A field guide for
THE DIAGNOSIS, TREATMENT
AND PREVENTION OF AFRICAN
ANIMAL TRYPANOSOMOSIS

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(adapted from the original edition by W.P. Boyt)

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Preface

This new edition of the well-known field guide on African animal trypanosomosis adheres as much as possible to the original style and, particularly, to the intention of the author of the first edition in that it is essentially meant to be a guide for field control personnel. Its scope has been extended somewhat beyond that of the African continent, as trypanosomes of African origin have spread to the Americas as well as to Asia, and even to Europe, but the main emphasis remains on Africa. More attention is also given to methods of control of the disease other than those using chemotherapy and chemoprophylaxis, as it is being realized that drugs alone are not a sustainable answer, and have to be integrated into a multidisciplinary and flexible approach to control of the disease. For instance, the first edition did not touch upon the important subject of control of trypanosomosis through vector control.

Molecular methods have considerably changed virtually all aspects of our knowledge of African trypanosomosis, particularly in the fields of taxonomy, immunology and diagnosis. Nevertheless, this progress has not (yet) had much impact on the situation in the field, as will be evident from this second edition.

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Livestock are of enormous importance in Africa, economically, for nutritional and agricultural purposes, and socially. The problem of African animal trypanosomosis (AAT), also called “nagana”, was recognized by African stockmen long before the cause of the disease was known, and many pastoralists associated the disease with the presence of tsetse flies. By experience and folk memory, methods of husbandry were evolved whereby domestic livestock could be maintained in strictly defined areas. By a process of trial and error it became known that certain zones were safe from the ravages of the disease, some were death traps and others were seasonally affected and fluctuated between good and bad years.

The impact of the tsetse-associated disease extends in sub-Saharan Africa over some 10 million km$^2$ (a third of the continent). Of these 10 million km$^2$ some 3 million are covered by equatorial rain forest; the remaining area contains some very good grazing areas, which perhaps fortunately have been protected so far by the tsetse fly against (over)grazing. The disease threatens enormous numbers of cattle and other livestock, while some trypanosomes affect humans also directly in most of this area by causing sleeping sickness. Over this vast area the process of development as seen elsewhere has been greatly hindered. Throughout the rest of the world progress has been attended by the increasing use of harnessed power, and the use of draught animals. For centuries trained oxen provided traction for cart and plough, while cattle also provided meat, milk and manure. Their absence over a great part of the African continent meant a constraint to the progress of development of huge proportions. The appearance of the internal combustion engine brought a change, but its use remains very limited in the small-scale farming practised in most African countries, and needs large amounts of scarce foreign exchange.

The successful treatment of human sleeping sickness, during the second decade of the twentieth century, was noticed by veterinary authorities, who attempted to adapt these methods to the control of animal trypanosomosis. The idea of preventing a constantly present disease by the use of drugs had been a reality in human medicine since quinine was first used in the control of malaria, and it was realized that the development of compounds with appreciable prophylactic effects against cattle trypanosomosis would be highly desirable. Sodium antimony tartrate was the only relatively successful remedy for African cattle trypanosomosis between the two world wars. It was however difficult to use, the tissue irritation attendant upon its injection required that it be administered intravenously and a complete cure could, at best, be assured only by repeated treatments.

During the late 1940s and early 1950s other drugs began to appear, which were immediately efficient in curing the disease and, additionally, produced appreciable periods of freedom from the disease after only one injection. Great optimism was expressed, the use of these compounds was extended and for the first time cattle could enter areas where previously this had not been possible.

It was not long however before the disease reappeared and drug-resistant strains of trypanosomes became a recognized problem. It has been said that “drug resistance attends chemotherapy like a faithful shadow” and so indeed it proved to be as further newly discovered compounds appeared, were hailed as being successful where others had failed, and in turn were overcome by the trypanosome. Pessimism then replaced recently expressed confidence. A period of concentrated logical research on drug resistance in the late 1950s and early 1960s reimposed a degree of order upon a scene of doubt and confusion and established the pattern
of resistance, cross-resistance between alternative drugs and the existence of the so-called "avid" compounds which (at first) appeared to remain effective in the face of resistance to others.

Even now, several decades later, the position remains to a large extent unchanged, the same problems appear, virtually no new treatments have become available and the same mistakes are being made in their use.

Very few drugs are available for the control of animal trypanosomosis. Why this small range of effective treatments? Is there any likelihood of new and better therapeutic compounds in the near future? Regretfully, the answers are not encouraging. In order to establish the reasons, the problem must be examined on a wide scale.

African animal trypanosomosis is indisputably an enormous problem on the African scene, but the perspective alters when it is examined against a global background, even when taking into account mechanically and venereally transmitted African trypanosomes which have spread to other continents (*Trypanosoma evansi*, causing surra, mechanically transmitted *T. vivax*, and *T. equiperdum*, the causal agent of the venereal disease dourine). Placed in a global context, animal trypanosomosis is of less economic importance. The cost of the development of new compounds has increased enormously in keeping with inflation and increasingly exacting and expensive requirements of the licencing authorities on the absence of chronic toxicity, carcinogenicity and residue problems. At the same time, the market for recovering the enormous investments needed to develop new compounds to the commercial stage is limited and mostly poor. Logically, the economic stimulus required by the private industry for attracting their investment in research on new drug development is sadly lacking.

