The Sterile Insect Technique for Control of Tsetse Flies in Africa

by Willem Takken and Michael Weiss

African trypanosomiasis and its major vector, the tsetse fly, have drawn world-wide attention due to the devasting effects they cause in large areas of tropical Africa. Trypanosomiasis is a parasitic disease which causes serious illness in domestic animals and man, eventually leading to death In cattle the disease is called nagana and in man, sleeping sickness.

Programmes are under way to free Africa of the disease either by developing new drugs and prophylactics or by massive control and eradication of the tsetse fly. The increasing concern that trypanosomiasis is preventing social and economic development in many countries has led to the Joint FAO/WHO Tsetse and Trypanosomiasis Control Programme. This was officially launched in November 1974. It is anticipated to put every effort into controlling or eradicating nagana and sleeping sickness in co-operation with 33 African countries. Scientists and organizations are called in for technical assistance whenever necessary.

The Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture also has a strong interest in tsetse fly control and conducts research on rearing and sterilization techniques of the tsetse fly at its Seibersdorf (Austria) laboratories. This research is conducted in support of an IAEA/Nigeria tsetse fly project and a similar, related project between Tanzania and the US Agency for International Development.

The tsetse fly, why it is such a plague

Tsetse flies are found only in Africa, where they occur in a belt south of the Sahara deserts. They feed solely on blood of humans, domestic animals and, of course, wild animals. In this way the tsetse flies acquire and transmit the trypanosomes that cause nagana and sleeping sickness. This is why they are such important insects; they spread disease

The map shows the present distribution of the flies, covering an area of 13 million km^2. Of this, 7 million km^2 are suitable grazing land for cattle, about half the potential grazing area of Africa. At present, cattle cannot be raised in this area without heavy economic losses due to nagana. Also, many people are at a constant risk of being infected by the disease carried by the tsetse fly Several drugs can be used for treatment, but they have to be administered at an early stage of the infection. As there is as yet no trypanosomiasis vaccine available, the only way to solve the problem is intensive medical and veterinarian care and extensive control or eradication of the vector, the tsetse fly.

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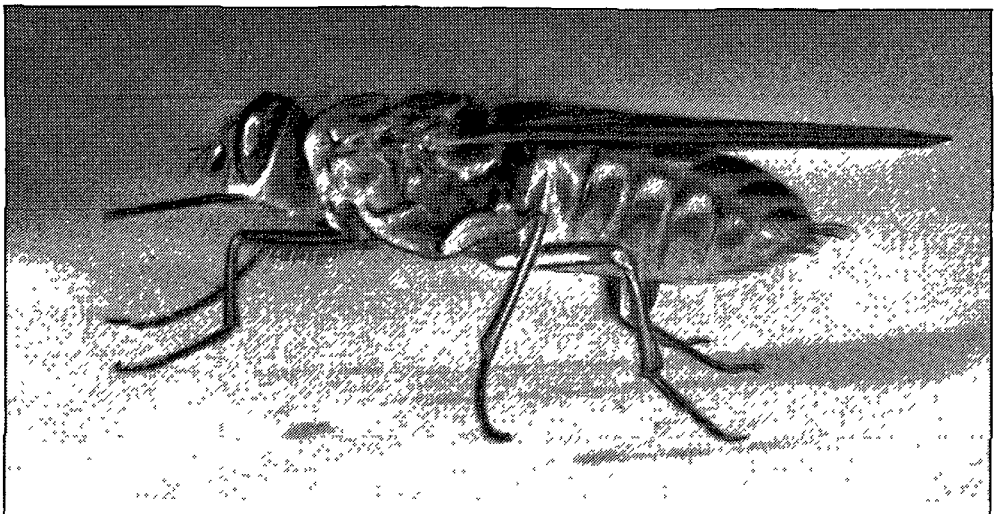


Female tsetse fly of the species **Glossina palpalis palpalis** R.D

Distribution of tsetse flies on the African continent.
Shaded areas indicate the tsetse fly infested areas.

What has been done?

