Zanzibar tsetse project was done at the Tsetse and Trypanosomiasis Research Institute, (TTRI), Tanga facility. The procedures for fly production, male handling and quality control measures are described by Malele *et. al.*, (1997), Kiwia *et. al.*, (1997) and Kitwika *et. al.*, (1997). The production was achieved through a stabilising large tsetse colony exhibiting low mortality and high fecundity through appropriate quality control measures, well-trained and dedicated staff. Laboratory flies were marked with fluorescent dye to distinguish them from indigenous wild flies and were fed daily with bovine blood for five days and two blood meals mixed with Samorin^R to reduce vectorial capacity before release.

Fly suppression

Fly populations have been continuously suppressed from 1988 to 1993 mainly in the middle belt of Unguja Island using pour-on insecticides (Horeth-Bontgen, 1992). Blue cotton insecticide impregnated screens was used to suppress tsetse fly in areas with low cattle density.

Fly release and monitoring

Fly release, entomological and parasitological monitoring activities are described by Saleh, *et. al.* (1997). After some trials of ground release of sterile male flies in Jozani forest from 1992 to 1993, aerial dispersal of sterile flies was started in August 1994 to the end of project in December 1997. Marked gamma-sterilized flies were collected at Tanga and released twice in a week. Dispersal of the flies was done along the specific flight paths separated by 1-2 km using the global positioning system (GPS) which allowed accurate navigation. Flies were released at an altitude of 700 – 900 feet and at a speed of 100 -130 miles per hour. Releases were conducted on Tuesday morning and Friday morning. Almost 8 million sterile male flies were dispersed by air over Unguja Island from August 1994 to completion in December 1997. A sample box was taken before and after every release and parameters related to quality of the sterile males were assessed.

Sites were set up across the island and by 1996 more than 500 sticky panels were deployed. All panels were made sticky with the non-setting adhesive Temocid[R] and suspended from over handing branches allowing free rotation. Panels were checked once every day and replaced every week. Insects captured by the traps provided data on the distribution and survival of the released flies establish the ratio of sterile to fertile insects in all these habitat. The captured wild female flies were dissected to find out whether they were mated with a fertile or sterile male. Normally females mated by sterile males contained a developing larva whereas those mated by sterile males show a degenerating egg, developmental arrest of the larva, abortion or blockage. It was therefore not difficult to determine if a wild female was mated with a sterile or a wild male.

Blood sampling of animals at risk is another way of monitoring the extent of trypanosomosis transmission. A parasitological monitoring programme was established in 1994. The entire Island was divided into 38 blocks and in each one a sentinel herd of 30 - 40 animals was selected. Blood samples were taken every 2 – 5 months and examined for the presence of trypanosomes using the Micro Haematocrit Centrifuge Technique (MHCT). Animals, which were positive, received immediately a treatment with Berenil[R].

The Mafia Island study

Site description

The sketch map of Mafia Island is shown in Mafia Island has a land of 692 km^2 and is situated off to the Eastern Coast of Tanzana. Fromthe mainland the northern part is about 60 km and the southern part is roughly 20 km. Farmers are engaged on mixed crop and livestock systems and small-scale intensive dairy units with improved breeds (about 15,456 cattle, 1,902 goats and sheep). Most of the livestock keeping is on the northern part of the island.

Tsetse survey

TTRI Tanga in collaboration with the Mafia District Agricultural and Livestock Development Office conducted a preliminary tsetse survey on the Mafia Island in May 1998 intended to confirm the presence or absence of tsetse flies. The survey was necessary following the uncertainty of the presence of tsetse fly (Willet *et. al.*, 1964) on Mafia Island (Fig. II). During the survey efforts were made to sample the wholeIsland although more samples were taken in the northern part (particularly at the Ngome forest and Mkamba thicket) where livestock keeping dominates. Three types of traps (5 Vavouas, 2 Biconicals and 2 sticky panels) were used on each site and were set at a distance of 150 metres apart. Traps were odour baited with a 4ml sachet containing 3-n-propylphenol, 4- methly phenol and octenol at a ratio of 1:8:4. Traps were checked and emptied every day. All trapped flies were identified and sexed.