In parallel to research on trypanocidal drugs and their application, various ways of controlling the vectors of AAT, the tsetse flies, have been and are being explored. Tsetse flies are the natural vectors of AAT; in the fly the trypanosomes undergo a biological cycle which results in their multiplication, and the removal of these biological vectors is generally followed by the disappearance of the disease.

The subject of tsetse control is addressed in detail in the FAO publication series “Training manuals for tsetse control personnel” (Vols 4 and 5), and we limit ourselves to a general review.

Tsetse control became widespread with the arrival of synthetic insecticides in the 1940s. Selective spraying of the vegetational support of the flies and later the application of insecticides by aircraft opened the way for large-scale tsetse eradication. However, although eradication of isolated tsetse populations was successful, this approach proved more difficult in areas not separated from the main tsetse belts. Complications arose with:

- The immensity of the tsetse-infested areas.
- Reinvasion of the treated areas from adjoining regions (tsetse flies do not recognize borders).
- The financial (and foreign exchange) cost. The requirement to maintain cleared areas permanently free from reinvasion makes the exercise very costly and has led to “donor fatigue”.
- Even the best plans for the use of land cleared from tsetse flies are not always implemented, which may lead to uncontrolled settlement and land degradation.
Environmental problems may also ensue from the side-effects of the insecticide itself, although the negative impact of a one-time application is limited and temporary.

Another approach towards tsetse eradication is the use of the so-called sterile male technique, or sterile insect technique (SIT). The principle of this method is based on sterilization of males, reared in the laboratory, through irradiation with gamma rays. Female tsetse flies, unlike males, only mate once during their life span, shortly after hatching, and thus will not produce any offspring after mating with a sterile male. Provided that sterile males are continuously released in numbers sufficient to compete with wild males, the population of tsetse will gradually decrease until it becomes extinct. Studies on this approach started in the 1960s. The method is attractive, as in itself it is not polluting, and very selective. The sterile males will actively search for females belonging to the same species, also in sites where insecticide application is impossible, and this makes the method extremely alluring indeed. However, there are serious complications:

- Rearing tsetse flies is costly and labour-intensive and it is difficult to rear them in sufficient numbers for integrating SIT in large-scale eradication campaigns.
- Each species to be eradicated has to be reared separately.
- As the impact of SIT used by itself is only gradually felt, it is usually preceded by application of insecticides, to bring down the population to a low level and decrease the duration of the release of sterile males. The use of insecticides takes away the advantage of being selective and non-polluting. More recently, targets (see below) are also used prior to SIT.
- Further drawbacks are the same as with any tsetse eradication campaign (size of infested regions, reinvasion, donor fatigue, uncontrolled settlement).

A successful project using this technique, supported by the Joint FAO/IAEA Division for Animal Health and Production, has recently been completed against the isolated tsetse population of Unguja island (Zanzibar, United Republic of Tanzania), where some 1 600 km$^2$ were cleared of tsetse flies (G. austeni). The project was carried out from 1994 to 1997. Although an earlier successful eradication scheme in Burkina Faso, using traps followed by the release of large numbers of sterile males, succeeded in clearing over 3 000 km$^2$ of two species of riverine tsetse (G. tachinoides and G. palpalis) and one savannah species (G. morsitans), reinvasion occurred.

With the advent of artificial bait devices such as traps and insecticide impregnated screens, as well as the application of small quantities of persistent powerful (mostly synthetic pyrethroid) insecticides on the animals (which is far less polluting than their application on the vegetation), continued tsetse suppression has come within reach of local communities. However, such measures have to be sustainable and the village population has to remain motivated and understand that this type of control will go on and on. Eventually, the farming landscape may become unfriendly to tsetse survival (depending on the species) but this may take many years.

The present tendency is indeed towards control of tsetse flies, that is to say a continuous effort to keep the size of the populations down to a level where the trypanosomosis problem is tolerable, instead of large-scale eradication schemes. Control has to be sustainable. This word is very much in fashion these days and needs perhaps an explanation. Sustainable control measures are those that are durable, that can be sustained over time. Sustainability may apply to financial aspects, for example, are funds for continuing the measures over the foreseeable future assured? (Think of donor fatigue, of foreign exchange and budget problems of national governments, of the cost-effectiveness of the measures.) Measures such as repeated large-
scale insecticide application to the environment are not ecologically sustainable. The term sustainability can also apply to control measures against trypanosomosis itself. For instance, once resistance to a particular trypanocidal drug becomes generalized, then the use of this drug is no longer sustainable. If the cost of preventing the disease by the use of a drug exceeds the financial benefit that the owner derives from it, or if the foreign exchange situation of the country is such that continuous importation of the drug cannot be secured, then such drug use is no longer sustainable.