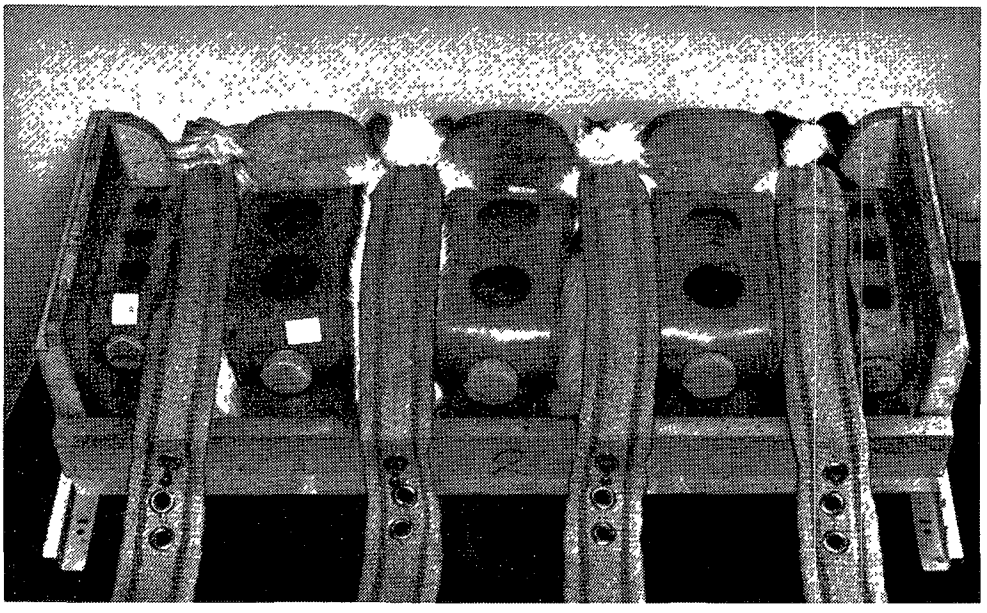
There is a long history of tsetse control and eradication programmes. Initially, flies were eradicated by shooting the wild animals and bush-clearing. In the first case, natural host animals were eliminated, thus depriving the flies of their primary food sources. In the second case, barrier-zones were made by clearing bushes and trees, thus preventing migration of flies from one area to another. Both methods have largely been dropped because of their adverse environmental impact.

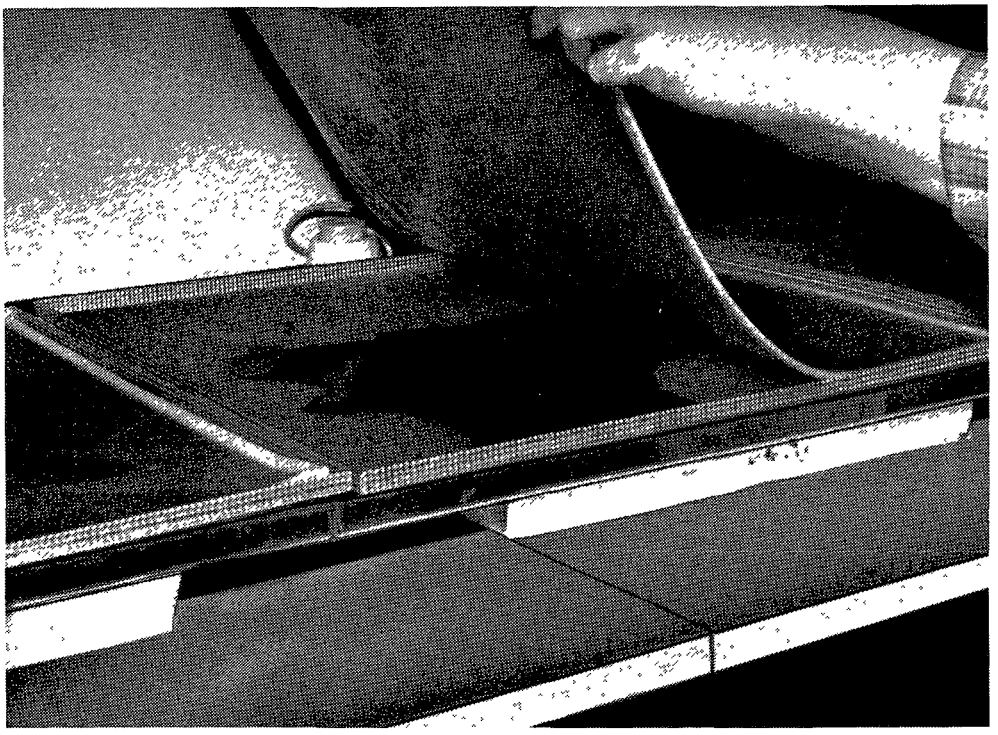
In the past 25 years, enormous improvements in tsetse control were achieved by the application of insecticides. At present, experts can deposit proper amounts of insecticides exactly at the preferred resting sites of the flies, usually in shaded areas. However, in many cases insecticide application is not possible without environmental pollution (e.g killing of non-target organisms). There is also a risk that the flies may develop resistance to the insecticides. On the other hand, tsetse fly control by the release of sterile insects is species specific and does not have any of the disadvantages mentioned.

How does the SIT work?

The principle of the Sterile Insect Technique (SIT) is that fertile insects are unable to produce normal offspring when they have mated with a sexually sterile partner. Insects can be sterilized by treating them with mutagenic agents (e.g. gamma rays, chemosterilants) Such individuals, partially or totally sterile, are released into a native insect population. The greater the ratio of sterile to native insects, the greater the chance of a rapid population suppression. In spite of their genetic aberration, sterile flies usually display the same behaviour as their wild counterparts This, of course, is a primary requirement for the success of the SIT.