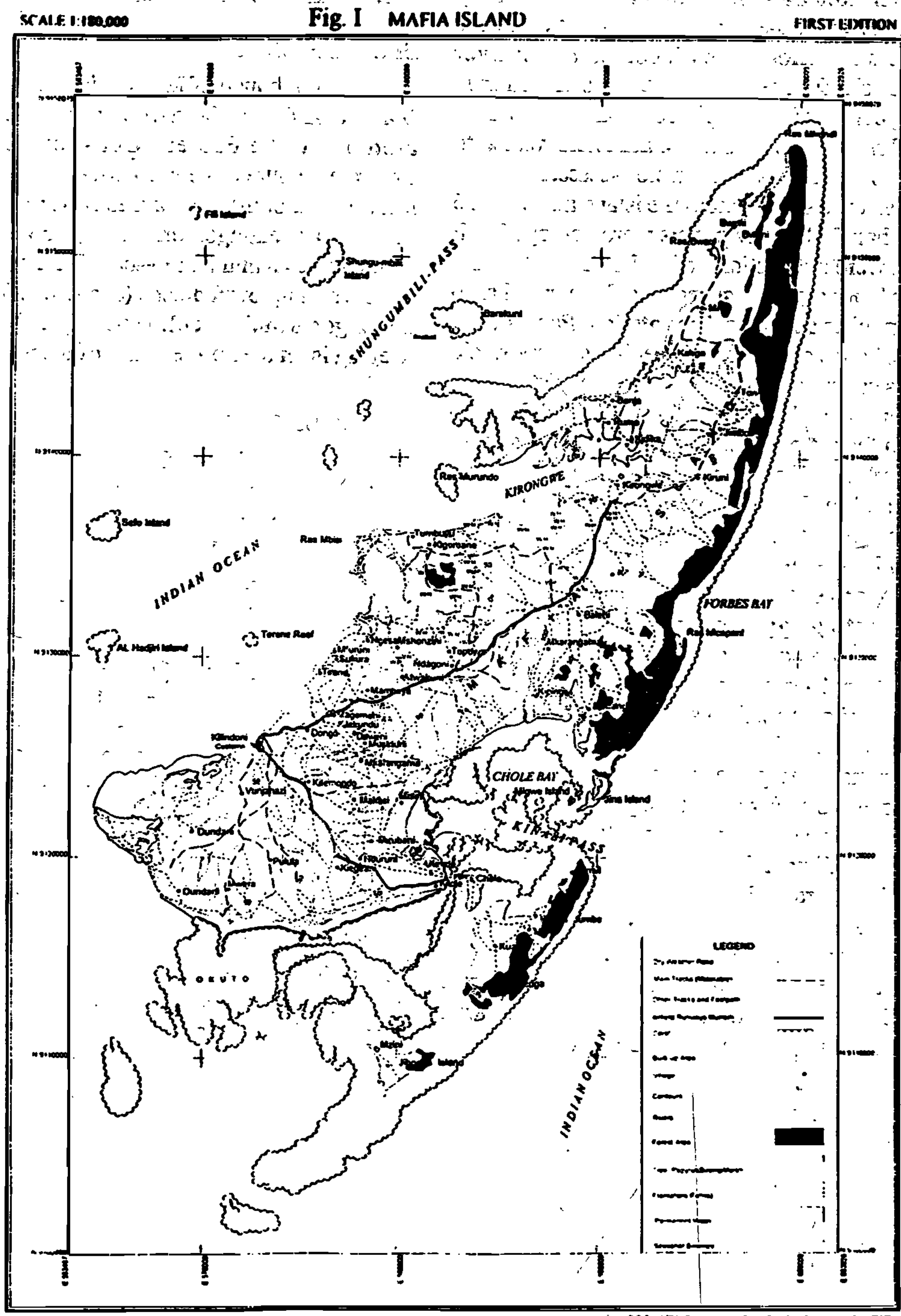

Figure 1: Mafia Island

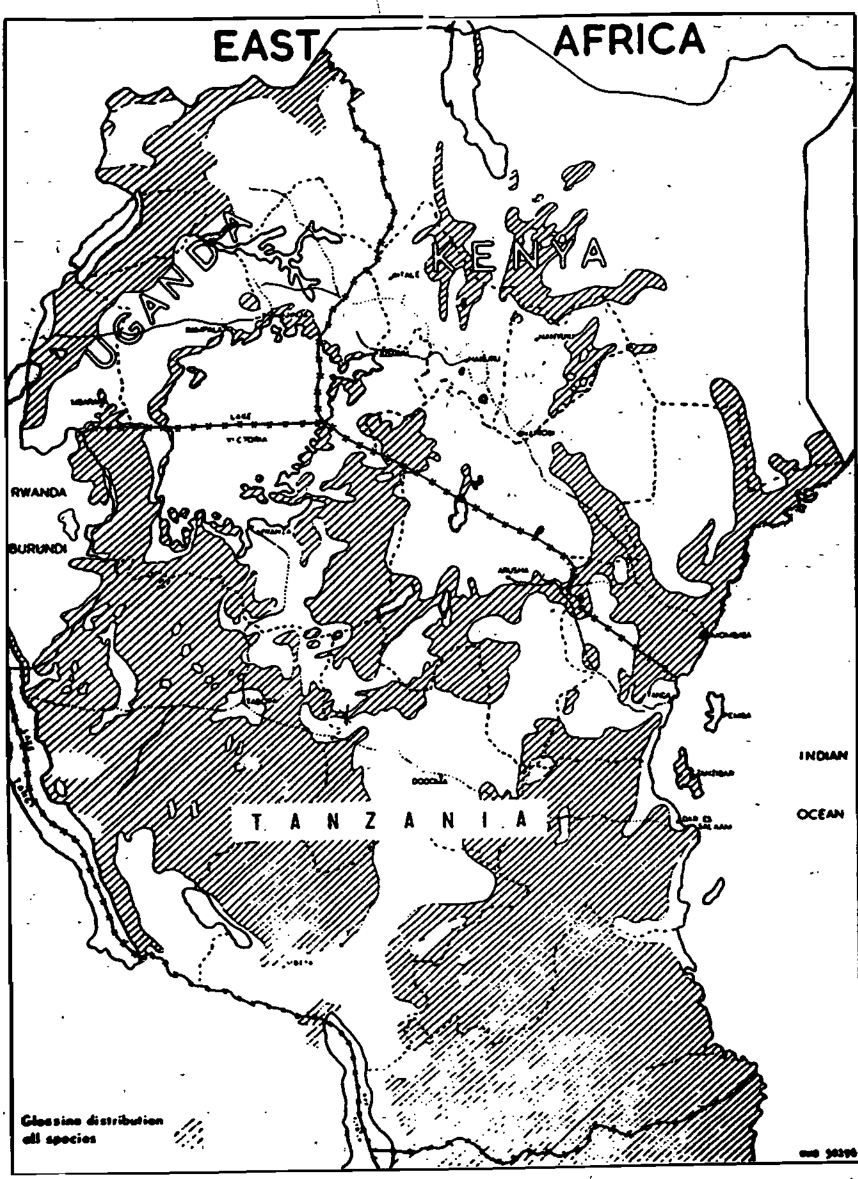

Figure 2: Distribution of Tsetse Flies in East Africa

Results

The case of Zanzibar Island

TTRI maintained a colony of up to 1,000,000 producing females. the largest colony ever in the world. This colony gave an average of 50,000 sterile males for release per week. The numbers of the sterile *Glossina*.males produced at TTRI Tanga and released over Unguja Island every week is shown in Fig. III. In the beginning, it shows that the releases were small around 10,000 males. Later the colony increased to more than 100,000 males per week due to improved rearing conditions.The apparent density of wild *G. austeni* on Unguja Island is shown in Fig. IV. Before suppression the apparent fly density was about 3.0 flies/panel/day. Suppression efforts