The control of the vectors of trypanosomes which are not transmitted by tsetse flies is even more difficult than that of tsetse flies. As we shall see, strains of two species of African trypanosomes have succeeded in adapting themselves to so-called mechanical transmission by various biting flies; there is no biological cycle in these flies, no multiplication, and the fly just acts as a needle: a fly feeding on an infected animal transfers a small quantity of infected blood to a second animal and directly infects it if the interval between feedings is sufficiently short for the trypanosomes to survive. This happens particularly when the first (infected) animal disrupts feeding of the fly by swishing its tail or some other movement, and it then continues feeding on the second host. The most important of these mechanical vectors are the tabanids (horse flies, etc.) and stable flies and related insects (the stomoxys group). Eradication of these flies, which are often occur in large numbers, is for the foreseeable future out of the question; control methods are generally not very effective. Trypanosomes of African origin which have dissociated themselves from tsetse flies will be discussed in a separate chapter in this publication.

What of the possibility of successful vaccination? The study of immunity has made enormous advances in recent years but, in the case of the protozoa in general, some of which "inhabit the very arsenals of the immune response", and trypanosomes in particular, many problems remains unsolved. This is in spite of many years of intensive research in various universities and research institutes throughout the world, including Africa. The main obstacles preventing vaccine development are the almost unlimited antigenic variation during infection by one single strain of trypanosome and the antigenic strain diversity within each of the several trypanosome species and types. Some scientists continue attempts at vaccine development using internal non-variable antigens (but a difficulty is that such antigens are out of reach of host antibodies as long as the trypanosome is alive and intact) or at immunizing against proteins causing pathogenic effects, instead of against the parasite itself. So far there is no breakthrough.

In some parts of Africa, rearing of ancient local breeds of trypanotolerant livestock offers another solution to the problem. Trypanotolerance in taurine (humpless) cattle is particularly well known and widespread in subhumid and humid West Africa, but the phenomenon had received little scientific attention, until studies on its nature began in the 1970s in the Centre de recherches sur la trypanosomose animale = Centre for Research on Animal Trypanosomosis (CRTA), now Centre international pour la recherche et le developpement de l'elevage en zone subhumide = International Centre for Livestock Research and Development in the Subhumid zone (CIRDES), in Burkina Faso, and later in the International Trypanotolerance Centre (ITC) in the Gambia and in the International Laboratory for Research on Animal Diseases (ILRAD), now absorbed into the International Livestock Research Institute (ILRI) in Kenya. West African breeds of sheep and goats also possess a fair degree of trypanotolerance, although this has as yet not been studied extensively. It is also known at present that there are differences in susceptibility to trypanosomosis between various East African breeds of cattle and small ruminants. One of the limitations to the use of West African trypanotolerant cattle breeds is their
small size; still, genetic studies might lead in the (probably rather distant) future to the transfer of the trypanotolerance trait to more productive breeds.

It appears that for the foreseeable future we will have to rely on the currently available means to protect and maintain livestock. These include, with all their shortcomings, tsetse control, chemoprophylaxis and chemotherapy, and the use of trypanotolerant livestock. Complete dependence on drugs in many situations has now become very risky in many areas because of drug resistance and foreign exchange problems.

The tendency towards placing less reliance on public services and more on private veterinarians has increased the self-reliance of livestock owners. Apart from large (commercial) farms, the owners' approach will mostly have to be a community-based effort, in particular if grazing is communal, and the problems are shared by all alike. Private veterinarians and extension services will have an increasingly important role as advisers of owners and owner associations on the methods and strategies to adopt. The field worker must have a sound knowledge of the diagnosis of the disease in domestic animals. This obviously includes clinical appearance and pathology. He/she also has to be able to formulate recommendations for applying remedial action, promptly and efficiently.

In countries with few monetary and foreign exchange resources, community-managed traps and screens for killing tsetse flies, insecticide application on the animals, and the use of trypanotolerant livestock, are to be favoured. Control should be flexible and integrate all available methods which are suitable in a particular situation.

It is appreciated that “Africa is not one place but many places” and it is not possible to cater in one small volume for every local variation or contingency which may arise over some 10 million km² and among 37 countries involved. Conditions in Latin America and Asia are very different again. Although local detail therefore is not provided, an attempt has nevertheless been made to provide in a concise manner the basic working knowledge which, hopefully, will provide the reader with the main principles behind efficient trypanosomosis control.

This field guide is aimed primarily at field operators, including personnel of extension services and private veterinarians. Although many are certainly familiar with routine veterinary terminology, throughout the text attempts have been made to avoid highly specialized scientific terms. Where such scientific terms are used, they are usually accompanied with an explanation in brackets. Some practical hints have been incorporated. It is hoped that this book may prove useful also to (as yet) inexperienced professional trypanosomosis control officers and to laboratory scientists who often have little contact with field realities.

For those readers who desire additional knowledge, a short list of further reading is presented in an appendix.

Finally, all suggestions for improvement of the field guide are welcome.

1 Formerly the disease was called trypanosomiasis, but international agreement has now been reached over the name trypanosomosis.

2 There is indirect pollution in that the irradiating source creates nuclear waste after its useful life span has ended and it has to be replaced.