A method for rearing tsetse flies was successfully developed using guinea pigs as the host animals.





Artificial membrane made of silicon, which simulates skin, is placed over a pool of blood. The membrane was developed at the Agency's Seibersdorf Laboratory to permit the feeding of tsetse flies in the absence of live host animals

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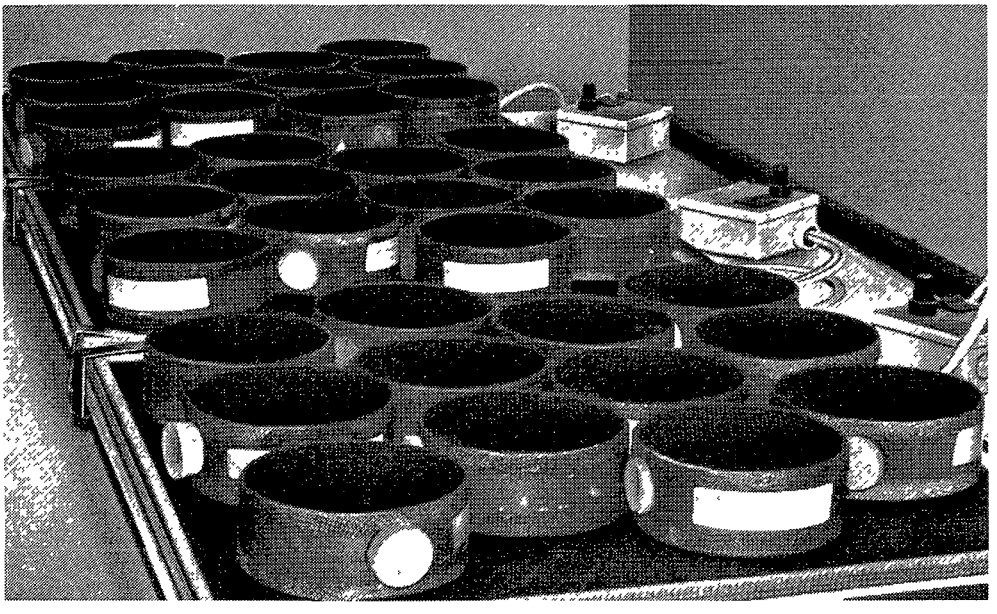
Tsetse flies, in small cages, are placed on silicon membranes The flies pierce the membrane and suck up the underlying blood, which is kept warm by electric heating



A detailed knowledge of the habits of the target insect in nature is necessary so as to know where and at what time to release the sterile insects. The technique can be used to reduce insect populations to very low levels and in some cases even eliminate the pest from isolated areas. In this way, target insects can be controlled or even eliminated in a highly selective ways without disturbing other organisms in the environment.

Present activities

At various places in Africa, tsetse control and eradication programmes are under way. In most cases, this is done by application of insecticides, but already two SIT programmes are in an executionary phase as field research projects. A third project, in Nigeria, will be carried out by the Joint FAO/IAEA Division in close co-operation with the Nigerian Government. The Seibersdorf Entomology Laboratory is studying several aspects of tsetse fly biology which will serve as background information for these field programmes.

Research is being conducted on mass-rearing techniques for two species of tsetse flies, *Glossina morsitans morsitans* and *Glossina palpalis palpalis.* A system has been developed to rear the flies successfully on guinea pigs. To become independent of living host animals (tsetse flies need a bloodmeal almost every day), research has led to the development of a system negating the requirement of live hosts. For this purpose, an artificial membrane, which simulates skin, was developed at Seibersdorf. Flies pierce these membranes and suck up blood from an underlying blood-pool. At present, studies are continuing to find an artificial medium which can replace blood.

A second research subject at Seibersdorf is the sterilization of the flies by gamma rays. Male tsetse flies can be sterilized with a cobalt-60 source with 12–17 krad. Investigations are conducted to determine if the sterilized males are still able to do their "job", viz. the insemination of females with sterile sperm. As sterilized flies should not differ too much from wild flies, laboratory-reared and irradiated flies are checked for their quality and behaviour as compared to their wild counterparts.

At the Seibersdorf laboratory, there are training facilities for scientists from developing countries. It is hoped that they will take part in tsetse control campaigns in Africa. In addition, the Agency has contracts or agreements for tsetse fly research with institutes in Ghana, Kenya, Belgium, France, F.R. Germany, UK, the Netherlands, Canada and the USA. This world-wide engagement distinctly reflects the importance of the tsetse-trypanosomiasis problem and the Sterile Insect Technique provides a useful tool in the arsenal of tsetse fly control methods.