in the Island reduced the wild fly density by over 95% giving an apparent density of 0.1.Ground releases caused a little further reduction. However aerial release managed to reduce fly population up to 0.01 flies/panel/day at the end of 1995. The population crushed in the beginning of 1996 with apparent density of less than 0.01flies/panel/day and the last wild fly was caught in September 1996. Aerial releases gave a much better distribution pattern of the flies and enhanced their quality and effectiveness in the field. Fig. V shows the disease incidence which was reduced to undetectable levels for *Trypanosoma congolense* and occasional infection (0.1%) of *Trypanosoma. vivax* at the end of the project in December 1997.

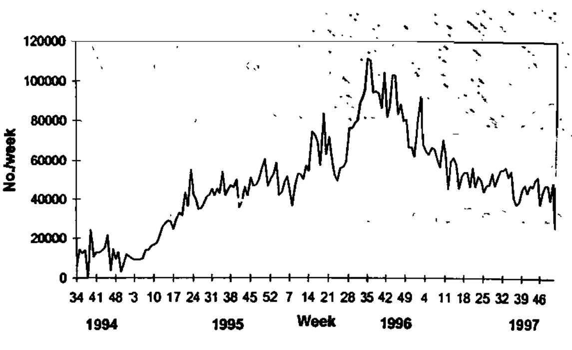

Figure 3: Weekly numbers of sterile *G.austeni* males relaesed over Unguja by air.

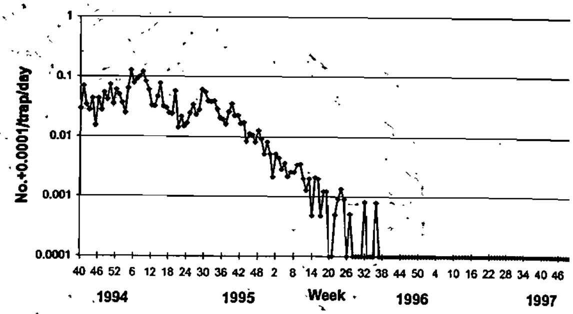

Figure 4: Apparent density of wild *G.austeni* on Unguja Island

The Mafia Island Study

Only *Glossina brevipalpis* was caught on Mafia Island. Very few flies were caught in all flies trap types as shown in Table 1. In the thicket area of Mkamba *G.brevepalpis* was caught in Biconical traps. In the Ngome forest areas female flies were caught in vavoua traps.

Table 1: Number of *G. brevipalpis* caught different traps and vegetion on Mafia Island for one week.

Trap type	Thicket		Forest		
	Male	Female	Male	Female	Total
Monoconical	0	0	0	1	1
Biconical	1	1	0	0	2
Stick Pane	0	0	0	0	0
Total	1	1	0	1	3

Discussion

The full eradication of Tsetse fly on Zanzibar was a combination of many factors. the technology itself. availability of funds. improvement of fly production facility. trained and dedicated staff. Fly production at TTRI was faced with poor insectary conditions at the early stages but later the facility was refurbished and colony performance improved. The rapid decline and eventual elimination of the wild tsetse population was a result of constant pressure of aerial release of high ratios of more than 50 sterile: 1 wild male fly. The decline of wild tsetse population also led to the decline in the disease incidence.

The Zanzibar success was the first of its kind and has attracted the attention of the World community. SIT is now being considered in number of affected countries as a new tool in integrated area wide eradication campaigns. The Ethiopian Government is planning to eradicate tsetse flies from 25,000 km^2 of potentially productive land in theSouthern Rift Valley where Tsetse and Trypanosomosis have had detrimental effects on farming (Assefa and Feldmann, 1998). Botswana like many other affected areas has been waging a war against tsetse flies for over 70 years and to date tsetse have not been eradicated although cases of Trypanosomosis had been reduced to insignificant levels. To maintain the status quo, Botswana requires a recurrent expenditure in excess of US$ 1.5 million per year (Allsopp and Philemon-Motsu.1998). The Botswana Government is planning to integrate SIT with other techniques to eradicate tsetse fly from an isolated area in Botswana (Allsopp & Philemon-Motsu, 1998).

The total cost of the Zanzibar tsetse eradication project was about US$ 6,000,000. This include the operational cost of the fly rearing, transportation and releasing components totalled US$ 3,000,000 for an area of 1,600km^2, i.e. US$ 1,875 per km^2. For very large and continuous programmes the costs may be reduced significantly to below US$ 800 per km^2. Eradication of tsetse fly from Zanzibar will eliminate the current need to import trypanocidal drugs and insecticides, as well as animal products including milk, which are estimated to cost at least US$ 2,000,000 per year.

The existence of tsetse flies on Mafia Island had for a very long time remained uncertain despite of reported information by Potts (1937) on the presence of *G. brevipalpis* and the reported cases of livestock trypanosomosis. It is possible that the behaviour of this fly, unlike the more common tsetse on Mainland Tanzania, may explain why the fly was difficult to be trapped. The fly was poorly attracted to the early sampling devices, not attracted to moving objects, inhabits thick vegetation. The fly is also large and is commonly mistaken as Tabanids (another large blood sucking insect) by the local communities. The preliminary survey confirmed presence of only one species (*G. brevipalpis*) on Mafia Island. The area infested is small (692 km^2) with no possibility of re-invasion from Mainland Tanzania and the capacity of using SIT is available at TTRI, Tanga. All these factors make the island of Mafia another ideal and easy area in Tanzania for SIT program to have a chance to succeed. Based on the Zanzibar experience, i.e. US$ 1,875 per km^2, Mafia project is estimated to cost US$ 1,312,500. The successful implementation of SIT will open Mafia Island and generate sustainable agricultural development.

Conclusion

The Zanzibar tsetse project enabled the Tsetse and Trypanosomiasis Research Institute (TTRI) of the Ministry of agriculture and Co-operatives in Tanga to have the World's largest tsetse breeding facility. The expertise and capacity established at TTRI for fly production and the use of SIT will enable the Institute to play a vital role in the eradication of tsetse fly, not only in Tanzania but also in other parts of Africa infested by this pest. The tsetse eradication project on Mafia Island is an example.The achievements in Zanzibar using SIT, the most environmental friendly technique, have far reaching socio-economic implications not only to the people of Zanzibar but also to the rest of Tanzania and the continent of Africa in areas where the SIT technology can be applied.

Acknowledgement

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